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# TUGAS AKHIR
# REDESAIN STRUKTUR GEDUNG ADMINISTRASI UNIVERSITAS SANATA DHARMA YOGYAKARTA

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FAKULTAS TEKNIK SIPIL DAN
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JURUSAN TEKNIK SIPIL
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA
2003

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# KATA PENGANTAR

*Bismillaahirrahmaanirrahiim*

*Assalamu'alaikum Wr. Wb.*

Dengan memanjatkan puji syukur kehadirat Allah SWT serta sholawat dan salam dilimpahkan kepada nabi besar Muhammad SAW, yang telah melimpahkan rakhmat dan hidayah-Nya, sehingga laporan Tugas Akhir ini dapat diselesaikan. Laporan Tugas Akhir ini disusun guna memenuhi salah satu syarat yang harus ditempuh untuk menyelesaikan studi jenjang Program Strata Satu (S1) di Jurusan Teknik Sipil, Fakultas Teknik Sipil dan Perencanaan, Universitas Islam Indonesia.

Pada penulisan Tugas Akhir ini penulis mengambil judul "Redesign Struktur Gedung Administrasi Universitas Sanata Dharma Yogyakarta" dan maksud dari Tugas Akhir ini dibuat untuk mendapatkan alternatif lain design yang efektif dan efisien dengan tingkat keamanan sesuai dengan yang telah disyaratkan.

Selama penulisan Tugas Akhir ini, penulis banyak mendapatkan bantuan, bimbingan, fasilitas dan penjelasan dari berbagai pihak. Oleh karena itu pada kesempatan ini perkenankanlah penulis menyampaikan terima kasih yang sebesar-besarnya kepada :

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Penulis

## *Motto*

*"Allah akan meninggikan orang-orang yang beriman diantaramu dan orang-orang yang diberi ilmu pengetahuan beberapa derajat."(Qs. Al Mujaadilah : 11)*

*"Barangsiapa mengamalkan apa-apa yang ia ketahui, maka Allah akan mewariskan kepadanya ilmu yang belum diketahuinya, dan Allah akan menolong dia dalam amalannya sehingga ia mendapatkan surga. Dan barangsiapa yang tidak mengamalkan ilmunya, maka ia akan tersesat oleh ilmunya itu, dan Allah tidak menolong dia dalam amalannya, sehingga ia akan mendapatkan neraka."(Hadits Rasulullah SAW)*

*"Iman tanpa ilmu, sama dengan pelita di tangan bayi; sedangkan ilmu tanpa iman, bagaikan pelita di tangan pencuri."*

*"Orang-orang yang*
*Saat ini merasa gagal yang*
*Mampu menatap kegagalannya dengan*
*Kepala tegaklah yang*
*Akan siap menjadi dewasa dan*
*Sukses secara utuh.."*

*"Allah tidak akan merubah nasib suatu kaum, kecuali kaum itu merubah nasibnya"*
*(Al Quranul Karim)*

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# BAB I

# PENDAHULUAN

## 1.1 Latar Belakang

Pembangunan Nasional yang dilaksanakan di Indonesia bertujuan mewujudkan masyarakat yang adil dan makmur. Salah satu syarat yang penting untuk mencapai tujuan tersebut ialah penguasaan ilmu dan teknologi serta profesionalisme pada bidang yang ditekuni. Penguasaan ilmu dan teknologi merupakan elemen penting yang tidak bisa ditawar-tawar lagi dalam menghadapi kompetisi di masa mendatang. Sumber daya manusia yang profesional juga menjadi penentu dan pengarah kemana bangsa ini akan dituntun.

Seiring pesatnya pembangunan konstruksi di Indonesia menuntut para lulusan sarjana agar mampu mengaplikasikan ilmunya secara maksimal di lapangan bukan hanya memiliki kemampuan secara teoritis saja.

Untuk mengantisipasi permasalahan ini penulis mengambil tugas akhir tentang perencanaan Gedung Administrasi Universitas Sanata Dharma Yogyakarta sebagai penerapan ilmu yang didapat dibangku kuliah untuk merencanakan suatu bangunan sebagai bekal untuk mempersiapkan diri dalam dunia kerja yang akan dijalani secara profesional.

## 1.2 Maksud dan Tujuan

Perencanaan ulang ini dimaksudkan untuk merencanakan Gedung Administrasi Universitas Sanata Dharma Yogyakarta, guna menerapkan ilmu yang didapat

dibangku kuliah pada kondisi di lapangan, sehingga diperoleh gambaran dan pengetahuan tentang kegiatan perencanaan yang sebenarnya.

Adapun tujuan dari perencanaan ulang ini adalah memperoleh hasil perencanaan akhir dari data-data arsitektural dan lapangan, yang meliputi :

1. Perencanaan atap,
2. Perencanaan pelat lantai,
3. Perencanaan balok dan kolom,
4. Perencanaan pondasi,
5. Perencanaan tangga.

**1.3 Batasan Masalah**

Batasan masalah yang digunakan di dalam perencanaan Gedung Administrasi Universitas Sanata Dharma Yogyakarta ini adalah :

1. Masalah dibatasi pada perencanaan Gedung Administrasi Universitas Sanata Dharma Yogyakarta yang berlokasi di Paingan, Maguwoharjo, Depok, Sleman, Yogyakarta.
2. Perencanaan struktur beton berdasarkan SK-SNI-T-15-1991-03.
3. Perencanaan struktur baja menggunakan metode AISC-ASD.
4. Pembebanan mengacu kepada Peraturan Pembebanan Untuk Gedung 1983.
5. Analisa mekanika menggunakan SAP 2000.
6. Perencanaan struktur menggunakan tingkat daktilitas penuh.
7. Mutu beton yang digunakan fc' = 25 Mpa.
8. Mutu baja tulangan polos fy = 240 Mpa dan tulangan ulir fy = 400 Mpa.

9. Data tanah menggunakan data tanah setempat dengan $\sigma_{ijin\ tanah} =$ 250 Kn/m$^2$ berdasarkan data sondir pada kedalaman 3 m dari muka tanah asli.
10. Peraturan gempa mengacu kepada Pedoman Perencanaan Ketahanan Gempa Untuk Rumah dan Gedung 1987.

**1.4 Manfaat**

Manfaat yang diperoleh dari penulisan ini adalah memberikan tahapan ilmu dan wawasan baru bagi mahasiswa dalam bidang perencanaan khususnya dalam menganalisis perencanaan pada suatu proyek konstruksi bangunan gedung bertingkat.

# BAB II

# TINJAUAN PUSTAKA

## 2.1 Pendahuluan

Disain struktur merupakan salah satu bagian dari proses perencanaan bangunan. Proses disain tersebut merupakan gabungan antar unsur seni dan sains yang membutuhkan keahlian untuk mengolahnya. Proses ini dibagi menjadi dua bagian. Pertama, disain umum yang merupakan peninjauan umum secara garis-garis besar keputusan disain. Tipe struktur dipilih dari berbagai alternatif yang mungkin. Tata letak struktur, geometri atau bentuk bangunan, jarak antar kolom, tinggi lantai dan material bangunan telah ditetapkan dengan pasti dalam tahap ini. Kedua, disain terinci yang antara lain meninjau tentang penentuan besar penampang lintang balok, kolom, tebal pelat, dan elemen struktur lainnya. (L. Wahyudi dan Syahril,1997).

## 2.2 Struktur Atas

Yang dimaksud dengan struktur atas (*upper struktur*) adalah elemen bangunan yang berada di atas permukaan tanah. Dalam hal ini terdiri atas :

### 2.2.1 Pelat

Pelat merupakan panel-panel beton bertulang yang mungkin tulangannya dua arah atau satu arah saja, tergantung sistem strukturnya. Kontinuitas tulangan pelat diteruskan ke dalam balok-balok dan diteruskan ke dalam kolom. Dengan demikian sistem pelat secara keseluruhan menjadi satu kesatuan membentuk rangka struktur

bangunan kaku statis tak tentu yang sangat kompleks, sehingga mengakibatkan timbulnya momen, gaya geser, dan lendutan (Istimawan, 1994).

#### 2.2.1.1 Pelat Satu Arah

Pelat satu arah adalah pelat yang didukung pada dua tepi yang berhadapan saja, sehingga lendutan yang timbul hanya satu arah saja yaitu pada arah tegak lurus terhadap dukungan tepi. Atau dengan kata lain pelat satu arah adalah pelat yang mempunyai perbandingan antara sisi panjang terhadap sisi pendek yang saling tegak lurus lebih besar dari dua, dengan lendutan utama pada sisi yang lebih pendek (Istimawan, 1994).

#### 2.2.1.2 Pelat Dua Arah

Pelat dua arah adalah pelat yang didukung sepanjang keempat sisinya dengan lendutan yang akan timbul pada dua arah yang saling tegak lurus, atau perbandingan antara sisi panjang dan sisi pendek yang saling tegak lurus kurang dari dua (Istimawan, 1994).

### 2.2.2 Kolom

Kolom adalah batang tekan vertikal dari rangka struktur yang memikul beban dari balok. Kolom meneruskan beban dari elevasi atas ke elevasi yang lebih bawah hingga akhirnya sampai ke tanah melalui pondasi (Istimawan, 1994).

Kolom merupakan elemen vertikal yang memikul sistem lantai struktural. Elemen ini merupakan elemen yang mengalami tekan dan pada umumnya disertai dengan momen lentur (Edward G. Nawy, 1985).

### 2.2.3 Balok

Balok adalah batang struktural yang hanya menerima beban-beban tegak saja dan dapat dianalisa dengan lengkap apabila diagram geser dan diagram momennya telah didapatkan (Istimawan, 1994).

Balok merupakan bagian struktural yang penting yaitu bertujuan untuk memikul beban transversal yang dapat berupa beban lentur, geser maupun torsi. Oleh karena itu perencanaan balok yang efisien, ekonomis, cepat dan aman sangat penting (Sudarmoko, 1996).

### 2.2.4 Portal

Portal merupakan suatu rangka struktur pada bangunan yang harus mampu menahan beban yang bekerja, baik beban mati, beban hidup maupun beban sementara.

#### 2.2.4.1 Portal Tidak Bergoyang (*braced frame*)

Portal tak bergoyang didefinisikan sebagai portal dimana tekuk goyangan dicegah oleh elemen-elemen topangan struktur tersebut dan bukan oleh portal itu sendiri (Salmon & Johnson, 1996).

Portal tidak bergoyang mempunyai sifat :

1. Portal tersebut simetris dan bekerja beban simetris.
2. Beban yang mempunyai ikatan dengan kostruksi lain yang tidak dapat bergoyang.

#### 2.2.4.2 Portal Bergoyang

Suatu portal dikatakan bergoyang jika :

1. Beban yang tidak simetris yang bekerja pada portal yang simetris atau tidak simetris.
2. Beban simetris yang bekerja pada portal tidak simetris.

## 2.3 Struktur Bawah

Yang dimaksud dengan struktur bawah (sub struktur) adalah pondasi yaitu bagian bangunan yang dibawah permukaan. Pondasi merupakan bagian dari suatu sistem rekayasa yang meneruskan beban yang ditopang oleh pondasi dan beratnya sendiri kepada ke dalam tanah dan batuan yang terletak di bawahnya (Bowles, 1991).

Pondasi umumnya berlaku sebagai komponen pendukung bangunan yang terbawah dan telapak pondasi berfungsi sebagai elemen terakhir yang meneruskan beban ke tanah, sehingga telapak pondasi harus memenuhi persyaratan untuk mampu dengan aman menyebar beban-beban yang diteruskannya sedemikian rupa sehingga kapasitas atau daya dukung tidak terlampaui (Istimawan, 1994).

# BAB III

# PERENCANAAN

## 3.1 Perencanaan Konstruksi

### 3.1.1 Dasar-dasar perencanaan

Dasar-dasar perencanaan gedung Administrasi Universitas Sanata Dharma Yogyakarta ini adalah :

1. Tata cara perhitungan Struktur Beton untuk Bangunan gedung (SK-SNI-T-15-1991-03).
2. Peraturan Pembebanan untuk Gedung 1987.
3. Peraturan Beton Bertulang Indonesia (PBBI-1971).
4. Peraturan Perencanaan Tahan Gempa untuk Rumah dan Gedung, 1987.
5. Hasil penyelidikan tanah di lapangan.
6. Metode perencanaan baja AISC-ASD.
7. Peraturan lain yang berkaitan dengan perencanaan bangunan untuk gedung yang berlaku di Indonesia.

### 3.1.2 Perencanaan pembebanan

Agar struktur dan komponen struktur memenuhi syarat kekakuan dan layak pakai terhadap bermacam-macam kombinasi beban, maka harus dipenuhi ketentuan dari faktor beban. Menurut SK-SNI-T-15-1991-03 pasal 3.2 ayat 3.2.2 faktor beban ditentukan sebagai berikut :

U = 1,2 D + 1,6 L dengan D = beban mati dan L = beban hidup dan bila terdapat perhitungan gempa maka faktor beban sebagai berikut :

U = 0,9 D ± E

U = 1,05(D + $L_R$ ± E) dengan E = beban gempa dan $L_R$ = beban hidup yang telah direduksi sesuai dengan ketentuan SNI 1726-1989-F tentang Tata Cara Perencanaan Ketahanan Gempa Untuk Rumah dan Gedung.

U = kuat perlu adalah kekuatan suatu komponen struktur atau penampang yang diperlukan untuk menahan beban terfaktor atau momen dan gaya dalam yang berkaitan dengan beban tersebut dalam suatu kombinasi.

Kepastian kekuatan bahan terhadap pembebanan dianggap sebagai faktor reduksi kekuatan ($\phi$). Menurut SK-SNI-T-15-1991-03 ayat 3.2.3 faktor reduksi kekuatan ditentukan sebagai berikut :

1. Lentur, tanpa beban aksial $\phi = 0,80$
2. Aksial tarik, dan aksial tarik dengan lentur $\phi = 0,80$
3. Aksial tekan, dan aksial tekan dengan lentur :
   - dengan tulangan sengkang spiral $\phi = 0,70$
   - dengan tulangan sengkang ikat $\phi = 0,65$
4. Geser dan torsi $\phi = 0,60$
5. Tumpuan pada beton $\phi = 0,70$

Faktor reduksi kekuatan di atas juga dipakai untuk mereduksi kekuatan beton dan baja berikut ini :

1. Untuk beton : fc'(kuat tekan beton yang disyaratkan),
2. Untuk baja : fy (tegangan leleh baja).

### 3.1.3 Data hitungan secara garis besar

Data keperluan perencanaan dan perhitungan gedung antara lain sebagai berikut:

1. Mutu beton fc' = 25 Mpa
2. Mutu baja tulangan polos fy = 240 Mpa dengan diameter tulangan 8-12 sedangkan tulangan ulir fy = 400 Mpa dengan diameter lebih besar dari 12
3. Gaya gempa termasuk wilayah 3
4. Perhitungan mekanika dalam perencanaan gedung ini menggunakan program komputer SAP 2000
5. Kedalaman tanah

## 3.2 Kriteria Perencanaan

### 3.2.1 Perencanaan gedung tahan gempa

Perencanaan dan pelaksanaan penulangan struktur bangunan gedung bertingkat harus tahan terhadap gempa. Perencanaan beban gempa menurut Pedoman Ketahanan Gempa untuk Rumah Tinggal Gedung adalah :

1. Gaya geser horisontal total akibat gempa.

   $V_X=V_Y=C \cdot I \cdot K \cdot W_t$

2. Distribusi gaya geser horisontal total akibat gempa ke sepanjang tinggi gedung :

   a. arah x

      H/A < 3

      $F_{ix}= \frac{W_i.h_i}{\sum W_i.h_i}.V_x$

b. arah y

H/B < 3

$$F_{iy} = \frac{W_i . h_i}{\sum W_i . h_i} . V_y$$

Bila H/A > 3, maka makin langsing bangunannya sehingga makin besar tegangan yang terjadi akibat beban guling gempa terutama pada kolom-kolom luar yang tertekan.

dimana :

$V_x = V_y$ = gaya geser dasar horisontal total akibat gempa untuk arah x dan y

C = koefisien gempa dasar berdasar letak wilayah gempa (untuk Yogyakarta adalah wilayah gempa 3)

I = faktor keutamaan

K = faktor jenis struktur (K = 1, untuk gedung dengan daktilitas penuh)

$W_i$ = berat total bangunan

$F_i$ = gaya geser horizontal akibat gempa pada lantai ke-i

H, $h_i$ = tinggi lantai ke-i terhadap lantai dasar

A, B = panjang sisi bangunan dalam arah x dan y

Langkah-langkah perencanaan struktur rangka beton bertulang dengan daktilitas penuh sebagai berikut :

1. Perencanaan balok portal terhadap beban lentur adalah sebagai berikut :

   $M_{U,b} = 1,2\ M_{D,b} + 1,6\ M_{L,b}$

   $M_{U,b} = 1,05(M_{D,b} + M_{L,bR} + M_{E,b})$

   $M_{U,b} = 0,9\ M_{D,b} + M_{E,b}$

Dalam perencanaan kapasitas balok portal, momen tumpuan negatif akibat kombinasi beban gravitasi dan beban gempa balok boleh diredistribusikan dengan menambah atau mengurangi dengan prosentase yang tidak melebihi:

$$q = 30\left(1 - \frac{3}{4}.\frac{\rho - \rho'}{\rho b}\right)\%$$

dengan syarat apabila tulangan lentur balok portal telah direncanakan sehingga ($\rho$-$\rho$') tidak melebihi 0,50 $\rho$b.

$M_{kap,b} = \phi_o . M_{nak,b}$

dimana :

$M_{U,b}$ = kuat lentur balok portal

$M_{D,b}$ = momen lentur balok akibat beban mati

$M_{L,b}$ = momen lentur balok akibat beban hidup

$M_{E,b}$ = momen lentur balok akibat beban gempa

$M_{kap,b}$ = kapasitas lentur balok pada pusat pertemuan balok kolom

$M_{nak,b}$ = kuat lentur nominal balok

$\phi_o$ = faktor penambahan kekuatan sebesar 1,25 untuk fy < 400 Mpa, dan 1,40 untuk fy > 400 Mpa

2. Perencanaan balok portal terhadap beban geser

$V_{U,b} = 0,7\frac{M_{kap} + M'_{kap}}{ln} + 1,05$ Vg tetapi tidak perlu lebih besar dari

$V_{U,b} = 1,05\left[V_{D,b} + V_{L,b} + 4V_{E,b}/K\right]$

dimana :

$M_{kap}$ = momen kapasitas balok berdasarkan tulangan yang sebenarnya terpasang pada salah satu ujung balok atau bidang muka kolom

$M'_{kap}$ = momen kapasitas balok berdasarkan tulangan yang sebenarnya terpasang pada ujung balok atau bidang muka kolom yang lain

n = bentang bersih balok

$V_{U,b}$ = kuat geser balok portal

$V_{D,b}$ = gaya geser balok akibat beban mati

$V_{L,b}$ = gaya geser balok akibat beban hidup

$V_{E,b}$ = gaya geser balok akibat beban gempa

3. Perencanaan kolom portal terhadap beban lentur dan aksial

$\sum M_{U,k} = 0,7\omega d \sum M_{kap,b}$

atau

$\sum M_{U,k} = 0,7\omega d\, \alpha k(M_{kap,ki} + M_{kap,ka})$

Tetapi dalam segala hal tak perlu lebih besar dari

$M_{U,k} = 1,05[M_{D,k} + M_{L,k} + 4M_{E,k}/K]$

Beban aksial rencana, $N_{U,k}$ yang bekerja pada kolom portal adalah sebagai berikut :

$$N_{U,k} = \frac{0,7Rv\sum M_{kap,b}}{l_b} + 1,05\, N_{g,k}$$

Tetapi dalam segala hal tidak perlu lebih besar dari

$N_{U,k} = 1,05[N_{g,k} + 4N_{E,k}/K]$

dengan :

Rv = faktor reduksi yang ditentukan sebesar :

-1,0 untuk $1<n\leq4$

-1,1-0,025n untuk $4<n\leq20$

- 0,6 untuk $n>20$

$\omega d$ = faktor pembesar dinamis yang ditentukan sebesar :

- $\omega d = 1,3$ , kecuali pada lantai 1 dan lantai paling atas

- $\omega d = 1$ , karena pada lantai tersebut diperbolehkan terjadinya sendi plastis pada kolom

$\alpha k$ = faktor distribusi momen kolom portal yang ditinjau sesuai dengan kekakuan relatif kolom atas dan kolom bawah

n = jumlah lantai di atas kolom yang ditinjau

$l_b$ = bentang balok dari pusat ke pusat kolom

$N_{g,k}$ = gaya aksial kolom akibat beban gravitasi

$N_{E,k}$ = gaya aksial kolom akibat beban gempa

4. Perencanaan kolom portal terhadap beban geser

Untuk kolom lantai atas : $V_{U,k} = [M_{U,k\ atas} + M_{U,k\ bawah}]/h'_k$

Untuk kolom lantai dasar : $V_{U,k} = [M_{U,k\ atas} + M_{U,k\ bawah}]/h'_k$

Dan dalam segala hal tidak perlu lebih besar dari :

$V_{U,k} = 1,05(M_{D,k} + M_{L,k} + 4V_{E,k}/K)$

dengan :

$h'_k$ = tinggi bersih kolom

5. Perencanaan panel pertemuan balok kolom

Panel pertemuan balok kolom portal harus diproporsikan untuk memenuhi persyaratan kuat geser horisontal perlu $V_{u,h}$ dan kuat geser vertikal perlu $V_{u,v}$.

$V_{jh} = C_{ki} + T_{ka} - V_{kol}$

$$C_{ki} = T_{ki} = 0{,}70 \frac{M_{kap.ki}}{Z_{ka}}$$

$$C_{ka} = T_{ka} = 0{,}70 \frac{M_{kap.ka}}{Z_{ka}}$$

$$V_{kol} = \frac{0{,}70\left( \frac{l_{ki}}{l_{ki'}} M_{kap.ki} + \frac{l_{ka}}{l_{ka'}} M_{kap.ka} \right)}{\frac{1}{2}\left(h_{k.a} + h_{k.b}\right)}$$

Tegangan geser horizontal nominal dalam joint adalah

$$V_{jh} = \frac{V_{jh}}{b_j . h_c} < 1{,}5 \sqrt{fc'}$$

dengan :

$b_j$ = lebar efektif joint (mm)

$h_c$ = tinggi total penampang kolom dalam arah geser yang ditinjau (mm)

Tegangan geser horizontal ditahan oleh dua mekanisme kuat geser inti joint, yaitu $V_{ch}$ dan $V_{sh}$. Besarnya $V_{ch}$ harus diambil sama dengan nol kecuali bila:

a. tegangan tekan rata-rata minimal pada penampang bruto kolom beton di atas joint, termasuk tegangan prategang, apabila ada, melebihi nilai 0,1 fc', maka :

$$V_{ch} = \frac{2}{3}\sqrt{\left(\frac{N_{u.k}}{A_g}\right)} - 0{,}1\,fc'.b_j.h_c$$

b. balok diberi gaya prategang yang melewati joint, maka :

$V_{ch} = 0{,}7\ P_{cr}$

c. seluruh balok pada joint dirancang sehingga penampang kritis dari sendi plastis terletak pada jarak yang lebih kecil dari tinggi penampang balok diukur dari muka kolom maka :

$$V_{ch} = 0{,}5\frac{As'}{As}V_{jh}\left(1 + \frac{N_{u.k}}{0{,}4\,Ag.\,fc'}\right) \text{ dimana } \frac{As'}{As} < 1$$

Besarnya $V_{sh}$ bila $\rho c < 0{,}1$ fc' adalah :

$$V_{sh} = V_{jh} - \frac{2}{3}\sqrt{\left(\frac{N_{u.k}}{Ag}\right)} - 0{,}1\,fc'.b_{jh}$$

Pada joint rangka dengan melakukan relokasi sendi plastis

$$V_{sh} = V_{jh} - 0{,}5\frac{As'}{As}V_{jh}\left(1 + \frac{N_{u.k}}{0{,}4\,Ag.\,fc'}\right)$$

Luas total efektif dari tulangan geser horisontal yang melewati bidang kritis diagonal dengan yang diletakan di daerah tekan joint efektif $b_j$ tidak boleh lebih dari :

$$A_{jh} = \frac{V_{jh}}{b_j}$$

Geser joint vertical $V_{jv}$ dapat dihitung dari :

$$V_{jv} = V_{jh}\frac{h_c}{b_j}$$

Sedang tulangan joint geser vertikal didapat dari :

$V_{sv} = V_{jv} - V_{cv}$

menjadi :

$$V_{cv} = A_{sc'} \frac{V_{sh}}{V_{sc}} \left( 0{,}6 + \frac{N_{u.k}}{Ag.fc'} \right)$$

dengan :

$A_{sc'}$ = luas tulangan longitudinal tekan

$A_{sc}$ = luas tulangan longitudinal tarik luas tulangan joint vertikal

$$A_{jv} = \frac{V_{sv}}{fy}$$

### 3.2.2 Perencanaan konstruksi

#### 3.2.2.1 Perencanaan atap

Perencanaan atap pada gedung ini memakai konstruksi kuda-kuda baja. Ketentuan umum perencanaan kuda-kuda baja ini adalah menggunakan rumus-rumus AISC dengan metode ASD.

Langkah-langkah perencanaan konstruksi kuda-kuda baja sebagai berikut :

1. Perencanaan Gording

   a. Pembebanan tetap (q)

      $q\perp = q \cos \alpha$

      $q// = q \sin \alpha$

   b. Pembebanan angin

      angin tekan (wt) = $c_1$.w.d

      angin hisap (wh) = $c_2$.w.d

dengan :

$c_1$ = koefisien angin tekan = 0,02.α.-0,4

$c_2$ = koefisien angin hisap = -0,4

w = beban angin = 25 kg/$m^2$

d = jarak gording

c. Perhitungan momen

Akibat beban tetap :

Mmaks⊥ = 1/8.q⊥.$L^2$ , Mmaks// = 1/32.q//.$L^2$

Akibat beban angin :

Mmaks = 1/8.wh.$L^2$

Momen terpakai :

Mmaks = (Mmaks⊥ + Mmaks angina).0,8

d. Pemilihan dimensi gording

e. Kontrol tegangan

$\frac{fbx}{0,6.Fy} + \frac{fby}{0,75.Fy} \leq 1$, dengan :

$fbx = \frac{M\perp}{Sx}$, $fby = \frac{M//}{Sy}$

f. Kontrol lendutan

$$\delta\perp = \frac{5}{384}.\frac{q\perp.L^4}{E.Ix} \leq \frac{L}{360}$$

$$\delta// = \frac{5}{384}.\frac{q//.\left(\frac{L}{a+1}\right)^4}{E.Iy} \leq \frac{L}{360}$$

a = jumlah sagrod dalam satu bentang

2. Perencanaan sagrod

Pembebanan sagrod (ρ) :

$\rho// = \rho.\sin\alpha.Ss$ , dengan Ss = jarak sagrod

$$A_{sagrod} = \frac{\rho//}{0{,}33.Fu} = \frac{1}{4}.\pi.D^2_{sagrod} \qquad , D = \sqrt{\frac{4.\rho//}{0{,}33.Fu.\pi}}$$

3. Perencanaan tierod

Pembebanan tierod (T) :

$T = \rho//.\cos\alpha$

$$A_{sagrod} = \frac{T}{0{,}33.Fu} = \frac{1}{4}.\pi.D^2_{tierod} \qquad , D = \sqrt{\frac{4.T}{0{,}33.Fu.\pi}}$$

4. Perencanaan batang tarik

a. $Ag_{perlu} = \dfrac{T}{0{,}60.Fy}$

b. $Ae_{perlu} = \dfrac{T}{0{,}50.Fu}$

c. $An_{perlu}$ → lihat Tabel 3.5.1 Salmon-Johnson, Luas Netto Efektif Ae (diambil dari tabel AISC – 1.14.2.2 dan 1.14.2.3).

Ag = luas brutto penampang

Ae = luas efektif

An = luas netto = $Ag - A_{perlemahan\ baut}$

$A_{perlemahan\ baut}$ (diameter baut dalam in)

Nilai dari a, b, dan c, diambil yang terbesar

$R_{min}$ = L/240 untuk batang primer, $R_{min}$ = L/300 untuk batang sekunder.

Dipakai profil yang luasannya (A) lebih besar dari nilai $A_{perlu}$ terpakai

Kontrol :

Tu = 0,60.Fy.Ag > T

Tu = 0,50.Fu.Ae > T

L/r ≤ 240

5. Perencanaan batang desak

$$Kl/r \le Cc \rightarrow Fa = \frac{Fy}{Fs}\left(1 - 0{,}5\left(\frac{Kl/r}{Cc}\right)^2\right)$$

$$Cc = \sqrt{2.\pi^2.\frac{E}{Fy}} = \frac{755}{\sqrt{Fy}} \text{ ; (Fy dalam ksi)}$$

$$Cc = \frac{6400}{\sqrt{Fy}} \text{ ; (Fy dalam kg/cm}^2\text{)}$$

$$Cc = \frac{1987}{\sqrt{Fy}} \text{ ; (Fy dalam Mpa)}$$

$$Fs = \frac{5}{3} + \frac{3\frac{kl}{r}}{8.Cc} - \frac{\left(\frac{kl}{r}\right)^3}{8.Cc^3}$$

Kl/r > Cc

$$Fa = \frac{12}{23}.\frac{\pi^2.E}{\left(\frac{kl}{r}\right)^2}$$

T = Fa . A

Fa = tegangan ijin pada luas brutto dalam kondisi beban kerja

Kl/r = angka kelangsingan kolom berujung sendi ekivalen

Fs = faktor keamanan

6. Perencanaan Sambungan

$P_{tumpuan} = tp.D_{baut}.1,2.Fu.n$

$P_{geser} = A_{baut}.Fv.2n = \frac{1}{4}.\pi.D^2_{baut}.Fv.2n$

$Fv = 0,22.Fu_{baut}$ ,untuk baut non Full Draat

$Fv = 0,17.Fu_{baut}$ ,untuk baut Full Draat

$P_{tumpuan}$ dan $P_{geser}$ untuk perhitungan 1 buah baut, dipilih nilai dari keduanya yang terkecil, sehingga :

$$N = \frac{P}{Ppakai}$$

### 3.2.2.2 Perencanaan pelat lantai

Perencanaan pelat lantai sebagai berikut :

1. Mencari momen

$Mtx = 0,001.qu.Lx^2.X_{tx}$

$Mlx = 0,001.qu.Lx^2.X_{lx}$

$Mty = 0,001.qu.Lx^2.X_{ty}$

$Mly = 0,001.qu.Lx^2.X_{ly}$

Untuk perencanaan diambil momen terbesar dari Mtx, Mlx, Mty, Mly, dengan :

qu = pembebanan pelat

X = koefisien penulangan momen dari tabel Gideon seri 4

Lx = lebar bentang pelat

2. Penentuan luasan tulangan lapangan dan tulangan tumpuan

Tulangan lapangan : $As = \frac{(Mu/\phi)_{lapangan}}{\gamma d.fy}$

Tulangan tumpuan : $As = \frac{(Mu/\phi)_{tumpuan}}{(Mu/\phi)_{lapangan}}$

As min = (1,4/fy).b.d

Cek harga As :

a. Bila $As_{perlu} < As_{min}$

Hitung harga $1,33As_{perlu}$ bila $1,33As_{perlu} < As_{min}$, maka $As = 1,33As_{perlu}$

Bila $1,33As_{perlu} > As_{min}$, maka $As = As_{min}$

b. Bila $As_{perlu} > As_{min}$, maka dipakai $As = As_{perlu}$

3. Penentuan jarak tulangan

$X = \frac{A\phi.1000}{As_{pakai}}$

4. Kontrol kapasitas

Kontrol harga Mn :

$A = \frac{As.fy}{0,85.fc'.b}$

$Mn = As.fy\ (d-a/2) \geq Mu/\phi$

### 3.2.2.3 Perencanaan balok

Perencanaan balok gedung Administrasi USD sebagai berikut :

1. Perencanaan balok lentur

a. Perencanaan balok

Diketahui : Mn = Mu/ϕ; b; h; fc'; fy; d'

$$\rho_b = \frac{0{,}85.fc'.\beta_1}{fy}\left(\frac{600}{600+fy}\right)$$

$\rho_{max} = 0{,}75.\rho_b$

$\rho_{min} = 1{,}4/fy$

Dalam perencanaan dipakai nilai ρ ; $\rho_{pakai} = 0{,}5\ \rho_{maks}$

$$m = \frac{fy}{0{,}85.fc'}$$

$Rn = \rho.fy.(1-0{,}5.\rho.m)$

b. Perencanaan dimensi

Tentukan b, hitung :

$b.d^2_{perlu} = \frac{Mu/\phi}{Rn}$, didapat $d_{perlu}$

Dicoba ukuran b/h hitung :

$d = h\text{-}pb\text{-}\phi_{sengkang}\text{-}0{,}5.\phi_{tulangan\ pokok}$

Chek $d > d_{perlu}$ maka dipakai perhitungan tulangan sebelah dan jika $d < d_{perlu}$ dipakai perhitungan tulangan rangkap.

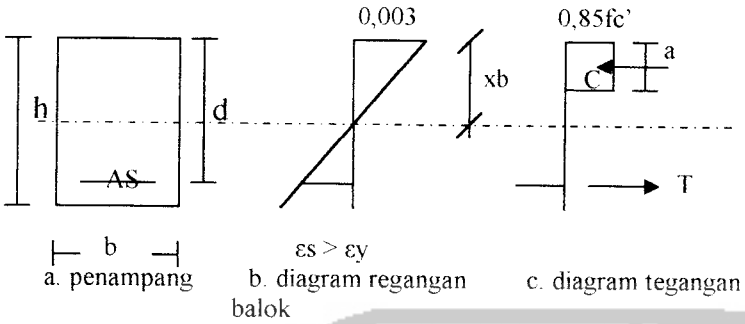
c. Penulangan sebelah

$$Rn_{baru} = \frac{Mn}{b \cdot d^2}$$

$$\rho_{perlu} = \rho_{lama}.\frac{Rn_{baru}}{Rn_{lama}}$$

$As_{ada} = \rho_{perlu}.b.d$

Kontrol kapasitas :




Gambar 3.1 Penampang balok dan diagram tegangan regangan

$$a = \frac{As_{ada}.fy}{0,85.fc'.b}$$

Kontrol kapasitas lentur :

$Mn = As_{ada}.\ fy.\ (d - a/2) > Mu/\phi$ ..... aman.

d. Penulangan rangkap

Menentukan $Mn_1$ :

$(\rho - \rho') = \rho_1 = \rho_{awal} = 0,5\ \rho_{maks}$

$As_1 = \rho_1.b.d$

$$a = \frac{As_1.fy}{0,85.fc'.b}$$

$Mn_1 = As_1.fy.(d-a/2)$

Merencanakan tulangan desak :

$Mn_2 = Mn - Mn_1$

$$fs' = 600 \cdot \left(1 - \frac{0,85 \cdot fc' \cdot \beta_1 \cdot d'}{(\rho - \rho') \cdot fy \cdot d}\right)$$

Jika : fs' > fy ,maka dipakai fs' = fy

fs' < fy ,maka dipakai fs' = fs'

$$As' = As_2 = \frac{Mn_2}{fs'.(d - d')}$$

Menentukan tulangan tarik :

$As = As_1 + As'$

Kontrol harga Mn :

$$\rho = \frac{As}{b.d}$$

$$\rho' = \frac{As'}{b.d}$$

$$fs' = 600 \cdot \left( 1 - \frac{0{,}85 \cdot fc' \cdot \beta_1 \cdot d'}{(\rho - \rho') \cdot fy \cdot d} \right)$$

Jika : fs' > fy ,maka dipakai fs' = fy

f's < fy ,maka dipakai fs' = fs'

$$a = \frac{As.fy - As.fs'}{0{,}85.fc'.b}$$

$Mn_1 = (As.fy\text{-}As'.fs').(d\text{-}a/2)$

$Mn_2 = As'.fs'.(d\text{-}d')$

$Mn_1 + Mn_2 > Mn$

### 3.2.2.4 Penulangan geser dan torsi

Prosedur perencanaan untuk kombinasi geser dan torsi adalah sebagai berikut :

1. Diketahui gaya geser (Vu), momen torsi (Tu), momen lentur (Mn), gaya aksial (Nu).

2. Diketahui penampang material : lebar badan (bw), tinggi (h), tinggi efektif (d), penutup beton (pb), luas sengkang s kaki (Ask), luas tulangan lentur (As), kuat desak beton (f'c), tegangan leleh baja (fy).
3. Kontrol
   - Struktur statis tertentu : torsi keseimbangan

     $Tu > \phi \left( \frac{1}{20}\sqrt{fc'}.\sum x^2.y^2 \right)$

   - Struktur statis tak tentu : torsi kompabilitas

     $Tu \geq \phi \left\{ \frac{1}{9}\sqrt{fc'}.\sum x^2.y \right\}$

4. Menghitung kekakuan momen torsi nominal Tn = Tu/$\phi$
5. Menghitung kuat momen torsi nominal (Tc) yang disumbangkan oleh beton

   $Tc = \frac{\left(1/15\sqrt{fc'}\right)\sum x^2 y}{\sqrt{1+\left(\frac{0,4.Vu}{Ct.Tu}\right)^2}}$ , dimana $Ct = \frac{bw.d}{\sum x^2 y}$

   Elemen struktur yang mengalami gaya aksial tarik yang cukup besar harus direncanakan terhadap harga Tc yang dikalikan dengan $(1 + 0,3.N_u/Ag)$ dimana $N_u$ bernilai negatif untuk tarik.

   Jika $\frac{Tu}{\phi} \leq Tc \longrightarrow$ Torsi diabaikan

   Jika $\frac{Tu}{\phi} > Tc \longrightarrow$ Perlu tulangan torsi

   Jika Tn>Tu/Ø ; Ts > 4 Tc $\longrightarrow$ Tampang diperbesar

Menghitung kuat momen torsi nominal yang disumbangkan oleh tulangan torsi (Ts), Ts = $\frac{4}{3}\sqrt{fc'}\sum x^2 y - Tc$ atau Ts = Tn – Tc diambil nilai yang terkecil, dengan harga Tn tidak boleh lebih kecil dari Tu/ϕ.

6. Pilih sengkang tertutup sebagai tulangan melintang, dengan spasi dari sengkang tidak melebihi nilai antara $(x_1+y_1)/4$ atau 300 mm. Ukuran tulangan minimum No.3 (diameter 9,5mm). Apabila s = jarak konstan sengkang, hitunglah luas sengkang untuk torsi persatu lengan persatuan jarak : $\frac{At}{s} = \frac{Ts}{\alpha_1 x_1 y_1 fy}$

7. Hitung penulangan geser yang diperlukan oleh Av per satuan jarak dalam penampang melintang.

   Bila Vc ≤ $\frac{Vu}{\phi}$, maka diperlukan tulangan geser

   Vs = $\frac{Vu}{\phi}$-Vc dan Vc = $\frac{\left(1/6\sqrt{fc'}\right)\cdot bw\cdot d}{\sqrt{1+\left(2{,}5.Ct.\frac{Tu}{Vu}\right)^2}}$

8. Dapatkan luas total sengkang tertutup yang diperlukan untuk torsi dan geser Avt dan desainlah luasan sengkang dengan memenuhi:

   $\frac{Avt}{s} = \frac{2.At}{s} + \frac{Av}{s} \geq \frac{bw\cdot s}{3.fy}$

9. Hitung luas tulangan memanjang Al yang diperlukan untuk torsi di mana :

   Al = 2.At. $\frac{x_1 + y_1}{s}$ atau

$$Al = \left[ \frac{2,8.x.s}{fy} \left[ \frac{Tu}{Tu + \frac{Vu}{3.Ct}} \right] - 2.At \right] \frac{x_1 + y_1}{s}$$, dipilih yang terbesar dengan Al

pada persamaan yang kedua tidak boleh lebih dari

$$Al = \left[ \frac{2,8 \cdot x \cdot s}{fy} \cdot \frac{Tu}{Tu + \frac{Vu}{3.Ct}} - \frac{bw.s}{fy} \right] \frac{x_1 + y_1}{s}$$

10. Rencanakan tulangan dengan menggunakan petunjuk di bawah ini :

    a. Jarak s dari sengkang tertutup tidak boleh melebihi $(x_1+y_1)/4$ atau 300 mm.

    b. Tulangan memanjang harus berjarak sama di sekeliling sengkang tertutup. Jarak tulangan ini harus kurang dari 300 mm dan paling sedikit satu tulangan memanjang harus diletakan pada masing-masing ujung sengkang tertutup.

    c. Kekuatan leleh untuk desain tulangan torsi tidak boleh melebihi 400 Mpa.

    d. Sengkang-sengkang yang digunakan untuk tulangan torsi harus cukup dijangkarkan ke jarak d dari tepi serat yang tertekan.

    e. Tulangan torsi harus ada juga pada jarak paling sedikit (d+b) di luar titik yang secara teoritis memerlukannya dengan maksud mengatasi tegangan geser yang secara potensial dapat berlebihan.

### 3.2.2.5 Perencanaan kolom

Perhitungan untuk menentukan tulangan pada kolom dimana ukuran penampang serta beban aksial dan momen yang bekerja telah diketahui, dan menggunakan grafik-grafik dari buku Grafik dan Tabel Perhitungan Beton Bertulang Gideon Kusuma.

Berikut ini diberikan langkah-langkah perencanaan kolom terhadap lentur :

1. Penentuan luas tulangan total yang diperlukan dengan bantuan tabel yang diperoleh dari :

   Ag = b.h

   Ast = n%.Ag

   $P_{sentris}$ = Po = 0,85.fc'.(Ag-Ast)+Ast.fy

   - Untuk sengkang biasa :

     Pno = 0,8.Po = 0,8.(0,85.fc'.(Ag-Ast)+Ast.fy)

   - Untuk sengkang Spiral :

     Pno = 0,85.Po = 0,85.(0,85.fc'.(Ag-Ast)+Ast.fy)

2. Penentuan kelangsingan kolom

   Tentukan inersia :

   $Ig = (b_b.h_b^3)/12$

   $Ic = (b_k.h_k^3)/12$

   Tentukan kekuatan relatif

$$\psi = \frac{\sum\left(Ec \cdot \frac{Ic}{Lc}\right)kolom}{\sum\left(Eg \cdot \frac{Ig}{Lg}\right)balok}$$

Kemudian nilai ψ diplotkan kedalam grafik nomogram sehingga didapat nilai k.

Tentukan kelangsingan kolom :

r = 0,3.$h_k$ (untuk kolom tampang persegi)

r =0,25 $D_k$ (untuk kolom tampang bulat)

Jika k.Lk/r < 22 (kolom tidak langsing atau kolom pendek)

Jika 22 < k.Lk/r < 100 (kolom langsing, maka ada faktor pembesar momen)

Jika k.lk/r > 100 (perbaiki dimensi betonnya).

Menentukan kekuatan kolom :

Ec = $4700\sqrt{fc'}$ Mpa

Es = 2. $10^5$ Mpa

$$EI = \frac{\frac{1}{5}\cdot(Ec\cdot Ig)+Es\cdot Ise}{(1+\beta d)}$$

$$EI = \frac{0{,}4\cdot Ec.Ig}{(1+\beta d)}$$

$$P_c = \frac{\pi^2.E.I}{(k.l)^2}$$

$\delta_b = \dfrac{C_m}{1-\dfrac{P_u}{\phi.P_c}} \geq 1$ dengan $C_m = 1$ untuk kolom tanpa pengekang

$$\delta_s = \frac{1}{1-\dfrac{\sum P_u}{\phi.\sum P_c}}$$

$M_c = \delta_b.M_{2b}+\delta_s.M_{2s}$

3. Kapasitas penampang

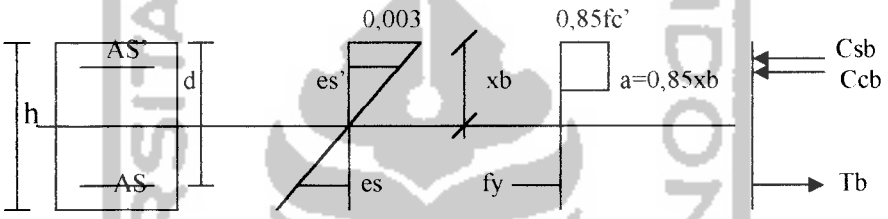
Keadaan regangan seimbang :

$$x_b = \frac{600}{600 + fy}.d$$

$$fs' = \frac{x_b - d'}{x_b}.600$$

Dimana jika fs' > fy maka dipakai fs' = fy jika tidak maka dipakai fs'.

Kapasitas penampang.




Gambar 3.2 Penampang kolom dan diagram tegangan regangan

$Ccb = 0{,}85.fc'.(\beta_1.x_b).b$

$Csb = As'.(fs'-0{,}85.fc')$

$Tb = As.fy$

$Pnb = Ccb+Csb-Tb$

$$Mnb = Ccb.\left(\bar{y} - \frac{a}{2}\right) + Csb.(\bar{y} - d') + Tb.(d - \bar{y})$$

$$eb = \frac{Mnb}{Pnb}$$

4. Tentukan nilai x yang akan digunakan:

Jika x > xb ; kolom ditinjau terhadap kegagalan akibat desak

Jika x < xb ; kolom ditinjau terhadap kegagalan akibat tarik

Dengan $$xb = \frac{600}{600 + fy} \cdot d$$

Syarat kegagalan :

a. runtuh seimbang

x = xb

b. runtuh desak

x > xb, Mn < Mnb ; e < eb ; Pn > Pnb

c. runtuh tarik

x < xb, Mn < Mnb ; e > eb ; Pn < Pnb

Kemudian dihitung :

$$a = \beta_1 \cdot x$$

$$fs' = \frac{x - d'}{x} \cdot 600$$

jika fs' > fy ; fs' = fy

Ccb = 0,85.fc'.b.(xb.$\beta_1$)

Csb = As'.(fs'-0,85.fc')

Tb = As.fy

Pnb = Ccb + Csb + Tb

$$Mnb = Ccb.\left(\bar{y} - \frac{a}{2}\right) + Csb.(\bar{y} - d') + Tb.(d - \bar{y})$$

$$eb = \frac{Mnb}{Pnb}$$

dimana :

Mnb = kapasitas lentur kolom dalam keadaan seimbang (Nmm)

Pnb = kuat desak aksial kolom dalam keadaan seimbang (N)

eb = eksentrisitas gaya pada kolom dalam keadaan seimbang (mm)

fs' = tegangan leleh baja tulangan yang terjadi (MPa)

xb = jarak serat terluar beton ke titik ditinjau keadaan seimbang (mm)

x = jarak serat terluar beton ke titik ditinjau (mm)

5. Pada saat Pn = 0 ;Mn dihitung seperti balok bertulangan sebelah

$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b}$$

$$Mn = As \cdot fy \cdot (d - \frac{a}{2})$$

6. Gambar diagram momen nominal (Mn) dan gaya desak aksial nominal (Pn) ($A_{st} = 1\%.A_g$ ; $A_{st} = 2\%.A_g$ ; $A_{st} = 3\%.A_g$ ; $A_{st} = 4\%.A_g$ ; $A_{st} = 5\%.A_g$)

### 3.2.2.6 Perencanaan pondasi

Gambar 3.3 Perencanaan pondasi

Pondasi yang direncanakan dalam perhitungan gedung ini adalah pondasi sumuran dan pondasi telapak. Cara perencanaan pondasi telapak sama dengan perencanaan pelat dua arah pada umumnya, hanya pada bagian bawah dari pelat pondasi ini diberi balok sloof yang berfungsi sebagai pengikat kolom.

Langkah-langkah perencanaan pondasi sumuran dan pondasi telapak adalah sebagai berikut :

1. Pondasi sumuran

Dalam perencanaan pondasi terlebih dahulu diketahui data-data dari hasil sondir tanah, yaitu :

a. Daya dukung tanah (qc)

b. Kedalaman tanah keras

Setelah diketahui data diatas maka dapat ditentukan pondasi yang akan digunakan pada bangunan tersebut

Langkah-langkah perhitungan pondasi sumuran :

a. Menentukan beban pondasi sumuran

P pondasi sumuran = $\frac{1}{4}$. $\pi.D^2$ . h. $\gamma$

P total = P + P pondasi sumuran

b. Menentukan daya dukung tanah netto :

$q = h_1 . \gamma_1 + h_2 . \gamma_2$

$\sigma$ netto = $\sigma_{ijin\ dibawah\ sumuran} - q$

c. Menentukan dimensi pondasi sumuran

$$A_{perlu} = \frac{P_{total}}{\sigma_{netto}}$$

$$D = \sqrt{\frac{A_{perlu}}{\frac{1}{4} \cdot \pi}}$$

2. Pondasi telapak

a. Diketahui beban kerja, fc', fy, $\sigma_{tanah}$

Tebal pelat kaki diasumsikan

b. Menentukan dimensi pondasi telapak

Dimensi pondasi bujur sangkar (terdapat momen yang bekerja pada arah x dan y :

$$A_{perlu} = \frac{p}{\sigma_{sumuran} - \left(\frac{Mx}{\frac{1}{6} \cdot Bx \cdot By^2}\right) - \left(\frac{My}{\frac{1}{6} \cdot By \cdot Bx^2}\right)}$$

$$B_p = \sqrt{A_{perlu}}$$

c. Pemeriksaan terhadap kuat geser

1) Perhitungan gaya geser beton untuk dua arah

$d = h - pb - 0{,}5.\emptyset_{tul.pokok}$

$$qu = \frac{Pu}{A_{ada}} \pm \frac{Mux}{\frac{1}{6} \cdot Bx \cdot By^2} \pm \frac{Muy}{\frac{1}{6} \cdot By \cdot Bx^2}$$

$Vu = qu_{terjadi}.(A^2 - B^2)$

A = luas telapak pondasi empat persegi

B = lebar kolom + tinggi efektif

Kuat beton menahan geser :

$Vc = (1+(2/\beta_c)).(2\sqrt{fc'}.bo.d)$

$\beta_c$ = rasio panjang/lebar kolom

bo = 2 (B1 + B2)

Sehingga kuat geser maksimum adalah :

$Vc = 4\sqrt{fc'}.bo.d$

$\phi Vn = \phi Vc \rightarrow Vu < \phi Vn$

Gambar 3.4 Penampang kritis dan permukaan geser beton 2 arah

2) Perhitungan geser beton untuk satu arah

$G = (B_p - 2.d - b_{kolom})/2$

❖ **Arah X**

$$qu = \frac{Pu}{A_{ada}} \pm \frac{Mux}{\frac{1}{6} \cdot Bx \cdot By^2}$$

$Vu = qu_{terjadi}. L_p. G$

Kuat beton menahan geser :

$$Vc = \frac{1}{6} \cdot \sqrt{fc'} \cdot L_p.d$$

Kontrol gaya geser ;

$Vc \geq Vu/\phi$

❖ **Arah Y**

$$qu = \frac{Pu}{A_{ada}} \pm \frac{Muy}{\frac{1}{6} \cdot By \cdot Bx^2}$$

$Vu = qu_{terjadi} \cdot B_p \cdot G$

Kuat beton menahan geser :

$$Vc = \frac{1}{6} \cdot \sqrt{fc'} \cdot B_p \cdot d$$

Kontrol gaya geser ;

$Vc \geq Vu/\phi$

Gambar 3.5 Penampang kritis dan permukaan geser beton 1 arah

d. Perencanaan tulangan lentur telapak pondasi

Diambil lebar b = 1meter

$M = (1/2).qu_{maks}.((L_p-h_k)/2)^2$

$jd = 0{,}9.d$

$$As_{perlu} = \frac{Mu}{\phi \over jd \cdot fy}$$

$As_{min} = \rho_{min}.b.d$

Untuk langkah selanjutnya dapat dilihat pada perhitungan pelat.

e. Kontrol kapasitas lentur pelat pondasi :

$$As_{ada} = \frac{A\phi \cdot\cdot 1000}{jarak\ tulangan}$$

$$a = \frac{As_{ada}.fy}{0{,}85.fc'.b}$$

$Mn = As_{ada}.fy.(d-a/2) \geq Mn$

### 3.2.2.7 Perencanaan tangga

Langkah-langkah perencanaan tangga adalah sebagai berikut :

1. Menetukan lebar dan jumlah optrede dan antrede
   a. Tinggi bersih antar lantai (h) dalam meter dapat diketahui.
   b. Lebar bordes ($L_b$) dalam meter dapat ditentukan, diambil ≥ 1,2 meter.
   c. Sandaran tangga dapat ditentukan bahannya, tebal, dan tinggi jadinya.
   d. Tinggi optrede ideal ≤ 20 cm (15 – 18 cm), missal diambil nilai perkiraan awal tinggi optrede ($h_o$) = 18 cm, maka jumlah optrede (buah) :

      Jumlah optrede = $\frac{h}{h_o}$ (dibulatkan keatas)

      sehingga tinggi optrede sebenarnya : $h'_o = \frac{h}{jumlah\ optrede}$

e. Lebar antrede ideal ≥ 30 cm, diambil nilai lebar antrede ($L_a$) = 30 cm

Jumlah antrede = jumlah optrede – 2

Tangga dibagi menjadi dua (2) bagian, sehingga panjang bentang tangga ($P_t$) :

$$P_t = \left( \frac{L_a \cdot jumlah \text{ tangga}}{2} \right) + L_b \leq 4{,}50 \; meter$$

2. Menentukan tebal pelat tangga (h1) dan lebar tangga (Lt)

Untuk panjang bentang tangga ± 4,50 meter.

a. Diambil nilai tebal pelat (h) = 15 cm

b. Sudut kemiringan ideal tangga antara 30° – 35°, missal diambil sudut perkiraan awal (α) = 30°, maka tebal pelat sisi miring (h') :

$$h' = \frac{h}{\cos \alpha}$$

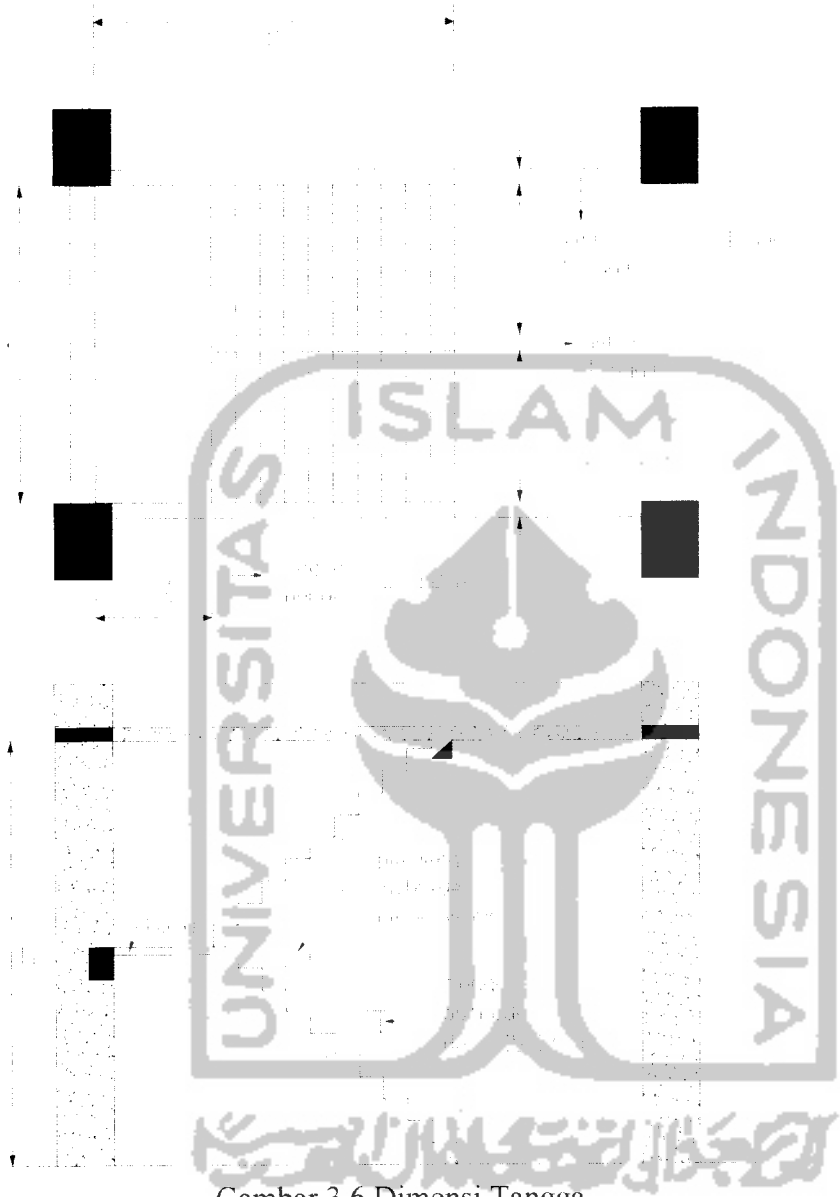
Sehingga sudut tangga sebenarnya (α') : $\alpha' = \frac{h'}{L_a}$

c. Jarak antar as-as kolom (d) dalam meter dapat diketahui, sehingga jarak bersih antar as-as kolom (d') :

d' = d – 2.(1/2. lebar balok induk)

d. Jarak antar balok-tangga, jarak antar tangga-tangga, diambil nilai = 10 cm, sehingga lebar bersih untuk 1 buah tangga :

$L_t$ = 1/2. (d' – (3. 0,1)) ≥ 1,20 meter



Gambar 3.6 Dimensi Tangga

3. Perencanaan tulangan tangga

Perencanaan tulangan pada tangga sama dengan perhitungan pada pelat lantai.

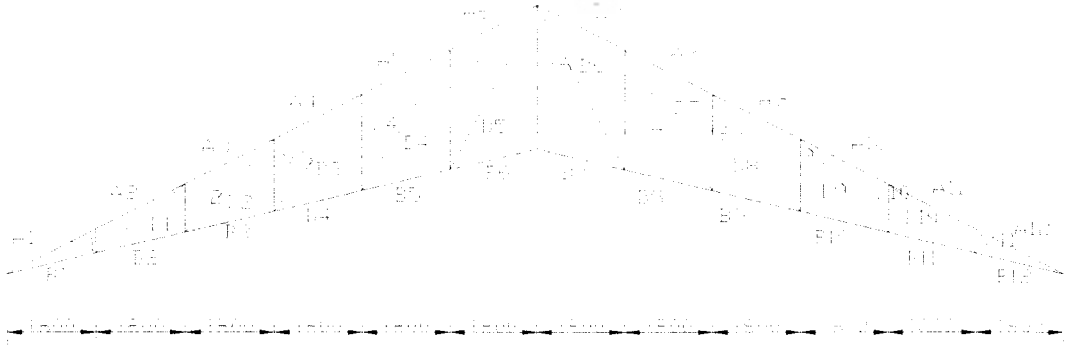
# BAB IV

# PERHITUNGAN KONSTRUKSI

## 4.1 Perhitungan Perencanaan Atap

Hasil perencanaan atap Gedung Administrasi Universitas Sanata Dharma Yogyakarta sebagai berikut :

1. Data :
   a. Gording = 6,13 kg/m
   b. Eternit dan plafond = 18 kg/$m^2$
   c. Penutup atap = 50 kg/$m^2$
   d. Beban hidup = 20 kg/$m^2$
   e. Fy = 2400 kg/$cm^2$
   f. E = 2,1x$10^6$ kg/$cm^2$
   g. Fu = 3600 kg/$cm^2$



Gambar 4.1 Rencana kuda-kuda

2. Hasil perhitungan perencanaan atap

Hitungan sambungan pada setengah bentang

Data :

Tebal pelat sambung(tp) = 1 cm

Fy = 2400 kg/cm$^2$

Fu = 3600 kg/cm$^2$

Ø baut (5/8 inchi) = 1,59 cm

Perhitungan :

Kekuatan untuk satu baut (n) = 1 baut

$P_{tumpuan}$ = tp. $D_{baut}$. 1,2. Fu. n

= 1. 1,59. 1,2. 3600. 1

= 6868,8 kg

$P_{geser}$ = $A_{baut}$. 0,17. Fu. 2.n

= 1/4.π. $D^2_{baut}$. 0,17. Fu. 2.n

= 1/4.π. $(1,59)^2$. 0,17. 3600. 2.1

= 2430,332 kg

Dipakai nilai P yang terkecil = 2430,332 kg

Untuk batang A1(tekan): gaya batang(P) = 14754,61 Kg

n = $P/P_{pakai}$

= 14754,61 / 2430,332

= 6,071

n pakai = 7 baut

Tabel 4.1 Hasil perhitungan perencanaan atap

| Batang | Panjang (m) | Jenis batang | Profil | n baut tiap join |
|---|---|---|---|---|
| A1 | 2,078 | Tekan | 2 L 70 x 70 x7 | 7 Ø 5/8" |
| A2 | 2,078 | Tekan | 2 L 70 x 70 x7 | 7 Ø 5/8" |
| A3 | 2,078 | Tekan | 2 L 70 x 70 x7 | 6 Ø 5/8" |
| A4 | 2,078 | Tekan | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| A5 | 2,078 | Tekan | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| A6 | 2,078 | Tekan | 2 L 70 x 70 x7 | 4 Ø 5/8" |
| A7 | 2,078 | Tekan | 2 L 70 x 70 x7 | 4 Ø 5/8" |
| A8 | 2,078 | Tekan | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| A9 | 2,078 | Tekan | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| A10 | 2,078 | Tekan | 2 L 70 x 70 x7 | 6 Ø 5/8" |
| A11 | 2,078 | Tekan | 2 L 70 x 70 x7 | 7 Ø 5/8" |
| A12 | 2,078 | Tekan | 2 L 70 x 70 x7 | 7 Ø 5/8" |
| B1 | 1,863 | Tarik | 2 L 70 x 70 x7 | 6 Ø 5/8" |
| B2 | 1,863 | Tarik | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| B3 | 1,863 | Tarik | 2 L 70 x 70 x7 | 5 Ø 5/8" |
| B4 | 1,863 | Tarik | 2 L 70 x 70 x7 | 4 Ø 5/8" |
| B5 | 1,863 | Tarik | 2 L 70 x 70 x7 | 4 Ø 5/8" |
| B6 | 1,863 | Tarik | 2 L 70 x 70 x7 | 3 Ø 5/8" |
| B7 | 1,863 | Tarik | 2 L 70 x 70 x7 | 3 Ø 5/8" |
| B8 | 1,863 | Tarik | 2 L 70 x 70 x7 | 4 Ø 5/8" |

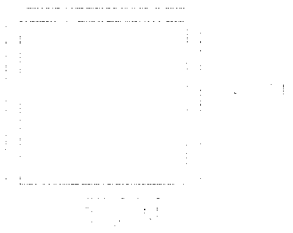
| | | | | |
|---|---|---|---|---|
| B9 | 1,863 | Tarik | 2 L 70 x 70 x7 | 7 Ø ½ " |
| B10 | 1,863 | Tarik | 2 L 70 x 70 x7 | 7 Ø ½ " |
| B11 | 1,863 | Tarik | 2 L 70 x 70 x7 | 8 Ø ½ " |
| B12 | 1,863 | Tarik | 2 L 70 x 70 x7 | 9 Ø ½ " |
| D1 | 2,406 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D2 | 2,807 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D3 | 3,208 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D4 | 3,609 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D5 | 4,01 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D6 | 4,01 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D7 | 3,609 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D8 | 3,208 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D9 | 2,807 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| D10 | 2,406 | Tarik | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V1 | 0,557 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V2 | 1,114 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V3 | 1,671 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V4 | 2,228 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V5 | 2,785 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V6 | 3,342 | Tarik | 2 L 50 x 50 x5 | 3 Ø ½ " |
| V7 | 2,785 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V8 | 2,228 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |

| | | | | |
|---|---|---|---|---|
| V9 | 1,671 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V10 | 1,114 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |
| V11 | 0,557 | Tekan | 2 L 50 x 50 x5 | 2 Ø ½ " |

**4.2 Perencanaan Pelat Atap**

Perhitungan pelat atap Gedung Administrasi Sanata Dharma Yogyakarta sebagai berikut :

1. Diketahui :
   a. Tebal lapis kedap air : 1 cm
   b. Tebal finishing beton : 2 cm
   c. fc' (mutu beton) : 25 Mpa
   d. Fy polos (mutu baja) : 240 Mpa
   e. Bj beton : 24 KN/$m^3$
   f. Beban hidup : 100 Kg/$m^2$
   g. Di gunakan tebal pelat atap (ht) = 100 mm
   h. Penutup beton (pb) = 40 mm
   i. Digunakan tulangan berdiameter(Ø) = 8 mm.
2. Perencanaan pembebanan :



Gambar 4.2 Dimensi pelat atap

a. Beban mati (WD)

1) berat pelat = tebal pelat x bj beton = 0,1x24 = 2,4KN/$m^2$

2) berat finishing beton = tebal finishing beton x bj beton

= 0,02x24 = 0,48 KN/$m^2$

3) berat lapis kedap air = tebal lapis kedap air x bj beton

= 0,01x24 = 0,24 KN/$m^2$

4) berat langit$^2$ + penggantung = 11 + 7 = 0,18 KN/$m^2$

WD total = 3,3 KN/$m^2$

b. beban hidup (WL) = 1,0 KN/$m^2$

c. beban ultimit (qu)

qu = 1,2.WD + 1,6.WL = 1,2x3,3 + 1,6x1,0 = 5,56 KN/$m^2$

3. Perhitungan momen

Mu (lx, tx, ly, ty) = (±) 0,001. qu. $L^2$. x

Hitung nilai ly/lx untuk mendapatkan faktor perhitungan momen x yang dapat dilihat pada buku *Gideon seri 4 tabel 14.*

a. Momen lapangan arah x dan y

$\frac{ly}{lx} = \frac{3,6}{3,6} = 1$ lihat tabel didapat x = 25

maka Mlx = Mly = ± 0,001. qu. $L^2$. x

= ± 0.001.5,56. $3,6^2$. 25

= ± 1,801 KNm

b. Momen tumpuan arah x dan y

$\frac{ly}{lx} = \frac{3,6}{3,6} = 1$ lihat tabel didapat x = 51

maka Mtx = Mty = ± 0,001. qu. $L^2$. x

= ± 0.001.5,56. $3,6^2$. 51

= ± 3,675 KNm

c. Perencanaan tulangan

d = t.pelat – pb – 0,5.Øtul

= 100 – 40 – 0,5. 8

= 56 mm

γd = 0,9. d = 0,9. 56 = 50,4 mm

d. Menghitung luasan tulangan lapangan atau tumpuan arah x dan y

Untuk $Aslx = Asly = \dfrac{\frac{Mu}{\phi}}{\gamma d \cdot fy}$

$= \dfrac{(\frac{1,801}{0,8}) \cdot 10\text{^}6}{50,4 \cdot 240}$

= 186,115 $mm^2$

Untuk $Astx = Asty = \dfrac{(Mu/\phi)_{tump(lx)}}{(Mu/\phi)_{lap(lx)}} \cdot Aslx$

$= \dfrac{(3,675/0,8)}{(1,801/0,8)} \cdot 186,115$

= 379,774 $mm^2$

e. $As\min = \dfrac{1,4}{fy} \cdot b \cdot d$ , b = 1000 mm (tinjauan per-meter)

$= \dfrac{1,4}{240} \cdot 1000 \cdot 56$

=326,667 $mm^2$

f. 1,33.Aslx = 1,33 Asly = 1,33. 186,115 = 247,533 $mm^2$

1,33.Astx = Asty = 1,33.379,774 = 505,1$mm^2$

g. Check nilai As > As min

Jika As < As min dan 1,33 As > As min ⟶ As min dipakai

Jika As < As min dan 1,33 As < As min ⟶ 1,33 As dipakai

Jika As > As min ⟶ Dipakai As

As pakai lx = ly : 247,533 $mm^2$

As pakai tx = ty : 379,774 $mm^2$ > Ass = 0.002.1000.100

= 200 $mm^2$

.....Ok

h. Menghitung $A\phi = 1/4 \cdot \pi \cdot d^2$

Dipakai $Ø_{tul}$ = 8 mm

$A\phi$ = 50,24 $mm^2$

i. Menghitung jarak tulangan

$$x = \frac{A\phi \cdot 1000}{As_{pakai}}$$

x arah $lx = ly = \frac{50,24 \cdot 1000}{247,533}$

= 202,91mm

Dipakai jarak tulangan = 200 mm ≤ 2.ht = 2.100 = 200 mm ..... Ok

x arah $tx = ty = \frac{50,24 \cdot 1000}{379,774}$

= 132,2913 mm

Dipakai jarak tulangan = 130 mm ≤ 2.ht = 200 mm ..... Ok

j. Dicoba tulangan :

Arah lx = arah ly : $P_{8\text{-}200}$ , As = (Aθ.1000)/x

= (50,24.1000)/200

= 251,2 $mm^2$

Arah tx = arah ty : $P_{8\text{-}130}$ , As = (Aθ.1000)/x

=(50,24.1000)/130

= 386,4615 $mm^2$

k. Kontrol Mn

$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b} \qquad Mn = As.fy\ (d\text{-}a/2) > Mu/Ø$$

arah lx a = arah ly a = $\frac{251{,}2.240}{0{,}85.25.1000} = 2{,}84$ mm

Mn = $251{,}2.240.(56\text{-}(2{,}84/2)).10^{-6}$

= 3,29 KNm > 1,33 Mu/Ø = 1,33.(1,801/0,8) = 2,994 KNm ..... Ok

arah tx a = arah ty a = $\frac{386{,}461.240}{0{,}85.25.1000} = 4{,}365$ mm

Mn = $386{,}461.240.(56\text{-}(4{,}365/2)).10^{-6}$

= 4,991 KNm > Mu/Ø = 4,594 KNm .....Ok

l. Menghitung tulangan susut

As susut = 0,002.b.h

= 0,002.1000.100

= 200 $mm^2$

Dipakai tulangan Ø = 8 mm ⟶ Aθ = 50,24 $mm^2$

Jarak tulangan susut (s) :

$$s = \frac{A\phi \cdot 1000}{As} = \frac{50{,}24 \cdot 1000}{200}$$

s = 251,2 mm , dipakai s = 200 mm ≤ 2.ht = 200 mm

Digunakan tulangan $P_{8\text{-}200}$

Tabel 4.2 Hasil Perencanaan Pelat Atap (Type A)

| Perencanaan Pelat Atap | | | | |
|---|---|---|---|---|
| | Pelat Atap | | | |
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 1.80144 | 1.80144 | 3.674938 | 3.674938 |
| Mr = Mu/Ø | 2.2518 | 2.2518 | 4.593672 | 4.593672 |
| 1,33 Mu/Ø | 2.994894 | 2.994894 | 6.109584 | 6.109584 |
| As (mm^2) | 186.1607143 | 186.16071 | 379.7679 | 379.7679 |
| 1,33 As (mm^2) | 247.59375 | 247.59375 | 505.0913 | 505.0913 |
| As min (mm^2) | 326.6666667 | 326.66667 | 326.6667 | 326.6667 |
| As perlu (mm^2) | 247.59375 | 247.59375 | 379.7679 | 379.7679 |
| Jrk tul (mm) | 202.913038 | 202.91304 | 132.2913 | 132.2913 |
| Pakai Tulangan | P8-200 | P8-200 | P8-130 | P8-130 |
| As pakai (mm) | 251.2 | 251.2 | 386.4615 | 386.4615 |
| A | 2.837082353 | 2.8370824 | 4.364742 | 4.364742 |
| Mn | 3.29060699 | 3.290607 | 4.991626 | 4.991626 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan Susut | $P_{8\text{-}200}$ | $P_{8\text{-}200}$ | --- | --- |

## 4.3 Perencanaan Pelat Lantai

Perhitungan pelat lantai Gedung Administrasi Universitas Sanata Dharma Yogyakarta sebagai berikut :

1. Diketahui :
   a. Tebal pasir : 0,05 m
   b. Tebal spesi : 0,03 m
   c. Tebal keramik : 0,01 m
   d. fc' (mutu beton) : 25 Mpa

e. Fy polos (mutu baja) : 240 Mpa

f. Bj pasir : 16 KN/$m^3$

g. Bj spesi : 24 KN/$m^3$

h. Bj keramik : 20 KN/$m^3$

i. Bj beton : 24 KN/$m^3$

j. Beban hidup : 400 Kg/$m^2$

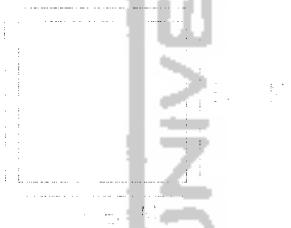
k. Digunakan tebal pelat lantai (ht) = 120 mm

l. Penutup beton (pb) = 20 mm

m. Digunakan tulangan berdiameter(Ø) = 8 dan 10 mm.

n. Θ = 0,8 (faktor reduksi kekuatan untuk pembebanan lentur tanpa aksial)

2. Perencanaan pembebanan :



Gambar 4.3 Dimensi pelat lantai

a. Beban mati (WD)

1) berat pelat = t pelat x bj beton = 0,12 x 24 = 2,88 KN/$m^2$

2) berat pasir = t pasir x bj pasir = 0,05 x 16 = 0,8 KN/$m^2$

3) berat spesi = t spesi x bj spesi = 0,03 x 24 = 0,72 KN/$m^2$

4) berat keramik = t keramik x bj keramik = 0,01 x 20 = 0,2 KN/$m^2$

WD total = 4,6 KN/$m^2$

b. beban hidup (WL) = 4,0 KN/$m^2$

c. beban ultimit (qu)

qu = 1,2.WD + 1,6.WL = 1,2 x 4,6 + 1,6 x 4,0 = 11,92 KN/$m^2$

3. Perhitungan momen

Mu (lx, tx, ly, ty) = (±) 0,001. qu. $L^2$. x

Hitung nilai ly/lx untuk mendapatkan faktor perhitungan momen x yang dapat dilihat pada buku *Gideon seri 4 tabel 14.*

a. Momen lapangan arah x dan y

$\frac{ly}{lx} = \frac{3,6}{3,6} = 1$ lihat tabel didapat x = 25

maka Mlx = Mly = ± 0,001. qu. $L^2$. x

= ± 0.001.11,92 .$3,6^2$. 25

= ± 3,862 KNm

b. Momen tumpuan arah x dan y

$\frac{ly}{lx} = \frac{3,6}{3,6} = 1$ lihat tabel didapat x = 51

maka Mtx = Mty = ± 0,001. qu. $L^2$. x

= ± 0.001.11,92. $3,6^2$. 51

= ± 7,879 KNm

c. Perencanaan tulangan

d = t.pelat – pb – 0,5.Øtul

= 120 – 20 – 0,5. 8

= 96 mm

γd = 0,9. d = 0,9. 96 = 86,4 mm

d. Menghitung luasan tulangan lapangan atau tumpuan arah x dan y

Untuk $Aslx = Asly = \dfrac{\dfrac{Mu}{\phi}}{\gamma d \cdot fy}$

$$= \frac{(^{3,862}_{0,8}) \cdot 10\text{^}6}{86,4 \cdot 240}$$

$$= 232,808 \text{ mm}^2$$

Untuk $Astx = Asty = \dfrac{(Mu/\phi)_{tump(tx)}}{(Mu/\phi)_{lap(lx)}} \cdot Aslx$

$$= \frac{(7,879/0,8)}{(3,862/0,8)} \cdot 232,808$$

$$= 474,96 \text{ mm}^2$$

e. $As\min = \dfrac{1,4}{fy} \cdot b \cdot d$ , b = 1000 mm (tinjauan per-meter)

$$= \frac{1,4}{240} \cdot 1000 \cdot 96$$

$$= 560 \text{ mm}^2$$

f. 1,33.Aslx = 1,33 Asly = 1,33. 232,808 = 309,635 $\text{mm}^2$

1,33.Astx = Asty = 1,33. 474,96 = 631,697 $\text{mm}^2$

g. Check nilai As > As min

Jika As < As min dan 1,33 As > As min ⟶ As min dipakai

Jika As < As min dan 1,33 As < As min ⟶ 1,33 As dipakai

Jika As > As min ⟶ Dipakai As

As pakai lx = ly : 309,635 $\text{mm}^2$

As pakai tx = ty : 560 $\text{mm}^2$ > Ass = 0.002.1000.120 = 240 $\text{mm}^2$ ..... Ok

h. Menghitung $A\phi = 1/4 \cdot \pi \cdot d^2$

Dipakai $\emptyset_{tul}$ = 8 mm $\longrightarrow A\phi = 50{,}24$ mm$^2$

$\emptyset_{tul}$ = 10 mm $\longrightarrow A\phi = 78{,}54$ mm$^2$

i. Menghitung jarak tulangan

$$x = \frac{A\phi \cdot 1000}{As_{pakai}}$$

x arah $lx = ly = \dfrac{50{,}24 \cdot 1000}{309{,}635}$

= 162,253 mm

Dipakai jarak tulangan = 160 mm ≤ 2.ht = 2.100 = 200 mm ..... Ok

x arah $tx = ty = \dfrac{78{,}54 \cdot 1000}{560}$

= 140,25 mm

Dipakai jarak tulangan = 140 mm ≤ 2.ht = 200 mm ..... Ok

j. Dicoba tulangan :

Arah lx = arah ly : $P_{8\text{-}160}$ , As = (Aθ.1000)/x

= (50,27.1000)/160

= 314,188 mm$^2$

Arah tx = arah ty : $P_{8\text{-}140}$ , As = (Aθ.1000)/x

= (78,54.1000)/140

= 561 mm$^2$

k. Kontrol Mn

$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b}$$

Mn = As.fy (d-a/2) > Mu/Ø

arah lx a = arah ly a = $\frac{314,188.240}{0,85.25.1000}$ = 3,55 mm

Mn =314,188.240.(96-(3,55/2)).$10^{-6}$

= 7,105 KNm > 1,33 Mu/Ø = 6,42 KNm ..... Ok

arah tx a = arah ty a = $\frac{561.240}{0,85.25.1000}$ = 6,336 mm

Mn = 561.240.(96-(6,336/2)).$10^{-6}$

= 12,499 KNm > Mu/Ø = 9,849 KNm .....Ok

l. Menghitung tulangan susut/bagi

As susut = 0,002.b.h

= 0,002.1000.120

= 240 $mm^2$

Dipakai tulangan Ø = 8 mm ⟶ Aθ = 50,24 $mm^2$

Jarak tulangan susut (s) :

$$s = \frac{A\phi \cdot 1000}{Ass} = \frac{50,24 \cdot 1000}{240}$$

s = 209,333 mm , dipakai s = 200 mm ≤ 2.ht = 200 mm .....Ok

Digunakan tulangan $P_{8\text{-}200}$

Selanjutnya hasil perhitungan pelat lantai dan pelat atap terdapat pada tabel dengan perhitungan lengkapnya terdapat pada lampiran.

Tabel 4.3 Hasil Perencanaan Pelat Lantai Type A

| | Pelat Lantai Hall | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 3.86208 | 3.86208 | 7.878643 | 7.878643 |
| Mr = Mu/Ø | 4.8276 | 4.8276 | 9.848304 | 9.848304 |
| As (mm^2) | 232.8125 | 232.8125 | 474.9375 | 474.9375 |
| 1,33 As (mm^2) | 309.640625 | 309.64063 | 631.6669 | 631.6669 |
| As min (mm^2) | 560 | 560 | 560 | 560 |
| As perlu (mm^2) | 309.640625 | 309.64063 | 560 | 560 |
| Jrk tul (mm) | 162.2526114 | 162.25261 | 140,25 | 140,25 |
| Tulangn pokok | P8-160 | P8-160 | P10-140 | P10-140 |
| As pakai (mm) | 334.9333333 | 334.93333 | 561 | 561 |
| a | 3.782776471 | 3.7827765 | 6,336 | 6,336 |
| Mn | 7.564826648 | 7.5648266 | 12,499 | 12,499 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan Bagi | --- | --- | P8-200 | P8-200 |

Tabel 4.4 Hasil Perencanaan Pelat Lantai Type A

| | Plat lantai Bank | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 3.08448 | 3.08448 | 6.292339 | 6.292339 |
| Mr = Mu/Ø | 3.8556 | 3.8556 | 7.865424 | 7.865424 |
| As (mm^2) | 185.9375 | 185.9375 | 383.3053 | 383.3053 |
| 1,33 As (mm^2) | 247.2969 | 247.2969 | 509.796 | 509.796 |
| As min (mm^2) | 560 | 560 | 554.1667 | 554.1667 |
| As perlu (mm^2) | 247.2969 | 247.2969 | 509.796 | 509.796 |
| Jrk tul (mm) | 203.1566 | 203.1566 | 153.9832 | 153.9832 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P10 - 150 | P10 -150 |
| As pakai (mm) | 251.2 | 251.2 | 523.3333 | 523.3333 |
| A | 2.837082 | 2.837082 | 5.910588 | 5.910588 |
| Mn | 5.702127 | 5.702127 | 11.56082 | 11.56082 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan bagi | --- | --- | P8 - 200 | P8 - 200 |

Tabel 4.5 Hasil Perencanaan Pelat Atap Type B

| | Pelat Atap Type B | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 6.218312 | 1.850688 | 9.753126 | 6.662477 |
| Mr = Mu/Ø | 7.77289 | 2.31336 | 12.19141 | 8.328096 |
| As (mm^2) | 654.2836 | 194.7273 | 1045.217 | 714 |
| 1,33 As (mm^2) | 870.1972 | 258.9873 | 1390.138 | 949.62 |
| As min (mm^2) | 320.8333 | 320.8333 | 315 | 315 |
| As perlu (mm^2) | 654.2836 | 258.9873 | 1045.217 | 714 |
| Jrk tul (mm) | 119.9785 | 303.1037 | 108.1498 | 158.3193 |
| Tulangan pokok | P10 - 110 | P10 - 200 | P12 -100 | P12 -150 |
| As pakai (mm) | 713.6364 | 392.5 | 1130.4 | 753.6 |
| a | 8.059893 | 4.432941 | 12.76687 | 8.511247 |
| Mn | 8.72978 | 4.972208 | 12.91818 | 8.996967 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan susut | P8 - 200 | P8 - 200 | --- | --- |

Tabel 4.6 Hasil Perencanaan Pelat Atap Type C

| | Pelat Atap Type C | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 1.17872 | 0.3336 | 1.80144 | 1.20096 |
| Mr = Mu/Ø | 1.4734 | 0.417 | 2.2518 | 1.5012 |
| As (mm^2) | 121.8089 | 34.47421 | 186.1607 | 124.1071 |
| 1,33 As (mm^2) | 162.0058 | 45.85069 | 247.5938 | 165.0625 |
| As min (mm^2) | 326.6667 | 326.6667 | 326.6667 | 326.6667 |
| As perlu (mm^2) | 162.0058 | 45.85069 | 247.5938 | 165.0625 |
| Jrk tul (mm) | 310.1124 | 1095.73 | 202.913 | 304.3696 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |
| As pakai (mm) | 251.2 | 251.2 | 251.2 | 251.2 |
| a | 2.837082 | 2.837082 | 2.837082 | 2.837082 |
| Mn | 3.290607 | 3.290607 | 3.290607 | 3.290607 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan susut | P8 - 200 | P8 - 200 | --- | --- |

Tabel 4.7 Hasil Perencanaan Pelat Atap Type D

| | Pelat Atap Type D | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 4.179341 | 1.080864 | 5.908723 | 3.819053 |
| Mr = Mu/Ø | 5.224176 | 1.35108 | 7.385904 | 4.773816 |
| As (mm^2) | 439.7455 | 113.7273 | 621.7091 | 401.8364 |
| 1,33 As (mm^2) | 584.8615 | 151.2573 | 826.8731 | 534.4424 |
| As min (mm^2) | 320.8333 | 320.8333 | 320.8333 | 320.8333 |
| As perlu (mm^2) | 439.7455 | 151.2573 | 621.7091 | 401.8364 |
| Jrk tul (mm) | 178.5124 | 518.9833 | 126.2648 | 195.3532 |
| Tulangan pokok | P10 - 170 | P10 - 200 | P10 - 120 | P10 -190 |
| As pakai (mm) | 461.7647 | 392.5 | 654.1667 | 413.1579 |
| a | 5.215225 | 4.432941 | 7.388235 | 4.666254 |
| Mn | 5.806309 | 4.972208 | 8.055024 | 5.222336 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan susut | P8 - 200 | P8 - 200 | --- | --- |

Tabel 4.8 Hasil Perencanaan Pelat Atap Type E

| Pelat Atap Type E | |
|---|---|
| Mu (knm) | 2.2518 |
| Mr = Mu/Ø | 2.81475 |
| As (mm^2) | 232.7009 |
| 1,33 As (mm^2) | 309.4922 |
| As min (mm^2) | 326.6667 |
| As perlu (mm^2) | 309.4922 |
| Jrk tul (mm) | 162.3304 |
| Tulangan pokok | P8 - 160 |
| As pakai (mm) | 314 |
| a | 3.546353 |
| Mn | 4.086533 |
| Kontrol | Aman |
| Tulangan Susut | P8 - 200 |

Tabel 4.9 Hasil Perencanaan Pelat Atap Type F

| Pelat Atap Type F | |
|---|---|
| Mu (knm) | 1.56375 |
| Mr = Mu/Ø | 1.954688 |
| As (mm^2) | 161.5978 |
| 1,33 As (mm^2) | 214.9251 |
| As min (mm^2) | 326.6667 |
| As perlu (mm^2) | 214.9251 |
| Jrk tul (mm) | 233.7558 |
| Tulangan pokok | P8 - 200 |
| As pakai (mm) | 251.2 |
| a | 2.837082 |
| Mn | 3.290607 |
| Kontrol | Aman |
| Tulangan Susut | P8 - 200 |

Tabel 4.10 Hasil Perencanaan Pelat Lantai Type G

| | Pelat Lantai Type G | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 2.01824 | 0.5712 | 3.08448 | 2.05632 |
| Mr = Mu/Ø | 2.5228 | 0.714 | 3.8556 | 2.5704 |
| As (mm^2) | 121.6628 | 34.43287 | 185.9375 | 123.9583 |
| 1,33 As (mm^2) | 161.8115 | 45.79572 | 247.2969 | 164.8646 |
| As min (mm^2) | 560 | 560 | 560 | 560 |
| As perlu (mm^2) | 161.8115 | 45.79572 | 247.2969 | 164.8646 |
| Jrk tul (mm) | 310.4847 | 1097.046 | 203.1566 | 304.7349 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P8 - 200 | P8 – 200 |
| As pakai (mm) | 251.2 | 251.2 | 251.2 | 251.2 |
| a | 2.837082 | 2.837082 | 2.837082 | 2.837082 |
| Mn | 5.702127 | 5.702127 | 5.702127 | 5.702127 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan Bagi | --- | --- | P8 - 200 | P8 – 200 |

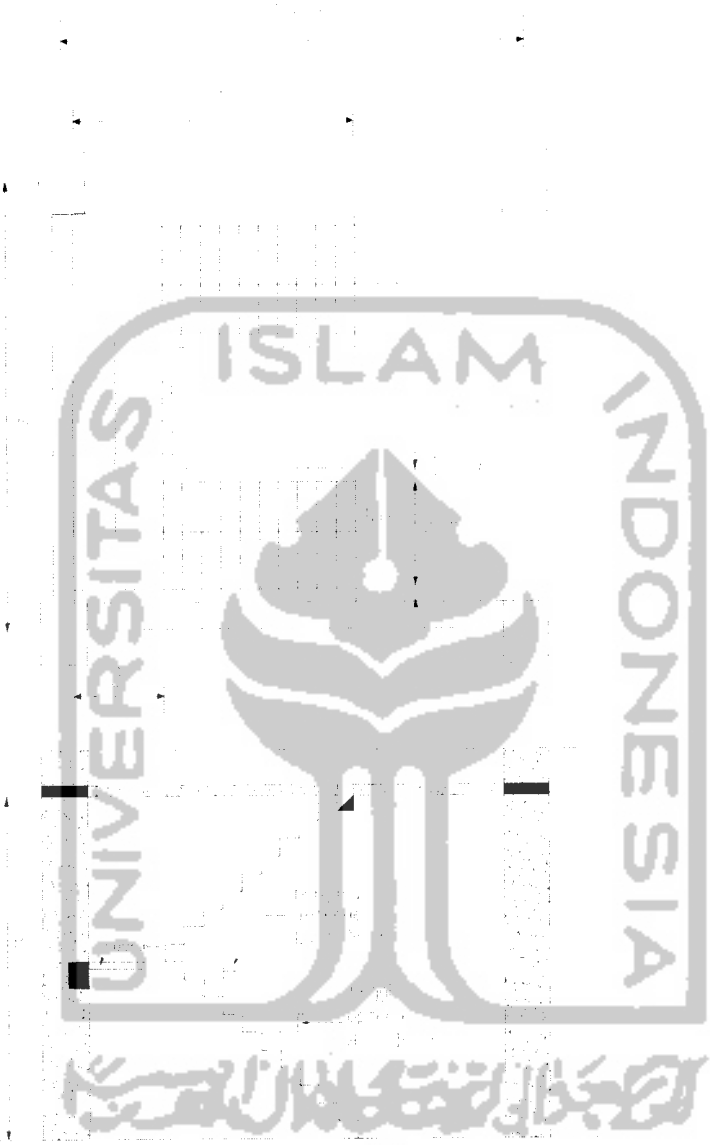
Tabel 4.11 Hasil Perencanaan Pelat Lantai Type H

| Pelat Lantai Type H | |
|---|---|
| Mu (knm) | 1.19 |
| Mr = Mu/Ø | 1.4875 |
| As (mm^2) | 71.73515 |
| 1,33 As (mm^2) | 95.40774 |
| As min (mm^2) | 560 |
| As perlu (mm^2) | 95.40774 |
| Jrk tul (mm) | 526.582 |
| Tulangan pokok | P8 – 200 |
| As pakai (mm) | 251.2 |
| a | 2.837082 |
| Mn | 5.702127 |
| Kontrol | Aman |
| Tulangan Bagi | P8 – 200 |

Tabel 4.12 Hasil Perencanaan Pelat Lantai Type I

| | Pelat Lantai Type I | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| Mu (knm) | 2.664305 | 1.1777 | 4.585308 | 3.494166 |
| Mr = Mu/Ø | 3.330382 | 1.472125 | 5.731635 | 4.367707 |
| As (mm^2) | 160.6087 | 70.99369 | 276.4099 | 210.634 |
| 1,33 As (mm^2) | 213.6095 | 94.42161 | 367.6251 | 280.1432 |
| As min (mm^2) | 560 | 560 | 560 | 560 |
| As perlu (mm^2) | 213.6095 | 94.42161 | 367.6251 | 280.1432 |
| Jrk tul (mm) | 235.1955 | 532.0816 | 136.661 | 179.3368 |
| Tulangan pokok | P8 – 200 | P8 – 200 | P8 - 130 | P8 – 170 |
| As pakai (mm) | 251.2 | 251.2 | 386.4615 | 295.5294 |
| a | 2.837082 | 2.837082 | 4.364742 | 3.337744 |
| Mn | 5.702127 | 5.702127 | 8.701657 | 6.690629 |
| Kontrol | Aman | Aman | Aman | Aman |
| Tulangan Bagi | --- | --- | P8 - 200 | P8 – 200 |

## 4.4 Perencanaan Tangga



Gambar 4.4 Denah tangga lantai basement

1. Data perencanaan tangga :

   a. Tinggi antar lantai = 3,5 m = 350 cm

   b. Lebar bordes = 2,0 m = 200 cm

   c. Lebar tangga = 2,0 m = 200 cm

   d. Beban sandaran tangga :

      Tinggi sandaran = 1 m

      Tebal sandaran = 0,12 m

      Berat sandaran total = 0,12. 24. 2 = 2,88 KN/$m^2$

   e. Tinggi optrede rencana diambil 16 cm

      Jumlah optrede = 350/16 = 22 buah

      Tinggi optrede pakai = 350/22 = 15,9 cm ≈ 16 cm

      Jumlah antrede = 22 – 2 = 20 buah

      Diambil panjang antrede = 30 cm

   f. Sudut kemiringan tangga = 16/30 = arc tg α ⟶ α = 28,072 °

   g. Dimensi tangga

      Panjang tangga = (panjang antrede x jml antrede/2) + lebar bordes

      = (30. 20/2) + 200 = 500 cm

      Lebar bersih tangga = 200 cm

   h. Tebal pelat bordes diambil 20 cm

2. Pembebanan :

   a. Pembebanan bordes :

      ❖ Beban mati (untuk panjang 1 m) :

      - berat sendiri pelat = 0,2.1. 24 = 4,80 KN/m

- berat spesi = 0,03.1. 24 = 0,72 KN/m
- berat keramik = 0,01.1. 20 = 0,20 KN/m
- berat sandaran = (0,12. 24.1. 1)/3,6 = 0,80 KN/m +

$Q_D$ = 6,52 KN/m

❖ Beban hidup (untuk panjang 1 m) :

$Q_L$ = 300.1 = 3 KN/m

b. Pembebanan tangga :

❖ Beban mati (untuk panjang 1m) :

- berat sendiri tangga = $\left(\frac{0,2}{\cos 28,072}+\frac{0,16}{2}\right)\cdot 1.24$ = 7,76 KN/m
- berat spesi = 0,03.1. 24 = 0,72 KN/m
- berat lantai keramik = 0,01.1. 20 = 0,20 KN/m
- berat sandaran = (0,12. 24.1.1. 2)/2 = 2,88 KN/m +

$Q_D$ = 11,56 KN/m

❖ Beban hidup (untuk panjang 1m) :

$Q_L$ = 300.1 = 3 KN/m

3. Perhitungan perencanaan tulangan pelat tangga

Tinggi pelat = 20 cm = 200 mm

$$\rho_b = \frac{0,85\cdot fc'\cdot\beta_1}{fy}\cdot\left(\frac{600}{600+fy}\right)=\frac{0,85\cdot 25\cdot 0,85}{240}\cdot\left(\frac{600}{600+240}\right)$$

= 0,0537

$d = h_{pelat} - pb - 1/2\ \emptyset_{tul}$

= 200 – 20 – 1/2.12 = 174 mm

Jd = 0,9.174 = 156,6 mm

As max = 0,75.$\rho_b$. b.d = 0,75. 0,0537.1000.174 = 7015,346 $mm^2$

As min = 1,4/fy .b.d = 1,4/240.1000.174 = 1015 $mm^2$

a. Perencanaan tulangan lapangan

Data dari SAP 2000 seperti tercantum pada lampiran, didapat momen maksimum lapangan ($M^+$) = 26,36 KNm

Mn = Mu/Ø = 26,36 /0,8 = 32,95 KNm

$$As = \frac{Mu/\phi}{Jd.fy} = \frac{32,95 \cdot 10^6}{156,6.240} = 876,703\ mm^2$$

1,33 As = 1,33. 876,703 = 1166,015 $mm^2$

Check : 1,33 As = 1166,015 $mm^2$ > As min = 1015 $mm^2$ ,maka dipakai As = As min = 1015 $mm^2$ > Ass = 0,002.b.h = 0,002.1000.200 = 400 $mm^2$

Dipakai Ø tulangan = 12 mm ⟶ $A_1Ø = 1/4.\pi. 12^2$ = 113,04 $mm^2$

Jarak tulangan (x) = $A_1Ø$.1000/As = 113,04.1000/1015

= 111,369 mm

Dipakai jarak tulangan (x) = 110 mm

As ada = $A_1Ø$.1000/x = 113,04.1000/110 = 1027,636 $mm^2$

Dipakai tulangan P12 - 110

$$a = \frac{As\ ada \cdot fy}{0,85 \cdot fc' \cdot b} = \frac{1027,636 \cdot 240}{0,85 \cdot 25 \cdot 1000} = 11,606mm$$

$Mn_1$ = As ada. fy.(d – a/2) = 1027,636.240.(174 – 11,606/2).$10^{-6}$

= 41,482 KNm >.Mn =.Mu/ Ø = 32,95 KNm ……Ok

b. Perencanaan tulangan tumpuan

Data dari SAP 2000 seperti tercantum pada lampiran, didapat momen maksimum tumpuan ($M^-$) = 25,93 KNm

Mn = Mu/Ø = 25,93/0,8 = 32,4125 KNm

$$As = \frac{Mu/\phi}{Jd.fy} = \frac{32{,}4125 \cdot 10^6}{156{,}6.240} = 862{,}402\ mm^2$$

1,33 As = 1,33. 862,402 = 1146,994 $mm^2$

Check : 1,33As = 1146,994 $mm^2$ > As min = 1015 $mm^2$ , maka dipakai As min = 1015 $mm^2$ > Ass = 0,002.b.h = 400 $mm^2$ .....Ok

Dipakai Ø tulangan = 12 mm ⟶ $A_1Ø = 1/4.\pi. 12^2 = 113{,}04\ mm^2$

Jarak tulangan (x) = $A_1Ø$.1000/As = 113,04.1000/1015

= 111,369 mm

Dipakai jarak tulangan (x) = 110 mm

As ada = $A_1Ø$.1000/x = 113,04.1000/110 = 1027,636 $mm^2$

Dipakai tulangan P12- 110

$$a = \frac{As\ ada \cdot fy}{0{,}85 \cdot fc' \cdot b} = \frac{1027{,}636 \cdot 240}{0{,}85 \cdot 25 \cdot 1000} = 11{,}606\ mm$$

$Mn_1$ = As ada. fy.(d – a/2) = 1027,636. 240.(174 – 11,606/2).$10^{-6}$

= 41,482 KNm >.Mn =.Mu/ Ø = 32,413 KNm .....Ok

c. Perencanaan tulangan tumpuan pada bordes

Data dari SAP 2000 seperti tercantum pada lampiran, didapat momen maksimum tumpuan ($M^-$) = 25,93 KNm

Mn = Mu/Ø = 25,93/0,8 = 32,4125 KNm

$$As = \frac{Mu/\phi}{Jd.fy} = \frac{32{,}4125 \cdot 10^6}{156{,}6.240} = 862{,}4016\ mm^2$$

1,33 As = 1,33. 862,4016 = 1146,994 $mm^2$

Check : 1,33As = 1146,994 $mm^2$ > As min = 1015 $mm^2$ , maka dipakai As min = 1015 $mm^2$ > Ass = 0,002.b.h = 400 $mm^2$ .....Ok

Dipakai Ø tulangan = 12 mm ⟶ $A_1Ø = 1/4.\pi. 12^2 = 113,04\ mm^2$

Jarak tulangan (x) = $A_1Ø.1000/As$ = 113,04.1000/1015

= 111,369 mm

Dipakai jarak tulangan (x) = 110 mm

As ada = $A_1Ø.1000/x$ = 113,04.1000/110 = 1027,636 $mm^2$

Dipakai tulangan P12 - 110

$$a = \frac{As\ ada \cdot fy}{0,85 \cdot fc' \cdot b} = \frac{1027,636 \cdot 240}{0,85 \cdot 25 \cdot 1000} = 11,606\ mm$$

$Mn_1$ = As ada. fy.(d – a/2) = 1027,636.240.(174 – 11,606/2).$10^{-6}$

= 41,483 KNm >.Mn =.Mu/ Ø = 32,413 KNm .....Ok

4. Perhitungan pondasi tangga

Gambar 4.5 Perencanaan pondasi tangga

a. Data : - σ tanah = 250 KN/$m^2$

- γ batu = 22 KN/$m^3$

- γ tanah = 18 KN/$m^3$

- balok diatas pondasi 40/60

Tinjauan untuk lebar tangga = 2 m

Tinggi pondsi tangga = 1m

b. Pembebanan :

- Akibat beban tangga = 111,85 KN

- Berat balok diatas pondasi = 0,4. 0,6. 2. 24 = 11,52 KN

Diperoleh beban P = 111,89 + 11,52 = 123,41 KN

Tegangan ijin tanah pakai :

σ = σ tanah – berat pondasi

= 250 - 1. 22 = 228 KN/$m^2$

Diketahui pada kondisi kritis ⟶ σ = P/A

A = P/ σ = 123,41 /228 = 0,541 $m^2$

B =A/L = 0,541 /2 = 0,271 m ⟶ diambil lebar (B) = 30 cm

Kontrol tegangan tanah :

σ = P/A = 123,41/(0,3. 2) = 205,683 KN/$m^2$ < σ tanah = 228 KN/$m^2$ .....Ok

## 4.5 Perencanaan Balok Induk

1. Data perencanaan balok :

   a. fy = 400 MPa

   b. fc' = 25 MPa

   c. penutup beton (Pb) = 40 mm

   d. diameter tul.pokok = 22 mm

   e. diameter tul.sengkang = 10 mm

   f. lebar balok (b) = 400 mm

   g. tinggi balok (h) = 600 mm

   h. $\theta = 0,8$

   i. $\beta = 0,85$

   j. d' = 40+10+(22/2) = 61 mm

   k. d = 600 – 61 =539 mm

   l. $\rho b = \frac{0,85 \cdot fc' \cdot \beta_1}{fy} \cdot \left( \frac{600}{600 + fy} \right) = \frac{0,85 \cdot 25 \cdot 0,85}{400} \cdot \left( \frac{600}{600 + 400} \right) = 0,0271$

   m. $\rho \max = 0,75 \cdot \rho b = 0,75 \cdot 0,0271 = 0,0203$

   n. $\rho \min = \frac{1,4}{fy} = \frac{1,4}{400} = 0,0035$

   o. $m = \frac{fy}{0,85.fc'} = \frac{400}{0,85.25} = 18,824$

   p. $\rho_{pakai} = 0,5.\ \rho_{maks} = 0,5.0,0203 = 0,0102$

   q. $Rn = \rho_{pakai}.fy.(1-0,5.\ \rho_{pakai}.\ m)$

   $= 0,0102.\ 400.(1-0,5.\ 0,0102.\ 18,824) = 3,624$ Mpa

2. Perencanaan dimensi balok portal A lantai dasar (GF)

a. Perencanaan tulangan tumpuan

Data dari SAP 2000 seperti tercantum pada lampiran, didapat momen maksimum tumpuan (M) = 254,577 KNm

Mu/O = 254,577 /0,8 = 318,221 KNm

$$bd^2 = \frac{Mn}{Rn} = \frac{318{,}221 \cdot 10^6}{3{,}624} = 87{,}809.10^6$$

Dicoba ukuran b = 400 mm dan h = 600 mm

$$d_{perlu} = \sqrt{\frac{bd^2}{b}} = \sqrt{\frac{87{,}809 \cdot 10^6}{400}} = 468{,}532\ mm$$

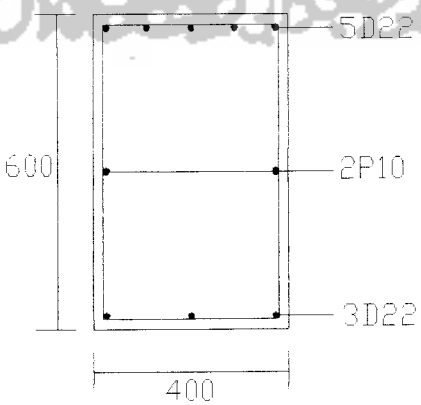
Check : $d_{perlu}$ = 468,532 mm < d = 539 mm, dipakai tulangan sebelah

$$Rn_{baru} = \frac{Mn}{b \cdot d^2} = \frac{318{,}221 \cdot 10^6}{400 \cdot 539^2} = 2{,}738\ MPa < Rn_{lama} = 3{,}624\ \text{MPa}$$

$$\rho_{baru} = \rho_{lama} \cdot \frac{Rn_{baru}}{Rn_{lama}} = 0{,}0102 \cdot \frac{2{,}738}{3{,}624} = 0{,}008$$

$As_{perlu} = \rho_{baru}.b.d = 0{,}008.400.\ 539 = 1724{,}8\ mm^2$

Dipakai 5D22 ⟶ $As_{ada} = 5.\ (1/4).\ \pi.\ 22^2 = 1900\ mm^2$



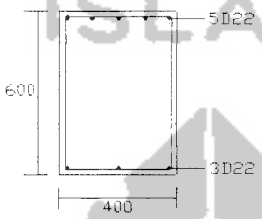

Gambar 4.6 Detail potongan balok induk pada tumpuan

Periksa penempatan tulangan :

$$Ybd = \frac{b - 2\cdot(pb + \theta_{sengkang}) - (n\cdot\theta_{pokok})}{n-1} = \frac{400 - 2\cdot(40+10) - (5\cdot 22)}{5-1}$$

= 47,5 mm > D22 = 22 mm .....Ok

❖ Momen Nominal Aktual Balok Negatif (Mnak,b$^{(-)}$) :




Tulangan atas = 5D22 dengan $As_{ada}$ = 1900 mm$^2$

Tulangan bawah = 3D22 dengan $As'_{ada}$ = 1140 mm$^2$

$$\rho = \frac{As_{ada}}{b\cdot d_{pakai}} = \frac{1900}{400\cdot 539} = 0{,}0088 \;;\; \rho' = \frac{As'_{ada}}{b\cdot d_{pakai}} = \frac{1140}{400\cdot 539} = 0{,}00528$$

$$fs' = 600\cdot\left\{1 - \frac{0{,}85\cdot fc'\cdot\beta_1\cdot d'}{(\rho - \rho')\cdot fy\cdot d}\right\} = 600\cdot\left\{1 - \frac{0{,}85\cdot 25\cdot 0{,}85\cdot 61}{(0{,}0088 - 0{,}00528)\cdot 400\cdot 539}\right\}$$

$$= 271{,}099 \;\; MPa$$

fs' < fy dipakai fs' = 271,099 MPa

$$a = \frac{(As_{ada}\cdot fy) - (As'_{ada}\cdot fs')}{0{,}85\cdot fc'\cdot b} = \frac{(1900\cdot 400) - (1140\cdot 271{,}099)}{0{,}85\cdot 25\cdot 400} = 53{,}053\; mm$$

$Mn_1 = (As_{ada} \,.\, fy - As'_{ada} \,.\, fs') \,.\, (d - a/2)$

$= (1900 \,.\, 400 - 1140 \,.\, 271{,}099) \,.\, (539 - 53{,}053/2) \,.\, 10^{-6}$

= 231,098 KNm

$Mn_2 = (As'_{ada} \,.\, fs') \,.(d\text{-}d')$

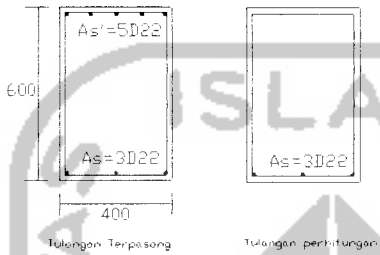
$= (1140 \,.\, 271{,}099) \,.\, (539\text{-}61) \,.10^{-6}$ = 147,727 KNm

$Mnak,b^{(-)} = Mn_1 + Mn_2$

$= 231,098 + 147,727 = 378,825$ KNm > Mu/O = 318,221 KNm …Ok

$Mkap,b^{(-)} = 1,25 \,.\, 378,825 = 473,531$ KNm

❖ Momen Nominal Aktual Balok Positif ($Mnak,b^{(+)}$) :




As = As' = 3D22 =1140 $mm^2$

$$\rho_{aktual} = \frac{As'_{ada}}{b \cdot d} = \frac{1140}{400 \cdot 539} = 0,00528$$

Rn = ρ .fy .(1-0,5 .m .ρ)

$= 0,00528 \,.400 \,.(1-0,5 \,.18,824 \,.0,00528) = 2$ MPa

$Mnak,b^{(+)} = Rn \,.b \,.d^2$

$= 2 \,.400 \,.539^2 \,.10^{-6} = 233,55$ KNm

$Mkap,b^{(+)} = 1,25 \,.233,55 = 291,9375$ KNm

b. Perencanaan tulangan lapangan

Data dari SAP 2000 seperti tercantum pada lampiran, didapat momen maksimum lapangan ($M^+$) = 236,115 KNm

Mn = Mu/O = 236,115/0,8 = 295,144 KNm

$$bd^2 = \frac{Mn}{Rn} = \frac{295,144 \cdot 10^6}{3,624} = 81,442 \cdot 10^6$$

Dicoba ukuran b = 400 mm dan h = 600 mm

$$d_{perlu} = \sqrt{\frac{bd^2}{b}} = \sqrt{\frac{81{,}442 \cdot 10^6}{400}} = 451{,}226\ mm$$

Check : $d_{perlu}$ = 451,226 mm < d = 539 mm, dipakai tulangan sebelah

$$Rn_{baru} = \frac{Mn}{b \cdot d^2} = \frac{295{,}144 \cdot 10^6}{400 \cdot 539^2} = 2{,}54\ MPa < Rn_{lama} = 3{,}624\ \text{MPa}$$

$$\rho_{baru} = \rho_{lama} \cdot \frac{Rn_{baru}}{Rn_{lama}} = 0{,}0102 \cdot \frac{2{,}54}{3{,}624} = 0{,}007$$

$As_{perlu}$ = ρ.b.d = 0,007.400. 539 = 1509,2 $mm^2$

Dipakai 4D22 ⟶ $As_{ada}$ = 4. (1/4). π. $22^2$ = 1520,531 $mm^2$

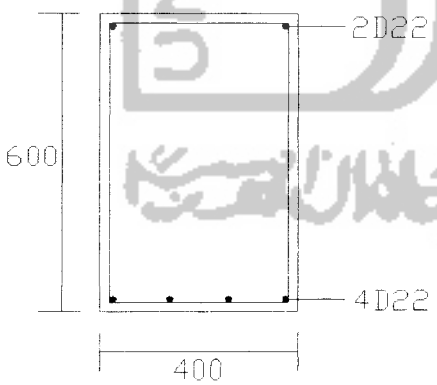
Periksa kapasitas penampang :

$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b} = \frac{1520{,}531 \cdot 400}{0{,}85 \cdot 25 \cdot 400} = 71{,}554\ \text{mm}$$

Mn = As.fy.(d-a/2)

= 1520,531. 400.(539-(71,554/2)).$10^{-6}$

= 306,066 KNm > Mn = Mu/Ø = 295,144 KNm .....Ok




Gambar 4.7 Detail potongan balok induk pada lapangan

Periksa penempatan tulangan :

$$Jbd = \frac{b - 2 \cdot (pb + \theta_{sengkang}) - (n \cdot \theta_{pokok})}{n - 1} = \frac{400 - 2 \cdot (40 + 10) - (4 \cdot 22)}{4 - 1}$$

= 70,667 mm > D22 = 22 mm .....Ok

$$Rn_{baru} = \frac{Mn}{b \cdot d^2} = \frac{295{,}144 \cdot 10^6}{400 \cdot 539^2} = 2{,}54\ MPa < \text{Rn}_{\text{lama}} = 3{,}624\ \text{MPa}$$

$$\rho_{baru} = \rho_{lama} \cdot \frac{Rn_{baru}}{Rn_{lama}} = 0{,}0102 \cdot \frac{2{,}54}{3{,}624} = 0{,}007$$

$\text{As}_{\text{perlu}} = \rho.b.d = 0{,}007.400.\ 539 = 1509{,}2\ \text{mm}^2$

Dipakai 4D22 ⟶ $\text{As}_{\text{ada}} = 4.\ (1/4).\ \pi.\ 22^2 = 1520{,}531\ \text{mm}^2$

Periksa kapasitas penampang :

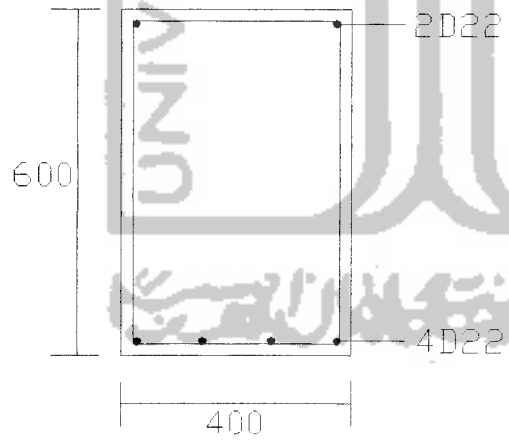
$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b} = \frac{1520{,}531 \cdot 400}{0{,}85 \cdot 25 \cdot 400}$$

$= 71{,}554$ mm

Mn = As.fy.(d-a/2)

$= 1520{,}531.\ 400.(539\text{-}(71{,}554/2)).10^{-6}$

= 306,066 KNm > Mn = Mu/Ø = 295,144 KNm .....Ok




Gambar 4.7 Detail potongan balok induk pada lapangan

Periksa penempatan tulangan :

$$Jbd = \frac{b - 2 \cdot (pb + \theta_{sengkang}) - (n \cdot \theta_{pokok})}{n - 1} = \frac{400 - 2 \cdot (40 + 10) - (4 \cdot 22)}{4 - 1}$$

= 70,667 mm > D22 = 22 mm .....Ok

c. Perencanaan Gaya Geser

Data dari SAP 2000 seperti tercantum pada lampiran, didapat gaya geser maksimum sebagai berikut :

VD = 141,431 KN

VL = 34,031 KN

VE = 21,912 KN

$$Vu_1b = 0,7 \cdot \left( \frac{Mkap,b^{(+)} + Mkap,b^{(-)}}{Ln} \right) + 1,05 \cdot Vg \quad ; Vg = VD + VL$$

$$= 0,7 \cdot \left( \frac{291,9375 + 473,531}{6,5} \right) + 1,05 \cdot (141,431 + 34,031)$$

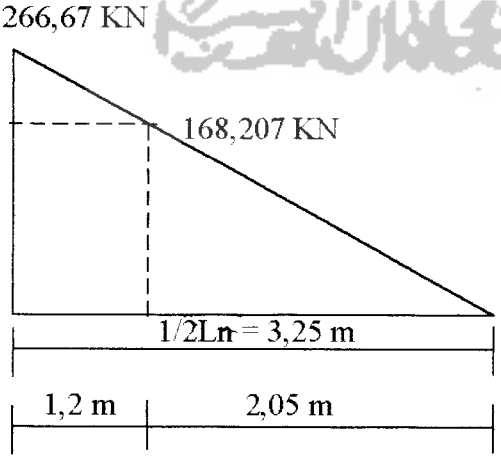
$$= 266,67\ KN$$

$$Vu_2b = 1,05 \cdot \left( VD + VL + \left( {}^{4}/_{K} \right) \cdot VE \right)$$

$$= 1,05 \cdot \left( 141,431 + 34,031 + \left( {}^{4}/_{1} \right) \cdot 21,912 \right)$$

$$= 276,266\ KN$$

Vu pakai adalah nilai terkecil antara $Vu_1b$ dan $Vu_2b$, sehingga didapat Vu pakai = 266,67 KN




$$\frac{266,67}{X} = \frac{3,25}{2,05}$$

X = 168,207 KN

Gambar 4.8 Diagram segitiga tegangan geser

Daerah sendi plastis (sepanjang 2h) :

Vc = 0 (beton dianggap tidak menerima geser)

$$Vs = \frac{Vub\ pakai}{\phi} = \frac{266,67}{0,6} = 444,45\ KN$$

Tersedia tul.sengkang $P_{10}$ mm ⟶ fy = 240 Mpa

$$S = \frac{4 \cdot A_V \cdot fy \cdot d}{Vs} = \frac{4 \cdot 0,25 \cdot \pi \cdot 10^2 \cdot 240 \cdot 539}{444,45 \cdot 10^3}$$

= 91,43 mm < d/4 = 539/4 = 134,75 mm, maka S pakai = 90 mm

Dipakai tulangan $P_{10\text{-}90}$

Periksa :

Vub/Ø < Vc + Vs

266,67 /0,8 < 0 + 444,45

333,33 KN < 444,45 KN .....Ok

Daerah luar sendi plastis :

Vub diluar daerah sendi plastis diperoleh = 174,107 KN

$$Vc = \frac{1}{6} \cdot \sqrt{fc'} \cdot b \cdot d = \frac{1}{6} \cdot \sqrt{25} \cdot 400 \cdot 539 \cdot 10^{-3} = 179,667\ KN$$

$$Vs = \frac{Vub\ pakai}{0,6} \quad Vc = \frac{168,207}{0,6} - 179,667 = 100,678\ KN$$

$$S = \frac{4 \cdot Av \cdot fy \cdot d}{Vs} = \frac{4 \cdot 0,25 \cdot \pi \cdot 10^2 \cdot 240 \cdot 539}{100,678 \cdot 10^3}$$

= 403,659 mm > d/2 = 539/2 = 269,5 mm, maka S pakai = 265 mm

Dipakai tulangan $P_{10\text{-}265}$

Periksa :

Vub/O < Vc + Vs

168,207 /0,8 < 179,667 + 100,678

210,258 KN < 280,345 KN .....Ok

## 4.6 Perencanaan Kolom

1. Data :

   a. Ukuran kolom :

      b = 700 mm

      h = 700 mm

   b. Ukuran balok :

      b = 400 mm

      h = 600 mm

   c. r = 0,3.h = 0,3.0,7 = 0,21 m

   d. fc' = 25 MPa

   e. Fy deform = 400 MPa

   f. Fy polos = 240 MPa

   g. $Ec = Eg = 4700 \cdot \sqrt{fc'} = 4700 \cdot \sqrt{25} = 23500\ MPa = 23500000\ KN/m^2$

   h. Ic (Inersia kolom) = $1/12.b_k.h_k^3 = 1/12.\ 0,7.\ 0,7^3 = 0,02\ m^4$

   i. Ig (Inersia balok) = $1/12.b_b.h_b^3 = 1/12.\ 0,4.\ 0,6^3 = 0,0072\ m^4$

   j. Tinggi kolom = 4,5 m

   k. Tinggi (h) pondasi = 1,8 m

   l. Panjang balok ($Lb_1$) = 7,2 m

   m. $Lb_1$' (bentang bersih balok) = $Lb_1$-b kolom = 7,2 – 0,7 = 6,5 m

   n. $Lb_2$ = 7,2 m

   o. $Lb_2$' = 6,5 m

   p. Cm = 1 (unbraced frame)

   q. Ø = 0,65

   r. Øo = 1,25

s. d' = 61 mm

t. d = h-d' = 700-61 = 639 mm

2. Perencanaan grafik Mn – Pn

a. Batang desak aksial

Ag = b.h

= 700. 700 = 490000 $mm^2$

Ast = 1%.Ag

= 1%. 490000 = 4900 $mm^2$

Po = (0,85.fc'.(Ag-Ast) + Ast..fy).$10^{-3}$

= (0,85. 25. (490000-4900) + 4900. 400).$10^{-3}$

= 12268,375 KN = 1226,8375 T

Pno = 0,8.Po

= 0,8. 12268,375

= 9814,7 KN = 981,47 T

b. Batang desak dan momen

1) Keadaan seimbang

$$xb = \frac{600}{600 + fy} \cdot d = \frac{600}{600 + 400} \cdot 639 = 383{,}4\ mm$$

$$fs' = \frac{xb - d'}{xb} \cdot 600 = \frac{383{,}4 - 61}{383{,}4} \cdot 600$$

= 504,5383 MPa ≥ fy = 400 MPa

fs' pakai = fy = 400 MPa

a = $\beta_1$. xb = 0,85. 383,4 = 325,89 mm

Cc = 0,85. fc'. b. a. $10^{-3}$ = 0,85. 25. 700. 325,89. $10^{-3}$

= 4847,6138 KN = 484,7614 T

As = As' = 1/2. Ast = 1/2. 4900 = 2450 $mm^2$

Cs = As'. (fs'- 0,85. fc'). $10^{-3}$ = 2450. (400 – 0,85. 25). $10^{-3}$

= 927,9375 KN = 92,7938 T

Ts = As. fy. $10^{-3}$ = 2450. 400. $10^{-3}$

= 980 KN = 98 T

Mnb = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= (4847,6138.(700/2 –325,89 /2) + 927,9375. (700/2 –61) + 980.

(639 – 700/2)). $10^{-3}$

= 1458,1643 KNm = 145,8164 Tm

Pnb = Cc + Cs – Ts = 4847,6138 + 927,9375 – 980

= 4795,5513 KN = 479,5551 T

$$eb = \frac{Mnb}{Pnb} = \frac{1458,1643}{4795,5513} = 0,3041\ m$$

2) Patah desak

- x = 190 %. xb = 1,9. 383,4

= 728,46 mm > xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{728,46 - 61}{728,46} \cdot 600$$

= 549,757 MPa ≥ fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 728,46}{728,46} \cdot 600$$

= -73,6842 MPa < fy = 400 MPa

fs pakai = -73,6842 MPa

a = $\beta_1$. x = 0,85. 728,46 = 619,191 mm

Cc = 0,85. fc'.b. a. $10^{-3}$ = 0,85. 25. 700. 619,191. $10^{-3}$

= 9210,4661 KN = 921,0466 T

Cs = As'.(fs'- 0,85.fc').$10^{-3}$ = 2450.(400 – 0,85. 25).$10^{-3}$

= 927,9375 KN = 92,7938 T

Ts = As. fs. $10^{-3}$ = 2450.( -73,6842).$10^{-3}$ = -180,5263 KN

Pn = Cc + Cs – Ts

= 9210,4661 + 927,9375 + 180,5263 = 10318,9299 KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= (9210,4661.(700/2 – 619,191/2 )+ 927,9375.(700/2 – 61) –

180,5263 .(639 - 700/2)).$10^{-3}$

= 588,15 KNm = 58,815 Tm

$$e = \frac{Mn}{Pn} = \frac{588,15}{10318,9299} = 0,057\ m$$

- x = 150 %. xb = 1,5. 383,4

= 575,1 mm > xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{575,1 - 61}{575,1} \cdot 600$$

= 536,3589 MPa > fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 575,1}{575,1} \cdot 600$$

= 66,6667 MPa ≤ fy = 400 MPa

fs pakai = 66,6667 MPa

$a = \beta_1 . x = 0,85 . 575,1 = 488,835$ mm

$Cc = 0,85 . fc' . b . a . 10^{-3} = 0,85 . 25 . 700 . 488,835 . 10^{-3}$

$= 7271,4206$ KN = 727,1421 T

$Cs = As'.(fs' - 0,85.fc').10^{-3} = 2450.(400 - 0,85 . 25).10^{-3}$

$= 927,9375$ KN = 92,7938 T

$Ts = As . fs . 10^{-3} = 2450.( 66,6667).10^{-3} = 163,3334$ KN

Pn = Cc + Cs – Ts

$= 7271,4206 + 927,9375 - 163,3334 = 8036,0247$ KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

$= 7271,4206 . (700/2 - 488,835/2) + 927,9375.(700/2 - 61) + 163,3334.(639 - 700/2).10^{-3}$

$= 1083,1121$ KNm = 108,3112 Tm

$$e = \frac{Mn}{Pn} = \frac{1083,1121}{8036,0247} = 0,1345\ m$$

- x = 125 %. xb = 1,25. 383,4

  = 479,25 mm > xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{479,25 - 61}{479,25} \cdot 600$$

= 523,6307 MPa > fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 479,25}{479,25} \cdot 600$$

= 200 MPa ≤ fy = 400 MPa

fs pakai = 200 MPa

a = $\beta_1$. x = 0,85. 479,25 = 407,3625 mm

Cc = 0,85. fc'.b. a. $10^{-3}$ = 0,85. 25. 700. 407,3625. $10^{-3}$

= 6059,5172 KN = 605,9517 T

Cs = As'.(fs'- 0,85.fc').$10^{-3}$ = 2450.(400 – 0,85. 25).$10^{-3}$

= 927,9375 KN = 92,7938 T

Ts = As. fs. $10^{-3}$ = 2450.(200).$10^{-3}$ = 490 KN

Pn = Cc + Cs – Ts

= 6059,5172 + 927,9375 - 490 = 6497,4547 KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= 6059,5172.(700/2 – 407,3625/2) + 927,9375.(700/2 - 61) + 490.(639 -700/2).$10^{-3}$

= 1296,4049 KNm = 129,6405 Tm

$$e = \frac{Mn}{Pn} = \frac{1296,4049}{6497,4547} = 0,1995\ m$$

3) Patah tarik

- x = 75 %. xb = 0,75. 383,4

= 287,55 mm < xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{287,55 - 61}{287,55} \cdot 600$$

= 472,7178 MPa > fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 287,55}{287,55} \cdot 600$$

= 733,3333 MPa ≥ fy = 400 MPa

fs pakai = 400 MPa

a = $\beta_1$. x = 0,85. 287,55 = 244,4175 mm

Cc = 0,85. fc'.b. a. $10^{-3}$ = 0,85. 25. 700. 244,4175. $10^{-3}$

= 3635,7103 KN = 363,571 T

Cs = As'.(fs'- 0,85.fc').$10^{-3}$ = 2450.(400 – 0,85. 25).$10^{-3}$

= 927,9375 KN = 92,7938 T

Ts = As. fs. $10^{-3}$ = 2450. 400.$10^{-3}$ = 980 KN

Pn = Cc + Cs – Ts

= 3635,7103 + 927,9375 -980 = 3583,6478 KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= 3635,7103.(700/2 - 244,4175/2) + 927,9375.(700/2 - 61) + 980.(639-700/2).$10^{-3}$

= 1379,5769 KNm = 137,9577 Tm

$$e = \frac{Mn}{Pn} = \frac{1379,5769}{3583,6478} = 0,385\ m$$

- x = 60 %. xb = 0,6. 383,4

= 230,04 mm < xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{230,04 - 61}{230,04} \cdot 600$$

= 440,8972 MPa > fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 230,04}{230,04} \cdot 600$$

= 1066,6667 MPa ≥ fy = 400 MPa

fs pakai = 400 MPa

$a = \beta_1 . x = 0,85 . 230,04 = 195,534$ mm

$Cc = 0,85 . fc' . b . a . 10^{-3} = 0,85 . 25 . 700 . 195,534 . 10^{-3}$

= 2908,5683 KN = 290,8568 T

$Cs = As' . (fs' - 0,85 . fc') . 10^{-3} = 2450 . (400 - 0,85 . 25) . 10^{-3}$

= 927,9375 KN = 92,7938 T

$Ts = As . fs . 10^{-3} = 2450 . 400 . 10^{-3} = 980$ KN

Pn = Cc + Cs – Ts

= 2908,5683 + 927,9375- 980= 2856,5058 KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= 2908,5683.(700/2-195,534/2) + 927,9375.(700/2- 61) + 980.(639-700/2).$10^{-3}$

= 1285,0308 KNm = 128,5031 Tm

$$e = \frac{Mn}{Pn} = \frac{1285,0308}{2856,5058} = 0,4499\ m$$

- x = 50 %. xb = 0,5. 383,4

= 191,7 mm < xb = 383,4 mm

$$fs' = \frac{x - d'}{x} \cdot 600 = \frac{191,7 - 61}{191,7} \cdot 600$$

= 409,0767 MPa > fy = 400 MPa

fs' pakai = fy = 400 MPa

$$fs = \frac{d - x}{x} \cdot 600 = \frac{639 - 191,7}{191,7} \cdot 600$$

= 1400 MPa ≥ fy = 400 MPa

fs pakai = 400 MPa

$a = \beta_1 . x = 0,85 . 191,7 = 162,945$ mm

$Cc = 0,85 . fc'.b . a . 10^{-3} = 0,85 . 25 . 700 . 162,945 . 10^{-3}$

= 2423,8069 KN = 242,3807 T

$Cs = As'.(fs' - 0,85.fc').10^{-3} = 2450.(400 - 0,85 . 25).10^{-3}$

= 927,9375 KN = 92,7938 T

$Ts = As . fs . 10^{-3} = 2450 . 400 . 10^{-3} = 980$ KN

Pn = Cc + Cs – Ts

= 2423,8069 + 927,9375 -980 = 2371,7444 KN

Mn = Cc.(h/2 – a/2) + Cs.(h/2 – d') + Ts.(d – h/2)

= 2423,8069.(700/2 – 162,945/2) + 927,9375.(700/2 - 61) + 980.(639 -700/2).$10^{-3}$

= 1202,2527 KNm = 120,2253 Tm

$$e = \frac{Mn}{Pn} = \frac{1202,2527}{2371,7444} = 0,5069\ m$$

c. Lentur murni

$$a = \frac{As \cdot fy}{0,85 \cdot fc \cdot b} = \frac{2450 \cdot 400}{0,85 \cdot 25 \cdot 700} = 65,8824\ mm$$

$Mn = As . fy.(d – a/2).10^{-6} = 2450 . 400.(639 – 65,8824/2).10^{-6}$

= 593,9376 KNm = 59,3938 Tm

3. Perencanaan kolom tengah portal B-A elemen KA28

   a. Data momen diperoleh dari SAP 2000 seperti tercantum pada lampiran :

   $MD_A$ = 56,242 KNm  $MD_B$ = 53,906 KNm

   $ML_A$ = 20,43 KNm  $ML_B$ = 16,08 KNm

   $ME_A$ = 119,514 KNm  $ME_B$ = 139,24 KNm

   $Mu_A$ = 198,284 KNm  $Mu_B$ = 214,438 KNm

   b. Data gaya aksial diperoleh dari SAP 2000 seperti tercantum pada lampiran :

   $PD_A$ = 1968,199 KN  $PD_B$ = 2021,119 KN

   $PL_A$ = 381,926 KN  $PL_B$ = 381,926 KN

   $PE_A$ = 103,155 KN  $PE_B$ =103,155 KN

   $Pu_A$ = 2972,92 KN  $Pu_B$ = 3036,424 KN

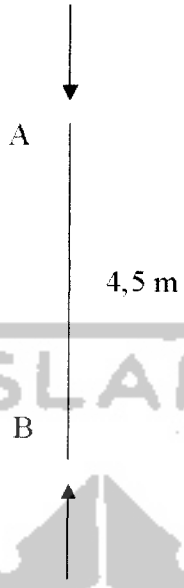
   c. Data gaya geser diperoleh dari SAP 2000 seperti tercantum pada lampiran :

   $VD_A$ = 8,578 KN  $VD_B$ = 9,785 KN

   $VL_A$ = 15,272 KN  $VL_B$ = 15,272 KN

   $VE_A$ = 35,378 KN  $VE_B$ = 35,378 KN

d. Perhitungan momen rencana (Mc)




Gambar 4.9 Elemen kolom

e = Mu/Pu

= 198.284 /2972.92 = 0,0667 m

$e_{min}$ = (1,5 + 0,03.h) cm = (1,5 + 0,03.70) cm = 3,6 cm = 0,036 m

= 0,036 m < 0,0667 m, maka dipakai e = 0,0667 m

$$\psi_A = \frac{\sum\left(\frac{Ec \cdot Ic}{Lc}\right)}{\sum\left(\frac{Eg \cdot Ig}{Lg}\right)} = \frac{\sum\left(\frac{23500000 \cdot 0,02}{4,5}\right) + \left(\frac{23500000 \cdot 0,02}{4,5}\right)}{\sum\left(\frac{23500000 \cdot 0,0072}{6,5}\right) + \left(\frac{23500000 \cdot 0,0072}{6,5}\right)}$$

= 4,014

$$\psi_B = \frac{\sum\left(\frac{Ec \cdot Ic}{Lc}\right)}{\sum\left(\frac{Eg \cdot Ig}{Lg}\right)} = \frac{\sum\left(\frac{23500000 \cdot 0,02}{4,5}\right) + \left(\frac{23500000 \cdot 0,02}{5}\right)}{\sum\left(\frac{23500000 \cdot 0,0072}{6,5}\right) + \left(\frac{23500000 \cdot 0,0072}{6,5}\right)}$$

= 3,813

Lihat nomogram unbranced frames, didapat k = 2

$$\frac{k \cdot l}{r} = \frac{2 \cdot (4{,}5 - 0{,}6)}{0{,}21}$$

= 37,143 > 22 dan ≤ 100, maka termasuk kolom panjang, sehingga dipakai konsep perbesaran momen :

$$EI_1 = \frac{\frac{1}{5} \cdot (Ec \cdot Ig) + Es \cdot Ise}{1 + \beta d}$$

$$= \frac{\frac{1}{5} \cdot (23500000 \cdot 0{,}0072) + (2.10^8 \cdot 0{,}025 \cdot 0{,}7 \cdot 0{,}7 \cdot 0{,}289^2)}{\left(1 + \frac{2361{,}8388}{2972{,}9204}\right)}$$

$$= 132891{,}054\ KNm^2$$

$$EI_2 = \frac{0{,}4 \cdot Ec \cdot Ig}{1 + \beta d} = \frac{0{,}4 \cdot 23500000 \cdot 0{,}0072}{\left(1 + \frac{2361{,}8388}{2972{,}9204}\right)}$$

$$= 37716{,}276\ KNm^2$$

dipakai EI = 132891,054 $KNm^2$

$$Pc = \frac{\pi^2 \cdot EI}{(k \cdot l)^2} = \frac{\pi^2 \cdot 132891{,}054}{(2 \cdot 3{,}9)^2} = 21557{,}993\ KN$$

$$\delta b = \frac{Cm}{1 - \left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

$$= \frac{1}{1 - \left(\frac{2972{,}9204}{0{,}65 \cdot 21557{,}993}\right)} \geq 1$$

$$= 1{,}269$$

ΣPu = 2407,796+2848,042+2791,534+2972,92+2919,828+2298,98

= 16239,1 KN

ΣPc =126427,604+22002,37+21743,841+21557,993+21977,94+127512,32

= 341222,065 KN

$$\delta s = \frac{1}{1-\left(\frac{\sum Pu}{\phi \cdot \sum Pc}\right)} \geq 1$$

$$= \frac{1}{1-\left(\frac{16239,1}{0,65 \cdot 341222,065}\right)} \geq 1$$

= 1,079

$Mu_1$ = 1,2. MD + 1,6.ML = 1,2. 56,242 + 1,6. 20,43 = 100,178 KNm

$Mu_2$ = ME = 119,514 KNm

Mc = δb.$Mu_1$ + δs.$Mu_2$

= 1,269. 100,178 + 1,097. 119,514 = 258,233 KNm

e. Perencanaan tulangan kolom

Kolom tengah portal B-A elemen KA28

hk = 4,5 m

hk' = 4,5 – h balok

= 4,5 – 0,6 = 3,9 m

Rv = 1

$Mkap_{kiri}$ = 292,038 KNm

$Mkap_{kanan}$ = 473,711 KNm

$Nuk_1$ = 0,7. Rv. ($Mkap_{kiri}$ + $Mkap_{kanan}$)/hk + 1,05. Ng

= 0,7. 1.( (-292,038) + 473,711)/4,5 + 1,05. (1968,199 + 381,926)

= 2495,891 KN

$Nuk_2$ = 1,05. ($P_D$ + $P_L$ + (4/K). $P_E$)

= 1,05. (1968,199 + 381,926 + (4/1). 103,155)

= 2900,882 KN

dipakai Nuk minimum, yaitu $Nuk_1$ = 2495,891 KN

$Mmaks_{atas}$ = 198,284 KNm

$Mmaks_{bawah}$ = 214,438 KNm

$$\alpha_k = \frac{Mmaks_{atas}}{Mmaks_{atas} + Mmaks_{bawah}} = \frac{198,284}{198,284 + 214,438}$$

$$= 0,48$$

$\omega_d$ = 1,3

$$Muk_1 = \frac{hk}{hk'} \cdot 0,7 \cdot \omega_d \cdot \alpha_k \cdot \left( \frac{l_{ki}}{l_{nki}} \cdot (\Sigma Mkap\ bx + 0,3 \cdot \Sigma Mkap\ by) \right)$$

$$= \frac{4,5}{3,9} \cdot 0,7 \cdot 1,3 \cdot 0,48 \cdot \left( \frac{7,2}{6,5} \cdot ((473,711 + 292,038) + 0,3 \cdot (564,33 + 292,038)) \right)$$

$$= 570,927\ KNm$$

$$Muk_2 = \frac{hk}{hk'} \cdot 0,7 \cdot \omega_d \cdot \alpha_k \cdot \left( \frac{l_{ki}}{l_{nki}} \cdot (0,3 \cdot \Sigma Mkap\ bx + \Sigma Mkap\ by) \right)$$

$$= \frac{4,5}{3,9} \cdot 0,7 \cdot 1,3 \cdot 0,48 \cdot \left( \frac{7,2}{6,5} \cdot (0,3 \cdot (473,711 + 292,038) + (564,33 + 292,038)) \right)$$

$$= 606,34\ KNm$$

$Muk_3 = 1,05.(M_{Dk} + M_{Lk} + (4/K).M_{Ek})$

= 1,05. (56,242 +20,43 + (4/1).119,514)

= 582,464 KNm

Dipakai Muk minimum, yaitu $Muk_3$ = 570,927 KNm

Bandingkan Mc = 258,233 KNm dan Muk pakai = 570,927 KNm, sehingga dipakai yang terbesar, yaitu Mu terpakai = 570,927 KNm

Mu/Ø = 570,927 /0,65 = 878,349 KNm = 87,8349 Tm

Nu/Ø = 2495,891 /0,65 = 3839,832 KN = 383,983 T

$$e = \frac{Mu/\phi}{Nu/\phi} = \frac{87,8349}{383,983} = 0,2287\ m$$

Dari grafik Pn-Mn, didapat luas tulangan total (Ast) :

Ast ≤ 1%. b. h = 1%. 700. 700 = 4900 mm$^2$ ⟶ diambil Ast = 1 %. b. h

As perlu = Ast/2

= 4900/2 = 2450 mm$^2$

dipakai 7D22 ⟶ As ada = 2660,929 mm$^2$ > As perlu .....Ok

As = As' = 2660,929 mm$^2$

Keadaan seimbang :

$$cb = \frac{600}{600 + fy} \cdot d = \frac{600}{600 + 400} \cdot 639 = 383,4\ mm$$

$$fs' = \frac{cb - d'}{cb} \cdot 600 = \frac{383,4 - 61}{383,4} \cdot 600 = 504,538\ MPa > \text{fy} = 400\ \text{MPa}$$

dipakai fs' = fy = 400 MPa

Cc = 0,85. fc'.b. β. cb = (0,85. 25. 700. 0,85. 383,4). $10^{-3}$ = 4847,614 KN

Cs = As'. (fs'-0,85. fc') = 2660,929.(400-0,85. 25).$10^{-3}$ = 1007,827 KN

Ts = As. fy = (2660,929. 400).$10^{-3}$ = 1064,372 KN

Pnb = Cc + Cs – Ts

= 4847,614 + 1007,827 - 1064,372 = 4791,069 KN = 479,107 T

Mnb = Cc.((h/2)-((β.cb)/2)) + Cs.((h/2)-d') + Ts.(d-(h/2))

= (4847,614.((700/2)-((0,85.383,4)/2)) + 1007,827((700/2)-61) +

1064,372. (639-(700/2))).$10^{-3}$

= 1505,636 KNm = 150,564 Tm

Nu / Ø = 3839,832 KN < Pnb = 4791,107 KN

Terjadi patah tarik :

Kontrol patah tarik dengan rumus Whitney :

$$Pn = 0{,}85 \cdot fc' \cdot b \cdot d \cdot \left[ \frac{h - 2 \cdot e}{2 \cdot d} + \sqrt{\left( \left( \frac{h - 2 \cdot e}{2 \cdot d} \right)^2 + 2 \cdot m \cdot \rho_b \cdot \left( 1 - \frac{d}{d'} \right) \right)} \right]$$

$$= 0{,}85 \cdot 25 \cdot 10^3 \cdot 700 \cdot 10^{-3} \cdot 639 \cdot 10^{-3} \cdot \{ \frac{700 \cdot 10^{-3} - 2 \cdot 0{,}2314 \cdot 10^{-3}}{2 \cdot 639 \cdot 10^{-3}} +$$

$$\sqrt{\left( \frac{700 \cdot 10^{-3} - 2 \cdot 0{,}2314 \cdot 10^{-3}}{2 \cdot 639 \cdot 10^{-3}} \right)^2 + \frac{2 \cdot 400}{0{,}85 \cdot 25} \cdot \frac{2660{,}929}{700 \cdot 639} \cdot \left( 1 - \frac{61}{639} \right)} \}$$

$$= 11938{,}675\ KN \quad > \quad Nu / \phi = 4023{,}089\ KN$$

.....Ok

f. Perencanaan tulangan geser kolom

$Vuk_1 = (Muk_{atas} + Muk_{bawah})/hk'$

$= (571{,}439 + 617{,}993)/3{,}9$

$= 304{,}982$ KN

$Vuk_2 = 1{,}05.(V_{Dk} + V_{Lk} + (4/K).\ V_{Ek})$

$= 1{,}05.\ (8{,}578 + 15{,}272 + (4/1).35{,}378)$

$= 173{,}63$ KN

Vu pakai adalah nilai terkecil antara $Vuk_1$ dan $Vuk_2$, sehingga didapat Vuk pakai = 173,63 KN

$$Vs = \frac{Vuk\ pakai}{\phi}$$

$$= \frac{173{,}63}{0{,}6} = 289{,}383\ KN$$

Tersedia tul.sengkang $P_{10}$ mm ⟶ fy = 240 Mpa

$$S = \frac{2 \cdot A_V \cdot fy \cdot d}{Vs}$$

$$= \frac{2 \cdot 0{,}25 \cdot \pi \cdot 10^2 \cdot 240 \cdot 639}{289{,}383 \cdot 10^3}$$

= 83,245 mm ≤ 8D22 = 176 mm, maka S pakai = 80 mm

Periksa :

Vuk/Ø < Vs

173,63 /0,8 < 289,383 KN

217,0375 KN < 289,383 KN .....Ok

4. Pertemuan balok kolom (JG41)

➢ Pertemuan balok kolom luar

1. Perhitungan gaya-gaya dalam

Mnak,ki = 233,63 KNm

Mnak,ka = 378,968 KNm

Mkap,ki = 1,25. Mnak,b

= 1,25. 233,63 = 292,038 KNm

Mkap,ka = 1,25. Mnak,b

= 1,25. 378,968 = 473,710 KNm

$$V_{kol} = \frac{0,7 \cdot \left( Lki/Lnki \cdot Mkap,ki + Lka/Lnka \cdot Mkap,ka \right)}{1/2 \cdot (hk,a + Hk,b)}$$

$$= \frac{0,7 \cdot \left( 7,2/6,5 \cdot 292,038 + 1/0,65 \cdot 473,710 \right)}{1/2 \cdot (5 + 3,5)} = 173,315\ KN$$

$T_{ka}$ = 0,7. Mkap,ka/zka

$C_{ki}$ = 0,7. Mkap,ki/zki

d = 639 mm = 0,639 m

zka = zki = 0,85. d

= 0,85. 639 = 543,15 mm = 0,5432 m

$T_{ka}$ = 0,7. 473,710 /0,5432 = 610,507 KN

$C_{ki}$ = 0,7. 292,038 /0,5432 = 376,372 KN

Vj,h = $T_{ka}$ + $C_{ki}$ – Vkol

= 610,507 + 376,372 – 173,315 = 813,563 KN

2. Kontrol tegangan geser horizontal minimal

$$vj,h = \frac{Vj,h}{bj \cdot hc} \leq 1{,}5 \cdot \sqrt{fc'} \quad ; bj = h = 700\ mm$$

$$vj,h = \frac{813{,}563}{0{,}7 \cdot 0{,}7} = 1660\ KN/m^2 = 1{,}660\ \text{N/mm}^2 < 1{,}5.\sqrt{25} = 7{,}5\ \text{N/m}^2$$

.....Ok

3. Penulangan geser horizontal

Nu = 2556,448 KN

$$\frac{Nu}{Ag} = \frac{2556{,}448}{0{,}7 \cdot 0{,}7} = 5217\ KN/m^2 = 5{,}217\ \text{N/mm}^2$$

$$Vc,h = \tfrac{2}{3} \cdot \sqrt{\left\{\left(Nuk/Ag\right) - 0{,}1 \cdot fc'\right\}} \cdot bj \cdot hc$$

$$Vc,h = \tfrac{2}{3} \cdot \sqrt{\{5{,}217 - 0{,}1 \cdot 25\}} \cdot 700 \cdot 700$$

$$= 538479\ \text{N} = 538{,}479\ \text{KN}$$

Vs,h + Vc,h = Vj,h

Vs,h = 813,563 - 538,479 = 275,084 KN

$$Aj,h = \frac{Vs,h}{fy} = \frac{275084}{240} = 1146{,}184\ mm^2$$

Digunakan sengkang rangkap P10 dengan Av = 314,159 mm$^2$

$$Jumlah\ lapis\ sengkang = \frac{1146{,}184}{314{,}159} = 3{,}648 = 4\ lapis$$

4. Penulangan geser vertikal

$$Vc,v = \frac{As'}{As} \cdot Vj,h \cdot \left(0{,}6 + Nuk/Ag \cdot fc'\right)$$

$$= 1 \cdot 813{,}563 \cdot 10^3 \cdot (0{,}6 + 5{,}217 / 25)$$

$$= 657920N = 657{,}920KN$$

Vj,v = bc/hc. Vj,h = (0,7/0,7). 813,563= 813,563 KN

Vs,v = Vj,v – Vc,v = 813,563 – 657,920 = 155,643 KN

$$Aj,v = \frac{Vs,v}{fy} = \frac{155643}{240} = 648{,}513\ mm^2$$

pakai 9D10 dengan As = 706,86 $mm^2$ > Aj,v = 648,513 $mm^2$

5. Kontrol jarak tulangan vertikal

s = (hc – 2. pb – 2.$O_{sengkang}$ – n. $O_{tulangan}$)/(n -1)

= (700 – 2. 40 – 2. 10 – 2. 10)/9 = 63,75 mm ≥ 20 mm .....Ok

➢ Pertemuan balok kolom dalam

1. Perhitungan gaya-gaya dalam

Mnak,ki = 158,474 KNm

Mnak,ka = 305,76 KNm

Mkap,ki = 1,25. Mnak,b = 1,25. 158,474 = 198,093 KNm

Mkap,ka = 1,25. Mnak,b = 1,25. 305,76 = 382,200 KNm

$$V_{kol} = \frac{0{,}7 \cdot \left(\frac{Lki}{Lnki} \cdot Mkap,ki + \frac{Lka}{Lnka} \cdot Mkap,ka\right)}{\frac{1}{2} \cdot (hk,a + Hk,b)}$$

$$= \frac{0{,}7 \cdot \left(\frac{3{,}6}{3{,}05} \cdot 198{,}093 + \frac{7{,}2}{6{,}5} \cdot 382{,}200\right)}{\frac{1}{2} \cdot (5 + 3{,}5)} = 108{,}240\ KN$$

$T_{ka}$ = 0,7. Mkap,ka/zka

$C_{ki}$ = 0,7. Mkap,ki/zki

d = 639 mm = 0,639 m

zka = zki = 0,85. d = 0,85. 639 = 543,15 mm = 0,5432 m

$T_{ka}$ = 0,7. 382,200 /0,5432 = 492,571 KN

$C_{ki}$ = 0,7. 198,093 /0,5432 = 255,297 KN

$Vj,h = T_{ka} + C_{ki} - Vkol = 492,571 + 255,297 - 108,24 = 639,628$ KN

2. Kontrol tegangan geser horizontal minimal

$$vj,h = \frac{Vj,h}{bj \cdot hc} \leq 1,5 \cdot \sqrt{fc'} \quad ; bj = h = 700\ mm$$

$$vj,h = \frac{639,628}{0,7 \cdot 0,7} = 1305\ KN/m^2 = 1,305\ \text{N/mm}^2 < 1,5.\sqrt{25} = 7,5\ \text{N/m}^2$$

.....Ok

3. Penulangan geser horizontal

Nu = 2556,448 KN

$$\frac{Nu}{Ag} = \frac{2556,448}{0,7 \cdot 0,7} = 5217\ KN/m^2 = 5,217\ \text{N/mm}^2$$

$$Vc,h = \frac{2}{3} \cdot \sqrt{\left\{\left(\frac{Nuk}{Ag}\right) - 0,1 \cdot fc'\right\}} \cdot bj \cdot hc$$

$$Vc,h = \frac{2}{3} \cdot \sqrt{\{5,217 - 0,1 \cdot 25\}} \cdot 700 \cdot 700$$

$= 538,479$ N $= 538,479$ KN

Vs,h + Vc,h = Vj,h

Vs,h = 639,628 – 538,479 = 101,149 KN

$$Aj,h = \frac{Vs,h}{fy} = \frac{101149}{240} = 421,454\ mm^2$$

Digunakan sengkang rangkap P10 dengan Av = 314,159 mm$^2$

$$Jumlah lapis\ sengkang = \frac{421,454}{314,159} = 1,342 = 2\ lapis$$

4. Penulangan geser vertikal

$$Vc,v = \frac{As'}{As} \cdot Vj,h \cdot \left(0{,}6 + {Nuk}/{Ag \cdot fc'}\right)$$
$$= 1 \cdot 639{,}628 \cdot 10^3 \cdot (0{,}6 + 5{,}217/25)$$
$$= 517261\ N = 517{,}261\ KN$$

Vj,v = bc/hc. Vj,h = (0,7/0,7). 639,628 = 639,628 KN

Vs,v = Vj,v – Vc,v = 639,628 – 517,261 = 122,367 KN

$$Aj,v = \frac{Vs,v}{fy} = \frac{122367}{240} = 509{,}864\ mm^2$$

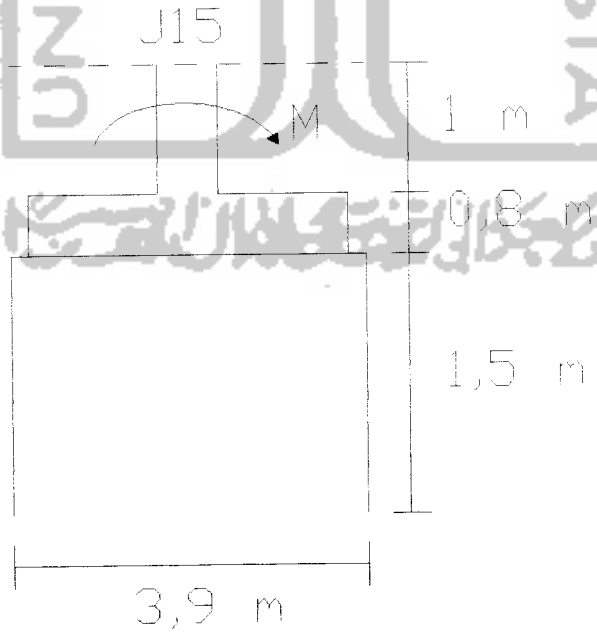
pakai 7P10 dengan As = 549,78 $mm^2$ > Aj,v = 509,864 $mm^2$

5. Kontrol jarak tulangan vertikal

s = (hc – 2. pb – 2.$O_{sengkang}$ – n. $O_{tulangan}$)/(n -1)

= (700 – 2. 40 – 2. 10 – 2. 10)/6 = 88,33 mm ≥ 20 mm .....Ok

## 4.7 Perencanaan Pondasi




Gambar 4.11 Perencanaan pondasi J15

1. Data : J15

   a. σ tanah = 250 KN/$m^2$

   b. h tanah keras = 1,8 m

   c. fc' = 25 MPa

   d. fy = 400 MPa

   e. γ tanah = 18 KN/$m^3$

   f. γ beton = 24 KN/$m^3$

   g. P = 4475,201 KN

   h. Mx = 24,311 KNm

   i. My = 19,613 KNm

2. Perencanaan pondasi sumuran

   Bj beton siklop = 23 KN/$m^3$

   Coba $Ø_{sumuran}$ = 3 m

   h pondasi sumuran = 1,5 m

   P pondasi sumuran = 0,25. π. $Ø^2$. h. γ

   = 0,25. π. $3^2$. 1,5. 23

   = 243,866 KN

   P total = P + P pondasi sumuran

   = 4475,201 + 243,866

   = 4719,067 KN

   σ ijin di bawah sumuran = 450 KN/$m^2$

   Daya dukung tanah netto :

   $q = h_1 . \gamma_1 + h_2 . \gamma_2$

$= 1.18 + 0{,}8.\ 24 = 37{,}2\ \text{KN/m}^2$

q netto $= \sigma_{\text{sumuran}} - q$

$= 450 - 37{,}2 = 412{,}8\ \text{KN/m}^2$

$$A\ perlu = \frac{P_{total}}{\sigma_{\text{tanah}}} = \frac{4719{,}067}{412{,}8} = 11{,}43\ m^2$$

$$Diameter\ sumuran\ perlu = \sqrt{\frac{A\ perlu}{0{,}25 \cdot \pi}} = \sqrt{\frac{11{,}43}{0.25 \cdot \pi}} = 3{,}815\ m$$

Dipakai diameter sumuran = 3,9 m

3. Perencanaan pondasi telapak

Asumsi tebal pelat pondasi = 0,8 m

Ukuran kolom : $b_k = 700$ mm

$h_k = 700$ mm

σ ijin di bawah pondasi telapak :

σ netto $= 0{,}5.\ 10\%.\ 25\ \text{MPa} = 1250\ \text{KN/m}^2$

Dimensi pondasi bujur sangkar (terdapat momen yang bekerja pada arah x dan y) :

$$\sigma_{netto} = \frac{P}{A_{perlu}} + \frac{Mx}{1/6 \cdot Bx \cdot By^2} + \frac{My}{1/6 \cdot By \cdot Bx^2}$$

dicoba dengan nilai B = 2 m

$$A_{perlu} = \frac{P}{\sigma_{netto} - \left(\frac{Mx}{1/6 \cdot Bx \cdot By^2}\right) - \left(\frac{My}{1/6 \cdot By \cdot Bx^2}\right)}$$

$$= \frac{4719{,}067}{1250 - \left(\frac{24{,}311}{1/6 \cdot 2 \cdot 2^2}\right) - \left(\frac{19{,}613}{1/6 \cdot 2 \cdot 2^2}\right)}$$

$= 3{,}877\ m^2$

$B_p = \sqrt{A} = \sqrt{3{,}877} = 1{,}97\ m$

dicoba $B_p = 2{,}3$ m , $L_p = 2{,}3$ m

Luas penampang pelat pondasi : $A_{ada} = B_p \times L_p = 2{,}3 \times 2{,}3 = 5{,}29\ m^2$

Kontrol luas pelat pondasi dan tegangan yang terjadi :

$A_{ada} = 5{,}29\ m^2 > A_{perlu} = 3{,}877\ m^2$ ..... Ok

Tegangan kontak yang terjadi di dasar pondasi :

$$\sigma = \frac{P}{A_{ada}} + \frac{Mx}{1/6 \cdot Bx \cdot By^2} + \frac{My}{1/6 \cdot By \cdot Bx^2}$$

$$\sigma = \frac{4719{,}067}{5{,}29} + \frac{24{,}311}{1/6 \cdot 2{,}3 \cdot 2{,}3^2} + \frac{19{,}613}{1/6 \cdot 2{,}3 \cdot 2{,}3^2}$$

$= 913{,}734\ KN/m^2 < \sigma_{netto} = 1250\ KN/m^2$ ..... Ok

Perencanaan tebal pondasi telapak (syarat kuat geser) :

Asumsi tebal pondasi ($h_p$) = 800 mm

Tebal selimut beton (pb) = 70 mm

Ø tulangan pokok = 22 mm

d = t pondasi – t penutup beton – 0,5. Ø tulangan

= 800 – 70 – 0,5.22 = 719 mm

4. Tinjauan terhadap beban sementara

Eksentrisitas yang terjadi :

$$ex = \frac{Mx}{P} = \frac{24{,}311}{4719{,}067} = 0{,}0052\ m$$

$$ey = \frac{My}{P} = \frac{19{,}613}{4719{,}067} = 0{,}0042\ m$$

Kontrol tegangan yang terjadi :

$$\sigma = \frac{P}{B_p \cdot (L_p - 2 \cdot ex) + L_p \cdot (B_p - 2 \cdot ey)}$$

$$= \frac{4719,067}{2,3 \cdot (2,3 - 2 \cdot 0,0052) + 2,3 \cdot (2,3 - 2 \cdot 0,0042)}$$

$= 447,867 \text{ KN/m}^2 < 1,5.\sigma_{netto} = 1,5.\ 1250 = 1875 \text{ KN/m}^2$ .....Ok

5. Perhitungan geser beton untuk 2 arah

➢ Ditinjau pada arah momen terbesar :

Pu = 4541,95 KN

Mux = 70,101 KN/m$^2$

Muy = 72,908 KN/m$^2$

$B_1 = b_{kolom} + d$

= 700 + 719 = 1419 mm

$B2 = h_{kolom} + d$

= 700 + 719 = 1419 mm

- Tegangan kontak yang terjadi :

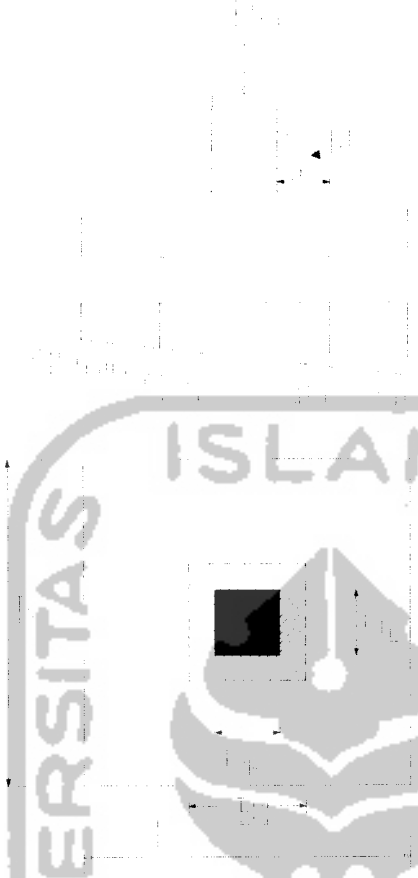
$$qu = \frac{Pu}{A_{ada}} \pm \frac{Mux}{1/6 \cdot Bx \cdot By^2} \pm \frac{Muy}{1/6 \cdot By \cdot Bx^2}$$

$$= \frac{4541,95}{5,29} \pm \frac{70,101}{1/6 \cdot 2,3 \cdot 2,3^2} \pm \frac{72,908}{1/6 \cdot 2,3 \cdot 2,3^2}$$

$qu_{max} = 929,115 \text{ KN/m}^2$

$qu_{min} = 788,069 \text{ KN/m}^2$

$qu_{terjadi} = ½..(\ qu_{max} + qu_{min}) = ½.(929,115 + 788,069) = 858,592 \text{ KN/m}^2$



Gambar 4.12 Penampang kritis dan permukaan geser beton 2 arah

- Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

  $Vu = qu_{terjadi}.((B_p.\ L_p) - (B1.\ B2))$

  $= 858{,}592.((2{,}3.\ 2{,}3) - (1{,}419.\ 1{,}419)) = 2813{,}124\ KN$

  $Vu/\phi = 2813{,}124/0{,}6 = 4688{,}54\ KN$

- Kekuatan beton menahan geser :

  $$\beta c = \frac{sisi\ panjang}{sisi\ pendek} = \frac{B_p}{L_p} = \frac{2{,}3}{2{,}3} = 1$$

  $bo = 2.(B1 + B2) = 2.(1419 + 1419) = 5676\ mm$

$$Vc_1 = \left(1 + \frac{2}{\beta c}\right) \cdot \left(2 \cdot \sqrt{fc'}\right) \cdot bo \cdot d$$

$$= \left(1 + \frac{2}{1}\right) \cdot \left(2 \cdot \sqrt{25}\right) \cdot 5676 \cdot 719 \cdot 10^{-3} = 122431{,}32KN$$

Tetapi nilai tersebut tidak boleh lebih besar dari nilai :

$Vc_2 = (4.\ \sqrt{fc'}).bo.\ d$

$= (4.\ \sqrt{25}).\ 5676.\ 719.\ 10^{-3} = 81620{,}88$ KN

Digunakan nilai terkecil dari $Vc_1$ dan $Vc_2$, yaitu $Vc_2 = 81620{,}88$ KN

- Kontrol gaya geser :

$Vc_2 = 81620{,}88$ KN $\geq Vu/\phi = 2813{,}124/0{,}6 = 4688{,}54\ KN$ ..... Ok

6. Perhitungan geser beton untuk 1 arah

➢ Ditinjau pada arah momen terbesar

$G = (B_p - 2.d - b_{kolom})/2$

$= (2300 - 2.\ 719 - 700)/2 = 81$ mm

**Arah X :**

- Tegangan kontak yang terjadi :

$$qux = \frac{Pu}{A_{ada}} \pm \frac{Mux}{1/6 \cdot Bx \cdot By^2}$$

$$= \frac{4541{,}95}{5{,}29} \pm \frac{70{,}101}{1/6 \cdot 2{,}3 \cdot 2{,}3^2}$$

$qux_{max} = 893{,}161$ KN/m$^2$

$qux_{min} = 824{,}022$ KN/m$^2$

$$qu_m = \frac{(L_p - G) \cdot qux_{max} + G \cdot qux_{min}}{L_p}$$

$$= \frac{(2{,}3 - 0{,}081) \cdot 893{,}161 + 0{,}081 \cdot 824{,}022}{2{,}3} = 890{,}726\ KN/m^2$$

$qux_{terjadi} = ½.(qux_{max} + qux_{min}) = ½.(893,161 + 824,022) = 858,592\ KN/m^2$

- Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

  $Vu = qu_{terjadi}.\ L_p.\ G$

  $= 858,592.\ 2,3.\ 0,081 = 159,956\ KN$

  $Vu/\phi = 159,956/0,6 = 266,593\ KN$

- Kekuatan beton menahan geser :

  $Vc = 1/6.\ \sqrt{fc'}.\ L_p.\ d$

  $= 1/6.\ \sqrt{25}.\ 2300.\ 719.\ 10^{-3} = 1378,083\ KN$

- Kontrol gaya geser :

  $Vc = 1378,083\ KN \geq Vu/\phi = 159,956/0,6 = 266,593\ KN$ .....Ok

**Arah Y :**

- Tegangan kontak yang terjadi :

$$quy = \frac{Pu}{A_{ada}} \pm \frac{Muy}{1/6 \cdot By \cdot Bx^2}$$

$$= \frac{4541,95}{5,29} \pm \frac{72,908}{1/6 \cdot 2,3 \cdot 2,3^2}$$

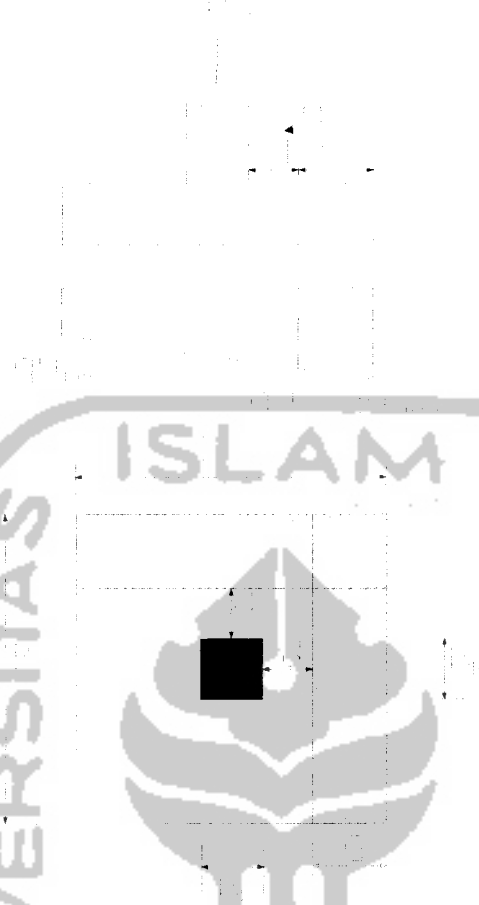
$quy_{max} = 894,545\ KN/m^2$

$quy_{min} = 822,638\ KN/m^2$

$$qu_m = \frac{(L_p - G) \cdot quy_{max} + G \cdot quy_{min}}{L_p}$$

$$= \frac{(2,3 - 0,081) \cdot 894,545 + 0,081 \cdot 822,638}{2,3} = 892,013\ KN/m^2$$

$qux_{terjadi} = ½.(qux_{max} + qux_{min}) = ½.(894,545 + 822,638) = 858,592\ KN/m^2$



Gambar 4.13 Penampang kritis dan permukaan geser beton 1 arah

- Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

  $Vu = qu_{terjadi}. B_p. G$

  $= 858{,}592. 2{,}3. 0{,}081 = 159{,}956$ KN

  $Vu/\phi = 159{,}956/0{,}6 = 266{,}593\ KN$

- Kekuatan beton menahan geser :

  $Vc = 1/6. \sqrt{fc'}. B_p. d$

  $= 1/6. \sqrt{25}. 2300. 719. 10^{-3} = 1378{,}083$ KN

- Kontrol gaya geser :

$$Vc = 1378{,}083 \text{ KN} \geq Vu/\phi = 159{,}956/0{,}6 = 266{,}593 \text{ KN} \quad \ldots\ldots\ldots\text{Ok}$$

7. Kuat tumpuan pondasi

- Kuat tumpuan pondasi :

$$\phi.Pn = \phi.(0{,}85.\ fc'.\ A_1.\sqrt{A_2/A_1})$$

Luas pelat pondasi ($A_2$) $= B_p.\ L_p = 2{,}3.\ 2{,}3 = 5{,}29\ m^2$

Luas penampang kolom ($A_1$) $= b_k.\ h_k = 0{,}7.\ 0{,}7 = 0{,}49\ m^2$

$$\sqrt{A_2/A_1} = \sqrt{5{,}29/0{,}49} = 3{,}286 > 2 \text{ (jika lebih besar dari 2, dipakai nilai 2)}$$

$$\phi.Pn = \phi.(0{,}85.\ fc'.\ A_1.\ 2)$$

$$= 0{,}7.\ (0{,}85.\ 25.\ 490000.\ 2).\ 10^{-3} = 14577{,}5 \text{ KN}$$

- Kuat tumpuan kolom :

$$\phi.Pn = \phi.(0{,}85.\ fc'.\ A_1)$$

$$= 0{,}7.\ (0{,}85.\ 25.\ 490000).\ 10^{-3} = 7288{,}75 \text{ KN}$$

- Kontrol kuat tumpuan :

$\phi.Pn_{pondasi} = 14577{,}5 \text{ KN} > \phi.Pn_{kolom} = 7288{,}75 \text{ KN}$ .....Ok

8. Perencanaan tulangan lentur telapak pondasi

Momen yang terjadi :

$$l = \frac{L_p - h_k}{2} = \frac{2{,}3 - 0{,}7}{2} = 0{,}8\ m$$

$qu_{maks} = 929{,}115 \text{ KN/m}^2$

$Mu = 0{,}5.\ qu_{maks}.\ l^2 = 0{,}5.\ 929{,}115.\ 0{,}8^2 = 297{,}317 \text{ KNm}$

$$Mu/\phi = 297{,}317/0{,}8 = 371{,}646\ KNm$$

- Digunakan tulangan pokok $Ø_{22\ mm}$ ⟶ $A_1Ø = ¼ . \pi . 22^2 = 380{,}133\ mm^2$
- Tebal pelat pondasi : h = 800 mm, selimut beton (pb) = 70 mm

  d = h – pb – 0,5. $Ø_{tul\ pokok}$ = 800 – 70 – 0,5.22 = 719 mm

$$As_{perlu} = \frac{Mu}{\gamma d \cdot fy} = \frac{371{,}646 \cdot 10^6}{0{,}9 \cdot 719 \cdot 400} = 1435{,}814\ mm^2$$

$As_{min}$ = (1,4/fy). b. d = (1,4/400). 1000. 719 = 2516,5 $mm^2$

1,33 $As_{perlu}$ = 1,33. 1435,814 = 1909,633 $mm^2$

Check :

1,33 $As_{perlu}$ < $As_{min}$, maka dipakai As = 1,33.$As_{perlu}$ = 1909,633 $mm^2$

Jarak tulangan :
$$x = \frac{A\phi \cdot 1000}{As_{pakai}} = \frac{0{,}25 \cdot \pi \cdot 22^2 \cdot 1000}{1909{,}633} = 199{,}061\ mm$$

Dipakai jarak tulangan (x) = 195 mm ⟶ dipakai tul pokok : $D_{22\ -\ 195}$

$$As_{ada} = \frac{A\phi \cdot 1000}{jarak\ tulangan} = \frac{0{,}25 \cdot \pi \cdot 22^2 \cdot 1000}{195} = 1949{,}399\ mm^2$$

- Kontrol kapasitas lentur pelat pondasi :

$$a = \frac{As \cdot fy}{0{,}85 \cdot fc' \cdot b} = \frac{1949{,}399 \cdot 400}{0{,}85 \cdot 25 \cdot 1000} = 36{,}695\ mm$$

Mn = $As_{ada}$. fy. (d – a/2)

= 1949,399. 400. (719 – 36,695/2). $10^{-6}$

= 546,341 KNm > 1,33.Mu/Ø = 1,33. 371,646 = 494,289 KNm .....Ok

- Perencanaan tulangan susut pondasi :

  $As_{tul\ susut} = 0{,}002.\ b.\ h = 0{,}002.\ 1000.\ 800 = 1600\ mm^2$

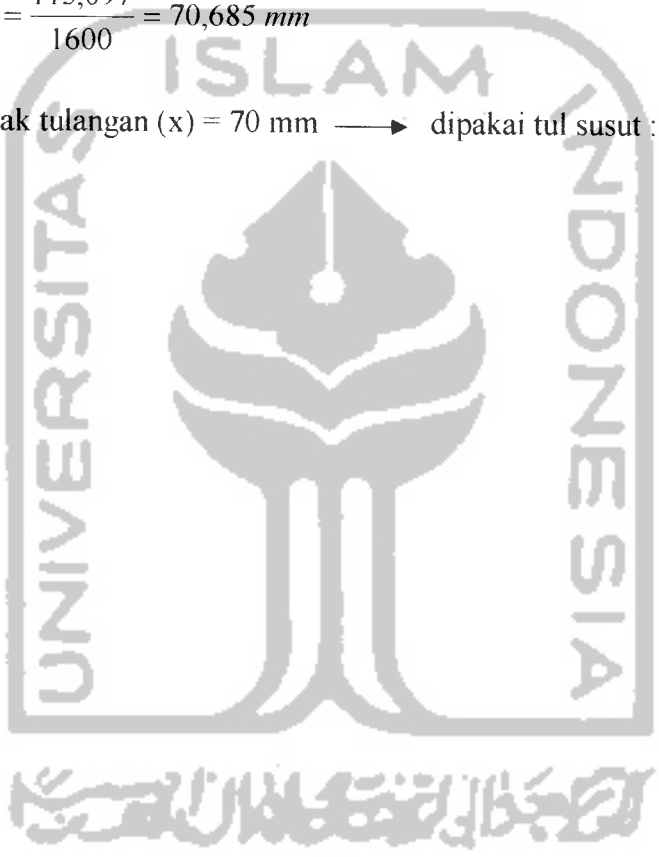
- Digunakan tulangan bagi Ø12 mm, sehingga luas tampang 1 tul. susut :

  $A_1Ø = ¼.\ \pi.12^2 = 113{,}097\ mm^2$

  Jarak antar tulangan susut :

$$s \le \frac{A_1\phi}{As_{susut}} = \frac{113{,}097}{1600} = 70{,}685\ mm$$

  Dipakai jarak tulangan (x) = 70 mm ⟶ dipakai tul susut : $P_{12\ -\ 70}$



# BAB V

# PEMBAHASAN

## 5.1 Umum

Tugas akhir ini menggunakan program SAP 2000 dengan bentuk 3 dimensi untuk bangunan gedung dan 2 dimensi untuk rangka atap dan tangga sebagai cara untuk mendapatkan hasil momen dan gaya-gaya yang bekerja pada struktur. Faktor-faktor pembebanan dimasukkan ke dalam program SAP 2000 guna mempermudah dalam mendapatkan nilai-nilai yang diperlukan dalam perhitungan perencanaan.

Spesifikasi bahan yang dipakai yaitu, untuk beton menggunakan fc'= 25 Mpa, sedangkan baja tulangannya dengan diameter kurang atau sama dengan 12 mm menggunakan mutu baja fy = 240 Mpa dan untuk diameternya baja yang lebih besar dari 12 mm menggunakan mutu baja fy = 400 Mpa.

## 5.2 Atap

Perencanaan atap pada gedung ini memakai konstruksi kuda-kuda baja. Ketentuan umum perencanaan kuda-kuda baja ini adalah menggunakan rumus-rumus AISC dengan metode ASD. Tipe kuda-kuda baja mempunyai 3 macam tipe bentuk kuda-kuda. Profil baja yang digunakan yaitu 2L 70x70x7 dan 2L 50x50x5, diameter baut ½ in dan tebal pelat sambung 1 cm. Hasil analisis SAP 2000 pada rangka kuda-kuda, gaya reaksi pada join digunakan sebagai beban titik pada perhitungan struktur 3 dimensi.

## 5.3 Pelat

Penggunaan pelat pada bangunan ini terdiri 2 macam pelat, yaitu pelat lantai dan pelat atap. Tipe pelatnya yaitu pelat satu arah dan dua arah dan mengacu pada peraturan SK-SNI T-15-1991-03.

Tebal pelat lantai yaitu 120 mm, sedangkan pelat atap 100 mm.
Pada pelat lantai menggunakan tulangan Ø 8 dan Ø 10 mm. Sedangkan pelat atap menggunakan tulangan Ø 8 mm dan untuk tulangan susut pada lantai atap adalah tulangan Ø 8 mm. Mutu baja yang digunakan pada pelat lantai dan pelat atap adalah fy = 240 Mpa sedangkan mutu betonnya fc' =25 MPa.

## 5.4 Balok anak

Analisis Balok anak pada bangunan ini merupakan bagian dari perhitungan penggunaan SAP 2000 dengan bentuk 3 dimensi, sehingga momen dan gaya geser yang dihasilkan merupakan keluaran dari SAP 2000. Dimensi balok anak ini adalah 300/400 dan tulangan pokok yang digunakan adalah Ø22 mm, Ø 25, Ø 28 mm dan untuk tulangan geser menggunakan Ø 10 mm. Mutu beton yang digunakan adalah fc' =25 Mpa dan mutu bajanya fy = 400 Mpa untuk deform, fy = 240 Mpa untuk polos.

## 5.5 Balok Induk

Balok induk merupakan struktur portal dan analisis untuk struktur tersebut menggunakan bentuk 3 dimensi dari SAP 2000 sehingga portal satu dengan yang lain saling terkait.

Penulangan yang dipakai pada balok induk menggunakan tulangan sebelah dan rangkap. Penentuan terhadap tulangan sebelah dan tulangan rangkap didasarkan pada tinggi efektif dari balok.

Spesifikasi bahan yang digunakan adalah fc' = 25 Mpa, mutu bajanya fy = 400 Mpa untuk deform, fy = 240 Mpa untuk polos. Tulangan pokok yang digunakan Ø22 mm.

**5.6 Kolom**

Kolom juga merupakan bagian dari struktur portal dan direncanakan didasrkan atas hasil dari analisis 3 dimensi dari SAP 2000.

Ukuran dimensi kolom yang digunakan adalah 70cmx70cm dan 40cmx80cm. Ukuran pendimensian kolom juga didasarkan atas aspek arsitektur yang menginginkan hal tersebut. Tulangan pokok yang digunakan adalah Ø22 mm serta tulangan geser memakai dan Ø10 mm.

**5.7 Pondasi**

Adapun tipe pondasi yang digunakan yaitu penggabungan antara telapak dan sumuran. Sumuran digunakan sebagai dasar dari pondasi telapak dikarenakan nilai daya dukung tanah yang dapat digunakan untuk struktur bangunan tersebut terletak dibawah pondasi sumuran. Tulangan pokok yang digunakan adalah dan Ø16 mm serta tulangan susut memakai Ø12 mm.

## 5.8 Tangga

Perencanaan tangga terdiri dari perencanaan pelat tangga dan pelat bordes dan dianalis menggunakan sistem 2 dimensi dari SAP 2000. Gaya-gaya reaksi pada join struktur tangga digunakan sebagai beban merata pada perhitungan struktur 3 dimensi. Perencanaan tangga menggunakan tulangan pokok O16 mm dan O12 mm.

Tabel 5.1 Rekapitulasi Perhitungan Kuda-kuda

| Keterangan | | Perencanaan Ulang | Perencanaan |
|---|---|---|---|
| Kuda-kuda | profil kuda-kuda | 2L 70x70x7<br>2L 50x50x5 | 2L 80x80x8<br>2L 50x50x5 |
| | profil gording | C 150x50x20x2,3 | C 150x50x20x2,3 |
| | sambungan | baut 1/2",5/8" | baut Ø16mm |

Tabel 5.2 Rekapitulasi Tulangan Plat Terpasang

| Keterangan | Perencanaan Ulang Plat | | Keterangan | Perencanaan Ulang Plat | |
|---|---|---|---|---|---|
| Plat lantai atap | Tipe A | | Plat lantai | Hall/ Tipe A | |
| | Lx | P8-200 | | Lx | P8-160 |
| | Ly | P8-200 | | Ly | P8-160 |
| | tx | P8-130 | | tx | P10-140 |
| | ty | P8-130 | | ty | P10-140 |
| Plat lantai atap | Tipe B | | Plat lantai | Bank/ Tipe A | |
| | Lx | P10-110 | | Lx | P8-200 |
| | Ly | P10-200 | | Ly | P8-200 |
| | tx | P12-100 | | tx | P10-150 |
| | ty | P12-150 | | ty | P10-150 |
| Plat lantai atap | Tipe C | | Plat lantai | Tipe G | |
| | Lx | P8-200 | | Lx | P8-200 |
| | Ly | P8-200 | | Ly | P8-200 |
| | tx | P8-200 | | tx | P8-200 |
| | ty | P8-200 | | ty | P8-200 |
| Plat lantai atap | Tipe D | | Plat lantai | Tipe H | P8-200 |
| | Lx | P10-170 | Plat lantai | Tipe I | |
| | Ly | P10-200 | | Lx | P8-200 |
| | tx | P10-120 | | Ly | P8-200 |
| | ty | P10-190 | | tx | P8-130 |
| Plat lantai atap | Tipe E | P8-160 | | ty | P8-170 |
| Plat lantai atap | Tipe F | P8-200 | | | |

Tabel 5.3 Hasil Perencanaan Plat Terpasang di Proyek

| Perencanaan Plat | | | |
|---|---|---|---|
| No Lantai | Tul Arah x | Tul Arah y | Tul susut |
| Lantai dasar | P8-200 | P8-200 | P8-200 |
| Lantai 1 | P8-200 | P8-200 | P8-200 |
| Lantai 2 | P8-200 | P8-200 | P8-200 |
| Lantai 3 | P8-200 | P8-200 | P8-200 |
| Lantai 4 | P8-200 | P8-200 | P8-200 |
| Lantai atap | P8-200 | P8-200 | P8-200 |

Tabel 5.4 Rekapitulasi Tulangan Balok Anak Terpasang

Rekapitulasi Balok Anak Terpasang

| Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | atas | bawah | | atas | bawah | |
| Ground | GBA 1-3<br>GBA 4-6<br>GBA 42<br>GBA 56<br>GBA 67-72<br>GBA 73-74<br>GBA 75-76<br>GBA 77-79<br>GBA 80-82<br>GBA 112-114<br>GBA 115-117<br>GBA 118-119<br>GBA 120-121 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 19<br>GBA 95-98 | 300/400 | 3D22 | 3D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 7-18 | 300/400 | 5D22 | 3D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | GBA 20-31 | 300/400 | 6D22 | 6D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 32-41 | 300/400 | 8D22 | 5D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 43-55 | 300/400 | 8D25 | 6D25 | P10-80 | 2D25 | 2D25 | P10-165 |
| | GBA 57-66 | 300/400 | 7D22 | 4D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 83-94 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GBA 99-111 | 300/400 | 8D22 | 6D22 | P10-80 | 2D22 | 3D22 | P10-165 |

Rekapitulasi Balok Anak Terpasang

| Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | atas | bawah | | atas | bawah | |
| 1 | 1BA 1-4<br>1BA 120-123 | 300/400 | 3D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 13-22<br>1BA 23-25<br>1BA 26-28<br>1BA 63<br>1BA 77<br>1BA 88-90<br>1BA 91-93<br>1BA 94-95<br>1BA 96-97<br>1BA 98-100<br>1BA 101-103<br>1BA 116<br>1BA 117<br>1BA 118<br>1BA 119<br>1BA 137-139<br>1BA 140-142<br>1BA 143-144<br>1BA 145-146 | 300/400 | 2D22 | 2D22 | P10-75 | 2D22 | 2D22 | P10-165 |
| | 1BA 5-12<br>1BA 104-115 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 29-39 | 300/400 | 5D22 | 3D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 40<br>1BA 41-52 | 300/400 | 9D22 | 6D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 53-62 | 300/400 | 7D22 | 4D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 64-76 | 300/400 | 10D22 | 7D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1BA 124-136 | 300/400 | 10D22 | 7D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 1BA 78-87 | 300/400 | 4D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |

Rekapitulasi Balok Anak Terpasang

| Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | atas | bawah | | atas | bawah | |
| 2 | 2BA 1-3<br>2BA 4-6<br>2BA 39<br>2BA 53<br>2BA 64-66<br>2BA 67-69<br>2BA 70-71<br>2BA 72-73<br>2BA 74-76 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2BA 77-79<br>2BA 92-95<br>2BA 109-111<br>2BA 112-114<br>2BA 115-116<br>2BA 117-118 | | | | | | | |
| | 2BA 7-17 | 300/400 | 6D22 | 3D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 18<br>2BA 19-23 | 300/400 | 8D22 | 5D22 | P10-75 | 2D22 | 2D22 | P10-165 |
| | 2BA 24-28 | 300/400 | 9D22 | 6D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 29-38 | 300/400 | 7D22 | 4D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 40-52 | 300/400 | 10D22 | 7D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 54-63 | 300/400 | 4D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 80-91 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2BA 96-108 | 300/400 | 10D22 | 7D22 | P10-75 | 2D22 | 3D22 | P10-165 |

Rekapitulasi Balok Anak Terpasang

| Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | atas | bawah | | atas | bawah | |
| 3 | 3BA 1-3<br>3BA 4-6<br>3BA 41<br>3BA 55<br>3BA 66-68<br>3BA 69-71<br>3BA 72-73<br>3BA 74-75<br>3BA 76-78<br>3BA 79-81<br>3BA 111-113<br>3BA 114-116<br>3BA 117-118<br>3BA 119-120 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 94-97 | 300/400 | 3D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 7-17 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 18-30 | 300/400 | 10D22 | 7D22 | P10-70 | 2D22 | 2D22 | P10-165 |
| | 3BA 31-40 | 300/400 | 9D22 | 7D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 42-54 | 300/400 | 10D22 | 8D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 56-65 | 300/400 | 4D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3BA 82-93 | 300/400 | 8D22 | 5D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 3BA 98-110 (D28) | 300/400 | 7D28 | 5D28 | P10-70 | 2D28 | 3D28 | P10-165 |

Rekapitulasi Balok Anak Terpasang

| Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | atas | bawah | | atas | bawah | |
| 4 | 4BA 1-12<br>4BA 49<br>4BA 63 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 74-85<br>4BA 86-97<br>4BA 110-113<br>4BA 127-138 | 300/400 | 3D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 13-23 | 300/400 | 5D22 | 3D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 24 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 25-36<br>4BA 37-48 | 300/400 | 7D22 | 4D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 4BA 50-62 | 300/400 | 7D22 | 5D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 64-73 | 300/400 | 4D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 98-109 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4BA 114-126 | 300/400 | 10D22 | 8D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| Atap | ABA 1-7<br>ABA 8-19<br>ABA 20-21<br>ABA 22-23<br>ABA 24-25<br>ABA 26-27<br>ABA 31-32<br>ABA 33-34<br>ABA 35-36<br>ABA 43-54<br>ABA 55-61<br>ABA 62-68<br>ABA 69-80<br>ABA 99-110<br>ABA 111-117 | 300/400 | 2D13 | 2D13 | P10-135 | 2D13 | 2D13 | P10-270 |
| | ABA 28-30<br>ABA 40-42<br>ABA 81-86 | 300/400 | 4D13 | 2D13 | P10-135 | 2D13 | 2D13 | P10-270 |
| | ABA 91-98 | 300/400 | 4D13 | 2D13 | P10-135 | 2D13 | 3D13 | P10-270 |
| | ABA 37-39<br>ABA 87-90 | 300/400 | 3D13 | 2D13 | P10-135 | 2D13 | 3D13 | P10-270 |

Tabel 5.5 Rekapitulasi Tulangan Balok Induk Terpasang

Rekapitulasi Balok Induk Terpasang

| Portal | Lantai | Balok | Dimensi | Tumpuan | | | Lapangan | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tul pasang | | Geser | Tul pasang | | Geser |
| | | | | atas | bawah | | atas | bawah | |
| BA | Sloof | BA1-BA5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BA6-BA17 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 4D22 | P10-265 |
| | 1 | BA18-BA29 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 5D22 | P10-265 |
| | 2 | BA30-BA41 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 3 | BA42-BA53 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 4 | BA54-BA65 | 400/600 | 5D22 | 2D22 | P10-90 | 2D22 | 4D22 | P10-265 |
| | atap | BA66-BA79 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | ring | BA80-BA85 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BB | Sloof | BB1-BB5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BB6-BB17 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 5D22 | P10-265 |
| | 1 | BB18-BB34 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 4D22 | P10-265 |
| | 2 | BB35-BB46 | 400/600 | 5D22 | 2D22 | P10-95 | 2D22 | 4D22 | P10-265 |
| | 3 | BB47-BB58 | 400/600 | 6D22 | 2D22 | P10-75 | 2D22 | 6D22 | P10-265 |
| | 4 | BB59-BB70 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 4D22 | P10-265 |
| | atap | BB71-BB78 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | ring | BB79-BB82 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BC | GF | BC1-BC10 | 300/400 | 6D22 | 3D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 1 | BC11-BC14 | 300/700 | 8D22 | 2D22 | P10-105 | 2D22 | 4D22 | P10-235 |
| | 1 | BC15-BC24 | 300/500 | 4D22 | 2D22 | P10-105 | 2D22 | 2D22 | P10-215 |
| | 1 | BC25 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2 | BC26-BC35 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3 | BC36-BC45 | 300/400 | 9D22 | 6D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 4 | BC46-BC57 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | atap | BC58-BC59 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BD | Sloof | BD1-BD5 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BD6-BD15 | 400/600 | 5D22 | 2D22 | P10-95 | 2D22 | 5D22 | P10-265 |
| | 1 | BD16-BD27 | 400/600 | 9D22 | 3D22 | P1075 | 2D22 | 4D22 | P10-265 |
| | 2 | BD28-BD37 | 400/600 | 6D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 3 | BD38-BD47 | 400/600 | 6D22 | 2D22 | P10-75 | 2D22 | 6D22 | P10-265 |
| | 4 | BD48-BD59 | 400/600 | 5D22 | 2D22 | P10-100 | 2D22 | 4D22 | P10-265 |
| | atap | BD60-BD63 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 4D22 | P10-265 |
| BE | GF | BE1-BE10 | 300/400 | 6D22 | 3D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 1 | BE11-BE14 | 400/700 | 9D22 | 2D22 | P10-135 | 2D22 | 6D22 | P10-315 |
| | 1 | BE15-BE24 | 300/600 | 4D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | 1 | BE25 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2 | BE26-BE33 | 300/400 | 6D22 | 3D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 3 | BE34-BE43 | 300/400 | 6D22 | 4D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 4 | BE44-BE55 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | atap | BE56-BE57 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BF | Sloof | BF1-BF5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BF6-BF15 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 5D22 | P10-265 |
| | 1 | BF16-BF27 | 400/600 | 9D22 | 3D22 | P10-75 | 2D22 | 4D22 | P10-265 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | BF28-BF37 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 4D22 | P10-265 |
| | 3 | BF38-BF47 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 4 | BF48-BF59 | 400/600 | 5D22 | 2D22 | P10-90 | 2D22 | 4D22 | P10-265 |
| | atap | BF60-BF63 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| BG | GF | BG1-BG10 | 300/400 | 7D22 | 4D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| | 1 | BG11-BG14 | 400/700 | 7D22 | 2D22 | P10-120 | 2D22 | 4D22 | P10-290 |
| | 1 | BG15-BG24 | 300/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | 1 | BG25 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2 | BG26-BG35 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3 | BG36-BG45 | 300/400 | 3D24 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4 | BG46-BG57 | 300/400 | 5D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | atap | BG58-BG59 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BH | Sloof | BH1-BH5 | 400/600 | 3D22 | 2D22 | P10-125 | 2D22 | 2D22 | P10-265 |
| | GF | BH6-BH17 | 400/600 | 5D22 | 2D22 | P10-70 | 2D22 | 5D22 | P10-245 |
| | 1 | BH18-BH34 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 5D22 | P10-230 |
| | 2 | BH35-BH46 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 5D22 | P10-240 |
| | 3 | BH47-BH58 | 400/600 | 6D22 | 2D22 | P10-75 | 2D22 | 5D22 | P10-250 |
| | 4 | BH59-BH70 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 4D22 | P10-265 |
| | atap | BH71-BH78 | 400/600 | 4D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | ring | BH79-BH82 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BI | Sloof | BI1-BI5 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | Bordes | BI6 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | GF | BI7-BI19 | 400/600 | 6D22 | 2D22 | P10-60 | 2D22 | 6D22 | P10-175 |
| | Bordes | BI20 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1 | BI21-BI33 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 5D22 | P10-225 |
| | Bordes | BI34 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2 | BI35-BI47 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 5D22 | P10-235 |
| | Bordes | BI48 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3 | BI49-BI61 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 6D22 | P10-205 |
| | Bordes | BI62 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4 | BI63-BI75 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | atap | BI76-BI89 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 3D22 | P10-265 |
| | ring | BI90-BI95 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BJ | atap | BJ1-BJ4 | 400/700 | 9D22 | 2D22 | P10-65 | 2D22 | 9D22 | P10-205 |
| BK | Sloof | BK1-BK8 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BK9-BK20 | 400/600 | 4D22 | 2D22 | P10-110 | 2D22 | 4D22 | P10-265 |
| | Bordes | BK21-BK22 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 1 | BK23-BK34 | 400/600 | 4D22 | 2D22 | P10105 | 2D22 | 4D22 | P10-265 |
| | Bordes | BK35-BK36 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 2 | BK37-BK48 | 400/600 | 5D22 | 2D22 | P10-100 | 2D22 | 4D22 | P10-265 |
| | Bordes | BK49-BK50 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 3 | BK51-BK62 | 400/600 | 4D22 | 2D22 | P10-105 | 2D22 | 4D22 | P10-265 |
| | Bordes | BK63-BK64 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| | 4 | BK65-BK76 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | atap | BK77-BK90 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | ring | BK91-BK100 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BL | Sloof | BL1-BL5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |

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|---|---|---|---|---|---|---|---|---|---|
| | GF | BL6-BL19 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 1 | BL20-BL33 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 7D22 | P10-190 |
| | 2 | BL34-BL47 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 6D22 | P10-220 |
| | 3 | BL48-BL61 | 400/600 | 7D22 | 2D22 | P10-60 | 2D22 | 7D22 | P10-185 |
| | 4 | BL62-BL73 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 7D22 | P10-210 |
| | atap | BL74-BL77 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| BM | Sloof | BM1-BM5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BM6-BM17 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 5D22 | P10-265 |
| | 1 | BM18-BM29 | 400/600 | 6D22 | 2D22 | P10-75 | 2D22 | 7D22 | P10-255 |
| | 2 | BM30-BM41 | 400/600 | 6D22 | 2D22 | P10-75 | 2D22 | 6D22 | P10-260 |
| | 3 | BM42-BM53 | 400/600 | 7D22 | 2D22 | P10-75 | 2D22 | 7D22 | P10-260 |
| | 4 | BM54-BM65 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 7D22 | P10-245 |
| | atap | BM66-BM69 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| BN | Sloof | BN1-BN5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BN6-BN18 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 6D22 | P10-205 |
| | 1 | BN19-BN31 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 5D22 | P10-190 |
| | 2 | BN32-BN44 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 5D22 | P10-205 |
| | 3 | BN45-B57 | 400/600 | 6D22 | 2D22 | P10-65 | 2D22 | 6D22 | P10-190 |
| | 4 | BN58-BN70 | 400/600 | 6D22 | 2D22 | P10-70 | 2D22 | 6D22 | P10-220 |
| | atap | BN71-BN83 | 400/600 | 3D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | ring | BN84-BN93 | 300/400 | 3D22 | 2D22 | P10-80 | 2D22 | 3D22 | P10-165 |
| BO | Sloof | BO1-BO5 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BO6-BO20 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 4D22 | P10-265 |
| | 1 | BO21-BO35 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 2 | BO36-BO51 | 400/600 | 5D22 | 2D22 | P10-85 | 2D22 | 4D22 | P10-265 |
| | 3 | BO52-BO66 | 400/600 | 5D22 | 2D22 | P10-80 | 2D22 | 5D22 | P10-265 |
| | 4 | BO67-BO79 | 400/600 | 6D22 | 2D22 | P10-80 | 2D22 | 4D22 | P10-265 |
| | atap | BO80-BO89 | 400/600 | 4D22 | 2D22 | P10-125 | 2D22 | 3D22 | P10-265 |
| BP | Sloof | BP1-BP8 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 2D22 | P10-265 |
| | GF | BP9-BP20 | 400/600 | 4D22 | 2D22 | P10-110 | 2D22 | 4D22 | P10-265 |
| | 1 | BP21-BP32 | 400/600 | 4D22 | 2D22 | P10-115 | 2D22 | 4D22 | P10-265 |
| | 2 | BP33-BP44 | 400/600 | 5D22 | 2D22 | P10-105 | 2D22 | 4D22 | P10-265 |
| | 3 | BP45-BP56 | 400/600 | 4D22 | 2D22 | P10-110 | 2D22 | 4D22 | P10-265 |
| | 4 | BP57-BP68 | 400/600 | 4D22 | 2D22 | P10-95 | 2D22 | 4D22 | P10-265 |
| | atap | BP69-BP82 | 400/600 | 2D22 | 2D22 | P10-130 | 2D22 | 3D22 | P10-265 |
| | ring | BP83-BP88 | 300/400 | 2D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |
| BQ | atap | BQ1-BQ6 | 300/400 | 3D22 | 2D22 | P10-80 | 2D22 | 2D22 | P10-165 |

Tabel 5.6 Rekapitulasi Tulangan Kolom Terpasang

Rekapitulasi Tulangan Kolom Terpasang

| Portal | Kolom | Lantai | Dimensi | Tulangan | Geser | |
|---|---|---|---|---|---|---|
| BA | KA1 | Dasar | 700/700 | 7D22 | P10-110 | |
| | KA9 | | | | P10-105 | |
| | KA17 | | | | P10-95 | |
| | KA25 | | | | P10-90 | |
| | KA33 | | | | P10-85 | |
| | KA40 | | | | P10-80 | |
| | KA2 | Basement | 700/700 | 7D22 | P10-150 | P10-315 |
| | KA10 | | | | P10-110 | P10-315 |
| | KA18 | | | | P10-115 | P10-315 |
| | KA26 | | | | P10-105 | P10-315 |
| | KA34 | | | | P10-110 | P10-315 |
| | KA41 | | | | P10-165 | P10-315 |
| | KA3 | GF | 700/700 | 7D22 | P10-135 | P10-315 |
| | KA11 | | | | P10-155 | P10-315 |
| | KA19 | | | | P10-135 | P10-315 |
| | KA27 | | | | P10-115 | P10-315 |
| | KA35 | | | | P10-110 | P10-315 |
| | KA42 | | | | P10-130 | P10-315 |
| | KA4 | 1 | 700/700 | 7D22 | P10-80 | P10-315 |
| | KA12 | | | | P10-85 | P10-315 |
| | KA20 | | | | P10-85 | P10-315 |
| | KA28 | | | | P10-80 | P10-315 |
| | KA36 | | | | P10-85 | P10-315 |
| | KA43 | | | | P10-85 | P10-315 |
| | KA5 | 2 | 700/700 | 7D22 | P10-85 | P10-315 |
| | KA13 | | | | P10-80 | P10-315 |
| | KA21 | | | | P10-70 | P10-315 |
| | KA29 | | | | P10-90 | P10-315 |
| | KA37 | | | | P10-100 | P10-315 |
| | KA44 | | | | P10-90 | P10-315 |
| | KA6 | 3 | 700/700 | 7D22 | P10-125 | P10-315 |
| | KA14 | | | | P10-95 | P10-315 |
| | KA22 | | | | P10-95 | P10-315 |
| | KA30 | | | | P10-180 | P10-315 |
| | KA38 | | | | P10-185 | P10-315 |
| | KA45 | | | | P10-120 | P10-315 |
| | KA7 | 4 | 700/700 | 7D22 | P10-310 | P10-315 |
| | KA15 | | | | P10-160 | P10-315 |
| | KA23 | | | | .P10-165 | P10-315 |
| | KA31 | | | | P10-170 | P10-315 |
| | KA39 | | | | P10-165 | P10-315 |
| | KA46 | | | | P10-315 | P10-315 |
| | KA8 | Atap | 700/700 | 7D22 | P10-315 | P10-315 |
| | KA16 | | | | P10-305 | P10-315 |

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|---|---|---|---|---|---|---|
| | KA24 | | | | P10-175 | P10-315 |
| | KA32 | | | | P10-265 | P10-315 |
| BB | KB2 | Dasar | 700/700 | 7D22 | P10-75 | |
| | KB10 | | | | P10-85 | |
| | KB16 | | | | P10-75 | |
| | KB22 | | | | P10-75 | |
| | KB30 | | | | P10-65 | |
| | KB38 | | | | P10-50 | |
| | KB3 | Basement | 700/700 | 7D22 | P10-135 | P10-315 |
| | KB11 | | | | P10-75 | P10-315 |
| | KB17 | | | | P10-75 | P10-315 |
| | KB23 | | | | P10-75 | P10-315 |
| | KB31 | | | | P10-75 | P10-315 |
| | KB39 | | | | P10-150 | P10-315 |
| | KB1 | GF | 700/700 | 7D22 | P10-150 | P10-315 |
| | KB4 | | | | P10-120 | P10-315 |
| | KB12 | | | | P10-90 | P10-315 |
| | KB18 | | | | P10-90 | P10-315 |
| | KB24 | | | | P10-90 | P10-315 |
| | KB32 | | | | P10-90 | P10-315 |
| | KB40 | | | | P10-70 | P10-315 |
| | KB46 | | | | P10-185 | P10-315 |
| | KB5 | 1 | 700/700 | 7D22 | P10-95 | P10-315 |
| | KB13 | | | | P10-55 | P10-315 |
| | KB19 | | | | P10-55 | P10-315 |
| | KB25 | | | | P10-55 | P10-315 |
| | KB33 | | | | P10-65 | P10-315 |
| | KB41 | | | | P10-85 | P10-315 |
| | KB6 | 2 | 700/700 | 7D22 | P10-85 | P10-315 |
| | KB14 | | | | P10-70 | P10-315 |
| | KB20 | | | | P10-70 | P10-315 |
| | KB26 | | | | P10-105 | P10-315 |
| | KB34 | | | | P10-100 | P10-315 |
| | KB42 | | | | P10-135 | P10-315 |
| | KB7 | 3 | 700/700 | 7D22 | P10-305 | P10-315 |
| | KB15 (a) | | | 8D22 | P10-75 | P10-315 |
| | KB15 (b) | | | 7D22 | P10-75 | P10-315 |
| | KB21 | | 700/700 | 7D22 | P10-75 | P10-315 |
| | KB27 | | | | P10-110 | P10-315 |
| | KB35 | | | | P10-120 | P10-315 |
| | KB43 | | | | P10-205 | P10-315 |
| | KB8 | 4 | 700/700 | 7D22 | P10-315 | P10-315 |
| | KB28 | | | | P10-240 | P10-315 |
| | KB36 | | | | .P10-150 | P10-315 |
| | KB44 | | | | P10-315 | P10-315 |
| | KB9 | Atap | 700/700 | 7D22 | P10-315 | P10-315 |
| | KB29 | | | | P10-220 | P10-315 |
| | KB37 | | | | P10-200 | P10-315 |
| | KB45 | | | | P10-165 | P10-315 |

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|---|---|---|---|---|---|---|
| BC | KC2 | Dasar | 400/800 | 5D22 | P10-140 | |
| | KC10 | | | | P10-100 | |
| | KC3 | Basement | 400/800 | 5D22 | P10-260 | P10-365 |
| | KC11 | | | | P10-245 | P10-365 |
| | KC1 | GF | 700/700 | 9D22 | P10-80 | P10-365 |
| | KC4 | | 400/800 | 5D22 | P10-185 | P10-365 |
| | KC12 | | | | P10-365 | P10-365 |
| | KC5 | 1 | 400/800 | 5D22 | P10-165 | P10-365 |
| | KC13 | | | | P10-180 | P10-365 |
| | KC6 | 2 | 400/800 | 5D22 | P10-155 | P10-280 |
| | KC14 | | | | P10-170 | P10-280 |
| | KC7 | 3 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KC15 | | | | P10-170 | P10-280 |
| | KC8 | 4 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KC16 | | | | P10-180 | P10-280 |
| | KC9 | Atap | 400/800 | 5D22 | P10-180 | P10-280 |
| | KC17 | | | | P10-180 | P10-280 |
| BD | KD1 | Dasar | 400/800 | 5D22 | P10-150 | |
| | KD9 | | 700/700 | 7D22 | P10-85 | |
| | KD15 | | | | P10-80 | |
| | KD21 | | | | P10-70 | |
| | KD29 | | | | P10-70 | |
| | KD35 | | 400/800 | 5D22 | P10-105 | |
| | KD2 | Basement | 400/800 | 5D22 | P10-155 | P10-280 |
| | KD10 | | 700/700 | 7D22 | P10-85 | P10-185 |
| | KD16 | | | | P10-80 | P10-185 |
| | KD22 | | | | P10-75 | P10-185 |
| | KD30 | | | | P10-65 | P10-185 |
| | KD36 | | 400/800 | 5D22 | P10-110 | P10-280 |
| | KD3 (a) | GF | 400/800 | 5D22 | P10-175 | P10-280 |
| | KD3 (b) | | | 9D22 | P10-175 | P10-280 |
| | KD11 | | 700/700 | 7D22 | P10-100 | P10-185 |
| | KD17 | | | | P10-90 | P10-185 |
| | KD23 | | | | P10-90 | P10-185 |
| | KD31 | | | | P10-90 | P10-185 |
| | KD37 | | 400/800 | 5D22 | P10-125 | P10-280 |
| | KD43 (a) | | 700/700 | 7D22 | P10-75 | P10-185 |
| | KD43 (b) | | | 8D22 | P10-75 | P10-185 |
| | KD4 | 1 | 400/800 | 5D22 | P10-100 | P10-280 |
| | KD12 | | 700/700 | 7D22 | P10-50 | P10-185 |
| | KD18 | | | | P10-50 | P10-185 |
| | KD24 | | | | P10-55 | P10-185 |
| | KD32 | | | | P10-55 | P10-185 |
| | KD38 | | 400/800 | 5D22 | P10-95 | P10-280 |
| | KD5 | 2 | 400/800 | 5D22 | P10-110 | P10-280 |
| | KD13 | | 700/700 | 7D22 | P10-65 | P10-185 |
| | KD19 | | | | P10-65 | P10-185 |
| | KD25 | | | | P10-60 | P10-185 |
| | KD33 | | | | P10-65 | P10-185 |

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|---|---|---|---|---|---|---|
| | KD39 | | 400/800 | 5D22 | P10-105 | P10-280 |
| | KD6 | 3 | 400/800 | 5D22 | P10-160 | P10-280 |
| | KD14 (a) | | 700/700 | 8D22 | P10-75 | P10-185 |
| | KD14 (b) | | | 7D22 | P10-75 | P10-185 |
| | KD20 (a) | | 700/700 | 8D22 | P10-80 | P10-185 |
| | KD20 (b) | | | 7D22 | P10-80 | P10-185 |
| | KD26 | | 700/700 | 7D22 | P10155 | P10-185 |
| | KD34 (a) | | 700/700 | 8D22 | P10-75 | P10-185 |
| | KD34 (b) | | | 7D22 | P10-75 | P10-185 |
| | KD40 | | 400/800 | 5D22 | P10-150 | P10-280 |
| | KD7 | 4 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KD27 | | 700/700 | 7D22 | P10-155 | P10-185 |
| | KD41 (a) | | 400/800 | 5D22 | P10-180 | P10-280 |
| | KD41 (b) | | | 9D22 | P10-180 | P10-280 |
| | KD8 | Atap | 400/800 | 5D22 | P10-180 | P10-280 |
| | KD28 | | 700/700 | 7D22 | P10-155 | P10-185 |
| | KD42 | | 400/800 | 5D22 | P10-180 | P10-280 |
| BE | KE1 | Dasar | 400/800 | 5D22 | P10-150 | |
| | KE9 | | | | P10-105 | |
| | KE2 | Basement | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE10 | | | | P10-135 | P10-280 |
| | KE3 (a) | GF | 400/800 | 9D22 | P10-170 | P10-280 |
| | KE3 (b) | | | 5D22 | P10-170 | P10-280 |
| | KE11 | | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE4 | 1 | 400/800 | 5D22 | P10-115 | P10-280 |
| | KE12 | | | | P10-170 | P10-280 |
| | KE5 | 2 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE13 | | | | P10-180 | P10-280 |
| | KE6 | 3 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE14 | | | | P10-155 | P10-280 |
| | KE7 | 4 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE15 | | | | P10-180 | P10-280 |
| | KE8 | Atap | 400/800 | 5D22 | P10-180 | P10-280 |
| | KE16 | | | | P10-180 | P10-280 |
| BF | KF1 | Dasar | 400/800 | 5D22 | P10-150 | |
| | KF9 | | 700/700 | 7D22 | P10-85 | |
| | KF15 | | | | P10-80 | |
| | KF21 | | | | P10-75 | |
| | KF29 | | | | P10-65 | |
| | KF35 | | 400/800 | 5D22 | P10-105 | |
| | KF2 | Basement | 400/800 | 5D22 | P10-155 | P10-280 |
| | KF10 | | 700/700 | 7D22 | P10-85 | P10-185 |
| | KF16 | | | | P10-80 | P10-185 |
| | KF22 | | | | P10-75 | P10-185 |
| | KF30 | | | | P10-70 | P10-185 |
| | KF36 | | 400/800 | 5D22 | P10-110 | P10-280 |
| | KF3 | GF | 400/800 | 5D22 | P10-170 | P10-280 |
| | KF11 | | 700/700 | 7D22 | P10-90 | P10-185 |
| | KF17 | | | | P10-85 | P10-185 |

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|---|---|---|---|---|---|---|
| | KF23 | | | | P10-80 | P10-185 |
| | KF31 | | | | P10-75 | P10-185 |
| | KF37 | | 400/800 | 5D22 | P10-125 | P10-280 |
| | KF43 (a) | | 700/700 | 7D22 | P10-70 | P10-185 |
| | KF43 (b) | | | 8D22 | P10-70 | P10-185 |
| | KF4 | 1 | 400/800 | 5D22 | P10-105 | P10-280 |
| | KF12 | | 700/700 | 7D22 | P10-55 | P10-185 |
| | KF18 | | | | P10-50 | P10-185 |
| | KF24 | | | | P10-55 | P10-185 |
| | KF32 | | | | P10-50 | P10-185 |
| | KF38 | | 400/800 | 5D22 | P10-95 | P10-280 |
| | KF5 | 2 | 400/800 | 5D22 | P10-110 | P10-280 |
| | KF13 | | 700/700 | 7D22 | P10-65 | P10-185 |
| | KF19 | | | | P10-65 | P10-185 |
| | KF25 | | | | P10-65 | P10-185 |
| | KF33 | | | | P1065 | P10-185 |
| | KF39 | | 400/800 | 5D22 | P10-105 | P10-280 |
| | KF6 | 3 | 400/800 | 5D22 | P10-160 | P10-280 |
| | KF14 (a) | | 700/700 | 9D22 | P10-80 | P10-185 |
| | KF14 (b) | | | 7D22 | P10-80 | P10-185 |
| | KF20 | | 700/700 | 7D22 | P10-80 | P10-185 |
| | KF26 | | | | P10100 | P10-185 |
| | KF34 (a) | | 700/700 | 9D22 | P10-80 | P10-185 |
| | KF34 (b) | | | 7D22 | P10-80 | P10-185 |
| | KF40 | | 400/800 | 5D22 | P10-150 | P10-280 |
| | KF7 | 4 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KF27 | | 700/700 | 7D22 | P10-155 | P10-185 |
| | KF41 (a) | | 400/800 | 5D22 | P10-180 | P10-280 |
| | KF41 (b) | | | 9D22 | P10-180 | P10-280 |
| | KF8 | Atap | 400/800 | 5D22 | P10-180 | P10-280 |
| | KF28 | | 700/700 | 7D22 | P10-155 | P10-185 |
| | KF42 | | 400/800 | 5D22 | P10-180 | P10-280 |
| BG | KG2 | Dasar | 400/800 | 5D22 | P10-140 | |
| | KG10 | | | | P10-95 | |
| | KG3 | Basement | 400/800 | 5D22 | P10-180 | P10-280 |
| | KG11 | | | | P10-125 | P10-280 |
| | KG1 | GF | 400/800 | 10D22 | P10-35 | P10-240 |
| | KG4 | | 400/800 | 5D22 | P10-160 | P10-280 |
| | KG12 | | | | P10-180 | P10-280 |
| | KG5 | 1 | 400/800 | 5D22 | P10-130 | P10-280 |
| | KG13 | | | | P10-180 | P10-280 |
| | KG6 | 2 | 400/800 | 5D22 | P10-160 | P10-280 |
| | KG14 | | | | P10-180 | P10-280 |
| | KG7 | 3 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KG15 | | | | P10-170 | P10-280 |
| | KG8 | 4 | 400/800 | 5D22 | P10-180 | P10-280 |
| | KG16 | | | | P10-180 | P10-280 |
| | KG9 | Atap | 400/800 | 5D22 | P10-180 | P10-280 |
| | KG17 | | | | P10-180 | P10-280 |

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|---|---|---|---|---|---|---|
| BH | KH2 | Dasar | 700/700 | 7D22 | P10-80 | |
| | KH14 | | | | P10-85 | |
| | KH20 | | | | P10-80 | |
| | KH26 | | | | P10-75 | |
| | KH34 | | | | P1065 | |
| | KH42 | | | | P10-155 | |
| | KH3 | Basement | 700/700 | 7D22 | P10-75 | P10-160 |
| | KH15 | | | | P10-75 | P10-160 |
| | KH21 | | | | P10-75 | P10-160 |
| | KH27 | | | | P10-65 | P10-160 |
| | KH35 | | | | P10-65 | P10-160 |
| | KH43 | | | | P10-75 | P10-160 |
| | KH1 (a) | GF | 700/700 | 8D22 | P10-40 | P10-160 |
| | KH1 (b) | | | 11D22 | P10-40 | P10-160 |
| | KH4 | | 700/700 | 7D22 | P10-90 | P10-160 |
| | KH5 | | | | P10-110 | P10-160 |
| | KH16 | | | | P10-80 | P10-160 |
| | KH22 | | | | P10-80 | P10-160 |
| | KH28 | | | | P10-70 | P10-160 |
| | KH36 | | | | P10-65 | P10-160 |
| | KH44 | | | | P10-65 | P10-160 |
| | KH50 (a) | | 700/700 | 7D22 | P10-60 | P10-160 |
| | KH50 (b) | | | 8D22 | P10-60 | P10-160 |
| | KH6 | 1 | 700/700 | 7D22 | P10-95 | P10-160 |
| | KH7 | | | | P10-110 | P10-160 |
| | KH17 | | | | P10-50 | P10-160 |
| | KH23 | | | | P10-55 | P10-160 |
| | KH29 | | | | P10-50 | P10-160 |
| | KH37 | | | | P10-50 | P10-160 |
| | KH45 | | | | P10-55 | P10-160 |
| | KH8 | 2 | 700/700 | 7D22 | P10-150 | P10-160 |
| | KH9 | | | | P10-100 | P10-160 |
| | KH18 | | | | P10-60 | P10-160 |
| | KH24 | | | | P10-65 | P10-160 |
| | KH30 | | | | P10-55 | P10-160 |
| | KH38 | | | | P10-60 | P10-160 |
| | KH46 | | | | P10-90 | P10-160 |
| | KH10 | 3 | 700/700 | 7D22 | P10-155 | P10-315 |
| | KH11 | | | | P10-95 | P10-315 |
| | KH19 (a) | | 700/700 | 8D22 | P10-65 | P10-315 |
| | KH19 (b) | | | 7D22 | P10-65 | P10-315 |
| | KH25 (a) | | 700/700 | 8D22 | P10-70 | P10-315 |
| | KH25 (b) | | | 7D22 | P10-70 | P10-315 |
| | KH31 | | 700/700 | 7D22 | P10-85 | P10-315 |
| | KH39 | | | | P10-90 | P10-315 |
| | KH47 | | | | P10-155 | P10-315 |
| | KH12 | 4 | 700/700 | 7D22 | P10-155 | P10-160 |
| | KH32 | | | | P10-110 | P10-160 |
| | KH40 | | | | .P10-155 | P10-160 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | KH48 | | | | P10-135 | P10-160 |
| | KH13 | Atap | 700/700 | 7D22 | P10-155 | P10-160 |
| | KH33 | | | | P10-155 | P10-160 |
| | KH41 | | | | P10-155 | P10-160 |
| | KH49 | | | | P10-155 | P10-160 |
| BI | KI1 | Dasar | 700/700 | 7D22 | P10-120 | |
| | KI13 | | | | P10-105 | |
| | KI21 | | | | P10-100 | |
| | KI29 | | | | P10-95 | |
| | KI37 | | | | P10-90 | |
| | KI49 | | | | P10-100 | |
| | KI2 | Basement | 700/700 | 7D22 | P10-105 | P10-160 |
| | KI14 | | | | P10-105 | P10-160 |
| | KI22 | | | | P10-100 | P10-160 |
| | KI30 | | | | P10-90 | P10-160 |
| | KI38 | | | | P10-110 | P10-160 |
| | KI39 | | | | P10-85 | P10-160 |
| | KI50 | | | | P10-120 | P10-160 |
| | KI51 | | | | P10-155 | P10-160 |
| | KI3 | GF | 700/700 | 7D22 | P10-115 | P10-160 |
| | KI4 | | | | P10-155 | P10-160 |
| | KI15 | | | | P10-105 | P10-160 |
| | KI23 | | | | P10-110 | P10-160 |
| | KI31 | | | | P10-95 | P10-160 |
| | KI40 | | | | P10-90 | P10-160 |
| | KI41 | | | | P10-95 | P10-160 |
| | KI52 | | | | P10-145 | P10-160 |
| | KI53 | | | | P10-155 | P10-160 |
| | KI5 | 1 | 700/700 | 7D22 | P10-145 | P10-160 |
| | KI6 | | | | P10-155 | P10-160 |
| | KI16 | | | | P10-65 | P10-160 |
| | KI24 | | | | P10-75 | P10-160 |
| | KI32 | | | | P10-70 | P10-160 |
| | KI42 | | | | P10-80 | P10-160 |
| | KI43 | | | | P10-75 | P10-160 |
| | KI54 | | | | P10-155 | P10-160 |
| | KI55 | | | | P10-155 | P10-160 |
| | KI7 | 2 | 700/700 | 7D22 | P10-155 | P10-160 |
| | KI8 | | | | P10-135 | P10-160 |
| | KI17 | | | | P10-80 | P10-160 |
| | KI25 | | | | P10-90 | P10-160 |
| | KI33 | | | | P10-85 | P10-160 |
| | KI44 | | | | P10-110 | P10-160 |
| | KI45 | | | | P10-90 | P10-160 |
| | KI56 | | | | P10-155 | P10-160 |
| | KI57 | | | | P10-155 | P10-160 |
| | KI9 | 3 | 700/700 | 7D22 | P10-155 | P10-160 |
| | KI10 | | | | P10-140 | P10-160 |
| | KI18 | | | | P10-105 | P10-160 |
| | KI26 | | | | P10-125 | P10-160 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | KI34 | | | | P10-135 | P10-160 |
| | KI46 | | | | P10-115 | P10-160 |
| | KI47 | | | | P10-115 | P10-160 |
| | KI58 | | | | P10-155 | P10-160 |
| | KI59 | | | | P10-150 | P10-160 |
| | KI11 | 4 | 700/700 | 7D22 | P10-155 | P10-160 |
| | KI19 | | | | P10-155 | P10-160 |
| | KI27 | | | | P10-155 | P10-160 |
| | KI35 | | | | P10-155 | P10-160 |
| | KI48 | | | | P10-155 | P10-160 |
| | KI60 | | | | P10-155 | P10-160 |
| | KI12 | Atap | 700/700 | 7D22 | P10-155 | P10-160 |
| | KI20 | | | | P10-155 | P10-160 |
| | KI28 | | | | P10-155 | P10-160 |
| | KI36 | | | | P10-155 | P10-160 |

Tabel 5.7 Rekapitulasi Pondasi Sumuran dan Telapak

Rekapitulasi Perhitungan Pondasi Sumuran dan Telapak

| Pondasi | Dimensi | | Tulangan terpasang | | | |
|---|---|---|---|---|---|---|
| | Sumuran | Telapak | Arah x | | Arah y | |
| | (m) | (m) | tul pokok | tul susut | tul pokok | tul susut |
| Pt1 | 3.5 | 2.3 | D16-135 | P12-70 | D16-135 | P12-70 |
| Pt2 | 2.6 | 2.3 | D16-245 | P12-70 | D16-245 | P12-70 |
| Pt3 | 3.9 | 2.3 | D16-105 | P12-70 | D16-105 | P12-70 |

# BAB VI

# KESIMPULAN DAN SARAN

## 6.1 Kesimpulan

Berdasarkan hasil perhitungan da pembahasan dari bab-bab sebelumnya, dapat diambil kesimpulan sebagai berikut :

1. Gedung Administrasi Sanata Dharma yang terletak di daerah Paingan, Maguwoharjo, Depok, Sleman, Daerah Istimewa Yogyakarta , didesain ulang dan direncanakan menggunakan analisis 3-D dengan menggunakan program SAP 2000. Untuk perencanaan kuda-kuda dan tangga menggunakan analisis 2-D, juga menggunakan program SAP 2000.
2. Perhitungan konstruksi meliputi :
   - Perencanaan atap dengan menggunakan *Allowable stress design* dari AISC
   - Perencanaan pelat menggunakan metode koefisien momen dengan menganggap tumpuan tepi jepit elastis sehingga didapat koefisien dari buku Gideon Kusuma seri ke-4.
   - Perencanaan balok anak merupakan hasil dari analisis SAP 2000 3-D
   - Perencanaan portal dengan daktilitas penuh meliputi balok dan kolom direncanakan berdasarkan SK-SNI T-15-1991-03.

## 6.2 Saran

Dengan mempertimbangkan hal-hal tersebut diatas, maka dapat diberikan beberapa saran antara lain sebagai berikut :

1. Perlu adanya perhitungan sampai tahap akhir pada Tugas Akhir ini (RAB), sehingga penghematan dari segi biaya dapat diketahui dengan jelas.
2. Perlu adanya perhitungan re-desain untuk Tugas Akhir ini dengan peningkatan spesifikasi bahan yang lain sehingga diketahui sejauh mana efisiensi bahan yang digunakan.
3. Perlu adanya perbandingan perhitungan dengan menggunakan *software* yang lain, seperti ETABS, SANS PRO untuk mengecek desain yang telah ada sehingga didapatkan perbandingan perencanaan.

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FM-UII-AA-FPU-09

# KARTU PESERTA TUGAS AKHIR

| NO. | NAMA | NO. MHS. | BID.STUDI |
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**JUDUL TUGAS AKHIR :**

REDESAIN GEDUNG ADMINISTRASI UNIVERSITAS SANATA DHARMA YK.

## PERIODE IV : JUNI - NOPEMBER
## TAHUN : 2002 / 2002

| No. | Kegiatan | Bulan Ke : | | | | | |
|---|---|---|---|---|---|---|---|
| | | Jun. | Jul. | Aug. | Sep. | Okt. | Nop. |
| 1. | Pendaftaran | | | | | | |
| 2. | Penentuan Dosen Pembimbing | | | | | | |
| 3. | Pembuatan Proposal | | | | | | |
| 4. | Seminar Proposal | | | | | | |
| 5. | Konsultasi Penyusunan TA. | | | | | | |
| 6. | Sidang-Sidang | | | | | | |
| 7. | Pendadaran. | | | | | | |

DOSEN PEMBIMBING I : Ir. H. Ilman Noor, MSCE.
DOSEN PEMBIMBING II : Ir. Tri Fajar Budiono, MT.

Yogyakarta, 03 Juni 2002
Sp. Dekan,

Munadhir
(Ir.H. [illegible] MS

**Catatan.**

Seminar : 28 OKTOBER 2002
Sidang : 16 APRIL 2003
Pendadaran : 1 MEI 2003

# CATATAN KONSULTASI TUGAS AKHIR

| NO | TANGGAL | CATATAN KONSULTASI | TANDA TANGAN |
|---|---|---|---|
| 1 | 26 Juni '02 | - Siapkan data untuk perencanaan yg menggunakan program SAP 2000 atau SAP 90 | |
| 2 | 20/07 | lanjutkan | |
| 3 | 1/8/02 | - Lengkapi denah kuda-kuda nama kuda-kuda (KK1, dst)<br>- beri nomor pada beban lantai dan hitung<br>- pd kuda2 cantumkan beban angin<br>- Lanjutkan | |
| 4 | 14/10/02 | bisa dilanjutkan ke D.P.I | |

# LAMPIRAN HITUNGAN

# Perencanaan Kuda-Kuda 1

1.Perencanaan Gording

Jarak antar gording ( d ) = 2078 mm
Jarak antar kuda-kuda (L) = 3600 mm
Besar Sudut ( α ) = 30

Pembebanan :
Beban penutup atap = 50 kg/m²
Beban hidup = 20 kg/m²
Beban gording = 8 kg/m

Pembebanan Gording
a. Beban Tetap :

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban penutup atap | = | 50 | kg/m² | x | 2.078 m | = | 103.9 | kg/m |
| Beban hidup | = | 20 | kg/m² | x | 2.078 m | = | 41.56 | kg/m |
| Beban gording | = | 8 | kg/m | | | = | 8 | kg/m |
| | | | | | | q | = 153.46 | kg/m |

$q^{\perp}$ = q . Cos α = 153.46 kg/m x cos 30 = 132.9 kg/m
q // = q . Sin α = 153.46 kg/m x sin 30 = 76.73 kg/m

b. Beban Angin : w = 25 kg/m²
Angin Tekan (wt) = c1 w.d
c1 = 0.02 x α - 0.4 = 0.2
Wt = c1 w.jarak gording = 10.39 kg/m
Angin Hisap (wh) = c2 w.d
c2 = - 0.4
Wh = c2 w.jarak gording = -20.78 kg/m

c.Perhitungan Momen
Beban Tetap :
$Mmax^{\perp}$ = 1/8 . $q^{\perp}$ .L2 = 215.2984 kgm
Mmax // = 1/32 .q// .L2 = 31.07565 kgm ( 1 sagrod diantara kuda-kuda )
Akibat Beban Angin :
Mmax = 1/8 . wh . L2 = 33.6636 kgm
Beban Momen Maksimal Tegak Lurus :
Mmax = $Mmax^{\perp}$ +Mmax angin = 249 kgm
Mmax = $Mmax^{\perp}$ .1.25 = 269.1 kgm
Momen terpakai = 269.1 kgm

d.Pemilihan Gording
Dicoba Profil C (baja kanal tipis) :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C | 150 x 50 x 20 x 2.3 | | | | | | |
| Sx | 28 | cm3 | | | | | |
| Sy | 6.33 | cm3 | | | | | |
| Ix | 210 | cm4 | | | | | |
| Iy | 21.9 | cm4 | | | | | |
| Fy | 2400 | kg/cm2 | | | | | |
| Berat | 4.96 | kg/m | < | taksiran | = | 8 | kg/m |

e.Kontrol Tegangan

$$fbx = \frac{M \perp}{Sx} = 961.1537 \text{ kg/cm}^2$$

$$fby = \frac{M //}{Sy} = 490.9265 \text{ kg/cm}^2$$

$$\frac{fbx}{0,66\,Fy} + \frac{fby}{0,75\,Fy} \leq 1,0$$

0.879526 ≤ 1,0 Aman

f.Kontrol Lendutan

$$\delta \perp = {}^{5}/_{384} \cdot \frac{q \perp \cdot L^4}{E \cdot Ix} \leq \frac{L}{360}$$

0.659076792 cm ≤ 1 cm

$$\delta // = {}^{5}/_{384} \cdot \frac{q // \cdot \left(\frac{L}{(a+1)}\right)^4}{E \cdot Iy} \leq \frac{L}{360} \qquad a = 1$$

0.228050269 cm ≤ 1 cm

| | | | |
|---|---|---|---|
| Jumlah Gording 1 sisi | = | 7 | batang |
| Jarak antar kuda-kuda | = | 3.6 | m |
| Jarak Gording | = | 2.078 | m |
| Sudut Atap | = | 30 | |
| Panjang Kuda2 ( L ) | = | 21.6 | m |
| Panjang Beban Sagrod | = | 2 | m |

2.Perencanaan Sagrod

a.Data Beban Tetap :

| | | | |
|---|---|---|---|
| Gording | = | 4.96 | kg/m |
| Eternit + Plafond | = | 13 | kg/m |
| Penutup Atap | = | 50 | kg/m |
| Beban Hidup | = | 20 | kg/m |

Taksiran Berat Kuda-Kuda $= (10 + \frac{L - 12}{3}) \times jarak\ kuda\ 2$

= 93.6 kg/m

| | | | |
|---|---|---|---|
| fy | = | 2400 | kg/cm² |
| E | = | 2.1*10^6 | kg/cm² |
| Fu | = | 3600 | kg/cm² |

b.Beban Sagrod

Beban Penutup Atap $\left(\frac{1/2}{\cos \alpha} \cdot L\right)$ = 623.54 kg/m

Beban Hidup $\left(\frac{1/2}{\cos \alpha} \cdot L\right)$ = 249.42 kg/m

Berat Gording x Jml.Gording 1sisi = 34.72 kg/m

P = 907.67 kg/m

P// = P sin α .Sisi Sagrod = 907.67 kg

c.Dimensi Sagrod

$$Asagrod = \frac{P\ //}{0,33\ Fu} \rightarrow \frac{1}{4}\pi\ D^2\ sagrod = \frac{P\ //}{0,33\ Fu}$$

$$Dsagrod = \sqrt{\frac{4P//}{0,33Fu \cdot \pi}} = 0.986305 \text{ cm} + 0.3 \text{ cm} = 1.2863 \text{ cm}$$

Dipakai Sagrod = 15 mm

d.Dimensi Tierod

T = P// cos α = 786.0684 kg

$$Ttierod = \frac{T}{0,33Fu} \rightarrow \frac{1}{4}\pi\ D^2 tierod = \frac{T}{0,33Fu}$$

$$Dtierod = \sqrt{\frac{4T}{0,33Fu \cdot \pi}} = 0.918 \text{ cm} + 0.3 \text{ cm} = 1.21786 \text{ cm}$$

Dipakai Tierod = 15 mm

e.Kontrol Sagrod dan Tierod

*Sagrod

$$\frac{P\ //}{Asagrod} \leq 0,33Fu \rightarrow$$ 513.637 kg/cm² ≤ 1188 kg/cm² → aman

*Tierod

$$\frac{T}{Atierod} \leq 0,33Fu \rightarrow$$ 444.8227 kg/cm² ≤ 1188 kg/cm² → aman

Beban Masing-masing Joint

*P1=P13

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban Gording | = | 4.96 | x | 3.6 | | | = | 17.856 kg |
| Beban penutup Atap | = | 50 | x | 3.6 | x | 1.039 | = | 187.02 kg |
| Beban Hidup | = | 20 | x | 3.6 | x | 1.039 | = | 74.808 kg |
| | | | | | | P | = | 279.684 kg |

*P2=P3=P4=P5=P6=P8=P9=P10=P11=P12

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban Gording | = | 4.96 | x | 3.6 | | | = | 17.856 kg |
| Beban penutup Atap | = | 50 | x | 3.6 | x | 2.078 | = | 374.04 kg |
| Beban Hidup | = | 20 | x | 3.6 | x | 2.078 | = | 149.616 kg |
| | | | | | | P | = | 541.512 kg |

*P7

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban Gording | = | 2 | x | 4.96 | x | 3.6 | = | 35.712 kg |
| Beban penutup Atap | = | 50 | x | 3.6 | x | 2.078 | = | 374.04 kg |
| Beban Hidup | = | 20 | x | 3.6 | x | 2.078 | = | 149.616 kg |
| | | | | | | P | = | 559.368 kg |

*P1'=P13'

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban eternit + plafond | = | 18 | x | 0.9 | x | 3.6 | = | 58.32 kg |
| Beban taksiran Kuda2 | = | 93.6 | x | 0.9 | | | = | 84.24 kg |
| | | | | | | P | = | 142.56 kg |

*P2'=P3'=P4'=P5'=P6'=P7'=P8'=P9'=P10'=P11'=P12'

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Beban eternit + plafond | = | 18 | x | 1.8 | x | 3.6 | = | 116.64 kg |
| Beban taksiran Kuda2 | = | 93.6 | x | 1.8 | | | = | 168.48 kg |
| | | | | | | P | = | 285.12 kg |

## Perencanaan Kuda-Kuda 2

| | | | |
|---|---|---|---|
| Jumlah Gording 1 sisi | = | 5 | batang |
| Jarak antar kuda-kuda | = | 3.6 | m |
| Jarak Gording | = | 2.078 | m |
| Sudut Atap | = | 30 | |
| Panjang Kuda2 ( L ) | = | 21.6 | m |
| Panjang Beban Sagrod | = | 2 | m |

2.Perencanaan Sagrod

a.Data Beban Tetap

| | | | |
|---|---|---|---|
| Gording | = | 4.96 | kg/m |
| Eternit + Plafond | = | 18 | kg/m² |
| Penutup Atap | = | 50 | kg/m² |
| Beban Hidup | = | 20 | kg/m² |

Taksiran Berat Kuda-Kuda $\frac{L}{3} \cdot 5$ jarak kuda 2

| | | | |
|---|---|---|---|
| | | 93.6 | kg/m |
| fy | = | 2400 | kg/cm² |
| E | = | 2.1*10^6 | kg/cm² |
| Fu | = | 3600 | kg/cm² |

b.Beban Sagrod

Beban Penutup Atap $\frac{1}{\cos\alpha} \cdot L$ = 623.5383 kg/m

Beban Hidup $\frac{1}{\cos\alpha}$ = 249.4153 kg/m

Berat Gording x Jml Gording 1 sisi = 24.8 kg/m

P = 897.7536 kg/m

P// = P sin α . Sisi Sagrod = 897.7536 kg

c.Dimensi Sagrod

$$Asagrod = \frac{P//}{0.33\ Fu} \rightarrow \frac{1}{4}\pi\ D^2 sagrod = \frac{P//}{0.33\ Fu}$$

$$Dsagrod = \sqrt{\frac{4P//}{0{,}33Fu \cdot \pi}}$$ = 0.9809 cm + 0.3 cm

= 1.2809 cm

Dipakai Sagrod = 15 mm

d.Dimensi Tierod

T = P// cos α = 777.4774 kg

$$Ttierod = \frac{T}{0{,}33Fu} \rightarrow \frac{1}{4}\pi\ D^2 tierod = \frac{T}{0{,}33Fu}$$

$$Dtierod = \sqrt{\frac{4T}{0{,}33Fu \cdot \pi}}$$ = 0.912831 cm + 0.3 cm

= 1.212831 cm

Dipakai Tierod = 15 mm

e.Kontrol Sagrod dan Tierod

*Sagrod

$\frac{P//}{Asagrod} \leq 0{,}33Fu \rightarrow$ 508.0234 kg/cm² ≤ 1188 kg/cm² → aman

*Tierod

$\frac{T}{Atierod} \leq 0{,}33Fu \rightarrow$ 439.9612 kg/cm² ≤ 1188 kg/cm² → aman

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PEMBEBANAN BALOK

Pembebanan Beban Mati :

1. Tipe 1

Beban mati ($q_D$) :

- untuk pelat lantai

berat pelat = $W_D$. 1.8 = 4.6. 1.8 = 8.28 KN/m

- untuk pelat atap

berat pelat = $W_D$. 1.8 = 3.3. 1.8 = 5.94 KN/m

2. Tipe 2

Beban mati ($q_D$) :

berat pelat = $W_D$. 1 = 4.6. 1 = 4.6 KN/m

3. Tipe 3

Beban mati ($q_D$) :

berat pelat = $W_D$. 1 = 4.6. 1 = 4.6 KN/m

4. Tipe 4

Beban mati ($q_D$) :

berat pelat = $W_D$. 0.5 = 4.6. 0.5 = 2.3 KN/m

5. Tipe 5

Beban mati ($q_D$) :

berat pelat = $W_D$. 0.5 = 4.6. 0.5 = 2.3 KN/m

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- untuk pelat atap

berat pelat = $W_D$ . 1 = 3,3. 1 = 3,3 KN/m

13. Tipe 13

Beban mati ($q_D$) :

- untuk pelat lantai

berat pelat = $W_D$ . 1,8 = 4,6. 1,8 = 8,28 KN/m

- untuk pelat atap

berat pelat = $W_D$ . 1,8 = 3,3. 1,8 = 5,94 KN/m

14. Tipe 14

Beban mati ($q_D$) :

berat pelat = $W_D$ . 1,8 = 3,3. 1,8 = 5,94 KN/m

15. Tipe 15

Beban mati ($q_D$) :

berat pelat = $W_D$ . 1,8 = 3,3. 1,8 = 5,94 KN/m

16. Tipe 16

Beban mati ($q_D$) :

berat pelat = $W_D$. 1,8 = 3,3. 1,8 = 5,94 KN/m

17. Tipe 17

Beban mati ($q_D$) :

berat pelat = $W_D$. 0,9 = 3,3. 0,9 = 2,97 KN/m

18. Tipe 18

Beban mati ($q_D$) :

berat pelat = $W_D$. 0,9 = 3,3. 0,9 = 2,97 KN/m

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44. Tipe 44

Beban hidup ($q_L$):

$q_L = W_L \cdot 1 = 1 \cdot 1 = 1$ KN/m

45. Tipe 45

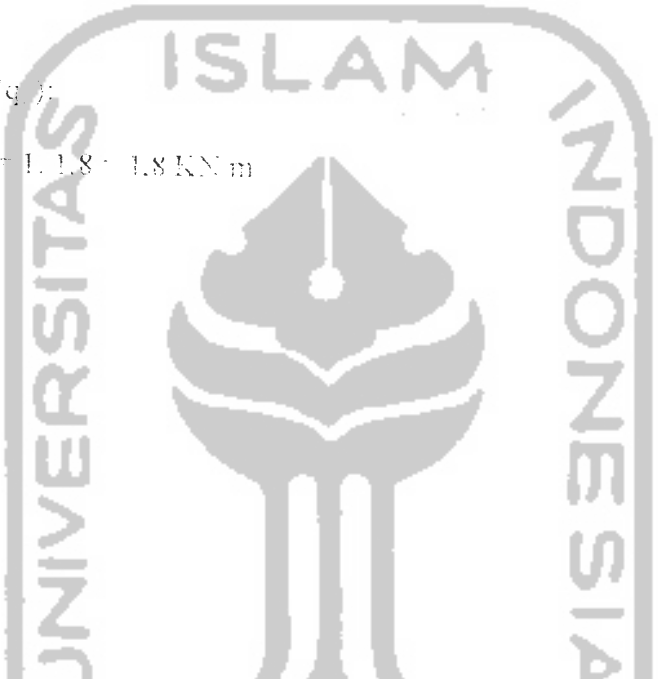
Beban hidup ($q_L$):

$q_L = W_L \cdot 1.8 = 1 \cdot 1.8 = 1.8$ KN/m

46. Tipe 46

Beban hidup ($q_L$):

$q_L = W_L \cdot 1.8 = 1 \cdot 1.8 = 1.8$ KN/m



**Berat Bangunan Total**

**1.Balok Ring**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Luas Plafond (m^2) | = 1088.64 | bj beton (kg/m^3) | = 2400 | Luas atap (m^2) | = 1256.854 |
| tebal pelat (m) | = 0 | Dinding1/2batu (kg/m^2) | = 250 | plafond (kg/m^2) | = 18 |
| b balok I (m) | = 0 | b balok A (m) | = 0.3 | spesi (kg/m^2) | = 21 |
| h balok I (m) | = 0 | h balok A (m) | = 0.4 | tegel (kg/m^2) | = 24 |
| Panjang Balok I (m) | = 0 | 1/2 kolom atas (m) | = 0 | Pjg Dinding Atas | = 0 |
| Panjang Balok A (m) | = 165.5 | 1/2 kolom bawah (m) | = 1.25 | Pjg Dinding bwh | = 273.6 |
| jumlah kolom atas (0.7x0.7) | = 0 | b1 kolom (m) | = 0.7 | | |
| jumlah kolom bawah (0.7x0.7) | = 18 | h1 kolom (m) | = 0.7 | | |
| jumlah kolom atas (0.4x0.8) | = 0 | b2 kolom (m) | = 0.4 | | |
| jumlah kolom bawah (0.4x0.8) | = 10 | h2 kolom (m) | = 0.8 | | |

BEBAN MATI

| | | |
|---|---|---|
| *Genteng | = 50x1256.854 | = 62842.7 kg |
| *kuda-kuda | | = 16596.4 kg |
| *Gording | = 698.4x4.96 | = 3464.06 kg |
| *balok (Ba) | = 279x0.3x0.4x2400 | = 47664 kg |
| *kolom | = 18x1.25x0.7x0.7x2400 | = 26460 kg |
| | = 10x1.25x0.4x0.8x2400 | = 9600 kg |
| *dinding | = 273.6x1.25x250 | = 85500 kg |
| *plafond | = 1088.64x18 | = 19595.5 kg |
| | Wm | = 271723 kg |

Beban Hidup

| | | |
|---|---|---|
| *qh atap | = 40-0.8xsudut atap | = 16 kg/m2 |
| *koef reduksi | = 0.3 | |
| Wh | = 0.3x16x1256.854 | = 6032.9 kg |

Beban Total (W7) = Wm+Wh
= 277756 kg

**2.Berat lantai atap**

| | | | | | |
|---|---|---|---|---|---|
| Luas Pelat (m^2) | = 489.56 | bj beton (kg/m^3) | = 2400 | plafond (kg/m^2) | = 18 |
| tebal pelat (m) | = 0.1 | Dinding1/2batu (kg/m^2) | = 250 | spesi (kg/m^2) | = 21 |
| b balok I (m) | = 0.4 | b balok A (m) | = 0.3 | tegel (kg/m^2) | = 24 |
| h balok I (m) | = 0.6 | h balok A (m) | = 0.4 | Pjg Dinding Atas | = 164.8 |
| Panjang Balok I (m) | = 271.2 | 1/2 kolom atas (m) | = 1.25 | Pjg Dinding bwh | = 273.6 |
| Panjang Balok A (m) | = 279 | 1/2 kolom bawah (m) | = 2.5 | | |
| jumlah kolom atas (0.7x0.7) | = 18 | b1 kolom (m) | = 0.7 | | |
| jumlah kolom bawah (0.7x0.7) | = 22 | h1 kolom (m) | = 0.7 | | |
| jumlah kolom atas (0.4x0.8) | = 10 | b2 kolom (m) | = 0.4 | | |
| jumlah kolom bawah (0.4x0.8) | = 10 | h2 kolom (m) | = 0.8 | | |

BEBAN MATI

| | | |
|---|---|---|
| *plat | = 489.56x0.1x2400 | = 117494 kg |
| *balok (Bi) | = 271.2x0.5x0.4x2400 | = 130176 kg |
| *balok (Ba) | = 279x0.3x0.3x2400 | = 60264 kg |
| *kolom | = 18x1.25x0.7x0.7x2400 | = 26460 kg |
| | = 22x2.5xx0.7x0.7x2400 | = 64680 kg |
| | = 10x1.25x0.4x0.8x2400 | = 9600 kg |
| | = 10x2.5x0.4x0.8x2400 | = 19200 kg |
| *dinding | = 164.8x1.25x250 | = 51500 kg |
| | = 273.6x2.5x250 | = 171000 kg |
| *plafond | = 489.56x18 | = 24478 kg |
| | Wm | = 674852 kg |

Beban Hidup

| | | |
|---|---|---|
| *qh atap | | = 20 kg/m2 |
| *koef reduksi | = 0.3 | |
| Wh | = 0.3x489.56x20 | = 2937.36 kg |

Beban Total (W6) = Wm+Wh
= 677790 kg

**5.Berat lantai 2**

| | | | | | |
|---|---|---|---|---|---|
| Luas Pelat (m^2) | = 1248.48 | bj beton (kg/m^3) | = 2400 | plafond (kg/m^2) | = 18 |
| tebal pelat (m) | = 0.12 | Dinding1/2batu (kg/m^2) | = 250 | spesi (kg/m^2) | = 21 |
| b balok I (m) | = 0.4 | b balok A (m) | = 0.3 | tebal spesi (m) | = 0.03 |
| h balok I (m) | = 0.6 | h balok A (m) | = 0.4 | tegel (kg/m^2) | = 24 |
| Panjang Balok I (m) | = 440 | 1/2 kolom atas (m) | = 2.25 | Pjg Dinding Atas | = 326.4 |
| Panjang Balok A (m) | = 474 | 1/2 kolom bawah (m) | = 2.25 | Pjg Dinding bwh | = 268.8 |
| jumlah kolom atas (0.7x0.7) | = 32 | b1 kolom (m) | = 0.7 | | |
| jumlah kolom bawah (0.7x0.7) | = 32 | h1 kolom (m) | = 0.7 | | |
| jumlah kolom atas (0.4x0.8) | = 10 | b2 kolom (m) | = 0.4 | | |
| jumlah kolom bawah (0.4x0.8) | = 10 | h2 kolom (m) | = 0.8 | | |

BEBAN MATI

| | | |
|---|---|---|
| *plat | = 1248.48x0.12x2400 | = 359562.2 kg |
| *balok (Bl) | = 440x0.48x0.4x2400 | = 202752 kg |
| *balok (Ba) | = 474x0.28x0.3x2400 | = 95558.4 kg |
| *kolom | = 32x2.25x0.7x0.7x2400 | = 84672 kg |
| | = 32x2.25x0.7x0.7x2400 | = 84672 kg |
| | = 10x2.25x0.4x0.8x2400 | = 17280 kg |
| | = 10x2.25x0.4x0.8x2400 | = 17280 kg |
| *dinding | = 326.4x2.25x250 | = 183600 kg |
| | = 268.8x2.25x250 | = 151200 kg |
| *plafond | = 1248.48x18 | = 22472.64 kg |
| *spesi | = 1248.48x21x0.03 | = 786.5424 kg |
| *tegel | = 1248.4x24 | = 29963.52 kg |
| | Wm | = 1249799 kg |

Beban Hidup

| | | |
|---|---|---|
| *qh lantai | = 340 kg/m2 | |
| *koef reduksi | = 0.3 | |
| Wh | = 0.3x1248.48x340 | = 127345 kg |

Beban Total (W3) = Wm+Wh
= 1377144 kg

**6.Berat lantai 1**

| | | | | | |
|---|---|---|---|---|---|
| Luas Pelat (m^2) | = 1721.52 | b1 balok A (m) | = 0.3 | bj beton (kg/m^3) | = 2400 |
| tebal pelat (m) | = 0.12 | h1 balok A (m) | = 0.4 | Dinding1/2batu (kg/ | = 250 |
| b1 balok I (m) | = 0.4 | Panjang Balok A (0.3x0.4)(m) | = 456.2 | plafond (kg/m^2) | = 18 |
| h1 balok I (m) | = 0.6 | b2 balok A (m) | = 0.3 | spesi (kg/m^2) | = 21 |
| Panjang Balok I (0.4x0.6) (m) | = 495.8 | h2 balok A (m) | = 0.5 | tebal spesi (m) | = 0.03 |
| b2 balok I (m) | = 0.4 | Panjang Balok A (0.3x0.5)(m) | = 72 | tegel (kg/m^2) | = 24 |
| h2 balok I (m) | = 0.7 | b3 balok A (m) | = 0.3 | Pjg Dinding Atas | = 268.8 |
| Panjang Balok I (0.4x0.7) (m) | = 32.4 | h3 balok A (m) | = 0.6 | Pjg Dinding bwh | = 294 |
| b3 balok I (m) | = 0.3 | Panjang Balok A (0.3x0.6)(m) | = 36 | | |
| h3 balok I (m) | = 0.7 | 1/2 kolom atas (m) | = 2.25 | | |
| Panjang Balok I (0.3x0.7) (m) | = 31.8 | 1/2 kolom bawah (m) | = 2.5 | | |
| jumlah kolom atas (0.7x0.7) | = 32 | b1 kolom (m) | = 0.7 | | |
| jumlah kolom bawah (0.7x0.7) | = 40 | h1 kolom (m) | = 0.7 | | |
| jumlah kolom atas (0.4x0.8) | = 10 | b2 kolom (m) | = 0.4 | | |
| jumlah kolom bawah (0.4x0.8) | = 10 | h2 kolom (m) | = 0.8 | | |

BEBAN MATI

| | | |
|---|---|---|
| *plat | = 1721.52x0.12x2400 | = 495797.8 kg |
| *balok (Bl) | = 495.8x0.48x0.4x2400 | = 228464.6 kg |
| | = 32.4x0.58x0.4x2400 | = 18040.32 kg |
| | = 31.8x0.58x0.3x2400 | = 13279.68 kg |
| *balok (Ba) | = 456.2x0.28x0.3x2400 | = 91969.92 kg |
| | = 72x0.38x0.3x2400 | = 19699.2 kg |
| | = 36x0.48x0.3x2400 | = 12441.6 kg |
| *kolom | = 32x2.25x0.6x0.6x2400 | = 84672 kg |
| | = 40x2.5x0.6x0.6x2400 | = 117600 kg |
| | = 10x2.25x0.4x0.8x2400 | = 17280 kg |
| | = 10x2.5x0.4x0.8x2400 | = 19200 kg |
| *dinding | = 268.8x2.25x250 | = 151200 kg |
| | = 294x2.5x250 | = 183750 kg |
| *plafond | = 1721.52x18 | = 30987.36 kg |
| *spesi | = 1721.52x21x0.03 | = 1084.558 kg |
| *tegel | = 1721.52x24 | = 41316.48 kg |
| | Wm | = 1526784 kg |

Beban Hidup

| | | |
|---|---|---|
| *qh lantai | = 375 kg/m2 | |
| *koef reduksi | = 0.3 | |
| Wh | = 0.3x1721.52x375 | = 193671 kg |

Beban Total (W2) = Wm+Wh
= 1720455 kg

**7.Berat lantai GF**

| | | | | | |
|---|---|---|---|---|---|
| Luas Pelat (m^2) | = 1300.32 | bj beton (kg/m^3) | = 2400 | plafond (kg/m^2) | = 18 |
| tebal pelat (m) | = 0.12 | Dinding1/2batu (kg/m^2) | = 250 | spesi (kg/m^2) | = 21 |
| b balok I (m) | = 0.4 | b balok A (m) | = 0.3 | tebal spesi (m) | = 0.03 |
| h balok I (m) | = 0.6 | h balok A (m) | = 0.4 | tegel (kg/m^2) | = 24 |
| Panjang Balok I (m) | = 440 | 1/2 kolom atas (m) | = 2.5 | Pjg Dinding Atas | = 294 |
| Panjang Balok A (m) | = 492 | 1/2 kolom bawah (m) | = 1.75 | Pjg Dinding bwh | = 284.4 |
| jumlah kolom atas (0.7x0.7) | = 32 | b1 kolom (m) | = 0.7 | | |
| jumlah kolom bawah (0.7x0.7) | = 32 | h1 kolom (m) | = 0.7 | | |
| jumlah kolom atas (0.4x0.8) | = 10 | b2 kolom (m) | = 0.4 | | |
| jumlah kolom bawah (0.4x0.8) | = 10 | h2 kolom (m) | = 0.8 | | |

BEBAN MATI

| | | |
|---|---|---|
| *plat | = 1300.32x0.12x2400 | = 374492.2 kg |
| *balok (Bi) | = 440x0.48x0.4x2400 | = 202752 kg |
| *balok (Ba) | = 492.4x0.28x0.3x2400 | = 99187.2 kg |
| *kolom | = 32x2.5x0.7x0.7x2400 | = 94080 kg |
| | = 32x1.75x0.7x0.7x2400 | = 65856 kg |
| | = 10x2.5x0.4x0.8x2400 | = 19200 kg |
| | = 10x1.75x0.4x0.8x2400 | = 13440 kg |
| *dinding | = 294x2.5x250 | = 183750 kg |
| | = 284.4x1.75x250 | = 124425 kg |
| *plafond | = 1300.32x18 | = 23405.76 kg |
| *spesi | = 1300.32x21x0.03 | = 819.2016 kg |
| *tegel | = 1300.32x24 | = 31207.68 kg |
| | Wm | = 1232615 kg |

Beban Hidup

| | | |
|---|---|---|
| *qh lantai | = 360 kg/m2 | |
| *koef reduksi | = 0.3 | |
| Wh | = 0.3x1300.32x360 | = 140434.6 kg |
| Beban Total (W1) | = Wm+Wh | |
| | = 1373050 kg | |

**Berat total seluruhnya :**

Wt = W7+W6+W5+W4+W3+W2+W1

= 8520945 kg

**Waktu Getar Bangunan (T)**

dengan rumus empiris

Tx=Ty=0.06.H^3/4

H=1.8+3.5+5+4.5+ 4.5+5+5+2.5= 31.8 m

Tx=Ty = 0.06.H^3/4

Tx=Ty = 0.06.(31.8)^3/4

= 0.803474 detik

Untuk Tx=Ty=0.803474 detik zone 3 dan jenis tanah keras , diperoleh C= 0.03

Faktor Keutamaan I = 1

Faktor jenis struktur K= 1

**Gaya geser horisontal total akibat gempa**

Vx=Vy = C.I.K .Wt

= 0.03x1x1x8520945 kg

= 255628.4 kg

**Distribusi gaya gesr horisontal total akibat gempa sepanjang tinggi gedung**

a. arah x

H/A =33/40=0.825<3

$$Fi\ ,\ x\ =\ \frac{Wi\ \cdot hi}{\sum Wi\ \cdot hi}\cdot Vx$$

b. arah y

H/A = 33/38=0.868<3

$$Fi\ ,\ y\ =\ \frac{Wi\ \cdot hi}{\sum Wi\ \cdot hi}\cdot Vy$$

Distribusi gaya geser dasar horisontal total akibat gempa ke sepanjang tinggi gedung dalam arah x dan arah y untuk tiap portal

| Tingkat | h i (m) | Wi (t) | Wi.hi ( tm ) | Fix,y total (t) | Untuk tiap portal | | |
|---|---|---|---|---|---|---|---|
| | | | | | 1/6 Fix (t) | 1/9 Fiy (t) | 1/8 Fix (t) |
| Balok Ring | 31.8 | 277.7556 | 8832.627 | 15.92492 | 2.654154 | 1.769436 | |
| Lantai Atap | 29.3 | 677.7898 | 19859.24 | 35.80553 | 5.967588 | 3.978392 | |
| 4 | 24.3 | 1596.399 | 38792.49 | 69.94153 | 11.65692 | 7.771281 | |
| 3 | 19.3 | 1498.353 | 28918.21 | 52.13854 | 8.689757 | 5.793172 | |
| 2 | 14.8 | 1377.144 | 20381.74 | 36.74757 | 6.124595 | 4.083064 | |
| 1 | 10.3 | 1720.455 | 17720.68 | 31.94978 | | 3.549976 | 3.993723 |
| GF | 5.3 | 1373.05 | 7277.163 | 13.12048 | 2.186746 | 1.457831 | |
| Bs | 1.8 | | 0 | | 0 | 0 | |
| | | | 141782.1 | 255.6284 | 37.27976 | 28.40315 | 3.993723 |

Waktu getar struktur dengan cara T Rayleigh

$$Tx = 6{,}3 \cdot \sqrt{\left( \frac{\sum W_i \cdot d_i x^2}{g \cdot \sum F_i x \cdot d_i x} \right)}$$ untuk portal arah x

$$Ty = 6{,}3 \cdot \sqrt{\left( \frac{\sum W_i \cdot d_i y^2}{g \cdot \sum F_i y \cdot d_i y} \right)}$$

| Tingkat | Wi (t) | dix (cm) | dix^2 ( cm ) | Fix total (t) | Wi.dix^2 (t cm^2) | Fix.dix (t cm) |
|---|---|---|---|---|---|---|
| Balok Ring | 277.756 | 2.160 | 4.665 | 15.925 | 1295.596 | 34.394 |
| Lantai Atap | 677.790 | 2.127 | 4.526 | 35.806 | 3067.533 | 76.172 |
| 4 | 1596.399 | 1.945 | 3.783 | 69.942 | 6039.775 | 136.043 |
| 3 | 1498.353 | 1.608 | 2.584 | 52.139 | 3871.828 | 83.813 |
| 2 | 1377.144 | 1.218 | 1.483 | 36.748 | 2042.222 | 44.750 |
| 1 | 1720.455 | 0.766 | 0.586 | 31.950 | 1008.960 | 24.467 |
| GF | 1373.050 | 0.264 | 0.070 | 13.120 | 95.667 | 3.463 |
| Bs | | | | | | |
| | | | | | 17421.581 | 403.102 |

$$Tx = 6{,}3 \cdot \sqrt{\left( \frac{\sum W_i \cdot d_i x^2}{g \cdot \sum F_i x \cdot d_i x} \right)} = 1.3223 \text{ detik}$$

| Tingkat | Wi (t) | diy (cm) | diy^2 ( cm ) | Fiy total (t) | Wi.diy^2 (t cm^2) | Fiy.diy (t cm) |
|---|---|---|---|---|---|---|
| Balok Ring | 277.756 | 2.055 | 4.223 | 15.925 | 1173.083 | 32.727 |
| Lantai Atap | 677.790 | 1.995 | 3.980 | 35.806 | 2697.539 | 71.431 |
| 4 | 1596.399 | 1.787 | 3.193 | 69.942 | 5097.434 | 124.980 |
| 3 | 1498.353 | 1.449 | 2.100 | 52.139 | 3146.551 | 75.556 |
| 2 | 1377.144 | 1.080 | 1.166 | 36.748 | 1605.617 | 39.679 |
| 1 | 1720.455 | 0.676 | 0.457 | 31.950 | 787.044 | 21.610 |
| GF | 1373.050 | 0.235 | 0.055 | 13.120 | 76.072 | 3.088 |
| Bs | | | | | | |
| | | | | | 14583.340 | 369.071 |

$$Ty = 6{,}3 \cdot \sqrt{\left( \frac{\sum W_i \cdot d_i y^2}{g \cdot \sum F_i y \cdot d_i y} \right)} = 1.2644 \text{ detik}$$

Dengan cara yang sama diperoleh koefisien gempa dasar C sebagai berikut :
Untuk Tx= 1.3223 detik zone 3 jenis tanah keras diperoleh C=0.0363
Untuk Ty= 1.2644 detik zone 3 jenis tanah keras diperoleh C=0.0373

**Syarat :**
**TR<0,8TE maka yang dipakai TE**
**TR>1,25TE maka yang dipakai TR**

TE=0.803474 detik
TR=1.2644 detik
TR=1,2644detik >1,25 .0.803474 detik
> 1.00434 detik ok

1. Plat Lantai Type A

| Pelat Lantai | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat lantai | 0.12 | 24 | 2.88 | 1.2 | 3.456 |
| pasir | 0.05 | 16 | 0.8 | 1.2 | 0.96 |
| spesi | 0.03 | 24 | 0.72 | 1.2 | 0.864 |
| keramik | 0.01 | 20 | 0.2 | 1.2 | 0.24 |
| beban hidup | | | 2.5 | 1.6 | 4 |
| | | | | qu total = | 9.52 |

| Pelat Lantai | ly (m) | lx (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mlx | 3.6 | 3.6 | 1 | 0.025 | 9.52 | 3.08448 |
| Mly | 3.6 | 3.6 | 1 | 0.025 | 9.52 | 3.08448 |
| (-)Mtx | 3.6 | 3.6 | 1 | 0.051 | 9.52 | 6.292339 |
| (-)Mty | 3.6 | 3.6 | 1 | 0.051 | 9.52 | 6.292339 |

| | Pelat Lantai Type A | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| f'c (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β1 | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 3.08448 | 3.08448 | 6.292339 | 6.292339 |
| Mr = Mu/Ø | 3.8556 | 3.8556 | 7.865424 | 7.865424 |
| ø tul (mm) | 20 | 20 | 20 | 20 |
| h (mm) | 120 | 120 | 120 | 120 |
| d (mm) | 96 | 96 | 96 | 96 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| Xc | 86.4 | 86.4 | 85.5 | 85.5 |
| As (mm^2) | 185.9375 | 185.9375 | 383.3053 | 383.3053 |
| 1.33 As (mm^2) | 247.2969 | 247.2969 | 509.796 | 509.796 |
| As min (mm^2) | 560 | 560 | 554.1667 | 554.1667 |
| As perlu (mm^2) | 247.2969 | 247.2969 | 509.796 | 509.796 |
| Pakai Ø tul (mm) | 8 | 8 | 10 | 10 |
| AØ1 (mm^2) | 50.24 | 50.24 | 78.5 | 78.5 |
| Jrk tul (mm) | 203.1566 | 203.1566 | 153.9832 | 153.9832 |
| Pakai jarak (mm) | 200 | 200 | 150 | 150 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P10 - 150 | P10 - 150 |
| As pakai (mm) | 251.2 | 251.2 | 523.3333 | 523.3333 |
| a | 2.837082 | 2.837082 | 5.910588 | 5.910588 |
| Mn | 5.702127 | 5.702127 | 11.56082 | 11.56082 |
| Kontrol | Aman | Aman | Aman | Aman |
| As susut | 240 | 240 | 240 | 240 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 209.3333 | 209.3333 | 209.3333 | 209.3333 |
| Tulangan susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

2. Pelat Atap Type B

| Pelat Atap | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat atap | 0.12 | 24 | 2.88 | 1.2 | 3.456 |
| pasir | 0.05 | 16 | 0.8 | 1.2 | 0.96 |
| spesi | 0.03 | 24 | 0.72 | 1.2 | 0.864 |
| keramik | 0.01 | 20 | 0.2 | 1.2 | 0.24 |
| beban hidup | | | 2.5 | 1.6 | 4 |
| | | | | qu total = | 9.52 |

| Pelat Atap | lx (m) | ly (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mx | 6 | 3.6 | 1.666667 | 0.0504 | 9.52 | 6.218312 |
| My | 6 | 3.6 | 1.666667 | 0.015 | 9.52 | 1.850388 |
| (-)Mtx | 6 | 3.6 | 1.666667 | 0.07905 | 9.52 | 9.753126 |
| (-)Mty | 6 | 3.6 | 1.666667 | 0.054 | 9.52 | 6.662477 |

| | Pelat Atap Type B | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| f'c (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β' | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 6.218312 | 1.850388 | 9.753126 | 6.662477 |
| Mn = Mu/Ø | 7.772889 | 2.313235 | 12.19141 | 8.328096 |
| selimut (mm) | 40 | 40 | 40 | 40 |
| h (mm) | 100 | 100 | 100 | 100 |
| d (mm) | 55 | 55 | 54 | 54 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| yc | 49.5 | 49.5 | 48.6 | 48.6 |
| As (mm^2) | 654.2836 | 194.7273 | 1045.217 | 714 |
| 1.33 As (mm^2) | 870.1972 | 258.9873 | 1390.138 | 949.62 |
| As min (mm^2) | 320.8333 | 320.8333 | 315 | 315 |
| As perlu (mm^2) | 654.2836 | 258.9873 | 1045.217 | 714 |
| Pakai Ø tul (mm) | 10 | 10 | 12 | 12 |
| AØ1 (mm^2) | 78.5 | 78.5 | 113.04 | 113.04 |
| Jrk tul (mm) | 119.9785 | 303.1037 | 108.1498 | 158.3193 |
| Pakai jarak (mm) | 110 | 200 | 100 | 150 |
| Tulangan pokok | P10 - 110 | P10 - 200 | P12 - 100 | P12 - 150 |
| As pakai (mm) | 713.6364 | 392.5 | 1130.4 | 753.6 |
| a | 8.059893 | 4.432941 | 12.76687 | 8.511247 |
| Mn | 8.72978 | 4.972208 | 12.91818 | 8.996967 |
| Kontrol | Aman | Aman | Aman | Aman |
| As susut | 200 | 200 | 200 | 200 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 251.2 | 251.2 | 251.2 | 251.2 |
| Tulangan susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

3. Pelat Atap Type C

| Pelat Atap | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat atap | 0.1 | 24 | 2.4 | 1.2 | 2.88 |
| finishing beton | 0.02 | 24 | 0.48 | 1.2 | 0.576 |
| lapis kedap air | 0.01 | 24 | 0.24 | 1.2 | 0.288 |
| langit+penggantung | | | 0.18 | 1.2 | 0.216 |
| beban hidup | | | 1 | 1.6 | 1.6 |
| | | | | qu total = | 5.56 |

| Pelat Atap | ly (m) | lx (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mlx | 3.6 | 2 | 1.8 | 0.053 | 5.56 | 1.17872 |
| Mly | 3.6 | 2 | 1.8 | 0.015 | 5.56 | 0.3336 |
| -Mtx | 3.6 | 2 | 1.8 | 0.081 | 5.56 | 1.80144 |
| -Mty | 3.6 | 2 | 1.8 | 0.054 | 5.56 | 1.20096 |

| | Pelat Atap Type C | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| f'c (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β1 | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 1.17872 | 0.3336 | 1.80144 | 1.20096 |
| Mn = Mu/Ø | 1.4734 | 0.417 | 2.2518 | 1.5012 |
| selimut beton (mm) | 40 | 40 | 40 | 40 |
| h (mm) | 100 | 100 | 100 | 100 |
| d (mm) | 56 | 56 | 56 | 56 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| d' | 50.4 | 50.4 | 50.4 | 50.4 |
| As (mm^2) | 124.8089 | 34.47421 | 186.1607 | 124.1071 |
| 1.33 As (mm^2) | 166.0058 | 45.85069 | 247.5938 | 165.0625 |
| As min (mm^2) | 326.6667 | 326.6667 | 326.6667 | 326.6667 |
| As perlu (mm^2) | 162.0058 | 45.85069 | 247.5938 | 165.0625 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jrk tul (mm) | 310.1124 | 1095.73 | 202.913 | 304.3696 |
| Pakai jarak (mm) | 200 | 200 | 200 | 200 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |
| As pakai (mm) | 251.2 | 251.2 | 251.2 | 251.2 |
| a | 2.837082 | 2.837082 | 2.837082 | 2.837082 |
| Mn | 3.290607 | 3.290607 | 3.290607 | 3.290607 |
| Kontrol | Aman! | Aman! | Aman | Aman |
| As susut | 200 | 200 | 200 | 200 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 251.2 | 251.2 | 251.2 | 251.2 |
| Tulangan susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

4. Pelat Atap Type D

| Pelat Atap | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat atap | 0.1 | 24 | 2.4 | 1.2 | 2.88 |
| finishing beton | 0.02 | 24 | 0.48 | 1.2 | 0.576 |
| lapis kedap air | 0.01 | 24 | 0.24 | 1.2 | 0.288 |
| langit+penggantung | | | 0.18 | 1.2 | 0.216 |
| beban hicup | | | 1 | 1.6 | 1.6 |
| | | | | qu total = | 5.56 |

| Pelat Atap | ly (m) | lx (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mlx | 7.2 | 3.6 | 2 | 0.058 | 5.56 | 4.179341 |
| Mly | 7.2 | 3.6 | 2 | 0.015 | 5.56 | 1.080864 |
| -Mtx | 7.2 | 3.6 | 2 | 0.082 | 5.56 | 5.908723 |
| (-)Mty | 7.2 | 3.6 | 2 | 0.053 | 5.56 | 3.819053 |

| | Pelat Atap Type D | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| f'c (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β1 | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 4.179341 | 1.080864 | 5.908723 | 3.819053 |
| Mn = Mu/Ø | 5.224176 | 1.35108 | 7.385904 | 4.773816 |
| ps (mm) | 40 | 40 | 40 | 40 |
| h (mm) | 100 | 100 | 100 | 100 |
| d (mm) | 55 | 55 | 55 | 55 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| x2 | 49.5 | 49.5 | 49.5 | 49.5 |
| As (mm^2) | 439.7455 | 113.7273 | 621.7091 | 401.8364 |
| 1.33 As (mm^2) | 584.9616 | 151.2573 | 826.8731 | 534.4424 |
| As min (mm^2) | 320.8333 | 320.8333 | 320.8333 | 320.8333 |
| As perlu (mm^2) | 439.7455 | 151.2573 | 621.7091 | 401.8364 |
| Pakai Ø tul (mm) | 10 | 10 | 10 | 10 |
| AØ1 (mm^2) | 78.5 | 78.5 | 78.5 | 78.5 |
| Jrk tul (mm) | 178.5124 | 518.9833 | 126.2648 | 195.3532 |
| Pakai jarak (mm) | 170 | 200 | 120 | 190 |
| Tulangan pokok | P10 - 170 | P10 - 200 | P10 - 120 | P10 - 190 |
| As pakai (mm) | 461.7647 | 392.5 | 654.1667 | 413.1579 |
| a | 5.215225 | 4.432941 | 7.388235 | 4.666254 |
| Mn | 5.806309 | 4.972208 | 8.055024 | 5.222336 |
| Kontrol | Aman | Aman | Aman | Aman |
| As susut | 200 | 200 | 200 | 200 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 251.2 | 251.2 | 251.2 | 251.2 |
| Tulangan susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

5. Pelat Atap Type E

| Pelat Atap | tebal (m) | $b_j$ (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat atap | 0.1 | 24 | 2.4 | 1.2 | 2.88 |
| finishing beton | 0.02 | 24 | 0.48 | 1.2 | 0.576 |
| lapis kedap air | 0.01 | 24 | 0.24 | 1.2 | 0.288 |
| langit+penggantung | | | 0.18 | 1.2 | 0.216 |
| beban hidup | | | 1 | 1.6 | 1.6 |
| | | | | qu total = | 5.56 |

Cek Ly/Lx = 7.2/1.8 = 4 > 2 maka pelat 1 arah

| Pelat Atap Type E | |
|---|---|
| f'c (mpa) | 25 |
| fy (mpa) | 240 |
| Ø | 0.8 |
| β1 | 0.85 |
| Mu (knm) | 2.2518 |
| Mr = Mu/Ø | 2.81475 |
| pb (mm) | 40 |
| h (mm) | 100 |
| d (mm) | 56 |
| b (mm) | 1000 |
| yd | 50.4 |
| As (mm^2) | 232.7009 |
| 1.33 As (mm^2) | 309.4922 |
| As min (mm^2) | 326.6667 |
| As perlu (mm^2) | 309.4922 |
| Pakai Ø tul (mm) | 8 |
| AØ1 (mm^2) | 50.24 |
| s tul (mm) | 162.3304 |
| Pakai jarak (mm) | 160 |
| Tulangan pokok | P8 - 160 |
| As pakai (mm) | 314 |
| a | 3.546353 |
| Mn | 4.086533 |
| Kontrol | Aman |
| As susut | 200 |
| Pakai Ø tul (mm) | 8 |
| AØ1 (mm^2) | 50.24 |
| Jarak tulangan susut | 251.2 |
| Tulangan Susut | P8 - 200 |

6. Pelat Atap Type F

| Pelat Atap | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat atap | 0.1 | 24 | 2.4 | 1.2 | 2.88 |
| finishing beton | 0.02 | 24 | 0.48 | 1.2 | 0.576 |
| lapis kedap air | 0.01 | 24 | 0.24 | 1.2 | 0.288 |
| langit+penggantung | | | 0.18 | 1.2 | 0.216 |
| beban hidup | | | 1 | 1.6 | 1.6 |
| | | | | qu total = | 5.56 |

Cek Lv/Lx = 7.2/1.5 = 4.8 > 2 maka pelat 1 arah

| Pelat Atap Type F | |
|---|---|
| f'c (mpa) | 25 |
| fy (mpa) | 240 |
| Ø | 0.8 |
| β1 | 0.85 |
| Mu (knm) | 1.56375 |
| Mn = Mu/Ø | 1.954688 |
| cb (mm) | 40 |
| h (mm) | 100 |
| d (mm) | 56 |
| b (mm) | 1000 |
| fyd | 50.4 |
| As (mm^2) | 161.5978 |
| 1.33 As (mm^2) | 214.9251 |
| As min (mm^2) | 326.6667 |
| As perlu (mm^2) | 214.9251 |
| Pakai Ø tul (mm) | 8 |
| AØ1 (mm^2) | 50.24 |
| Jarak (mm) | 233.7668 |
| Pakai jarak (mm) | 200 |
| Tulangan pokok | P8 - 200 |
| As pakai (mm) | 251.2 |
| a | 2.837082 |
| Mn | 3.290607 |
| Kontrol | Aman |
| As susut | 200 |
| Pakai Ø tul (mm) | 8 |
| AØ1 (mm^2) | 50.24 |
| Jarak tulangan susut | 251.2 |
| Tulangan Susut | P8 - 200 |

7. Pelat Lantai Type G

| Pelat Lantai | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat lantai | 0.12 | 24 | 2.88 | 1.2 | 3.456 |
| pasir | 0.05 | 16 | 0.8 | 1.2 | 0.96 |
| spesi | 0.03 | 24 | 0.72 | 1.2 | 0.864 |
| keramik | 0.01 | 20 | 0.2 | 1.2 | 0.24 |
| beban hidup | | | 2.5 | 1.6 | 4 |
| | | | | qu total = | 9.52 |

| Pelat Lantai | ly (m) | lx (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mlx | 3.6 | 2 | 1.8 | 0.053 | 9.52 | 2.01824 |
| Mly | 3.6 | 2 | 1.8 | 0.015 | 9.52 | 0.5712 |
| (-)Mtx | 3.6 | 2 | 1.8 | 0.081 | 9.52 | 3.08448 |
| (-)Mty | 3.6 | 2 | 1.8 | 0.054 | 9.52 | 2.05632 |

| | Pelat Lantai Type G | | | |
|---|---|---|---|---|
| Perhitungan | Mlx | Mly | Mtx | Mty |
| f'c (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β1 | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 2.01824 | 0.5712 | 3.08448 | 2.05632 |
| Mr = Mu/Ø | 2.5228 | 0.714 | 3.8556 | 2.5704 |
| pb (mm) | 20 | 20 | 20 | 20 |
| h (mm) | 120 | 120 | 120 | 120 |
| d (mm) | 96 | 96 | 96 | 96 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| fyd | 86.4 | 86.4 | 86.4 | 86.4 |
| As (mm^2) | 121.6628 | 34.43287 | 185.9375 | 123.9583 |
| 1.33 As (mm^2) | 161.8115 | 45.79572 | 247.2969 | 164.8646 |
| As min (mm^2) | 560 | 560 | 560 | 560 |
| As perlu (mm^2) | 161.8115 | 45.79572 | 247.2969 | 164.8646 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jrk tul (mm) | 310.4847 | 1097.046 | 203.1566 | 304.7349 |
| Pakai jarak (mm) | 200 | 200 | 200 | 200 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |
| As pakai (mm) | 251.2 | 251.2 | 251.2 | 251.2 |
| a | 2.837082 | 2.837082 | 2.837082 | 2.837082 |
| Mn | 5.702127 | 5.702127 | 5.702127 | 5.702127 |
| Kontrol | Aman | Aman | Aman | Aman |
| As susut | 240 | 240 | 240 | 240 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 209.3333 | 209.3333 | 209.3333 | 209.3333 |
| Tulangan Susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

8. Pelat Lantai Type H

| Pelat Lantai | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat lantai | 0.12 | 24 | 2.88 | 1.2 | 3.456 |
| pasir | 0.05 | 16 | 0.8 | 1.2 | 0.96 |
| spesi | 0.03 | 24 | 0.72 | 1.2 | 0.864 |
| keramik | 0.01 | 20 | 0.2 | 1.2 | 0.24 |
| beban hidup | | | 2.5 | 1.6 | 4 |
| | | | | qu total = | 9.52 |

Cek Ly/Lx = 3.6/1 = 3.6 > 2 maka pelat 1 arah

| Pelat Lantai Type H | |
|---|---|
| fc (mpa) | 25 |
| fy (mpa) | 240 |
| Ø | 0.6 |
| β1 | 0.85 |
| Mu (knm) | 1.19 |
| Mr = Mu/Ø | 1.4875 |
| pb (mm) | 20 |
| h (mm) | 120 |
| d (mm) | 96 |
| b (mm) | 1000 |
| yc | 86.4 |
| As (mm^2) | 71.73515 |
| 1.33 As (mm^2) | 95.40774 |
| As min (mm^2) | 560 |
| As perlu (mm^2) | 95.40774 |
| Pakai Ø tul (mm) | 6 |
| AØ1 (mm^2) | 50.24 |
| Jrk tul (mm) | 526.582 |
| Pakai jarak (mm) | 200 |
| Tulangan pokok | P8 - 200 |
| As pakai (mm) | 251.2 |
| a | 2.837082 |
| Mn | 5.702127 |
| Kontrol | Aman |
| As susut | 240 |
| Pakai Ø tul (mm) | 8 |
| AØ1 (mm^2) | 50.24 |
| Jarak tulangan susut | 209.3333 |
| Tulangan Susut | P8 - 200 |

9. Pelat Lantai Type A

| Pelat Lantai | tebal (m) | bj (kn/m^3) | q (kn/m^2) | faktor | qu (kn/m^2) |
|---|---|---|---|---|---|
| pelat lantai | 0.12 | 24 | 2.88 | 1.2 | 3.456 |
| pasir | 0.05 | 16 | 0.8 | 1.2 | 0.96 |
| spesi | 0.03 | 24 | 0.72 | 1.2 | 0.864 |
| keramik | 0.01 | 20 | 0.2 | 1.2 | 0.24 |
| beban hidup | | | 2.5 | 1.6 | 4 |
| | | | | qu total = | 9.52 |

| Pelat Lantai | ly (m) | lx (m) | ly/lx | faktor | qu (kn/m^2) | M (kn-m) |
|---|---|---|---|---|---|---|
| Mlx | 3.6 | 2.6 | 1.384615 | 0.03414 | 9.52 | 2.664305 |
| Mly | 3.6 | 2.6 | 1.384615 | 0.02163 | 9.52 | 1.1777 |
| (-)Mtx | 3.6 | 2.6 | 1.384615 | 0.07125 | 9.52 | 4.585308 |
| (-)Mty | 3.6 | 2.6 | 1.384615 | 0.054295 | 9.52 | 3.494166 |

| Perhitungan | Pelat Lantai Type A | | | |
|---|---|---|---|---|
| | Mly | Mlx | Mtx | Mty |
| Fc (mpa) | 25 | 25 | 25 | 25 |
| fy (mpa) | 240 | 240 | 240 | 240 |
| Ø | 0.8 | 0.8 | 0.8 | 0.8 |
| β1 | 0.85 | 0.85 | 0.85 | 0.85 |
| Mu (knm) | 2.664305 | 1.1777 | 4.585308 | 3.494166 |
| Mn = Mu/Ø | 3.330382 | 1.472125 | 5.731635 | 4.367707 |
| pb (mm) | 20 | 20 | 20 | 20 |
| h (mm) | 120 | 120 | 120 | 120 |
| d (mm) | 96 | 96 | 96 | 96 |
| b (mm) | 1000 | 1000 | 1000 | 1000 |
| ρc | 86.4 | 86.4 | 86.4 | 86.4 |
| As (mm^2) | 160.6087 | 70.99369 | 276.4099 | 210.634 |
| 1.33 As (mm^2) | 213.6095 | 94.42161 | 367.6251 | 280.1432 |
| As min (mm^2) | 560 | 560 | 560 | 560 |
| As perlu (mm^2) | 213.6095 | 94.42161 | 367.6251 | 280.1432 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jrk tul (mm) | 235.1955 | 532.0816 | 136.661 | 179.3368 |
| Pakai jarak (mm) | 200 | 200 | 130 | 170 |
| Tulangan pokok | P8 - 200 | P8 - 200 | P8 - 130 | P8 - 170 |
| As pakai (mm) | 251.2 | 251.2 | 386.4615 | 295.5294 |
| a | 2.837082 | 2.837082 | 4.364742 | 3.337744 |
| Mn | 5.702127 | 5.702127 | 8.701657 | 6.690629 |
| Kontrol | Aman | Aman | Aman | Aman |
| As susut | 240 | 240 | 240 | 240 |
| Pakai Ø tul (mm) | 8 | 8 | 8 | 8 |
| AØ1 (mm^2) | 50.24 | 50.24 | 50.24 | 50.24 |
| Jarak tulangan susut | 209.3333 | 209.3333 | 209.3333 | 209.3333 |
| Tulangan Susut | P8 - 200 | P8 - 200 | P8 - 200 | P8 - 200 |

**KOMBINASI PEMBEBANAN KUDA - KUDA 1**
**TUGAS AKHIR REDESIGN GEDUNG ADMINISTRASI USD JOGJAKARTA**

| FRAME | STATION | TETAP | ANGINKI | ANGINKA | KOMBINASI BEBAN (Kg) | | | BEBAN RENCANA |
|---|---|---|---|---|---|---|---|---|
| | | | | | TETAP + ANGINKI | TETAP + ANGINKA | 1,33 TETAP | |
| A1 | 2.08 | -14754.61 | -182.7538 | 752.6498 | -14937.364 | -15507.260 | -19623.631 | -14754.61 |
| A2 | 2.08 | -14754.61 | -204.41 | 795.962 | -14959.020 | -15550.572 | -19623.631 | -14754.61 |
| A3 | 2.08 | -13415.92 | -156.0717 | 699.2858 | -13571.992 | -14115.206 | -17843.174 | -13415.92 |
| A4 | 2.08 | -12077.22 | -107.7331 | 602.6085 | -12184.953 | -12679.829 | -16062.703 | -12077.22 |
| A5 | 2.08 | -10738.52 | -59.39457 | 505.9314 | -10797.915 | -11244.451 | -14282.232 | -10738.52 |
| A6 | 2.08 | -9399.814 | -11.05603 | 409.2542 | -9410.870 | -9809.068 | -12501.753 | -9399.814 |
| A7 | 2.08 | -9399.814 | 166.4438 | 231.7544 | -9233.370 | -9631.568 | -12501.753 | -9399.814 |
| A8 | 2.08 | -10738.52 | 263.1209 | 183.4159 | -10475.399 | -10921.936 | -14282.232 | -10738.52 |
| A9 | 2.08 | -12077.22 | 359.798 | 135.0774 | -11717.422 | -12212.297 | -16062.703 | -12077.22 |
| A10 | 2.08 | -13415.92 | 456.4752 | 86.73891 | -12959.445 | -13502.659 | -17843.174 | -13415.92 |
| A11 | 2.08 | -14754.61 | 553.1517 | 38.40031 | -14201.458 | -14793.010 | -19623.631 | -14754.61 |
| A12 | 2.08 | -14754.61 | 509.8394 | 60.05653 | -14244.771 | -14814.667 | -19623.631 | -14754.61 |
| B1 | 1.84 | 13080.32 | 497.9941 | -993.6212 | 13578.314 | 14073.941 | 17396.826 | 13080.32 |
| B2 | 1.84 | 11893.54 | 435.9422 | -869.5177 | 12329.482 | 12763.058 | 15818.408 | 11893.54 |
| B3 | 1.84 | 10706.75 | 373.8901 | -745.4134 | 11080.640 | 11452.163 | 14239.978 | 10706.75 |
| B4 | 1.84 | 9519.955 | 311.8381 | -621.3093 | 9831.793 | 10141.264 | 12661.540 | 9519.955 |
| B5 | 1.84 | 8333.165 | 249.786 | -497.2052 | 8582.951 | 8830.370 | 11083.109 | 8333.165 |
| B6 | 1.84 | 7146.376 | 187.734 | -373.1012 | 7334.110 | 7519.477 | 9504.680 | 7146.376 |
| B7 | 1.84 | 7146.376 | 187.734 | -373.1012 | 7334.110 | 7519.477 | 9504.680 | 7146.376 |
| B8 | 1.84 | 8333.165 | 63.62994 | -311.0491 | 8396.795 | 8644.214 | 11083.109 | 8333.165 |
| B9 | 1.84 | 9519.955 | -60.47415 | -248.9971 | 9459.481 | 9768.952 | 12661.540 | 9519.955 |
| B10 | 1.84 | 10706.75 | -184.5783 | -186.9451 | 10522.172 | 10893.695 | 14239.978 | 10706.75 |
| B11 | 1.84 | 11893.54 | -308.6825 | -124.893 | 11584.858 | 12018.433 | 15818.408 | 11893.54 |
| B12 | 1.84 | 13080.32 | -432.7862 | -62.84096 | 12647.534 | 13143.161 | 17396.826 | 13080.32 |
| D1 | 2.47 | 1586.626 | 82.95824 | -165.9162 | 1669.584 | 1752.542 | 2110.213 | 1586.626 |
| D2 | 2.94 | 1893.254 | 98.98975 | -197.9797 | 1992.244 | 2091.234 | 2518.028 | 1893.254 |
| D3 | 3.47 | 2234.51 | 116.8326 | -233.6652 | 2351.343 | 2468.175 | 2971.898 | 2234.51 |
| D4 | 4.03 | 2596.79 | 135.7746 | -271.5494 | 2732.565 | 2868.339 | 3453.731 | 2596.79 |
| D5 | 4.62 | 2972.412 | 155.4146 | -310.829 | 3127.827 | 3283.241 | 3953.308 | 2972.412 |
| D6 | 4.62 | 2972.412 | -310.8291 | 155.4147 | 2661.583 | 2816.997 | 3953.308 | 2972.412 |
| D7 | 4.03 | 2596.79 | -271.5493 | 135.7746 | 2325.241 | 2461.015 | 3453.731 | 2596.79 |
| D8 | 3.47 | 2234.51 | -233.6652 | 116.8325 | 2000.845 | 2117.678 | 2971.898 | 2234.51 |
| D9 | 2.94 | 1893.254 | -197.9796 | 98.98965 | 1695.274 | 1794.264 | 2518.028 | 1893.254 |
| D10 | 2.47 | 1586.626 | -165.9164 | 82.95847 | 1420.710 | 1503.668 | 2110.213 | 1586.626 |
| V1 | 0.64 | -541.5049 | -43.22086 | 86.44154 | -584.726 | -627.946 | -720.202 | -541.5049 |
| V2 | 1.28 | -954.8312 | -64.83147 | 129.663 | -1019.663 | -1084.494 | -1269.925 | -954.8312 |
| V3 | 1.93 | -1368.146 | -86.44193 | 172.8839 | -1454.588 | -1541.030 | -1819.634 | -1368.146 |
| V4 | 2.57 | -1781.461 | -108.0524 | 216.1049 | -1889.513 | -1997.566 | -2369.343 | -1781.461 |
| V5 | 3.21 | -2194.772 | -129.6629 | 259.3256 | -2324.435 | -2454.098 | -2919.047 | -2194.772 |
| V6 | 3.85 | 3385.654 | 81.45044 | -161.874 | 3467.104 | 3547.528 | 4502.920 | 3385.654 |
| V7 | 3.21 | -2194.772 | 259.3257 | -129.6629 | -1935.446 | -2065.109 | -2919.047 | -2194.772 |
| V8 | 2.57 | -1781.461 | 216.1048 | -108.0524 | -1565.356 | -1673.409 | -2369.343 | -1781.461 |
| V9 | 1.93 | -1368.146 | 172.8839 | -86.44188 | -1195.262 | -1281.704 | -1819.634 | -1368.146 |
| V10 | 1.28 | -954.8312 | 129.663 | -64.83141 | -825.168 | -890.000 | -1269.925 | -954.8312 |
| V11 | 0.64 | -541.5049 | 86.44166 | -43.22097 | -455.063 | -498.284 | -720.202 | -541.5049 |

BEBAN ANGIN + BEBAN TETAP <= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP
BEBAN ANGIN + BEBAN TETAP >= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP + BEBAN ANGIN

**KOMBINASI PEMBEBANAN KUDA - KUDA 2**
**TUGAS AKHIR REDESIGN GEDUNG ADMINISTRASI USD JOGJAKARTA**

| FRAME | STATION | TETAP | ANGINKI | ANGINKA | KOMBINASI BEBAN (Kg) | | | BEBAN |
|---|---|---|---|---|---|---|---|---|
| | | | | | TETAP + ANGINKI | TETAP + ANGINKA | 1,33 TETAP | RENCANA |
| A1 | 2.078346 | -12145.5 | -243.2579 | 607.0816 | -12388.758 | -11538.418 | -16153.515 | -12145.5 |
| A2 | 2.078346 | -12145.5 | -264.8484 | 650.2625 | -12410.348 | -11495.238 | -16153.515 | -12145.5 |
| A3 | 2.078346 | -10801.19 | -216.2043 | 552.9744 | -11017.394 | -10248.216 | -14365.583 | -10801.19 |
| A4 | 2.078346 | -9456.883 | -167.5603 | 455.6862 | -9624.443 | -9001.197 | -12577.654 | -9456.883 |
| A5 | 1.8 | -7026.084 | -93.64075 | 291.7003 | -7119.725 | -6734.384 | -9344.692 | -7026.084 |
| A6 | 1.8 | -7327.268 | -32.81255 | 228.3375 | -7360.081 | -7098.931 | -9745.266 | -7327.268 |
| A7 | 1.8 | -7327.268 | 88.84385 | 101.6121 | -7238.424 | -7225.656 | -9745.266 | -7327.268 |
| A8 | 1.8 | -7026.084 | 149.6721 | 38.24941 | -6876.412 | -6987.835 | -9344.692 | -7026.084 |
| A9 | 2.078346 | -9456.883 | 291.6953 | -26.98082 | -9165.188 | -9483.864 | -12577.654 | -9456.883 |
| A10 | 2.078346 | -10801.19 | 388.9834 | -99.03635 | -10412.207 | -10900.226 | -14365.583 | -10801.19 |
| A11 | 2.078346 | -12145.5 | 486.2715 | -217.9148 | -11659.229 | -12363.415 | -16153.515 | -12145.5 |
| A12 | 2.078346 | -12145.5 | 443.0907 | -174.734 | -11702.409 | -12320.234 | -16153.515 | -12145.5 |
| B1 | 1.843909 | 10775.49 | 436.1013 | -768.4633 | 11211.591 | 10007.027 | 14331.402 | 10775.49 |
| B2 | 1.843909 | 9582.821 | 373.7893 | -643.8392 | 9956.610 | 8938.982 | 12745.152 | 9582.821 |
| B3 | 1.843909 | 8390.149 | 311.4772 | -519.2151 | 8701.626 | 7870.934 | 11158.898 | 8390.149 |
| B4 | 1.843909 | 7197.478 | 249.1652 | -394.5911 | 7446.643 | 6802.887 | 9572.646 | 7197.478 |
| B5 | 1.8 | 7327.268 | 182.4037 | -321.832 | 7509.672 | 7005.436 | 9745.266 | 7327.268 |
| B6 | 1.8 | 7427.662 | 121.5755 | -258.4693 | 7549.238 | 7169.193 | 9878.790 | 7427.662 |
| B7 | 1.8 | 7427.662 | 121.5755 | -258.4693 | 7549.238 | 7169.193 | 9878.790 | 7427.662 |
| B8 | 1.8 | 7327.268 | 60.74726 | -195.1066 | 7388.015 | 7132.161 | 9745.266 | 7327.268 |
| B9 | 1.843909 | 7197.478 | -8.292165E-02 | -134.9576 | 7197.395 | 7062.520 | 9572.646 | 7197.478 |
| B10 | 1.843909 | 8390.149 | -124.707 | -62.26022 | 8265.442 | 8327.889 | 11158.898 | 8390.149 |
| B11 | 1.843909 | 9582.821 | -249.3311 | 20.82249 | 9333.490 | 9603.643 | 12745.152 | 9582.821 |
| B12 | 1.843909 | 10775.49 | -373.9551 | 145.4465 | 10401.535 | 10920.937 | 14331.402 | 10775.49 |
| D1 | 2.46083 | 1591.706 | 83.15991 | -166.3199 | 1674.866 | 1425.386 | 2116.969 | 1591.706 |
| D2 | 2.934023 | 1897.776 | 99.15073 | -198.3015 | 1996.927 | 1699.475 | 2524.042 | 1897.776 |
| D3 | 3.460916 | 2238.579 | 116.9563 | -233.9125 | 2355.535 | 2004.667 | 2977.310 | 2238.579 |
| D4 | 3.126202 | -523.0884 | 105.6451 | -110.047 | -417.443 | -633.135 | -695.708 | -523.0884 |
| D5 | 3.126202 | -174.3628 | 105.6451 | -110.047 | -68.718 | -284.410 | -231.903 | -284.410 |
| D6 | 3.126202 | -174.3628 | -105.6451 | 110.047 | -280.008 | -64.316 | -231.903 | -280.008 |
| D7 | 3.126202 | -523.0884 | -105.6451 | 110.047 | -628.734 | -413.041 | -695.708 | -523.0884 |
| D8 | 3.460916 | 2238.579 | -233.9125 | 136.449 | 2004.667 | 2375.028 | 2977.310 | 2238.579 |
| D9 | 2.934023 | 1897.776 | -198.3015 | 132.201 | 1699.475 | 2029.977 | 2524.042 | 1897.776 |
| D10 | 2.46083 | 1591.706 | -166.3199 | 166.3198 | 1425.386 | 1758.026 | 2116.969 | 1591.706 |
| V1 | 0.639 | -541.512 | -43.18802 | 86.37605 | -584.700 | -455.136 | -720.211 | -541.512 |
| V2 | 1.278 | -954.8281 | -64.78203 | 129.5641 | -1019.610 | -825.264 | -1269.921 | -954.8281 |
| V3 | 1.917 | -1368.144 | -86.37604 | 172.7521 | -1454.520 | -1195.392 | -1819.632 | -1368.144 |
| V4 | 2.556 | 2274.152 | -32.32452 | 4.376228 | 2241.827 | 2278.528 | 3024.622 | 2274.152 |
| V5 | 2.556 | 427.68 | -86.37605 | 89.97505 | 341.304 | 517.655 | 568.814 | 427.68 |
| V6 | 2.556 | 285.12 | 0 | 0 | 285.120 | 285.120 | 379.210 | 285.12 |
| V7 | 2.556 | 427.68 | 86.37605 | -89.97505 | 514.056 | 337.705 | 568.814 | 427.68 |
| V8 | 2.556 | 2274.152 | 86.35806 | -119.2515 | 2360.510 | 2154.901 | 3024.622 | 2274.152 |
| V9 | 1.917 | -1368.144 | 172.7521 | -100.772 | -1195.392 | -1468.916 | -1819.632 | -1368.144 |
| V10 | 1.278 | -954.8281 | 129.5641 | -86.37604 | -825.264 | -1041.204 | -1269.921 | -954.8281 |
| V11 | 0.639 | -541.512 | 86.37605 | -86.37604 | -455.136 | -627.888 | -720.211 | -541.512 |

BEBAN ANGIN + BEBAN TETAP <= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP
BEBAN ANGIN + BEBAN TETAP >= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP + BEBAN ANGIN

**KOMBINASI PEMBEBANAN KUDA - KUDA 3**
**TUGAS AKHIR REDESIGN GEDUNG ADMINISTRASI USD JOGJAKARTA**

| FRAME | STATION | TETAP | ANGINKI | ANGINKA | KOMBINASI BEBAN (Kg) | | | BEBAN RENCANA |
|---|---|---|---|---|---|---|---|---|
| | | | | | TETAP + ANGINKI | TETAP + ANGINKA | 1,33 TETAP | |
| A1 | 2.078346 | -8622.969 | -162.1438 | 313.4313 | -8785.113 | -8309.538 | -11468.54877 | -8622.969 |
| A2 | 2.078346 | -8622.969 | -183.7342 | 356.6122 | -8806.703 | -8266.357 | -11468.54877 | -8622.969 |
| A3 | 1.8 | -6303.854 | -107.6486 | 205.8948 | -6411.503 | -6097.959 | -8384.12582 | -6303.854 |
| A4 | 1.8 | -7709.375 | -77.23448 | 175.4807 | -7786.609 | -7533.894 | -10253.46875 | -7709.375 |
| A5 | 1.8 | -8713.318 | -46.82038 | 145.0666 | -8760.138 | -8568.251 | -11588.71294 | -8713.318 |
| A6 | 1.8 | -9315.685 | -16.40628 | 114.6525 | -9332.091 | -9201.033 | -12389.86105 | -9315.685 |
| A7 | 1.8 | -9315.685 | 44.42192 | 53.82429 | -9271.263 | -9261.861 | -12389.86105 | -9315.685 |
| A8 | 1.8 | -8713.318 | 74.83602 | 23.41018 | -8638.482 | -8689.908 | -11588.71294 | -8713.318 |
| A9 | 1.8 | -7709.375 | 105.2501 | -7.003916 | -7604.125 | -7716.379 | -10253.46875 | -7709.375 |
| A10 | 1.8 | -6303.854 | 135.6642 | -37.41802 | -6168.190 | -6341.272 | -8384.12582 | -6303.854 |
| A11 | 2.078346 | -8622.969 | 275.5214 | -102.6435 | -8347.448 | -8725.613 | -11468.54877 | -8622.969 |
| A12 | 2.078346 | -8622.969 | 232.3405 | -81.05303 | -8390.629 | -8704.022 | -11468.54877 | -8622.969 |
| B1 | 1.843909 | 7650.3 | 249.2067 | -373.8515 | 7899.507 | 7276.449 | 10174.899 | 7650.3 |
| B2 | 1.843909 | 6457.628 | 186.8946 | -249.2274 | 6644.523 | 6208.401 | 8588.64524 | 6457.628 |
| B3 | 1.8 | 7709.375 | 152.03 | -212.8784 | 7861.405 | 7496.497 | 10253.46875 | 7709.375 |
| B4 | 1.8 | 8713.318 | 121.6159 | -182.4644 | 8834.934 | 8530.854 | 11588.71294 | 8713.318 |
| B5 | 1.8 | 9315.685 | 91.20184 | -152.0503 | 9406.887 | 9163.635 | 12389.86105 | 9315.685 |
| B6 | 1.8 | 9516.473 | 60.78773 | -121.6362 | 9577.261 | 9394.837 | 12656.90909 | 9516.473 |
| B7 | 1.8 | 9516.473 | 60.78773 | -121.6362 | 9577.261 | 9394.837 | 12656.90909 | 9516.473 |
| B8 | 1.8 | 9315.685 | 30.37363 | -91.22206 | 9346.059 | 9224.463 | 12389.86105 | 9315.685 |
| B9 | 1.8 | 8713.318 | -4.046937E- | -60.80796 | 8713.278 | 8652.510 | 11588.71294 | 8713.318 |
| B10 | 1.8 | 7709.375 | -30.45457 | -30.39386 | 7678.920 | 7678.981 | 10253.46875 | 7709.375 |
| B11 | 1.843909 | 6457.628 | -62.35349 | 2.073254E- | 6395.275 | 6457.649 | 8588.64524 | 6457.628 |
| B12 | 1.843909 | 7650.3 | -186.9776 | 62.33276 | 7463.322 | 7712.633 | 10174.899 | 7650.3 |
| D1 | 2.46083 | 1591.706 | 83.15991 | -166.3199 | 1674.866 | 1425.386 | 2116.96898 | 1591.706 |
| D2 | 2.207551 | -1723.756 | 37.30039 | -37.30039 | -1686.456 | -1761.056 | -2292.59548 | -1723.756 |
| D3 | 2.207551 | -1231.254 | 37.30039 | -37.30039 | -1193.954 | -1268.554 | -1637.56782 | -1231.254 |
| D4 | 2.207551 | -738.7524 | 37.30039 | -37.30039 | -701.452 | -776.053 | -982.540692 | -738.7524 |
| D5 | 2.207551 | -246.2508 | 37.30039 | -37.30039 | -208.950 | -283.551 | -327.513564 | -246.2508 |
| D6 | 2.207551 | -246.2508 | -37.30039 | 37.30039 | -283.551 | -208.950 | -327.513564 | -246.2508 |
| D7 | 2.207551 | -738.7524 | -37.30039 | 37.30039 | -776.053 | -701.452 | -982.540692 | -738.7524 |
| D8 | 2.207551 | -1231.254 | -37.30039 | 37.30039 | -1268.554 | -1193.954 | -1637.56782 | -1231.254 |
| D9 | 2.207551 | -1723.756 | -37.30039 | 37.30039 | -1761.056 | -1686.456 | -2292.59548 | -1723.756 |
| D10 | 2.46083 | 1591.706 | -166.3199 | 83.15991 | 1425.386 | 1674.866 | 2116.96898 | 1591.706 |
| V1 | 0.639 | -541.512 | -43.18802 | 86.37605 | -584.700 | -455.136 | -720.21096 | -541.512 |
| V2 | 1.278 | 2683.896 | 18.94913 | -32.471 | 2702.845 | 2651.425 | 3569.58168 | 2683.896 |
| V3 | 1.278 | 997.92 | -21.59401 | 21.59401 | 976.326 | 1019.514 | 1327.2336 | 997.92 |
| V4 | 1.278 | 712.8 | -21.59401 | 21.59401 | 691.206 | 734.394 | 948.024 | 712.8 |
| V5 | 1.278 | 427.68 | -21.59401 | 21.59401 | 406.086 | 449.274 | 568.8144 | 427.68 |
| V6 | 1.278 | 285.12 | 0 | 0 | 285.120 | 285.120 | 379.2096 | 285.12 |
| V7 | 1.278 | 427.68 | 21.59401 | -21.59401 | 449.274 | 406.086 | 568.8144 | 427.68 |
| V8 | 1.278 | 712.8 | 21.59401 | -21.59401 | 734.394 | 691.206 | 948.024 | 712.8 |
| V9 | 1.278 | 997.92 | 21.59401 | -21.59401 | 1019.514 | 976.326 | 1327.2336 | 997.92 |
| V10 | 1.278 | 2683.896 | 8.06764 | -21.58951 | 2691.964 | 2662.306 | 3569.58168 | 2683.896 |
| V11 | 0.639 | -541.512 | 86.37605 | -43.18802 | -455.136 | -584.700 | -720.21096 | -541.512 |

BEBAN ANGIN + BEBAN TETAP <= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP
BEBAN ANGIN + BEBAN TETAP >= 1,33 BEBAN TETAP, BEBAN RENCANA = BEBAN TETAP + BEBAN ANGIN

Perencanaan Dimensi Batang Kuda-Kuda KK1

1. Batang Tarik

a. Batang Bawah (Batang B1 s/d B12)

| Input | | | Input Profil | | |
|---|---|---|---|---|---|
| Panjang batang (L) | = | 1.84 m | Dicoba : 2L 70x70x7 | | |
| Gaya ( T ) | = | 13080.32 kg | Data 1 Profil: | | |
| Fy | = | 2400 Kg/cm$^2$ | A | = | 9.4 cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ | t | = | 0.7 cm |
| Ø Baut | = | 0.625 inchi | Ix=Iy | = | 42.4 cm$^4$ |
| Jumlah lubang | = | 1 buah | Berat | = | 7.38 kg/m |

Ø lubang = diameter baut + (1/8)" = 0.750 inchi = 1.905 cm

A lubang = Ø lubang x t profil x jml lubang = 1.334 cm$^2$

Ag1 perlu = $\frac{T}{0,6Fy}$ = 9.084 cm$^2$

Ag2 perlu = $\frac{T}{0,5 \cdot Fu \cdot \mu} + A\text{lubang}$ = 9.883 cm$^2$ $\mu$ = 0,75 - 1

$\mu$ pakai = 0.85

Ag pakai = 9.883 cm$^2$

Ix = 2x42,4 = 84.8 cm$^4$

Iy = 2x42,4+2x9,4x(1,97)^2 = 157.761 cm$^4$

A = 2x9,4 = 18.8 cm$^2$

ix = $\sqrt{\frac{Ix}{A}} = \sqrt{\frac{84,8}{18,8}} = 2,124\ cm$

iy = $\sqrt{\frac{Iy}{A}} = \sqrt{\frac{157,761}{18,8}} = 2,897\ cm$

Digunakan i min = 2,124 cm

Lmin = L/240 = 0.767 cm < ix Ok

A bruto = 2xA = 18.8 cm$^2$

A netto = Abruto - A lubang = 17.467 cm$^2$

A efektif = 0,85 x A netto = 14.847 cm$^2$

Syarat :

A efektif > Ag pakai

14.847 > 9.883 Ok

Cek

$\frac{T}{Abruto}$ = 695.762 Kg/cm$^2$ < 0,6Fy = 1440 Kg/cm$^2$ Ok

$\frac{T}{Aefektif}$ = 881.036 Kg/cm$^2$ < 0,5Fu = 1800 Kg/cm$^2$ Ok

b.Batang Diagonal (Batang D1 s/d D10)

| Input | | | Input Profil | | |
|---|---|---|---|---|---|
| Panjang batang (L) | = | 4.03 m | Dicoba : | 2L 50x50x5 | |
| Gaya ( T ) | = | 2596.79 kg | Data 1 Profil: | | |
| Fy | = | 2400 Kg/cm$^2$ | A | = | 4.8 cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ | t | = | 0.5 cm |
| Ø Baut | = | 0.5 inchi | Ix=Iy | = | 11 cm |
| Jumlah lubang | = | 1 buah | Berat | = | 3.77 kg/m |

Ø lubang = diameter baut + (1/8)"
= 0.625 inchi = 1.5875 cm

A lubang = Ø lubang x t profil x jml lubang
= 0.794 cm$^2$

Ag1 perlu = $\frac{T}{0{,}6Fy}$ = 1.803 cm$^2$

Ag2 perlu = $\frac{T}{0{,}5 \cdot Fu \cdot \mu} + A\text{lubang}$ = 2.491 cm$^2$ $\mu$ = 0,75 - 1

$\mu$ pakai = 0.85

Ag pakai = 2.491 cm$^2$

Ix = 2x11 = 22 cm$^4$
Iy = 2x11+2x4,8x(1,4)^2 = 59.257 cm$^4$
A = 2x4,8 = 9.6 cm$^2$

ix = $\sqrt{\frac{Ix}{A}} = \sqrt{\frac{22}{9{,}6}} = 1{,}514$ cm

iy = $\sqrt{\frac{Iy}{A}} = \sqrt{\frac{59{,}257}{9{,}6}} = 2{,}484$ cm

Digunakan i min = 1,514 cm
L min = L/240 = 1.343 < ix Ok

A bruto = 2xA = 9.6 cm$^2$
A netto = Abruto - A lubang = 8.806 cm$^2$
A efektif = 0,85 x A netto = 7.485 cm$^2$

Syarat :
A efektif > Ag pakai
0 > 2.491 Ok

Cek

$\frac{T}{Abruto}$ = 270.499 Kg/cm$^2$ < 0,6Fy = 1440 Kg/cm$^2$ Ok

$\frac{T}{Aefektif}$ = 346.918 Kg/cm$^2$ < 0,5Fu = 1800 Kg/cm$^2$ Ok

c.Batang vertikal (Batang V6)

| Input | | | Input Profil | | |
|---|---|---|---|---|---|
| Panjang batang (L) | = | 3.85 m | Dicoba : | 2L 50x50x5 | |
| Gaya ( T ) | = | 3385.654 kg | Data 1 Profil: | | |
| Fy | = | 2400 Kg/cm$^2$ | A | = | 4.8 cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ | t | = | 0.5 cm |
| Ø Baut | = | 0.5 inchi | Ix=Iy | = | 11 cm |
| Jumlah lubang | = | 1 buah | Berat | = | 3.77 kg/m |

Ø lubang = diameter baut + (1/8)"
= 0.625 inchi = 1.5875 cm

A lubang = Ø lubang x t profil x jml lubang
= 0.794 cm$^2$

Ag1 perlu = $\frac{T}{0{,}6Fy}$ = 2.351 cm$^2$

Ag2 perlu = $\frac{T}{0{,}5 \cdot Fu \cdot \mu} + A\,\text{lub}\,ang$ = 3.007 cm$^2$ $\mu$ = 0,75 - 1

$\mu$ pakai = 0.85

Ag pakai = 3.007 cm$^2$

Ix = 2x11 = 22 cm$^4$

Iy = 2x11+2x4,8x(1,4)^2 = 59.257 cm$^4$

A = 2x4,8 = 9.6 cm$^2$

ix = $\sqrt{\frac{Ix}{A}} = \sqrt{\frac{22}{9{,}6}} = 1{,}514\ cm$

iy = $\sqrt{\frac{Iy}{A}} = \sqrt{\frac{592571}{9{,}6}} = 2484\ cm$

Digunakan i min = 1,514 cm

Lmin = L/240 = 1.283 cm < ix Ok

A bruto = 2xA = 9.6 cm$^2$

A netto = Abruto - A lubang = 8.806 cm$^2$

A efektif = 0,85 x A netto = 7.485 cm$^2$

Syarat :

A efektif > Ag pakai

7.485313 > 3.007 Ok

Cek

$\frac{T}{Abruto}$ = 352.672 Kg/cm$^2$ < 0,6Fy = 1440 Kg/cm$^2$ Ok

$\frac{T}{Aefektif}$ = 452.306 Kg/cm$^2$ < 0,5Fu = 1800 Kg/cm$^2$ Ok

2. Batang Tekan

a.Batang Atas (A1 s/d A12)

| Input : | | | Input Profil | : | |
|---|---|---|---|---|---|
| Panjang batang | = | 2.08 m | Dicoba | : | 2L 70x70x7 |
| T maks | = | 14754.61 kg | Data 1 Profil | | |
| Fy | = | 2400 Kg/cm$^2$ | A | = | 9.4 cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ | t | = | 0.7 cm |
| E | = | 2100000 Kg/cm$^2$ | ix=iy | = | 2.12 cm |
| | | | Ix=Iy | = | 42.4 cm$^4$ |
| | | | Berat(w) | = | 7.38 kg/m |

$\frac{K \cdot L}{r_{min}} \leq 200 \longrightarrow$ r min $= \frac{K.L}{200} =$ 0.0104 m

$Cc = \sqrt{\frac{2.\pi^2.E}{Fy}} =$ 131.3556

$\frac{K \cdot L}{i_{min}} =$ 98.11321 < Cc = 131.3556242

Rumus:

Jika : $\frac{K \cdot L}{i_{min}} >$ Cc Status ⟶ diabaikan

$Fa = \frac{12}{23} \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{i}\right)^2}$

Jika : $\frac{K \cdot L}{i_{min}} <$ Cc Status ⟶ digunakan

$Fs = \frac{5}{3} + \frac{3}{8} \cdot \frac{K \cdot L/i}{Cc} - \frac{1}{8} \frac{\left(K \cdot L/i\right)^3}{Cc^3} =$ 1.89467566

$Fa = \frac{Fy}{Fs} \cdot \left[1 - \frac{\left(K \cdot L/i\right)^2}{2 \cdot Cc^2}\right] =$ 913.358483 Kg/cm$^2$

A bruto = 2xA = 18.8 cm$^2$

T=P = Fa x Abruto = 17171.1395 kg ≥ Pmaks = 14754.61 kg

b.Batang Vertikal (V1s/d V5 dan V7s/dV11)

| Input : | | | Input Profil | : | |
|---|---|---|---|---|---|
| Panjang batang | = | 3.21 m | Dicoba | : | 2L 50x50x5 |
| T maks | = | 2194.772 kg | Data 1 Profil | | |
| Fy | = | 2400 Kg/cm$^2$ | A | = | 4.8 cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ | t | = | 0.5 cm |
| E | = | 2100000 Kg/cm$^2$ | ix=iy | = | 1.51 cm |
| | | | Ix=Iy | = | 11 cm$^4$ |
| | | | Berat(w) | = | 3.77 kg/m |

$\frac{K \ . L}{r_{min}} \leq 200 \longrightarrow$ r min $= \frac{K.L}{200} =$ 0.01605 m

$Cc = \sqrt{\frac{2.\pi^2.E}{Fy}} =$ 131.3556

$\frac{K \ . L}{i_{min}} =$ 212.5828 > Cc = 131.3556242

Rumus:

Jika : $\frac{K \ . L}{i_{min}} >$ Cc Status $\longrightarrow$ digunakan

$Fa = \frac{12}{23} \cdot \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{i}\right)^2} =$ 239.04289

Jika : $\frac{K \ . L}{i_{min}} <$ Cc Status $\longrightarrow$ diabaikan

$Fs = \frac{5}{3} + \frac{3}{8} \cdot \frac{K \cdot L/i}{Cc} - \frac{1}{8} \frac{\left(K \cdot L/i\right)^3}{Cc^3} =$ 1.74371336

$Fa = \frac{Fy}{Fs} \cdot \left[1 - \frac{\left(K \cdot L/i\right)^2}{2 \cdot Cc^2}\right] =$ -426.08426 Kg/cm$^2$

A bruto = 2xA = 9.6 cm$^2$

T=P = Fa x Abruto = 2294.81174 kg $\geq$ Pmaks = 2194.772 kg

**PERENCANAAN SAMBUNGAN KUDA-KUDA**

Hitungan sambungan pada setengah bentang

Data:

| | | |
|---|---|---|
| Tebal pelat sambung | = | 1 cm |
| Fy | = | 2400 Kg/cm$^2$ |
| Fu | = | 3600 Kg/cm$^2$ |
| Ø baut (1/2 inchi) | = | 1,27 cm |
| Ø baut (5/8 inchi) | = | 1,59 cm |

Perhitungan :

**1.Untuk alat sambung dengan Ø baut (5/8 inchi) pada batang A & B :**

Kekuatan untuk 1 baut (n) = 1 baut

P tumpuan = tp . D baut . 1,2 . Fu . n
= 6868,800 kg

P geser = Abaut . 0,17 . Fu . 2n = 1/4 π D$^2$ .0,17 . Fu . 2n
= 2430,332 kg

Dipakai P :Yg terkecil = 2430,332 kg

**2.Untuk alat sambung dengan Ø baut (1/2 inchi) pada batang D & V :**

Kekuatan untuk 1 baut (n) = 1 baut

P tumpuan = tp . D baut . 1,2 . Fu . n
= 5486,400 kg

P geser = Abaut . 0,17 . Fu . 2n = 1/4 π D$^2$ .0,17 . Fu . 2n
= 1550,525 kg

Dipakai P :Yg terkecil = 1550,525 kg

| Joint | Nama batang | P (Kg) | Pgeser (kg) | $\frac{P}{P_{geser}}$ | Jumlah baut |
|---|---|---|---|---|---|
| 1 | A1 (tekan) | 14754,61 | 2430,332 | 6,071 | 7 |
| | B1 (tarik) | 13080,32 | 2430,332 | 5,382 | 6 |
| 2 | B1 (tarik) | 13080,32 | 2430,332 | 5,382 | 6 |
| | B2 (tarik) | 11893,54 | 2430,332 | 4,894 | 5 |
| | V1 (tekan) | 541,5049 | 1550,525 | 0,349 | 2 |
| | D1 (tarik) | 1586,626 | 1550,525 | 1,023 | 2 |
| 3 | A1 (tekan) | 14754,61 | 2430,332 | 6,071 | 7 |
| | A2 (tekan) | 14754,61 | 2430,332 | 6,071 | 7 |
| | V1 (tekan) | 541,5049 | 1550,525 | 0,349 | 2 |
| 4 | B2 (tarik) | 11893,54 | 2430,332 | 4,894 | 5 |
| | B3 (tarik) | 10706,75 | 2430,332 | 4,405 | 5 |
| | V2 (tekan) | 954,8312 | 1550,525 | 0,616 | 2 |
| | D2 (tarik) | 1893,254 | 1550,525 | 1,221 | 2 |
| 5 | A2 (tekan) | 14754,61 | 2430,332 | 6,071 | 7 |
| | A3 (tekan) | 13415,92 | 2430,332 | 5,520 | 6 |
| | D1 (tarik) | 1586,626 | 1550,525 | 1,023 | 2 |
| | V2 (tekan) | 954,8312 | 1550,525 | 0,616 | 2 |
| 6 | B3 (tarik) | 10706,75 | 2430,332 | 4,405 | 5 |
| | B4 (tarik) | 9519,955 | 2430,332 | 3,917 | 4 |
| | V3 (tekan) | 1368,146 | 1550,525 | 0,882 | 2 |
| | D3 (tarik) | 2234,51 | 1550,525 | 1,441 | 2 |
| 7 | A3 (tekan) | 13415,92 | 2430,332 | 5,520 | 6 |
| | A4 (tekan) | 12077,22 | 2430,332 | 4,969 | 5 |
| | D2 (tarik) | 1893,254 | 1550,525 | 1,221 | 2 |
| | V3 (tekan) | 1368,146 | 1550,525 | 0,882 | 2 |
| 8 | B4 (tarik) | 9519,955 | 2430,332 | 3,917 | 4 |
| | B5 (tarik) | 8333,165 | 2430,332 | 3,429 | 4 |
| | V4 (tekan) | 1781,461 | 1550,525 | 1,149 | 2 |
| | D4 (tarik) | 2596,79 | 1550,525 | 1,675 | 2 |
| 9 | A4 (tekan) | 12077,22 | 2430,332 | 4,969 | 5 |
| | A5 (tekan) | 10738,52 | 2430,332 | 4,419 | 5 |
| | D3 (tarik) | 2234,51 | 1550,525 | 1,441 | 2 |
| | V4 (tekan) | 1781,461 | 1550,525 | 1,149 | 2 |
| 10 | B5 (tarik) | 8333,165 | 2430,332 | 3,429 | 4 |
| | B6 (tarik) | 7146,376 | 2430,332 | 2,940 | 3 |
| | V5 (tekan) | 2194,772 | 1550,525 | 1,416 | 2 |
| | D5 (tarik) | 2972,412 | 1550,525 | 1,917 | 2 |
| 11 | A5 (tekan) | 10738,52 | 2430,332 | 4,419 | 5 |
| | A6 (tekan) | 9399,814 | 2430,332 | 3,868 | 4 |
| | D4 (tarik) | 2596,79 | 1550,525 | 1,675 | 2 |
| | V5 (tekan) | 2194,772 | 1550,525 | 1,416 | 2 |
| 12 | B6 (tarik) | 7146,376 | 2430,332 | 2,940 | 3 |
| | B7 (tarik) | 7146,376 | 2430,332 | 2,940 | 3 |
| | V6 (tarik) | 3385,654 | 1550,525 | 2,184 | 3 |
| 13 | A6 (tekan) | 9399,814 | 2430,332 | 3,868 | 4 |
| | A7 (tekan) | 9399,814 | 2430,332 | 3,868 | 4 |
| | D5 (tarik) | 2972,412 | 1550,525 | 1,917 | 2 |
| | V6 (tarik) | 3385,654 | 1550,525 | 2,184 | 3 |
| | D6 (tarik) | 2972,412 | 1550,525 | 1,917 | 2 |

**Tangga Atas Lantai Basement untuk lebar tangga 2 meter**

Didapat dari SAP :

Momen (M+)lapangan 15.25 Knm

Momen (M-)tumpuan 32.74 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0.8 |
| Mn= Mu/Ø (Knm) | 19.0625 |
| h bordes (m) | 0.2 |
| fc' (Mpa) | 25 |
| B1 | 0.85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156.6 |
| As (mm^2) | 507.1972 |
| pb | 0.053757 |
| As max (mm^2) | 7015.346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 674.5723 |
| As pakai (mm^2) | 674.5723 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113.04 |
| jarak tulangan(x) (mm) | 167.5728 |
| x pakai (mm) | 165 |
| tulangan pokok (mm) | D12-165 |
| As ada (mm^2) | 685.0909 |
| a (mm) | 7.737497 |
| Mn1 (Knm) | 27.97329 |
| 1.33 Mn (Knm) | 25.35313 |
| Cek Mn1 > 1,33 Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0.8 |
| Mn= Mu/Ø (Knm) | 40.925 |
| h bordes (m) | 0.2 |
| fc' (Mpa) | 25 |
| B1 | 0.85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156.6 |
| As (mm^2) | 1088.89421 |
| pb | 0.05375744 |
| As max (mm^2) | 7015.34598 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1448.2293 |
| As pakai (mm^2) | 1088.89421 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113.04 |
| jarak tulangan(x) (mm) | 103.811738 |
| x pakai (mm) | 110 |
| tulangan pokok (mm) | D12-110 |
| As ada (mm^2) | 1027.63636 |
| a (mm) | 11.606246 |
| Mn1 (Knm) | 41.4828545 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-)tumpuan 15.42 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0.8 |
| Mn= Mu/Ø (Knm) | 19.275 |
| h bordes (m) | 0.2 |
| fc' (Mpa) | 25 |
| B1 | 0.85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156.6 |
| As (mm^2) | 512.8512 |
| pb | 0.053757 |
| As max (mm^2) | 7015.346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 682.0921 |
| As pakai (mm^2) | 682.0921 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113.04 |
| jarak tulangan(x) (mm) | 165.7254 |
| x pakai (mm) | 165 |
| tulangan pokok (mm) | D12-165 |
| As ada (mm^2) | 685.0909 |
| a (mm) | 7.737497 |
| Mn1 (Knm) | 27.97329 |
| 1.33 Mn (Knm) | 25.63575 |
| Cek Mn1 > 1,33 Mn | Aman |

**Tangga Atas Lantai Basement untuk lebar tangga 2 meter**

Didapat dari SAP :

Momen (M+)lapangan 15,25 Knm

Momen (M-)tumpuan 32,74 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 19,0625 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 507,1972 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 674,5723 |
| As pakai (mm^2) | 674,5723 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 167,5728 |
| x pakai (mm) | 165 |
| tulangan pokok (mm) | D12-165 |
| As ada (mm^2) | 685,0909 |
| a (mm) | 7,737497 |
| Mn1 (Knm) | 27,97329 |
| 1.33 Mn (Knm) | 25,35313 |
| Cek Mn1 > 1,33 Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 40,925 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 1088,89421 |
| pb | 0,05375744 |
| As max (mm^2) | 7015,34598 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1448,2293 |
| As pakai (mm^2) | 1088,89421 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 103,811738 |
| x pakai (mm) | 110 |
| tulangan pokok (mm) | D12-110 |
| As ada (mm^2) | 1027,63636 |
| a (mm) | 11,606246 |
| Mn1 (Knm) | 41,4828545 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-)tumpuan 15,42 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 19,275 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 512,8512 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 682,0921 |
| As pakai (mm^2) | 682,0921 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 165,7254 |
| x pakai (mm) | 165 |
| tulangan pokok (mm) | D12-165 |
| As ada (mm^2) | 685,0909 |
| a (mm) | 7,737497 |
| Mn1 (Knm) | 27,97329 |
| 1.33 Mn (Knm) | 25,63575 |
| Cek Mn1 > 1,33 Mn | Aman |

**Tangga Atas Lantai Ground dan 3 untuk lebar tangga 2 meter**

Didapat dari SAP :

Momen (M+)lapangan 33,67 Knm

Momen (M-)tumpuan 69,56 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 42,0875 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 1119,825 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1489,367 |
| As pakai (mm^2) | 1119,825 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 100,9444 |
| x pakai (mm) | 100 |
| tulangan pokok (mm) | D12-100 |
| As ada (mm^2) | 1130,4 |
| a (mm) | 12,76687 |
| Mn1 (Knm) | 45,4737 |
| Cek Mn1 > Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 86,95 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 400 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 16 |
| d efektif (mm) | 172 |
| jd (mm) | 154,8 |
| As (mm^2) | 1404,23127 |
| pb | 0,02709375 |
| As max (mm^2) | 3495,09375 |
| As min (mm^2) | 602 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1867,62758 |
| As pakai (mm^2) | 1404,23127 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 200,96 |
| jarak tulangan(x) (mm) | 143,11033 |
| x pakai (mm) | 140 |
| tulangan pokok (mm) | D16-140 |
| As ada (mm^2) | 1435,42857 |
| a (mm) | 27,0198319 |
| Mn1 (Knm) | 91,000478 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-) tumpuan 37,96 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 47,45 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 400 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 16 |
| d efektif (mm) | 172 |
| jd (mm) | 154,8 |
| As (mm^2) | 766,3114 |
| pb | 0,027094 |
| As max (mm^2) | 3495,094 |
| As min (mm^2) | 602 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1019,194 |
| As pakai (mm^2) | 766,3114 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 200,96 |
| jarak tulangan(x) (mm) | 262,2433 |
| x pakai (mm) | 200 |
| tulangan pokok (mm) | D16-200 |
| As ada (mm^2) | 1004,8 |
| a (mm) | 18,91388 |
| Mn1 (Knm) | 65,32931 |
| Cek Mn1 > Mn | Aman |

**Tangga Atas Lantai 1 dan 2 untuk lebar tangga 2 meter**

Didapat dari SAP :

Momen (M+)lapangan 27,41 Knm

Momen (M-)tumpuan 57,07 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 34,2625 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 911,6246 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1212,461 |
| As pakai (mm^2) | 1015 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 111,3695 |
| x pakai (mm) | 110 |
| tulangan pokok (mm) | D12-110 |
| As ada (mm^2) | 1027,636 |
| a (mm) | 11,60625 |
| Mn1 (Knm) | 41,48285 |
| Cek Mn1 > Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø | 71,3375 |
| h bordes | 0,2 |
| fc' | 25 |
| B1 | 0,85 |
| fy | 400 |
| penutup beton | 20 |
| Ø tulangan | 16 |
| d efektif | 172 |
| jd | 154,8 |
| As | 1152,09141 |
| pb | 0,02709375 |
| As max | 3495,09375 |
| As min | 602 |
| As susut | 400 |
| 1,33 As | 1532,28157 |
| As pakai | 1152,09141 |
| Cek As>As susut | Aman |
| AØ | 200,96 |
| jarak tulangan(x) | 174,430604 |
| x pakai | 170 |
| tulangan pokok | D16-170 |
| As ada | 1182,11765 |
| a | 22,2516263 |
| Mn1 | 76,0688861 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-)tumpuan 29,73 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø | 37,1625 |
| h bordes | 0,2 |
| fc' | 25 |
| B1 | 0,85 |
| fy | 240 |
| penutup beton | 20 |
| Ø tulangan | 12 |
| d efektif | 174 |
| jd | 156,6 |
| As | 988,7851 |
| pb | 0,053757 |
| As max | 7015,346 |
| As min | 1015 |
| As susut | 400 |
| 1,33 As | 1315,084 |
| As pakai | 1015 |
| Cek As>As susut | Aman |
| AØ | 113,04 |
| jarak tulangan(x) | 111,3695 |
| x pakai | 110 |
| tulangan pokok | D12-110 |
| As ada | 1027,636 |
| a | 11,60625 |
| Mn1 | 41,48285 |
| Cek Mn1 > Mn | Aman |

**Tangga Atas Lantai Ground & 3 untuk lebar tangga 1.8 meter**

Didapat dari SAP :

Momen (M+)lapangan 30,64 Knm

Momen (M-)tumpuan 63,28 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 38,3 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 1019,051 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1355,337 |
| As pakai (mm^2) | 1019,051 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 110,9268 |
| x pakai (mm) | 110 |
| tulangan pokok (mm) | D12-110 |
| As ada (mm^2) | 1027,636 |
| a (mm) | 11,60625 |
| Mn1 (Knm) | 41,48285 |
| Cek Mn1 > Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 79,1 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 400 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 16 |
| d efektif (mm) | 172 |
| jd (mm) | 154,8 |
| As (mm^2) | 1277,45478 |
| pb | 0,02709375 |
| As max (mm^2) | 3495,09375 |
| As min (mm^2) | 602 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1699,01486 |
| As pakai (mm^2) | 1277,45478 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 200,96 |
| jarak tulangan(x) (mm) | 157,312809 |
| x pakai (mm) | 155 |
| tulangan pokok (mm) | D16-155 |
| As ada (mm^2) | 1296,51613 |
| a (mm) | 24,4050095 |
| Mn1 (Knm) | 82,872012 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-)tumpuan 34,72 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 43,4 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 1154,747 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1535,813 |
| As pakai (mm^2) | 1154,747 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 97,8916 |
| x pakai (mm) | 95 |
| tulangan pokok (mm) | D12-95 |
| As ada (mm^2) | 1189,895 |
| a (mm) | 13,43881 |
| Mn1 (Knm) | 47,77111 |
| Cek Mn1 > Mn | Aman |

**Tangga Atas Lantai 1& 2 untuk lebar tangga 1.8 meter**

Didapat dari SAP :

Momen (M+)lapangan 24,97 Knm

Momen (M-)tumpuan 51,95 Knm

| Perhitungan tulangan lapangan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 31,2125 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 830,4731 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1104,529 |
| As pakai (mm^2) | 1015 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 111,3695 |
| x pakai (mm) | 110 |
| tulangan pokok (mm) | D12-110 |
| As ada (mm^2) | 1027,636 |
| a (mm) | 11,60625 |
| Mn1 (Knm) | 41,48285 |
| Cek Mn1 > Mn | Aman |

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 64,9375 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 400 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 16 |
| d efektif (mm) | 172 |
| jd (mm) | 154,8 |
| As (mm^2) | 1048,73224 |
| pb | 0,02709375 |
| As max (mm^2) | 3495,09375 |
| As min (mm^2) | 602 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1394,81387 |
| As pakai (mm^2) | 1048,73224 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 200,96 |
| jarak tulangan(x) (mm) | 191,621839 |
| x pakai (mm) | 190 |
| tulangan pokok (mm) | D16-190 |
| As ada (mm^2) | 1057,68421 |
| a (mm) | 19,9093498 |
| Mn1 (Knm) | 68,5571127 |
| Cek Mn1 > Mn | Aman |

Perhitungan Bordes

Didapat dari SAP :

Momen (M-)tumpuan 27,12 Knm

| Perhitungan tulangan tumpuan | |
|---|---|
| Ø | 0,8 |
| Mn= Mu/Ø (Knm) | 33,9 |
| h bordes (m) | 0,2 |
| fc' (Mpa) | 25 |
| B1 | 0,85 |
| fy (Mpa) | 240 |
| penutup beton (mm) | 20 |
| Ø tulangan (mm) | 12 |
| d efektif (mm) | 174 |
| jd (mm) | 156,6 |
| As (mm^2) | 901,9796 |
| pb | 0,053757 |
| As max (mm^2) | 7015,346 |
| As min (mm^2) | 1015 |
| As susut (mm^2) | 400 |
| 1,33 As (mm^2) | 1199,633 |
| As pakai (mm^2) | 901,9796 |
| Cek As>As susut | Aman |
| AØ (mm^2) | 113,04 |
| jarak tulangan(x) (mm) | 125,3243 |
| x pakai (mm) | 125 |
| tulangan pokok (mm) | D12-125 |
| As ada (mm^2) | 904,32 |
| a (mm) | 10,2135 |
| Mn1 (Knm) | 36,65605 |
| Cek Mn1 > Mn | Aman |

**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 800 | mm |
| d | = | 339 | | h | = | 400 | mm |
| Ag | = | 320000 | mm^2 | β | = | 0,85 | |
| Ast | = | 3200 | mm^2 | % | = | 0,01 | |
| As | = | 1600 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 1600 | mm^2 | f'c | = | 25 | Mpa |

| 1% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 203,400 | 386,460 | 305,100 | 254,250 | 152,550 | 122,040 | 101,700 | | |
| a (mm) | 172,890 | 328,491 | 259,335 | 216,113 | 129,668 | 103,734 | 86,445 | | 37,647 |
| fs' hitungan (Mpa) | 420,059 | 505,294 | 480,039 | 456,047 | 360,079 | 300,098 | 240,118 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 360,079 | 300,098 | 240,118 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 293,913 | 558,435 | 440,870 | 367,391 | 220,435 | 176,348 | 146,957 | | |
| Cs (Ton) | 60,600 | 60,600 | 60,600 | 60,600 | 54,213 | 44,616 | 35,019 | | |
| Ts (Ton) | 64,000 | -11,789 | 10,667 | 32,000 | 64,000 | 64,000 | 64,000 | | |
| Pnb (Ton) | 290,513 | 630,824 | 490,803 | 395,991 | 210,647 | 156,964 | 117,975 | | |
| Mnb (T m) | 50,695 | 26,751 | 40,914 | 46,651 | 46,227 | 41,221 | 36,803 | | |
| eb (m) | 0,175 | 0,042 | 0,083 | 0,118 | 0,219 | 0,263 | 0,312 | | |
| Po (Ton) | | | | | | | | 801,200 | |
| Pno (Ton) | | | | | | | | 640,960 | |
| Mn (T m) | | | | | | | | | 20,491 |

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**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 800 | mm |
| d | = | 339 | | h | = | 400 | mm |
| Ag | = | 320000 | mm^2 | β | = | 0,85 | |
| Ast | = | 6400 | mm^2 | % | = | 0,02 | |
| As | = | 3200 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 3200 | mm^2 | f'c | = | 25 | Mpa |

| 2% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 203,400 | 386,460 | 305,100 | 254,250 | 152,550 | 122,040 | 101,700 | | |
| a (mm) | 172,890 | 328,491 | 259,335 | 216,113 | 129,668 | 103,734 | 86,445 | | 75,294 |
| fs' hitungan (Mpa) | 420,059 | 505,294 | 480,039 | 456,047 | 360,079 | 300,098 | 240,118 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 360,079 | 300,098 | 240,118 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 293,913 | 558,435 | 440,870 | 367,391 | 220,435 | 176,348 | 146,957 | | |
| Cs (Ton) | 121,200 | 121,200 | 121,200 | 121,200 | 108,425 | 89,231 | 70,038 | | |
| Ts (Ton) | 128,000 | -23,579 | 21,333 | 64,000 | 128,000 | 128,000 | 128,000 | | |
| Pnb (Ton) | 287,113 | 703,214 | 540,736 | 424,591 | 200,860 | 137,579 | 88,994 | | |
| Mnb (T m) | 68,014 | 33,536 | 50,820 | 59,522 | 62,658 | 56,318 | 50,567 | | |
| eb (m) | 0,237 | 0,048 | 0,094 | 0,140 | 0,312 | 0,409 | 0,568 | | |
| Po (Ton) | | | | | | | | 922,400 | |
| Pno (Ton) | | | | | | | | 737,920 | |
| Mn (T m) | | | | | | | | | 38,573 |

**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 400 | mm |
| d | = | 739 | | h | = | 800 | mm |
| Ag | = | 320000 | mm^2 | β | = | 0.85 | |
| Ast | = | 9600 | mm^2 | % | = | 0.03 | |
| As | = | 4800 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 4800 | mm^2 | f'c | = | 25 | Mpa |

| 3% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 443.400 | 842.460 | 665.100 | 554.250 | 332.550 | 266.040 | 221.700 | | |
| a (mm) | 376.890 | 716.091 | 565.335 | 471.113 | 282.668 | 226.134 | 188.445 | | 225.882 |
| fs' hitungan (Mpa) | 517.456 | 556.556 | 544.971 | 533.965 | 489.941 | 462.427 | 434.912 | | |
| fs' pakai (Mpa) | 400.000 | 400.000 | 400.000 | 400.000 | 400.000 | 400.000 | 400.000 | | |
| fs hitungan (Mpa) | | -73.684 | 66.667 | 200.000 | 733.333 | 1066.667 | 1400.000 | | |
| fs pakai (Mpa) | | -73.684 | 66.667 | 200.000 | 400.000 | 400.000 | 400.000 | | |
| Cc (Ton) | 320.357 | 608.677 | 480.535 | 400.446 | 240.267 | 192.214 | 160.178 | | |
| Cs (Ton) | 181.800 | 181.800 | 181.800 | 181.800 | 181.800 | 181.800 | 181.800 | | |
| Ts (Ton) | 192.000 | -35.368 | 32.000 | 96.000 | 192.000 | 192.000 | 192.000 | | |
| Pnb (Ton) | 310.157 | 825.846 | 630.335 | 486.246 | 230.067 | 182.014 | 149.978 | | |
| Mnb (T m) | 194.491 | 75.177 | 128.861 | 160.025 | 188.867 | 181.871 | 175.697 | | |
| eb (m) | 0.627 | 0.091 | 0.204 | 0.329 | 0.821 | 0.999 | 1.171 | | |
| Po (Ton) | | | | | | | | 1043.600 | |
| Pno (Ton) | | | | | | | | 834.880 | |
| Mn (T m) | | | | | | | | | 120.203 |

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**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 800 | mm |
| d | = | 339 | | h | = | 400 | mm |
| Ag | = | 320000 | mm^2 | β | = | 0,85 | |
| Ast | = | 12800 | mm^2 | % | = | 0,04 | |
| As | = | 6400 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 6400 | mm^2 | f'c | = | 25 | Mpa |

| 4% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 203,400 | 386,460 | 305,100 | 254,250 | 152,550 | 122,040 | 101,700 | | |
| a (mm) | 172,890 | 328,491 | 259,335 | 216,113 | 129,668 | 103,734 | 86,445 | | 150,588 |
| fs' hitungan (Mpa) | 420,059 | 505,294 | 480,039 | 456,047 | 360,079 | 300,098 | 240,118 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 360,079 | 300,098 | 240,118 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 293,913 | 558,435 | 440,870 | 367,391 | 220,435 | 176,348 | 146,957 | | |
| Cs (Ton) | 242,400 | 242,400 | 242,400 | 242,400 | 216,850 | 178,463 | 140,076 | | |
| Ts (Ton) | 256,000 | -47,158 | 42,667 | 128,000 | 256,000 | 256,000 | 256,000 | | |
| Pnb (Ton) | 280,313 | 847,993 | 640,603 | 481,791 | 181,285 | 98,811 | 31,032 | | |
| Mnb (T m) | 102,653 | 47,105 | 70,632 | 85,265 | 95,522 | 86,513 | 78,094 | | |
| eb (m) | 0,366 | 0,056 | 0,110 | 0,177 | 0,527 | 0,876 | 2,517 | | |
| Po (Ton) | | | | | | | | 1164,800 | |
| Pno (Ton) | | | | | | | | 931,840 | |
| Mn (T m) | | | | | | | | | 67,509 |

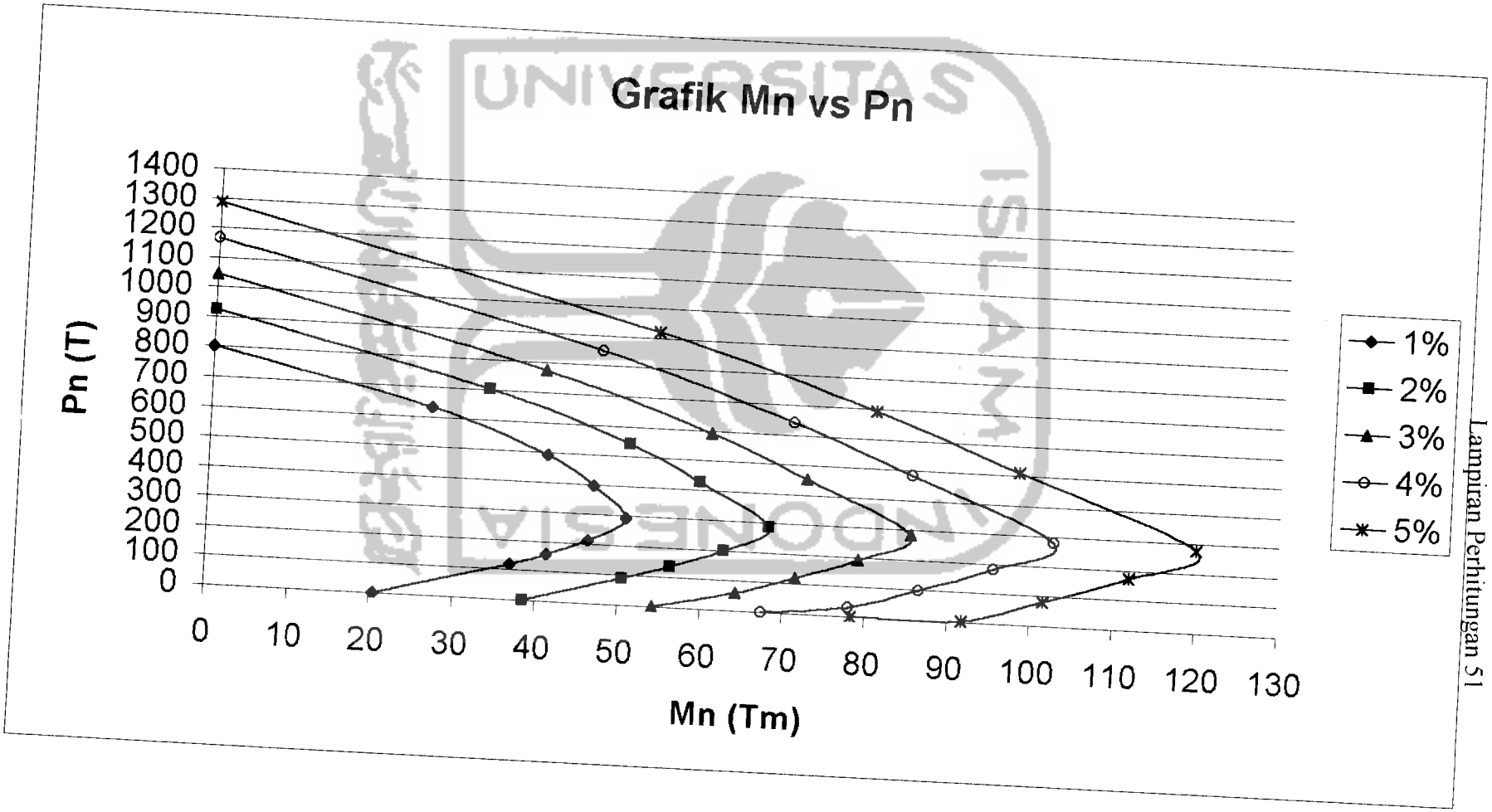
**Penyelesaian dengan cara tabel**

| | | | | | | |
|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = 800 | mm |
| d | = | 339 | | h | = 400 | mm |
| Ag | = | 320000 | mm^2 | β | = 0,85 | |
| Ast | = | 16000 | mm^2 | % | = 0,05 | |
| As | = | 8000 | mm^2 | fy | = 400 | Mpa |
| As' | = | 8000 | mm^2 | f'c | = 25 | Mpa |

| 5% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 203,400 | 386,460 | 305,100 | 254,250 | 152,550 | 122,040 | 101,700 | | |
| a (mm) | 172,890 | 328,491 | 259,335 | 216,113 | 129,668 | 103,734 | 86,445 | | 188,235 |
| fs' hitungan (Mpa) | 420,059 | 505,294 | 480,039 | 456,047 | 360,079 | 300,098 | 240,118 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 360,079 | 300,098 | 240,118 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 293,913 | 558,435 | 440,870 | 367,391 | 220,435 | 176,348 | 146,957 | | |
| Cs (Ton) | 303,000 | 303,000 | 303,000 | 303,000 | 271,063 | 223,079 | 175,094 | | |
| Ts (Ton) | 320,000 | -58,947 | 53,333 | 160,000 | 320,000 | 320,000 | 320,000 | | |
| Pnb (Ton) | 276,913 | 920,382 | 690,536 | 510,391 | 171,498 | 79,426 | 2,051 | | |
| Mnb (T m) | 119,972 | 53,890 | 80,538 | 98,136 | 111,953 | 101,611 | 91,858 | | |
| eb (m) | 0,433 | 0,059 | 0,117 | 0,192 | 0,653 | 1,279 | 44,789 | | |
| Po (Ton) | | | | | | | | 1286,000 | |
| Pno (Ton) | | | | | | | | 1028,800 | |
| Mn (T m) | | | | | | | | | 78,362 |

Data :

| | | | |
|---|---|---|---|
| b = | 800 mm | fc' = | 25 Mpa |
| h = | 400 mm | fy = | 400 Mpa |



**Penyelesaian dengan cara tabel**

| | | | | | |
|---|---|---|---|---|---|
| d' | = 61 | mm | b | = 700 | mm |
| d | = 639 | | h | = 700 | mm |
| Ag | = 490000 | mm^2 | β | = 0,85 | |
| Ast | = 4900 | mm^2 | % | = 0,01 | |
| As | = 2450 | mm^2 | fy | = 400 | Mpa |
| As' | = 2450 | mm^2 | f'c | = 25 | Mpa |

| 1% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 383,400 | 728,460 | 575,100 | 479,250 | 287,550 | 230,040 | 191,700 | | |
| a (mm) | 325,890 | 619,191 | 488,835 | 407,363 | 244,418 | 195,534 | 162,945 | | 65,882 |
| fs' hitungan (Mpa) | 504,538 | 549,757 | 536,359 | 523,631 | 472,718 | 440,897 | 409,077 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 484,761 | 921,047 | 727,142 | 605,952 | 363,571 | 290,857 | 242,381 | | |
| Cs (Ton) | 92,794 | 92,794 | 92,794 | 92,794 | 92,794 | 92,794 | 92,794 | | |
| Ts (Ton) | 98,000 | -18,053 | 16,333 | 49,000 | 98,000 | 98,000 | 98,000 | | |
| Pnb (Ton) | 479,555 | 1031,893 | 803,602 | 649,745 | 358,365 | 285,651 | 237,174 | | |
| Mnb (T m) | 145,816 | 58,815 | 108,311 | 129,640 | 137,958 | 128,503 | 120,225 | | |
| eb (m) | 0,304 | 0,057 | 0,135 | 0,200 | 0,385 | 0,450 | 0,507 | | |
| Po (Ton) | | | | | | | | 1226,838 | |
| Pno (Ton) | | | | | | | | 981,470 | |
| Mn (T m) | | | | | | | | | 59,394 |

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**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 700 | mm |
| d | = | 639 | | h | = | 700 | mm |
| Ag | = | 490000 | mm^2 | β | = | 0,85 | |
| Ast | = | 9800 | mm^2 | % | = | 0,02 | |
| As | = | 4900 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 4900 | mm^2 | f'c | = | 25 | Mpa |

| 2% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 383,400 | 728,460 | 575,100 | 479,250 | 287,550 | 230,040 | 191,700 | | |
| a (mm) | 325,890 | 619,191 | 488,835 | 407,363 | 244,418 | 195,534 | 162,945 | | 131,765 |
| fs' hitungan (Mpa) | 504,538 | 549,757 | 536,359 | 523,631 | 472,718 | 440,897 | 409,077 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 484,761 | 921,047 | 727,142 | 605,952 | 363,571 | 290,857 | 242,381 | | |
| Cs (Ton) | 185,588 | 185,588 | 185,588 | 185,588 | 185,588 | 185,588 | 185,588 | | |
| Ts (Ton) | 196,000 | -36,105 | 32,667 | 98,000 | 196,000 | 196,000 | 196,000 | | |
| Pnb (Ton) | 474,349 | 1142,739 | 880,063 | 693,539 | 353,159 | 280,444 | 231,968 | | |
| Mnb (T m) | 200,956 | 80,415 | 139,849 | 170,619 | 193,097 | 183,642 | 175,365 | | |
| eb (m) | 0,424 | 0,070 | 0,159 | 0,246 | 0,547 | 0,655 | 0,756 | | |
| Po (Ton) | | | | | | | | 1412,425 | |
| Pno (Ton) | | | | | | | | 1129,940 | |
| Mn (T m) | | | | | | | | | 112,331 |

**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 700 | mm |
| d | = | 639 | | h | = | 700 | mm |
| Ag | = | 490000 | mm^2 | β | = | 0,85 | |
| Ast | = | 14700 | mm^2 | % | = | 0,03 | |
| As | = | 7350 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 7350 | mm^2 | f'c | = | 25 | Mpa |

| 3% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 383,400 | 728,460 | 575,100 | 479,250 | 287,550 | 230,040 | 191,700 | | |
| a (mm) | 325,890 | 619,191 | 488,835 | 407,363 | 244,418 | 195,534 | 162,945 | | 197,647 |
| fs' hitungan (Mpa) | 504,538 | 549,757 | 536,359 | 523,631 | 472,718 | 440,897 | 409,077 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 484,761 | 921,047 | 727,142 | 605,952 | 363,571 | 290,857 | 242,381 | | |
| Cs (Ton) | 278,381 | 278,381 | 278,381 | 278,381 | 278,381 | 278,381 | 278,381 | | |
| Ts (Ton) | 294,000 | -54,158 | 49,000 | 147,000 | 294,000 | 294,000 | 294,000 | | |
| Pnb (Ton) | 469,143 | 1253,586 | 956,523 | 737,333 | 347,952 | 275,238 | 226,762 | | |
| Mnb (T m) | 256,095 | 102,015 | 171,387 | 211,597 | 248,236 | 238,782 | 230,504 | | |
| eb (m) | 0,546 | 0,081 | 0,179 | 0,287 | 0,713 | 0,868 | 1,017 | | |
| Po (Ton) | | | | | | | | 1598,013 | |
| Pno (Ton) | | | | | | | | 1278,410 | |
| Mn (T m) | | | | | | | | | 158,812 |

**Penyelesaian dengan cara tabel**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 700 | mm |
| d | = | 639 | | h | = | 700 | mm |
| Ag | = | 490000 | mm^2 | β | = | 0,85 | |
| Ast | = | 19600 | mm^2 | % | = | 0,04 | |
| As | = | 9800 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 9800 | mm^2 | f'c | = | 25 | Mpa |

| 4% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 383,400 | 728,460 | 575,100 | 479,250 | 287,550 | 230,040 | 191,700 | | |
| a (mm) | 325,890 | 619,191 | 488,835 | 407,363 | 244,418 | 195,534 | 162,945 | | 263,529 |
| fs' hitungan (Mpa) | 504,538 | 549,757 | 536,359 | 523,631 | 472,718 | 440,897 | 409,077 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 484,761 | 921,047 | 727,142 | 605,952 | 363,571 | 290,857 | 242,381 | | |
| Cs (Ton) | 371,175 | 371,175 | 371,175 | 371,175 | 371,175 | 371,175 | 371,175 | | |
| Ts (Ton) | 392,000 | -72,211 | 65,333 | 196,000 | 392,000 | 392,000 | 392,000 | | |
| Pnb (Ton) | 463,936 | 1364,432 | 1032,984 | 781,127 | 342,746 | 270,032 | 221,556 | | |
| Mnb (T m) | 311,235 | 123,615 | 202,924 | 252,576 | 303,376 | 293,921 | 285,643 | | |
| eb (m) | 0,671 | 0,091 | 0,196 | 0,323 | 0,885 | 1,088 | 1,289 | | |
| Po (Ton) | | | | | | | | 1783,600 | |
| Pno (Ton) | | | | | | | | 1426,880 | |
| Mn (T m) | | | | | | | | | 198,836 |

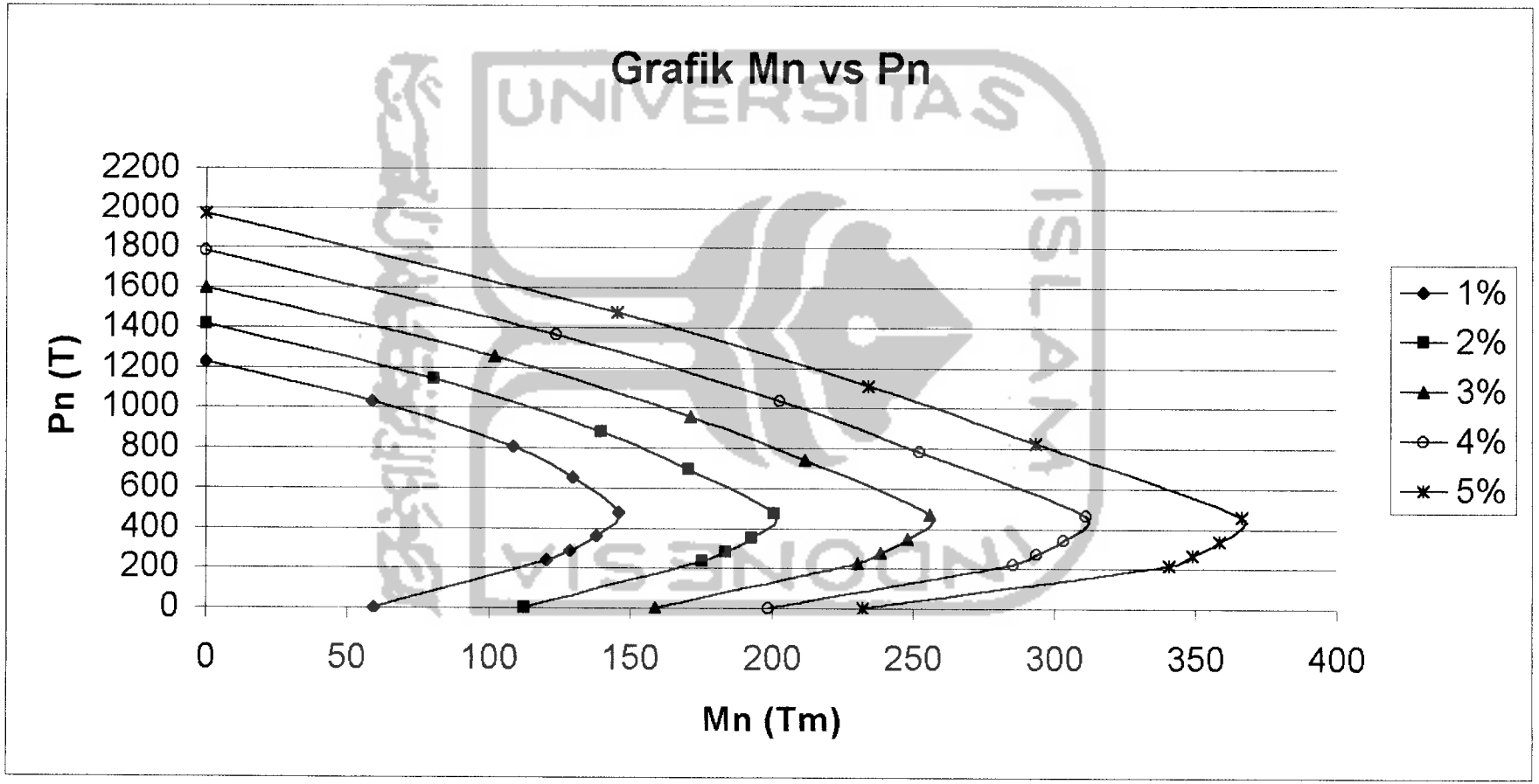
**Penyelesaian dengan cara tabel**

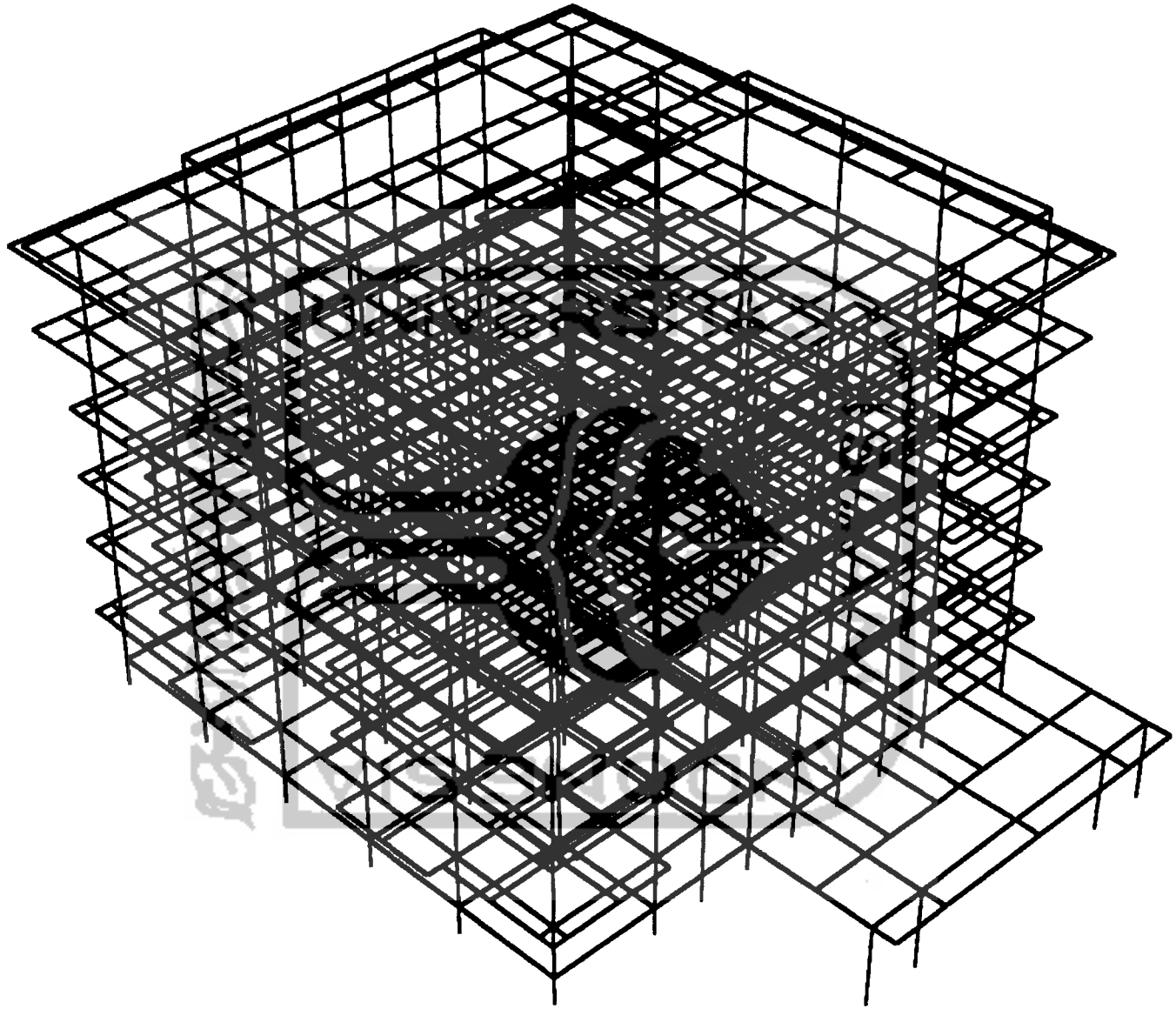
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| d' | = | 61 | mm | b | = | 700 | mm |
| d | = | 639 | | h | = | 700 | mm |
| Ag | = | 490000 | mm^2 | β | = | 0,85 | |
| Ast | = | 24500 | mm^2 | % | = | 0,05 | |
| As | = | 12250 | mm^2 | fy | = | 400 | Mpa |
| As' | = | 12250 | mm^2 | f'c | = | 25 | Mpa |

| 5% | Seimbang | Patah Desak | | | Patah Tarik | | | Desak Aksial | Lentur Murni |
|---|---|---|---|---|---|---|---|---|---|
| x (mm) | 383,400 | 728,460 | 575,100 | 479,250 | 287,550 | 230,040 | 191,700 | | |
| a (mm) | 325,890 | 619,191 | 488,835 | 407,363 | 244,418 | 195,534 | 162,945 | | 329,412 |
| fs' hitungan (Mpa) | 504,538 | 549,757 | 536,359 | 523,631 | 472,718 | 440,897 | 409,077 | | |
| fs' pakai (Mpa) | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | 400,000 | | |
| fs hitungan (Mpa) | | -73,684 | 66,667 | 200,000 | 733,333 | 1066,667 | 1400,000 | | |
| fs pakai (Mpa) | | -73,684 | 66,667 | 200,000 | 400,000 | 400,000 | 400,000 | | |
| Cc (Ton) | 484,761 | 921,047 | 727,142 | 605,952 | 363,571 | 290,857 | 242,381 | | |
| Cs (Ton) | 463,969 | 463,969 | 463,969 | 463,969 | 463,969 | 463,969 | 463,969 | | |
| Ts (Ton) | 490,000 | -90,263 | 81,667 | 245,000 | 490,000 | 490,000 | 490,000 | | |
| Pnb (Ton) | 458,730 | 1475,279 | 1109,444 | 824,920 | 337,540 | 264,826 | 216,349 | | |
| Mnb (T m) | 366,374 | 145,215 | 234,462 | 293,554 | 358,515 | 349,061 | 340,783 | | |
| eb (m) | 0,799 | 0,098 | 0,211 | 0,356 | 1,062 | 1,318 | 1,575 | | |
| Po (Ton) | | | | | | | | 1969,188 | |
| Pno (Ton) | | | | | | | | 1575,350 | |
| Mn (T m) | | | | | | | | | 232,404 |

Data :

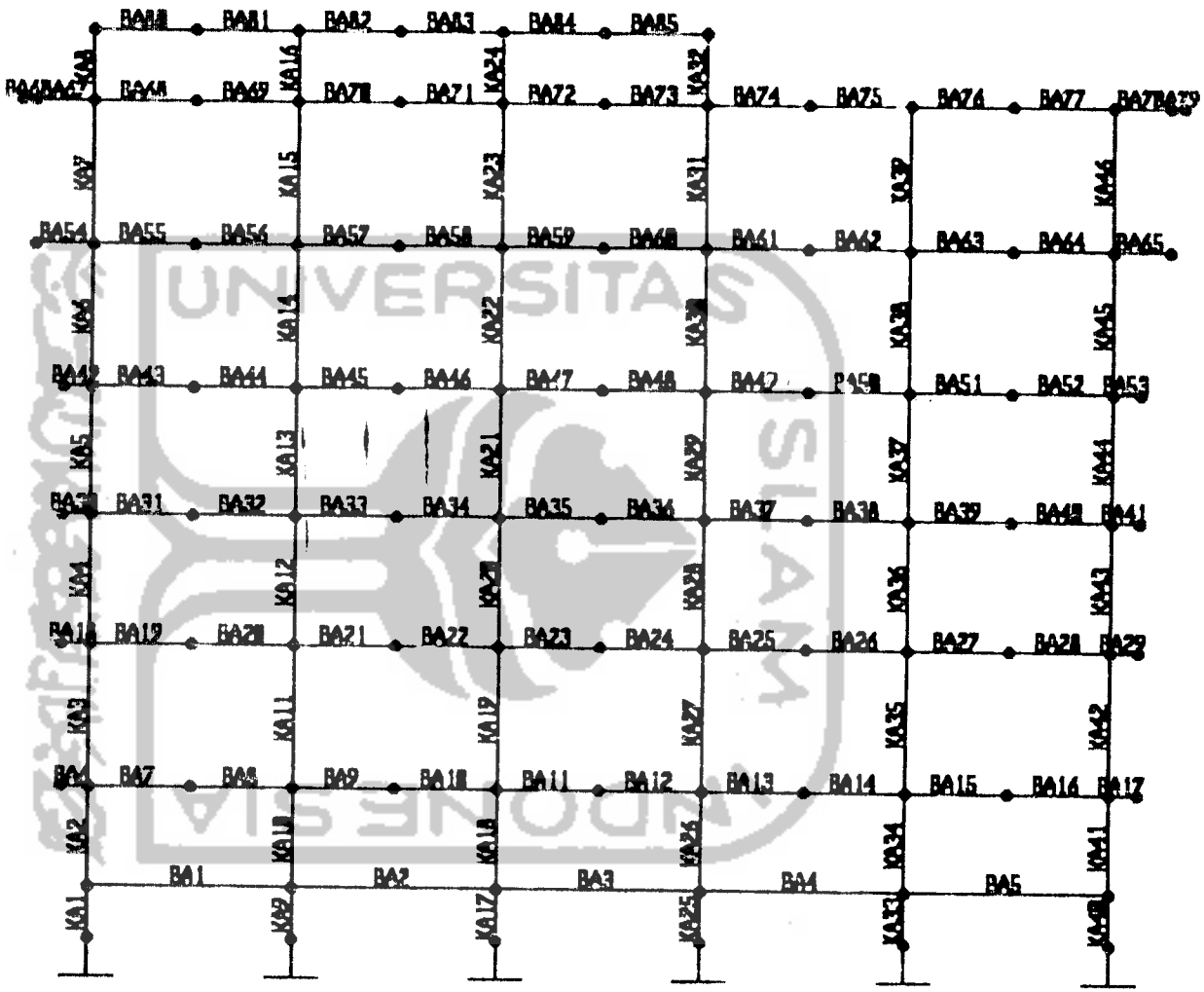
| | | | |
|---|---|---|---|
| b = | 700 mm | fc' = | 25 Mpa |
| h = | 700 mm | fy = | 400 Mpa |



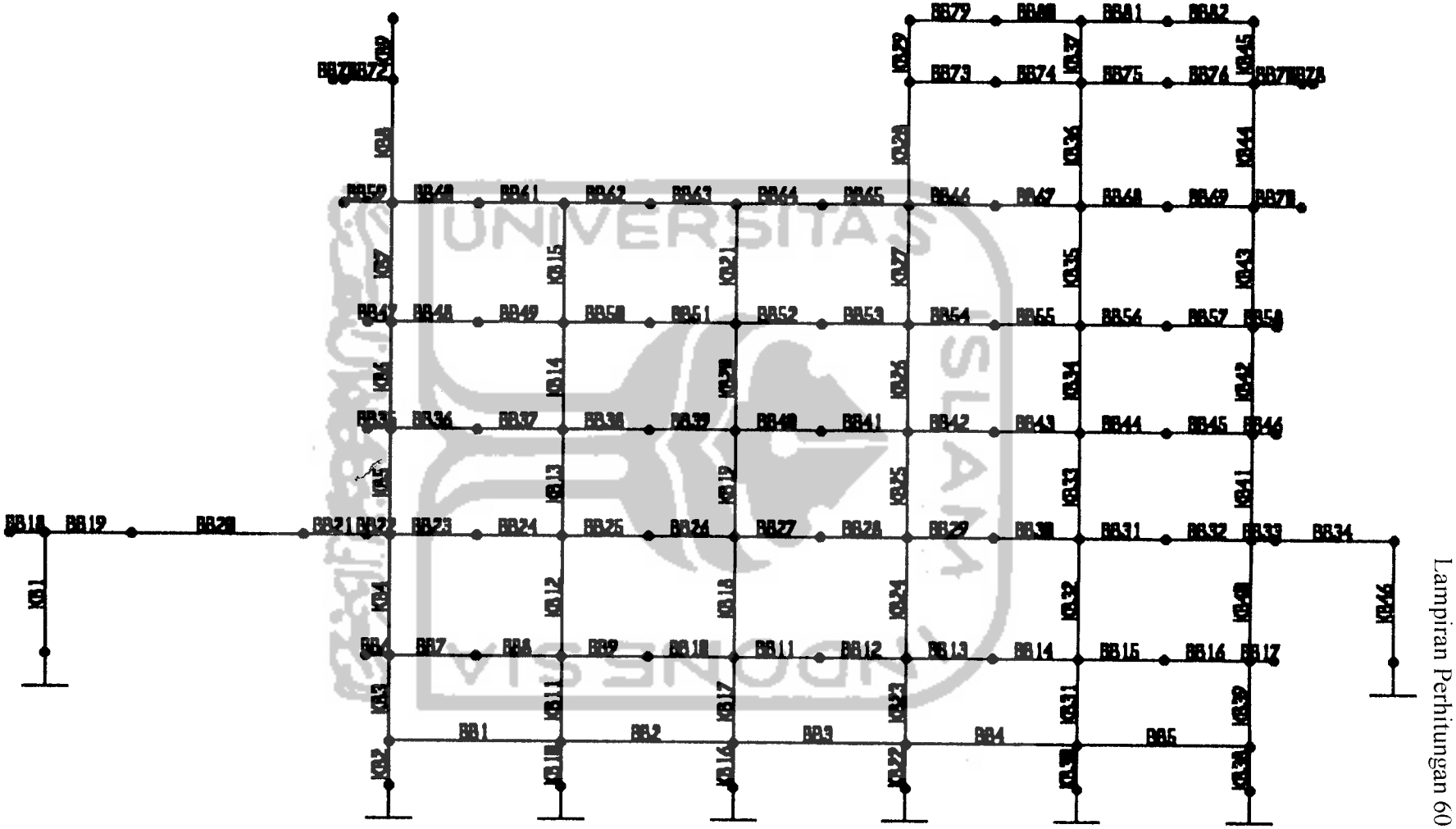




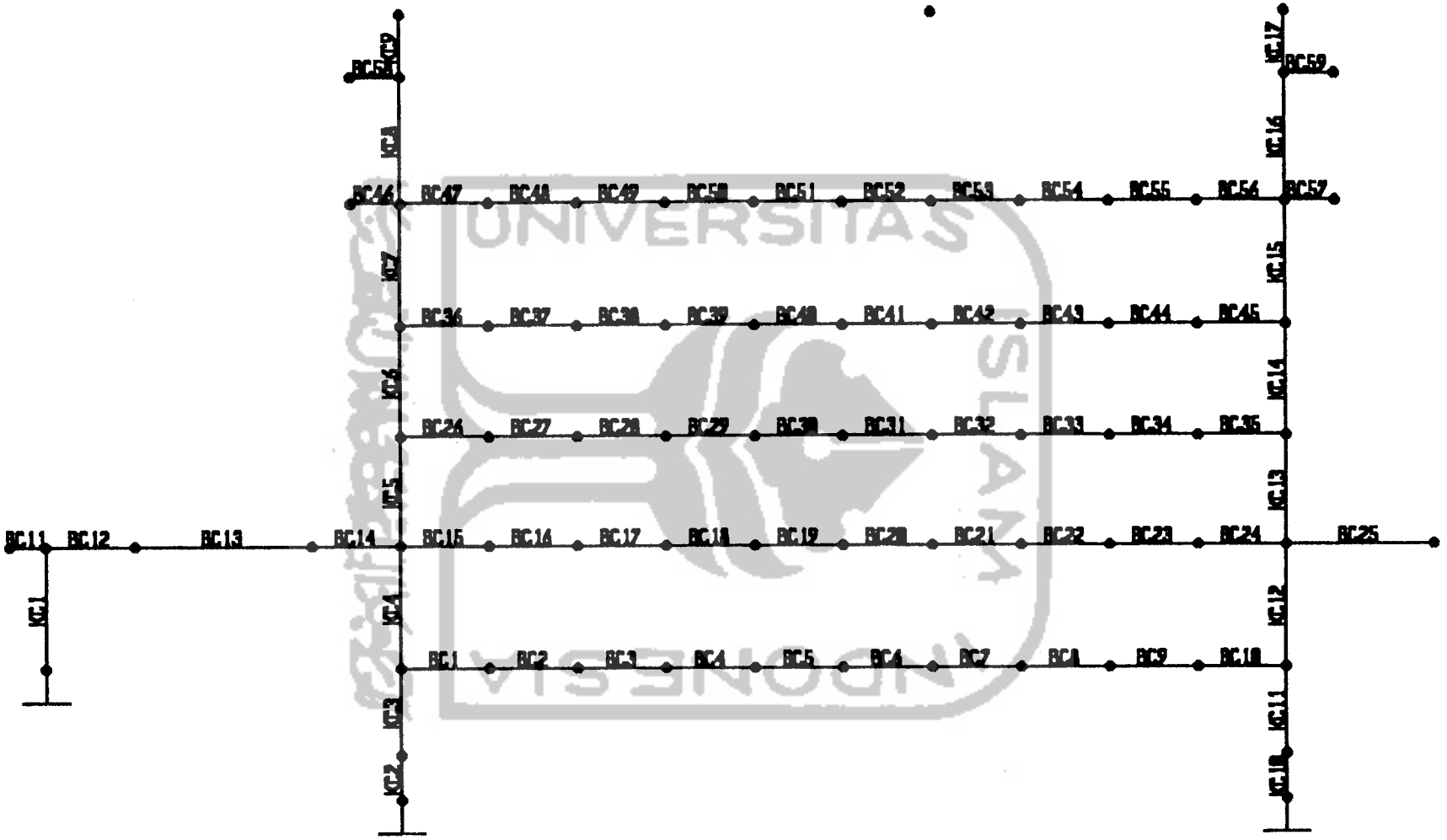
SAP2000 v7.50 - File:3dta - 3-D View - KN-m Units



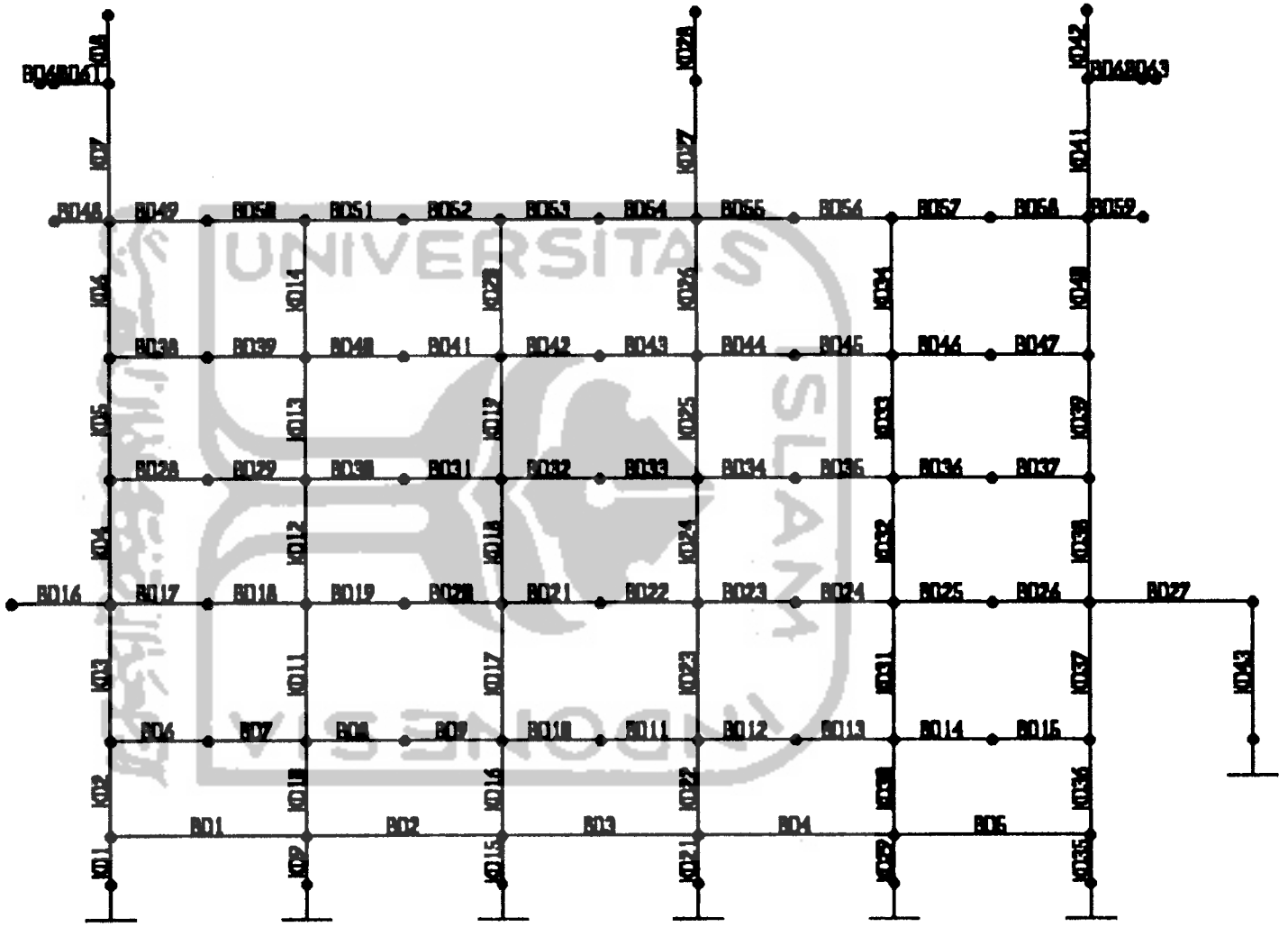
Portal B-A



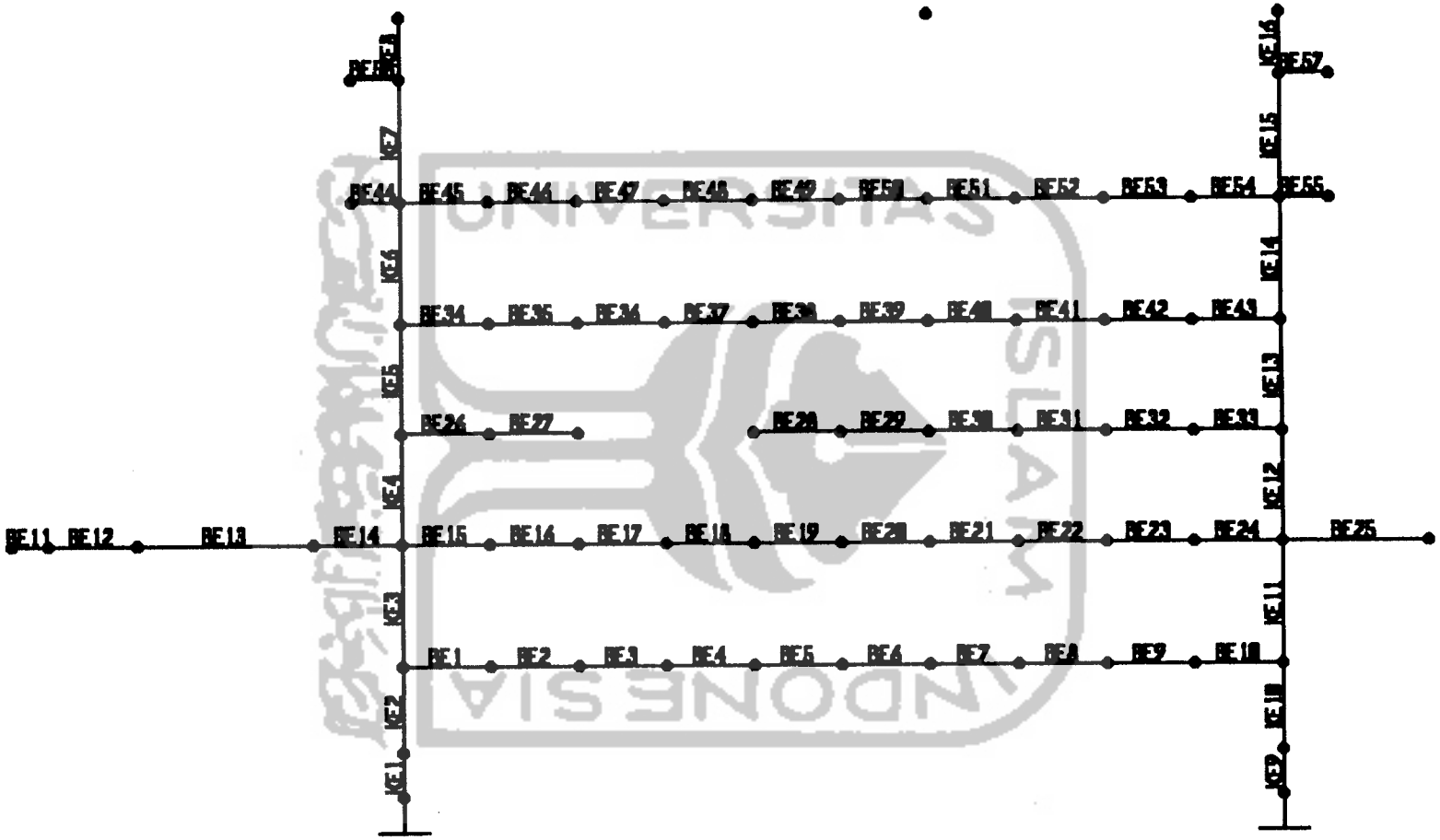
Portal B-B


BC11 BC12 BC13 BC14 BC15 BC16 BC17 BC18 BC19 BC20 BC21 BC22 BC23 BC24 BC25
BC1 BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9 BC10
BC26 BC27 BC28 BC29 BC30 BC31 BC32 BC33 BC34 BC35
BC36 BC37 BC38 BC39 BC40 BC41 BC42 BC43 BC44 BC45
BC46 BC47 BC48 BC49 BC50 BC51 BC52 BC53 BC54 BC55 BC56 BC57
BC58 BC59
KC1 KC2 KC3 KC4 KC5 KC6 KC7 KC8
KC9 KC10 KC11 KC12 KC13 KC14 KC15 KC16 KC17

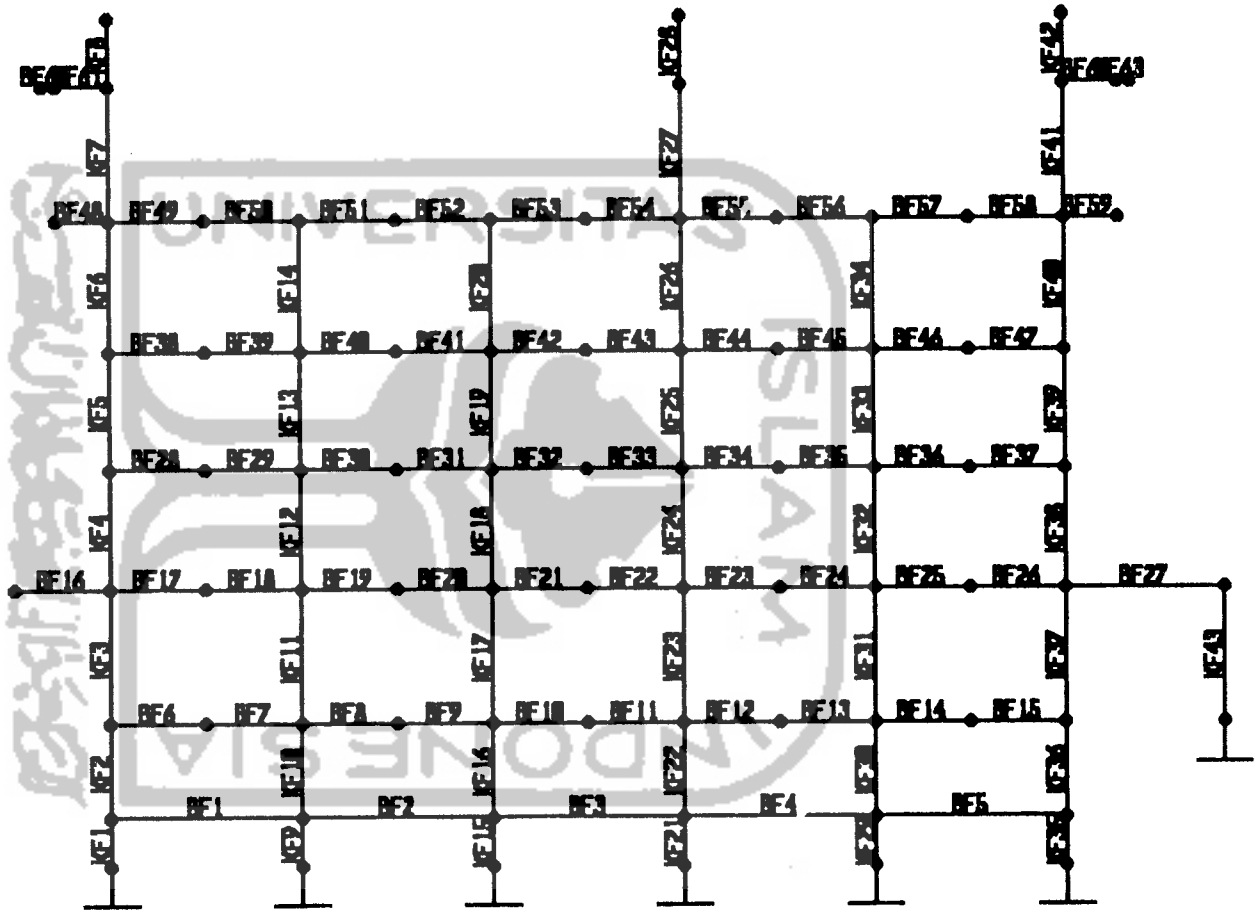
Portal B-C



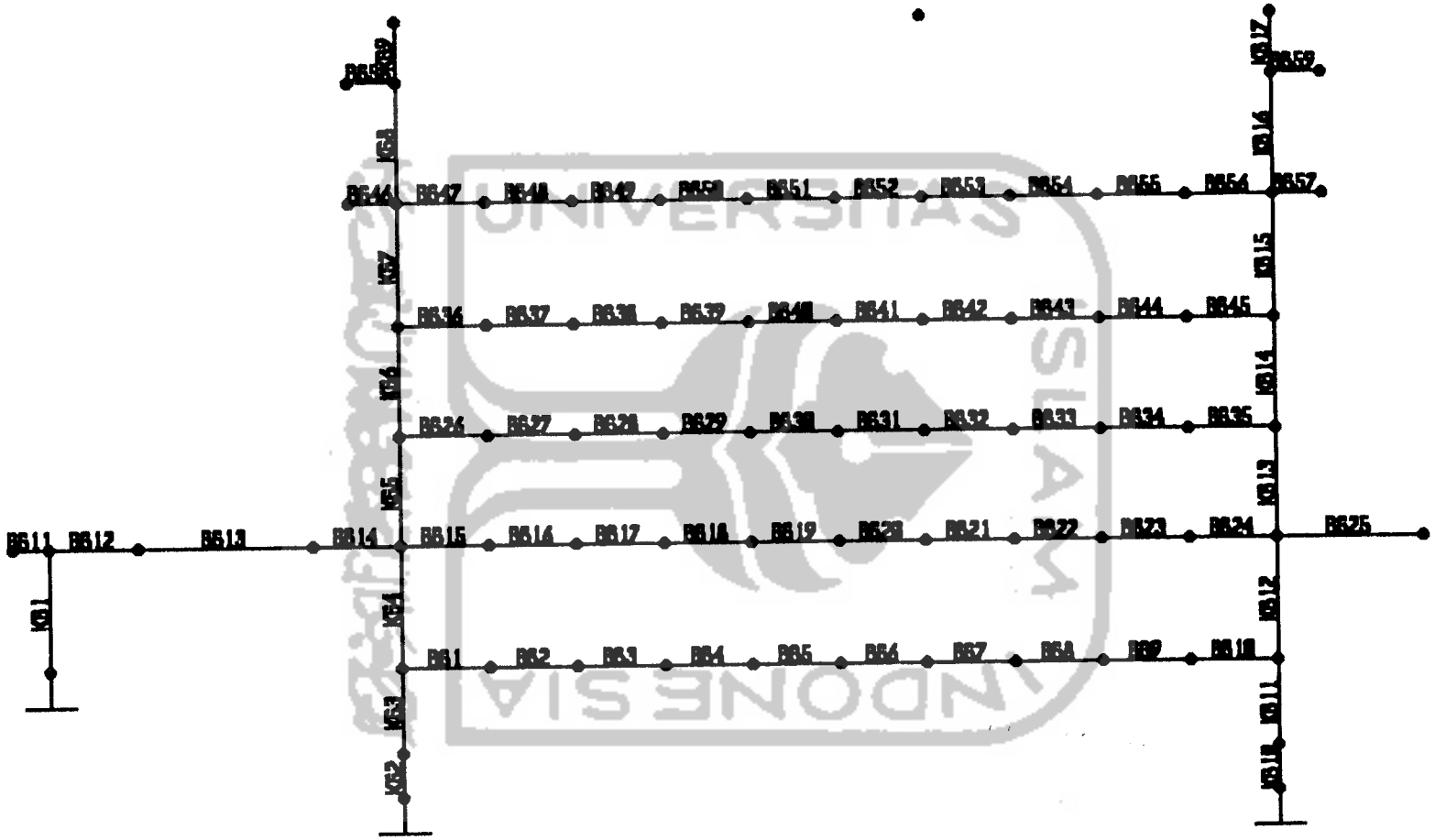
Portal B-D



Portal B-E



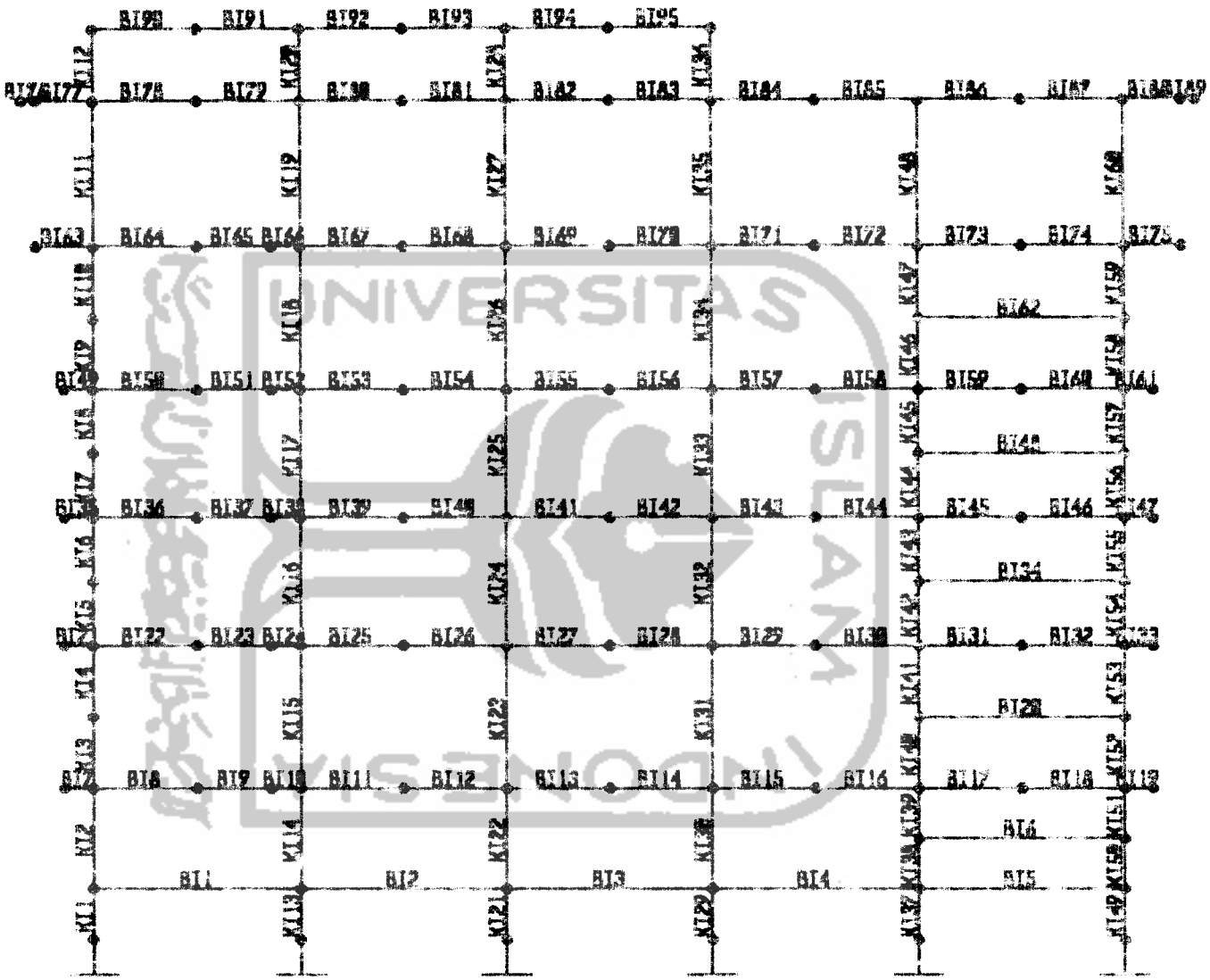
Portal B-F



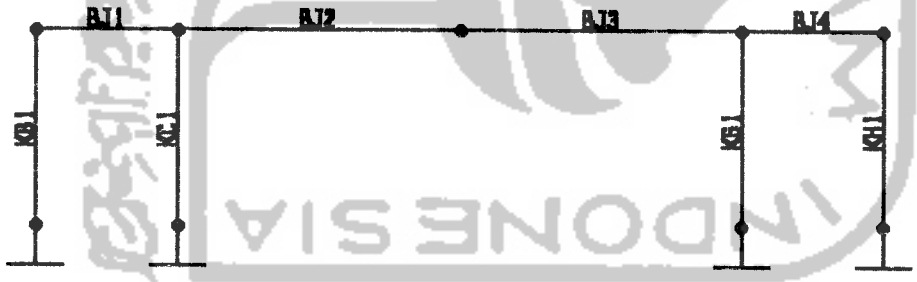
Portal B-G



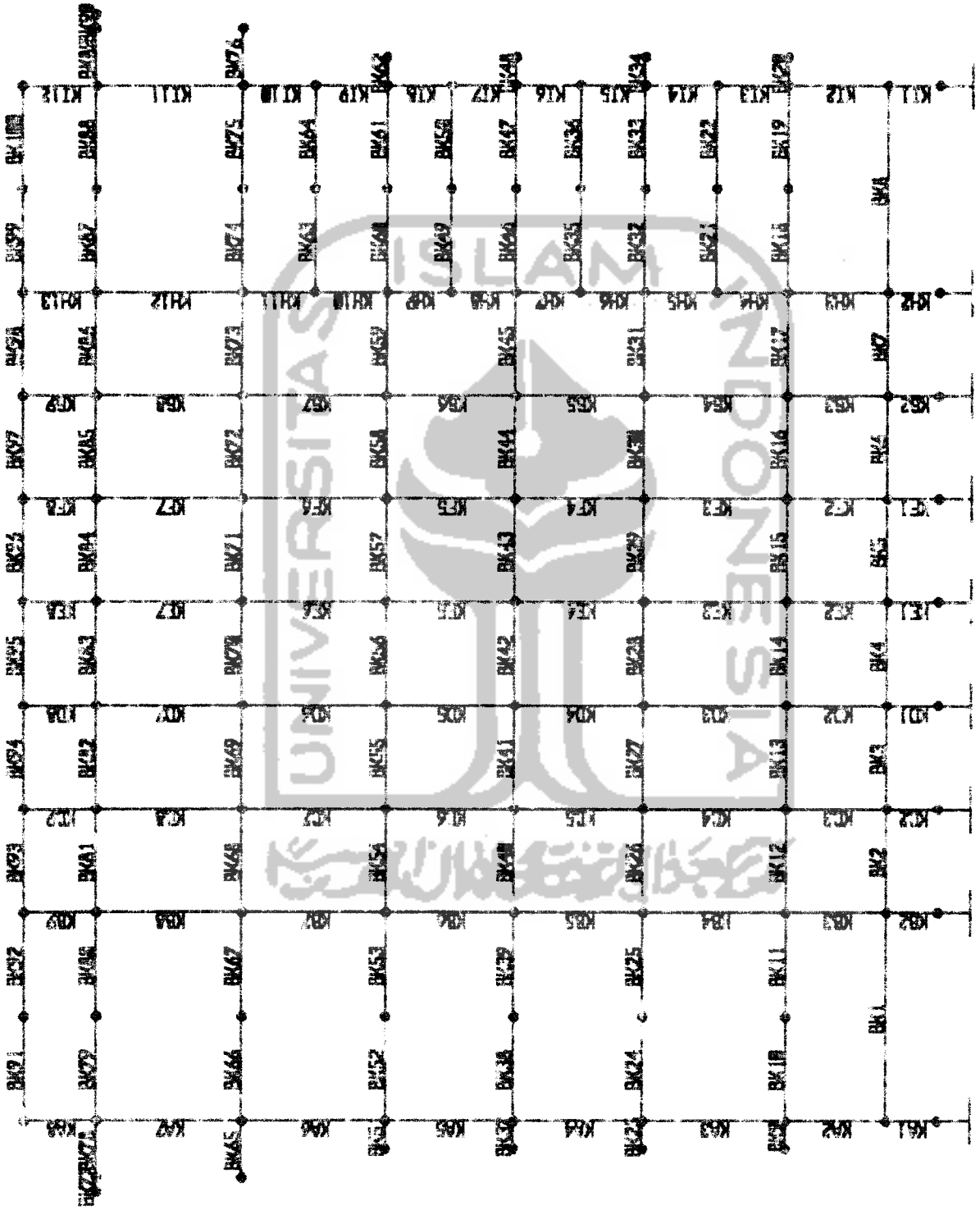
Lampiran Perhitungan 65



Portal B-I

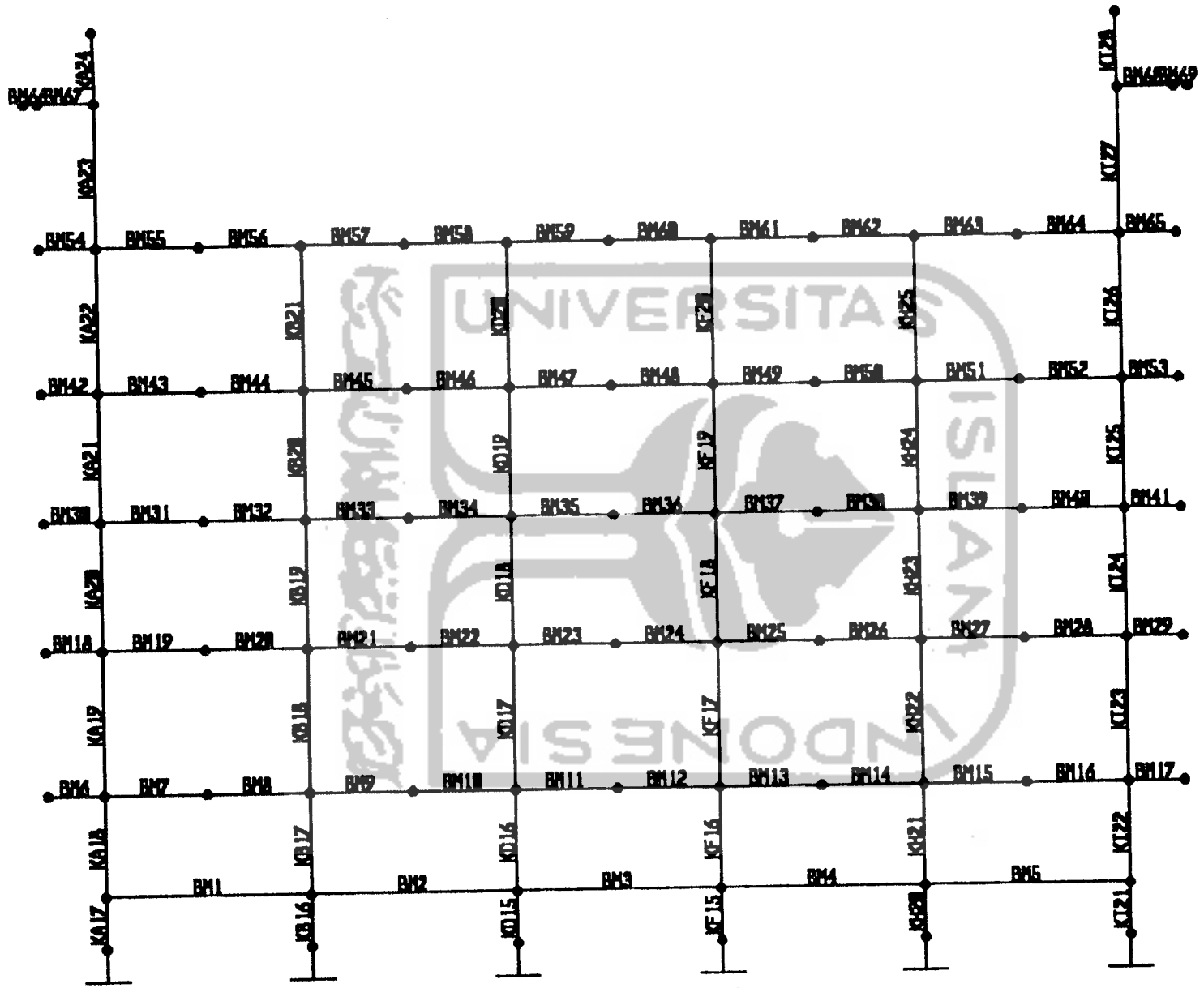



Portal B-J

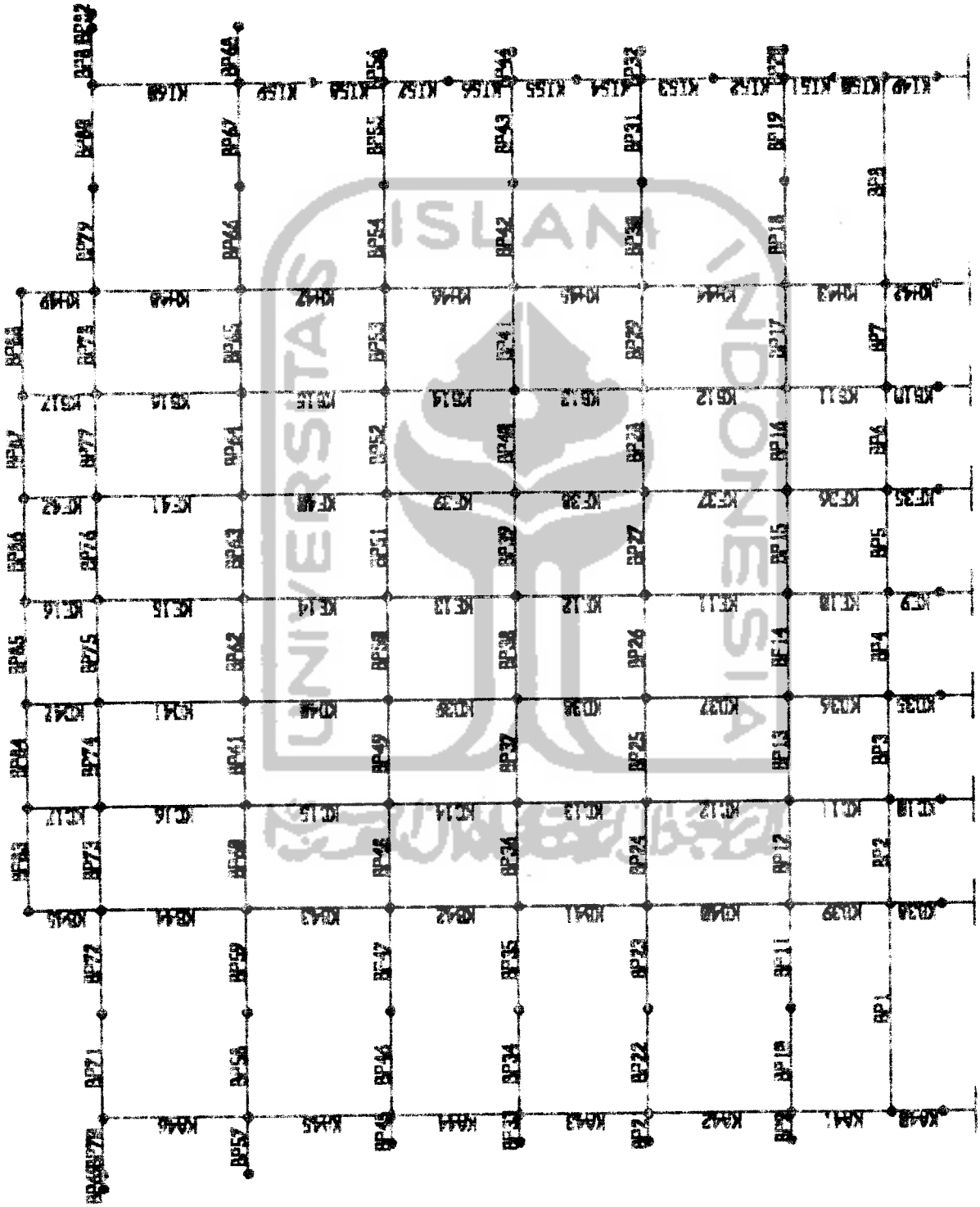


Portal B-K

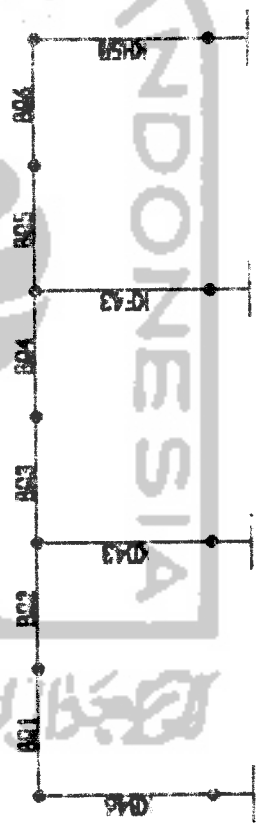
Portal B-L



Portal B-M



Portal B-P



Portal B-Q

SAP2000 v7.50 - File 3dtu - X-Z Plane @ Y=42 - KN-m Units

**PENULANGAN LENTUR BALOK ANAK PADA LANTAI DASAR (GF)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 339 | mm |
| Fy polos | = | 240 MPa | d' | = | 61 | mm |
| fc' | = | 25 MPa | d'/d | = | 0,180 | |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 | |
| diameter tul.pokok | = | 22 mm | pb | = | 0,027 | |
| diameter tul.pokok | = | 25 mm | ρ maks | = | 0,020 | |
| diameter sengkang | = | 10 mm | ρ min | = | 0,004 | |
| $\Phi_o$ | = | 1,25 | ρ pakai | = | 0,010 | |
| b | = | 300 mm | m | = | 18,824 | |
| h | = | 400 mm | Rn | = | 3,675 | MPa |
| Φ | = | 0,8 | β | = | 0,85 | |

**1.Perencanaan Tulangan Tumpuan**

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GBA 1-3 | 51,410 | 17484317,738 | Tul. sebelah | 1,864 | 0,005 | 524,022 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 4-6 | 44,430 | 15110450,050 | Tul. sebelah | 1,611 | 0,004 | 452,875 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 7-18 | 122,004 | 41493030,563 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 25,790 | 120,157 | 120,157 | 772,056 | 3 | 1140,401 | 3D22 | 1805,344 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| GBA 19 | 98,316 | 33436844,635 | Tul. sebelah | 3,565 | 0,010 | 1002,134 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| GBA 20-31 | 152,555 | 51883292,987 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 63,978 | 120,157 | 120,157 | 1915,304 | 6 | 2280,802 | 6D22 | 2948,592 | 6 | 2280,802 | 6D22 | 4 | 37,3 |
| GBA 32-41 | 148,028 | 50343679,947 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 58,320 | 120,157 | 120,157 | 1745,899 | 5 | 1900,668 | 5D22 | 2779,187 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| GBA 42 | 3,641 | 1238288,288 | Tul. sebelah | 0,132 | 0,000 | 37,113 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 43-55 (D25) | 177,509 | 60370040,017 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 95,171 | 120,157 | 120,157 | 2849,106 | 6 | 2945,250 | 6D25 | 3882,394 | 8 | 3927,000 | 8D25 | 4 | 33,3 |
| GBA 56 | 8,864 | 3014607,906 | Tul. sebelah | 0,321 | 0,001 | 90,351 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 57-66 | 139,860 | 47565778,618 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 48,110 | 120,157 | 120,157 | 1440,245 | 4 | 1520,534 | 4D22 | 2473,532 | 7 | 2660,935 | 7D22 | 4 | 37,3 |
| GBA 67-72 | 53,068 | 18048196,337 | Tul. sebelah | 1,924 | 0,005 | 540,922 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 73-74 | 35,719 | 12147876,780 | Tul. sebelah | 1,295 | 0,004 | 364,084 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 75-76 | 36,419 | 12385943,740 | Tul. sebelah | 1,320 | 0,004 | 371,219 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 77-79 | 52,308 | 17789723,638 | Tul. sebelah | 1,897 | 0,005 | 533,175 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 80-82 | 51,072 | 17369365,405 | Tul. sebelah | 1,852 | 0,005 | 520,577 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 83-94 | 114,437 | 38919526,725 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 16,331 | 120,157 | 120,157 | 488,891 | 2 | 760,267 | 2D22 | 1522,179 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| GBA 95-98 | 79,124 | 26909728,782 | Tul. sebelah | 2,869 | 0,008 | 806,510 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| GBA 99-111 | 153,651 | 52256037,827 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 65,348 | 120,157 | 120,157 | 1956,317 | 6 | 2280,802 | 6D22 | 2989,605 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| GBA 112-114 | 51,922 | 17658446,714 | Tul. sebelah | 1,883 | 0,005 | 529,241 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 115-117 | 56,309 | 19150446,362 | Tul. sebelah | 2,042 | 0,006 | 573,957 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 118-119 | 35,203 | 11972387,421 | Tul. sebelah | 1,276 | 0,004 | 358,824 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| GBA 120-121 | 36,053 | 12261468,730 | Tul. sebelah | 1,307 | 0,004 | 367,488 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Frame | Mu | bd² | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GBA 1-3 | 27.514 | 9357391.913 | Tul. sebelah | 0.998 | 0.003 | 280.450 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 4-6 | 28.843 | 9809379.041 | Tul. sebelah | 1.046 | 0.003 | 293.997 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 7-18 | 77.329 | 26299257.077 | Tul. sebelah | 2.804 | 0.008 | 788.214 | 3 | 1140.401 | 3D22 | 3 | 67.0 | | | | | | | | | | | | | | | |
| GBA 19 | 41.945 | 14265312.342 | Tul. sebelah | 1.521 | 0.004 | 427.545 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 20-31 | 48.053 | 16342616.616 | Tul. sebelah | 1.742 | 0.005 | 489.804 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 32-41 | 63.731 | 21674636.330 | Tul. sebelah | 2.311 | 0.006 | 649.610 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 42 | 26.104 | 8877857.036 | Tul. sebelah | 0.946 | 0.003 | 266.078 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 43-55 (D25) | 72.223 | 24562728.651 | Tul. sebelah | 2.619 | 0.007 | 736.169 | 2 | 981.750 | 2D25 | 2 | 150.0 | | | | | | | | | | | | | | | |
| GBA 56 | 22.198 | 7549443.399 | Tul. sebelah | 0.805 | 0.002 | 226.264 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 57-66 | 52.803 | 17958070.988 | Tul. sebelah | 1.914 | 0.005 | 538.221 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 67-72 | 29.019 | 9869235.877 | Tul. sebelah | 1.052 | 0.003 | 295.790 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 73-74 | 40.778 | 13868420.710 | Tul. sebelah | 1.478 | 0.004 | 415.650 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 75-76 | 40.893 | 13907531.711 | Tul. sebelah | 1.483 | 0.004 | 416.822 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 77-79 | 18.736 | 6372032.234 | Tul. sebelah | 0.679 | 0.002 | 190.976 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 80-82 | 15.521 | 5278624.696 | Tul. sebelah | 0.563 | 0.002 | 158.205 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 83-94 | 55.845 | 18992641.977 | Tul. sebelah | 2.025 | 0.006 | 569.228 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 95-98 | 39.277 | 13357937.129 | Tul. sebelah | 1.424 | 0.004 | 400.350 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 99-111 | 87.465 | 29746466.659 | Tul. sebelah | 3.171 | 0.009 | 891.530 | 3 | 1140.401 | 3D22 | 3 | 67.0 | | | | | | | | | | | | | | | |
| GBA 112-114 | 18.534 | 6303332.911 | Tul. sebelah | 0.672 | 0.002 | 188.917 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 115-117 | 19.089 | 6492066.001 | Tul. sebelah | 0.692 | 0.002 | 194.574 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 118-119 | 4.494 | 1528389.884 | Tul. sebelah | 0.163 | 0.000 | 45.807 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |
| GBA 120-121 | 42.703 | 14523104.850 | Tul. sebelah | 1.548 | 0.004 | 435.271 | 2 | 760.267 | 2D22 | 2 | 156.0 | | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6.5 m

Gaya Geser

| Frame | Daerah Sendi Plastis | | | | | | | | | | | | Kontrol : |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD | VL | VE | Vub1 | Vub2 | Vu b | Vc | Vs min | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | mm | mm | mm | tulangan | |
| GBA 1-3 | 41.77 | 2.842 | 6.701 | 54.7 | 74.987 | 54.671 | 84.750 | 33.900 | 91.11867 | 280.5 | 84.75 | 80 | P10-80 | AMAN |
| GBA 4-6 | 38.273 | 2.435 | 1.805 | 49.8 | 50.324 | 49.824 | 84.750 | 33.900 | 83.03933 | 307.8 | 84.75 | 80 | P10-80 | AMAN |
| GBA 7-18 | 55.865 | 23.949 | 3.633 | 105 | 99.063 | 99.063 | 84.750 | 33.900 | 165.1055 | 154.8 | 84.75 | 80 | P10-80 | AMAN |
| GBA 19 | 131.02 | 20.413 | 1.516 | 190 | 165.37 | 165.372 | 84.750 | 33.900 | 275.6198 | 92.74 | 84.75 | 80 | P10-80 | AMAN |
| GBA 20-31 | 64.049 | 26.331 | 2.534 | 119 | 105.54 | 105.542 | 84.750 | 33.900 | 175.903 | 145.3 | 84.75 | 80 | P10-80 | AMAN |
| GBA 32-41 | 72.514 | 27.268 | 2.38 | 131 | 114.77 | 114.767 | 84.750 | 33.900 | 191.2785 | 133.6 | 84.75 | 80 | P10-80 | AMAN |
| GBA 42 | 26.284 | 1.969 | 0.541 | 34.7 | 31.938 | 31.938 | 84.750 | 33.900 | 53.22975 | 480.2 | 84.75 | 80 | P10-80 | AMAN |
| GBA 43-55 | 90.772 | 26.436 | 3.136 | 151 | 136.24 | 136.240 | 84.750 | 33.900 | 227.066 | 112.6 | 84.75 | 80 | P10-80 | AMAN |
| GBA 56 | 27.24 | 2.007 | 1.425 | 35.9 | 36.694 | 35.899 | 84.750 | 33.900 | 59.832 | 427.2 | 84.75 | 80 | P10-80 | AMAN |
| GBA 57-66 | 70.859 | 27.141 | 4.016 | 128 | 119.77 | 119.767 | 84.750 | 33.900 | 199.612 | 128 | 84.75 | 80 | P10-80 | AMAN |
| GBA 67-72 | 41.592 | 4.528 | 8.768 | 57.2 | 85.252 | 57.155 | 84.750 | 33.900 | 95.25867 | 268.3 | 84.75 | 80 | P10-80 | AMAN |
| GBA 73-74 | 44.297 | 4.397 | 0.858 | 60.2 | 54.732 | 54.732 | 84.750 | 33.900 | 91.2205 | 280.2 | 84.75 | 80 | P10-80 | AMAN |
| GBA 75-76 | 44.177 | 4.518 | 1.205 | 60.2 | 56.191 | 56.191 | 84.750 | 33.900 | 93.65125 | 272.9 | 84.75 | 80 | P10-80 | AMAN |
| GBA 77-79 | 41.425 | 2.813 | 6.701 | 54.2 | 74.594 | 54.211 | 84.750 | 33.900 | 90.35133 | 282.9 | 84.75 | 80 | P10-80 | AMAN |
| GBA 80-82 | 41.984 | 4.599 | 2.001 | 57.7 | 57.316 | 57.316 | 84.750 | 33.900 | 95.52725 | 267.6 | 84.75 | 80 | P10-80 | AMAN |
| GBA 83-94 | 52.784 | 26.771 | 3.136 | 106 | 96.704 | 96.704 | 84.750 | 33.900 | 161.1733 | 158.6 | 84.75 | 80 | P10-80 | AMAN |
| GBA 95-98 | 58.817 | 8.5 | 5.657 | 84.2 | 94.442 | 84.180 | 84.750 | 33.900 | 140.3007 | 182.2 | 84.75 | 80 | P10-80 | AMAN |
| GBA 99-111 | 89.189 | 26.52 | 3.698 | 149 | 137.03 | 137.026 | 84.750 | 33.900 | 228.3768 | 111.9 | 84.75 | 80 | P10-80 | AMAN |
| GBA 112-114 | 39.166 | 0.303 | 3.433 | 47.5 | 55.861 | 47.484 | 84.750 | 33.900 | 79.14 | 323 | 84.75 | 80 | P10-80 | AMAN |
| GBA 115-117 | 39.812 | 0.256 | 8.768 | 48.2 | 78.897 | 48.184 | 84.750 | 33.900 | 80.30667 | 318.3 | 84.75 | 80 | P10-80 | AMAN |
| GBA 118-119 | 44.219 | 4.262 | 1.435 | 59.9 | 56.932 | 56.932 | 84.750 | 33.900 | 94.88675 | 269.4 | 84.75 | 80 | P10-80 | AMAN |
| GBA 120-121 | 45.398 | 4.484 | 1.113 | 61.7 | 57.051 | 57.051 | 84.750 | 33.900 | 95.0845 | 268.8 | 84.75 | 80 | P10-80 | AMAN |

| Frame | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| GBA 1-3 | 34,4849 | 84,750 | 33,900 | -27 | -937,12 | 169,5 | 165 | P10-165 | AMAN |
| GBA 4-6 | 31,4272 | 84,750 | 33,900 | -32 | -789,59 | 169,5 | 165 | P10-165 | AMAN |
| GBA 7-18 | 62,4861 | 84,750 | 33,900 | 19,4 | 1317,97 | 169,5 | 165 | P10-165 | AMAN |
| GBA 19 | 104,311 | 84,750 | 33,900 | 89,1 | 286,861 | 169,5 | 165 | P10-165 | AMAN |
| GBA 20-31 | 66,5725 | 84,750 | 33,900 | 26,2 | 975,418 | 169,5 | 165 | P10-165 | AMAN |
| GBA 32-41 | 72,3916 | 84,750 | 33,900 | 35,9 | 711,928 | 169,5 | 165 | P10-165 | AMAN |
| GBA 42 | 20,1454 | 84,750 | 33,900 | -51 | -499,47 | 169,5 | 165 | P10-165 | AMAN |
| GBA 43-55 | 85,9357 | 84,750 | 33,900 | 58,5 | 437,102 | 169,5 | 165 | P10-165 | AMAN |
| GBA 56 | 22,6441 | 84,750 | 33,900 | -47 | -543,72 | 169,5 | 165 | P10-165 | AMAN |
| GBA 57-66 | 75,5455 | 84,750 | 33,900 | 41,2 | 621,006 | 169,5 | 165 | P10-165 | AMAN |
| GBA 67-72 | 36,0517 | 84,750 | 33,900 | -25 | -1036,3 | 169,5 | 165 | P10-165 | AMAN |
| GBA 73-74 | 34,5235 | 84,750 | 33,900 | -27 | -939,33 | 169,5 | 165 | P10-165 | AMAN |
| GBA 75-76 | 35,4434 | 84,750 | 33,900 | -26 | -995,42 | 169,5 | 165 | P10-165 | AMAN |
| GBA 77-79 | 34,1945 | 84,750 | 33,900 | -28 | -920,78 | 169,5 | 165 | P10-165 | AMAN |
| GBA 80-82 | 36,1534 | 84,750 | 33,900 | -24 | -1043,5 | 169,5 | 165 | P10-165 | AMAN |
| GBA 83-94 | 60,9979 | 84,750 | 33,900 | 16,9 | 1511,26 | 169,5 | 165 | P10-165 | AMAN |
| GBA 95-98 | 53,0984 | 84,750 | 33,900 | 3,75 | 6820,85 | 169,5 | 165 | P10-165 | AMAN |
| GBA 99-111 | 86,4318 | 84,750 | 33,900 | 59,3 | 431,008 | 169,5 | 165 | P10-165 | AMAN |
| GBA 112-114 | 29,9514 | 84,750 | 33,900 | -35 | -733,83 | 169,5 | 165 | P10-165 | AMAN |
| GBA 115-117 | 30,393 | 84,750 | 33,900 | -34 | -749,67 | 169,5 | 165 | P10-165 | AMAN |
| GBA 118-119 | 35,911 | 84,750 | 33,900 | -25 | -1026,6 | 169,5 | 165 | P10-165 | AMAN |
| GBA 120-121 | 35,9858 | 84,750 | 33,900 | -25 | -1031,7 | 169,5 | 165 | P10-165 | AMAN |

**PENULANGAN LENTUR BALOK ANAK PADA LANTAI 1**

| | | | | | |
|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 339 mm |
| Fy polos | = | 240 MPa | d' | = | 61 mm |
| fc' | = | 25 MPa | d'/d | = | 0,180 |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 |
| diameter tul.pokok | = | 22 mm | pb | = | 0,027 |
| diameter sengkang | = | 10 mm | ρ maks | = | 0,020 |
| $\Phi_0$ | = | 1,25 | ρ min | = | 0,004 |
| b | = | 300 mm | ρ pakai | = | 0,010 |
| h | = | 400 mm | m | = | 18,824 |
| Φ | = | 0,8 | Rn | = | 3,675 MPa |
| β | = | 0,85 | | | |

**1.Perencanaan Tulangan Tumpuan**

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 1BA 1-4 | 86,846 | 29535947,447 | Tul. sebelah | 3,149 | 0,009 | 885,221 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 1BA 5-12 | 118,001 | 40131627,647 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 20,786 | 120,157 | 120,157 | 622,260 | 2 | 760,267 | 2D22 | 1655,548 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 1BA 13-22 | 61,814 | 21022672,955 | Tul. sebelah | 2,241 | 0,006 | 630,070 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 23-25 | 58,239 | 19806830,981 | Tul. sebelah | 2,112 | 0,006 | 593,630 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 26-28 | 44,152 | 15015903,457 | Tul. sebelah | 1,601 | 0,004 | 450,041 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 29-39 | 121,904 | 41459020,997 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 25,665 | 120,157 | 120,157 | 768,314 | 3 | 1140,401 | 3D22 | 1801,602 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 1BA 40 | 156,263 | 53144367,684 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 68,613 | 120,157 | 120,157 | 2054,061 | 6 | 2280,802 | 6D22 | 3087,348 | 9 | 3421,202 | 9D22 | 5 | 22,5 |
| 1BA 41-52 | 156,933 | 53372231,774 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 69,451 | 120,157 | 120,157 | 2079,133 | 6 | 2280,802 | 6D22 | 3112,420 | 9 | 3421,202 | 9D22 | 5 | 22,5 |
| 1BA 53-62 | 137,693 | 46828791,329 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 45,401 | 120,157 | 120,157 | 1359,153 | 4 | 1520,534 | 4D22 | 2392,441 | 7 | 2660,935 | 7D22 | 4 | 37,3 |
| 1BA 63 | 4,981 | 1694016,469 | Tul. sebelah | 0,181 | 0,000 | 50,771 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 64-76 | 167,470 | 56955819,714 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 82,622 | 120,157 | 120,157 | 2473,437 | 7 | 2660,935 | 7D22 | 3506,725 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 1BA 77 | 9,534 | 3242471,996 | Tul. sebelah | 0,346 | 0,001 | 97,180 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 78-87 | 108,635 | 36946291,722 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 9,078 | 120,157 | 120,157 | 271,775 | 2 | 760,267 | 2D22 | 1305,063 | 4 | 1520,534 | 4D22 | 4 | 37,3 |
| 1BA 88-90 | 60,012 | 20409820,581 | Tul. sebelah | 2,176 | 0,006 | 611,702 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 91-93 | 61,350 | 20864868,570 | Tul. sebelah | 2,224 | 0,006 | 625,340 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 94-95 | 32,601 | 11087458,521 | Tul. sebelah | 1,182 | 0,003 | 332,302 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 96-97 | 33,976 | 11555090,050 | Tul. sebelah | 1,232 | 0,003 | 346,317 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 98-100 | 59,647 | 20285685,666 | Tul. sebelah | 2,163 | 0,006 | 607,982 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 101-103 | 53,211 | 18096830,016 | Tul. sebelah | 1,929 | 0,005 | 542,379 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 104-115 | 121,149 | 41202248,776 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 24,721 | 120,157 | 120,157 | 740,061 | 2 | 760,267 | 2D22 | 1773,349 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 1BA 116 | 13,967 | 4750116,044 | Tul. sebelah | 0,506 | 0,001 | 142,366 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 117 | 20,049 | 6818577,832 | Tul. sebelah | 0,727 | 0,002 | 204,359 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 118 | 20,399 | 6937611,312 | Tul. sebelah | 0,740 | 0,002 | 207,927 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 119 | 14,427 | 4906560,047 | Tul. sebelah | 0,523 | 0,001 | 147,054 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 120-123 | 74,695 | 25403445,116 | Tul. sebelah | 2,708 | 0,007 | 761,366 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 1BA 124-136 | 171,964 | 58484209,598 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 88,240 | 120,157 | 120,157 | 2641,607 | 7 | 2660,935 | 7D22 | 3674,895 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 1BA 137-139 | 55,955 | 19030052,500 | Tul. sebelah | 2,029 | 0,006 | 570,349 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 140-142 | 56,253 | 19131401,005 | Tul. sebelah | 2,040 | 0,006 | 573,386 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 143-144 | 33,225 | 11299678,211 | Tul. sebelah | 1,205 | 0,003 | 338,662 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 145-146 | 32,999 | 11222816,593 | Tul. sebelah | 1,196 | 0,003 | 336,359 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

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**2.Perencanaan Tulangan Lapangan**

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 1BA 1-4 | 39,907 | 13572197,393 | Tul. sebelah | 1,447 | 0,004 | 406,772 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 5-12 | 59,178 | 20126180,803 | Tul. sebelah | 2,146 | 0,006 | 603,201 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 13-22 | 29,136 | 9909027,069 | Tul. sebelah | 1,056 | 0,003 | 296,983 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 23-25 | 23,310 | 7927629,770 | Tul. sebelah | 0,845 | 0,002 | 237,599 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 26-28 | 21,050 | 7159013,584 | Tul. sebelah | 0,763 | 0,002 | 214,563 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 29-39 | 54,977 | 18697438,947 | Tul. sebelah | 1,993 | 0,006 | 560,380 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 40 | 66,529 | 22626223,979 | Tul. sebelah | 2,412 | 0,007 | 678,130 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 41-52 | 49,220 | 16739508,248 | Tul. sebelah | 1,785 | 0,005 | 501,699 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 53-62 | 60,721 | 20650948,402 | Tul. sebelah | 2,202 | 0,006 | 618,929 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 63 | 24,630 | 8376556,037 | Tul. sebelah | 0,893 | 0,002 | 251,053 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 64-76 | 68,086 | 23155752,917 | Tul. sebelah | 2,469 | 0,007 | 694,000 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 77 | 21,382 | 7271925,343 | Tul. sebelah | 0,775 | 0,002 | 217,947 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 78-87 | 55,532 | 18886192,037 | Tul. sebelah | 2,013 | 0,006 | 566,037 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 88-90 | 26,125 | 8884999,045 | Tul. sebelah | 0,947 | 0,003 | 266,292 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 91-93 | 26,383 | 8972743,724 | Tul. sebelah | 0,957 | 0,003 | 268,922 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 94-95 | 36,645 | 12462805,359 | Tul. sebelah | 1,329 | 0,004 | 373,522 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 96-97 | 38,269 | 13015120,706 | Tul. sebelah | 1,388 | 0,004 | 390,076 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 98-100 | 20,587 | 7001549,295 | Tul. sebelah | 0,746 | 0,002 | 209,843 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 101-103 | 20,225 | 6878434,667 | Tul. sebelah | 0,733 | 0,002 | 206,153 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 104-115 | 57,562 | 19576586,221 | Tul. sebelah | 2,087 | 0,006 | 586,729 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 116 | 52,944 | 18006024,476 | Tul. sebelah | 1,920 | 0,005 | 539,658 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 117 | 51,716 | 17588387,009 | Tul. sebelah | 1,875 | 0,005 | 527,141 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 118 | 51,763 | 17604371,505 | Tul. sebelah | 1,877 | 0,005 | 527,620 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 119 | 53,001 | 18025409,928 | Tul. sebelah | 1,922 | 0,005 | 540,239 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 120-123 | 35,977 | 12235621,460 | Tul. sebelah | 1,304 | 0,004 | 366,713 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 124-136 | 86,072 | 29272713,408 | Tul. sebelah | 3,121 | 0,009 | 877,331 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 1BA 137-139 | 16,865 | 5735713,259 | Tul. sebelah | 0,611 | 0,002 | 171,905 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 140-142 | 20,959 | 7128064,880 | Tul. sebelah | 0,760 | 0,002 | 213,635 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 143-144 | 41,942 | 14264292,055 | Tul. sebelah | 1,521 | 0,004 | 427,515 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 1BA 145-146 | 39,623 | 13475610,226 | Tul. sebelah | 1,437 | 0,004 | 403,877 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6,5 m

Gaya Geser

| Lantai | Daerah Sendi Plastis | | | | | | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD Kn | VL Kn | VE Kn | Vub1 Kn | Vub2 Kn | Vu b Kn | Vc | Vs min mm^2 | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| 1BA 1-4 | 30,631 | 4,206 | 6,282 | 43,487 | 62,963 | 43,487 | 84,750 | 33,900 | 72,478 | 352,660 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 5-12 | 57,583 | 9,520 | 3,909 | 84,332 | 86,876 | 150,000 | 84,750 | 33,900 | 250,000 | 102,240 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 13-22 | 37,805 | 5,917 | 7,350 | 54,833 | 76,778 | 200,000 | 84,750 | 33,900 | 333,333 | 76,680 | 84,8 | 75 | P10-75 | AMAN |
| 1BA 23-25 | 39,453 | 4,653 | 10,208 | 54,788 | 89,185 | 120,000 | 84,750 | 33,900 | 200,000 | 127,800 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 26-28 | 36,438 | 3,669 | 3,699 | 49,596 | 57,648 | 110,000 | 84,750 | 33,900 | 183,333 | 139,418 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 29-39 | 46,262 | 26,478 | 5,597 | 97,879 | 99,884 | 140,000 | 84,750 | 33,900 | 233,333 | 109,543 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 40 | 157,420 | 28,567 | 3,012 | 234,611 | 207,937 | 112,000 | 84,750 | 33,900 | 186,667 | 136,929 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 41-52 | 62,840 | 25,916 | 3,544 | 116,874 | 108,079 | 100,000 | 84,750 | 33,900 | 166,667 | 153,360 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 53-62 | 68,107 | 26,548 | 3,225 | 124,205 | 112,933 | 101,000 | 84,750 | 33,900 | 168,333 | 151,842 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 63 | 24,524 | 1,935 | 0,767 | 32,525 | 31,003 | 102,000 | 84,750 | 33,900 | 170,000 | 150,353 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 64-76 | 85,062 | 25,899 | 4,149 | 143,513 | 133,935 | 103,000 | 84,750 | 33,900 | 171,667 | 148,894 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 77 | 25,193 | 1,913 | 1,858 | 33,292 | 36,265 | 104,000 | 84,750 | 33,900 | 173,333 | 147,462 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 78-87 | 46,188 | 26,540 | 6,712 | 97,890 | 104,555 | 105,000 | 84,750 | 33,900 | 175,000 | 146,057 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 88-90 | 39,814 | 4,671 | 5,985 | 55,250 | 71,846 | 106,000 | 84,750 | 33,900 | 176,667 | 144,680 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 91-93 | 37,961 | 0,232 | 11,634 | 45,924 | 88,965 | 107,000 | 84,750 | 33,900 | 178,333 | 143,327 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 94-95 | 40,033 | 4,304 | 1,256 | 54,926 | 51,829 | 108,000 | 84,750 | 33,900 | 180,000 | 142,000 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 96-97 | 41,425 | 4,315 | 1,702 | 56,614 | 55,175 | 109,000 | 84,750 | 33,900 | 181,667 | 140,698 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 98-100 | 39,350 | 4,536 | 10,208 | 54,478 | 88,954 | 110,000 | 84,750 | 33,900 | 183,333 | 139,418 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 101-103 | 39,173 | 4,526 | 3,132 | 54,249 | 59,038 | 111,000 | 84,750 | 33,900 | 185,000 | 138,162 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 104-115 | 43,923 | 27,604 | 3,785 | 96,874 | 91,000 | 112,000 | 84,750 | 33,900 | 186,667 | 136,929 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 116 | 21,536 | 3,188 | 1,120 | 30,944 | 30,664 | 113,000 | 84,750 | 33,900 | 188,333 | 135,717 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 117 | 22,931 | 3,397 | 0,752 | 32,952 | 30,803 | 114,000 | 84,750 | 33,900 | 190,000 | 134,527 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 118 | 22,913 | 3,394 | 0,864 | 32,926 | 31,251 | 115,000 | 84,750 | 33,900 | 191,667 | 133,357 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 119 | 21,494 | 3,183 | 1,349 | 30,886 | 31,577 | 116,000 | 84,750 | 33,900 | 193,333 | 132,207 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 120-123 | 55,658 | 6,533 | 7,256 | 77,242 | 95,776 | 117,000 | 84,750 | 33,900 | 195,000 | 131,077 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 124-136 | 149,963 | 31,923 | 4,700 | 231,032 | 210,720 | 118,000 | 84,750 | 33,900 | 196,667 | 129,966 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 137-139 | 35,249 | 0,156 | 4,753 | 42,548 | 57,138 | 119,000 | 84,750 | 33,900 | 198,333 | 128,874 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 140-142 | 36,272 | 0,260 | 11,634 | 43,942 | 87,221 | 120,000 | 84,750 | 33,900 | 200,000 | 127,800 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 143-144 | 41,181 | 6,411 | 1,880 | 59,675 | 57,868 | 121,000 | 84,750 | 33,900 | 201,667 | 126,744 | 84,8 | 80 | P10-80 | AMAN |
| 1BA 145-146 | 42,121 | 4,446 | 1,440 | 57,659 | 54,943 | 122,000 | 84,750 | 33,900 | 203,333 | 125,705 | 84,8 | 80 | P10-80 | AMAN |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1BA 67-69 | 33,786 | 11490 | 64,969 | 84,750 | 33,900 | 20,3782 | 774,7 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 70-71 | 33,801 | 1149 | 65,600 | 84,750 | 33,900 | 21,4295 | 1254,3 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 72-73 | 62,170 | 211 | 66,231 | 84,750 | 33,900 | 22,4808 | 1192,8 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 74-76 | 56,826 | 19 | 66,862 | 84,750 | 33,900 | 23,5321 | 1137 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 77-79 | 117,275 | 3 | 67,492 | 84,750 | 33,900 | 24,5833 | 1086,2 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 80-91 | 73,976 | | 68,123 | 84,750 | 33,900 | 25,6346 | 1039,7 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 92-95 | 167,233 | | 68,754 | 84,750 | 33,900 | 26,6859 | 997,09 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 96-108 | 57,230 | | 69,385 | 84,750 | 33,900 | 27,7372 | 957,81 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 109-111 | 56,064 | | 70,015 | 84,750 | 33,900 | 28,7885 | 921,51 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 112-114 | 32,86 | | 70,646 | 84,750 | 33,900 | 29,8397 | 887,86 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 115-116 | 32,8 | | 71,277 | 84,750 | 33,900 | 30,891 | 856,58 | 169,5 | 165 | P10-165 | AMAN | | |
| 1BA 117-118 | | | 71,908 | 84,750 | 33,900 | 31,9423 | 827,43 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 72,538 | 84,750 | 33,900 | 32,9936 | 800,19 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 73,169 | 84,750 | 33,900 | 34,0449 | 774,7 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 73,800 | 84,750 | 33,900 | 35,0962 | 750,78 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 74,431 | 84,750 | 33,900 | 36,1474 | 728,29 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 75,062 | 84,750 | 33,900 | 37,1987 | 707,11 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 75,692 | 84,750 | 33,900 | 38,25 | 687,12 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 76,323 | 84,750 | 33,900 | 39,3013 | 668,24 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | 76,954 | 84,750 | 33,900 | 40,3526 | 650,36 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | | | 33,900 | 41,4038 | 633,42 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | | | 33,900 | 42,4551 | 617,34 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | | | 33,900 | 43,5064 | 602,05 | 169,5 | 165 | P10-165 | AMAN | | |
| | | | | | | | 587,5 | 169,5 | 165 | P10-165 | AMAN | | |

2.Perencanaan Tulang

| Frame |
|---|
| 2BA 1-3 |
| 2BA 4-6 |
| 2BA 7-17 |
| 2BA 18 |
| 2BA 19-23 |
| 2BA 24-28 |
| 2BA 29-38 |
| 2BA 39 |
| 2BA 40 |
| 2BA 5 |
| 2BA |
| 2BA |
| 2B |
| 2 |

UNIVERSITAS ISLAM INDONESIA

| Lantai | Daerah Luar Sendi Plastis | | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Vu b/φ<Vc+Vs |
| 1BA 1-4 | 27,430 | 84,750 | 33,900 | -39,0331 | -654,83 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 5-12 | 94,615 | 84,750 | 33,900 | 72,9423 | 350,41 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 13-22 | 126,154 | 84,750 | 33,900 | 125,506 | 203,66 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 23-25 | 75,692 | 84,750 | 33,900 | 41,4038 | 617,34 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 26-28 | 69,385 | 84,750 | 33,900 | 30,891 | 827,43 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 29-39 | 88,308 | 84,750 | 33,900 | 62,4295 | 409,42 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 40 | 70,646 | 84,750 | 33,900 | 32,9936 | 774,7 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 41-52 | 63,077 | 84,750 | 33,900 | 20,3782 | 1254,3 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 53-62 | 63,708 | 84,750 | 33,900 | 21,4295 | 1192,8 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 63 | 64,338 | 84,750 | 33,900 | 22,4808 | 1137 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 64-76 | 64,969 | 84,750 | 33,900 | 23,5321 | 1086,2 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 77 | 65,600 | 84,750 | 33,900 | 24,5833 | 1039,7 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 78-87 | 66,231 | 84,750 | 33,900 | 25,6346 | 997,09 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 88-90 | 66,862 | 84,750 | 33,900 | 26,6859 | 957,81 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 91-93 | 67,492 | 84,750 | 33,900 | 27,7372 | 921,51 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 94-95 | 68,123 | 84,750 | 33,900 | 28,7885 | 887,86 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 96-97 | 68,754 | 84,750 | 33,900 | 29,8397 | 856,58 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 98-100 | 69,385 | 84,750 | 33,900 | 30,891 | 827,43 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 101-103 | 70,015 | 84,750 | 33,900 | 31,9423 | 800,19 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 104-115 | 70,646 | 84,750 | 33,900 | 32,9936 | 774,7 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 116 | 71,277 | 84,750 | 33,900 | 34,0449 | 750,78 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 117 | 71,908 | 84,750 | 33,900 | 35,0962 | 728,29 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 118 | 72,538 | 84,750 | 33,900 | 36,1474 | 707,11 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 119 | 73,169 | 84,750 | 33,900 | 37,1987 | 687,12 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 120-123 | 73,800 | 84,750 | 33,900 | 38,25 | 668,24 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 124-136 | 74,431 | 84,750 | 33,900 | 39,3013 | 650,36 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 137-139 | 75,062 | 84,750 | 33,900 | 40,3526 | 633,42 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 140-142 | 75,692 | 84,750 | 33,900 | 41,4038 | 617,34 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 143-144 | 76,323 | 84,750 | 33,900 | 42,4551 | 602,05 | 169,5 | 165 | P10-165 | AMAN |
| 1BA 145-146 | 76,954 | 84,750 | 33,900 | 43,5064 | 587,5 | 169,5 | 165 | P10-165 | AMAN |

## PENULANGAN LENTUR BALOK ANAK PADA LANTAI 2

| | | | | | |
|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 339 mm |
| Fy polos | = | 240 MPa | d' | = | 61 mm |
| fc' | = | 25 MPa | d'/d | = | 0,180 |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 |
| diameter tul.pokok | = | 22 mm | pb | = | 0,027 |
| diameter sengkang | = | 10 mm | ρ maks | = | 0,020 |
| $\Phi_0$ | = | 1,25 | ρ min | = | 0,004 |
| b | = | 300 mm | ρ pakai | = | 0,010 |
| h | = | 400 mm | m | = | 18,824 |
| Φ | = | 0,8 | Rn | = | 3,675 MPa |
| β | = | 0,85 | | | |

### 1.Perencanaan Tulangan Tumpuan

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | KNm | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 2BA 1-3 | 59,598 | 20269020,979 | Tul. sebelah | 2,161 | 0,006 | 607,482 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 4-6 | 45,674 | 15533529,048 | Tul. sebelah | 1,656 | 0,005 | 465,555 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 7-17 | 125,356 | 42633031,206 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 29,980 | 120,157 | 120,157 | 897,491 | 3 | 1140,401 | 3D22 | 1930,779 | 6 | 2280,802 | 6D22 | 3 | 67,0 |
| 2BA 18 | 148,918 | 50646365,082 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 59,432 | 120,157 | 120,157 | 1779,204 | 5 | 1900,668 | 5D22 | 2812,491 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| 2BA 19-23 | 147,017 | 49999843,237 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 57,056 | 120,157 | 120,157 | 1708,066 | 5 | 1900,668 | 5D22 | 2741,354 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| 2BA 24-28 | 156,808 | 53329719,817 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 69,295 | 120,157 | 120,157 | 2074,455 | 6 | 2280,802 | 6D22 | 3107,743 | 9 | 3421,202 | 9D22 | 5 | 22,5 |
| 2BA 29-38 | 137,385 | 46724041,867 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 45,016 | 120,157 | 120,157 | 1347,628 | 4 | 1520,534 | 4D22 | 2380,916 | 7 | 2660,935 | 7D22 | 4 | 37,3 |
| 2BA 39 | 4,573 | 1555257,440 | Tul. sebelah | 0,166 | 0,000 | 46,613 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 40-52 | 167,784 | 57062609,751 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 83,015 | 120,157 | 120,157 | 2485,187 | 7 | 2660,935 | 7D22 | 3518,475 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 2BA 53 | 9,411 | 3200640,230 | Tul. sebelah | 0,341 | 0,001 | 95,926 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 54-63 | 113,691 | 38665815,365 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 15,398 | 120,157 | 120,157 | 460,975 | 2 | 760,267 | 2D22 | 1494,263 | 4 | 1520,534 | 4D22 | 4 | 37,3 |
| 2BA 64-66 | 51,357 | 17466292,668 | Tul. sebelah | 1,862 | 0,005 | 523,482 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 67-69 | 60,132 | 20450632,060 | Tul. sebelah | 2,180 | 0,006 | 612,925 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 70-71 | 33,786 | 11490471,875 | Tul. sebelah | 1,225 | 0,003 | 344,381 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 72-73 | 33,801 | 11495573,310 | Tul. sebelah | 1,226 | 0,003 | 344,533 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 74-76 | 62,170 | 21143747,009 | Tul. sebelah | 2,254 | 0,006 | 633,698 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 77-79 | 56,826 | 19326275,817 | Tul. sebelah | 2,060 | 0,006 | 579,227 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 80-91 | 117,275 | 39884718,200 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 19,878 | 120,157 | 120,157 | 595,092 | 2 | 760,267 | 2D22 | 1628,380 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 2BA 92-95 | 73,976 | 25158916,338 | Tul. sebelah | 2,682 | 0,007 | 754,037 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 96-108 | 167,233 | 56875217,043 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 82,326 | 120,157 | 120,157 | 2464,569 | 7 | 2660,935 | 7D22 | 3497,856 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 2BA 109-111 | 57,230 | 19463674,463 | Tul. sebelah | 2,075 | 0,006 | 583,345 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 112-114 | 56,064 | 19067122,926 | Tul. sebelah | 2,033 | 0,006 | 571,460 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 115-116 | 32,869 | 11178604,157 | Tul. sebelah | 1,192 | 0,003 | 335,034 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 117-118 | 32,862 | 11176223,487 | Tul. sebelah | 1,191 | 0,003 | 334,962 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | KNm | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 2BA 1-3 | 28,014 | 9527439,741 | Tul. sebelah | 1,016 | 0,003 | 285,547 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 4-6 | 26,979 | 9175440,736 | Tul. sebelah | 0,978 | 0,003 | 274,997 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 7-17 | 53,982 | 18359043,768 | Tul. sebelah | 1,957 | 0,005 | 550,238 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 18 | 62,762 | 21345083,638 | Tul. sebelah | 2,276 | 0,006 | 639,733 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 19-23 | 65,315 | 22213347,851 | Tul. sebelah | 2,368 | 0,007 | 665,755 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 24-28 | 56,505 | 19217105,111 | Tul. sebelah | 2,049 | 0,006 | 575,955 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 29-38 | 61,680 | 20977100,137 | Tul. sebelah | 2,236 | 0,006 | 628,704 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 39 | 25,062 | 8523477,361 | Tul. sebelah | 0,909 | 0,003 | 255,457 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 40-52 | 68,297 | 23227513,101 | Tul. sebelah | 2,476 | 0,007 | 696,151 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 53 | 21,398 | 7277366,873 | Tul. sebelah | 0,776 | 0,002 | 218,110 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 54-63 | 54,425 | 18509706,144 | Tul. sebelah | 1,973 | 0,005 | 554,754 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 64-66 | 26,610 | 9049945,439 | Tul. sebelah | 0,965 | 0,003 | 271,236 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 67-69 | 25,561 | 8693185,094 | Tul. sebelah | 0,927 | 0,003 | 260,543 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 70-71 | 38,593 | 13125311,699 | Tul. sebelah | 1,399 | 0,004 | 393,378 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 72-73 | 38,416 | 13065114,768 | Tul. sebelah | 1,393 | 0,004 | 391,574 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 74-76 | 21,544 | 7327020,839 | Tul. sebelah | 0,781 | 0,002 | 219,598 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 77-79 | 20,985 | 7136907,367 | Tul. sebelah | 0,761 | 0,002 | 213,900 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 80-91 | 53,952 | 18348840,898 | Tul. sebelah | 1,956 | 0,005 | 549,932 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 92-95 | 36,135 | 12289356,574 | Tul. sebelah | 1,310 | 0,004 | 368,324 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 96-108 | 85,906 | 29216257,529 | Tul. sebelah | 3,115 | 0,009 | 875,639 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | |
| 2BA 109-111 | 17,625 | 5994185,958 | Tul. sebelah | 0,639 | 0,002 | 179,652 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 112-114 | 20,866 | 7096435,984 | Tul. sebelah | 0,757 | 0,002 | 212,687 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 115-116 | 41,849 | 14232663,159 | Tul. sebelah | 1,517 | 0,004 | 426,567 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| 2BA 117-118 | 39,463 | 13421194,921 | Tul. sebelah | 1,431 | 0,004 | 402,246 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6.5 m

Gaya Geser

| Frame | Daerah Sendi Plastis | | | | | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD | VL | VE | Vub1 | Vub2 | Vu b | Vc | Vs min | Vs | S | d/4 | S pakai | Digunakan tulangan | |
| | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | mm | mm | mm | | |
| 2BA 1-3 | 39.089 | 4.611 | 11.307 | 54.284 | 93.374 | 54.284 | 84.750 | 33.900 | 90.474 | 282.513 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 4-6 | 33.322 | 3.333 | 3.509 | 45.319 | 53.226 | 45.319 | 84.750 | 33.900 | 75.532 | 338.400 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 7-17 | 46.367 | 26.86 | 6.061 | 98.616 | 102.345 | 98.616 | 84.750 | 33.900 | 164.361 | 155.512 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 18 | 152.136 | 27.851 | 3.3 | 227.125 | 202.846 | 202.846 | 84.750 | 33.900 | 338.077 | 75.604 | 84.75 | 75 | P10-75 | AMAN |
| 2BA 19-23 | 60.241 | 27.006 | 3.655 | 115.499 | 106.960 | 106.960 | 84.750 | 33.900 | 178.267 | 143.381 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 24-28 | 60.676 | 27.022 | 3.744 | 116.046 | 107.808 | 107.808 | 84.750 | 33.900 | 179.680 | 142.254 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 29-38 | 68.614 | 26.271 | 3.354 | 124.370 | 113.716 | 113.716 | 84.750 | 33.900 | 189.527 | 134.863 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 39 | 24.478 | 1.897 | 0.748 | 32.409 | 30.835 | 30.835 | 84.750 | 33.900 | 51.392 | 497.352 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 40-52 | 85.322 | 26.349 | 4.154 | 144.545 | 134.701 | 134.701 | 84.750 | 33.900 | 224.502 | 113.852 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 53 | 25.134 | 1.921 | 1.863 | 33.234 | 36.232 | 33.234 | 84.750 | 33.900 | 55.391 | 461.451 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 54-63 | 62.372 | 26.909 | 5.185 | 117.901 | 115.522 | 115.522 | 84.750 | 33.900 | 192.537 | 132.754 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 64-66 | 38.164 | 4.445 | 3.779 | 52.909 | 60.611 | 52.909 | 84.750 | 33.900 | 88.181 | 289.858 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 67-69 | 38.12 | 0.274 | 10.795 | 46.182 | 85.653 | 46.182 | 84.750 | 33.900 | 76.971 | 332.075 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 70-71 | 41.339 | 4.31 | 1.412 | 56.503 | 53.862 | 53.862 | 84.750 | 33.900 | 89.770 | 284.729 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 72-73 | 41.353 | 4.321 | 1.861 | 56.537 | 55.774 | 55.774 | 84.750 | 33.900 | 92.957 | 274.968 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 74-76 | 39.117 | 4.588 | 11.307 | 54.281 | 93.380 | 54.281 | 84.750 | 33.900 | 90.469 | 282.529 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 77-79 | 39.416 | 4.617 | 3.866 | 54.686 | 62.472 | 54.686 | 84.750 | 33.900 | 91.144 | 280.436 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 80-91 | 49.46 | 27.395 | 5.235 | 103.184 | 102.685 | 102.685 | 84.750 | 33.900 | 171.141 | 149.351 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 92-95 | 55.648 | 6.428 | 7.384 | 77.062 | 96.193 | 77.062 | 84.750 | 33.900 | 128.437 | 199.008 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 96-108 | 143.143 | 30.459 | 5.15 | 220.506 | 203.912 | 203.912 | 84.750 | 33.900 | 339.854 | 75.209 | 84.75 | 75 | P10-75 | AMAN |
| 2BA 109-111 | 35.857 | 0.105 | 4.604 | 43.196 | 57.097 | 43.196 | 84.750 | 33.900 | 71.994 | 355.030 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 112-114 | 36.21 | 0.274 | 10.795 | 43.890 | 83.647 | 43.890 | 84.750 | 33.900 | 73.151 | 349.417 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 115-116 | 41.11 | 6.359 | 1.911 | 59.506 | 57.869 | 57.869 | 84.750 | 33.900 | 96.448 | 265.015 | 84.75 | 80 | P10-80 | AMAN |
| 2BA 117-118 | 42.054 | 4.438 | 1.422 | 57.566 | 54.789 | 54.789 | 84.750 | 33.900 | 91.315 | 279.911 | 84.75 | 80 | P10-80 | AMAN |

| Frame | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs min | Vs | S | d/2 | S pakai | Digunakan tulangan | |
| | Kn | Kn | Kn | Kn | mm | mm | mm | | |
| 2BA 1-3 | 34.2409 | 84.750 | 33.900 | -27.682 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 4-6 | 28.586 | 84.750 | 33.900 | -37.107 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 7-17 | 62.2042 | 84.750 | 33.900 | 18.924 | 1350.694 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 18 | 127.949 | 84.750 | 33.900 | 128.499 | 198.913 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 19-23 | 67.4673 | 84.750 | 33.900 | 27.695 | 922.896 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 24-28 | 68.0018 | 84.750 | 33.900 | 28.586 | 894.137 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 29-38 | 71.7286 | 84.750 | 33.900 | 34.798 | 734.534 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 39 | 19.45 | 84.750 | 33.900 | -52.333 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 40-52 | 84.9655 | 84.750 | 33.900 | 56.859 | 449.533 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 53 | 20.9632 | 84.750 | 33.900 | -49.811 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 54-63 | 72.8678 | 84.750 | 33.900 | 36.696 | 696.530 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 64-66 | 33.3732 | 84.750 | 33.900 | -29.128 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 67-69 | 29.1304 | 84.750 | 33.900 | -36.199 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 70-71 | 33.9744 | 84.750 | 33.900 | -28.126 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 72-73 | 35.1805 | 84.750 | 33.900 | -26.116 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 74-76 | 34.2389 | 84.750 | 33.900 | -27.685 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 77-79 | 34.4945 | 84.750 | 33.900 | -27.259 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 80-91 | 64.7704 | 84.750 | 33.900 | 23.201 | 1101.696 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 92-95 | 48.6086 | 84.750 | 33.900 | -3.736 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 96-108 | 128.621 | 84.750 | 33.900 | 129.619 | 197.194 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 109-111 | 27.247 | 84.750 | 33.900 | -39.338 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 112-114 | 27.6847 | 84.750 | 33.900 | -38.609 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 115-116 | 36.5018 | 84.750 | 33.900 | -23.914 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 2BA 117-118 | 34.5592 | 84.750 | 33.900 | -27.151 | 753.984 | 169.5 | 165 | P10-165 | AMAN |

## PENULANGAN LENTUR BALOK ANAK PADA LANTAI 3

| | | | | | |
|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 339 mm |
| Fy polos | = | 240 MPa | d' | = | 61 mm |
| fc' | = | 25 MPa | d'/d | = | 0,180 |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 |
| diameter tul.pokok | = | 22 mm | pb | = | 0,027 |
| diameter tul.pokok | = | 28 mm | ρ maks | = | 0,020 |
| diameter sengkang | = | 10 mm | ρ min | = | 0,004 |
| $\Phi_0$ | = | 1,25 | ρ pakai | = | 0,010 |
| b | = | 300 mm | m | = | 18,824 |
| h | = | 400 mm | Rn | = | 3,675 MPa |
| Φ | = | 0,8 | β | = | 0,85 |

**1.Perencanaan Tulangan Tumpuan**

| Frame | Mu | bd² | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 3BA 1-3 | 58,755 | 19982320,340 | Tul. sebelah | 2,130 | 0,006 | 598,889 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 4-6 | 45,215 | 15377425,141 | Tul. sebelah | 1,639 | 0,005 | 460,876 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 7-17 | 119,099 | 40505052,679 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 22,158 | 120,157 | 120,157 | 663,348 | 2 | 760,267 | 2D22 | 1696,636 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 3BA 18-30 | 170,208 | 57887001,624 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 86,045 | 120,157 | 120,157 | 2575,896 | 7 | 2660,935 | 7D22 | 3609,184 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 3BA 31-40 | 162,812 | 55371654,143 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 76,800 | 120,157 | 120,157 | 2299,130 | 7 | 2660,935 | 7D22 | 3332,418 | 9 | 3421,202 | 9D22 | 5 | 22,5 |
| 3BA 41 | 3,854 | 1310728,663 | Tul. sebelah | 0,140 | 0,000 | 39,284 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 42-54 | 177,758 | 60454723,836 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 95,482 | 120,157 | 120,157 | 2858,424 | 8 | 3041,069 | 8D22 | 3891,712 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 3BA 55 | 8,630 | 2935025,522 | Tul. sebelah | 0,313 | 0,001 | 87,966 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 56-65 | 108,304 | 36833720,059 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 8,665 | 120,157 | 120,157 | 259,389 | 2 | 760,267 | 2D22 | 1292,676 | 4 | 1520,534 | 4D22 | 4 | 37,3 |
| 3BA 66-68 | 49,525 | 16843237,424 | Tul. sebelah | 1,796 | 0,005 | 504,808 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 69-71 | 59,969 | 20395196,468 | Tul. sebelah | 2,174 | 0,006 | 611,264 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 72-73 | 35,641 | 12121349,319 | Tul. sebelah | 1,292 | 0,004 | 363,289 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 74-75 | 35,740 | 12155018,789 | Tul. sebelah | 1,296 | 0,004 | 364,298 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 76-78 | 61,721 | 20991044,059 | Tul. sebelah | 2,238 | 0,006 | 629,122 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 79-81 | 58,544 | 19910560,156 | Tul. sebelah | 2,123 | 0,006 | 596,739 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 82-93 | 145,435 | 49461811,907 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 55,078 | 120,157 | 120,157 | 1648,866 | 5 | 1900,668 | 5D22 | 2682,154 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| 3BA 94-97 | 77,117 | 26227156,798 | Tul. sebelah | 2,796 | 0,008 | 786,053 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 3BA 98-110 (D28) | 181,206 | 61627373,662 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 99,792 | 120,157 | 120,157 | 2987,452 | 5 | 3078,768 | 5D28 | 4020,740 | 7 | 4310,275 | 7D28 | 4 | 29,3 |
| 3BA 111-113 | 56,703 | 19284444,051 | Tul. sebelah | 2,056 | 0,006 | 577,973 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 114-116 | 56,482 | 19209282,911 | Tul. sebelah | 2,048 | 0,006 | 575,721 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 117-118 | 33,809 | 11498294,075 | Tul. sebelah | 1,226 | 0,003 | 344,615 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 119-120 | 35,426 | 12048228,753 | Tul. sebelah | 1,284 | 0,004 | 361,097 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Frame | Mu | bd² | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 3BA 1-3 | 29,236 | 9943036,634 | Tul. sebelah | 1,060 | 0,003 | 298,002 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 4-6 | 28,683 | 9754963,736 | Tul. sebelah | 1,040 | 0,003 | 292,366 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 7-17 | 54,261 | 18453930,456 | Tul. sebelah | 1,967 | 0,005 | 553,082 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 18-30 | 66,692 | 22681659,571 | Tul. sebelah | 2,418 | 0,007 | 679,791 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 31-40 | 62,838 | 21370930,908 | Tul. sebelah | 2,278 | 0,006 | 640,507 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 41 | 26,757 | 9099939,500 | Tul. sebelah | 0,970 | 0,003 | 272,734 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 42-54 | 73,591 | 25027979,510 | Tul. sebelah | 2,668 | 0,007 | 750,113 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 55 | 23,113 | 7860630,925 | Tul. sebelah | 0,838 | 0,002 | 235,591 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 56-65 | 53,015 | 18030171,267 | Tul. sebelah | 1,922 | 0,005 | 540,382 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 66-68 | 28,165 | 9578794,186 | Tul. sebelah | 1,021 | 0,003 | 287,086 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 69-71 | 26,545 | 9027839,221 | Tul. sebelah | 0,962 | 0,003 | 270,573 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 72-73 | 40,452 | 13757549,526 | Tul. sebelah | 1,467 | 0,004 | 412,327 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 74-75 | 40,838 | 13888826,449 | Tul. sebelah | 1,481 | 0,004 | 416,261 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 76-78 | 22,348 | 7600457,747 | Tul. sebelah | 0,810 | 0,002 | 227,793 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 79-81 | 20,705 | 7041680,583 | Tul. sebelah | 0,751 | 0,002 | 211,046 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 82-93 | 86,929 | 29564175,386 | Tul. sebelah | 3,152 | 0,009 | 886,067 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 3BA 94-97 | 37,977 | 12915812,774 | Tul. sebelah | 1,377 | 0,004 | 387,099 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 98-110 | 87,917 | 29900189,896 | Tul. sebelah | 3,188 | 0,009 | 896,137 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 3BA 111-113 | 17,778 | 6046220,594 | Tul. sebelah | 0,645 | 0,002 | 181,211 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 114-116 | 20,404 | 6939311,790 | Tul. sebelah | 0,740 | 0,002 | 207,978 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 117-118 | 43,682 | 14856058,499 | Tul. sebelah | 1,584 | 0,004 | 445,250 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 3BA 119-120 | 42,375 | 14411553,475 | Tul. sebelah | 1,536 | 0,004 | 431,928 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6.5 m

Gaya Geser

| Frame | Daerah Sendi Plastis | | | | | | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD | VL | VE | Vub1 | Vub2 | Vu b | Vc | Vs min | Vs | S | d/4 | S pakai | Digunakan | |
| | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | mm | mm | mm | tulangan | |
| 3BA 1-3 | 41.927 | 4.634 | 10.144 | 57.73 | 91.494 | 57.727 | 84.750 | 33.900 | 96.211 | 265.666 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 4-6 | 36.061 | 3.271 | 2.985 | 48.51 | 53.836 | 48.507 | 84.750 | 33.900 | 80.845 | 316.163 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 7-17 | 49.968 | 26.878 | 5.362 | 103 | 103.209 | 102.966 | 84.750 | 33.900 | 171.611 | 148.942 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 18-30 | 164.116 | 29.826 | 3.216 | 244.7 | 217.146 | 217.146 | 84.750 | 33.900 | 361.911 | 70.625 | 84.75 | 70 | P10-70 | AMAN |
| 3BA 31-40 | 76.772 | 26.543 | 2.732 | 134.6 | 119.955 | 119.955 | 84.750 | 33.900 | 199.925 | 127.848 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 41 | 26.394 | 1.886 | 0.616 | 34.69 | 32.281 | 32.281 | 84.750 | 33.900 | 53.802 | 475.076 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 42-54 | 91.498 | 26.234 | 3.503 | 151.8 | 138.331 | 138.331 | 84.750 | 33.900 | 230.552 | 110.865 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 55 | 27.121 | 1.926 | 1.57 | 35.63 | 37.093 | 35.627 | 84.750 | 33.900 | 59.378 | 430.463 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 56-65 | 49.497 | 26.968 | 4.243 | 102.5 | 98.109 | 98.109 | 84.750 | 33.900 | 163.515 | 155.317 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 66-68 | 40.728 | 4.411 | 3.032 | 55.93 | 60.130 | 55.931 | 84.750 | 33.900 | 93.219 | 274.195 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 69-71 | 41.314 | 0.283 | 9.393 | 50.03 | 83.127 | 50.030 | 84.750 | 33.900 | 83.383 | 306.539 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 72-73 | 44.372 | 4.263 | 1.149 | 60.07 | 55.893 | 55.893 | 84.750 | 33.900 | 93.154 | 274.384 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 74-75 | 44.376 | 4.313 | 1.636 | 60.15 | 57.995 | 57.995 | 84.750 | 33.900 | 96.658 | 264.439 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 76-78 | 41.744 | 4.565 | 10.144 | 57.4 | 91.229 | 57.397 | 84.750 | 33.900 | 95.661 | 267.193 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 79-81 | 42.44 | 4.639 | 3.606 | 58.35 | 64.578 | 58.350 | 84.750 | 33.900 | 97.251 | 262.827 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 82-93 | 55.335 | 27.3 | 4.603 | 110.1 | 106.099 | 106.099 | 84.750 | 33.900 | 176.832 | 144.544 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 94-97 | 59.06 | 6.365 | 6.323 | 81.06 | 95.253 | 81.056 | 84.750 | 33.900 | 135.093 | 189.203 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 98-110 | 150.049 | 30.85 | 4.447 | 229.4 | 208.621 | 208.621 | 84.750 | 33.900 | 347.702 | 73.511 | 84.75 | 70 | P10-70 | AMAN |
| 3BA 111-113 | 38.453 | 0.101 | 4.077 | 46.31 | 57.605 | 46.305 | 84.750 | 33.900 | 77.175 | 331.195 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 114-116 | 39.351 | 0.283 | 9.393 | 47.67 | 81.066 | 47.674 | 84.750 | 33.900 | 79.457 | 321.686 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 117-118 | 43.393 | 6.349 | 1.669 | 62.23 | 59.239 | 59.239 | 84.750 | 33.900 | 98.732 | 258.885 | 84.75 | 80 | P10-80 | AMAN |
| 3BA 119-120 | 45.258 | 4.471 | 1.243 | 61.46 | 57.436 | 57.436 | 84.750 | 33.900 | 95.727 | 267.011 | 84.75 | 80 | P10-80 | AMAN |

| Frame | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs min | Vs | S | d/2 | S pakai | Digunakan | |
| | Kn | Kn | Kn | Kn | mm | mm | mm | tulangan | |
| 3BA 1-3 | 36.412 | 84.750 | 33.900 | -24.063 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 4-6 | 30.597 | 84.750 | 33.900 | -33.756 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 7-17 | 64.948 | 84.750 | 33.900 | 23.497 | 1087.813 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 18-30 | 136.969 | 84.750 | 33.900 | 143.532 | 178.079 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 31-40 | 75.664 | 84.750 | 33.900 | 41.357 | 618.039 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 41 | 20.362 | 84.750 | 33.900 | -50.813 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 42-54 | 87.255 | 84.750 | 33.900 | 60.675 | 421.261 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 55 | 22.472 | 84.750 | 33.900 | -47.296 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 56-65 | 61.884 | 84.750 | 33.900 | 18.390 | 1389.883 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 66-68 | 35.280 | 84.750 | 33.900 | -25.951 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 69-71 | 31.557 | 84.750 | 33.900 | -32.155 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 72-73 | 35.255 | 84.750 | 33.900 | -25.991 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 74-75 | 36.581 | 84.750 | 33.900 | -23.781 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 76-78 | 36.204 | 84.750 | 33.900 | -24.410 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 79-81 | 36.806 | 84.750 | 33.900 | -23.407 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 82-93 | 66.924 | 84.750 | 33.900 | 26.790 | 954.077 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 94-97 | 51.128 | 84.750 | 33.900 | 0.463 | 55238.959 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 98-110 | 131.592 | 84.750 | 33.900 | 134.570 | 189.939 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 111-113 | 29.208 | 84.750 | 33.900 | -36.070 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 114-116 | 30.071 | 84.750 | 33.900 | -34.631 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 3BA 117-118 | 37.366 | 84.750 | 33.900 | -22.473 | 753.984 | 169.5 | 165 | P10-165 | AMAN |

**PENULANGAN LENTUR BALOK ANAK PADA LANTAI 4**

| | | | | | |
|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 339 mm |
| Fy polos | = | 240 MPa | d' | = | 61 mm |
| fc' | = | 25 MPa | d'/d | = | 0,180 |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 |
| diameter tul.pokok | = | 22 mm | pb | = | 0,027 |
| diameter sengkang | = | 10 mm | ρ maks | = | 0,020 |
| $\Phi_0$ | = | 1,25 | ρ min | = | 0,004 |
| b | = | 300 mm | ρ pakai | = | 0,010 |
| h | = | 400 mm | m | = | 18,824 |
| Φ | = | 0,8 | Rn | = | 3,675 MPa |
| β | = | 0,85 | | | |

**1.Perencanaan Tulangan Tumpuan**

| Frame | Mu | bd^2 | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 4BA 1-12 | 74,499 | 25336786,367 | Tul. sebelah | 2,701 | 0,0075 | 759,368 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 13-23 | 124,186 | 42235119,287 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 28,517 | 120,157 | 120,157 | 853,708 | 3 | 1140,401 | 3D22 | 1886,996 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 4BA 24 | 114,505 | 38942653,230 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 16,416 | 120,157 | 120,157 | 491,436 | 2 | 760,267 | 2D22 | 1524,724 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 4BA 25-36 | 136,104 | 46288379,330 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 43,415 | 120,157 | 120,157 | 1299,691 | 4 | 1520,534 | 4D22 | 2332,979 | 7 | 2660,935 | 7D22 | 5 | 22,5 |
| 4BA 37-48 | 136,432 | 46399930,706 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 43,825 | 120,157 | 120,157 | 1311,965 | 4 | 1520,534 | 4D22 | 2345,253 | 7 | 2660,935 | 7D22 | 5 | 22,5 |
| 4BA 49 | 3,042 | 1034570,989 | Tul. sebelah | 0,110 | 0,0003 | 31,007 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 50-62 | 142,646 | 48513285,119 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 51,592 | 120,157 | 120,157 | 1544,499 | 5 | 1900,668 | 5D22 | 2577,787 | 7 | 2660,935 | 7D22 | 5 | 22,5 |
| 4BA 63 | 6,789 | 2308909,417 | Tul. sebelah | 0,246 | 0,0007 | 69,200 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 64-73 | 109,476 | 37232312,170 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 10,130 | 120,157 | 120,157 | 303,246 | 2 | 760,267 | 2D22 | 1336,534 | 4 | 1520,534 | 4D22 | 4 | 37,3 |
| 4BA 74-85 | 85,882 | 29208095,233 | Tul. sebelah | 3,114 | 0,0086 | 875,395 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 4BA 86-97 | 83,404 | 28365338,195 | Tul. sebelah | 3,024 | 0,0084 | 850,136 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 4BA 98-109 | 120,700 | 41049545,826 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 24,160 | 120,157 | 120,157 | 723,259 | 2 | 760,267 | 2D22 | 1756,547 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| 4BA 110-113 | 76,088 | 25877198,366 | Tul. sebelah | 2,759 | 0,0076 | 775,565 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 4BA 114-126 | 172,977 | 58828726,499 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 89,506 | 120,157 | 120,157 | 2679,515 | 8 | 3041,069 | 8D22 | 3712,802 | 10 | 3801,336 | 10D22 | 5 | 22,5 |
| 4BA 127-138 | 87,410 | 29727761,397 | Tul. sebelah | 3,169 | 0,0088 | 890,970 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Frame | Mu | bd^2 | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| 4BA 1-12 | 27,841 | 9468603,193 | Tul. sebelah | 1,009 | 0,003 | 283,783 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 13-23 | 51,204 | 17414258,032 | Tul. sebelah | 1,856 | 0,005 | 521,922 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 24 | 33,506 | 11395245,091 | Tul. sebelah | 1,215 | 0,003 | 341,526 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 25-36 | 79,411 | 27007336,235 | Tul. sebelah | 2,879 | 0,008 | 809,436 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 4BA 37-48 | 80,011 | 27211393,630 | Tul. sebelah | 2,901 | 0,008 | 815,552 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| 4BA 49 | 26,602 | 9047224,673 | Tul. sebelah | 0,965 | 0,003 | 271,154 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 50-62 | 72,563 | 24678361,175 | Tul. sebelah | 2,631 | 0,007 | 739,634 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 63 | 22,859 | 7774246,628 | Tul. sebelah | 0,829 | 0,002 | 233,002 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 64-73 | 52,903 | 17992080,554 | Tul. sebelah | 1,918 | 0,005 | 539,240 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 74-85 | 36,695 | 12479810,142 | Tul. sebelah | 1,330 | 0,004 | 374,032 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 86-97 | 26,441 | 8992469,272 | Tul. sebelah | 0,959 | 0,003 | 269,513 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 98-109 | 53,203 | 18094109,251 | Tul. sebelah | 1,929 | 0,005 | 542,298 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 110-113 | 38,354 | 13044028,837 | Tul. sebelah | 1,391 | 0,004 | 390,942 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 114-126 | 73,627 | 25040222,954 | Tul. sebelah | 2,669 | 0,007 | 750,480 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| 4BA 127-138 | 34,259 | 11651337,121 | Tul. sebelah | 1,242 | 0,003 | 349,202 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6.5 m

Gaya Geser

| Frame | Daerah Sendi Plastis | | | | | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD | VL | VE | Vub1 | Vub2 | Vu b | Vc | Vs min | Vs | S | d/4 | S pakai | Digunakan tulangan | |
| | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | Kn | mm | mm | mm | | |
| 4BA 1-12 | 55.354 | 5.086 | 3.288 | 74.56 | 77.272 | 74.562 | 84.750 | 33.900 | 124.27 | 205.6805 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 13-23 | 46.182 | 26.623 | 3.273 | 98.02 | 90.192 | 90.192 | 84.750 | 33.900 | 150.32 | 170.0379 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 24 | 75.782 | 13.291 | 1.85 | 112.2 | 101.3 | 101.297 | 84.750 | 33.900 | 168.83 | 151.3973 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 25-36 | 52.468 | 26.478 | 3.176 | 105.3 | 96.233 | 96.233 | 84.750 | 33.900 | 160.39 | 159.3644 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 37-48 | 52.79 | 26.66 | 2.762 | 106 | 95.023 | 95.023 | 84.750 | 33.900 | 158.37 | 161.393 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 49 | 26.533 | 1.96 | 0.351 | 34.98 | 31.392 | 31.392 | 84.750 | 33.900 | 52.32 | 488.5355 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 50-62 | 91.562 | 16.311 | 2.643 | 136 | 124.37 | 124.367 | 84.750 | 33.900 | 207.28 | 123.3125 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 63 | 26.895 | 1.901 | 1.14 | 35.32 | 35.024 | 35.024 | 84.750 | 33.900 | 58.373 | 437.8747 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 64-73 | 40.996 | 26.294 | 3.832 | 91.27 | 86.749 | 86.749 | 84.750 | 33.900 | 144.58 | 176.7865 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 74-85 | 58.518 | 6.025 | 2.57 | 79.86 | 78.564 | 78.564 | 84.750 | 33.900 | 130.94 | 195.204 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 86-97 | 56.209 | 5.462 | 3.307 | 76.19 | 78.644 | 76.190 | 84.750 | 33.900 | 126.98 | 201.2867 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 98-109 | 41.891 | 26.97 | 3.414 | 93.42 | 86.643 | 86.643 | 84.750 | 33.900 | 144.4 | 177.0029 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 110-113 | 59.043 | 6.538 | 4.789 | 81.31 | 88.974 | 81.312 | 84.750 | 33.900 | 135.52 | 188.6063 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 114-126 | 136.662 | 28.224 | 3.003 | 209.2 | 185.74 | 185.743 | 84.750 | 33.900 | 309.57 | 82.56593 | 84.75 | 80 | P10-80 | AMAN |
| 4BA 127-138 | 57.757 | 6.124 | 2.57 | 79.11 | 77.869 | 77.869 | 84.750 | 33.900 | 129.78 | 196.9465 | 84.75 | 80 | P10-80 | AMAN |

| Frame | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs min | Vs | S | d/2 | S pakai | Digunakan tulangan | |
| | Kn | Kn | Kn | Kn | mm | mm | mm | | |
| 4BA 1-12 | 47.0317 | 84.750 | 33.900 | -6.364 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 13-23 | 56.8902 | 84.750 | 33.900 | 10.067 | 2538.976 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 24 | 63.8948 | 84.750 | 33.900 | 21.741 | 1175.643 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 25-36 | 60.7005 | 84.750 | 33.900 | 16.418 | 1556.879 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 37-48 | 59.9375 | 84.750 | 33.900 | 15.146 | 1687.593 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 49 | 19.801 | 84.750 | 33.900 | -51.75 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 50-62 | 78.447 | 84.750 | 33.900 | 45.995 | 555.7131 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 63 | 22.0919 | 84.750 | 33.900 | -47.93 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 64-73 | 54.7185 | 84.750 | 33.900 | 6.4476 | 3964.298 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 74-85 | 49.5558 | 84.750 | 33.900 | -2.157 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 86-97 | 48.0583 | 84.750 | 33.900 | -4.653 | 753.984 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 98-109 | 54.6516 | 84.750 | 33.900 | 6.3361 | 4034.053 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 110-113 | 51.2894 | 84.750 | 33.900 | 0.7323 | 34905.4 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 114-126 | 117.161 | 84.750 | 33.900 | 110.52 | 231.2747 | 169.5 | 165 | P10-165 | AMAN |
| 4BA 127-138 | 49.1174 | 84.750 | 33.900 | -2.888 | 753.984 | 169.5 | 165 | P10-165 | AMAN |

**PENULANGAN LENTUR BALOK ANAK PADA LANTAI ATAP**

| | | | | | |
|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | d | = | 544 mm |
| Fy polos | = | 240 MPa | d' | = | 57 mm |
| fc' | = | 25 MPa | d'/d | = | 0,104 |
| penutup beton (pb) | = | 40 mm | Φ | = | 0,600 |
| diameter tul.pokok | = | 13 mm | pb | = | 0,027 |
| diameter sengkang | = | 10 mm | ρ maks | = | 0,020 |
| $\Phi_n$ | = | 1,25 | ρ min | = | 0,004 |
| b | = | 400 mm | ρ pakai | = | 0,010 |
| h | = | 600 mm | m | = | 18,824 |
| Φ | = | 0,8 | Rn | = | 3,675 MPa |
| β | = | 0,85 | | | |

**1.Perencanaan Tulangan Tumpuan**

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| ABA 1-7 | 20,953 | 7126024,306 | Tul. sebelah | 0,222 | 0,001 | 133,213 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 8-19 | 34,443 | 11713914,722 | Tul. sebelah | 0,364 | 0,001 | 218,979 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 20-21 | 23,889 | 8124545,155 | Tul. sebelah | 0,253 | 0,001 | 151,880 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 22-23 | 25,688 | 8736377,243 | Tul. sebelah | 0,272 | 0,001 | 163,317 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 24-25 | 24,393 | 8295953,367 | Tul. sebelah | 0,258 | 0,001 | 155,084 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 26-27 | 13,259 | 4509328,319 | Tul. sebelah | 0,140 | 0,000 | 84,297 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 28-30 | 64,184 | 21828699,663 | Tul. sebelah | 0,679 | 0,002 | 408,064 | 4 | 530,930 | 4D13 | 4 | 82,7 | | | | | | | | | | | | | | |
| ABA 31-32 | 34,582 | 11761188,018 | Tul. sebelah | 0,366 | 0,001 | 219,863 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 33-34 | 36,714 | 12486271,959 | Tul. sebelah | 0,388 | 0,001 | 233,418 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 35-36 | 10,635 | 3616917,315 | Tul. sebelah | 0,113 | 0,000 | 67,614 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 37-39 | 59,832 | 20348603,363 | Tul. sebelah | 0,633 | 0,002 | 380,396 | 3 | 398,198 | 3D13 | 3 | 130,5 | | | | | | | | | | | | | | |
| ABA 40-42 | 78,473 | 26688326,509 | Tul. sebelah | 0,830 | 0,002 | 498,910 | 4 | 530,930 | 4D13 | 4 | 82,7 | | | | | | | | | | | | | | |
| ABA 43-54 | 24,305 | 8266024,949 | Tul. sebelah | 0,257 | 0,001 | 154,525 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 55-61 | 26,805 | 9116264,092 | Tul. sebelah | 0,284 | 0,001 | 170,419 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 62-68 | 27,939 | 9501932,567 | Tul. sebelah | 0,296 | 0,001 | 177,629 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 69-80 | 37,769 | 12845072,877 | Tul. sebelah | 0,400 | 0,001 | 240,125 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 81-86 | 67,550 | 22973461,645 | Tul. sebelah | 0,715 | 0,002 | 429,465 | 4 | 530,930 | 4D13 | 4 | 82,7 | | | | | | | | | | | | | | |
| ABA 87-90 | 50,098 | 17038112,235 | Tul. sebelah | 0,530 | 0,001 | 318,509 | 3 | 398,198 | 3D13 | 3 | 130,5 | | | | | | | | | | | | | | |
| ABA 91-98 | 81,056 | 27566793,591 | Tul. sebelah | 0,858 | 0,002 | 515,332 | 4 | 530,930 | 4D13 | 4 | 82,7 | | | | | | | | | | | | | | |
| ABA 99-110 | 38,620 | 13134494,282 | Tul. sebelah | 0,409 | 0,001 | 245,535 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 111-117 | 24,127 | 8205487,922 | Tul. sebelah | 0,255 | 0,001 | 153,393 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Frame | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As ada | n | As perlu | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' perlu | Pakai | As | n | As perlu | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| ABA 1-7 | 9,394 | 3194858,604 | Tul. sebelah | 0,099 | 0,00027 | 59,724 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 8-19 | 15,803 | 5374531,671 | Tul. sebelah | 0,167 | 0,00046 | 100,471 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 20-21 | 0,425 | 144540,654 | Tul. sebelah | 0,004 | 0,00001 | 2,702 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 22-23 | 2,432 | 827112,638 | Tul. sebelah | 0,026 | 0,00007 | 15,462 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 24-25 | 0,752 | 255751,934 | Tul. sebelah | 0,008 | 0,00002 | 4,781 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 26-27 | 26,385 | 8973423,916 | Tul. sebelah | 0,279 | 0,00077 | 167,749 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 28-30 | 34,696 | 11799958,923 | Tul. sebelah | 0,367 | 0,00101 | 220,588 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 31-32 | 18,472 | 6282246,980 | Tul. sebelah | 0,195 | 0,00054 | 117,440 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 33-34 | 1,968 | 669308,253 | Tul. sebelah | 0,021 | 0,00006 | 12,512 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 35-36 | 27,956 | 9507714,193 | Tul. sebelah | 0,296 | 0,00082 | 177,737 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 37-39 | 30,854 | 10493311,408 | Tul. sebelah | 0,326 | 0,00090 | 196,161 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 40-42 | 35,772 | 12165901,850 | Tul. sebelah | 0,378 | 0,00105 | 227,429 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 43-54 | 8,262 | 2809870,320 | Tul. sebelah | 0,087 | 0,00024 | 52,528 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 55-61 | 11,188 | 3804990,213 | Tul. sebelah | 0,118 | 0,00033 | 71,130 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 62-68 | 11,685 | 3974017,755 | Tul. sebelah | 0,124 | 0,00034 | 74,290 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 69-80 | 15,375 | 5228970,730 | Tul. sebelah | 0,163 | 0,00045 | 97,750 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 81-86 | 34,115 | 11602363,346 | Tul. sebelah | 0,361 | 0,00100 | 216,894 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 87-90 | 23,512 | 7996329,092 | Tul. sebelah | 0,249 | 0,00069 | 149,483 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 91-98 | 51,057 | 17364263,971 | Tul. sebelah | 0,540 | 0,00149 | 324,607 | 3 | 398,198 | 3D13 | 3 | 130,5 | | | | | | | | | | | | | | |
| ABA 99-110 | 14,948 | 5083749,884 | Tul. sebelah | 0,158 | 0,00044 | 95,035 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |
| ABA 111-117 | 10,356 | 3522030,626 | Tul. sebelah | 0,110 | 0,00030 | 65,841 | 2 | 265,465 | 2D13 | 2 | 274,0 | | | | | | | | | | | | | | |

**3.Gaya Geser Rencana Balok Anak**

Ln = 6.5 m

Gaya Geser

| Frame | Daerah Sendi Plastis | | | | | | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VD Kn | VL Kn | VE Kn | Vub1 Kn | Vub2 Kn | Vu b Kn | Vc | Vs min mm^2 | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| ABA 1-7 | 11.852 | 0.182 | 0.807 | 14.514 | 16.025 | 14.514 | 181.167 | 72.467 | 24.189 | 1694.095 | 135.875 | 135 | P10-135 | AMAN |
| ABA 8-19 | 19.391 | 2.583 | 1.073 | 27.402 | 27.579 | 27.402 | 181.167 | 72.467 | 45.670 | 897.286 | 135.875 | 135 | P10-135 | AMAN |
| ABA 20-21 | 14.608 | 2.348 | 0.488 | 21.286 | 19.853 | 19.853 | 181.167 | 72.467 | 33.089 | 1238.449 | 135.875 | 135 | P10-135 | AMAN |
| ABA 22-23 | 15.308 | 2.413 | 1.941 | 22.230 | 26.759 | 22.230 | 181.167 | 72.467 | 37.051 | 1106.027 | 135.875 | 135 | P10-135 | AMAN |
| ABA 24-25 | 14.321 | 2.340 | 0.118 | 20.929 | 17.990 | 17.990 | 181.167 | 72.467 | 29.983 | 1366.754 | 135.875 | 135 | P10-135 | AMAN |
| ABA 26-27 | 20.739 | 0.695 | 1.355 | 25.999 | 28.197 | 25.999 | 181.167 | 72.467 | 43.331 | 945.714 | 135.875 | 135 | P10-135 | AMAN |
| ABA 28-30 | 34.005 | 6.797 | 2.422 | 51.681 | 53.015 | 51.681 | 181.167 | 72.467 | 86.135 | 475.752 | 135.875 | 135 | P10-135 | AMAN |
| ABA 31-32 | 43.853 | 0.308 | 1.065 | 53.116 | 50.842 | 50.842 | 181.167 | 72.467 | 84.737 | 483.604 | 135.875 | 135 | P10-135 | AMAN |
| ABA 33-34 | 24.129 | 2.353 | 0.470 | 32.720 | 29.780 | 29.780 | 181.167 | 72.467 | 49.634 | 825.632 | 135.875 | 135 | P10-135 | AMAN |
| ABA 35-36 | 19.884 | 0.883 | 1.166 | 25.274 | 26.703 | 25.274 | 181.167 | 72.467 | 42.123 | 972.850 | 135.875 | 135 | P10-135 | AMAN |
| ABA 37-39 | 32.386 | 6.585 | 1.780 | 49.399 | 48.396 | 48.396 | 181.167 | 72.467 | 80.659 | 508.051 | 135.875 | 135 | P10-135 | AMAN |
| ABA 40-42 | 59.831 | 6.545 | 1.456 | 82.269 | 75.810 | 75.810 | 181.167 | 72.467 | 126.350 | 324.329 | 135.875 | 135 | P10-135 | AMAN |
| ABA 43-54 | 15.252 | 2.188 | 3.815 | 21.803 | 34.335 | 21.803 | 181.167 | 72.467 | 36.339 | 1127.698 | 135.875 | 135 | P10-135 | AMAN |
| ABA 55-61 | 11.498 | 0.159 | 2.330 | 14.052 | 22.026 | 14.052 | 181.167 | 72.467 | 23.420 | 1749.745 | 135.875 | 135 | P10-135 | AMAN |
| ABA 62-68 | 11.881 | 0.184 | 2.782 | 14.552 | 24.353 | 14.552 | 181.167 | 72.467 | 24.253 | 1689.671 | 135.875 | 135 | P10-135 | AMAN |
| ABA 69-80 | 19.503 | 2.593 | 3.184 | 27.552 | 36.574 | 27.552 | 181.167 | 72.467 | 45.921 | 892.388 | 135.875 | 135 | P10-135 | AMAN |
| ABA 81-86 | 34.564 | 6.876 | 1.803 | 52.478 | 51.085 | 51.085 | 181.167 | 72.467 | 85.141 | 481.308 | 135.875 | 135 | P10-135 | AMAN |
| ABA 87-90 | 40.602 | 1.107 | 3.779 | 50.494 | 59.666 | 50.494 | 181.167 | 72.467 | 84.156 | 486.941 | 135.875 | 135 | P10-135 | AMAN |
| ABA 91-98 | 41.835 | 6.679 | 1.831 | 60.888 | 58.630 | 58.630 | 181.167 | 72.467 | 97.717 | 419.367 | 135.875 | 135 | P10-135 | AMAN |
| ABA 99-110 | 20.066 | 2.724 | 1.213 | 28.438 | 29.024 | 28.438 | 181.167 | 72.467 | 47.396 | 864.609 | 135.875 | 135 | P10-135 | AMAN |
| ABA 111-117 | 12.501 | 0.278 | 0.847 | 15.446 | 16.975 | 15.446 | 181.167 | 72.467 | 25.743 | 1591.831 | 135.875 | 135 | P10-135 | AMAN |

| Frame | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|
| | Vu b Kn | Vc | Vs min mm^2 | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| ABA 1-7 | 9.1547 | 181.167 | 72.467 | -165.9 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 8-19 | 17.284 | 181.167 | 72.467 | -152.4 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 20-21 | 12.523 | 181.167 | 72.467 | -160.3 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 22-23 | 14.022 | 181.167 | 72.467 | -157.8 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 24-25 | 11.347 | 181.167 | 72.467 | -162.3 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 26-27 | 16.399 | 181.167 | 72.467 | -153.8 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 28-30 | 32.599 | 181.167 | 72.467 | -126.8 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 31-32 | 32.07 | 181.167 | 72.467 | -127.7 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 33-34 | 18.784 | 181.167 | 72.467 | -149.9 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 35-36 | 15.942 | 181.167 | 72.467 | -154.6 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 37-39 | 30.526 | 181.167 | 72.467 | -130.3 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 40-42 | 47.819 | 181.167 | 72.467 | -101.5 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 43-54 | 13.753 | 181.167 | 72.467 | -158.2 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 55-61 | 8.8636 | 181.167 | 72.467 | -166.4 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 62-68 | 9.1787 | 181.167 | 72.467 | -165.9 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 69-80 | 17.379 | 181.167 | 72.467 | -152.2 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 81-86 | 32.223 | 181.167 | 72.467 | -127.5 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 87-90 | 31.85 | 181.167 | 72.467 | -128.1 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 91-98 | 36.982 | 181.167 | 72.467 | -119.5 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 99-110 | 17.938 | 181.167 | 72.467 | -151.3 | 565.488 | 271.75 | 270 | P10-270 | AMAN |
| ABA 111-117 | 9.7429 | 181.167 | 72.467 | -164.9 | 565.488 | 271.75 | 270 | P10-270 | AMAN |

## PENULANGAN LENTUR BALOK PADA PORTAL B-A

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BA1-BA5)1 | 82,575 | 28083398,895 | Tul. sebelah | 0,888 | 0,002 | 529,372 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BA6-BA17)1 | 254,577 | 86580532,127 | Tul. sebelah | 2,738 | 0,008 | 1632,044 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-1 (BA18-BA29)1 | 280,441 | 95376766,206 | Tul. sebelah | 3,017 | 0,008 | 1797,853 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-2 (BA30-BA41)1 | 295,518 | 100504388,430 | Tul. sebelah | 3,179 | 0,009 | 1894,509 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-3 (BA42-BA53)1 | 294,560 | 100178576,790 | Tul. sebelah | 3,168 | 0,009 | 1888,367 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-4 (BA54-BA65)1 | 257,448 | 87556946,759 | Tul. sebelah | 2,769 | 0,008 | 1650,449 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt atap (BA66-BA79)1 | 130,069 | 44235902,039 | Tul. sebelah | 1,399 | 0,004 | 833,847 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |
| blk ring (BA80-BA85)2 | 36,834 | 12527083,438 | Tul. sebelah | 1,335 | 0,004 | 375,449 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BA1-BA5)1 | 38,790 | 13192310,543 | Tul. sebelah | 0,417 | 0,001 | 248,675 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BA6-BA17)1 | 236,115 | 80301686,104 | Tul. sebelah | 2,540 | 0,007 | 1513,688 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| lt-1 (BA18-BA29)1 | 247,227 | 84080829,047 | Tul. sebelah | 2,659 | 0,007 | 1584,925 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-2 (BA30-BA41)1 | 249,710 | 84925286,564 | Tul. sebelah | 2,686 | 0,007 | 1600,843 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-3 (BA42-BA53)1 | 254,233 | 86463539,221 | Tul. sebelah | 2,735 | 0,008 | 1629,839 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-4 (BA54-BA65)1 | 218,649 | 74361575,355 | Tul. sebelah | 2,352 | 0,007 | 1401,717 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| lt atap (BA66-BA79)1 | 108,316 | 36837801,207 | Tul. sebelah | 1,165 | 0,003 | 694,393 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| blk ring (BA80-BA85)2 | 36,876 | 12541367,456 | Tul. sebelah | 1,337 | 0,004 | 375,877 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BA1-BA5)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BA6-BA17)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BA18-BA29)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-2 (BA30-BA41)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BA42-BA53)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-4 (BA54-BA65)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BA66-BA79)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BA80-BA85)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BA1-BA5)1 | 74,887 | 0,538 | 9,353 | 198,092 | 181,704 | 120,097 | 118,479 | 118,479 |
| GF (BA6-BA17)1 | 141,431 | 34,031 | 21,912 | 292,038 | 473,711 | 266,700 | 276,266 | 266,700 |
| lt-1 (BA18-BA29)1 | 133,745 | 40,305 | 32,18 | 292,038 | 473,711 | 265,218 | 317,909 | 265,218 |
| lt-2 (BA30-BA41)1 | 134,595 | 40,38 | 36,492 | 292,038 | 473,711 | 266,189 | 336,990 | 266,189 |
| lt-3 (BA42-BA53)1 | 140,358 | 40,145 | 33,086 | 292,038 | 473,711 | 271,993 | 328,489 | 271,993 |
| lt-4 (BA54-BA65)1 | 129,679 | 36,944 | 22,989 | 292,038 | 473,711 | 257,419 | 271,508 | 257,419 |
| lt atap (BA66-BA79)1 | 65,866 | 11,338 | 10,876 | 198,092 | 282,450 | 132,815 | 126,743 | 126,743 |
| blk ring (BA80-BA85)2 | 22,976 | 0,301 | 2,204 | 119,799 | 105,677 | 48,723 | 33,698 | 33,698 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BA1-BA5)1 | 118,479 | 0,000 | 197,465 | 205,808 | 134,75 | 130 | P10-130 | AMAN |
| GF (BA6-BA17)1 | 266,700 | 0,000 | 444,501 | 91,428 | 134,75 | 90 | P10-90 | AMAN |
| lt-1 (BA18-BA29)1 | 265,218 | 0,000 | 442,030 | 91,939 | 134,75 | 90 | P10-90 | AMAN |
| lt-2 (BA30-BA41)1 | 266,189 | 0,000 | 443,648 | 91,603 | 134,75 | 90 | P10-90 | AMAN |
| lt-3 (BA42-BA53)1 | 271,993 | 0,000 | 453,322 | 89,649 | 134,75 | 85 | P10-85 | AMAN |
| lt-4 (BA54-BA65)1 | 257,419 | 0,000 | 429,032 | 94,724 | 134,75 | 90 | P10-90 | AMAN |
| lt atap (BA66-BA79)1 | 126,743 | 0,000 | 211,239 | 192,387 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BA80-BA85)2 | 33,698 | 0,000 | 56,163 | 455,107 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BA1-BA5)1 | 74,7328 | 179,667 | -55,112 | -737,403 | 269,5 | 265 | P10-265 | AMAN |
| GF (BA6-BA17)1 | 168,226 | 179,667 | 100,711 | 403,530 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BA18-BA29)1 | 167,291 | 179,667 | 99,152 | 409,873 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BA30-BA41)1 | 167,904 | 179,667 | 100,173 | 405,695 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BA42-BA53)1 | 171,565 | 179,667 | 106,275 | 382,401 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BA54-BA65)1 | 162,372 | 179,667 | 90,954 | 446,818 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BA66-BA79)1 | 79,9458 | 179,667 | -46,424 | -875,411 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BA80-BA85)2 | 21,2554 | 113,000 | -77,574 | -329,491 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-B

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BB1-BB5)1 | 88,434 | 30076019,350 | Tul. sebelah | 0,951 | 0,003 | 566,933 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BB6-BB17)1 | 259,427 | 88229996,065 | Tul. sebelah | 2,791 | 0,008 | 1663,136 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-1 (BB18-BB34)1 | 294,464 | 100145927,607 | Tul. sebelah | 3,167 | 0,009 | 1887,752 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-2 (BB35-BB46)1 | 262,636 | 89321363,029 | Tul. sebelah | 2,825 | 0,008 | 1683,709 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-3 (BB47-BB58)1 | 307,427 | 104554587,611 | Tul. sebelah | 3,307 | 0,009 | 1970,855 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| lt-4 (BB59-BB70)1 | 281,620 | 95777738,986 | Tul. sebelah | 3,029 | 0,008 | 1805,411 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt atap (BB71-BB78)1 | 177,737 | 60447581,827 | Tul. sebelah | 1,912 | 0,005 | 1139,438 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | | |
| blk ring (BB79-BB82)2 | 70,873 | 24103599,514 | Tul. sebelah | 2,570 | 0,007 | 722,408 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BB1-BB5)1 | 37,837 | 12868199,382 | Tul. sebelah | 0,407 | 0,001 | 242,566 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BB6-BB17)1 | 252,261 | 85792870,585 | Tul. sebelah | 2,713 | 0,008 | 1617,197 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-1 (BB18-BB34)1 | 211,710 | 72001651,590 | Tul. sebelah | 2,277 | 0,006 | 1357,232 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt-2 (BB35-BB46)1 | 224,380 | 76310663,566 | Tul. sebelah | 2,414 | 0,007 | 1438,457 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt-3 (BB47-BB58)1 | 298,273 | 101441351,965 | Tul. sebelah | 3,208 | 0,009 | 1912,171 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| lt-4 (BB59-BB70)1 | 223,228 | 75918873,369 | Tul. sebelah | 2,401 | 0,007 | 1431,072 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt atap (BB71-BB78)1 | 85,201 | 28976490,091 | Tul. sebelah | 0,916 | 0,003 | 546,207 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| blk ring (BB79-BB82)2 | 66,796 | 22717029,520 | Tul. sebelah | 2,422 | 0,007 | 680,851 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BB1-BB5)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BB6-BB17)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BB18-BB34)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-2 (BB35-BB46)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BB47-BB58)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-4 (BB59-BB70)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BB71-BB78)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BB79-BB82)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BB1-BB5)1 | 48,38 | 0,892 | 10,406 | 198,092 | 181,704 | 92,637 | 95,441 | 92,637 |
| GF (BB6-BB17)1 | 130,3 | 48,792 | 21,761 | 292,038 | 473,711 | 270,508 | 279,439 | 270,508 |
| lt-1 (BB18-BB34)1 | 128,15 | 50,28 | 58,161 | 292,038 | 473,711 | 269,811 | 431,622 | 269,811 |
| lt-2 (BB35-BB46)1 | 96,646 | 52,97 | 33,836 | 292,038 | 473,711 | 239,562 | 299,208 | 239,562 |
| lt-3 (BB47-BB58)1 | 138,1 | 52,623 | 30,665 | 292,038 | 554,777 | 291,455 | 329,052 | 291,455 |
| lt-4 (BB59-BB70)1 | 131,2 | 52,45 | 25,1 | 292,038 | 473,711 | 275,300 | 298,255 | 275,300 |
| lt atap (BB71-BB78)1 | 72,214 | 8,196 | 21,576 | 198,092 | 282,450 | 136,181 | 175,050 | 136,181 |
| blk ring (BB79-BB82)2 | 38,149 | 0,511 | 4,54 | 119,799 | 105,677 | 64,875 | 59,661 | 59,661 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BB1-BB5)1 | 92,637 | 0,000 | 154,394 | 263,220 | 134,75 | 130 | P10-130 | AMAN |
| GF (BB6-BB17)1 | 270,508 | 0,000 | 450,846 | 90,141 | 134,75 | 90 | P10-90 | AMAN |
| lt-1 (BB18-BB34)1 | 269,811 | 0,000 | 449,686 | 90,374 | 134,75 | 90 | P10-90 | AMAN |
| lt-2 (BB35-BB46)1 | 239,562 | 0,000 | 399,270 | 101,785 | 134,75 | 100 | P10-100 | AMAN |
| lt-3 (BB47-BB58)1 | 291,455 | 0,000 | 485,758 | 83,663 | 134,75 | 80 | P10-80 | AMAN |
| lt-4 (BB59-BB70)1 | 275,300 | 0,000 | 458,833 | 88,572 | 134,75 | 85 | P10-85 | AMAN |
| lt atap (BB71-BB78)1 | 136,181 | 0,000 | 226,969 | 179,054 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BB79-BB82)2 | 59,661 | 0,000 | 99,435 | 257,053 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BB1-BB5)1 | 58,432 | 179,667 | -82,279 | -493,924 | 269,5 | 265 | P10-265 | AMAN |
| GF (BB6-BB17)1 | 170,63 | 179,667 | 104,713 | 388,105 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BB18-BB34)1 | 170,19 | 179,667 | 103,981 | 390,837 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BB35-BB46)1 | 151,11 | 179,667 | 72,181 | 563,028 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BB47-BB58)1 | 183,84 | 179,667 | 126,734 | 320,669 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BB59-BB70)1 | 173,65 | 179,667 | 109,751 | 370,290 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BB71-BB78)1 | 85,899 | 179,667 | -36,502 | -1113,361 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BB79-BB82)2 | 37,632 | 113,000 | -50,279 | -508,360 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-C

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 300 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 400 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 500 mm |
| diameter tul pokok | = | 22 mm | **ρ maks** | = | 0,020 | b3 | = | 300 mm |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | h3 | = | 700 mm |
| d' | = | 61 mm | **ρ pakai** | = | 0,010 | | | |
| d1 | = | 339 mm | m | = | 18,824 | | | |
| d2 | = | 439 mm | **Rn** | = | 3,675 MPa | | | |
| d3 | = | 639 mm | β | = | 0,85 | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BC1-BC10)1 | 131,131 | 44597083,627 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 37,198 | 120,157 | 120,157 | 1113,597 | 3 | 1140,401 | 3D22 | 2146,885 | 6 | 2280,802 | 6D22 | 4 | 37,3 |
| lt-1 (BC11-BC14)3 | 478,866 | 162860246,989 | Tul. rangkap | | | | | | | | | 1947,702 | 450,227 | 148,355 | 345,436 | 345,436 | 743,032 | 4 | 1520,534 | 4D22 | 2690,734 | 8 | 3041,069 | 8D22 | 4 | 37,3 |
| lt-1 (BC15-BC24)2 | 164,685 | 56008653,309 | Tul. sebelah | 3,561 | 0,010 | 1296,257 | 4 | 1520,534 | 4D22 | 4 | 37,3 | | | | | | | | | | | | | | | |
| lt-1 (BC25)1 | 69,639 | 23683921,473 | Tul. sebelah | 2,525 | 0,007 | 709,830 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-2 (BC26-BC35)1 | 120,635 | 41027439,608 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 24,078 | 120,157 | 120,157 | 720,826 | 3 | 1140,401 | 3D22 | 1754,114 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| lt-3 (BC36-BC45)1 | 161,778 | 55019995,233 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 75,507 | 120,157 | 120,157 | 2260,437 | 6 | 2280,802 | 6D22 | 3293,725 | 9 | 3421,202 | 9D22 | 5 | 22,5 |
| lt-4 (BC46-BC57)1 | 118,057 | 40150673,004 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 20,856 | 120,157 | 120,157 | 624,355 | 3 | 1140,401 | 3D22 | 1657,643 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| lt atap (BC58-BC59)1 | 47,262 | 16073600,951 | Tul. sebelah | 1,714 | 0,005 | 481,741 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BC1-BC10)1 | 86,723 | 29494115,681 | Tul. sebelah | 3,144 | 0,009 | 883,967 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| lt-1 (BC11-BC14)3 | 254,030 | 86394499,803 | Tul. sebelah | 2,592 | 0,007 | 1373,680 | 4 | 1520,534 | 4D22 | 4 | 37,3 | | | | | | | | | | | | | | | |
| lt-1 (BC15-BC24)2 | 90,108 | 30645339,481 | Tul. sebelah | 1,948 | 0,005 | 709,252 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-1 (BC25)1 | 44,108 | 15000939,249 | Tul. sebelah | 1,599 | 0,004 | 449,593 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-2 (BC26-BC35)1 | 66,040 | 22459917,203 | Tul. sebelah | 2,394 | 0,007 | 673,145 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-3 (BC36-BC45)1 | 86,096 | 29280875,704 | Tul. sebelah | 3,122 | 0,009 | 877,576 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| lt-4 (BC46-BC57)1 | 62,877 | 21384194,639 | Tul. sebelah | 2,280 | 0,006 | 640,905 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt atap (BC58-BC59)1 | 3,908 | 1329093,828 | Tul. sebelah | 0,142 | 0,000 | 39,834 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | **Mnak⁻** | **Mkap⁻** | **ρ aktual** | Rn | **Mnak⁺** | **Mkap⁺** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| GF (BC1-BC10)1 | 6 | 2280,802 | 3 | 1140,401 | | 400,000 | 71,555 | 138,318 | 126,813 | 265,131 | 331,413 | 0,0112 | 4,012 | 138,318 | 172,898 |
| lt-1 (BC11-BC14)3 | 8 | 3041,069 | 4 | 1520,534 | 273,920 | 273,920 | 125,478 | 460,964 | 240,740 | 701,704 | 877,130 | 0,0079 | 2,936 | 359,635 | 449,544 |
| lt-1 (BC15-BC24)2 | 4 | 1520,534 | 2 | 760,267 | -52,160 | 52,160 | 89,186 | 224,243 | 14,990 | 239,233 | 299,042 | 0,0058 | 2,184 | 126,250 | 157,812 |
| lt-1 (BC25)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-2 (BC26-BC35)1 | 5 | 1900,668 | 3 | 1140,401 | -52,160 | 52,160 | 109,927 | 199,048 | 16,536 | 215,585 | 269,481 | 0,0112 | 4,012 | 138,318 | 172,898 |
| lt-3 (BC36-BC45)1 | 9 | 3421,202 | 6 | 2280,802 | 165,227 | 165,227 | 155,550 | 259,039 | 104,764 | 363,803 | 454,754 | 0,0224 | 7,077 | 243,996 | 304,995 |
| lt-4 (BC46-BC57)1 | 5 | 1900,668 | 3 | 1140,401 | -52,160 | 52,160 | 109,927 | 199,048 | 16,536 | 215,585 | 269,481 | 0,0112 | 4,012 | 138,318 | 172,898 |
| lt atap (BC58-BC59)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^{+}$ | $Mkap^{-}$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| GF (BC1-BC10)1 | 79,755 | 29,005 | 4,984 | 172,898 | 331,413 | 168,508 | 135,131 | 135,131 |
| lt-1 (BC11-BC14)3 | 156,86 | 26,38 | 19,344 | 449,544 | 877,130 | 335,279 | 273,651 | 273,651 |
| lt-1 (BC15-BC24)2 | 58,589 | 34,804 | 11,029 | 157,812 | 299,042 | 147,262 | 144,384 | 144,384 |
| lt-1 (BC25)1 | 40,357 | 9,448 | 5,355 | 119,799 | 105,677 | 76,577 | 74,786 | 74,786 |
| lt-2 (BC26-BC35)1 | 45,16 | 29,347 | 7,445 | 172,898 | 269,481 | 125,873 | 109,501 | 109,501 |
| lt-3 (BC36-BC45)1 | 81,472 | 29,656 | 6,458 | 304,995 | 454,754 | 198,504 | 143,808 | 143,808 |
| lt-4 (BC46-BC57)1 | 57,543 | 29,325 | 6,92 | 172,898 | 269,481 | 138,852 | 120,275 | 120,275 |
| lt atap (BC58-BC59)1 | 28,306 | 4,067 | 0,685 | 119,799 | 105,677 | 58,274 | 36,869 | 36,869 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| GF (BC1-BC10)1 | 135,131 | 0,000 | 225,218 | 113,490 | 84,75 | 80 | P10-80 | AMAN |
| lt-1 (BC11-BC14)3 | 273,651 | 0,000 | 456,085 | 105,637 | 159,75 | 105 | P10-105 | AMAN |
| lt-1 (BC15-BC24)2 | 144,384 | 0,000 | 240,641 | 137,549 | 109,75 | 105 | P10-105 | AMAN |
| lt-1 (BC25)1 | 74,786 | 0,000 | 124,644 | 205,065 | 84,75 | 80 | P10-80 | AMAN |
| lt-2 (BC26-BC35)1 | 109,501 | 0,000 | 182,502 | 140,053 | 84,75 | 80 | P10-80 | AMAN |
| lt-3 (BC36-BC45)1 | 143,808 | 0,000 | 239,680 | 106,642 | 84,75 | 80 | P10-80 | AMAN |
| lt-4 (BC46-BC57)1 | 120,275 | 0,000 | 200,459 | 127,508 | 84,75 | 80 | P10-80 | AMAN |
| lt atap (BC58-BC59)1 | 36,869 | 0,000 | 61,448 | 415,964 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| GF (BC1-BC10)1 | 85,236 | 84,750 | 57,311 | 445,992 | 169,5 | 165 | P10-165 | AMAN |
| lt-1 (BC11-BC14)3 | 172,61 | 159,750 | 127,934 | 376,596 | 319,5 | 315 | P10-315 | AMAN |
| lt-1 (BC15-BC24)2 | 91,073 | 109,750 | 42,039 | 787,366 | 219,5 | 215 | P10-215 | AMAN |
| lt-1 (BC25)1 | 47,173 | 84,750 | -6,129 | -4170,648 | 169,5 | 165 | P10-165 | AMAN |
| lt-2 (BC26-BC35)1 | 69,07 | 84,750 | 30,367 | 841,710 | 169,5 | 165 | P10-165 | AMAN |
| lt-3 (BC36-BC45)1 | 90,71 | 84,750 | 66,433 | 384,751 | 169,5 | 165 | P10-165 | AMAN |
| lt-4 (BC46-BC57)1 | 75,866 | 84,750 | 41,693 | 613,049 | 169,5 | 165 | P10-165 | AMAN |
| lt atap (BC58-BC59)1 | 23,256 | 84,750 | -45,991 | -555,766 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-D

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | **Rn** | = | 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = | 0,85 |
| diameter tul pokok | = | 22 mm | **ρ maks** | = | 0,020 | | | |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | | | |
| d' | = | 61 mm | **ρ pakai** | = | 0,010 | | | |
| d | = | 539 mm | m | = | 18,824 | | | |

**1.Perencanaan Tulangan Tumpuan**

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BD1-BD5) | 92,028 | 31298323,142 | Tul. sebelah | 0,990 | 0,003 | 589,974 | 2 | 760,267 | 6D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BD6-BD15) | 267,572 | 91000075,193 | Tul. sebelah | 2,878 | 0,008 | 1715,352 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| It-1 (BD16-BD27) | 449,302 | 152805658,979 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 134,511 | 298,207 | 298,207 | 943,653 | 5 | 1900,668 | 5D22 | 3134,183 | 9 | 3421,202 | 9D22 | 7 | 24,3 |
| It-2 (BD28-BD37) | 307,936 | 104727696,301 | Tul. sebelah | 3,312 | 0,009 | 1974,118 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| It-3 (BD38-BD47) | 323,685 | 110083862,806 | Tul. sebelah | 3,482 | 0,010 | 2075,082 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| It-4 (BD48-BD59) | 268,690 | 91380302,138 | Tul. sebelah | 2,890 | 0,008 | 1722,520 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| It atap (BD60-BD63) | 120,136 | 40857731,875 | Tul. sebelah | 1,292 | 0,004 | 770,169 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BD1-BD5) | 38,026 | 12832477,461 | Tul. sebelah | 0,409 | 0,001 | 243,777 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BD6-BD15) | 286,662 | 97492501,289 | Tul. sebelah | 3,083 | 0,009 | 1837,735 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| It-1 (BD16-BD27) | 198,397 | 67472257,627 | Tul. sebelah | 2,134 | 0,006 | 1271,863 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| It-2 (BD28-BD37) | 259,097 | 87777668,841 | Tul. sebelah | 2,776 | 0,008 | 1654,610 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| It-3 (BD38-BD47) | 308,332 | 104862374,181 | Tul. sebelah | 3,317 | 0,009 | 1976,857 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| It-4 (BD48-BD59) | 223,169 | 75898807,726 | Tul. sebelah | 2,401 | 0,007 | 1430,683 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| It atap (BD60-BD63) | 187,610 | 63805346,251 | Tul. sebelah | 2,018 | 0,006 | 1202,732 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |

**3.Momen Nominal Aktual**

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | ρ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BD1-BD5) | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BD6-BD15) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-1 (BD16-BD27) | 9 | 3421,202 | 5 | 1900,668 | 165,227 | 165,227 | 124,052 | 502,940 | 150,112 | 653,052 | 816,315 | 0,0088 | 3,234 | 375,784 | 469,730 |
| It-2 (BD28-BD37) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-3 (BD38-BD47) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-4 (BD48-BD59) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It atap (BD60-BD63) | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^{+}$ | $Mkap^{-}$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| Sloop (BD1-BD5) | 48,878 | 11,378 | 0,999 | 198,092 | 191,704 | 104,170 | 67,465 | 67,465 |
| GF (BD6-BD15) | 119,734 | 23,971 | 51,7 | 292,038 | 473,711 | 233,355 | 368,030 | 233,355 |
| lt-1 (BD16-BD27) | 114,442 | 53,006 | 48,212 | 468,730 | 816,315 | 314,318 | 378,311 | 314,318 |
| lt-2 (BD28-BD37) | 140,214 | 35,155 | 50,497 | 292,038 | 554,777 | 275,333 | 396,225 | 275,333 |
| lt-3 (BD38-BD47) | 157,231 | 30,069 | 48,306 | 292,038 | 554,777 | 287,860 | 403,750 | 287,860 |
| lt-4 (BD48-BD59) | 106,41 | 31,059 | 52,705 | 292,038 | 473,711 | 226,808 | 365,703 | 226,808 |
| lt atap (BD60-BD63) | 57,75 | 4,512 | 4,94 | 198,092 | 282,450 | 117,126 | 86,123 | 86,123 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BD1-BD5) | 67,465 | 0,000 | 112,441 | 361,432 | 134,75 | 130 | P10-130 | AMAN |
| GF (BD6-BD15) | 233,355 | 0,000 | 388,926 | 104,492 | 134,75 | 100 | P10-100 | AMAN |
| lt-1 (BD16-BD27) | 314,318 | 0,000 | 523,863 | 77,577 | 134,75 | 75 | P10-75 | AMAN |
| lt-2 (BD28-BD37) | 275,333 | 0,000 | 458,888 | 88,561 | 134,75 | 85 | P10-85 | AMAN |
| lt-3 (BD38-BD47) | 287,860 | 0,000 | 479,767 | 84,707 | 134,75 | 80 | P10-80 | AMAN |
| lt-4 (BD48-BD59) | 226,808 | 0,000 | 378,013 | 107,509 | 134,75 | 105 | P10-105 | AMAN |
| lt atap (BD60-BD63) | 86,123 | 0,000 | 143,539 | 283,128 | 134,75 | 130 | P10-130 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BD1-BD5) | 42,5548 | 179,667 | -108,742 | -373,725 | 269,5 | 265 | P10-265 | AMAN |
| GF (BD6-BD15) | 147,193 | 179,667 | 85,656 | 618,982 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BD16-BD27) | 198,262 | 179,667 | 150,770 | 269,548 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BD28-BD37) | 173,672 | 179,667 | 109,786 | 370,173 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BD38-BD47) | 181,574 | 179,667 | 122,958 | 330,523 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BD48-BD59) | 143,063 | 179,667 | 58,772 | 691,479 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BD60-BD63) | 54,3238 | 179,667 | -89,127 | -455,976 | 269,5 | 265 | P10-265 | AMAN |

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**PENULANGAN LENTUR BALOK PADA PORTAL B-E**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_b$ | = | 1,25 | b1 | = | 300 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 400 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 600 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | b3 | = | 400 mm |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | h3 | = | 700 mm |
| d' | = | 61 mm | $\rho$ pakai | = | 0,010 | | | |
| d1 | = | 339 mm | m | = | 18,824 | | | |
| d2 | = | 539 mm | Rn | = | 3,675 MPa | | | |
| d3 | = | 639 mm | $\beta$ | = | 0,85 | | | |

**1.Perencanaan Tulangan Tumpuan**

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BE1-BE10)1 | 131,762 | 44811683,986 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 37,987 | 120,157 | 120,157 | 1137,210 | 3 | 1140,401 | 3D22 | 2170,497 | 6 | 2280,802 | 6D22 | 3 | 67,0 |
| It-1 (BE11-BE14)3 | 579,168 | 188972521,599 | Tul. rangkap | | | | | | | | | 2596,936 | 600,303 | 123,657 | 345,436 | 345,436 | 619,332 | 5 | 1900,668 | 5D22 | 3216,268 | 9 | 3421,202 | 9D22 | 5 | 47,5 |
| It-1 (BE15-BE24)2 | 234,243 | 79665027,034 | Tul. sebelah | 3,360 | 0,008 | 1501,687 | 4 | 1520,534 | 4D22 | 4 | 37,3 | | | | | | | | | | | | | | | |
| It-1 (BE25)1 | 69,984 | 23801254,475 | Tul. sebelah | 2,537 | 0,007 | 713,347 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| It-2 (BE26-BE33)1 | 124,712 | 42414009,603 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 29,175 | 120,157 | 120,157 | 873,392 | 3 | 1140,401 | 3D22 | 1906,680 | 6 | 2280,802 | 6D22 | 6 | 13,6 |
| It-3 (BE34-BE43)1 | 132,492 | 45059953,816 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 38,900 | 120,157 | 120,157 | 1164,527 | 4 | 1520,534 | 4D22 | 2197,815 | 6 | 2280,802 | 6D22 | 6 | 13,6 |
| It-4 (BE44-BE55)1 | 118,214 | 40204068,022 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 21,052 | 120,157 | 120,157 | 830,230 | 3 | 1140,401 | 3D22 | 1663,518 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| It atap (BE56-BE57)1 | 47,780 | 16249770,502 | Tul. sebelah | 1,732 | 0,005 | 487,021 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**2.Perencanaan Tulangan Lapangan**

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BE1-BE10)1 | 98,918 | 33641582,221 | Tul. sebelah | 3,586 | 0,010 | 1008,271 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| It-1 (BE11-BE14)3 | 390,233 | 132716548,603 | Tul. sebelah | 2,987 | 0,008 | 2110,205 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-1 (BE15-BE24)2 | 110,115 | 37449633,295 | Tul. sebelah | 1,579 | 0,004 | 705,926 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| It-1 (BE25)1 | 43,712 | 14868261,368 | Tul. sebelah | 1,585 | 0,004 | 445,556 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| It-2 (BE26-BE33)1 | 89,464 | 30426317,877 | Tul. sebelah | 3,244 | 0,009 | 911,906 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| It-3 (BE34-BE43)1 | 77,146 | 26237019,572 | Tul. sebelah | 2,797 | 0,008 | 786,349 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| It-4 (BE44-BE55)1 | 64,271 | 21858287,985 | Tul. sebelah | 2,330 | 0,006 | 655,114 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| It atap (BE56-BE57)1 | 6,171 | 2098730,301 | Tul. sebelah | 0,224 | 0,001 | 62,901 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

**3.Momen Nominal Aktual**

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | $\rho$ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| GF (BE1-BE10)1 | 6 | 2280,802 | 3 | 1140,401 | 165,227 | 165,227 | 113,552 | 204,301 | 52,382 | 256,683 | 320,853 | 0,0112 | 4,012 | 138,318 | 172,898 |
| It-1 (BE11-BE14)3 | 9 | 3421,202 | 5 | 1900,668 | 165,227 | 165,227 | 124,052 | 608,384 | 181,516 | 789,900 | 987,375 | 0,0074 | 2,766 | 451,810 | 564,763 |
| It-1 (BE15-BE24)2 | 4 | 1520,534 | 2 | 760,267 | -52,160 | 52,160 | 89,186 | 281,099 | 18,855 | 300,055 | 375,068 | 0,0047 | 1,797 | 156,660 | 195,825 |
| It-1 (BE25)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| It-2 (BE26-BE33)1 | 6 | 2280,802 | 3 | 1140,401 | 165,227 | 165,227 | 113,552 | 204,301 | 52,382 | 256,683 | 320,853 | 0,0112 | 4,012 | 138,318 | 172,898 |
| It-3 (BE34-BE43)1 | 6 | 2280,802 | 4 | 1520,534 | -52,160 | 52,160 | 130,668 | 227,966 | 22,048 | 250,015 | 312,519 | 0,0150 | 5,139 | 177,171 | 221,464 |
| It-4 (BE44-BE55)1 | 5 | 1900,668 | 3 | 1140,401 | -52,160 | 52,160 | 109,927 | 199,048 | 16,536 | 215,585 | 269,481 | 0,0112 | 4,012 | 138,318 | 172,898 |
| It atap (BE56-BE57)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | Mkap$^+$ | Mkap | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (kN) | (kN) | (kN) | (kNm) | (kNm) | (kN) | (kN) | (kN) |
| GF (BE1-BE10)1 | 59,467 | 29,046 | 5,425 | 172,898 | 320,863 | 146,112 | 115,724 | 115,724 |
| GF (BE1-BE10)1 | 59,467 | 29,046 | 8,739 | 564,763 | 987,375 | 337,756 | 207,303 | 207,303 |
| lt-1 (BE11-BE14)3 | 140,806 | 21,671 | 8,739 | 195,825 | 375,069 | 179,655 | 184,270 | 179,655 |
| lt-1 (BE11-BE14)3 | 73,011 | 39,536 | 15,737 | 195,825 | 375,069 | 179,655 | 75,181 | 75,181 |
| lt-1 (BE15-BE24)2 | 73,011 | 39,536 | 15,737 | 119,799 | 105,677 | 76,737 | 75,181 | 75,181 |
| lt-1 (BE15-BE24)2 | 40,416 | 9,541 | 5,411 | 119,799 | 105,677 | 76,737 | 128,294 | 128,294 |
| lt-1 (BE25)1 | 40,416 | 9,541 | 5,411 | 172,898 | 320,853 | 148,367 | 128,294 | 116,365 |
| lt-2 (BE26-BE33)1 | 60,118 | 30,643 | 7,881 | 172,898 | 320,853 | 148,367 | 116,365 | 116,365 |
| lt-2 (BE26-BE33)1 | 60,118 | 30,643 | 6,669 | 221,464 | 312,519 | 145,865 | 116,365 | 125,229 |
| lt-3 (BE34-BE43)1 | 54,527 | 29,625 | 6,669 | 221,464 | 312,519 | 145,865 | 125,229 | 125,229 |
| lt-3 (BE34-BE43)1 | 54,527 | 29,625 | 7,742 | 172,898 | 268,481 | 140,354 | 125,229 | 36,595 |
| lt-4 (BE44-BE55)1 | 58,862 | 29,436 | 7,742 | 172,898 | 268,481 | 140,354 | 36,595 | 36,595 |
| lt-4 (BE44-BE55)1 | 58,862 | 29,436 | 0,614 | 119,799 | 105,677 | 58,718 | 36,595 | 36,595 |
| lt atap (BE56-BE57)1 | 28,803 | 3,993 | 0,614 | 119,799 | 105,677 | 58,718 | 36,595 | 36,595 |

**5.Perencanaan Tulangan Geser**

Daerah Sendi Plastis

| Lantai | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|
| | Kn | | Kn | mm | mm | mm | | |
| GF (BE1-BE10)1 | 115,724 | 0,000 | 192,873 | 132,523 | 84,75 | 80 | P10-90 | AMAN |
| GF (BE1-BE10)1 | 207,303 | 0,000 | 345,504 | 139,447 | 159,75 | 135 | P10-135 | AMAN |
| lt-1 (BE11-BE14)3 | 179,655 | 0,000 | 299,425 | 135,726 | 134,75 | 130 | P10-130 | AMAN |
| lt-1 (BE15-BE24)2 | 75,181 | 0,000 | 125,302 | 203,988 | 84,75 | 80 | P10-80 | AMAN |
| lt-1 (BE25)1 | 128,294 | 0,000 | 213,824 | 119,538 | 84,75 | 80 | P10-80 | AMAN |
| lt-2 (BE26-BE33)1 | 116,365 | 0,000 | 193,942 | 131,792 | 84,75 | 80 | P10-80 | AMAN |
| lt-3 (BE34-BE43)1 | 125,229 | 0,000 | 208,716 | 122,464 | 84,75 | 80 | P10-80 | AMAN |
| lt-4 (BE44-BE55)1 | 36,595 | 0,000 | 60,991 | 419,079 | 84,75 | 80 | P10-80 | AMAN |
| lt atap (BE56-BE57)1 | 36,595 | 0,000 | 60,991 | 419,079 | 84,75 | 80 | P10-80 | AMAN |

Daerah Luar Sendi Plastis

| Lantai | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|
| | Kn | | Kn | mm | mm | mm | | |
| GF (BE1-BE10)1 | 72,3948 | 84,750 | 36,908 | 692,531 | 169,5 | 165 | P10-165 | AMAN |
| GF (BE1-BE10)1 | 130,76 | 213,000 | 4,933 | 9765,800 | 319,5 | 315 | P10-315 | AMAN |
| lt-1 (BE11-BE14)3 | 113,321 | 134,750 | 54,118 | 750,943 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BE15-BE24)2 | 47,4218 | 84,750 | -5,714 | -4473,616 | 169,5 | 165 | P10-165 | AMAN |
| lt-1 (BE25)1 | 80,9241 | 84,750 | 50,123 | 508,842 | 169,5 | 165 | P10-165 | AMAN |
| lt-2 (BE26-BE33)1 | 73,3996 | 84,750 | 37,583 | 680,103 | 169,5 | 165 | P10-165 | AMAN |
| lt-3 (BE34-BE43)1 | 78,9908 | 84,750 | 46,901 | 544,975 | 169,5 | 165 | P10-165 | AMAN |
| lt-4 (BE44-BE55)1 | 23,0827 | 84,750 | -46,279 | -552,307 | 169,5 | | | |

## PENULANGAN LENTUR BALOK PADA PORTAL B-F

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b | = 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | Rn | = 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = 0,85 |
| diameter tul pokok | = | 22 mm | **ρ maks** | = | 0,020 | | |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | | |
| d' | = | 61 mm | **ρ pakai** | = | 0,010 | | |
| d | = | 539 mm | m | = | 18,824 | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BF1-BF5) | 94,377 | 32097207,841 | Tul. sebelah | 1,015 | 0,003 | 605,033 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BF6-BF15) | 290,831 | 98910360,084 | Tul. sebelah | 3,128 | 0,009 | 1864,461 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-1 (BF16-BF27) | 448,025 | 152371356,825 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 132,915 | 298,207 | 298,207 | 932,455 | 5 | 1900,668 | 5D22 | 3122,984 | 9 | 3421,202 | 9D22 | 7 | 24,3 |
| lt-2 (BF28-BF37) | 293,516 | 99823516,924 | Tul. sebelah | 3,157 | 0,009 | 1881,674 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-3 (BF38-BF47) | 287,917 | 97919321,339 | Tul. sebelah | 3,097 | 0,009 | 1845,780 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-4 (BF48-BF59) | 266,432 | 90612366,144 | Tul. sebelah | 2,866 | 0,008 | 1708,044 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt atap (BF60-BF63) | 120,508 | 40984247,460 | Tul. sebelah | 1,296 | 0,004 | 772,554 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BF1-BF5) | 38,076 | 12949482,244 | Tul. sebelah | 0,410 | 0,001 | 244,098 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BF6-BF15) | 290,831 | 98910360,084 | Tul. sebelah | 3,128 | 0,009 | 1864,461 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-1 (BF16-BF27) | 207,011 | 70403542,096 | Tul. sebelah | 2,227 | 0,006 | 1327,108 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt-2 (BF28-BF37) | 226,725 | 77108187,883 | Tul. sebelah | 2,439 | 0,007 | 1453,490 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt-3 (BF38-BF47) | 242,335 | 82417081,092 | Tul. sebelah | 2,607 | 0,007 | 1553,563 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| lt-4 (BF48-BF59) | 224,666 | 76407930,924 | Tul. sebelah | 2,417 | 0,007 | 1440,290 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt atap (BF60-BF63) | 6,352 | 2160287,615 | Tul. sebelah | 0,068 | 0,000 | 40,721 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak⁻ | Mkap⁻ | ρ aktual | Rn | Mnak⁺ | Mkap⁺ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BF1-BF5) | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BF6-BF15) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BF16-BF27) | 9 | 3421,202 | 5 | 1900,668 | 165,227 | 165,227 | 124,052 | 502,840 | 150,112 | 653,052 | 816,315 | 0,0088 | 3,234 | 375,784 | 469,730 |
| lt-2 (BF28-BF37) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BF38-BF47) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-4 (BF48-BF59) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BF60-BF63) | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,899 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| Sloop (BF1-BF5) | 48,77 | 0,931 | 12,184 | 198,092 | 181,704 | 93,087 | 103,359 | 93,087 |
| GF (BF6-BF15) | 120,333 | 51,775 | 25,352 | 292,038 | 473,711 | 263,179 | 287,192 | 263,179 |
| lt-1 (BF16-BF27) | 119,826 | 48,157 | 55,814 | 489,730 | 816,315 | 314,879 | 410,801 | 314,879 |
| lt-2 (BF28-BF37) | 133,029 | 50,584 | 35,002 | 292,038 | 473,711 | 275,259 | 339,802 | 275,259 |
| lt-3 (BF38-BF47) | 140,845 | 40,087 | 30,478 | 292,038 | 473,711 | 272,444 | 317,986 | 272,444 |
| lt-4 (BF48-BF59) | 106,499 | 52,8 | 30,517 | 292,038 | 473,711 | 249,729 | 285,435 | 249,729 |
| lt atap (BF60-BF63) | 57,89 | 4,941 | 3,894 | 198,092 | 282,450 | 117,723 | 82,327 | 82,327 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BF1-BF5) | 93,087 | 0,000 | 155,145 | 261,946 | 134,75 | 130 | P10-130 | AMAN |
| GF (BF6-BF15) | 263,179 | 0,000 | 438,631 | 92,651 | 134,75 | 90 | P10-90 | AMAN |
| lt-1 (BF16-BF27) | 314,879 | 0,000 | 524,799 | 77,439 | 134,75 | 75 | P10-75 | AMAN |
| lt-2 (BF28-BF37) | 275,259 | 0,000 | 458,765 | 88,585 | 134,75 | 85 | P10-85 | AMAN |
| lt-3 (BF38-BF47) | 272,444 | 0,000 | 454,073 | 89,500 | 134,75 | 85 | P10-85 | AMAN |
| lt-4 (BF48-BF59) | 249,729 | 0,000 | 416,215 | 97,641 | 134,75 | 95 | P10-95 | AMAN |
| lt atap (BF60-BF63) | 82,327 | 0,000 | 137,212 | 296,182 | 134,75 | 130 | P10-130 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BF1-BF5) | 58,7165 | 179,667 | -81,806 | -496,783 | 269,5 | 265 | P10-265 | AMAN |
| GF (BF6-BF15) | 166,005 | 179,667 | 97,008 | 418,930 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BF16-BF27) | 198,616 | 179,667 | 151,360 | 268,497 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BF28-BF37) | 173,625 | 179,667 | 109,708 | 370,435 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BF38-BF47) | 171,849 | 179,667 | 106,749 | 380,705 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BF48-BF59) | 157,521 | 179,667 | 82,869 | 490,409 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BF60-BF63) | 51,9296 | 179,667 | -93,117 | -436,435 | 269,5 | 265 | P10-265 | AMAN |

## PENULANGAN LENTUR BALOK PADA PORTAL B-G

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | $\Phi_0$ | = | 1,25 | b1 = | 300 mm |
| Fy polos | = | 240 | MPa | $\Phi$ | = | 0,8 | h1 = | 400 mm |
| fc' | = | 25 | MPa | $\Phi$ | = | 0,600 | b2 = | 300 mm |
| penutup beton (pb) | = | 40 | mm | pb | = | 0,027 | h2 = | 600 mm |
| diameter tul.pokok | = | 22 | mm | $\rho$ maks | = | 0,020 | b3 = | 400 mm |
| diameter sengkang | = | 10 | mm | $\rho$ min | = | 0,004 | h3 = | 700 mm |
| d' | = | 61 | mm | $\rho$ pakai | = | 0,010 | | |
| d1 | = | 339 | mm | m | = | 18,824 | | |
| d2 | = | 539 | mm | Rn | = | 3,675 | MPa | |
| d3 | = | 639 | mm | $\beta$ | = | 0,85 | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BG1-BG10)1 | 141,472 | 48114012,818 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 50,125 | 120,157 | 120,157 | 1500,587 | 4 | 1520,534 | 4D22 | 2533,855 | 7 | 2660,935 | 7D22 | 4 | 37,3 |
| lt-1 (BG11-BG14)3 | 483,974 | 164587455,606 | Tul. rangkap | | | | | | | | | 2586,936 | 600,303 | 4,664 | 345,436 | 345,436 | 23,381 | 4 | 1520,534 | 4D22 | 2620,297 | 7 | 2660,935 | 7D22 | 4 | 70,7 |
| lt-1 (BG15-BG24)2 | 165,493 | 56283450,600 | Tul. sebelah | 2,374 | 0,007 | 1060,944 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| lt-1 (BG25)1 | 71,823 | 24426690,388 | Tul. sebelah | 2,604 | 0,007 | 732,091 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-2 (BG26-BG35)1 | 119,776 | 40735297,439 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 23,005 | 120,157 | 120,157 | 888,682 | 3 | 1140,401 | 3D22 | 1721,970 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| lt-3 (BG36-BG45)1 | 98,325 | 33439805,496 | Tul. sebelah | 3,565 | 0,010 | 1002,226 | 3 | 1140,401 | 3D24 | 3 | 67,0 | | | | | | | | | | | | | | | |
| lt-4 (BG46-BG57)1 | 116,778 | 39715690,659 | Tul. rangkap | | | | | | | | | 1033,288 | 126,715 | 19,257 | 120,157 | 120,157 | 576,484 | 3 | 1140,401 | 3D22 | 1609,782 | 5 | 1900,668 | 5D22 | 5 | 22,5 |
| lt atap (BG58-BG59)1 | 47,711 | 16226303,902 | Tul. sebelah | 1,730 | 0,005 | 486,318 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As perlu | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tu | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| GF (BG1-BG10)1 | 96,762 | 32908335,984 | Tul. sebelah | 3,508 | 0,010 | 986,295 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | | |
| lt-1 (BG11-BG14)3 | 254,184 | 86446874,534 | Tul. sebelah | 1,945 | 0,005 | 1374,513 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| lt-1 (BG15-BG24)2 | 87,752 | 29844074,112 | Tul. sebelah | 1,298 | 0,003 | 562,561 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-1 (BG25)1 | 43,861 | 14916935,621 | Tul. sebelah | 1,590 | 0,004 | 447,075 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-2 (BG26-BG35)1 | 65,005 | 22107918,197 | Tul. sebelah | 2,357 | 0,007 | 662,596 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-3 (BG36-BG45)1 | 66,507 | 22618741,875 | Tul. sebelah | 2,411 | 0,007 | 677,905 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt-4 (BG46-BG57)1 | 61,574 | 20941049,998 | Tul. sebelah | 2,232 | 0,006 | 627,623 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |
| lt atap (BG58-BG59)1 | 3,773 | 1283180,915 | Tul. sebelah | 0,137 | 0,000 | 38,458 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| GF (BG1-BG10)1 | 7 | 2660,935 | 4 | 1520,534 | 165,227 | 127,552 | 223,796 | 69,843 | 298,639 | 367,049 | 0,0150 | 5,139 | 177,171 | 221,464 |
| lt-1 (BG11-BG14)3 | 7 | 2660,935 | 4 | 1520,534 | 20,302 | 20,302 | 121,589 | 597,578 | 17,843 | 615,421 | 768,276 | 0,0059 | 2,246 | 366,888 | 458,610 |
| lt-1 (BG15-BG24)2 | 3 | 1140,401 | 2 | 760,267 | -704,319 | 400,000 | 23,852 | 80,143 | 145,363 | 225,507 | 281,883 | 0,0047 | 1,797 | 156,660 | 195,825 |
| lt-1 (BG25)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-2 (BG26-BG35)1 | 5 | 1900,668 | 3 | 1140,401 | -52,160 | 52,160 | 109,927 | 199,048 | 16,536 | 215,585 | 269,481 | 0,0112 | 4,012 | 138,318 | 172,898 |
| lt-3 (BG36-BG45)1 | 3 | 1140,401 | 2 | 760,267 | -704,319 | 400,000 | 23,852 | 48,733 | 84,542 | 134,274 | 167,843 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-4 (BG46-BG57)1 | 5 | 1900,668 | 3 | 1140,401 | -52,160 | 52,160 | 109,927 | 199,048 | 16,536 | 215,585 | 269,481 | 0,0112 | 4,012 | 138,318 | 172,898 |
| lt atap (BG58-BG59)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| GF (BG1-BG10)1 | 81,56 | 29,987 | 5,845 | 221,464 | 367,048 | 180,503 | 141,673 | 141,673 |
| lt-1 (BG11-BG14)3 | 137,094 | 26,518 | 15,681 | 458,610 | 769,276 | 304,027 | 237,653 | 237,653 |
| lt-1 (BG15-BG24)2 | 59,405 | 35,23 | 12,137 | 195,825 | 281,883 | 150,812 | 150,342 | 150,342 |
| lt-1 (BG25)1 | 40,683 | 9,436 | 5,75 | 119,799 | 105,677 | 76,907 | 76,775 | 76,775 |
| lt-2 (BG26-BG35)1 | 47,181 | 29,697 | 7,807 | 172,898 | 269,481 | 128,363 | 113,511 | 113,511 |
| lt-3 (BG36-BG45)1 | 48,876 | 18,903 | 6,688 | 119,799 | 167,843 | 102,145 | 99,258 | 99,258 |
| lt-4 (BG46-BG57)1 | 58,327 | 29,625 | 6,72 | 172,898 | 269,481 | 139,990 | 120,574 | 120,574 |
| lt atap (BG58-BG59)1 | 28,82 | 3,983 | 2,671 | 119,799 | 105,677 | 58,725 | 45,661 | 45,661 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| GF (BG1-BG10)1 | 141,673 | 0,000 | 236,122 | 108,248 | 84,75 | 80 | P10-80 | AMAN |
| lt-1 (BG11-BG14)3 | 237,653 | 0,000 | 396,088 | 121,639 | 159,75 | 120 | P10-120 | AMAN |
| lt-1 (BG15-BG24)2 | 150,342 | 0,000 | 250,570 | 162,189 | 134,75 | 130 | P10-130 | AMAN |
| lt-1 (BG25)1 | 76,775 | 0,000 | 127,958 | 199,753 | 84,75 | 80 | P10-80 | AMAN |
| lt-2 (BG26-BG35)1 | 113,511 | 0,000 | 189,186 | 135,106 | 84,75 | 80 | P10-80 | AMAN |
| lt-3 (BG36-BG45)1 | 99,258 | 0,000 | 165,429 | 154,507 | 84,75 | 80 | P10-80 | AMAN |
| lt-4 (BG46-BG57)1 | 120,574 | 0,000 | 200,956 | 127,192 | 84,75 | 80 | P10-80 | AMAN |
| lt atap (BG58-BG59)1 | 45,661 | 0,000 | 76,102 | 335,865 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| GF (BG1-BG10)1 | 89,3632 | 84,750 | 64,189 | 398,202 | 169,5 | 165 | P10-165 | AMAN |
| lt-1 (BG11-BG14)3 | 149,904 | 213,000 | 36,840 | 1307,802 | 319,5 | 315 | P10-315 | AMAN |
| lt-1 (BG15-BG24)2 | 94,8312 | 134,750 | 23,302 | 1744,045 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BG25)1 | 48,4273 | 84,750 | -4,038 | -6330,080 | 169,5 | 165 | P10-165 | AMAN |
| lt-2 (BG26-BG35)1 | 71,5984 | 84,750 | 34,582 | 739,106 | 169,5 | 165 | P10-165 | AMAN |
| lt-3 (BG36-BG45)1 | 62,6086 | 84,750 | 19,598 | 1304,239 | 169,5 | 165 | P10-165 | AMAN |
| lt-4 (BG46-BG57)1 | 76,0541 | 84,750 | 42,007 | 608,473 | 169,5 | 165 | P10-165 | AMAN |
| lt atap (BG58-BG59)1 | 28,8018 | 84,750 | 33,900 | 753,984 | 169,5 | 165 | P10-165 | AMAN |

## PENULANGAN LENTUR BALOK PADA PORTAL B-H

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbc |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BH1-BH5)1 | 126,731 | 43100662,735 | Tul. sebelah | 1,363 | 0,004 | 812,448 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | | |
| GF (BH6-BH17)1 | 280,323 | 95336634,918 | Tul. sebelah | 3,015 | 0,008 | 1797,097 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-1 (BH18-BH34)1 | 325,918 | 110843296,409 | Tul. sebelah | 3,506 | 0,010 | 2089,397 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-2 (BH35-BH46)1 | 328,250 | 111636388,482 | Tul. sebelah | 3,531 | 0,010 | 2104,347 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-3 (BH47-BH58)1 | 330,731 | 112480176,807 | Tul. sebelah | 3,558 | 0,010 | 2120,253 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-4 (BH59-BH70)1 | 273,121 | 92887265,995 | Tul. sebelah | 2,938 | 0,008 | 1750,926 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It atap (BH71-BH78)1 | 183,470 | 62397350,230 | Tul. sebelah | 1,974 | 0,005 | 1176,191 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| blk ring (BH79-BH82)2 | 69,966 | 23795132,753 | Tul. sebelah | 2,537 | 0,007 | 713,163 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BH1-BH5)1 | 50,632 | 17219723,316 | Tul. sebelah | 0,545 | 0,002 | 324,592 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BH6-BH17)1 | 273,169 | 92903590,586 | Tul. sebelah | 2,938 | 0,008 | 1751,234 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-1 (BH18-BH34)1 | 273,880 | 93145398,599 | Tul. sebelah | 2,946 | 0,008 | 1755,792 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-2 (BH35-BH46)1 | 264,522 | 89962783,439 | Tul. sebelah | 2,845 | 0,008 | 1695,800 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-3 (BH47-BH58)1 | 267,785 | 91072515,568 | Tul. sebelah | 2,880 | 0,008 | 1716,718 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-4 (BH59-BH70)1 | 234,209 | 79653483,781 | Tul. sebelah | 2,519 | 0,007 | 1501,469 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It atap (BH71-BH78)1 | 88,843 | 30215118,474 | Tul. sebelah | 0,956 | 0,003 | 569,555 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| blk ring (BH79-BH82)2 | 66,786 | 22713628,563 | Tul. sebelah | 2,421 | 0,007 | 680,749 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BH1-BH5)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BH6-BH17)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-1 (BH18-BH34)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-2 (BH35-BH46)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-3 (BH47-BH58)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-4 (BH59-BH70)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It atap (BH71-BH78)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BH79-BH82)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BH1-BH5)1 | 121,393 | 11,461 | 13,09 | 198,092 | 282,450 | 191,247 | 194,475 | 191,247 |
| GF (BH6-BH17)1 | 161,284 | 52,434 | 27,819 | 282,038 | 473,711 | 306,880 | 341,254 | 306,880 |
| lt-1 (BH18-BH34)1 | 162,39 | 51,11 | 60,353 | 282,038 | 554,777 | 315,370 | 477,658 | 315,370 |
| lt-2 (BH35-BH46)1 | 153,82 | 53,323 | 36,488 | 282,038 | 554,777 | 308,696 | 370,750 | 308,696 |
| lt-3 (BH47-BH58)1 | 157,605 | 42,425 | 30,586 | 282,038 | 554,777 | 301,227 | 338,409 | 301,227 |
| lt-4 (BH59-BH70)1 | 146,328 | 52,261 | 26,854 | 282,038 | 473,711 | 290,984 | 321,305 | 290,984 |
| lt atap (BH71-BH78)1 | 73,57 | 6,956 | 21,331 | 198,092 | 382,199 | 147,045 | 174,143 | 147,045 |
| blk ring (BH79-BH82)2 | 37,767 | 0,17 | 4,443 | 119,799 | 105,677 | 64,116 | 58,494 | 58,494 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BH1-BH5)1 | 191,247 | 0,000 | 318,746 | 127,499 | 134,75 | 125 | P10-125 | AMAN |
| GF (BH6-BH17)1 | 306,880 | 0,000 | 511,466 | 79,457 | 134,75 | 75 | P10-75 | AMAN |
| lt-1 (BH18-BH34)1 | 315,370 | 0,000 | 525,617 | 77,318 | 134,75 | 75 | P10-75 | AMAN |
| lt-2 (BH35-BH46)1 | 308,696 | 0,000 | 514,493 | 78,990 | 134,75 | 75 | P10-75 | AMAN |
| lt-3 (BH47-BH58)1 | 301,227 | 0,000 | 502,045 | 80,948 | 134,75 | 80 | P10-80 | AMAN |
| lt-4 (BH59-BH70)1 | 290,984 | 0,000 | 484,973 | 83,798 | 134,75 | 80 | P10-80 | AMAN |
| lt atap (BH71-BH78)1 | 147,045 | 0,000 | 245,075 | 165,825 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BH79-BH82)2 | 58,494 | 0,000 | 97,491 | 262,179 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BH1-BH5)1 | 120,633 | 179,667 | 21,388 | 1900,097 | 269,5 | 265 | P10-265 | AMAN |
| GF (BH6-BH17)1 | 193,57 | 179,667 | 142,950 | 284,293 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BH18-BH34)1 | 198,926 | 179,667 | 151,877 | 267,584 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BH35-BH46)1 | 194,716 | 179,667 | 144,859 | 280,546 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BH47-BH58)1 | 190,005 | 179,667 | 137,008 | 296,824 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BH59-BH70)1 | 183,544 | 179,667 | 126,239 | 321,926 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BH71-BH78)1 | 92,7516 | 179,667 | -25,081 | -1620,361 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BH79-BH82)2 | 36,8965 | 84,750 | -23,256 | -1099,082 | 169,5 | 165 | P10-165 | AMAN |

## PENULANGAN LENTUR BALOK PADA PORTAL B-I

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul.pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,924 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (Bl1-Bl5)1 | 125,146 | 42561611,118 | Tul. sebelah | 1,346 | 0,004 | 802,287 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |
| Bordes (Bl6)2 | 47,952 | 16308266,955 | Tul. sebelah | 1,739 | 0,005 | 488,774 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| GF (Bl7-Bl19)1 | 321,933 | 109454005,649 | Tul. sebelah | 3,462 | 0,010 | 2063,209 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| Bordes (Bl20)2 | 50,330 | 17117014,428 | Tul. sebelah | 1,825 | 0,005 | 513,013 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-1 (Bl21-Bl33)1 | 346,558 | 117862870,774 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 6,081 | 298,207 | 298,207 | 42,660 | 3 | 1140,401 | 3D22 | 2233,190 | 6 | 2280,802 | 6D22 | 6 | 33,6 |
| Bordes (Bl34)2 | 56,283 | 19141603,875 | Tul. sebelah | 2,041 | 0,006 | 573,692 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-2 (Bl35-Bl47)1 | 349,345 | 118810717,371 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 9,565 | 298,207 | 298,207 | 67,100 | 3 | 1140,401 | 3D22 | 2257,630 | 6 | 2280,802 | 6D22 | 6 | 33,6 |
| Bordes (Bl48)2 | 53,638 | 18242050,862 | Tul. sebelah | 1,945 | 0,005 | 546,732 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-3 (Bl49-Bl61)1 | 342,676 | 116542619,433 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 1,228 | 298,207 | 298,207 | 8,618 | 3 | 1140,401 | 3D22 | 2199,147 | 6 | 2280,802 | 6D22 | 6 | 33,6 |
| Bordes (Bl62)2 | 43,988 | 14960127,770 | Tul. sebelah | 1,595 | 0,004 | 448,369 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-4 (Bl63-Bl75)1 | 290,465 | 98785885,074 | Tul. sebelah | 3,124 | 0,009 | 1862,115 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| It atap (Bl76-Bl89)1 | 139,696 | 47510002,931 | Tul. sebelah | 1,503 | 0,004 | 895,564 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |
| blk ring (Bl90-Bl95)2 | 37,122 | 12625030,987 | Tul. sebelah | 1,346 | 0,004 | 378,384 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (Bl1-Bl5)1 | 38,902 | 13230401,257 | Tul. sebelah | 0,418 | 0,001 | 249,393 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| Bordes (Bl6)2 | 15,736 | 5351745,262 | Tul. sebelah | 0,571 | 0,002 | 160,397 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| GF (Bl7-Bl19)1 | 309,400 | 105225586,343 | Tul. sebelah | 3,328 | 0,009 | 1983,504 | 6 | 2280,802 | 6D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (Bl20)2 | 18,344 | 6238714,736 | Tul. sebelah | 0,665 | 0,002 | 186,980 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-1 (Bl21-Bl33)1 | 293,122 | 99689519,235 | Tul. sebelah | 3,153 | 0,009 | 1879,149 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| Bordes (Bl34)2 | 16,283 | 5537777,586 | Tul. sebelah | 0,590 | 0,002 | 165,973 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-2 (Bl35-Bl47)1 | 293,009 | 99651088,426 | Tul. sebelah | 3,152 | 0,009 | 1878,424 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| Bordes (Bl48)2 | 14,104 | 4796709,149 | Tul. sebelah | 0,511 | 0,001 | 143,762 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-3 (Bl49-Bl61)1 | 310,610 | 105637112,088 | Tul. sebelah | 3,341 | 0,009 | 1991,261 | 6 | 2280,802 | 6D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| Bordes (Bl62)2 | 12,619 | 4291667,098 | Tul. sebelah | 0,458 | 0,001 | 128,625 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| It-4 (Bl63-Bl75)1 | 269,947 | 91807802,379 | Tul. sebelah | 2,904 | 0,008 | 1730,578 | 5 | 1900,668 | 5D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| It atap (Bl76-Bl89)1 | 139,880 | 47572580,532 | Tul. sebelah | 1,505 | 0,004 | 896,744 | 3 | 1140,401 | 3D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| blk ring (Bl90-Bl95)2 | 36,996 | 12582178,934 | Tul. sebelah | 1,341 | 0,004 | 377,100 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (Bl1-Bl5)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| Bordes (Bl6)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| GF (Bl7-Bl19)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| Bordes (Bl20)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| It-1 (Bl21-Bl33)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| Bordes (Bl34)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| It-2 (Bl35-Bl47)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| Bordes (Bl48)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| It-3 (Bl49-Bl61)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| Bordes (Bl62)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| It-4 (Bl63-Bl75)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | | 146,933 | 146,933 | 183,666 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It atap (Bl76-Bl89)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (Bl90-Bl95)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (Bl1-Bl5)1 | 54,322 | 0,566 | 13,521 | 198,092 | 225,960 | 103,300 | 114,421 | 103,300 |
| Bordes (Bl6)2 | 22,063 | 2,487 | 5,509 | 119,799 | 84,542 | 47,783 | 48,916 | 47,783 |
| GF (Bl7-Bl19)1 | 234,474 | 26,81 | 27,889 | 292,038 | 443,821 | 353,595 | 391,482 | 353,595 |
| Bordes (Bl20)2 | 13,742 | 1,397 | 8,514 | 119,799 | 84,542 | 37,902 | 51,655 | 37,902 |
| lt-1 (Bl21-Bl33)1 | 176,625 | 39,057 | 34,562 | 292,038 | 443,821 | 305,712 | 371,627 | 305,712 |
| Bordes (Bl34)2 | 17,837 | 1,884 | 9,033 | 119,799 | 84,542 | 42,713 | 58,646 | 42,713 |
| lt-2 (Bl35-Bl47)1 | 170,681 | 39,254 | 34,669 | 292,038 | 443,821 | 299,678 | 366,042 | 299,678 |
| Bordes (Bl48)2 | 17,330 | 1,904 | 8,386 | 119,799 | 84,542 | 42,202 | 55,417 | 42,202 |
| lt-3 (Bl49-Bl61)1 | 183,806 | 39,52 | 30,813 | 292,038 | 443,821 | 313,739 | 363,907 | 313,739 |
| Bordes (Bl62)2 | 13,548 | 1,415 | 6,985 | 119,799 | 84,542 | 37,717 | 45,048 | 37,717 |
| lt-4 (Bl63-Bl75)1 | 163,807 | 35,65 | 21,255 | 292,038 | 146,933 | 256,704 | 298,701 | 256,704 |
| lt atap (Bl76-Bl89)1 | 80,554 | 10,653 | 9,802 | 198,092 | 225,960 | 141,434 | 136,936 | 136,936 |
| blk ring (Bl90-Bl95)2 | 23,358 | 1,987 | 0,568 | 119,799 | 84,542 | 48,618 | 28,998 | 28,998 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (Bl1-Bl5)1 | 103,300 | 0,000 | 172,166 | 236,050 | 134,75 | 130 | P10-130 | AMAN |
| Bordes (Bl6)2 | 47,783 | 0,000 | 79,639 | 320,949 | 84,75 | 80 | P10-80 | AMAN |
| GF (Bl7-Bl19)1 | 353,595 | 0,000 | 589,324 | 68,960 | 134,75 | 65 | P10-65 | AMAN |
| Bordes (Bl20)2 | 37,902 | 0,000 | 63,170 | 404,625 | 84,75 | 80 | P10-80 | AMAN |
| lt-1 (Bl21-Bl33)1 | 305,712 | 0,000 | 509,521 | 79,761 | 134,75 | 75 | P10-75 | AMAN |
| Bordes (Bl34)2 | 42,713 | 0,000 | 71,188 | 359,049 | 84,75 | 80 | P10-80 | AMAN |
| lt-2 (Bl35-Bl47)1 | 299,678 | 0,000 | 499,464 | 81,367 | 134,75 | 80 | P10-80 | AMAN |
| Bordes (Bl48)2 | 42,202 | 0,000 | 70,336 | 363,400 | 84,75 | 80 | P10-80 | AMAN |
| lt-3 (Bl49-Bl61)1 | 313,739 | 0,000 | 522,898 | 77,720 | 134,75 | 75 | P10-75 | AMAN |
| Bordes (Bl62)2 | 37,717 | 0,000 | 62,862 | 406,608 | 84,75 | 80 | P10-80 | AMAN |
| lt-4 (Bl63-Bl75)1 | 256,704 | 0,000 | 427,839 | 94,988 | 134,75 | 90 | P10-90 | AMAN |
| lt atap (Bl76-Bl89)1 | 136,936 | 0,000 | 228,226 | 178,068 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (Bl90-Bl95)2 | 28,998 | 0,000 | 48,330 | 528,868 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (Bl1-Bl5)1 | 65,1582 | 179,667 | -71,070 | -571,829 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (Bl6)2 | 30,1403 | 84,750 | -34,516 | -740,524 | 169,5 | 165 | P10-165 | AMAN |
| GF (Bl7-Bl19)1 | 223,037 | 179,667 | 192,061 | 211,598 | 269,5 | 210 | P10-210 | AMAN |
| Bordes (Bl20)2 | 23,9073 | 84,750 | -44,904 | -569,209 | 169,5 | 165 | P10-165 | AMAN |
| lt-1 (Bl21-Bl33)1 | 192,834 | 179,667 | 141,723 | 286,754 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (Bl34)2 | 26,942 | 84,750 | -39,847 | -641,460 | 169,5 | 165 | P10-165 | AMAN |
| lt-2 (Bl35-Bl47)1 | 189,028 | 179,667 | 135,380 | 300,191 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (Bl48)2 | 26,6195 | 84,750 | -40,384 | -632,922 | 169,5 | 165 | P10-165 | AMAN |
| lt-3 (Bl49-Bl61)1 | 197,897 | 179,667 | 150,161 | 270,641 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (Bl62)2 | 23,7907 | 84,750 | -45,099 | -566,757 | 169,5 | 165 | P10-165 | AMAN |
| lt-4 (Bl63-Bl75)1 | 161,921 | 179,667 | 90,201 | 283,367 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (Bl76-Bl89)1 | 86,3749 | 179,667 | -35,709 | -1138,095 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (Bl90-Bl95)2 | 18,291 | 84,750 | -54,265 | -471,022 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-J

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | $\Phi_0$ | = | 1,25 | b = | 400 mm |
| Fy polos | = | 240 | MPa | $\Phi$ | = | 0,8 | h = | 700 mm |
| fc' | = | 25 | MPa | $\Phi$ | = | 0,600 | Rn = | 3,675 MPa |
| penutup beton (pb) | = | 40 | mm | pb | = | 0,027 | β = | 0,85 |
| diameter tul pokok | = | 22 | mm | $\rho$ maks | = | 0,020 | | |
| diameter sengkang | = | 10 | mm | $\rho$ min | = | 0,004 | | |
| d' | = | 61 | mm | $\rho$ pakai | = | 0,010 | | |
| d1 | = | 639 | mm | m | = | 18,824 | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| It atap (BJ1-BJ4) | 591,759 | 201254666,019 | Tul. rangkap | | | | | | | | | 2596,936 | 600,303 | 139,396 | 345,436 | 345,436 | 698,159 | 5 | 1900,668 | 5D22 | 3295,095 | 9 | 3421,202 | 9D22 | 7 | 24,3 |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| It atap (BJ1-BJ4) | 580,710 | 197496949,103 | Tul. rangkap | | | | | | | | | 2596,936 | 600,303 | 125,584 | 345,436 | 345,436 | 628,985 | 2 | 760,267 | 2D22 | 3225,921 | 9 | 3421,202 | 9D22 | 7 | 24,3 |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | $\rho$ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| It atap (BJ1-BJ4) | 9 | 3421,202 | 5 | 1900,668 | 165,227 | 165,227 | 124,052 | 608,384 | 181,516 | 789,900 | 987,375 | 0,0074 | 2,766 | 451,810 | 564,763 |

### 4.Gaya Geser Rencana

Ln = 6,5 m

| Lantai | VD | VL | VE | Mkap$^+$ | Mkap$^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| It atap (BJ1-BJ4) | 167,2 | 25,063 | 124,594 | 564,763 | 987,375 | 369,028 | 725,170 | 369,028 |

### 5.Perencanaan Tulangan Geser

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| It atap (BJ1-BJ4) | 369,028 | 0,000 | 615,047 | 78,335 | 159,75 | 75 | P10-75 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| It atap (BJ1-BJ4) | 232,77 | 213,000 | 174,953 | 275,386 | 319,5 | 275 | P10-275 | AMAN |

## PENULANGAN LENTUR BALOK PADA PORTAL B-K

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,800 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BK1-BK8)1 | 78,666 | 26753964,971 | Tul. sebelah | 0,846 | 0,002 | 504,813 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BK9-BK20)1 | 206,488 | 70225672,068 | Tul. sebelah | 2,221 | 0,006 | 1323,755 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK21-BK22)2 | 40,396 | 13738504,169 | Tul. sebelah | 1,465 | 0,004 | 411,756 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-1 (BK23-BK34)1 | 229,033 | 77893128,660 | Tul. sebelah | 2,464 | 0,007 | 1468,286 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK35-BK36)2 | 52,670 | 17912838,266 | Tul. sebelah | 1,910 | 0,005 | 536,865 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-2 (BK37-BK48)1 | 238,584 | 81141382,282 | Tul. sebelah | 2,566 | 0,007 | 1529,516 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| Bordes (BK49-BK50)2 | 49,882 | 16968661,139 | Tul. sebelah | 1,812 | 0,005 | 509,486 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-3 (BK51-BK62)1 | 228,571 | 77736004,466 | Tul. sebelah | 2,459 | 0,007 | 1465,325 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK63-BK64)2 | 40,406 | 13741905,126 | Tul. sebelah | 1,465 | 0,004 | 411,858 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-4 (BK65-BK76)1 | 254,498 | 86554004,666 | Tul. sebelah | 2,738 | 0,008 | 1631,544 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt atap (BK77-BK90)1 | 136,312 | 46359119,227 | Tul. sebelah | 1,466 | 0,004 | 873,870 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |
| blk ring (BK91-BK100)2 | 40,950 | 13926917,163 | Tul. sebelah | 1,465 | 0,004 | 417,403 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BK1-BK8)1 | 38,624 | 13135854,664 | Tul. sebelah | 0,415 | 0,001 | 247,611 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BK9-BK20)1 | 210,552 | 71607820,818 | Tul. sebelah | 2,265 | 0,006 | 1349,808 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK21-BK22)2 | 13,34' | 4537216,163 | Tul. sebelah | 0,484 | 0,001 | 135,985 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-1 (BK23-BK34)1 | 204,232 | 69458416,265 | Tul. sebelah | 2,197 | 0,006 | 1309,282 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK35-BK36)2 | 19,019 | 6468279,305 | Tul. sebelah | 0,690 | 0,002 | 193,861 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-2 (BK37-BK48)1 | 207,829 | 70681740,344 | Tul. sebelah | 2,236 | 0,006 | 1332,352 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK49-BK50)2 | 17,926 | 6096554,751 | Tul. sebelah | 0,650 | 0,002 | 182,720 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-3 (BK51-BK62)1 | 219,162 | 74536044,427 | Tul. sebelah | 2,357 | 0,007 | 1405,005 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| Bordes (BK63-BK64)2 | 14,353 | 4881392,968 | Tul. sebelah | 0,520 | 0,001 | 146,300 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |
| lt-4 (BK65-BK76)1 | 245,922 | 83637004,214 | Tul. sebelah | 2,645 | 0,007 | 1576,558 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt atap (BK77-BK90)1 | 58,884 | 20026192,680 | Tul. sebelah | 0,633 | 0,002 | 377,494 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| blk ring (BK91-BK100)2 | 45,716 | 15547813,065 | Tul. sebelah | 1,658 | 0,005 | 465,983 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | $\rho$ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BK1-BK8)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BK9-BK20)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| Bordes (BK21-BK22)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-1 (BK23-BK34)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| Bordes (BK35-BK36)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-2 (BK37-BK48)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| Bordes (BK49-BK50)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-3 (BK51-BK62)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| Bordes (BK63-BK64)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |
| lt-4 (BK65-BK76)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BK77-BK90)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BK91-BK100)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BK1-BK8)1 | 47,884 | 0,581 | 23,033 | 198,092 | 145,363 | 87,981 | 147,732 | 87,981 |
| GF (BK9-BK20)1 | 105,305 | 21,167 | 39,4 | 198,092 | 305,760 | 187,057 | 298,276 | 187,057 |
| Bordes (BK21-BK22)2 | 13,055 | 6,222 | 1,475 | 119,799 | 84,542 | 42,247 | 26,436 | 26,436 |
| It-1 (BK23-BK34)1 | 97,606 | 33,801 | 56,093 | 198,092 | 305,760 | 192,238 | 373,568 | 192,238 |
| Bordes (BK35-BK36)2 | 18,603 | 2,451 | 8,339 | 119,799 | 84,542 | 44,113 | 57,131 | 44,113 |
| It-2 (BK37-BK48)1 | 100,389 | 34,398 | 63,585 | 292,038 | 378,969 | 213,789 | 408,583 | 213,789 |
| Bordes (BK49-BK50)2 | 18,489 | 2,471 | 7,694 | 119,799 | 84,542 | 44,014 | 54,323 | 44,014 |
| It-3 (BK51-BK62)1 | 105,609 | 34,397 | 53,326 | 198,092 | 305,760 | 201,267 | 370,976 | 201,267 |
| Bordes (BK63-BK64)2 | 12,374 | 1,528 | 6,361 | 119,799 | 84,542 | 36,603 | 41,313 | 36,603 |
| It-4 (BK65-BK76)1 | 139,351 | 36,213 | 35,127 | 292,038 | 378,969 | 256,604 | 331,876 | 256,604 |
| It atap (BK77-BK90)1 | 68,345 | 6,038 | 17,875 | 198,092 | 225,960 | 123,769 | 169,597 | 123,769 |
| blk ring (BK91-BK100)2 | 27,092 | 0,665 | 5,028 | 119,799 | 84,542 | 51,172 | 50,283 | 50,283 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan tulangan | |
| | Kn | | Kn | mm | mm | mm | | |
| Sloop (BK1-BK8)1 | 87,981 | 0,000 | 146,635 | 277,150 | 134,75 | 130 | P10-130 | AMAN |
| GF (BK9-BK20)1 | 187,057 | 0,000 | 311,761 | 130,355 | 134,75 | 130 | P10-130 | AMAN |
| Bordes (BK21-BK22)2 | 26,436 | 0,000 | 44,060 | 580,123 | 84,75 | 80 | P10-80 | AMAN |
| It-1 (BK23-BK34)1 | 192,238 | 0,000 | 320,397 | 126,842 | 134,75 | 125 | P10-125 | AMAN |
| Bordes (BK35-BK36)2 | 44,113 | 0,000 | 73,521 | 347,657 | 84,75 | 80 | P10-80 | AMAN |
| It-2 (BK37-BK48)1 | 213,789 | 0,000 | 356,314 | 114,056 | 134,75 | 110 | P10-110 | AMAN |
| Bordes (BK49-BK50)2 | 44,014 | 0,000 | 73,356 | 348,436 | 84,75 | 80 | P10-80 | AMAN |
| It-3 (BK51-BK62)1 | 201,267 | 0,000 | 335,445 | 121,152 | 134,75 | 120 | P10-120 | AMAN |
| Bordes (BK63-BK64)2 | 36,603 | 0,000 | 61,005 | 418,983 | 84,75 | 80 | P10-80 | AMAN |
| It-4 (BK65-BK76)1 | 256,604 | 0,000 | 427,674 | 95,025 | 134,75 | 95 | P10-95 | AMAN |
| It atap (BK77-BK90)1 | 123,769 | 0,000 | 206,282 | 197,010 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BK91-BK100)2 | 50,283 | 0,000 | 83,806 | 304,992 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan tulangan | |
| | Kn | | Kn | mm | mm | mm | | |
| Sloop (BK1-BK8)1 | 55,4955 | 179,667 | -87,174 | -466,190 | 269,5 | 265 | P10-265 | AMAN |
| GF (BK9-BK20)1 | 117,99 | 179,667 | 16,983 | 2393,035 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (BK21-BK22)2 | 16,6749 | 84,750 | -56,958 | -448,749 | 169,5 | 165 | P10-165 | AMAN |
| It-1 (BK23-BK34)1 | 121,258 | 179,667 | 22,430 | 1811,848 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (BK35-BK36)2 | 27,8249 | 84,750 | -38,375 | -666,056 | 169,5 | 165 | P10-165 | AMAN |
| It-2 (BK37-BK48)1 | 134,851 | 179,667 | 45,085 | 901,394 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (BK49-BK50)2 | 27,7626 | 84,750 | -38,479 | -664,260 | 169,5 | 165 | P10-165 | AMAN |
| It-3 (BK51-BK62)1 | 126,953 | 179,667 | 31,922 | 1273,096 | 269,5 | 265 | P10-265 | AMAN |
| Bordes (BK63-BK64)2 | 23,088 | 84,750 | -46,270 | -552,412 | 169,5 | 165 | P10-165 | AMAN |
| It-4 (BK65-BK76)1 | 161,858 | 179,667 | 90,097 | 451,057 | 269,5 | 265 | P10-265 | AMAN |
| It atap (BK77-BK90)1 | 78,0698 | 179,667 | -49,550 | -820,172 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BK91-BK100)2 | 31,7173 | 84,750 | -31,888 | -801,559 | 169,5 | 165 | P10-165 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PENULANGAN LENTUR BALOK PADA PORTAL B-L

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | Rn | = | 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = | 0,85 |
| diameter tul pokok | = | 22 mm | **ρ maks** | = | 0,020 | | | |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | | | |
| d' | = | 61 mm | **ρ pakai** | = | 0,010 | | | |
| d1 | = | 539 mm | m | = | 16,824 | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BL1-BL5) | 85,427 | 29053351,708 | Tul. sebelah | 0,919 | 0,003 | 547,656 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BL6-BL19) | 271,505 | 92337671,413 | Tul. sebelah | 2,920 | 0,008 | 1740,566 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-1 (BL20-BL33) | 351,871 | 119668799,001 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 12,722 | 298,207 | 298,207 | 89,251 | 3 | 1140,401 | 3D22 | 2279,781 | 6 | 2280,802 | 6D22 | 6 | 33,6 |
| It-2 (BL34-BL47) | 336,970 | 114602033,613 | Tul. sebelah | 3,625 | 0,010 | 2160,250 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-3 (BL48-BL61) | 370,467 | 125994217,842 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 35,967 | 298,207 | 298,207 | 252,325 | 4 | 1520,594 | 4D22 | 2442,855 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| It-4 (BL62-BL73) | 334,926 | 113906878,089 | Tul. sebelah | 3,603 | 0,010 | 2147,146 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It atap (BL74-BL77) | 143,918 | 48945886,795 | Tul. sebelah | 1,548 | 0,004 | 922,831 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BL1-BL5) | 38,723 | 13168524,134 | Tul. sebelah | 0,417 | 0,001 | 248,246 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BL6-BL19) | 282,209 | 95976142,183 | Tul. sebelah | 2,820 | 0,008 | 1680,971 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-1 (BL20-BL33) | 357,961 | 121740981,553 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 20,335 | 298,207 | 298,207 | 142,657 | 2 | 760,267 | 2D22 | 2333,186 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| It-2 (BL34-BL47) | 329,367 | 112016286,331 | Tul. sebelah | 3,543 | 0,010 | 2111,508 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | | |
| It-3 (BL48-BL61) | 376,428 | 128021528,055 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 43,418 | 298,207 | 298,207 | 304,599 | 2 | 760,267 | 2D22 | 2495,129 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| It-4 (BL62-BL73) | 361,698 | 123011919,024 | Tul. rangkap | | | | | | | | | 2190,530 | 427,117 | 25,006 | 298,207 | 298,207 | 175,427 | 2 | 760,267 | 2D22 | 2365,957 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| It atap (BL74-BL77) | 7,345 | 2498002,602 | Tul. sebelah | 0,079 | 0,000 | 47,087 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak⁻ | Mkap⁻ | ρ aktual | Rn | Mnak⁺ | Mkap⁺ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BL1-BL5) | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BL6-BL19) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-1 (BL20-BL33) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-2 (BL34-BL47) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-3 (BL48-BL61) | 7 | 2660,935 | 4 | 1520,534 | 20,302 | 20,302 | 121,589 | 484,227 | 14,756 | 508,983 | 636,229 | 0,0071 | 2,634 | 306,067 | 382,584 |
| It-4 (BL62-BL73) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,755 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It atap (BL74-BL77) | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^{+}$ | $Mkap^{-}$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| Sloop (BL1-BL5) | 48,442 | 0,792 | 9,728 | 198,092 | 181,704 | 93,647 | 93,603 | 93,603 |
| GF (BL6-BL19) | 153,434 | 52,651 | 20,491 | 292,038 | 473,711 | 298,854 | 302,451 | 298,854 |
| It-1 (BL20-BL33) | 182,271 | 54,724 | 29,519 | 292,038 | 554,777 | 340,040 | 372,825 | 340,040 |
| It-2 (BL34-BL47) | 158,538 | 53,035 | 31,703 | 292,038 | 554,777 | 313,347 | 355,304 | 313,347 |
| It-3 (BL48-BL61) | 197,607 | 53,189 | 27,308 | 382,584 | 636,229 | 373,054 | 378,029 | 373,054 |
| It-4 (BL62-BL73) | 179,058 | 52,44 | 26,006 | 292,038 | 554,777 | 334,268 | 352,298 | 334,268 |
| It atap (BL74-BL77) | 71,37 | 8,203 | 6,004 | 198,092 | 282,450 | 133,202 | 106,668 | 106,668 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BL1-BL5) | 93,603 | 0,000 | 156,006 | 260,502 | 134,75 | 130 | P10-130 | AMAN |
| GF (BL6-BL19) | 298,854 | 0,000 | 498,091 | 81,591 | 134,75 | 80 | P10-80 | AMAN |
| It-1 (BL20-BL33) | 340,040 | 0,000 | 566,734 | 71,709 | 134,75 | 70 | P10-70 | AMAN |
| It-2 (BL34-BL47) | 313,347 | 0,000 | 522,245 | 77,817 | 134,75 | 75 | P10-75 | AMAN |
| It-3 (BL48-BL61) | 373,054 | 0,000 | 621,757 | 65,363 | 134,75 | 65 | P10-65 | AMAN |
| It-4 (BL62-BL73) | 334,268 | 0,000 | 557,114 | 72,847 | 134,75 | 70 | P10-70 | AMAN |
| It atap (BL74-BL77) | 106,668 | 0,000 | 177,781 | 228,595 | 134,75 | 130 | P10-130 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BL1-BL5) | 59,0421 | 179,667 | -81,263 | -500,100 | 269,5 | 265 | P10-265 | AMAN |
| GF (BL6-BL19) | 188,508 | 179,667 | 134,514 | 302,123 | 269,5 | 265 | P10-265 | AMAN |
| It-1 (BL20-BL33) | 214,487 | 179,667 | 177,811 | 228,555 | 269,5 | 225 | P10-225 | AMAN |
| It-2 (BL34-BL47) | 197,65 | 179,667 | 148,749 | 271,385 | 269,5 | 265 | P10-265 | AMAN |
| It-3 (BL48-BL61) | 235,311 | 179,667 | 212,518 | 191,229 | 269,5 | 190 | P10-190 | AMAN |
| It-4 (BL62-BL73) | 210,846 | 179,667 | 171,744 | 236,630 | 269,5 | 235 | P10-235 | AMAN |
| It atap (BL74-BL77) | 67,2832 | 179,667 | -67,528 | -601,820 | 269,5 | 265 | P10-265 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-M

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b | = 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | Rn | = 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = 0,85 |
| diameter tul.pokok | = | 22 mm | **ρ maks** | = | 0,020 | | |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | | |
| d' | = | 61 mm | **ρ pakai** | = | 0,010 | | |
| d1 | = | 539 mm | m | = | 18,824 | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BM1-BM5) | 86,656 | 29471329,272 | Tul. sebelah | 0,932 | 0,003 | 555,535 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BM6-BM17) | 260,971 | 88755103,760 | Tul. sebelah | 2,807 | 0,008 | 1673,035 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-1 (BM18-BM29) | 288,245 | 98030872,715 | Tul. sebelah | | | | | | | | | 2190,530 | 427,117 | -66,810 | 298,207 | 298,207 | -468,704 | 3 | 1140,401 | 3D22 | 1721,826 | 6 | 2280,802 | 6D22 | 6 | 33,6 |
| lt-2 (BM30-BM41) | 296,973 | 100999227,811 | Tul. sebelah | 3,194 | 0,009 | 1903,837 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-3 (BM42-BM53) | 296,307 | 100772723,903 | Tul. sebelah | | | | | | | | | 2190,530 | 427,117 | -56,733 | 298,207 | 298,207 | -398,006 | 4 | 1520,534 | 4D22 | 1792,524 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| lt-4 (BM54-BM65) | 322,430 | 109657042,757 | Tul. sebelah | 3,468 | 0,010 | 2067,037 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt atap (BM66-BM69) | 150,573 | 51209223,394 | Tul. sebelah | 1,620 | 0,004 | 965,294 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BM1-BM5) | 36,985 | 13258629,197 | Tul. sebelah | 0,419 | 0,001 | 249,825 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BM6-BM17) | 252,299 | 85805794,220 | Tul. sebelah | 2,714 | 0,008 | 1617,440 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-1 (BM18-BM29) | 268,917 | 91457503,852 | Tul. sebelah | | | | | | | | | 2190,530 | 427,117 | -90,970 | 298,207 | 298,207 | -638,197 | 2 | 760,267 | 2D22 | 1552,333 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| lt-2 (BM30-BM41) | 264,291 | 89884221,342 | Tul. sebelah | 2,843 | 0,008 | 1894,319 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-3 (BM42-BM53) | 294,238 | 100089065,988 | Tul. sebelah | | | | | | | | | 2190,530 | 427,117 | -69,319 | 298,207 | 298,207 | -416,150 | 2 | 760,267 | 2D22 | 1774,380 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| lt-4 (BM54-BM65) | 308,068 | 104772588,928 | Tul. sebelah | | | | | | | | | 2190,530 | 427,117 | -42,032 | 298,207 | 298,207 | -294,870 | 2 | 760,267 | 2D22 | 1895,660 | 7 | 2660,935 | 7D22 | 7 | 24,3 |
| lt atap (BM66-BM69) | 6,923 | 2354482,235 | Tul. sebelah | 0,074 | 0,000 | 44,382 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | ρ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BM1-BM5) | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BM6-BM17) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BM18-BM29) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-2 (BM30-BM41) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BM42-BM53) | 7 | 2660,935 | 4 | 1520,534 | 20,302 | 20,302 | 121,589 | 494,227 | 14,756 | 508,983 | 636,229 | 0,0071 | 2,634 | 306,067 | 382,584 |
| lt-4 (BM54-BM65) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,755 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BM66-BM69) | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| Sloop (BM1-BM5) | 49,159 | 0,776 | 10,485 | 198,092 | 181,704 | 93,333 | 96,511 | 93,333 |
| GF (BM6-BM17) | 135,18 | 52,483 | 21,007 | 292,038 | 473,711 | 279,511 | 285,276 | 279,511 |
| lt-1 (BM18-BM29) | 130,998 | 56,798 | 29,319 | 292,038 | 554,777 | 288,381 | 320,326 | 288,38' |
| lt-2 (BM30-BM41) | 131,614 | 52,989 | 30,857 | 292,038 | 554,777 | 285,029 | 323,433 | 285,029 |
| lt-3 (BM42-BM53) | 145,515 | 53,881 | 26,174 | 382,584 | 636,229 | 319,084 | 319,287 | 319,084 |
| lt-4 (BM54-BM65) | 156,332 | 52,496 | 25,774 | 292,038 | 554,777 | 310,465 | 327,520 | 310,465 |
| lt atap (BM66-BM69) | 74,268 | 6,823 | 6,079 | 198,092 | 282,450 | 136,896 | 110,677 | 110,677 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BM1-BM5) | 93,333 | 0,000 | 155,555 | 261,257 | 134,75 | 130 | P10-130 | AMAN |
| GF (BM6-BM17) | 279,511 | 0,000 | 465,852 | 87,237 | 134,75 | 85 | P10-80 | AMAN |
| lt-1 (BM18-BM29) | 288,381 | 0,000 | 480,635 | 84,554 | 134,75 | 80 | P10-70 | AMAN |
| lt-2 (BM30-BM41) | 285,029 | 0,000 | 475,048 | 85,549 | 134,75 | 85 | P10-75 | AMAN |
| lt-3 (BM42-BM53) | 319,084 | 0,000 | 531,807 | 76,418 | 134,75 | 75 | P10-65 | AMAN |
| lt-4 (BM54-BM65) | 310,465 | 0,000 | 517,441 | 78,540 | 134,75 | 75 | P10-70 | AMAN |
| lt atap (BM66-BM69) | 110,677 | 0,000 | 184,462 | 220,316 | 134,75 | 130 | P10-130 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BM1-BM5) | 58,8715 | 179,667 | -81,548 | -496,356 | 269,5 | 265 | P10-265 | AMAN |
| GF (BM6-BM17) | 176,307 | 179,667 | 114,179 | 355,931 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BM18-BM29) | 181,902 | 179,667 | 123,503 | 329,058 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BM30-BM41) | 179,787 | 179,667 | 119,979 | 338,724 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BM42-BM53) | 201,268 | 179,667 | 155,781 | 260,878 | 269,5 | 260 | P10-260 | AMAN |
| lt-4 (BM54-BM65) | 195,832 | 179,667 | 146,719 | 276,989 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BM66-BM69) | 69,8119 | 179,667 | -63,314 | -641,881 | 269,5 | 265 | P10-265 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-N

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | $\rho$ maks | = | 0,020 | $\beta$ | = | 0,85 |
| diameter sengkang | = | 10 mm | $\rho$ min | = | 0,004 | Rn | = | 3,675 MPa |
| $d_1$ | = | 539 mm | $\rho$ pakai | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BN1-BN5)1 | 88,808 | 30203215,126 | Tul. sebelah | 0,955 | 0,003 | 569,331 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BN6-BN19)1 | 300,978 | 102361310,718 | Tul. sebelah | 3,237 | 0,009 | 1929,512 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-1 (BN19-BN31)1 | 321,367 | 109295521,073 | Tul. sebelah | 3,457 | 0,010 | 2060,222 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-2 (BN32-BN44)1 | 325,702 | 110769835,747 | Tul. sebelah | 3,503 | 0,010 | 2086,013 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-3 (BN45-B57)1 | 320,722 | 109076159,374 | Tul. sebelah | 3,450 | 0,010 | 2056,087 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-4 (BN58-BN70)1 | 325,796 | 110801804,739 | Tul. sebelah | 3,504 | 0,010 | 2088,615 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt atap (BN71-BN83)1 | 165,153 | 56167818,076 | Tul. sebelah | 1,776 | 0,005 | 1058,764 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |
| blk ring (BN84-BN93)2 | 85,578 | 29104706,153 | Tul. sebelah | 3,103 | 0,009 | 872,296 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | $\rho$ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BN1-BN5)1 | 38,391 | 13056812,376 | Tul. sebelah | 0,413 | 0,001 | 246,117 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BN6-BN18)1 | 298,257 | 101435910,435 | Tul. sebelah | 3,208 | 0,009 | 1912,080 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-1 (BN19-BN31)1 | 284,762 | 96846319,541 | Tul. sebelah | 3,063 | 0,008 | 1825,554 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-2 (BN32-BN44)1 | 286,601 | 97471755,454 | Tul. sebelah | 3,083 | 0,009 | 1837,344 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-3 (BN45-B57)1 | 316,112 | 107508318,394 | Tul. sebelah | 3,400 | 0,009 | 2026,533 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt-4 (BN58-BN70)1 | 309,183 | 105151795,586 | Tul. sebelah | 3,326 | 0,009 | 1982,113 | 6 | 2280,802 | 6D22 | 6 | 33,6 | | | | | | | | | | | | | | |
| lt atap (BN71-BN83)1 | 82,257 | 27975248,476 | Tul. sebelah | 0,885 | 0,002 | 527,334 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| blk ring (BN84-BN93)2 | 80,973 | 27538565,652 | Tul. sebelah | 2,936 | 0,008 | 825,357 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | $\rho$ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BN1-BN5)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BN6-BN18)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,755 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BN19-BN31)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-2 (BN32-BN44)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BN45-B57)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,754 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-4 (BN58-BN70)1 | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,755 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BN71-BN83)1 | 3 | 1140,401 | 2 | 760,267 | -1139,093 | 400,000 | 17,889 | 80,597 | 145,363 | 225,960 | 282,450 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BN84-BN93)2 | 3 | 1140,401 | 2 | 760,267 | | 400,000 | 23,852 | 49,733 | 84,542 | 134,274 | 167,843 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^{+}$ | $Mkap^{-}$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BN1-BN5)1 | 48,864 | 0,717 | 11,271 | 198,092 | 181,704 | 92,961 | 99,398 | 92,961 |
| GF (BN6-BN18)1 | 198,783 | 52,513 | 22,395 | 282,038 | 554,777 | 355,056 | 357,920 | 355,056 |
| lt-1 (BN19-BN31)1 | 189,915 | 58,689 | 30,021 | 282,038 | 554,777 | 350,130 | 385,022 | 350,130 |
| lt-2 (BN32-BN44)1 | 187,655 | 42,788 | 30,568 | 282,038 | 554,777 | 333,161 | 370,351 | 333,161 |
| lt-3 (BN45-B57)1 | 198,123 | 52,183 | 25,523 | 282,038 | 554,777 | 354,017 | 370,018 | 354,017 |
| lt-4 (BN58-BN70)1 | 204,396 | 42,917 | 20,014 | 282,038 | 554,777 | 350,874 | 343,737 | 343,737 |
| lt atap (BN71-BN83)1 | 93,034 | 8,662 | 14,684 | 198,092 | 282,450 | 158,531 | 168,454 | 158,531 |
| blk ring (BN84-BN93)2 | 65,546 | 0,478 | 2,778 | 119,799 | 167,843 | 100,302 | 80,993 | 80,993 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| Sloop (BN1-BN5)1 | 92,961 | 0,000 | 154,935 | 262,301 | 134,75 | 130 | P10-130 | AMAN |
| GF (BN6-BN18)1 | 355,056 | 0,000 | 591,760 | 68,676 | 134,75 | 65 | P10-65 | AMAN |
| lt-1 (BN19-BN31)1 | 350,130 | 0,000 | 583,549 | 69,642 | 134,75 | 65 | P10-65 | AMAN |
| lt-2 (BN32-BN44)1 | 333,161 | 0,000 | 555,268 | 73,189 | 134,75 | 70 | P10-70 | AMAN |
| lt-3 (BN45-B57)1 | 354,017 | 0,000 | 590,028 | 68,878 | 134,75 | 65 | P10-65 | AMAN |
| lt-4 (BN58-BN70)1 | 343,737 | 0,000 | 572,896 | 70,837 | 134,75 | 70 | P10-70 | AMAN |
| lt atap (BN71-BN83)1 | 158,531 | 0,000 | 264,219 | 153,811 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BN84-BN93)2 | 80,993 | 0,000 | 134,988 | 189,351 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| Sloop (BN1-BN5)1 | 58,637 | 179,667 | -81,938 | -495,980 | 269,5 | 265 | P10-265 | AMAN |
| GF (BN6-BN18)1 | 223,959 | 179,667 | 193,598 | 209,913 | 269,5 | 205 | P10-205 | AMAN |
| lt-1 (BN19-BN31)1 | 220,851 | 179,667 | 188,418 | 215,689 | 269,5 | 215 | P10-215 | AMAN |
| lt-2 (BN32-BN44)1 | 210,147 | 179,667 | 170,579 | 238,246 | 269,5 | 235 | P10-235 | AMAN |
| lt-3 (BN45-B57)1 | 223,303 | 179,667 | 192,505 | 211,110 | 269,5 | 210 | P10-210 | AMAN |
| lt-4 (BN58-BN70)1 | 216,819 | 179,667 | 181,698 | 223,686 | 269,5 | 220 | P10-220 | AMAN |
| lt atap (BN71-BN83)1 | 99,9968 | 179,667 | -13,005 | -3124,837 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BN84-BN93)2 | 51,0878 | 84,750 | 0,396 | 64500,495 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-O

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_o$ | = | 1,25 | b | = 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,800 | Rn | = 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = 0,85 |
| diameter tul pokok | = | 22 mm | ρ maks | = | 0,020 | | |
| diameter sengkang | = | 10 mm | ρ min | = | 0,004 | | |
| d' | = | 61 mm | ρ pakai | = | 0,010 | | |
| d1 | = | 539 mm | m | = | 18,824 | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BO1-BO5) | 91,695 | 31185071,289 | Tul. sebelah | 0,986 | 0,003 | 587,839 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BO6-BO20) | 246,476 | 83825417,208 | Tul. sebelah | 2,651 | 0,007 | 1580,110 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-1 (BO21-BO35) | 282,340 | 96022607,859 | Tul. sebelah | 3,037 | 0,008 | 1810,027 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-2 (BO36-BO51) | 270,656 | 92048930,200 | Tul. sebelah | 2,911 | 0,008 | 1735,123 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-3 (BO52-BO66) | 275,935 | 93844295,174 | Tul. sebelah | 2,968 | 0,008 | 1768,966 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-4 (BO67-BO79) | 299,609 | 101895719,763 | Tul. sebelah | 3,223 | 0,009 | 1920,735 | 6 | 2280,802 | 6D22 | 6 | 38,8 | | | | | | | | | | | | | | |
| lt atap (BO80-BO89) | 185,744 | 63170727,754 | Tul. sebelah | 1,998 | 0,006 | 1190,789 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BO1-BO5) | 40,218 | 13677967,142 | Tul. sebelah | 0,433 | 0,001 | 257,830 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | |
| GF (BO6-BO20) | 236,118 | 80302706,391 | Tul. sebelah | 2,540 | 0,007 | 1513,707 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| lt-1 (BO21-BO35) | 257,474 | 87565789,248 | Tul. sebelah | 2,770 | 0,008 | 1650,616 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-2 (BO36-BO51) | 222,015 | 75506337,337 | Tul. sebelah | 2,388 | 0,007 | 1423,295 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| lt-3 (BO52-BO66) | 244,157 | 83036735,379 | Tul. sebelah | 2,626 | 0,007 | 1565,243 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | |
| lt-4 (BO67-BO79) | 233,044 | 79257252,341 | Tul. sebelah | 2,507 | 0,007 | 1494,000 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | |
| lt atap (BO80-BO89) | 141,057 | 47972873,120 | Tul. sebelah | 1,517 | 0,004 | 904,239 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak⁻ | Mkap⁻ | ρ aktual | Rn | Mnak⁺ | Mkap⁺ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BO1-BO5) | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BO6-BO20) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,833 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-1 (BO21-BO35) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | -269,546 | 125,607 | 508,415 | -146,833 | 361,482 | 451,853 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-2 (BO36-BO51) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | -269,546 | 125,607 | 508,415 | -146,833 | 361,482 | 451,853 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-3 (BO52-BO66) | 5 | 1900,668 | 3 | 1140,401 | -269,546 | -269,546 | 125,607 | 508,415 | -146,833 | 361,482 | 451,853 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt-4 (BO67-BO79) | 6 | 2280,802 | 3 | 1140,401 | 20,302 | 20,302 | 104,608 | 432,755 | 11,067 | 443,821 | 554,777 | 0,0053 | 2,010 | 233,630 | 292,038 |
| lt atap (BO80-BO89) | 4 | 1520,534 | 2 | 760,267 | -269,546 | 400,000 | 35,777 | 158,474 | 146,363 | 303,837 | 379,796 | 0,0035 | 1,364 | 158,474 | 198,092 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| Sloop (BO1-BO5) | 49,134 | 0,564 | 12,015 | 198,092 | 181,704 | 93,084 | 102,646 | 93,084 |
| GF (BO6-BO20) | 148,197 | 52,799 | 29,064 | 292,038 | 473,711 | 293,511 | 333,115 | 293,511 |
| lt-1 (BO21-BO35) | 135,991 | 55,473 | 37,717 | 292,038 | 451,853 | 281,149 | 359,449 | 281,149 |
| lt-2 (BO36-BO51) | 127,933 | 52,79 | 37,427 | 292,038 | 451,853 | 269,870 | 346,953 | 269,870 |
| lt-3 (BO52-BO66) | 137,272 | 52,709 | 31,719 | 292,038 | 451,853 | 279,591 | 332,700 | 279,591 |
| lt-4 (BO67-BO79) | 152,605 | 42,847 | 21,037 | 292,038 | 554,777 | 296,420 | 293,580 | 293,580 |
| lt atap (BO80-BO89) | 99,303 | 14,608 | 20,888 | 198,092 | 379,796 | 181,841 | 206,496 | 181,841 |

**5.Perencanaan Tulangan Geser**

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BO1-BO5) | 93,084 | 0,000 | 155,140 | 261,955 | 134,75 | 130 | P10-130 | AMAN |
| GF (BO6-BO20) | 293,511 | 0,000 | 489,185 | 83,076 | 134,75 | 80 | P10-80 | AMAN |
| lt-1 (BO21-BO35) | 281,149 | 0,000 | 468,581 | 86,729 | 134,75 | 85 | P10-85 | AMAN |
| lt-2 (BO36-BO51) | 269,870 | 0,000 | 449,784 | 90,354 | 134,75 | 90 | P10-90 | AMAN |
| lt-3 (BO52-BO66) | 279,591 | 0,000 | 465,986 | 87,212 | 134,75 | 85 | P10-85 | AMAN |
| lt-4 (BO67-BO79) | 293,580 | 0,000 | 489,300 | 83,057 | 134,75 | 80 | P10-80 | AMAN |
| lt atap (BO80-BO89) | 181,841 | 0,000 | 303,068 | 134,095 | 134,75 | 130 | P10-130 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BO1-BO5) | 58,7145 | 179,667 | -81,909 | -496,763 | 269,5 | 265 | P10-265 | AMAN |
| GF (BO6-BO20) | 185,138 | 179,667 | 128,896 | 315,290 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BO21-BO35) | 177,34 | 179,667 | 115,900 | 350,646 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BO36-BO51) | 170,226 | 179,667 | 104,043 | 390,604 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BO52-BO66) | 176,358 | 179,667 | 114,263 | 355,689 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BO67-BO79) | 185,181 | 179,667 | 128,969 | 315,113 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BO80-BO89) | 114,699 | 179,667 | 11,499 | 3534,165 | 269,5 | 265 | P10-265 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-P

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_b$ | = | 1,25 | b1 | = | 400 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h1 | = | 600 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | b2 | = | 300 mm |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | h2 | = | 400 mm |
| diameter tul pokok | = | 22 mm | **ρ maks** | = | 0,020 | β | = | 0,85 |
| diameter sengkang | = | 10 mm | **ρ min** | = | 0,004 | **Rn** | = | 3,675 MPa |
| $d_1$ | = | 539 mm | **ρ pakai** | = | 0,010 | | | |
| $d_2$ | = | 339 mm | m | = | 18,824 | | | |
| d' | = | 61 mm | | | | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BP1-BP8)1 | 89,495 | 30436860,843 | Tul. sebelah | 0,963 | 0,003 | 573,735 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BP8-BP20)1 | 215,686 | 73353871,923 | Tul. sebelah | 2,320 | 0,006 | 1382,721 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-1 (BP21-BP32)1 | 233,604 | 79447705,909 | Tul. sebelah | 2,513 | 0,007 | 1497,590 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-2 (BP33-BP44)1 | 240,789 | 81891293,206 | Tul. sebelah | 2,590 | 0,007 | 1543,652 | 5 | 1900,668 | 5D22 | 5 | 47,5 | | | | | | | | | | | | | | | |
| It-3 (BP45-BP56)1 | 231,599 | 78765814,116 | Tul. sebelah | 2,491 | 0,007 | 1484,737 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-4 (BP57-BP68)1 | 231,271 | 78654262,740 | Tul. sebelah | 2,488 | 0,007 | 1482,634 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It atap (BP69-BP82)1 | 117,538 | 39974163,358 | Tul. sebelah | 1,264 | 0,003 | 753,513 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| blk ring (BP83-BP88)2 | 18,025 | 5450032,907 | Tul. sebelah | 0,581 | 0,002 | 163,343 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| Sloop (BP1-BP8)1 | 51,074 | 17370045,597 | Tul. sebelah | 0,549 | 0,002 | 327,426 | 2 | 760,267 | 2D22 | 2 | 256,0 | | | | | | | | | | | | | | | |
| GF (BP9-BP20)1 | 201,562 | 68550360,860 | Tul. sebelah | 2,168 | 0,006 | 1292,175 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-1 (BP21-BP32)1 | 185,206 | 62987756,291 | Tul. sebelah | 1,992 | 0,006 | 1187,320 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-2 (BP33-BP44)1 | 196,803 | 66931845,627 | Tul. sebelah | 2,117 | 0,006 | 1261,668 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-3 (BP45-BP56)1 | 203,990 | 69376113,116 | Tul. sebelah | 2,194 | 0,006 | 1307,741 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It-4 (BP57-BP68)1 | 227,613 | 77410192,826 | Tul. sebelah | 2,448 | 0,007 | 1459,183 | 4 | 1520,534 | 4D22 | 4 | 70,7 | | | | | | | | | | | | | | | |
| It atap (BP69-BP82)1 | 119,024 | 40479545,505 | Tul. sebelah | 1,280 | 0,004 | 763,040 | 3 | 1140,401 | 3D22 | 3 | 117,0 | | | | | | | | | | | | | | | |
| blk ring (BP83-BP88)2 | 9,948 | 3383271,598 | Tul. sebelah | 0,361 | 0,001 | 101,400 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | Mnak$^-$ | Mkap$^-$ | ρ aktual | Rn | Mnak$^+$ | Mkap$^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| Sloop (BP1-BP8)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| GF (BP9-BP20)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| It-1 (BP21-BP32)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| It-2 (BP33-BP44)1 | 5 | 1900,668 | 3 | 1140,401 | -269,546 | 269,546 | 53,280 | 232,036 | 146,933 | 378,969 | 473,711 | 0,0053 | 2,010 | 233,630 | 292,038 |
| It-3 (BP45-BP56)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| It-4 (BP57-BP68)1 | 4 | 1520,534 | 2 | 760,267 | -269,546 | 269,546 | 47,446 | 207,805 | 97,955 | 305,760 | 382,199 | 0,0035 | 1,364 | 158,474 | 198,092 |
| It atap (BP69-BP82)1 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 145,363 | 145,363 | 181,704 | 0,0035 | 1,364 | 158,474 | 198,092 |
| blk ring (BP83-BP88)2 | 2 | 760,267 | 2 | 760,267 | | 400,000 | 0,000 | 0,000 | 84,542 | 84,542 | 105,677 | 0,0075 | 2,780 | 95,839 | 119,799 |

**4.Gaya Geser Rencana**

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | KN | KN | KN | KNm | KNm | KN | KN | KN |
| Sloop (BP1-BP8)1 | 47,785 | 1,057 | 31,693 | 198,092 | 181,704 | 92,185 | 184,395 | 92,185 |
| GF (BP9-BP20)1 | 88,937 | 34,447 | 54,997 | 198,092 | 382,199 | 192,046 | 360,541 | 192,046 |
| lt-1 (BP21-BP32)1 | 85,352 | 33,81 | 66,876 | 198,092 | 382,199 | 187,613 | 405,999 | 187,613 |
| lt-2 (BP33-BP44)1 | 90,458 | 34,679 | 65,844 | 292,038 | 473,711 | 213,859 | 407,939 | 213,859 |
| lt-3 (BP45-BP56)1 | 94,077 | 34,82 | 53,896 | 198,092 | 382,199 | 197,835 | 360,865 | 197,835 |
| lt-4 (BP57-BP68)1 | 127,519 | 36,043 | 33,656 | 198,092 | 382,199 | 234,233 | 313,095 | 234,233 |
| lt atap (BP69-BP82)1 | 70,431 | 11,129 | 14,496 | 198,092 | 181,704 | 126,539 | 146,521 | 126,539 |
| blk ring (BP83-BP88)2 | 9,079 | 0,863 | 4,415 | 119,799 | 105,677 | 34,721 | 28,982 | 28,982 |

**5.Perencanaan Tulangan Geser**

Ln = 6,5 m

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BP1-BP8)1 | 92,185 | 0,000 | 153,642 | 264,509 | 134,75 | 130 | P10-130 | AMAN |
| GF (BP9-BP20)1 | 192,046 | 0,000 | 320,077 | 126,969 | 134,75 | 125 | P10-125 | AMAN |
| lt-1 (BP21-BP32)1 | 187,613 | 0,000 | 312,688 | 129,969 | 134,75 | 125 | P10-125 | AMAN |
| lt-2 (BP33-BP44)1 | 213,859 | 0,000 | 356,432 | 114,018 | 134,75 | 110 | P10-110 | AMAN |
| lt-3 (BP45-BP56)1 | 197,835 | 0,000 | 329,725 | 123,254 | 134,75 | 120 | P10-120 | AMAN |
| lt-4 (BP57-BP68)1 | 234,233 | 0,000 | 390,388 | 104,101 | 134,75 | 100 | P10-100 | AMAN |
| lt atap (BP69-BP82)1 | 126,539 | 0,000 | 210,898 | 192,698 | 134,75 | 130 | P10-130 | AMAN |
| blk ring (BP83-BP88)2 | 28,982 | 0,000 | 48,304 | 529,155 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | tulangan | |
| Sloop (BP1-BP8)1 | 58,1476 | 179,667 | -82,754 | -491,091 | 269,5 | 265 | P10-265 | AMAN |
| GF (BP9-BP20)1 | 121,137 | 179,667 | 22,228 | 1828,315 | 269,5 | 265 | P10-265 | AMAN |
| lt-1 (BP21-BP32)1 | 118,341 | 179,667 | 17,568 | 2313,343 | 269,5 | 265 | P10-265 | AMAN |
| lt-2 (BP33-BP44)1 | 134,896 | 179,667 | 45,160 | 899,914 | 269,5 | 265 | P10-265 | AMAN |
| lt-3 (BP45-BP56)1 | 124,788 | 179,667 | 28,313 | 1435,349 | 269,5 | 265 | P10-265 | AMAN |
| lt-4 (BP57-BP68)1 | 147,747 | 179,667 | 66,578 | 610,405 | 269,5 | 265 | P10-265 | AMAN |
| lt atap (BP69-BP82)1 | 79,817 | 179,667 | -46,638 | -871,379 | 269,5 | 265 | P10-265 | AMAN |
| blk ring (BP83-BP88)2 | 18,281 | 84,750 | -54,282 | -470,979 | 169,5 | 165 | P10-165 | AMAN |

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## PENULANGAN LENTUR BALOK PADA PORTAL B-Q

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | $\Phi_0$ | = | 1,25 | b | = | 300 mm |
| Fy polos | = | 240 MPa | $\Phi$ | = | 0,8 | h | = | 400 mm |
| fc' | = | 25 MPa | $\Phi$ | = | 0,600 | Rn | = | 3,675 MPa |
| penutup beton (pb) | = | 40 mm | pb | = | 0,027 | β | = | 0,85 |
| diameter tul pokok | = | 22 mm | ρ maks | = | 0,020 | | | |
| diameter sengkang | = | 10 mm | ρ min | = | 0,004 | | | |
| d' | = | 61 mm | ρ pakai | = | 0,010 | | | |
| d | = | 339 mm | m | = | 18,824 | | | |

### 1.Perencanaan Tulangan Tumpuan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| It atap (BQ1-BQ6) | 100,645 | 34228927,421 | Tul. sebelah | 3,649 | 0,010 | 1025,874 | 3 | 1140,401 | 3D22 | 3 | 67,0 | | | | | | | | | | | | | | |

### 2.Perencanaan Tulangan Lapangan

| Lantai | Mu | $bd^2$ | Tulangan | Tulangan sebelah | | | | | | | | Tulangan rangkap | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rn baru | ρ baru | As perlu | n | As ada | Pakai | tul | Jbd | As1 | Mn1 | Mn2 | fs' | fs' pakai | As'=As2 | n | As' ada | Pakai | As | n | As ada | Pakai | tul | Jbd |
| | KNm | | | Mpa | | mm^2 | tul | mm^2 | tul | 1 brs | mm | mm^2 | KNm | KNm | MPa | Mpa | mm^2 | tul | mm^2 | tul | mm^2 | tul | mm^2 | tul | 1 brs | mm |
| It atap (BQ1-BQ6) | 53,289 | 18123357,477 | Tul. sebelah | 1,932 | 0,005 | 543,174 | 2 | 760,267 | 2D22 | 2 | 156,0 | | | | | | | | | | | | | | |

### 3.Momen Nominal Aktual

| Lantai | n tul | As ada | n tul | As' ada | fs' | fs' pakai | a | Mn1 | Mn2 | $Mnak^-$ | $Mkap^-$ | ρ aktual | Rn | $Mnak^+$ | $Mkap^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As | mm^2 | As' | mm^2 | MPa | MPa | mm | KNm | KNm | KNm | KNm | | Mpa | KNm | KNm |
| It atap (BQ1-BQ6) | 3 | 1140,401 | 2 | 760,267 | -704,319 | 165,227 | 51,850 | 103,485 | 34,921 | 138,406 | 173,008 | 0,0075 | 2,780 | 95,839 | 119,799 |

### 4.Gaya Geser Rencana

Ln = 6,5 m

| Lantai | VD | VL | VE | $Mkap^+$ | $Mkap^-$ | Vu1b | Vu2b | Vu pakai |
|---|---|---|---|---|---|---|---|---|
| | (KN) | (KN) | (KN) | (KNm) | (KNm) | (KN) | (KN) | (KN) |
| It atap (BQ1-BQ6) | 34,578 | 6,235 | 19,991 | 119,799 | 173,008 | 74,387 | 126,816 | 74,387 |

### 5.Perencanaan Tulangan Geser

| Lantai | Daerah Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/4 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| It atap (BQ1-BQ6) | 74,387 | 0,000 | 123,978 | 206,166 | 84,75 | 80 | P10-80 | AMAN |

| Lantai | Daerah Luar Sendi Plastis | | | | | | | Kontrol |
|---|---|---|---|---|---|---|---|---|
| | Vu b | Vc | Vs | S | d/2 | S pakai | Digunakan tulangan | Vu b/Φ<Vc+Vs |
| | Kn | | Kn | mm | mm | mm | | |
| It atap (BQ1-BQ6) | 46,92082 | 84,750 | -6,549 | -3903,109 | 169,5 | 165 | P10-165 | AMAN |

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 3,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 1,2 m | Ig bawah | = 0 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 0 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkan | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 0 m | b blk bawah | = 0 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 0 m | h blk bawah | = 0 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 0 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 0 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KA1 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2478,785 | 424,540 | 1,833 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2499,953 | 424,540 | 1,833 | | | | | | |
| | KA9 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 2982,407 | 661,510 | 158,805 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3003,575 | 661,510 | 158,805 | | | | | | |
| | KA17 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 2886,464 | 591,049 | 152,879 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 2907,632 | 591,049 | 152,879 | | | | | | |
| | KA25 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3124,519 | 586,741 | 169,323 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3145,687 | 586,741 | 169,323 | | | | | | |
| | KA33 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3029,979 | 693,076 | 161,762 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3051,147 | 693,076 | 161,762 | | | | | | |
| | KA40 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2370,645 | 463,938 | 339,653 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2391,813 | 463,938 | 339,653 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KA1 | Atas | | | | 32,038 | 1,140 | 42,769 | | 0,925 | 198,092 | 0,000 | 3155,378 | 3056,190 | 3056,190 | 83,033 | 1 |
| | | Bawah | | | | 7,589 | 2,544 | 88,089 | | 0,925 | 0,000 | 0,000 | 3070,718 | 3078,416 | 3070,718 | 101,985 | 1 |
| | KA9 | Atas | | | | 4,516 | 0,780 | 29,696 | | 0,925 | 198,092 | 198,092 | 4039,887 | 4493,094 | 4039,887 | 102,460 | 1 |
| | | Bawah | | | | 4,495 | 1,203 | 93,730 | | 0,925 | 0,000 | 0,000 | 3848,339 | 4515,320 | 3848,339 | 94,374 | 1 |
| | KA17 | Atas | | | | 11,590 | 2,203 | 29,147 | | 0,925 | 198,092 | 198,092 | 3865,163 | 4293,480 | 3865,163 | 104,252 | 1 |
| | | Bawah | | | | 4,794 | 0,236 | 94,270 | | 0,925 | 0,000 | 0,000 | 3673,615 | 4315,707 | 3673,615 | 93,715 | 1 |
| | KA25 | Atas | | | | 8,527 | 1,150 | 29,138 | | 0,925 | 198,092 | 198,092 | 4110,597 | 4607,980 | 4110,597 | 107,341 | 1 |
| | | Bawah | | | | 6,805 | 1,125 | 94,665 | | 0,925 | 0,000 | 0,000 | 3919,049 | 4630,206 | 3919,049 | 91,456 | 1 |
| | KA33 | Atas | | | | 6,382 | 2,861 | 30,170 | | 0,925 | 198,092 | 198,092 | 4122,982 | 4588,608 | 4122,982 | 109,152 | 1 |
| | | Bawah | | | | 7,140 | 3,181 | 94,815 | | 0,925 | 0,000 | 0,000 | 3931,434 | 4610,835 | 3931,434 | 89,959 | 1 |
| | KA40 | Atas | | | | 27,893 | 3,977 | 44,082 | | 0,925 | 0,000 | 198,092 | 3083,199 | 4402,855 | 3083,199 | 116,579 | 1 |
| | | Bawah | | | | 18,389 | 5,145 | 89,465 | | 0,925 | 0,000 | 0,000 | 2998,539 | 4425,081 | 2998,539 | 73,047 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KA1 | Atas | 198,092 | 0,000 | 179,223 | 179,223 | 214,467 | 179,223 | 179,223 | 27,573 | 470,183 | 0,059 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 380,613 | 380,613 | 380,613 | 58,556 | 472,418 | 0,124 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA9 | Atas | 198,092 | 0,000 | 367,787 | 255,852 | 130,284 | 130,284 | 130,284 | 20,044 | 621,521 | 0,032 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 399,654 | 399,654 | 399,654 | 61,485 | 592,052 | 0,104 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA17 | Atas | 198,092 | 0,000 | 372,078 | 258,837 | 136,900 | 136,900 | 136,900 | 21,062 | 594,640 | 0,035 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 401,216 | 401,216 | 401,216 | 61,725 | 565,172 | 0,109 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA25 | Atas | 198,092 | 0,000 | 381,503 | 265,393 | 132,540 | 132,540 | 132,540 | 20,391 | 632,400 | 0,032 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 405,920 | 405,920 | 405,920 | 62,449 | 602,931 | 0,104 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA33 | Atas | 198,092 | 0,000 | 387,328 | 269,445 | 136,419 | 136,419 | 136,419 | 20,988 | 634,305 | 0,033 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 409,060 | 409,060 | 409,060 | 62,932 | 604,836 | 0,104 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA40 | Atas | 198,092 | 0,000 | 245,516 | 245,516 | 218,608 | 218,608 | 218,608 | 33,632 | 474,338 | 0,071 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 400,464 | 400,464 | 400,464 | 61,610 | 461,314 | 0,134 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KA1 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10423,725 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8803,907 | Aman |
| | KA9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 11017,041 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8712,586 | | Aman |
| | KA17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10889,407 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8578,286 | | Aman |
| | KA25 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 11017,278 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8719,586 | | Aman |
| | KA33 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10983,001 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8707,567 | | Aman |
| | KA40 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10112,942 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8573,955 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KA1 | Atas | 25,764 | 0,425 | 23,913 | 622,041 | 127,933 | 127,933 |
| | | Bawah | 25,764 | 0,425 | 23,913 | 622,041 | 127,933 | 127,933 |
| | KA9 | Atas | 22,349 | 2,148 | 26,396 | 588,820 | 136,585 | 136,585 |
| | | Bawah | 22,349 | 2,148 | 26,396 | 588,820 | 136,585 | 136,585 |
| | KA17 | Atas | 25,111 | 2,342 | 28,627 | 597,906 | 149,059 | 149,059 |
| | | Bawah | 25,111 | 2,342 | 28,627 | 597,906 | 149,059 | 149,059 |
| | KA25 | Atas | 24,488 | 2,427 | 30,975 | 598,289 | 158,356 | 158,356 |
| | | Bawah | 24,488 | 2,427 | 30,975 | 598,289 | 158,356 | 158,356 |
| | KA33 | Atas | 25,949 | 1,574 | 33,043 | 606,088 | 167,680 | 167,680 |
| | | Bawah | 25,949 | 1,574 | 33,043 | 606,088 | 167,680 | 167,680 |
| | KA40 | Atas | 29,555 | 0,738 | 33,045 | 687,857 | 170,597 | 170,597 |
| | | Bawah | 29,555 | 0,738 | 33,045 | 687,857 | 170,597 | 170,597 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Dasar | KA1 | Atas | 127,933 | 0 | 149,1 | 213,222 | 112,980 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 127,933 | 0 | 149,1 | 213,222 | 112,980 | 159,75 | 110 | P10-110 | AMAN |
| | KA9 | Atas | 136,585 | 0 | 149,1 | 227,642 | 105,823 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 136,585 | 0 | 149,1 | 227,642 | 105,823 | 159,75 | 105 | P10-105 | AMAN |
| | KA17 | Atas | 149,059 | 0 | 149,1 | 248,432 | 96,967 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 149,059 | 0 | 149,1 | 248,432 | 96,967 | 159,75 | 95 | P10-95 | AMAN |
| | KA25 | Atas | 158,356 | 0 | 149,1 | 263,926 | 91,275 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 158,356 | 0 | 149,1 | 263,926 | 91,275 | 159,75 | 90 | P10-90 | AMAN |
| | KA33 | Atas | 167,680 | 0 | 149,1 | 279,466 | 86,199 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 167,680 | 0 | 149,1 | 279,466 | 86,199 | 159,75 | 85 | P10-85 | AMAN |
| | KA40 | Atas | 170,597 | 0 | 149,1 | 284,328 | 84,725 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 170,597 | 0 | 149,1 | 284,328 | 84,725 | 159,75 | 80 | P10-80 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 3,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 1,2 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KA2 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2334,352 | 424,038 | 1,577 | 132112,748 | 37495,383 | 132112,748 | 134215,817 | 1,042 | 3479,683 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2375,512 | 424,038 | 1,577 | 131913,320 | 37438,782 | 131913,320 | 134013,214 | 1,042 | 3529,075 |
| | KA10 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2786,887 | 661,377 | 148,943 | 135520,478 | 38462,542 | 135520,478 | 31981,658 | 1,269 | 4402,468 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2828,047 | 661,377 | 148,943 | 135315,402 | 38404,339 | 135315,402 | 31933,262 | 1,273 | 4451,860 |
| | KA18 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2690,116 | 590,337 | 142,379 | 134450,524 | 38158,875 | 134450,524 | 31729,158 | 1,254 | 4172,678 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2731,276 | 590,337 | 142,379 | 134250,083 | 38101,987 | 134250,083 | 31681,856 | 1,258 | 4222,070 |
| | KA26 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2928,389 | 585,945 | 158,130 | 133266,310 | 37822,779 | 133266,310 | 31449,694 | 1,278 | 4451,579 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2969,549 | 585,945 | 158,130 | 133094,414 | 37773,993 | 133094,414 | 31409,128 | 1,283 | 4500,971 |
| | KA34 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2834,132 | 693,148 | 149,950 | 135948,534 | 38584,031 | 135948,534 | 32082,676 | 1,276 | 4509,995 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2875,292 | 693,148 | 149,950 | 135742,384 | 38525,522 | 135742,384 | 32034,026 | 1,280 | 4559,387 |
| | KA41 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2224,839 | 463,239 | 317,958 | 133766,449 | 37964,725 | 133766,449 | 135895,842 | 1,040 | 3410,989 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2265,999 | 463,239 | 317,958 | 133534,127 | 37898,789 | 133534,127 | 135659,822 | 1,041 | 3460,381 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Pv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KA2 | Atas | 24427,392 | 397354,845 | 1,104 | 43,589 | 14,271 | 5,099 | 144,654 | 0,95 | 469,730 | 469,730 | 3074,807 | 2902,933 | 2902,933 | 74,976 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 27,819 | 2,472 | 75,995 | 161,201 | 0,95 | 198,092 | 0,000 | 2977,165 | 2946,151 | 2946,151 | 110,538 | 1,3 |
| | KA10 | Atas | 24427,392 | 397354,845 | 1,104 | 27,587 | 3,368 | 34,498 | 123,178 | 0,95 | 469,730 | 469,730 | 3799,175 | 4246,238 | 3799,175 | 97,108 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 2,445 | 0,009 | 94,899 | 116,810 | 0,95 | 198,092 | 198,092 | 3739,170 | 4289,456 | 3739,170 | 102,180 | 1,3 |
| | KA18 | Atas | 24427,392 | 397354,845 | 1,104 | 47,133 | 8,541 | 32,250 | 186,039 | 0,95 | 469,730 | 469,730 | 3622,973 | 4042,467 | 3622,973 | 118,718 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 16,910 | 3,272 | 94,160 | 163,381 | 0,95 | 198,092 | 198,092 | 3562,969 | 4085,685 | 3562,969 | 88,866 | 1,3 |
| | KA26 | Atas | 24427,392 | 397354,845 | 1,104 | 37,674 | 6,529 | 32,273 | 156,808 | 0,95 | 469,730 | 469,730 | 3868,548 | 4354,197 | 3868,548 | 90,763 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 7,215 | 1,269 | 94,386 | 132,589 | 0,95 | 198,092 | 198,092 | 3808,544 | 4397,415 | 3808,544 | 107,447 | 1,3 |
| | KA34 | Atas | 24427,392 | 397354,845 | 1,104 | 33,914 | 7,083 | 36,316 | 152,760 | 0,95 | 469,730 | 469,730 | 3882,141 | 4333,434 | 3882,141 | 113,132 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 12,550 | 1,607 | 96,125 | 149,903 | 0,95 | 198,092 | 198,092 | 3822,137 | 4376,652 | 3822,137 | 88,731 | 1,3 |
| | KA41 | Atas | 24427,392 | 397354,845 | 1,104 | 48,034 | 26,535 | 7,484 | 186,964 | 0,95 | 469,730 | 469,730 | 3000,979 | 4157,906 | 3000,979 | 123,627 | 1,3 |
| | | Bawah | 24723,744 | 396731,309 | 1,106 | 36,103 | 6,250 | 77,848 | 192,193 | 0,95 | 0,000 | 198,092 | 2903,337 | 4201,124 | 2903,337 | 100,295 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KA2 | Atas | 382,584 | 382,584 | 574,771 | 514,784 | 82,169 | 82,169 | 144,654 | 22,255 | 446,605 | 0,050 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 186,671 | 186,671 | 350,985 | 186,671 | 186,671 | 28,719 | 453,254 | 0,063 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA10 | Atas | 469,730 | 469,730 | 723,979 | 723,979 | 177,394 | 177,394 | 177,394 | 27,291 | 584,488 | 0,047 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 284,191 | 197,698 | 401,153 | 284,191 | 284,191 | 43,722 | 575,257 | 0,076 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA18 | Atas | 469,730 | 469,730 | 849,718 | 849,718 | 193,908 | 193,908 | 193,908 | 29,832 | 557,380 | 0,054 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 237,283 | 165,067 | 416,663 | 237,283 | 237,283 | 36,505 | 548,149 | 0,067 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA26 | Atas | 553,475 | 553,475 | 708,346 | 773,659 | 181,960 | 181,960 | 181,960 | 27,994 | 595,161 | 0,047 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 300,465 | 209,019 | 405,329 | 300,465 | 300,465 | 46,225 | 585,930 | 0,079 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA34 | Atas | 469,730 | 469,730 | 832,685 | 832,685 | 195,574 | 195,574 | 195,574 | 30,088 | 597,253 | 0,050 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 243,637 | 169,487 | 418,590 | 243,637 | 243,637 | 37,483 | 588,021 | 0,064 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA41 | Atas | 382,584 | 382,584 | 785,173 | 703,228 | 109,730 | 109,730 | 186,964 | 28,764 | 461,689 | 0,062 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 0,000 | 140,321 | 140,321 | 371,432 | 140,321 | 192,193 | 29,568 | 446,667 | 0,066 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KA2 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10648,782 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10303,797 | Aman |
| | KA10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10458,550 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9483,621 | | Aman |
| | KA18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10213,838 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9775,998 | | Aman |
| | KA26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10445,985 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9397,328 | | Aman |
| | KA34 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10325,053 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9868,296 | | Aman |
| | KA41 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10330,704 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10231,896 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KA2 | Atas | 31,148 | 2,912 | 24,483 | 114,250 | 138,592 | 114,250 |
| | | Bawah | 31,148 | 2,912 | 24,483 | 114,250 | 138,592 | 114,250 |
| | KA10 | Atas | 15,344 | 3,513 | 25,683 | 159,167 | 127,668 | 127,668 |
| | | Bawah | 15,344 | 3,513 | 25,683 | 159,167 | 127,668 | 127,668 |
| | KA18 | Atas | 15,534 | 3,754 | 27,679 | 148,687 | 136,504 | 136,504 |
| | | Bawah | 15,534 | 3,754 | 27,679 | 148,687 | 136,504 | 136,504 |
| | KA26 | Atas | 24,314 | 4,217 | 30,094 | 166,353 | 156,877 | 156,877 |
| | | Bawah | 24,314 | 4,217 | 30,094 | 166,353 | 156,877 | 156,877 |
| | KA34 | Atas | 7,644 | 4,733 | 32,012 | 151,452 | 147,446 | 147,446 |
| | | Bawah | 7,644 | 4,733 | 32,012 | 151,452 | 147,446 | 147,446 |
| | KA41 | Atas | 33,059 | 10,622 | 33,241 | 130,744 | 185,477 | 130,744 |
| | | Bawah | 33,059 | 10,622 | 33,241 | 130,744 | 185,477 | 130,744 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Besment | KA2 | Atas | 114,250 | 0 | 149,1 | 190,417 | 126,511 | 159,75 | 125 | P10-125 | AMAN |
| | | Bawah | 114,250 | 0 | 149,1 | 190,417 | 126,511 | 159,75 | 125 | P10-125 | AMAN |
| | KA10 | Atas | 127,668 | 0 | 149,1 | 212,781 | 113,214 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 127,668 | 0 | 149,1 | 212,781 | 113,214 | 159,75 | 110 | P10-110 | AMAN |
| | KA18 | Atas | 136,504 | 0 | 149,1 | 227,507 | 105,886 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 136,504 | 0 | 149,1 | 227,507 | 105,886 | 159,75 | 105 | P10-105 | AMAN |
| | KA26 | Atas | 156,877 | 0 | 149,1 | 261,462 | 92,135 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 156,877 | 0 | 149,1 | 261,462 | 92,135 | 159,75 | 90 | P10-90 | AMAN |
| | KA34 | Atas | 147,446 | 0 | 149,1 | 245,744 | 98,028 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 147,446 | 0 | 149,1 | 245,744 | 98,028 | 159,75 | 95 | P10-95 | AMAN |
| | KA41 | Atas | 130,744 | 0 | 149,1 | 217,906 | 110,551 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 130,744 | 0 | 149,1 | 217,906 | 110,551 | 159,75 | 110 | P10-110 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Besment | KA2 | Atas | 3,940 | 372,750 | 149,1 | -366,184 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 3,940 | 372,750 | 149,1 | -366,184 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA10 | Atas | 4,402 | 372,750 | 149,1 | -365,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 4,402 | 372,750 | 149,1 | -365,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA18 | Atas | 4,707 | 372,750 | 149,1 | -364,905 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 4,707 | 372,750 | 149,1 | -364,905 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA26 | Atas | 5,410 | 372,750 | 149,1 | -363,734 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 5,410 | 372,750 | 149,1 | -363,734 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA34 | Atas | 5,084 | 372,750 | 149,1 | -364,276 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 5,084 | 372,750 | 149,1 | -364,276 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA41 | Atas | 4,508 | 372,750 | 149,1 | -365,236 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 4,508 | 372,750 | 149,1 | -365,236 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | : | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | : | 4,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | : | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | : | 3,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | : | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | : | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | : | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | : | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | : | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran | PD | PL | PE | $EI_1$ | $EI_2$ | EI pakai | Pc | δb | Pu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | ψ | K | ψ | K | | momen | KN | KN | KN | KNm^2 | KNm^2 | KNm^2 | KN | | KN |
| Ground Floor | KA3 | Atas | | | 7,627 | 2,7 | 56,571 | Ok | 1969,950 | 372,478 | 0,680 | 132580,497 | 37628,136 | 132580,497 | 110145,049 | 1,043 | 2959,905 |
| | | Bawah | | | 8,773 | 2,7 | 56,571 | Ok | 2028,750 | 372,478 | 0,680 | 132235,835 | 37530,316 | 132235,835 | 109858,711 | 1,044 | 3030,465 |
| | KA11 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2237,026 | 570,403 | 125,313 | 136556,708 | 38756,638 | 136556,708 | 16565,393 | 1,502 | 3597,076 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2295,826 | 570,403 | 125,313 | 136176,071 | 38648,609 | 136176,071 | 16519,219 | 1,519 | 3667,636 |
| | KA19 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2218,416 | 509,573 | 118,917 | 135067,187 | 38333,892 | 135067,187 | 16384,702 | 1,485 | 3477,416 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2277,216 | 509,573 | 118,917 | 134711,413 | 38232,919 | 134711,413 | 16341,544 | 1,502 | 3547,976 |
| | KA27 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2414,543 | 506,106 | 134,503 | 133851,881 | 37988,972 | 133851,881 | 16237,276 | 1,541 | 3707,221 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2473,343 | 506,106 | 134,503 | 133546,063 | 37902,177 | 133546,063 | 16200,178 | 1,559 | 3777,781 |
| | KA35 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2328,882 | 576,864 | 126,163 | 136132,044 | 38636,113 | 136132,044 | 16513,878 | 1,530 | 3717,641 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2387,682 | 576,864 | 126,163 | 135773,618 | 38534,387 | 135773,618 | 16470,398 | 1,548 | 3788,201 |
| | KA42 | Atas | | | 7,627 | 2,7 | 56,571 | Ok | 1860,148 | 379,892 | 267,512 | 133521,591 | 37895,231 | 133521,591 | 110926,889 | 1,041 | 2840,005 |
| | | Bawah | | | 8,773 | 2,7 | 56,571 | Ok | 1918,948 | 379,892 | 267,512 | 133134,816 | 37785,459 | 133134,816 | 110605,565 | 1,042 | 2910,565 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung | ΣPu | ΣPc | δs | MD | ML | ME | Mc | Rv | $Mkap_{ka}$ | $Mkap_{ki}$ | Nuk1 | Nuk2 | Nuk pakai | Mmaks | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KN | KN | | KNm | KNm | KNm | KNm | | KNm | KNm | KN | KN | KN | KNm | |
| Ground Floor | KA3 | Atas | 20299,264 | 286773,187 | 1,122 | 38,353 | 23,817 | 29,370 | 184,397 | 0,975 | 469,730 | 469,730 | 2587,786 | 2462,405 | 2462,405 | 85,588 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 45,507 | 20,559 | 76,254 | 249,847 | 0,975 | 469,730 | 469,730 | 2649,526 | 2524,145 | 2524,145 | 140,967 | 1,3 |
| | KA11 | Atas | 20299,264 | 286773,187 | 1,122 | 5,314 | 1,880 | 68,175 | 102,015 | 0,975 | 469,730 | 469,730 | 3076,037 | 3474,115 | 3076,037 | 85,928 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 26,086 | 3,283 | 109,591 | 218,182 | 0,975 | 469,730 | 469,730 | 3137,777 | 3535,855 | 3137,777 | 144,757 | 1,3 |
| | KA19 | Atas | 20299,264 | 286773,187 | 1,122 | 29,734 | 10,541 | 64,200 | 196,158 | 0,975 | 469,730 | 469,730 | 2992,625 | 3363,840 | 2992,625 | 158,905 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 39,724 | 9,811 | 105,939 | 274,239 | 0,975 | 469,730 | 469,730 | 3054,365 | 3425,580 | 3054,365 | 105,663 | 1,3 |
| | KA27 | Atas | 20299,264 | 286773,187 | 1,122 | 32,798 | 8,075 | 62,989 | 199,159 | 0,975 | 469,730 | 469,730 | 3194,918 | 3631,594 | 3194,918 | 105,288 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 43,270 | 8,913 | 104,636 | 284,319 | 0,975 | 469,730 | 469,730 | 3256,658 | 3693,334 | 3256,658 | 161,153 | 1,3 |
| | KA35 | Atas | 20299,264 | 286773,187 | 1,122 | 40,487 | 1,477 | 66,644 | 205,221 | 0,975 | 469,730 | 469,730 | 3179,270 | 3580,918 | 3179,270 | 148,911 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 37,381 | 5,037 | 107,685 | 256,895 | 0,975 | 469,730 | 469,730 | 3241,010 | 3642,658 | 3241,010 | 113,784 | 1,3 |
| | KA42 | Atas | 20299,264 | 286773,187 | 1,122 | 57,070 | 29,588 | 25,912 | 239,272 | 0,975 | 469,730 | 469,730 | 2480,278 | 3475,592 | 2480,278 | 144,966 | 1,3 |
| | | Bawah | 20722,624 | 285995,614 | 1,125 | 48,029 | 30,266 | 72,076 | 273,927 | 0,975 | 469,730 | 469,730 | 2542,018 | 3537,332 | 2542,018 | 116,510 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung | $Mkap_{ka,by}$ | $Mkap_{ki,by}$ | $Muk_1$ | $Muk_2$ | $Muk_3$ | Muk pakai | Mu | Mn | Pn | e | % | Ast | As' = As perlu | n tulangan | As = As' ada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KNm | KNm | KNm | KNm | KNm | KNm | terpakai KNm | Ton-m | Ton | m | | $mm^2$ | $mm^2$ | | $mm^2$ |
| Ground Floor | KA3 | Atas | 382,584 | 382,584 | 505,866 | 453,071 | 188,633 | 188,633 | 188,633 | 29,020 | 378,832 | 0,077 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 833,182 | 746,227 | 389,636 | 389,636 | 389,636 | 59,944 | 388,330 | 0,154 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA11 | Atas | 554,777 | 554,777 | 542,865 | 593,667 | 293,889 | 293,889 | 293,889 | 45,214 | 473,236 | 0,096 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 877,849 | 877,849 | 491,120 | 491,120 | 491,120 | 75,557 | 482,735 | 0,157 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA19 | Atas | 554,777 | 554,777 | 875,340 | 957,255 | 311,929 | 311,929 | 311,929 | 47,989 | 460,404 | 0,104 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 558,708 | 558,708 | 496,956 | 496,956 | 496,956 | 76,455 | 469,902 | 0,163 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA27 | Atas | 553,475 | 553,475 | 575,556 | 628,625 | 307,470 | 307,470 | 307,470 | 47,303 | 491,526 | 0,096 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 880,941 | 962,169 | 494,263 | 494,263 | 494,263 | 76,041 | 501,024 | 0,152 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA35 | Atas | 469,730 | 469,730 | 793,002 | 793,002 | 323,967 | 323,967 | 323,967 | 49,841 | 489,118 | 0,102 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 605,939 | 605,939 | 496,816 | 496,816 | 496,816 | 76,433 | 498,617 | 0,153 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA42 | Atas | 382,584 | 382,584 | 742,387 | 664,908 | 199,821 | 199,821 | 239,272 | 36,811 | 381,581 | 0,096 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 596,661 | 534,390 | 384,929 | 384,929 | 384,929 | 59,220 | 391,080 | 0,151 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KA3 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9969,370 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8084,169 | Aman |
| | KA11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9497,271 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7552,242 | | Aman |
| | KA19 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9283,158 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7891,372 | Aman |
| | KA27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8910,610 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7643,986 | | Aman |
| | KA35 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8762,489 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7614,368 | | Aman |
| | KA42 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9474,321 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8152,556 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KA3 | Atas | 22,092 | 5,563 | 17,992 | 131,425 | 104,604 | 104,604 |
| | | Bawah | 22,092 | 5,563 | 17,992 | 131,425 | 104,604 | 104,604 |
| | KA11 | Atas | 0,729 | 9,573 | 18,983 | 178,411 | 90,546 | 90,546 |
| | | Bawah | 0,729 | 9,573 | 18,983 | 178,411 | 90,546 | 90,546 |
| | KA19 | Atas | 4,223 | 10,694 | 21,321 | 183,837 | 105,211 | 105,211 |
| | | Bawah | 4,223 | 10,694 | 21,321 | 183,837 | 105,211 | 105,211 |
| | KA27 | Atas | 9,913 | 11,717 | 23,632 | 182,212 | 121,966 | 121,966 |
| | | Bawah | 9,913 | 11,717 | 23,632 | 182,212 | 121,966 | 121,966 |
| | KA35 | Atas | 6,164 | 9,866 | 26,325 | 186,542 | 127,397 | 127,397 |
| | | Bawah | 6,164 | 9,866 | 26,325 | 186,542 | 127,397 | 127,397 |
| | KA42 | Atas | 18,775 | 12,44 | 31,821 | 141,864 | 166,424 | 141,864 |
| | | Bawah | 18,775 | 12,44 | 31,821 | 141,864 | 166,424 | 141,864 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KA3 | Atas | 104,604 | 0 | 149,1 | 174,340 | 138,177 | 159,75 | 135 | P10-135 | AMAN |
| | | Bawah | 104,604 | 0 | 149,1 | 174,340 | 138,177 | 159,75 | 135 | P10-135 | AMAN |
| | KA11 | Atas | 90,546 | 0 | 149,1 | 150,910 | 159,631 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 90,546 | 0 | 149,1 | 150,910 | 159,631 | 159,75 | 155 | P10-155 | AMAN |
| | KA19 | Atas | 105,211 | 0 | 149,1 | 175,352 | 137,380 | 159,75 | 135 | P10-135 | AMAN |
| | | Bawah | 105,211 | 0 | 149,1 | 175,352 | 137,380 | 159,75 | 135 | P10-135 | AMAN |
| | KA27 | Atas | 121,966 | 0 | 149,1 | 203,277 | 118,507 | 159,75 | 115 | P10-115 | AMAN |
| | | Bawah | 121,966 | 0 | 149,1 | 203,277 | 118,507 | 159,75 | 115 | P10-115 | AMAN |
| | KA35 | Atas | 127,397 | 0 | 149,1 | 212,328 | 113,456 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 127,397 | 0 | 149,1 | 212,328 | 113,456 | 159,75 | 110 | P10-110 | AMAN |
| | KA42 | Atas | 141,864 | 0 | 149,1 | 236,440 | 101,886 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 141,864 | 0 | 149,1 | 236,440 | 101,886 | 159,75 | 100 | P10-100 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KA3 | Atas | 38,038 | 372,750 | 149,1 | -309,354 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 38,038 | 372,750 | 149,1 | -309,354 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA11 | Atas | 32,926 | 372,750 | 149,1 | -317,874 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 32,926 | 372,750 | 149,1 | -317,874 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA19 | Atas | 38,259 | 372,750 | 149,1 | -308,986 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 38,259 | 372,750 | 149,1 | -308,986 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA27 | Atas | 44,351 | 372,750 | 149,1 | -298,831 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,351 | 372,750 | 149,1 | -298,831 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA35 | Atas | 46,326 | 372,750 | 149,1 | -295,540 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,326 | 372,750 | 149,1 | -295,540 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA42 | Atas | 51,587 | 372,750 | 149,1 | -286,772 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 51,587 | 372,750 | 149,1 | -286,772 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| f'c | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| ' | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | EI1 KNm^2 | EI2 KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KA4 | Atas | | | 8,028 | 2,64 | 49,029 | Ok | 1621,418 | 288,809 | 0,652 | 131889,027 | 37431,838 | 131889,027 | 126427,604 | 1,030 | 2407,796 |
| | | Bawah | | | 7,627 | 2,64 | 49,029 | Ok | 1674,338 | 288,809 | 0,652 | 131530,276 | 37330,069 | 131530,276 | 126083,708 | 1,031 | 2471,300 |
| | KA12 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1799,508 | 430,395 | 91,646 | 135630,352 | 38493,726 | 135630,352 | 22002,370 | 1,249 | 2848,042 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1852,428 | 430,395 | 91,646 | 135224,746 | 38378,610 | 135224,746 | 21936,571 | 1,257 | 2911,546 |
| | KA20 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1812,434 | 385,383 | 86,398 | 134036,690 | 38041,423 | 134036,690 | 21743,841 | 1,246 | 2791,534 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1865,354 | 385,383 | 86,398 | 133667,558 | 37936,659 | 133667,558 | 21683,959 | 1,254 | 2855,038 |
| | KA28 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1968,199 | 381,926 | 103,155 | 132891,054 | 37716,276 | 132891,054 | 21557,993 | 1,269 | 2972,920 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2021,119 | 381,926 | 103,155 | 132573,455 | 37626,137 | 132573,455 | 21506,471 | 1,277 | 3036,424 |
| | KA36 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1849,621 | 437,677 | 95,343 | 135479,762 | 38450,937 | 135479,762 | 21977,941 | 1,257 | 2919,328 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1902,541 | 437,677 | 95,343 | 135087,949 | 38339,735 | 135087,949 | 21914,379 | 1,265 | 2983,332 |
| | KA43 | Atas | | | 8,028 | 2,64 | 49,029 | Ok | 1518,674 | 297,857 | 197,439 | 133020,597 | 37753,042 | 133020,597 | 127512,317 | 1,029 | 2298,380 |
| | | Bawah | | | 7,627 | 2,64 | 49,029 | Ok | 1571,594 | 297,857 | 197,439 | 132608,417 | 37636,060 | 132608,417 | 127117,204 | 1,029 | 2362,484 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{x}$ KNm | $Mkap_{y}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_x$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KA4 | Atas | 16239,100 | 341222,065 | 1,079 | 58,183 | 31,637 | 72,956 | 294,154 | 1 | 469,730 | 469,730 | 2151,877 | 2008,477 | 2008,477 | 158,143 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 58,853 | 33,447 | 94,346 | 324,712 | 1 | 469,730 | 469,730 | 2207,443 | 2064,043 | 2064,043 | 183,143 | 1,3 |
| | KA12 | Atas | 16239,100 | 341222,065 | 1,079 | 37,485 | 6,392 | 124,962 | 257,327 | 1 | 469,730 | 469,730 | 2487,536 | 2726,311 | 2487,536 | 175,497 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 23,045 | 6,078 | 144,388 | 241,200 | 1 | 469,730 | 469,730 | 2543,102 | 2781,877 | 2543,102 | 181,163 | 1,3 |
| | KA20 | Atas | 16239,100 | 341222,065 | 1,079 | 21,259 | 16,949 | 120,414 | 237,613 | 1 | 469,730 | 469,730 | 2453,846 | 2670,579 | 2453,846 | 161,753 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 8,238 | 12,094 | 139,977 | 213,172 | 1 | 469,730 | 469,730 | 2509,412 | 2726,145 | 2509,412 | 158,579 | 1,3 |
| | KA28 | Atas | 16239,100 | 341222,065 | 1,079 | 56,242 | 20,430 | 119,514 | 340,166 | 1 | 469,730 | 469,730 | 2613,769 | 2900,882 | 2613,769 | 198,284 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 53,906 | 16,080 | 139,240 | 345,740 | 1 | 469,730 | 469,730 | 2669,335 | 2956,448 | 2669,335 | 214,438 | 1,3 |
| | KA36 | Atas | 16239,100 | 341222,065 | 1,079 | 20,270 | 2,660 | 124,910 | 202,212 | 1 | 469,730 | 469,730 | 2547,801 | 2802,104 | 2547,801 | 174,572 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 20,753 | 3,718 | 144,736 | 229,442 | 1 | 469,730 | 469,730 | 2603,367 | 2857,670 | 2603,367 | 453,211 | 1,3 |
| | KA43 | Atas | 16239,100 | 341222,065 | 1,079 | 36,852 | 27,880 | 71,869 | 233,492 | 1 | 469,730 | 469,730 | 2053,496 | 2736,601 | 2053,496 | 158,451 | 1,3 |
| | | Bawah | 16620,124 | 340242,293 | 1,081 | 41,103 | 28,248 | 94,034 | 269,969 | 1 | 469,730 | 469,730 | 2109,062 | 2792,167 | 2109,062 | 131,185 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast mm² | As' = As perlu mm² | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KA4 | Atas | 469,730 | 469,730 | 658,206 | 658,206 | 400,726 | 400,726 | 400,726 | 61,650 | 308,996 | 0,200 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 729,623 | 653,476 | 493,168 | 493,168 | 493,168 | 75,872 | 317,545 | 0,239 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA12 | Atas | 553,475 | 553,475 | 727,705 | 794,803 | 570,911 | 570,911 | 570,911 | 87,833 | 332,698 | 0,230 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 751,661 | 822,002 | 637,009 | 637,009 | 637,009 | 98,001 | 391,247 | 0,250 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA20 | Atas | 553,475 | 553,475 | 746,779 | 815,636 | 545,857 | 545,857 | 545,857 | 83,978 | 377,515 | 0,222 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 732,575 | 801,131 | 609,252 | 609,252 | 609,252 | 93,731 | 386,063 | 0,243 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA28 | Atas | 553,475 | 553,475 | 710,510 | 776,023 | 582,464 | 582,464 | 582,464 | 89,610 | 402,118 | 0,223 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 768,395 | 839,245 | 658,293 | 658,293 | 658,293 | 101,276 | 410,667 | 0,247 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA36 | Atas | 469,730 | 469,730 | 394,998 | 394,998 | 548,699 | 394,998 | 394,998 | 60,769 | 391,969 | 0,155 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1025,465 | 1025,465 | 633,586 | 633,586 | 633,586 | 97,475 | 400,518 | 0,243 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA43 | Atas | 469,730 | 469,730 | 777,092 | 777,092 | 369,818 | 369,818 | 369,818 | 56,895 | 315,922 | 0,180 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 615,827 | 551,556 | 467,761 | 467,761 | 467,761 | 71,963 | 324,471 | 0,222 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 1 | KA4 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7066,782 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6238,179 | Aman |
| | KA12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6430,714 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6007,283 | Aman |
| | KA20 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6577,294 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6160,520 | Aman |
| | KA28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6569,040 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6084,033 | Aman |
| | KA36 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8068,573 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6148,788 | Aman |
| | KA43 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7496,292 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6591,167 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KA4 | Atas | 27,314 | 9,168 | 39,544 | 229,204 | 204,391 | 204,391 |
| | | Bawah | 27,314 | 9,168 | 39,544 | 229,204 | 204,391 | 204,391 |
| | KA12 | Atas | 7,596 | 16,688 | 34,013 | 309,723 | 168,353 | 168,353 |
| | | Bawah | 7,596 | 16,688 | 34,013 | 309,723 | 168,353 | 168,353 |
| | KA20 | Atas | 9,09 | 16,232 | 33,298 | 296,182 | 166,440 | 166,440 |
| | | Bawah | 10,09 | 16,232 | 33,298 | 296,182 | 167,490 | 167,490 |
| | KA28 | Atas | 8,578 | 15,272 | 35,378 | 318,143 | 173,630 | 173,630 |
| | | Bawah | 9,578 | 15,272 | 35,378 | 318,143 | 174,680 | 174,680 |
| | KA36 | Atas | 6,448 | 14,527 | 34,806 | 263,739 | 168,209 | 168,209 |
| | | Bawah | 7,448 | 14,527 | 34,806 | 263,739 | 169,259 | 169,259 |
| | KA43 | Atas | 20,587 | 13,671 | 36,573 | 214,764 | 189,578 | 189,578 |
| | | Bawah | 21,587 | 13,671 | 36,573 | 214,764 | 190,628 | 190,628 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KA4 | Atas | 204,391 | 0 | 149,1 | 340,652 | 70,717 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 204,391 | 0 | 149,1 | 340,652 | 70,717 | 159,75 | 70 | P10-70 | AMAN |
| | KA12 | Atas | 168,353 | 0 | 149,1 | 280,588 | 85,855 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 168,353 | 0 | 149,1 | 280,588 | 85,855 | 159,75 | 85 | P10-85 | AMAN |
| | KA20 | Atas | 166,440 | 0 | 149,1 | 277,400 | 86,842 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 167,490 | 0 | 149,1 | 279,150 | 86,297 | 159,75 | 85 | P10-85 | AMAN |
| | KA28 | Atas | 173,630 | 0 | 149,1 | 289,384 | 83,245 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 174,680 | 0 | 149,1 | 291,134 | 82,745 | 159,75 | 80 | P10-80 | AMAN |
| | KA36 | Atas | 168,209 | 0 | 149,1 | 280,348 | 85,928 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 169,259 | 0 | 149,1 | 282,098 | 85,396 | 159,75 | 85 | P10-85 | AMAN |
| | KA43 | Atas | 189,578 | 0 | 149,1 | 315,963 | 76,243 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 190,628 | 0 | 149,1 | 317,713 | 75,823 | 159,75 | 75 | P10-75 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KA4 | Atas | 57,649 | 372,750 | 149,1 | -276,669 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 57,649 | 372,750 | 149,1 | -276,669 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA12 | Atas | 47,484 | 372,750 | 149,1 | -293,610 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 47,484 | 372,750 | 149,1 | -293,610 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA20 | Atas | 46,945 | 372,750 | 149,1 | -294,509 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 47,241 | 372,750 | 149,1 | -294,016 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA28 | Atas | 48,973 | 372,750 | 149,1 | -291,129 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 49,269 | 372,750 | 149,1 | -290,635 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA36 | Atas | 47,444 | 372,750 | 149,1 | -293,677 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 47,740 | 372,750 | 149,1 | -293,184 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA43 | Atas | 53,471 | 372,750 | 149,1 | -283,632 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 53,767 | 372,750 | 149,1 | -283,139 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 4,5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 4,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KA5 | Atas | | | 7,627 | 2,65 | 49,214 | Ok | 1271,811 | 204,093 | 0,562 | 130756,360 | 37110,421 | 130756,360 | 124868,852 | 1,023 | 1852,722 |
| | | Bawah | | | 8,028 | 2,65 | 49,214 | Ok | 1324,731 | 204,093 | 0,562 | 130338,913 | 36991,944 | 130338,913 | 124470,201 | 1,024 | 1916,226 |
| | KA13 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1321,539 | 289,919 | 54,538 | 134446,480 | 38157,727 | 134446,480 | 21810,319 | 1,169 | 2049,717 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1374,459 | 289,919 | 54,538 | 133932,947 | 38011,980 | 133932,947 | 21727,012 | 1,176 | 2113,221 |
| | KA21 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1326,891 | 279,941 | 51,707 | 133935,511 | 38012,707 | 133935,511 | 21727,427 | 1,169 | 2040,175 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1379,811 | 279,941 | 51,707 | 133438,814 | 37871,738 | 133438,814 | 21646,852 | 1,176 | 2103,679 |
| | KA29 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1484,904 | 276,593 | 71,302 | 132404,051 | 37578,058 | 132404,051 | 21478,989 | 1,190 | 2224,434 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1537,824 | 276,593 | 71,302 | 131999,340 | 37463,196 | 131999,340 | 21413,336 | 1,197 | 2287,938 |
| | KA37 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1371,988 | 298,100 | 65,220 | 134319,043 | 38121,559 | 134319,043 | 21789,645 | 1,176 | 2123,346 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1424,908 | 298,100 | 65,220 | 133827,345 | 37982,008 | 133827,345 | 21709,880 | 1,183 | 2186,850 |
| | KA44 | Atas | | | 7,627 | 2,65 | 49,214 | Ok | 1174,499 | 214,652 | 125,878 | 132182,852 | 37515,279 | 132182,852 | 126231,114 | 1,022 | 1752,842 |
| | | Bawah | | | 8,028 | 2,65 | 49,214 | Ok | 1227,419 | 214,652 | 125,878 | 131682,828 | 37373,365 | 131682,828 | 125753,604 | 1,023 | 1816,346 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KA5 | Atas | 12043,235 | 337906,347 | 1,058 | 53,355 | 30,725 | 78,009 | 282,244 | 1 | 469,730 | 469,730 | 1695,837 | 1552,060 | 1552,060 | 157,808 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 39,687 | 28,329 | 63,899 | 229,438 | 1 | 469,730 | 469,730 | 1751,403 | 1607,626 | 1607,626 | 127,366 | 1,3 |
| | KA13 | Atas | 12043,235 | 337906,347 | 1,058 | 33,979 | 5,371 | 130,022 | 243,484 | 1 | 469,730 | 469,730 | 1838,169 | 1921,091 | 1838,169 | 176,634 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 26,783 | 4,040 | 116,839 | 207,974 | 1 | 469,730 | 469,730 | 1893,735 | 1976,657 | 1893,735 | 154,588 | 1,3 |
| | KA21 | Atas | 12043,235 | 337906,347 | 1,058 | 38,619 | 16,154 | 124,100 | 275,913 | 1 | 469,730 | 469,730 | 1833,312 | 1904,343 | 1833,312 | 183,270 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 51,557 | 20,891 | 111,575 | 307,597 | 1 | 469,730 | 469,730 | 1888,878 | 1959,909 | 1888,878 | 180,051 | 1,3 |
| | KA29 | Atas | 12043,235 | 337906,347 | 1,058 | 33,717 | 17,945 | 123,225 | 268,592 | 1 | 469,730 | 469,730 | 1995,710 | 2149,040 | 1995,710 | 177,094 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 30,777 | 19,298 | 110,609 | 251,427 | 1 | 469,730 | 469,730 | 2051,276 | 2204,606 | 2051,276 | 161,810 | 1,3 |
| | KA37 | Atas | 12043,235 | 337906,347 | 1,058 | 46,156 | 6,647 | 129,429 | 277,156 | 1 | 469,730 | 469,730 | 1899,731 | 2027,516 | 1899,731 | 175,352 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 48,208 | 6,066 | 116,340 | 267,169 | 1 | 469,730 | 469,730 | 1955,297 | 2083,082 | 1955,297 | 187,496 | 1,3 |
| | KA44 | Atas | 12043,235 | 337906,347 | 1,058 | 63,444 | 30,757 | 76,074 | 303,574 | 1 | 469,730 | 469,730 | 1604,747 | 1987,296 | 1604,747 | 150,460 | 1,3 |
| | | Bawah | 12424,259 | 336720,884 | 1,060 | 63,337 | 31,086 | 62,041 | 288,932 | 1 | 469,730 | 469,730 | 1660,313 | 2042,862 | 1660,313 | 165,332 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KA5 | Atas | 382,584 | 382,584 | 752,395 | 673,871 | 415,922 | 415,922 | 415,922 | 63,988 | 238,778 | 0,268 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 634,415 | 634,415 | 339,793 | 339,793 | 339,793 | 52,276 | 247,327 | 0,211 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA13 | Atas | 636,229 | 636,229 | 819,467 | 964,045 | 587,410 | 587,410 | 587,410 | 90,371 | 282,795 | 0,320 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 690,235 | 753,878 | 523,088 | 523,088 | 523,088 | 80,475 | 291,344 | 0,276 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA21 | Atas | 636,229 | 636,229 | 775,134 | 911,891 | 578,732 | 578,732 | 578,732 | 89,036 | 282,048 | 0,316 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 732,901 | 800,478 | 544,685 | 544,685 | 544,685 | 83,798 | 290,597 | 0,288 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA29 | Atas | 553,475 | 553,475 | 772,800 | 844,057 | 571,790 | 571,790 | 571,790 | 87,968 | 307,032 | 0,287 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 706,104 | 771,211 | 517,137 | 517,137 | 517,137 | 79,559 | 315,581 | 0,252 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA37 | Atas | 469,730 | 469,730 | 686,461 | 686,461 | 599,045 | 599,045 | 599,045 | 92,161 | 292,266 | 0,315 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 734,002 | 734,002 | 545,616 | 545,616 | 545,616 | 83,941 | 300,815 | 0,279 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA44 | Atas | 382,584 | 382,584 | 647,809 | 580,200 | 418,422 | 418,422 | 418,422 | 64,373 | 246,884 | 0,261 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 743,680 | 743,680 | 359,716 | 359,716 | 359,716 | 55,341 | 255,433 | 0,217 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KA5 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5668,740 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6811,458 | Aman |
| | KA13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4754,785 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5514,135 | Aman |
| | KA21 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4819,072 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5292,101 | Aman |
| | KA29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5325,558 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5975,365 | Aman |
| | KA37 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4824,798 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5461,864 | Aman |
| | KA44 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5807,176 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6699,076 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KA5 | Atas | 29,553 | 8,739 | 28,87 | 193,773 | 161,461 | 161,461 |
| | | Bawah | 29,553 | 8,739 | 28,87 | 193,773 | 161,461 | 161,461 |
| | KA13 | Atas | 0,869 | 15,623 | 36,537 | 284,743 | 170,772 | 170,772 |
| | | Bawah | 10,594 | 0,05 | 36,537 | 284,743 | 164,632 | 164,632 |
| | KA21 | Atas | 22,792 | 15,235 | 36,478 | 288,056 | 193,136 | 193,136 |
| | | Bawah | 22,792 | 15,235 | 36,478 | 288,056 | 193,136 | 193,136 |
| | KA29 | Atas | 23,028 | 14,994 | 27,49 | 279,212 | 155,381 | 155,381 |
| | | Bawah | 23,028 | 14,994 | 27,49 | 279,212 | 155,381 | 155,381 |
| | KA37 | Atas | 4,991 | 14,766 | 28,493 | 293,503 | 140,415 | 140,415 |
| | | Bawah | 4,991 | 14,766 | 28,493 | 293,503 | 140,415 | 140,415 |
| | KA44 | Atas | 24,863 | 14,496 | 27,499 | 199,523 | 156,823 | 156,823 |
| | | Bawah | 24,863 | 14,496 | 27,499 | 199,523 | 156,823 | 156,823 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KA5 | Atas | 161,461 | 0 | 149,1 | 269,101 | 89,520 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 161,461 | 0 | 149,1 | 269,101 | 89,520 | 159,75 | 85 | P10-85 | AMAN |
| | KA13 | Atas | 170,772 | 0 | 149,1 | 284,620 | 84,638 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 164,632 | 0 | 149,1 | 274,386 | 87,795 | 159,75 | 85 | P10-85 | AMAN |
| | KA21 | Atas | 193,136 | 0 | 149,1 | 321,893 | 74,838 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 193,136 | 0 | 149,1 | 321,893 | 74,838 | 159,75 | 70 | P10-70 | AMAN |
| | KA29 | Atas | 155,381 | 0 | 149,1 | 258,969 | 93,022 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 155,381 | 0 | 149,1 | 258,969 | 93,022 | 159,75 | 90 | P10-90 | AMAN |
| | KA37 | Atas | 140,415 | 0 | 149,1 | 234,026 | 102,936 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 140,415 | 0 | 149,1 | 234,026 | 102,936 | 159,75 | 100 | P10-100 | AMAN |
| | KA44 | Atas | 156,823 | 0 | 149,1 | 261,371 | 92,167 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 156,823 | 0 | 149,1 | 261,371 | 92,167 | 159,75 | 90 | P10-90 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KA5 | Atas | 45,540 | 372,750 | 149,1 | -296,850 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 45,540 | 372,750 | 149,1 | -296,850 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA13 | Atas | 48,166 | 372,750 | 149,1 | -292,473 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,435 | 372,750 | 149,1 | -295,359 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA21 | Atas | 54,474 | 372,750 | 149,1 | -281,960 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 54,474 | 372,750 | 149,1 | -281,960 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA29 | Atas | 43,825 | 372,750 | 149,1 | -299,708 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 43,825 | 372,750 | 149,1 | -299,708 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA37 | Atas | 39,604 | 372,750 | 149,1 | -306,743 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 39,604 | 372,750 | 149,1 | -306,743 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA44 | Atas | 44,232 | 372,750 | 149,1 | -299,030 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,232 | 372,750 | 149,1 | -299,030 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 4,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KA6 | Atas | | | 1,463 | 1,8 | 37,714 | Ok | 907,567 | 119,517 | 3,569 | 128856,231 | 36571,139 | 128856,231 | 160576,512 | 1,012 | 1280,308 |
| | | Bawah | | | 7,627 | 1,8 | 37,714 | Ok | 966,367 | 119,517 | 3,569 | 128315,306 | 36417,617 | 128315,306 | 159902,428 | 1,013 | 1350,868 |
| | KA14 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 824,066 | 149,835 | 24,962 | 132123,673 | 37498,483 | 132123,673 | 17180,931 | 1,124 | 1228,615 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 882,866 | 149,835 | 24,962 | 131352,415 | 37279,590 | 131352,415 | 17080,639 | 1,133 | 1299,175 |
| | KA22 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 837,881 | 155,026 | 24,438 | 132325,468 | 37555,755 | 132325,468 | 17207,171 | 1,126 | 1253,499 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 896,681 | 155,026 | 24,438 | 131555,668 | 37337,276 | 131555,668 | 17107,069 | 1,135 | 1324,059 |
| | KA30 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 956,286 | 151,928 | 45,285 | 130652,386 | 37080,912 | 130652,386 | 16989,609 | 1,144 | 1390,628 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 1015,086 | 151,928 | 45,285 | 130050,931 | 36910,211 | 130050,931 | 16911,398 | 1,153 | 1461,188 |
| | KA38 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 874,519 | 159,427 | 40,997 | 132153,919 | 37507,067 | 132153,919 | 17184,864 | 1,132 | 1304,506 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 933,319 | 159,427 | 40,997 | 131423,124 | 37299,658 | 131423,124 | 17089,833 | 1,141 | 1375,066 |
| | KA45 | Atas | | | 1,463 | 1,8 | 37,714 | Ok | 812,698 | 131,395 | 63,055 | 130834,352 | 37132,557 | 130834,352 | 163041,583 | 1,011 | 1185,470 |
| | | Bawah | | | 7,627 | 1,8 | 37,714 | Ok | 871,498 | 131,395 | 63,055 | 130123,113 | 36930,697 | 130123,113 | 162155,259 | 1,012 | 1256,030 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KA6 | Atas | 7643,025 | 392180,670 | 1,031 | 7,693 | 28,053 | 91,356 | 180,224 | 1 | 469,730 | 469,730 | 1209,963 | 1093,428 | 1093,428 | 123,198 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 35,051 | 28,296 | 47,856 | 196,808 | 1 | 469,730 | 469,730 | 1271,703 | 1155,168 | 1155,168 | 105,810 | 1,3 |
| | KA14 | Atas | 7643,025 | 392180,670 | 1,031 | 2,237 | 0,058 | 132,459 | 148,960 | 1 | 469,730 | 469,730 | 1154,120 | 1127,436 | 1127,436 | 143,319 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 20,468 | 2,336 | 91,841 | 155,367 | 1 | 469,730 | 469,730 | 1215,860 | 1189,176 | 1189,176 | 134,846 | 1,3 |
| | KA22 | Atas | 7643,025 | 392180,670 | 1,031 | 9,254 | 3,299 | 134,419 | 176,113 | 1 | 469,730 | 469,730 | 1174,077 | 1145,192 | 1145,192 | 131,248 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 17,039 | 7,974 | 89,686 | 158,624 | 1 | 469,730 | 469,730 | 1235,817 | 1206,932 | 1206,932 | 151,032 | 1,3 |
| | KA30 | Atas | 7643,025 | 392180,670 | 1,031 | 1,368 | 7,020 | 134,577 | 166,442 | 1 | 469,730 | 469,730 | 1295,149 | 1353,822 | 1295,149 | 137,348 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 16,792 | 3,820 | 89,386 | 147,923 | 1 | 469,730 | 469,730 | 1356,889 | 1415,562 | 1356,889 | 145,264 | 1,3 |
| | KA38 | Atas | 7643,025 | 392180,670 | 1,031 | 19,956 | 5,935 | 132,878 | 207,156 | 1 | 469,730 | 469,730 | 1217,168 | 1257,831 | 1217,168 | 127,662 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 30,406 | 1,315 | 91,719 | 177,342 | 1 | 469,730 | 469,730 | 1278,908 | 1319,571 | 1278,908 | 154,815 | 1,3 |
| | KA45 | Atas | 7643,025 | 392180,670 | 1,031 | 21,331 | 29,001 | 92,134 | 214,469 | 1 | 469,730 | 469,730 | 1122,822 | 1256,129 | 1122,822 | 109,229 | 1,3 |
| | | Bawah | 8066,385 | 390246,626 | 1,033 | 40,196 | 29,108 | 47,276 | 209,754 | 1 | 469,730 | 469,730 | 1184,562 | 1317,869 | 1184,562 | 135,860 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KA6 | Atas | 469,730 | 469,730 | 752,580 | 752,580 | 421,229 | 421,229 | 421,229 | 64,804 | 168,220 | 0,385 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 618,689 | 554,119 | 267,510 | 267,510 | 267,510 | 41,155 | 177,718 | 0,232 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA14 | Atas | 553,475 | 553,475 | 750,431 | 819,625 | 558,738 | 558,738 | 558,738 | 85,960 | 173,452 | 0,496 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 636,229 | 636,229 | 733,637 | 863,072 | 409,676 | 409,676 | 409,676 | 63,027 | 182,950 | 0,345 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA22 | Atas | 553,475 | 553,475 | 677,208 | 739,650 | 577,740 | 577,740 | 577,740 | 88,883 | 176,183 | 0,504 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 636,229 | 636,229 | 809,719 | 952,578 | 402,945 | 402,945 | 402,945 | 61,992 | 185,682 | 0,334 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA30 | Atas | 553,475 | 553,475 | 707,850 | 773,118 | 574,031 | 574,031 | 574,031 | 88,312 | 199,254 | 0,443 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 748,647 | 817,676 | 397,064 | 397,064 | 397,064 | 61,087 | 208,752 | 0,293 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA38 | Atas | 553,475 | 553,475 | 658,246 | 718,940 | 585,273 | 585,273 | 585,273 | 90,042 | 187,257 | 0,481 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 766,707 | 766,707 | 418,527 | 418,527 | 418,527 | 64,389 | 196,755 | 0,327 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA45 | Atas | 382,584 | 382,584 | 596,775 | 534,492 | 439,811 | 439,811 | 439,811 | 67,663 | 172,742 | 0,392 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 742,274 | 664,806 | 271,328 | 271,328 | 271,328 | 41,743 | 182,240 | 0,229 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keseimbangan | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
| Lantai 3 | KA6 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3785,980 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6388,161 | Aman |
| | KA14 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2629,460 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4360,665 | Aman |
| | KA22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2558,221 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4524,968 | Aman |
| | KA30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3110,641 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5215,833 | Aman |
| | KA38 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2753,715 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4629,851 | Aman |
| | KA45 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3702,559 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6440,101 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KA6 | Atas | 14,208 | 6,781 | 22,235 | 156,531 | 115,425 | 115,425 |
| | | Bawah | 14,208 | 6,781 | 22,235 | 156,531 | 115,425 | 115,425 |
| | KA14 | Atas | 43,831 | 13,862 | 21,101 | 220,094 | 149,202 | 149,202 |
| | | Bawah | 43,831 | 13,862 | 21,101 | 220,094 | 149,202 | 149,202 |
| | KA22 | Atas | 38,171 | 14,526 | 22,198 | 222,883 | 148,563 | 148,563 |
| | | Bawah | 38,171 | 14,526 | 22,198 | 222,883 | 148,563 | 148,563 |
| | KA30 | Atas | 0,907 | 12,746 | 15,443 | 220,703 | 79,196 | 79,196 |
| | | Bawah | 0,907 | 12,746 | 15,443 | 220,703 | 79,196 | 79,196 |
| | KA38 | Atas | 22,315 | 8,508 | 10,678 | 228,136 | 77,212 | 77,212 |
| | | Bawah | 22,315 | 8,508 | 10,678 | 228,136 | 77,212 | 77,212 |
| | KA45 | Atas | 4,788 | 10,389 | 23,848 | 161,623 | 116,097 | 116,097 |
| | | Bawah | 4,788 | 10,389 | 23,848 | 161,623 | 116,097 | 116,097 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KA6 | Atas | 115,425 | 0 | 149,1 | 192,376 | 125,223 | 159,75 | 125 | P10-125 | AMAN |
| | | Bawah | 115,425 | 0 | 149,1 | 192,376 | 125,223 | 159,75 | 125 | P10-125 | AMAN |
| | KA14 | Atas | 149,202 | 0 | 149,1 | 248,670 | 96,875 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 149,202 | 0 | 149,1 | 248,670 | 96,875 | 159,75 | 95 | P10-95 | AMAN |
| | KA22 | Atas | 148,563 | 0 | 149,1 | 247,606 | 97,291 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 148,563 | 0 | 149,1 | 247,606 | 97,291 | 159,75 | 95 | P10-95 | AMAN |
| | KA30 | Atas | 79,196 | 0 | 149,1 | 131,994 | 182,507 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 79,196 | 0 | 149,1 | 131,994 | 182,507 | 159,75 | 155 | P10-155 | AMAN |
| | KA38 | Atas | 77,212 | 0 | 149,1 | 128,686 | 187,198 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 77,212 | 0 | 149,1 | 128,686 | 187,198 | 159,75 | 155 | P10-155 | AMAN |
| | KA45 | Atas | 116,097 | 0 | 149,1 | 193,496 | 124,498 | 159,75 | 120 | P10-120 | AMAN |
| | | Bawah | 116,097 | 0 | 149,1 | 193,496 | 124,498 | 159,75 | 120 | P10-120 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KA6 | Atas | 41,973 | 372,750 | 149,1 | -302,795 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 41,973 | 372,750 | 149,1 | -302,795 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA14 | Atas | 54,255 | 372,750 | 149,1 | -282,325 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 54,255 | 372,750 | 149,1 | -282,325 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA22 | Atas | 54,023 | 372,750 | 149,1 | -282,712 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 54,023 | 372,750 | 149,1 | -282,712 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA30 | Atas | 28,799 | 372,750 | 149,1 | -324,752 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 28,799 | 372,750 | 149,1 | -324,752 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA38 | Atas | 28,077 | 372,750 | 149,1 | -325,955 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 28,077 | 372,750 | 149,1 | -325,955 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA45 | Atas | 42,217 | 372,750 | 149,1 | -302,388 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 42,217 | 372,750 | 149,1 | -302,388 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM NEGERI

## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 2,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KA7 | Atas | | | 2,194 | 1,55 | 32,476 | Ok | 357,165 | 21,762 | 3,862 | 123887,412 | 35160,921 | 123887,412 | 179285,259 | 1,004 | 463,417 |
| | | Bawah | | | 1,463 | 1,55 | 32,476 | Ok | 415,965 | 21,762 | 3,862 | 123251,678 | 34980,491 | 123251,678 | 178365,249 | 1,005 | 533,977 |
| | KA15 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 281,621 | 11,335 | 4,514 | 122348,976 | 34724,292 | 122348,976 | 14143,542 | 1,040 | 356,081 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 340,421 | 11,335 | 4,514 | 121822,488 | 34574,868 | 121822,488 | 14082,680 | 1,049 | 426,641 |
| | KA23 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 288,857 | 14,613 | 4,013 | 123123,292 | 34944,054 | 123123,292 | 14233,053 | 1,042 | 370,009 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 347,657 | 14,613 | 4,013 | 122483,290 | 34762,412 | 122483,290 | 14159,068 | 1,050 | 440,569 |
| | KA31 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 369,252 | 31,574 | 23,796 | 125663,590 | 35665,024 | 125663,590 | 14526,711 | 1,055 | 493,621 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 428,052 | 31,574 | 23,796 | 124821,674 | 35426,077 | 124821,674 | 14429,386 | 1,064 | 564,181 |
| | KA39 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 285,853 | 40,774 | 19,642 | 129586,924 | 36778,520 | 129586,924 | 14980,248 | 1,044 | 408,262 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 344,653 | 40,774 | 19,642 | 127949,648 | 36313,839 | 127949,648 | 14790,979 | 1,052 | 478,822 |
| | KA46 | Atas | | | 2,194 | 1,55 | 32,476 | Ok | 262,274 | 32,972 | 20,613 | 128453,475 | 36456,832 | 128453,475 | 185893,096 | 1,003 | 367,484 |
| | | Bawah | | | 1,463 | 1,55 | 32,476 | Ok | 321,074 | 32,972 | 20,613 | 126873,116 | 36008,304 | 126873,116 | 183606,058 | 1,004 | 438,044 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KA7 | Atas | 2458,874 | 423061,908 | 1,009 | 16,405 | 6,481 | 47,211 | 101,695 | 1 | 292,038 | 292,038 | 479,644 | 414,094 | 414,094 | 36,660 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 5,100 | 18,003 | 6,307 | 58,655 | 1 | 469,730 | 469,730 | 591,138 | 475,834 | 475,834 | 52,483 | 1,3 |
| | KA15 | Atas | 2458,874 | 423061,908 | 1,009 | 7,352 | 2,130 | 67,370 | 93,243 | 1 | 292,038 | 292,038 | 389,374 | 326,563 | 326,563 | 80,138 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 7,025 | 0,620 | 21,621 | 40,677 | 1 | 469,730 | 469,730 | 500,868 | 388,303 | 388,303 | 61,338 | 1,3 |
| | KA23 | Atas | 2458,874 | 423061,908 | 1,009 | 9,346 | 0,921 | 64,808 | 92,367 | 1 | 292,038 | 292,038 | 400,414 | 335,498 | 335,498 | 78,799 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 15,102 | 1,999 | 19,074 | 59,934 | 1 | 469,730 | 469,730 | 511,908 | 397,238 | 397,238 | 57,298 | 1,3 |
| | KA31 | Atas | 2458,874 | 423061,908 | 1,009 | 17,740 | 5,220 | 61,314 | 118,349 | 1 | 292,038 | 292,038 | 502,638 | 520,811 | 502,638 | 86,678 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 10,387 | 4,819 | 17,320 | 53,938 | 1 | 469,730 | 469,730 | 614,132 | 582,551 | 582,551 | 45,070 | 1,3 |
| | KA39 | Atas | 2458,874 | 423061,908 | 1,009 | 9,514 | 0,378 | 71,680 | 98,811 | 1 | 292,038 | 292,038 | 424,729 | 425,455 | 424,729 | 65,373 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 0,549 | 8,234 | 21,402 | 43,096 | 1 | 469,730 | 469,730 | 536,223 | 487,195 | 487,195 | 85,154 | 1,3 |
| | KA46 | Atas | 2458,874 | 423061,908 | 1,009 | 1,907 | 13,962 | 40,079 | 78,061 | 1 | 292,038 | 292,038 | 391,779 | 396,583 | 391,779 | 38,516 | 1,3 |
| | | Bawah | 2882,234 | 419433,420 | 1,011 | 6,985 | 19,474 | 10,364 | 70,497 | 1 | 469,730 | 469,730 | 503,273 | 458,323 | 458,323 | 52,670 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KA7 | Atas | 292,038 | 292,038 | 321,604 | 321,604 | 222,317 | 222,317 | 222,317 | 34,203 | 63,707 | 0,537 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 881,656 | 881,656 | 50,748 | 50,748 | 58,655 | 9,024 | 73,205 | 0,123 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA15 | Atas | 292,038 | 292,038 | 492,659 | 492,659 | 292,910 | 292,910 | 292,910 | 45,063 | 50,240 | 0,897 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 631,475 | 689,701 | 98,835 | 98,835 | 98,835 | 15,205 | 59,739 | 0,255 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA23 | Atas | 292,038 | 292,038 | 503,573 | 503,573 | 282,974 | 282,974 | 282,974 | 43,534 | 51,615 | 0,843 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 613,198 | 669,738 | 98,067 | 98,067 | 98,067 | 15,087 | 61,114 | 0,247 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA31 | Atas | 292,038 | 292,038 | 572,210 | 572,210 | 281,627 | 281,627 | 281,627 | 43,327 | 77,329 | 0,560 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 498,257 | 544,199 | 88,710 | 88,710 | 88,710 | 13,648 | 89,623 | 0,152 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA39 | Atas | 382,584 | 382,584 | 404,750 | 467,811 | 311,443 | 311,443 | 311,443 | 47,914 | 65,343 | 0,733 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 823,949 | 899,921 | 99,111 | 99,111 | 99,111 | 15,248 | 74,953 | 0,203 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA46 | Atas | 198,092 | 198,092 | 340,098 | 276,463 | 184,994 | 184,994 | 184,994 | 28,461 | 60,274 | 0,472 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 773,448 | 692,727 | 71,311 | 71,311 | 71,311 | 10,971 | 70,511 | 0,156 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KA7 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2322,151 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8820,325 | Aman |
| | KA15 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1056,237 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5927,756 | Aman |
| | KA23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1155,769 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6078,888 | Aman |
| | KA31 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2171,629 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8132,677 | Aman |
| | KA39 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1426,642 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6981,855 | Aman |
| | KA46 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2830,649 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8055,673 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KA7 | Atas | 19,283 | 0,99 | 10,742 | 63,857 | 66,403 | 63,857 |
| | | Bawah | 19,283 | 0,99 | 10,742 | 63,857 | 66,403 | 63,857 |
| | KA15 | Atas | 34,312 | 0,77 | 42,648 | 89,033 | 215,958 | 89,033 |
| | | Bawah | 34,312 | 0,77 | 42,648 | 89,033 | 215,958 | 89,033 |
| | KA23 | Atas | 34,793 | 0,993 | 43,237 | 86,600 | 219,171 | 86,600 |
| | | Bawah | 34,793 | 0,993 | 43,237 | 86,600 | 219,171 | 86,600 |
| | KA31 | Atas | 26,86 | 2,448 | 13,933 | 84,168 | 89,292 | 84,168 |
| | | Bawah | 26,86 | 2,448 | 13,933 | 84,168 | 89,292 | 84,168 |
| | KA39 | Atas | 0,648 | 4,201 | 28,206 | 93,308 | 123,557 | 93,308 |
| | | Bawah | 0,648 | 4,201 | 28,206 | 93,308 | 123,557 | 93,308 |
| | KA46 | Atas | 7,488 | 5,708 | 3,677 | 58,251 | 29,299 | 29,299 |
| | | Bawah | 7,488 | 5,708 | 3,677 | 58,251 | 29,299 | 29,299 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KA7 | Atas | 63,857 | 0 | 149,1 | 106,429 | 226,347 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 63,857 | 0 | 149,1 | 106,429 | 226,347 | 159,75 | 155 | P10-155 | AMAN |
| | KA15 | Atas | 89,033 | 0 | 149,1 | 148,388 | 162,343 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 89,033 | 0 | 149,1 | 148,388 | 162,343 | 159,75 | 155 | P10-155 | AMAN |
| | KA23 | Atas | 86,600 | 0 | 149,1 | 144,334 | 166,903 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 86,600 | 0 | 149,1 | 144,334 | 166,903 | 159,75 | 155 | P10-155 | AMAN |
| | KA31 | Atas | 84,168 | 0 | 149,1 | 140,279 | 171,727 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 84,168 | 0 | 149,1 | 140,279 | 171,727 | 159,75 | 155 | P10-155 | AMAN |
| | KA39 | Atas | 93,308 | 0 | 149,1 | 155,513 | 154,906 | 159,75 | 150 | P10-150 | AMAN |
| | | Bawah | 93,308 | 0 | 149,1 | 155,513 | 154,906 | 159,75 | 150 | P10-150 | AMAN |
| | KA46 | Atas | 29,299 | 0 | 149,1 | 48,832 | 493,320 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 29,299 | 0 | 149,1 | 48,832 | 493,320 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KA7 | Atas | 23,221 | 372,750 | 149,1 | -334,049 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 23,221 | 372,750 | 149,1 | -334,049 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA15 | Atas | 32,376 | 372,750 | 149,1 | -318,791 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 32,376 | 372,750 | 149,1 | -318,791 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA23 | Atas | 31,491 | 372,750 | 149,1 | -320,265 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 31,491 | 372,750 | 149,1 | -320,265 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA31 | Atas | 30,606 | 372,750 | 149,1 | -321,739 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 30,606 | 372,750 | 149,1 | -321,739 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA39 | Atas | 33,930 | 372,750 | 149,1 | -316,200 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 33,930 | 372,750 | 149,1 | -316,200 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KA46 | Atas | 10,654 | 372,750 | 149,1 | -354,993 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 10,654 | 372,750 | 149,1 | -354,993 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 0 m | Ig atas | = 0,0016 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 2,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 300 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 400 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KA8 | Atas | | | 32,514 | 2,5 | 25,000 | Ok | 70,438 | 0,448 | 0,196 | 106521,091 | 7551,751 | 106521,091 | 210265,189 | 1,001 | 85,242 |
| | | Bawah | | | 2,194 | 2,5 | 25,000 | Ok | 99,838 | 0,448 | 0,196 | 119588,849 | 33940,931 | 119588,849 | 236060,030 | 1,001 | 120,522 |
| | KA16 | Atas | 16,257 | 2,8 | | | 28,000 | Ok | 62,701 | 0,455 | 0,432 | 106583,913 | 7556,205 | 106583,913 | 187847,495 | 1,001 | 75,969 |
| | | Bawah | 5,419 | 2,8 | | | 28,000 | Ok | 92,101 | 0,455 | 0,432 | 119624,629 | 33951,086 | 119624,629 | 210830,944 | 1,001 | 111,249 |
| | KA24 | Atas | 16,257 | 2,8 | | | 28,000 | Ok | 63,675 | 0,081 | 0,207 | 106163,105 | 7526,372 | 106163,105 | 187105,848 | 1,001 | 76,540 |
| | | Bawah | 5,419 | 2,8 | | | 28,000 | Ok | 93,075 | 0,081 | 0,207 | 119302,361 | 33859,622 | 119302,361 | 210262,967 | 1,001 | 111,820 |
| | KA32 | Atas | | | 32,514 | 2,5 | 25,000 | Ok | 68,797 | 0,551 | 4,567 | 106636,582 | 7559,939 | 106636,582 | 210493,161 | 1,001 | 83,438 |
| | | Bawah | | | 2,194 | 2,5 | 25,000 | Ok | 98,197 | 0,551 | 4,567 | 119677,588 | 33966,116 | 119677,588 | 236235,195 | 1,001 | 118,718 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | RV | $Mkap_{ka}$ KNm | $Mkap_{ka}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KA8 | Atas | 321,189 | 795711,693 | 1,001 | 20,356 | 0,994 | 4,567 | 52,846 | 1 | 119,799 | 0,000 | 107,974 | 75,254 | 75,254 | 52,981 | 1 |
| | | Bawah | 462,309 | 893389,136 | 1,001 | 23,450 | 3,428 | 24,918 | 86,639 | 1 | 292,038 | 292,038 | 268,842 | 106,124 | 106,124 | 3,785 | 1 |
| | KA16 | Atas | 321,189 | 795711,693 | 1,001 | 15,225 | 0,553 | 12,655 | 48,808 | 1 | 119,799 | 119,799 | 133,401 | 68,128 | 68,128 | 29,665 | 1 |
| | | Bawah | 462,309 | 893389,136 | 1,001 | 10,893 | 1,349 | 2,771 | 30,452 | 1 | 292,038 | 292,038 | 260,725 | 98,998 | 98,998 | 15,168 | 1 |
| | KA24 | Atas | 321,189 | 795711,693 | 1,001 | 10,350 | 0,849 | 15,189 | 41,155 | 1 | 119,799 | 119,799 | 134,031 | 67,813 | 67,813 | 26,189 | 1 |
| | | Bawah | 462,309 | 893389,136 | 1,001 | 3,942 | 4,422 | 18,305 | 37,981 | 1 | 292,038 | 292,038 | 261,355 | 98,683 | 98,683 | 27,302 | 1 |
| | KA32 | Atas | 321,189 | 795711,693 | 1,001 | 18,379 | 0,326 | 7,405 | 49,886 | 1 | 0,000 | 119,799 | 106,359 | 91,997 | 91,997 | 3,200 | 1 |
| | | Bawah | 462,309 | 893389,136 | 1,001 | 15,603 | 6,226 | 17,216 | 67,120 | 1 | 292,038 | 292,038 | 267,227 | 122,867 | 122,867 | 38,345 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KA8 | Atas | 119,799 | 0,000 | 134,173 | 134,173 | 41,599 | 41,599 | 52,846 | 8,130 | 11,577 | 0,702 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 51,653 | 51,653 | 132,878 | 51,653 | 86,639 | 13,329 | 16,327 | 0,816 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA16 | Atas | 0,000 | 0,000 | 146,342 | 43,902 | 69,718 | 69,718 | 69,718 | 10,726 | 10,481 | 1,023 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 292,038 | 231,847 | 161,285 | 24,492 | 24,492 | 30,452 | 4,685 | 15,230 | 0,308 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA24 | Atas | 0,000 | 0,000 | 108,283 | 32,485 | 75,553 | 75,553 | 75,553 | 11,624 | 10,433 | 1,114 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 292,038 | 349,772 | 243,319 | 85,663 | 85,663 | 85,663 | 13,179 | 15,182 | 0,868 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KA32 | Atas | 172,898 | 0,000 | 12,206 | 14,848 | 50,741 | 14,848 | 49,886 | 7,675 | 14,153 | 0,542 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 0,000 | 632,500 | 440,000 | 95,228 | 95,228 | 95,228 | 14,650 | 18,903 | 0,775 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai Atap | KA8 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1524,721 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1213,008 | Aman |
| | KA16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 875,418 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4955,127 | Aman |
| | KA24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 778,452 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1107,880 | Aman |
| | KA32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2286,164 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1311,386 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KA8 | Atas | 14,524 | 3,353 | 18,78 | 69,743 | 97,647 | 69,743 |
| | | Bawah | 14,524 | 3,353 | 18,78 | 69,743 | 97,647 | 69,743 |
| | KA16 | Atas | 5,456 | 0,215 | 20,069 | 50,085 | 90,244 | 50,085 |
| | | Bawah | 5,456 | 0,215 | 20,069 | 50,085 | 90,244 | 50,085 |
| | KA24 | Atas | 5,314 | 0,26 | 20,052 | 80,608 | 90,071 | 80,608 |
| | | Bawah | 5,314 | 0,26 | 20,052 | 80,608 | 90,071 | 80,608 |
| | KA32 | Atas | 21,456 | 1,953 | 14 | 72,557 | 83,379 | 72,557 |
| | | Bawah | 21,456 | 1,953 | 14 | 72,557 | 83,379 | 72,557 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KA8 | Atas | 69,743 | 0 | 149,1 | 116,238 | 207,246 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 69,743 | 0 | 149,1 | 116,238 | 207,246 | 159,75 | 155 | P10-155 | AMAN |
| | KA16 | Atas | 50,085 | 0 | 149,1 | 83,475 | 288,588 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 50,085 | 0 | 149,1 | 83,475 | 288,588 | 159,75 | 155 | P10-155 | AMAN |
| | KA24 | Atas | 80,608 | 0 | 149,1 | 134,347 | 179,311 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 80,608 | 0 | 149,1 | 134,347 | 179,311 | 159,75 | 155 | P10-155 | AMAN |
| | KA32 | Atas | 72,557 | 0 | 149,1 | 120,928 | 199,208 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 72,557 | 0 | 149,1 | 120,928 | 199,208 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KA8 | Atas | -26,569 | 372,750 | 149,1 | -417,031 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -26,569 | 372,750 | 149,1 | -417,031 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KA16 | Atas | -19,080 | 372,750 | 149,1 | -404,550 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -19,080 | 372,750 | 149,1 | -404,550 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KA24 | Atas | -30,708 | 372,750 | 149,1 | -423,930 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -30,708 | 372,750 | 149,1 | -423,930 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KA32 | Atas | -27,641 | 372,750 | 149,1 | -418,818 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -27,641 | 372,750 | 149,1 | -418,818 | 161,568 | 319,500 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM NEGERI

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 3,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 1,2 m | Ig bawah | = | 0 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 0 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 0 m | b blk bawah | = | 0 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 0 m | h blk bawah | = | 0 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 0 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 0 m | | | |
| β | = | 0,85 | d' | = | 61 mm | c | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KB2 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2301,318 | 498,850 | 1,932 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2318,958 | 498,850 | 1,932 | | | | | | |
| | KB10 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2435,930 | 993,274 | 0,626 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 2453,571 | 993,274 | 0,626 | | | | | | |
| | KB16 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2549,006 | 963,717 | 18,572 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 2566,647 | 963,717 | 18,572 | | | | | | |
| | KB22 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 3184,834 | 932,756 | 33,180 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 3202,474 | 932,756 | 33,180 | | | | | | |
| | KB30 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 3008,308 | 969,826 | 37,871 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 3025,948 | 969,826 | 37,871 | | | | | | |
| | KB38 | Atas | | | 20,213 | 1,82 | 5,200 | Tidak | 2328,945 | 500,870 | 249,062 | | | | | | |
| | | Bawah | | | 391829,861 | 1,82 | 5,200 | Tidak | 2350,113 | 500,870 | 249,062 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KB2 | Atas | | | | 22,346 | 2,781 | 54,889 | | 0,925 | 198,092 | 0,000 | 3047,064 | 2948,291 | 2948,291 | 79,502 | 1 |
| | | Bawah | | | | 6,065 | 4,852 | 98,329 | | 0,925 | 0,000 | 0,000 | 2958,698 | 2966,813 | 2958,698 | 112,379 | 1 |
| | KB10 | Atas | | | | 8,616 | 2,566 | 45,155 | | 0,925 | 198,092 | 198,092 | 3814,438 | 3603,293 | 3603,293 | 56,105 | 1 |
| | | Bawah | | | | 6,914 | 2,558 | 105,517 | | 0,925 | 0,000 | 0,000 | 3619,187 | 3621,816 | 3619,187 | 104,831 | 1 |
| | KB16 | Atas | | | | 3,796 | 0,822 | 44,466 | | 0,925 | 198,092 | 198,092 | 3902,133 | 3766,362 | 3766,362 | 51,319 | 1 |
| | | Bawah | | | | 9,061 | 0,556 | 106,876 | | 0,925 | 0,000 | 0,000 | 3706,882 | 3784,885 | 3706,882 | 102,039 | 1 |
| | KB22 | Atas | | | | 2,877 | 0,326 | 44,758 | | 0,925 | 198,092 | 198,092 | 4537,244 | 4462,826 | 4462,826 | 50,348 | 1 |
| | | Bawah | | | | 10,073 | 2,366 | 107,449 | | 0,925 | 0,000 | 0,000 | 4341,992 | 4481,348 | 4341,992 | 100,437 | 1 |
| | KB30 | Atas | | | | 0,978 | 2,513 | 46,525 | | 0,925 | 198,092 | 198,092 | 4390,815 | 4336,099 | 4336,099 | 46,374 | 1 |
| | | Bawah | | | | 12,587 | 5,579 | 106,865 | | 0,925 | 0,000 | 0,000 | 4195,563 | 4354,621 | 4195,563 | 95,345 | 1 |
| | KB38 | Atas | | | | 22,922 | 4,301 | 48,413 | | 0,925 | 0,000 | 198,092 | 3078,193 | 4017,366 | 3078,193 | 29,615 | 1 |
| | | Bawah | | | | 23,922 | 7,879 | 99,895 | | 0,925 | 0,000 | 0,000 | 2993,532 | 4039,593 | 2993,532 | 78,186 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KB2 | Atas | 198,092 | 198,092 198,092 | 203,648 | 292,744 | 256,917 | 256,917 | 256,917 | 39,526 | 453,583 | 0,087 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 424,445 | 424,445 | 424,445 | 65,299 | 455,184 | 0,143 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB10 | Atas | 198,092 | 198,092 198,092 | 278,443 | 278,443 | 199,292 | 199,292 | 199,292 | 30,660 | 554,353 | 0,055 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 453,117 | 453,117 | 453,117 | 69,710 | 556,798 | 0,125 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB16 | Atas | 198,092 | 198,092 198,092 | 267,276 | 267,276 | 191,606 | 191,606 | 191,606 | 29,478 | 579,440 | 0,051 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 458,977 | 458,977 | 458,977 | 70,612 | 570,290 | 0,124 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB22 | Atas | 198,092 | 198,092 198,092 | 266,693 | 266,693 | 191,347 | 191,347 | 191,347 | 29,438 | 686,589 | 0,043 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 464,347 | 464,347 | 464,347 | 71,438 | 667,999 | 0,107 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB30 | Atas | 198,092 | 198,092 198,092 | 261,357 | 261,357 | 199,071 | 199,071 | 199,071 | 30,626 | 667,092 | 0,046 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 467,907 | 467,907 | 467,907 | 71,986 | 645,471 | 0,112 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB38 | Atas | 198,092 | 198,092 198,092 | 135,028 | 194,102 | 231,919 | 194,102 | 194,102 | 29,862 | 473,568 | 0,063 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 452,950 | 452,950 | 452,950 | 69,685 | 460,543 | 0,151 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KB2 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9705,780 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8339,371 | Aman |
| | KB10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10151,702 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8201,683 | | Aman |
| | KB16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10307,376 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8232,909 | | Aman |
| | KB22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10600,543 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8634,660 | | Aman |
| | KB30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10487,357 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8521,752 | | Aman |
| | KB38 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10311,501 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8155,284 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 kN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KB2 | Atas | 15,86 | 1,611 | 39,098 | 757,069 | 182,556 | 182,556 |
| | | Bawah | 15,86 | 1,611 | 39,098 | 757,069 | 182,556 | 182,556 |
| | KB10 | Atas | 6,811 | 1,684 | 37,76 | 724,899 | 167,512 | 167,512 |
| | | Bawah | 6,811 | 1,684 | 37,76 | 724,899 | 167,512 | 167,512 |
| | KB16 | Atas | 6,953 | 1,928 | 40,851 | 722,870 | 180,899 | 180,899 |
| | | Bawah | 6,953 | 1,928 | 40,851 | 722,870 | 180,899 | 180,899 |
| | KB22 | Atas | 3,377 | 1,868 | 44,168 | 728,548 | 191,013 | 191,013 |
| | | Bawah | 3,377 | 1,868 | 44,168 | 728,548 | 191,013 | 191,013 |
| | KB30 | Atas | 0,504 | 1,521 | 49,043 | 741,087 | 208,107 | 208,107 |
| | | Bawah | 0,504 | 1,521 | 49,043 | 741,087 | 208,107 | 208,107 |
| | KB38 | Atas | 24,319 | 8,06 | 57,421 | 718,947 | 275,166 | 275,166 |
| | | Bawah | 24,319 | 8,06 | 57,421 | 718,947 | 275,166 | 275,166 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Dasar | KB2 | Atas | 182,556 | 0 | 149,1 | 304,260 | 79,175 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 182,556 | 0 | 149,1 | 304,260 | 79,175 | 159,75 | 75 | P10-75 | AMAN |
| | KB10 | Atas | 167,512 | 0 | 149,1 | 279,186 | 86,286 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 167,512 | 0 | 149,1 | 279,186 | 86,286 | 159,75 | 85 | P10-85 | AMAN |
| | KB16 | Atas | 180,899 | 0 | 149,1 | 301,499 | 79,900 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 180,899 | 0 | 149,1 | 301,499 | 79,900 | 159,75 | 75 | P10-75 | AMAN |
| | KB22 | Atas | 191,013 | 0 | 149,1 | 318,355 | 75,670 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 191,013 | 0 | 149,1 | 318,355 | 75,670 | 159,75 | 75 | P10-75 | AMAN |
| | KB30 | Atas | 208,107 | 0 | 149,1 | 346,845 | 69,454 | 159,75 | 65 | P1065 | AMAN |
| | | Bawah | 208,107 | 0 | 149,1 | 346,845 | 69,454 | 159,75 | 65 | P10-65 | AMAN |
| | KB38 | Atas | 275,166 | 0 | 149,1 | 458,610 | 52,528 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 275,166 | 0 | 149,1 | 458,610 | 52,528 | 159,75 | 50 | P10-50 | AMAN |

UNIVERSITAS ISLAM SULTAN AGUNG

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 3,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 1,2 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,55 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE kN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KB3 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2131,294 | 498,946 | 1,740 | 1353,29,751 | 38408,411 | 1353,29,751 | 137484,030 | 1,039 | 3355,866 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2165,398 | 498,946 | 1,740 | 135109,995 | 38346,042 | 135109,995 | 137260,776 | 1,040 | 3396,791 |
| | KB11 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2183,862 | 994,574 | 0,677 | 147002,797 | 41721,380 | 147002,797 | 34691,386 | 1,230 | 4211,953 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2217,966 | 994,574 | 0,677 | 146674,075 | 41628,084 | 146674,075 | 34613,811 | 1,233 | 4252,878 |
| | KB17 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2296,995 | 964,349 | 18,293 | 145307,278 | 41240,169 | 145307,278 | 34291,258 | 1,239 | 4299,352 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2331,099 | 964,349 | 18,293 | 145008,277 | 41155,303 | 145008,277 | 34220,697 | 1,242 | 4340,277 |
| | KB23 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2934,565 | 933,236 | 32,864 | 140090,019 | 39759,440 | 140090,019 | 33060,030 | 1,304 | 5014,656 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2968,669 | 933,236 | 32,864 | 139891,931 | 39703,220 | 139891,931 | 33013,283 | 1,308 | 5055,580 |
| | KB31 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2757,113 | 971,198 | 37,505 | 141908,391 | 40275,519 | 141908,391 | 33489,151 | 1,288 | 4862,452 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2791,217 | 971,198 | 37,505 | 141683,505 | 40211,693 | 141683,505 | 33436,079 | 1,291 | 4903,377 |
| | KB39 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2157,100 | 501,197 | 219,357 | 1352,25,139 | 38378,721 | 135225,139 | 137377,753 | 1,039 | 3390,435 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2198,260 | 501,197 | 219,357 | 134965,216 | 38304,951 | 134965,216 | 137113,692 | 1,040 | 3439,827 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc kN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 kN | Nuk pakai kN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KB3 | Atas | 25134,715 | 410393,608 | 1,104 | 64,571 | 26,967 | 6,770 | 226,796 | 0,95 | 469,730 | 469,730 | 2940,249 | 2769,060 | 2769,060 | 120,622 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 20,643 | 2,076 | 76,267 | 143,131 | 0,95 | 198,092 | 0,000 | 2835,199 | 2804,869 | 2804,869 | 102,848 | 1,3 |
| | KB11 | Atas | 25134,715 | 410393,608 | 1,104 | 16,408 | 1,280 | 31,857 | 83,571 | 0,95 | 469,730 | 469,730 | 3515,855 | 3340,201 | 3340,201 | 17,012 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 10,872 | 1,753 | 94,056 | 142,553 | 0,95 | 198,092 | 198,092 | 3448,442 | 3376,010 | 3376,010 | 85,974 | 1,3 |
| | KB17 | Atas | 25134,715 | 410393,608 | 1,104 | 6,102 | 1,968 | 29,521 | 55,638 | 0,95 | 469,730 | 469,730 | 3602,909 | 3501,242 | 3501,242 | 23,957 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 5,489 | 1,468 | 93,000 | 126,437 | 0,95 | 198,092 | 198,092 | 3535,495 | 3537,051 | 3535,495 | 90,700 | 1,3 |
| | KB23 | Atas | 25134,715 | 410393,608 | 1,104 | 8,315 | 1,368 | 30,329 | 61,619 | 0,95 | 469,730 | 469,730 | 4239,688 | 4199,220 | 4199,220 | 22,771 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 4,781 | 0,772 | 93,515 | 123,748 | 0,95 | 198,092 | 198,092 | 4172,275 | 4235,029 | 4172,275 | 92,420 | 1,3 |
| | KB31 | Atas | 25134,715 | 410393,608 | 1,104 | 1,314 | 3,914 | 34,228 | 54,018 | 0,95 | 469,730 | 469,730 | 4093,224 | 4072,248 | 4072,248 | 36,908 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 2,652 | 0,613 | 95,507 | 119,733 | 0,95 | 198,092 | 198,092 | 4025,811 | 4108,057 | 4025,811 | 97,620 | 1,3 |
| | KB39 | Atas | 25134,715 | 410393,608 | 1,104 | 77,948 | 35,371 | 0,123 | 271,160 | 0,95 | 469,730 | 469,730 | 2969,709 | 3712,511 | 2969,709 | 70,051 | 1,3 |
| | | Bawah | 25388,731 | 409658,338 | 1,105 | 41,371 | 8,020 | 85,602 | 217,944 | 0,95 | 0,000 | 198,092 | 2872,067 | 3755,729 | 2872,067 | 48,222 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai kNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KB3 | Atas | 382,584 | 382,584 | 767,638 | 687,523 | 124,549 | 124,549 | 226,796 | 34,892 | 426,009 | 0,082 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 177,457 | 255,095 | 344,176 | 255,095 | 255,095 | 39,245 | 431,518 | 0,091 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB11 | Atas | 469,730 | 469,730 | 245,431 | 245,431 | 152,372 | 152,372 | 152,372 | 23,442 | 513,877 | 0,046 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 523,070 | 523,070 | 408,291 | 408,291 | 408,291 | 62,814 | 519,386 | 0,121 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB17 | Atas | 469,730 | 469,730 | 310,445 | 310,445 | 132,462 | 132,462 | 132,462 | 20,379 | 538,653 | 0,038 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 495,653 | 495,653 | 397,905 | 397,905 | 397,905 | 61,216 | 543,922 | 0,113 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB23 | Atas | 553,475 | 553,475 | 305,792 | 333,987 | 137,549 | 137,549 | 137,549 | 21,161 | 646,034 | 0,033 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 502,711 | 502,711 | 398,594 | 398,594 | 398,594 | 61,322 | 641,888 | 0,096 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB31 | Atas | 469,730 | 469,730 | 407,624 | 407,624 | 149,247 | 149,247 | 149,247 | 22,961 | 626,500 | 0,037 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 454,671 | 454,671 | 404,558 | 404,558 | 404,558 | 62,240 | 619,355 | 0,100 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB39 | Atas | 382,584 | 382,584 | 842,321 | 754,412 | 119,502 | 119,502 | 271,160 | 41,717 | 456,878 | 0,091 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 157,209 | 225,988 | 411,389 | 225,988 | 225,988 | 34,767 | 441,857 | 0,079 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts kN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KB3 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9836,528 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9611,120 | Aman |
| | KB11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10498,162 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8298,767 | | Aman |
| | KB17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10794,182 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8496,981 | | Aman |
| | KB23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10996,447 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8929,364 | | Aman |
| | KB31 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10840,641 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8798,878 | | Aman |
| | KB39 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9602,145 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9917,162 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KB3 | Atas | 26,354 | 3,536 | 41,872 | 166,169 | 207,247 | 166,169 |
| | | Bawah | 26,354 | 3,536 | 41,872 | 166,169 | 207,247 | 166,169 |
| | KB11 | Atas | 11,213 | 5,489 | 39,555 | 193,332 | 183,668 | 183,668 |
| | | Bawah | 11,213 | 5,489 | 39,555 | 193,332 | 183,668 | 183,668 |
| | KB17 | Atas | 3,548 | 5,77 | 42,756 | 182,885 | 189,359 | 182,885 |
| | | Bawah | 3,548 | 5,77 | 42,756 | 182,885 | 189,359 | 182,885 |
| | KB23 | Atas | 12,356 | 5,681 | 46,036 | 184,877 | 212,290 | 184,877 |
| | | Bawah | 12,356 | 5,681 | 46,036 | 184,877 | 212,290 | 184,877 |
| | KB31 | Atas | 2,142 | 0,298 | 44,796 | 190,967 | 190,705 | 190,705 |
| | | Bawah | 2,142 | 0,298 | 44,796 | 190,967 | 190,705 | 190,705 |
| | KB39 | Atas | 29,94 | 10,576 | 54,216 | 171,430 | 270,249 | 171,430 |
| | | Bawah | 29,94 | 10,576 | 54,216 | 171,430 | 270,249 | 171,430 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Besment | KB3 | Atas | 166,169 | 0 | 149,1 | 276,949 | 86,983 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 166,169 | 0 | 149,1 | 276,949 | 86,983 | 159,75 | 85 | P10-85 | AMAN |
| | KB11 | Atas | 183,668 | 0 | 149,1 | 306,114 | 78,696 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 183,668 | 0 | 149,1 | 306,114 | 78,696 | 159,75 | 75 | P10-75 | AMAN |
| | KB17 | Atas | 182,885 | 0 | 149,1 | 304,808 | 79,033 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 182,885 | 0 | 149,1 | 304,808 | 79,033 | 159,75 | 75 | P10-75 | AMAN |
| | KB23 | Atas | 184,377 | 0 | 149,1 | 308,128 | 78,181 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 184,377 | 0 | 149,1 | 308,128 | 78,181 | 159,75 | 75 | P10-75 | AMAN |
| | KB31 | Atas | 190,705 | 0 | 149,1 | 317,842 | 75,792 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 190,705 | 0 | 149,1 | 317,842 | 75,792 | 159,75 | 75 | P10-75 | AMAN |
| | KB39 | Atas | 171,430 | 0 | 149,1 | 285,717 | 84,313 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 171,430 | 0 | 149,1 | 285,717 | 84,313 | 159,75 | 80 | P10-80 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Besment | KB3 | Atas | 5,730 | 372,750 | 149,1 | -363,200 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 5,730 | 372,750 | 149,1 | -363,200 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB11 | Atas | 6,333 | 372,750 | 149,1 | -362,194 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,333 | 372,750 | 149,1 | -362,194 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB17 | Atas | 6,306 | 372,750 | 149,1 | -362,239 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,306 | 372,750 | 149,1 | -362,239 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB23 | Atas | 6,375 | 372,750 | 149,1 | -362,125 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,375 | 372,750 | 149,1 | -362,125 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB31 | Atas | 6,576 | 372,750 | 149,1 | -361,790 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,576 | 372,750 | 149,1 | -361,790 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB39 | Atas | 5,911 | 372,750 | 149,1 | -362,898 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 5,911 | 372,750 | 149,1 | -362,898 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 4,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 3,5 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KB1 | Atas | | | 1,245 | 2,3 | 48,190 | Ok | 38,897 | 2,660 | 123,744 | 124432,107 | 35315,513 | 124432,107 | 121353,894 | 1,001 | 50,932 |
| | | Bawah | | | 94039,167 | 2,3 | 48,190 | Ok | 93,581 | 2,660 | 123,744 | 121450,641 | 34469,333 | 121450,641 | 118446,185 | 1,002 | 116,553 |
| | KB4 | Atas | 5,173 | 2,5 | | | 52,381 | Ok | 1759,291 | 426,877 | 0,466 | 135834,992 | 38551,806 | 135834,992 | 11079,702 | 1,634 | 2794,152 |
| | | Bawah | 8,773 | 2,5 | | | 52,381 | Ok | 1811,035 | 426,877 | 0,466 | 135425,069 | 38435,464 | 135425,069 | 11046,265 | 1,661 | 2856,245 |
| | KB12 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1625,171 | 825,641 | 0,854 | 149399,283 | 42401,535 | 149399,283 | 18123,297 | 1,384 | 3271,231 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1676,914 | 825,641 | 0,854 | 148698,501 | 42202,643 | 148698,501 | 18038,287 | 1,397 | 3333,322 |
| | KB18 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1783,015 | 795,351 | 16,820 | 146563,404 | 41596,674 | 146563,404 | 17779,283 | 1,419 | 3412,180 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1834,759 | 795,351 | 16,820 | 145965,444 | 41426,965 | 145965,444 | 17706,746 | 1,432 | 3474,272 |
| | KB24 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2381,606 | 764,564 | 31,726 | 140252,824 | 39805,646 | 140252,824 | 17013,760 | 1,585 | 4081,230 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2433,350 | 764,456 | 31,726 | 139880,851 | 39700,075 | 139880,851 | 16968,637 | 1,602 | 4143,150 |
| | KB32 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2239,718 | 784,868 | 33,514 | 141813,412 | 40248,562 | 141813,412 | 17203,072 | 1,545 | 3943,450 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2291,462 | 784,868 | 33,514 | 141398,310 | 40130,751 | 141398,310 | 17152,717 | 1,561 | 4005,543 |
| | KB40 | Atas | 3,426 | 2,3 | | | 48,190 | Ok | 1782,037 | 411,275 | 172,055 | 135132,184 | 38352,339 | 135132,184 | 13022,655 | 1,493 | 2796,484 |
| | | Bawah | 8,773 | 2,3 | | | 48,190 | Ok | 1840,837 | 411,275 | 172,055 | 134690,175 | 38226,891 | 134690,175 | 12980,059 | 1,515 | 2867,044 |
| | KB46 | Atas | | | 2,946 | 2,8 | 58,667 | Ok | 72,958 | 10,550 | 71,874 | 129716,948 | 36815,422 | 129716,948 | 103917,285 | 1,002 | 104,430 |
| | | Bawah | | | 94039,167 | 2,8 | 58,667 | Ok | 131,758 | 10,550 | 71,874 | 125275,440 | 35554,862 | 125275,440 | 100359,157 | 1,003 | 174,990 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KB1 | Atas | 12960,680 | 319492,950 | 1,067 | 173,479 | 26,247 | 56,617 | 525,651 | 0,975 | 469,730 | 469,730 | 171,871 | 563,360 | 171,871 | 258,109 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 90,683 | 13,533 | 368,493 | 677,780 | 0,975 | 0,000 | 0,000 | 101,053 | 620,778 | 101,053 | 489,848 | 1,3 |
| | KB4 | Atas | 12960,680 | 319492,950 | 1,067 | 40,104 | 19,659 | 46,668 | 240,412 | 0,975 | 469,730 | 469,730 | 2423,713 | 2297,434 | 2297,434 | 19,005 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 46,565 | 29,912 | 69,817 | 329,537 | 0,975 | 469,730 | 469,730 | 2478,044 | 2351,765 | 2351,765 | 140,912 | 1,3 |
| | KB12 | Atas | 12960,680 | 319492,950 | 1,067 | 2,709 | 1,456 | 62,449 | 81,674 | 0,975 | 469,730 | 469,730 | 2701,589 | 2576,939 | 2576,939 | 69,029 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 9,114 | 2,003 | 100,681 | 149,714 | 0,975 | 469,730 | 469,730 | 2755,919 | 2631,270 | 2631,270 | 116,330 | 1,3 |
| | KB18 | Atas | 12960,680 | 319492,950 | 1,067 | 3,324 | 1,657 | 60,732 | 82,271 | 0,975 | 469,730 | 469,730 | 2835,521 | 2777,928 | 2777,928 | 68,003 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 12,214 | 1,483 | 98,390 | 154,930 | 0,975 | 469,730 | 469,730 | 2889,852 | 2832,260 | 2832,260 | 116,856 | 1,3 |
| | KB24 | Atas | 12960,680 | 319492,950 | 1,067 | 3,463 | 3,130 | 60,629 | 88,403 | 0,975 | 469,730 | 469,730 | 3431,715 | 3436,728 | 3431,715 | 57,751 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 5,418 | 0,045 | 97,737 | 131,334 | 0,975 | 469,730 | 469,730 | 3485,933 | 3490,946 | 3485,933 | 108,130 | 1,3 |
| | KB32 | Atas | 12960,680 | 319492,950 | 1,067 | 7,758 | 0,622 | 58,376 | 90,400 | 0,975 | 469,730 | 469,730 | 3304,052 | 3316,574 | 3304,052 | 52,475 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 6,532 | 4,847 | 96,946 | 148,894 | 0,975 | 469,730 | 469,730 | 3358,383 | 3370,905 | 3358,383 | 111,506 | 1,3 |
| | KB40 | Atas | 12960,680 | 319492,950 | 1,067 | 59,396 | 38,458 | 77,712 | 377,718 | 0,975 | 469,730 | 469,730 | 2431,214 | 3025,609 | 2431,214 | 24,016 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 62,323 | 38,932 | 81,412 | 403,271 | 0,975 | 469,730 | 469,730 | 2492,954 | 3087,349 | 2492,954 | 25,216 | 1,3 |
| | KB46 | Atas | 12960,680 | 319492,950 | 1,067 | 66,258 | 10,105 | 179,688 | 378,049 | 0,975 | 0,000 | 469,730 | 151,802 | 389,554 | 151,802 | 119,806 | 1,3 |
| | | Bawah | 20971,120 | 312698,053 | 1,115 | 33,708 | 5,319 | 412,129 | 574,814 | 0,975 | 0,000 | 0,000 | 149,423 | 451,294 | 149,423 | 393,020 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KB1 | Atas | 987,375 | 0,000 | 438,436 | 501,694 | 447,504 | 447,504 | 525,651 | 80,869 | 26,442 | 3,058 | 1,1 | 5390 | 2695 | 8 | 3041,069 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1657,097 | 1657,097 | 1657,097 | 254,938 | 15,547 | 16,398 | 1,3 | 6370 | 3185 | 9 | 3421,202 |
| | KB4 | Atas | 382,584 | 382,584 | 159,136 | 142,528 | 258,757 | 159,136 | 240,412 | 36,986 | 353,451 | 0,105 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1179,912 | 1056,770 | 373,532 | 373,532 | 373,532 | 57,467 | 361,310 | 0,159 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB12 | Atas | 554,777 | 554,777 | 542,743 | 593,534 | 266,659 | 266,659 | 266,659 | 41,024 | 396,452 | 0,103 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 877,966 | 877,966 | 434,533 | 434,533 | 434,533 | 66,851 | 404,811 | 0,165 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB18 | Atas | 554,777 | 554,777 | 536,122 | 586,293 | 260,304 | 260,304 | 260,304 | 40,047 | 427,374 | 0,094 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 884,321 | 884,321 | 427,620 | 427,620 | 427,620 | 65,788 | 435,732 | 0,151 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB24 | Atas | 553,475 | 553,475 | 507,075 | 553,830 | 261,564 | 261,564 | 261,564 | 40,241 | 527,956 | 0,076 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 949,422 | 1036,963 | 416,232 | 416,232 | 416,232 | 64,036 | 536,297 | 0,119 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB32 | Atas | 469,730 | 469,730 | 447,670 | 447,670 | 253,978 | 253,978 | 253,978 | 39,074 | 508,316 | 0,077 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 951,271 | 951,271 | 419,121 | 419,121 | 419,121 | 64,480 | 516,574 | 0,125 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB40 | Atas | 382,584 | 382,584 | 653,205 | 595,033 | 429,137 | 429,137 | 429,137 | 66,021 | 374,033 | 0,177 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 685,843 | 614,265 | 448,248 | 448,248 | 448,248 | 68,961 | 383,531 | 0,180 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB46 | Atas | 172,898 | 0,000 | 139,580 | 83,977 | 834,871 | 139,580 | 378,049 | 58,161 | 23,354 | 2,490 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1771,920 | 1771,920 | 1771,920 | 272,603 | 22,988 | 11,858 | 1,1 | 5390 | 2695 | 8 | 3041,069 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn kN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KB1 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 258,767 | Aman |
| | | Bawah | 9D22 | 50,250 | 383,4 | 504,538 | 400 | 4847,614 | 1295,780 | 1368,481 | 477,491 | 167,674 | 0,351 | Patah tarik | | 49,283 | Aman |
| | KB4 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9273,071 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7980,644 | Aman |
| | KB12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9301,655 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7835,394 | Aman |
| | KB18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9542,736 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8162,931 | Aman |
| | KB24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9477,113 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8334,340 | | Aman |
| | KB32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9457,615 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8210,704 | | Aman |
| | KB40 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7576,857 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7502,714 | Aman |
| | KB46 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 286,139 | Aman |
| | | Bawah | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 61,083 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KB1 | Atas | 8,212 | 0,73 | 124,154 | 496,079 | 530,836 | 496,079 |
| | | Bawah | 8,212 | 0,73 | 124,154 | 496,079 | 530,836 | 496,079 |
| | KB4 | Atas | 23,676 | 6,912 | 37,967 | 139,533 | 191,579 | 139,533 |
| | | Bawah | 23,676 | 6,912 | 37,967 | 139,533 | 191,579 | 139,533 |
| | KB12 | Atas | 6,726 | 2,547 | 35,298 | 159,362 | 157,988 | 157,988 |
| | | Bawah | 6,726 | 2,547 | 35,298 | 159,362 | 157,988 | 157,988 |
| | KB18 | Atas | 2,397 | 2,871 | 38,259 | 156,346 | 166,219 | 156,346 |
| | | Bawah | 2,397 | 2,871 | 38,259 | 156,346 | 166,219 | 156,346 |
| | KB24 | Atas | 6,876 | 2,967 | 41,710 | 154,045 | 185,517 | 154,045 |
| | | Bawah | 6,876 | 2,967 | 41,710 | 154,045 | 185,517 | 154,045 |
| | KB32 | Atas | 9,873 | 2,112 | 59,217 | 152,977 | 261,296 | 152,977 |
| | | Bawah | 9,873 | 2,112 | 59,217 | 152,977 | 261,296 | 152,977 |
| | KB40 | Atas | 38,204 | 12,015 | 64,479 | 199,406 | 323,542 | 199,406 |
| | | Bawah | 38,204 | 12,015 | 64,479 | 199,406 | 323,542 | 199,406 |
| | KB46 | Atas | 29,344 | 5,081 | 23,117 | 438,629 | 133,238 | 133,238 |
| | | Bawah | 29,344 | 5,081 | 23,117 | 438,629 | 133,238 | 133,238 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KB1 | Atas | 496,079 | 0 | 149,1 | 826,799 | 29,136 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 496,079 | 0 | 149,1 | 826,799 | 29,136 | 159,75 | 50 | P10-50 | AMAN |
| | KB4 | Atas | 139,533 | 0 | 149,1 | 232,555 | 103,588 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 139,533 | 0 | 149,1 | 232,555 | 103,588 | 159,75 | 100 | P10-100 | AMAN |
| | KB12 | Atas | 157,988 | 0 | 149,1 | 263,314 | 91,487 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 157,988 | 0 | 149,1 | 263,314 | 91,487 | 159,75 | 90 | P10-90 | AMAN |
| | KB18 | Atas | 156,346 | 0 | 149,1 | 260,577 | 92,448 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 156,346 | 0 | 149,1 | 260,577 | 92,448 | 159,75 | 90 | P10-90 | AMAN |
| | KB24 | Atas | 154,045 | 0 | 149,1 | 256,741 | 93,829 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 154,045 | 0 | 149,1 | 256,741 | 93,829 | 159,75 | 90 | P10-90 | AMAN |
| | KB32 | Atas | 152,977 | 0 | 149,1 | 254,962 | 94,484 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 152,977 | 0 | 149,1 | 254,962 | 94,484 | 159,75 | 90 | P10-90 | AMAN |
| | KB40 | Atas | 199,406 | 0 | 149,1 | 332,343 | 72,485 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 199,406 | 0 | 149,1 | 332,343 | 72,485 | 159,75 | 70 | P10-70 | AMAN |
| | KB46 | Atas | 133,238 | 0 | 149,1 | 222,063 | 108,482 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 133,238 | 0 | 149,1 | 222,063 | 108,482 | 159,75 | 105 | P10-105 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KB1 | Atas | 180,392 | 372,750 | 149,1 | -72,096 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 180,392 | 372,750 | 149,1 | -72,096 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB4 | Atas | 50,739 | 372,750 | 149,1 | -288,185 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 50,739 | 372,750 | 149,1 | -288,185 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB12 | Atas | 57,450 | 372,750 | 149,1 | -277,000 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 57,450 | 372,750 | 149,1 | -277,000 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB18 | Atas | 56,853 | 372,750 | 149,1 | -277,995 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 56,853 | 372,750 | 149,1 | -277,995 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB24 | Atas | 56,016 | 372,750 | 149,1 | -279,390 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 56,016 | 372,750 | 149,1 | -279,390 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB32 | Atas | 55,628 | 372,750 | 149,1 | -280,037 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 55,628 | 372,750 | 149,1 | -280,037 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB40 | Atas | 72,511 | 372,750 | 149,1 | -251,898 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 72,511 | 372,750 | 149,1 | -251,898 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB46 | Atas | 48,450 | 372,750 | 149,1 | -292,000 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 48,450 | 372,750 | 149,1 | -292,000 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KB5 | Atas | | | 8,028 | 2,5 | 46,429 | Ok | 1351,961 | 315,263 | 10,625 | 135275,284 | 38392,953 | 135275,284 | 136935,362 | 1,024 | 2126,774 |
| | | Bawah | | | 5,173 | 2,5 | 46,429 | Ok | 1397,825 | 315,263 | 10,265 | 134817,726 | 38263,092 | 134817,726 | 136472,189 | 1,025 | 2181,811 |
| | KB13 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1212,986 | 620,477 | 1,709 | 149554,048 | 42445,459 | 149554,048 | 24261,114 | 1,184 | 2448,346 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1258,850 | 620,477 | 1,709 | 148722,578 | 42209,477 | 148722,578 | 24126,231 | 1,190 | 2503,383 |
| | KB19 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1359,142 | 586,444 | 15,158 | 145869,197 | 41399,649 | 145869,197 | 23663,347 | 1,201 | 2569,281 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1405,006 | 586,444 | 15,158 | 145188,989 | 41206,597 | 145188,989 | 23553,001 | 1,207 | 2624,318 |
| | KB25 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1966,933 | 554,838 | 30,458 | 138106,447 | 39196,475 | 138106,447 | 22404,049 | 1,287 | 3248,060 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2012,797 | 554,838 | 30,458 | 137743,159 | 39093,369 | 137743,159 | 22345,116 | 1,294 | 3303,097 |
| | KB33 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1825,955 | 578,225 | 31,967 | 140017,174 | 39738,765 | 140017,174 | 22714,013 | 1,268 | 3116,306 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1871,819 | 578,225 | 31,967 | 139594,884 | 39618,914 | 139594,884 | 22645,508 | 1,275 | 3171,343 |
| | KB41 | Atas | | | 8,028 | 2,3 | 42,714 | Ok | 1454,487 | 312,728 | 171,541 | 134181,386 | 38082,490 | 134181,386 | 147639,174 | 1,024 | 2245,749 |
| | | Bawah | | | 3,426 | 2,3 | 42,714 | Ok | 1507,407 | 312,728 | 171,541 | 133720,369 | 37951,647 | 133720,369 | 147131,919 | 1,025 | 2309,253 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{x..}$ KNm | $Mkap_{y..}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KB5 | Atas | 15754,517 | 377617,060 | 1,069 | 22,295 | 36,084 | 61,698 | 205,090 | 1 | 469,730 | 469,730 | 1896,723 | 1795,210 | 1795,210 | 110,873 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 45,739 | 25,516 | 103,736 | 283,337 | 1 | 469,730 | 469,730 | 1944,881 | 1841,855 | 1841,855 | 77,045 | 1,3 |
| | KB13 | Atas | 15754,517 | 377617,060 | 1,069 | 17,862 | 5,930 | 110,408 | 184,519 | 1 | 469,730 | 469,730 | 2071,274 | 1932,314 | 1932,314 | 138,335 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 19,454 | 5,988 | 126,629 | 207,409 | 1 | 469,730 | 469,730 | 2119,432 | 1980,471 | 1980,471 | 157,225 | 1,3 |
| | KB19 | Atas | 15754,517 | 377617,060 | 1,069 | 16,637 | 13,021 | 107,579 | 197,118 | 1 | 469,730 | 469,730 | 2189,004 | 2106,529 | 2106,529 | 122,517 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 19,514 | 1,626 | 124,796 | 194,696 | 1 | 469,730 | 469,730 | 2237,161 | 2154,686 | 2154,686 | 150,568 | 1,3 |
| | KB25 | Atas | 15754,517 | 377617,060 | 1,069 | 18,788 | 15,526 | 105,955 | 211,407 | 1 | 469,730 | 469,730 | 2793,998 | 2775,783 | 2775,783 | 140,679 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 17,039 | 5,383 | 124,848 | 200,719 | 1 | 469,730 | 469,730 | 2842,155 | 2823,940 | 2823,940 | 152,436 | 1,3 |
| | KB33 | Atas | 15754,517 | 377617,060 | 1,069 | 10,518 | 1,206 | 107,434 | 151,600 | 1 | 469,730 | 469,730 | 2670,527 | 2658,650 | 2658,650 | 123,031 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 8,962 | 1,385 | 124,326 | 167,276 | 1 | 469,730 | 469,730 | 2718,684 | 2706,808 | 2706,808 | 139,169 | 1,3 |
| | KB41 | Atas | 15754,517 | 377617,060 | 1,069 | 24,554 | 40,070 | 81,381 | 241,656 | 1 | 469,730 | 469,730 | 2001,714 | 2576,048 | 2001,714 | 59,240 | 1,3 |
| | | Bawah | 16093,205 | 376273,964 | 1,070 | 26,816 | 39,006 | 146,594 | 318,139 | 1 | 469,730 | 469,730 | 2057,280 | 2631,614 | 2057,280 | 122,482 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KB5 | Atas | 469,730 | 469,730 | 838,084 | 838,084 | 320,430 | 320,430 | 320,430 | 49,297 | 276,186 | 0,178 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 502,715 | 316,832 | 510,509 | 502,715 | 502,715 | 77,341 | 283,362 | 0,273 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB13 | Atas | 553,475 | 553,475 | 601,803 | 454,720 | 488,695 | 488,695 | 488,695 | 75,184 | 297,279 | 0,253 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 684,223 | 517,619 | 558,556 | 558,556 | 558,556 | 85,932 | 304,688 | 0,282 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB19 | Atas | 553,475 | 553,475 | 576,855 | 435,869 | 482,973 | 482,973 | 482,973 | 74,303 | 324,081 | 0,229 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 709,180 | 536,499 | 546,340 | 546,340 | 546,340 | 84,052 | 331,490 | 0,254 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB25 | Atas | 553,475 | 553,475 | 617,105 | 466,282 | 481,041 | 481,041 | 481,041 | 74,006 | 427,044 | 0,173 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 668,679 | 505,251 | 547,905 | 547,905 | 547,905 | 84,293 | 434,452 | 0,194 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB33 | Atas | 469,730 | 469,730 | 589,612 | 410,165 | 463,533 | 463,533 | 463,533 | 71,313 | 409,023 | 0,174 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 666,952 | 463,966 | 533,034 | 533,034 | 533,034 | 82,005 | 416,432 | 0,197 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB41 | Atas | 469,730 | 469,730 | 409,630 | 284,960 | 409,655 | 409,630 | 409,630 | 63,020 | 307,956 | 0,205 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 846,934 | 589,171 | 684,808 | 684,808 | 684,808 | 105,355 | 316,505 | 0,333 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 1 | KB5 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7532,257 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5575,313 | Aman |
| | KB13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5959,607 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5407,004 | Aman |
| | KB19 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6435,552 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5946,809 | Aman |
| | KB25 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7649,488 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7186,977 | Aman |
| | KB33 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7625,714 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7123,380 | Aman |
| | KB41 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6955,739 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4540,517 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KB5 | Atas | 23,778 | 9,982 | 69,486 | 211,063 | 327,289 | 211,063 |
| | | Bawah | 23,778 | 9,982 | 69,486 | 211,063 | 327,289 | 211,063 |
| | KB13 | Atas | 0,368 | 0,838 | 61,116 | 268,526 | 257,954 | 257,954 |
| | | Bawah | 0,368 | 0,838 | 61,116 | 268,526 | 257,954 | 257,954 |
| | KB19 | Atas | 3,213 | 0,297 | 60,666 | 263,926 | 258,483 | 258,483 |
| | | Bawah | 3,213 | 0,297 | 60,666 | 263,926 | 258,483 | 258,483 |
| | KB25 | Atas | 5,824 | 1,03 | 59,958 | 263,832 | 259,020 | 259,020 |
| | | Bawah | 5,824 | 1,03 | 59,958 | 263,832 | 259,020 | 259,020 |
| | KB33 | Atas | 4,821 | 1,556 | 49,729 | 255,530 | 215,558 | 215,558 |
| | | Bawah | 4,821 | 1,556 | 49,729 | 255,530 | 215,558 | 215,558 |
| | KB41 | Atas | 39,864 | 12,392 | 53,497 | 280,625 | 279,556 | 279,556 |
| | | Bawah | 39,864 | 12,392 | 53,497 | 280,625 | 279,556 | 279,556 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KB5 | Atas | 211,063 | 0 | 149,1 | 351,771 | 68,481 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 211,063 | 0 | 149,1 | 351,771 | 68,481 | 159,75 | 65 | P10-65 | AMAN |
| | KB13 | Atas | 257,954 | 0 | 149,1 | 429,923 | 56,033 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 257,954 | 0 | 149,1 | 429,923 | 56,033 | 159,75 | 55 | P10-55 | AMAN |
| | KB19 | Atas | 258,483 | 0 | 149,1 | 430,805 | 55,918 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 258,483 | 0 | 149,1 | 430,805 | 55,918 | 159,75 | 55 | P10-55 | AMAN |
| | KB25 | Atas | 259,020 | 0 | 149,1 | 431,701 | 55,802 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 259,020 | 0 | 149,1 | 431,701 | 55,802 | 159,75 | 55 | P10-55 | AMAN |
| | KB33 | Atas | 215,558 | 0 | 149,1 | 359,263 | 67,053 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 215,558 | 0 | 149,1 | 359,263 | 67,053 | 159,75 | 65 | P10-65 | AMAN |
| | KB41 | Atas | 279,556 | 0 | 149,1 | 465,927 | 51,703 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 279,556 | 0 | 149,1 | 465,927 | 51,703 | 159,75 | 50 | P10-50 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KB5 | Atas | 59,531 | 372,750 | 149,1 | -273,532 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 59,531 | 372,750 | 149,1 | -273,532 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB13 | Atas | 72,756 | 372,750 | 149,1 | -251,490 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 72,756 | 372,750 | 149,1 | -251,490 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB19 | Atas | 72,905 | 372,750 | 149,1 | -251,241 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 72,905 | 372,750 | 149,1 | -251,241 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB25 | Atas | 73,057 | 372,750 | 149,1 | -250,988 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 73,057 | 372,750 | 149,1 | -250,988 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB33 | Atas | 60,798 | 372,750 | 149,1 | -271,419 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 60,798 | 372,750 | 149,1 | -271,419 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB41 | Atas | 78,849 | 372,750 | 149,1 | -241,335 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 78,849 | 372,750 | 149,1 | -241,335 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 4,5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 4,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | |
|---|---|---|
| b kolom | = | 700 mm |
| h kolom | = | 700 mm |
| b blk atas | = | 400 mm |
| h blk atas | = | 600 mm |
| b blk bawah | = | 400 mm |
| h blk bawah | = | 600 mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KB6 | Atas | | | 7,627 | 2,65 | 49,214 | Ok | 1037,164 | 217,220 | 6,680 | 133841,425 | 37986,004 | 133841,425 | 127815,006 | 1,020 | 1592,149 |
| | | Bawah | | | 8,028 | 2,65 | 49,214 | Ok | 1083,028 | 217,220 | 6,680 | 133295,759 | 37831,137 | 133295,759 | 127293,910 | 1,020 | 1647,186 |
| | KB14 | Atas | 3,813 | 2 | | | 37,143 | Ok | 787,657 | 411,432 | 4,002 | 150029,775 | 42580,477 | 150029,775 | 24338,288 | 1,113 | 1603,480 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 833,521 | 411,432 | 4,002 | 148754,779 | 42218,616 | 148754,779 | 24131,454 | 1,118 | 1658,516 |
| | KB20 | Atas | 3,813 | 2 | | | 37,143 | Ok | 851,120 | 417,950 | 13,244 | 148639,955 | 42186,027 | 148639,955 | 24112,827 | 1,121 | 1690,064 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 896,984 | 417,950 | 13,244 | 147492,719 | 41860,426 | 147492,719 | 23926,719 | 1,126 | 1745,101 |
| | KB26 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1477,146 | 387,610 | 29,426 | 136985,876 | 38878,442 | 136985,876 | 22222,267 | 1,199 | 2392,751 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1523,010 | 387,610 | 29,426 | 136528,819 | 38748,723 | 136528,819 | 22148,122 | 1,205 | 2447,788 |
| | KB34 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1416,101 | 371,495 | 27,426 | 136981,951 | 38877,328 | 136981,951 | 22221,630 | 1,189 | 2293,713 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1461,965 | 371,495 | 27,426 | 136505,808 | 38742,193 | 136505,808 | 22144,389 | 1,195 | 2348,750 |
| | KB42 | Atas | | | 7,627 | 2,65 | 49,214 | Ok | 1151,173 | 217,001 | 110,526 | 132544,396 | 37617,890 | 132544,396 | 126576,379 | 1,021 | 1728,609 |
| | | Bawah | | | 8,028 | 2,65 | 49,214 | Ok | 1204,093 | 217,001 | 110,526 | 132022,119 | 37469,661 | 132022,119 | 126077,618 | 1,022 | 1792,113 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KB6 | Atas | 11300,766 | 347286,398 | 1,053 | 69,181 | 39,250 | 61,861 | 319,542 | 1 | 553,475 | 553,475 | 1489,295 | 1345,159 | 1345,159 | 162,193 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 56,581 | 40,178 | 39,490 | 267,947 | 1 | 469,730 | 469,730 | 1511,399 | 1393,316 | 1393,316 | 132,216 | 1,3 |
| | KB14 | Atas | 11300,766 | 347286,398 | 1,053 | 6,024 | 4,101 | 111,758 | 148,254 | 1 | 553,475 | 553,475 | 1431,236 | 1275,852 | 1275,852 | 113,538 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 6,400 | 3,510 | 99,461 | 134,426 | 1 | 469,730 | 469,730 | 1453,339 | 1324,009 | 1324,009 | 99,966 | 1,3 |
| | KB20 | Atas | 11300,766 | 347286,398 | 1,053 | 39,677 | 3,970 | 109,115 | 227,585 | 1 | 553,475 | 553,475 | 1504,716 | 1388,148 | 1388,148 | 153,657 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 11,408 | 15,632 | 96,294 | 173,243 | 1 | 469,730 | 469,730 | 1526,819 | 1436,306 | 1436,306 | 106,619 | 1,3 |
| | KB26 | Atas | 11300,766 | 347286,398 | 1,053 | 5,557 | 7,379 | 117,415 | 162,962 | 1 | 553,475 | 553,475 | 2130,186 | 2081,583 | 2081,583 | 122,012 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 4,272 | 14,725 | 98,109 | 157,719 | 1 | 469,730 | 469,730 | 2152,289 | 2129,740 | 2129,740 | 107,840 | 1,3 |
| | KB34 | Atas | 11300,766 | 347286,398 | 1,053 | 16,638 | 3,220 | 117,284 | 180,023 | 1 | 553,475 | 553,475 | 2049,168 | 1992,165 | 1992,165 | 103,593 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 13,795 | 3,604 | 99,751 | 154,803 | 1 | 469,730 | 469,730 | 2071,271 | 2040,322 | 2040,322 | 88,046 | 1,3 |
| | KB42 | Atas | 11300,766 | 347286,398 | 1,053 | 87,087 | 45,507 | 74,534 | 389,947 | 1 | 553,475 | 553,475 | 1608,775 | 1900,792 | 1608,775 | 3,896 | 1,3 |
| | | Bawah | 11639,454 | 345722,213 | 1,055 | 67,330 | 44,652 | 42,264 | 307,130 | 1 | 469,730 | 469,730 | 1838,287 | 1956,358 | 1838,287 | 18,269 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KB6 | Atas | 382,584 | 382,584 | 856,364 | 703,066 | 373,669 | 373,669 | 373,669 | 57,488 | 206,948 | 0,278 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 564,310 | 392,563 | 267,455 | 267,455 | 267,947 | 41,223 | 214,356 | 0,192 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB14 | Atas | 636,229 | 636,229 | 802,708 | 598,908 | 480,015 | 480,015 | 480,015 | 73,848 | 196,285 | 0,376 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 602,025 | 454,887 | 428,142 | 428,142 | 428,142 | 65,868 | 203,694 | 0,323 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB20 | Atas | 636,229 | 636,229 | 891,129 | 664,879 | 504,112 | 504,112 | 504,112 | 77,556 | 213,561 | 0,363 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 526,706 | 397,977 | 432,827 | 432,827 | 432,827 | 66,589 | 220,970 | 0,301 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB26 | Atas | 553,475 | 553,475 | 785,938 | 546,740 | 506,726 | 506,726 | 506,726 | 77,958 | 320,244 | 0,243 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 603,253 | 455,816 | 432,005 | 432,005 | 432,005 | 66,462 | 327,652 | 0,203 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB34 | Atas | 469,730 | 469,730 | 784,573 | 504,126 | 513,444 | 513,444 | 513,444 | 78,991 | 306,487 | 0,258 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 577,297 | 401,598 | 437,223 | 437,223 | 437,223 | 67,265 | 313,896 | 0,214 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB42 | Atas | 382,584 | 382,584 | 249,766 | 146,105 | 452,267 | 249,766 | 389,947 | 59,992 | 247,504 | 0,242 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1035,694 | 720,483 | 295,300 | 295,300 | 307,130 | 47,251 | 252,044 | 0,187 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KB6 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5485,082 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7224,655 | Aman |
| | KB14 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3905,708 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4692,595 | Aman |
| | KB20 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4086,934 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5062,626 | Aman |
| | KB26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6147,560 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6994,563 | Aman |
| | KB34 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5865,397 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6749,151 | Aman |
| | KB42 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6168,540 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7331,631 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KB6 | Atas | 25,367 | 9,625 | 56,502 | 164,517 | 274,050 | 164,517 |
| | | Bawah | 25,367 | 9,625 | 56,502 | 164,517 | 274,050 | 164,517 |
| | KB14 | Atas | 3,264 | 0,747 | 46,699 | 232,861 | 200,347 | 200,347 |
| | | Bawah | 3,264 | 0,747 | 46,699 | 232,861 | 200,347 | 200,347 |
| | KB20 | Atas | 5,911 | 0,985 | 46,562 | 240,241 | 202,801 | 202,801 |
| | | Bawah | 5,911 | 0,985 | 46,562 | 240,241 | 202,801 | 202,801 |
| | KB26 | Atas | 0,808 | 0,019 | 32,303 | 240,700 | 136,541 | 136,541 |
| | | Bawah | 0,808 | 0,019 | 32,303 | 240,700 | 136,541 | 136,541 |
| | KB34 | Atas | 13,6 | 2,374 | 29,593 | 243,761 | 141,063 | 141,063 |
| | | Bawah | 13,6 | 2,374 | 29,593 | 243,761 | 141,063 | 141,063 |
| | KB42 | Atas | 43,516 | 12,36 | 40,104 | 178,738 | 227,107 | 178,738 |
| | | Bawah | 43,516 | 12,36 | 40,104 | 178,738 | 227,107 | 178,738 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KB6 | Atas | 164,517 | 0 | 149,1 | 274,195 | 87,857 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 164,517 | 0 | 149,1 | 274,195 | 87,857 | 159,75 | 85 | P10-85 | AMAN |
| | KB14 | Atas | 200,347 | 0 | 149,1 | 333,912 | 72,144 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 200,347 | 0 | 149,1 | 333,912 | 72,144 | 159,75 | 70 | P10-70 | AMAN |
| | KB20 | Atas | 202,801 | 0 | 149,1 | 338,002 | 71,271 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 202,801 | 0 | 149,1 | 338,002 | 71,271 | 159,75 | 70 | P10-70 | AMAN |
| | KB26 | Atas | 136,541 | 0 | 149,1 | 227,568 | 105,857 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 136,541 | 0 | 149,1 | 227,568 | 105,857 | 159,75 | 105 | P10-105 | AMAN |
| | KB34 | Atas | 141,063 | 0 | 149,1 | 235,106 | 102,464 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 141,063 | 0 | 149,1 | 235,106 | 102,464 | 159,75 | 100 | P10-100 | AMAN |
| | KB42 | Atas | 178,738 | 0 | 149,1 | 297,896 | 80,866 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 178,738 | 0 | 149,1 | 297,896 | 80,866 | 159,75 | 80 | P10-80 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KB6 | Atas | 46,402 | 372,750 | 149,1 | -295,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,402 | 372,750 | 149,1 | -295,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB14 | Atas | 56,508 | 372,750 | 149,1 | -278,570 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 56,508 | 372,750 | 149,1 | -278,570 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB20 | Atas | 57,200 | 372,750 | 149,1 | -277,416 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 57,200 | 372,750 | 149,1 | -277,416 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB26 | Atas | 38,512 | 372,750 | 149,1 | -308,564 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 38,512 | 372,750 | 149,1 | -308,564 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB34 | Atas | 39,787 | 372,750 | 149,1 | -306,438 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 39,787 | 372,750 | 149,1 | -306,438 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB42 | Atas | 50,413 | 372,750 | 149,1 | -288,728 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 50,413 | 372,750 | 149,1 | -288,728 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| ' | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KB7 | Atas | | | 1,463 | 1,9 | 39,810 | Ok | 711,011 | 118,990 | 0,555 | 131200,735 | 37236,541 | 131200,735 | 154892,992 | 1,010 | 1043,597 |
| | | Bawah | | | 7,627 | 1,9 | 39,810 | Ok | 762,755 | 118,990 | 0,555 | 130465,359 | 37027,831 | 130465,359 | 154024,821 | 1,011 | 1105,690 |
| | KB15 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 361,312 | 205,332 | 8,086 | 151994,350 | 43138,053 | 151994,360 | 19764,850 | 1,063 | 762,106 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 413,056 | 205,332 | 8,086 | 148911,879 | 42263,203 | 148911,879 | 19364,014 | 1,070 | 824,198 |
| | KB21 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 370,548 | 209,039 | 15,006 | 151820,053 | 43088,582 | 151820,053 | 19742,183 | 1,065 | 779,120 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 422,292 | 209,039 | 15,006 | 148817,883 | 42236,526 | 148817,883 | 19351,791 | 1,072 | 841,213 |
| | KB27 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 869,672 | 177,940 | 29,851 | 133544,931 | 37901,856 | 133544,931 | 17365,746 | 1,133 | 1328,310 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 921,416 | 177,940 | 29,851 | 132832,898 | 37699,771 | 132832,898 | 17273,156 | 1,141 | 1390,403 |
| | KB35 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 890,033 | 165,486 | 26,235 | 132382,817 | 37572,032 | 132382,817 | 17214,629 | 1,135 | 1332,817 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 941,777 | 165,486 | 26,235 | 131736,099 | 37388,485 | 131736,099 | 17130,532 | 1,143 | 1394,910 |
| | KB43 | Atas | | | 1,463 | 1,9 | 39,810 | Ok | 794,471 | 121,694 | 62,200 | 130280,859 | 36975,468 | 130280,859 | 153807,004 | 1,012 | 1148,076 |
| | | Bawah | | | 7,627 | 1,9 | 39,810 | Ok | 853,271 | 121,694 | 62,200 | 129585,653 | 36778,159 | 129585,653 | 152986,257 | 1,012 | 1218,636 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KB7 | Atas | 6394,026 | 382787,404 | 1,026 | 93,541 | 43,206 | 69,463 | 386,885 | 1 | 469,730 | 469,730 | 1003,025 | 873,832 | 873,832 | 2,244 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 0,920 | 38,069 | 31,968 | 122,873 | 1 | 553,475 | 553,475 | 1080,805 | 928,163 | 928,163 | 62,256 | 1,3 |
| | KB15 | Atas | 6394,026 | 382787,404 | 1,026 | 12,530 | 5,595 | 132,038 | 184,919 | 1 | 469,730 | 469,730 | 726,501 | 628,937 | 628,937 | 155,455 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 1,960 | 3,941 | 81,354 | 101,763 | 1 | 553,475 | 553,475 | 804,280 | 683,269 | 683,269 | 90,135 | 1,3 |
| | KB21 | Atas | 6394,026 | 382787,404 | 1,026 | 22,932 | 0,854 | 129,062 | 195,107 | 1 | 469,730 | 469,730 | 740,091 | 671,592 | 671,592 | 160,272 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 41,140 | 1,829 | 78,880 | 186,801 | 1 | 553,475 | 553,475 | 817,871 | 725,923 | 725,923 | 127,343 | 1,3 |
| | KB27 | Atas | 6394,026 | 382787,404 | 1,026 | 36,883 | 17,999 | 87,581 | 228,575 | 1 | 469,730 | 469,730 | 1231,517 | 1225,367 | 1225,367 | 120,955 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 12,011 | 7,436 | 67,953 | 121,176 | 1 | 553,475 | 553,475 | 1309,297 | 1279,698 | 1279,698 | 79,460 | 1,3 |
| | KB35 | Atas | 6394,026 | 382787,404 | 1,026 | 4,393 | 2,340 | 85,337 | 108,449 | 1 | 469,730 | 469,730 | 1239,819 | 1218,482 | 1218,482 | 95,917 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 8,358 | 1,403 | 66,251 | 95,489 | 1 | 553,475 | 553,475 | 1317,599 | 1272,813 | 1272,813 | 60,121 | 1,3 |
| | KB43 | Atas | 6394,026 | 382787,404 | 1,026 | 19,991 | 36,947 | 42,593 | 175,407 | 1 | 469,730 | 469,730 | 1093,498 | 1223,213 | 1093,498 | 60,773 | 1,3 |
| | | Bawah | 6775,050 | 380130,571 | 1,028 | 40,597 | 40,462 | 29,250 | 216,480 | 1 | 553,475 | 553,475 | 1178,686 | 1284,953 | 1178,686 | 7,135 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KB7 | Atas | 469,730 | 469,730 | 48,670 | 48,670 | 435,329 | 48,670 | 386,885 | 59,521 | 134,436 | 0,443 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1350,744 | 790,140 | 175,204 | 175,204 | 175,204 | 26,954 | 142,794 | 0,189 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB15 | Atas | 553,475 | 553,475 | 801,552 | 605,649 | 573,591 | 573,591 | 573,591 | 88,245 | 96,760 | 0,912 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 545,600 | 407,077 | 347,883 | 347,883 | 347,883 | 53,520 | 105,118 | 0,509 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB21 | Atas | 553,475 | 553,475 | 705,641 | 533,179 | 567,036 | 567,036 | 567,036 | 87,236 | 103,322 | 0,844 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 658,196 | 491,086 | 376,413 | 376,413 | 376,413 | 57,910 | 111,680 | 0,519 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB27 | Atas | 553,475 | 553,475 | 764,243 | 577,458 | 425,466 | 425,466 | 425,466 | 65,456 | 188,518 | 0,347 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 578,125 | 402,174 | 305,822 | 305,822 | 305,822 | 47,050 | 196,877 | 0,239 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB35 | Atas | 553,475 | 553,475 | 778,400 | 588,156 | 365,485 | 365,485 | 365,485 | 56,228 | 187,459 | 0,300 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 561,823 | 390,833 | 288,503 | 288,503 | 288,503 | 44,385 | 195,817 | 0,227 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB43 | Atas | 382,584 | 382,584 | 1080,700 | 681,101 | 238,676 | 238,676 | 238,676 | 36,719 | 168,230 | 0,218 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 147,036 | 86,011 | 207,962 | 147,036 | 216,480 | 33,305 | 181,336 | 0,184 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 3 | KB7 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3115,491 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7302,939 | Aman |
| | KB15 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1169,285 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2522,142 | Aman |
| | KB21 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1306,319 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2451,628 | Aman |
| | KB27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4319,756 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6237,236 | Aman |
| | KB35 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5086,906 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6489,506 | Aman |
| | KB43 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6665,058 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7416,390 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KB7 | Atas | 27,582 | 9,049 | 42,117 | 127,747 | 215,354 | 127,747 |
| | | Bawah | 27,582 | 9,049 | 42,117 | 127,747 | 215,354 | 127,747 |
| | KB15 | Atas | 4,031 | 0,363 | 44,443 | 209,426 | 191,274 | 191,274 |
| | | Bawah | 4,031 | 0,363 | 44,443 | 209,426 | 191,274 | 191,274 |
| | KB21 | Atas | 5,515 | 0,009 | 43,934 | 214,420 | 190,323 | 190,323 |
| | | Bawah | 5,515 | 0,009 | 43,934 | 214,420 | 190,323 | 190,323 |
| | KB27 | Atas | 9,208 | 0,665 | 28,248 | 166,202 | 129,008 | 129,008 |
| | | Bawah | 9,208 | 0,665 | 28,248 | 166,202 | 129,008 | 129,008 |
| | KB35 | Atas | 22,761 | 6,348 | 20,957 | 148,634 | 118,584 | 118,584 |
| | | Bawah | 22,761 | 6,348 | 20,957 | 148,634 | 118,584 | 118,584 |
| | KB43 | Atas | 27,605 | 7,052 | 14,208 | 103,444 | 96,063 | 96,063 |
| | | Bawah | 27,605 | 7,052 | 14,208 | 103,444 | 96,063 | 96,063 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KB7 | Atas | 127,747 | 0 | 149,1 | 212,912 | 113,144 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 127,747 | 0 | 149,1 | 212,912 | 113,144 | 159,75 | 110 | P10-110 | AMAN |
| | KB15 | Atas | 191,274 | 0 | 149,1 | 318,791 | 75,566 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 191,274 | 0 | 149,1 | 318,791 | 75,566 | 159,75 | 75 | P10-75 | AMAN |
| | KB21 | Atas | 190,323 | 0 | 149,1 | 317,205 | 75,944 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 190,323 | 0 | 149,1 | 317,205 | 75,944 | 159,75 | 75 | P10-75 | AMAN |
| | KB27 | Atas | 129,008 | 0 | 149,1 | 215,014 | 112,038 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 129,008 | 0 | 149,1 | 215,014 | 112,038 | 159,75 | 110 | P10-110 | AMAN |
| | KB35 | Atas | 118,584 | 0 | 149,1 | 197,640 | 121,887 | 159,75 | 120 | P10-120 | AMAN |
| | | Bawah | 118,584 | 0 | 149,1 | 197,640 | 121,887 | 159,75 | 120 | P10-120 | AMAN |
| | KB43 | Atas | 96,063 | 0 | 149,1 | 160,106 | 150,462 | 159,75 | 150 | P10-150 | AMAN |
| | | Bawah | 96,063 | 0 | 149,1 | 160,106 | 150,462 | 159,75 | 150 | P10-150 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KB7 | Atas | 46,454 | 372,750 | 149,1 | -295,327 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,454 | 372,750 | 149,1 | -295,327 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB15 | Atas | 69,554 | 372,750 | 149,1 | -256,826 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 69,554 | 372,750 | 149,1 | -256,826 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB21 | Atas | 69,208 | 372,750 | 149,1 | -257,403 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 69,208 | 372,750 | 149,1 | -257,403 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB27 | Atas | 46,912 | 372,750 | 149,1 | -294,563 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,912 | 372,750 | 149,1 | -294,563 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB35 | Atas | 43,121 | 372,750 | 149,1 | -300,881 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 43,121 | 372,750 | 149,1 | -300,881 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB43 | Atas | 34,932 | 372,750 | 149,1 | -314,530 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 34,932 | 372,750 | 149,1 | -314,530 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 2,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KB8 | Atas | | | 2,751 | 1,6 | 33,524 | Ok | 258,284 | 6,455 | 6,191 | 121187,243 | 34394,577 | 121187,243 | 169897,122 | 1,003 | 320,269 |
| | | Bawah | | | 1,463 | 1,6 | 33,524 | Ok | 310,028 | 6,455 | 6,191 | 120865,580 | 34303,284 | 120865,580 | 169446,170 | 1,003 | 382,362 |
| | KB28 | Atas | | | 10,838 | 2,4 | 50,286 | Ok | 327,595 | 10,258 | 26,304 | 121671,366 | 34531,977 | 121671,366 | 10768,676 | 1,062 | 409,527 |
| | | Bawah | | | 3,613 | 2,4 | 50,286 | Ok | 379,339 | 10,258 | 26,304 | 121344,679 | 34439,259 | 121344,679 | 10739,762 | 1,072 | 471,620 |
| | KB36 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 346,806 | 20,859 | 20,573 | 123829,848 | 35144,584 | 123829,848 | 14314,730 | 1,051 | 449,542 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 398,550 | 20,859 | 20,573 | 123253,186 | 34980,919 | 123253,186 | 14248,068 | 1,058 | 511,634 |
| | KB44 | Atas | | | 2,194 | 1,55 | 32,476 | Ok | 310,347 | 21,893 | 28,251 | 124588,787 | 35359,981 | 124588,787 | 180300,262 | 1,003 | 407,445 |
| | | Bawah | | | 1,463 | 1,55 | 32,476 | Ok | 369,147 | 21,893 | 28,251 | 123768,166 | 35127,077 | 123768,166 | 179112,690 | 1,004 | 478,005 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KB8 | Atas | 1586,782 | 375280,791 | 1,007 | 108,637 | 9,843 | 3,141 | 270,915 | 1 | 0,000 | 292,038 | 318,861 | 303,978 | 303,978 | 94,581 | 1,3 |
| | | Bawah | 1843,621 | 373546,691 | 1,008 | 34,858 | 13,746 | 2,112 | 111,887 | 1 | 469,730 | 469,730 | 463,832 | 358,309 | 358,309 | 63,468 | 1,3 |
| | KB28 | Atas | 1586,782 | 375280,791 | 1,007 | 30,430 | 4,475 | 71,299 | 156,743 | 1 | 292,038 | 0,000 | 395,631 | 465,222 | 395,631 | 110,704 | 1,3 |
| | | Bawah | 1843,621 | 373546,691 | 1,008 | 9,764 | 7,218 | 66,033 | 109,729 | 1 | 469,730 | 469,730 | 540,601 | 519,554 | 519,554 | 74,937 | 1,3 |
| | KB36 | Atas | 1586,782 | 375280,791 | 1,007 | 22,989 | 1,753 | 94,850 | 157,587 | 1 | 292,038 | 292,038 | 467,819 | 472,455 | 467,819 | 76,600 | 1,3 |
| | | Bawah | 1843,621 | 373546,691 | 1,008 | 39,321 | 9,039 | 76,607 | 193,646 | 1 | 469,730 | 469,730 | 571,904 | 526,786 | 526,786 | 44,770 | 1,3 |
| | KB44 | Atas | 1586,782 | 375280,791 | 1,007 | 7,302 | 6,831 | 56,507 | 91,531 | 1 | 292,038 | 292,038 | 430,623 | 467,506 | 430,623 | 63,128 | 1,3 |
| | | Bawah | 1843,621 | 373546,691 | 1,008 | 2,400 | 15,206 | 37,682 | 79,383 | 1 | 469,730 | 469,730 | 542,116 | 529,246 | 529,246 | 39,776 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KB8 | Atas | 292,038 | 292,038 | 320,294 | 460,423 | 137,596 | 137,596 | 270,915 | 41,679 | 46,766 | 0,891 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 496,955 | 345,708 | 59,905 | 59,905 | 111,887 | 17,213 | 55,125 | 0,312 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB28 | Atas | 292,038 | 292,038 | 259,328 | 259,328 | 336,106 | 259,328 | 259,328 | 39,897 | 60,866 | 0,655 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 511,164 | 386,233 | 295,170 | 295,170 | 295,170 | 45,411 | 79,931 | 0,568 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB36 | Atas | 0,000 | 382,584 | 422,245 | 126,674 | 424,349 | 422,245 | 422,245 | 64,961 | 71,972 | 0,903 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 467,104 | 352,942 | 372,527 | 372,527 | 372,527 | 57,312 | 81,044 | 0,707 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB44 | Atas | 198,092 | 198,092 | 452,188 | 262,327 | 252,169 | 252,169 | 252,169 | 38,795 | 66,250 | 0,586 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 466,771 | 294,178 | 176,751 | 176,751 | 176,751 | 27,192 | 81,422 | 0,334 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KB8 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1066,094 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4876,118 | Aman |
| | KB28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1697,018 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2124,761 | Aman |
| | KB36 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1046,690 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1508,341 | Aman |
| | KB44 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2025,804 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4523,271 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KB8 | Atas | 23,193 | 5,117 | 23,702 | 87,001 | 129,274 | 87,001 |
| | | Bawah | 23,193 | 5,117 | 23,702 | 87,001 | 129,274 | 87,001 |
| | KB28 | Atas | 13,602 | 0,157 | 10,761 | 126,022 | 59,643 | 59,643 |
| | | Bawah | 13,602 | 0,157 | 10,761 | 126,022 | 59,643 | 59,643 |
| | KB36 | Atas | 2,097 | 0,046 | 21,988 | 180,630 | 94,600 | 94,600 |
| | | Bawah | 2,097 | 0,046 | 21,988 | 180,630 | 94,600 | 94,600 |
| | KB44 | Atas | 18,101 | 2,605 | 2,223 | 97,482 | 31,078 | 31,078 |
| | | Bawah | 18,101 | 2,605 | 2,223 | 97,482 | 31,078 | 31,078 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KB8 | Atas | 87,001 | 0 | 149,1 | 145,001 | 166,135 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 87,001 | 0 | 149,1 | 145,001 | 166,135 | 159,75 | 155 | P10-155 | AMAN |
| | KB28 | Atas | 59,643 | 0 | 149,1 | 99,405 | 242,339 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 59,643 | 0 | 149,1 | 99,405 | 242,339 | 159,75 | 155 | P10-155 | AMAN |
| | KB36 | Atas | 94,600 | 0 | 149,1 | 157,666 | 152,790 | 159,75 | 150 | P10-150 | AMAN |
| | | Bawah | 94,600 | 0 | 149,1 | 157,666 | 152,790 | 159,75 | 150 | P10-150 | AMAN |
| | KB44 | Atas | 31,078 | 0 | 149,1 | 51,797 | 465,085 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 31,078 | 0 | 149,1 | 51,797 | 465,085 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KB8 | Atas | 31,637 | 372,750 | 149,1 | -320,022 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 31,637 | 372,750 | 149,1 | -320,022 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB28 | Atas | 21,688 | 372,750 | 149,1 | -336,603 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 21,688 | 372,750 | 149,1 | -336,603 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB36 | Atas | 34,400 | 372,750 | 149,1 | -315,417 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 34,400 | 372,750 | 149,1 | -315,417 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KB44 | Atas | 11,301 | 372,750 | 149,1 | -353,915 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 11,301 | 372,750 | 149,1 | -353,915 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-B

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 0 | m | Ig atas | = | 0,0016 | m^4 |
| fc' | = | 25 | MPa | tk | = | 2,5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 300 | mm |
| h blk atas | = | 400 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran | PD | PL | PE | $EI_1$ | $EI_2$ | EI pakai | Pc | δb | Pu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | ψ | K | ψ | K | | momen | KN | KN | KN | KNm^2 | KNm^2 | KNm^2 | KN | | KN |
| Lantai Atap | KB9 | Atas | | | 188078,333 | 2,8 | 28,000 | Ok | 80,885 | 0,728 | 1,433 | 106705,899 | 7564,853 | 106705,899 | 188062,488 | 1,001 | 98,227 |
| | | Bawah | | | 2,751 | 2,8 | 28,000 | Ok | 104,405 | 0,728 | 1,433 | 119784,924 | 33996,580 | 119784,924 | 211113,453 | 1,001 | 126,451 |
| | KB29 | Atas | | | 32,514 | 3,9 | 39,000 | Ok | 148,775 | 0,387 | 4,125 | 106256,855 | 7533,018 | 106256,855 | 134451,029 | 1,002 | 179,149 |
| | | Bawah | | | 10,838 | 3,9 | 39,000 | Ok | 172,295 | 0,387 | 4,125 | 119411,502 | 33890,597 | 119411,502 | 151096,127 | 1,002 | 207,373 |
| | KB37 | Atas | 16,257 | 2,8 | | | 28,000 | Ok | 113,382 | 0,695 | 0,456 | 106504,927 | 7550,605 | 106504,927 | 187708,288 | 1,001 | 137,170 |
| | | Bawah | 5,419 | 2,8 | | | 28,000 | Ok | 136,902 | 0,695 | 0,456 | 119635,399 | 33954,142 | 119635,399 | 210849,925 | 1,001 | 165,394 |
| | KB45 | Atas | | | 32,514 | 2,5 | 25,000 | Ok | 56,790 | 0,353 | 5,443 | 106510,970 | 7551,034 | 106510,970 | 210245,211 | 1,001 | 68,713 |
| | | Bawah | | | 2,194 | 2,5 | 25,000 | Ok | 86,190 | 0,353 | 5,443 | 119557,893 | 33932,145 | 119557,893 | 235998,925 | 1,001 | 103,993 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung | ΣPu | ΣPc | δs | MD | ML | ME | Mc | Rv | $Mkap_{ka}$ | $Mkap_{ki}$ | Nuk1 | Nuk2 | Nuk pakai | Mmaks | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KN | KN | | KNm | KNm | KNm | KNm | | KNm | KNm | KN | KN | KN | KNm | |
| Lantai Atap | KB9 | Atas | 483,259 | 720467,016 | 1,001 | 3,070 | 0,196 | 0,884 | 8,280 | 1 | 0,000 | 0,000 | 85,694 | 91,712 | 85,694 | 4,282 | 1 |
| | | Bawah | 603,211 | 809058,431 | 1,001 | 9,598 | 0,420 | 0,372 | 22,946 | 1 | 0,000 | 292,038 | 192,160 | 116,408 | 116,408 | 8,290 | 1 |
| | KB29 | Atas | 483,259 | 720467,016 | 1,001 | 45,379 | 0,154 | 15,317 | 118,707 | 1 | 119,799 | 0,000 | 190,164 | 173,945 | 173,945 | 63,630 | 1 |
| | | Bawah | 603,211 | 809058,431 | 1,001 | 28,215 | 8,238 | 0,210 | 82,215 | 1 | 292,038 | 0,000 | 263,087 | 198,641 | 198,641 | 46,991 | 1 |
| | KB37 | Atas | 483,259 | 720467,016 | 1,001 | 24,097 | 0,600 | 25,324 | 82,234 | 1 | 119,799 | 119,799 | 186,868 | 121,696 | 121,696 | 3,639 | 1 |
| | | Bawah | 603,211 | 809058,431 | 1,001 | 23,050 | 5,515 | 31,397 | 97,242 | 1 | 292,038 | 292,038 | 308,018 | 146,392 | 146,392 | 10,630 | 1 |
| | KB45 | Atas | 483,259 | 720467,016 | 1,001 | 45,474 | 1,638 | 8,300 | 114,772 | 1 | 0,000 | 119,799 | 93,544 | 82,861 | 82,861 | 32,613 | 1 |
| | | Bawah | 603,211 | 809058,431 | 1,001 | 3,483 | 1,551 | 19,733 | 32,049 | 1 | 292,038 | 292,038 | 254,411 | 113,731 | 113,731 | 23,397 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung | $Mkap_{ka,by}$ | $Mkap_{ki,by}$ | $Muk_1$ | $Muk_2$ | $Muk_3$ | Muk pakai | Mu | Mn | Pn | e | % | Ast | As' = As perlu | n tulangan | As = As' ada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KNm | KNm | KNm | KNm | KNm | KNm | terpakai KNm | Ton-m | Ton | m | | $mm^2$ | $mm^2$ | | mm2 |
| Lantai Atap | KB9 | Atas | 119,799 | 119,799 | 22,599 | 75,329 | 7,142 | 7,142 | 8,280 | 1,274 | 13,184 | 0,097 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 236,449 | 192,207 | 12,081 | 12,081 | 22,946 | 3,530 | 17,909 | 0,197 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB29 | Atas | 172,898 | 172,898 | 91,149 | 110,885 | 112,141 | 110,885 | 118,707 | 18,263 | 26,761 | 0,682 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 164,537 | 164,537 | 39,158 | 39,158 | 82,215 | 12,648 | 30,560 | 0,414 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB37 | Atas | 0,000 | 0,000 | 56,404 | 16,921 | 132,293 | 56,404 | 82,234 | 12,651 | 18,722 | 0,676 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 382,584 | 443,928 | 133,178 | 161,861 | 161,861 | 161,861 | 24,902 | 22,522 | 1,106 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KB45 | Atas | 119,799 | 0,000 | 83,707 | 83,707 | 84,328 | 83,707 | 114,772 | 17,657 | 12,748 | 1,385 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 274,252 | 159,101 | 88,164 | 88,164 | 88,164 | 13,564 | 17,497 | 0,775 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai Atap | KB9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9470,408 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7119,104 | Aman |
| | KB29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1593,751 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3432,107 | Aman |
| | KB37 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1618,401 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 786,605 | Aman |
| | KB45 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 583,285 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1310,993 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KB9 | Atas | 26,067 | 0,15 | 0,301 | 15,613 | 28,792 | 15,613 |
| | | Bawah | 26,067 | 0,15 | 0,301 | 15,613 | 28,792 | 15,613 |
| | KB29 | Atas | 8,366 | 2,965 | 47,102 | 100,461 | 209,726 | 100,461 |
| | | Bawah | 8,366 | 2,965 | 47,102 | 100,461 | 209,726 | 100,461 |
| | KB37 | Atas | 11,441 | 3,57 | 54,059 | 122,047 | 242,809 | 122,047 |
| | | Bawah | 11,441 | 3,57 | 54,059 | 122,047 | 242,809 | 122,047 |
| | KB45 | Atas | 0,894 | 0,821 | 106,936 | 101,468 | 450,932 | 101,468 |
| | | Bawah | 0,894 | 0,821 | 106,936 | 101,468 | 450,932 | 101,468 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KB9 | Atas | 15,613 | 0 | 149,1 | 26,022 | 925,739 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 15,613 | 0 | 149,1 | 26,022 | 925,739 | 159,75 | 155 | P10-155 | AMAN |
| | KB29 | Atas | 100,461 | 0 | 149,1 | 167,435 | 143,875 | 159,75 | 140 | P10-140 | AMAN |
| | | Bawah | 100,461 | 0 | 149,1 | 167,435 | 143,875 | 159,75 | 140 | P10-140 | AMAN |
| | KB37 | Atas | 122,047 | 0 | 149,1 | 203,412 | 118,428 | 159,75 | 115 | P10-115 | AMAN |
| | | Bawah | 122,047 | 0 | 149,1 | 203,412 | 118,428 | 159,75 | 115 | P10-115 | AMAN |
| | KB45 | Atas | 101,468 | 0 | 149,1 | 169,114 | 142,447 | 159,75 | 140 | P10-140 | AMAN |
| | | Bawah | 101,468 | 0 | 149,1 | 169,114 | 142,447 | 159,75 | 140 | P10-140 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KB9 | Atas | -5,948 | 372,750 | 149,1 | -382,663 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -5,948 | 372,750 | 149,1 | -382,663 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KB29 | Atas | -38,271 | 372,750 | 149,1 | -436,535 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -38,271 | 372,750 | 149,1 | -436,535 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KB37 | Atas | -46,494 | 372,750 | 149,1 | -450,240 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -46,494 | 372,750 | 149,1 | -450,240 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KB45 | Atas | -38,655 | 372,750 | 149,1 | -437,174 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -38,655 | 372,750 | 149,1 | -437,174 | 161,568 | 319,500 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 3,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 1,2 m | Ig bawah | = 0 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 0 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 0 m | b blk bawah | = 0 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 0 m | h blk bawah | = 0 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 0 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 0 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1336,431 | 283,414 | 113,847 | 94108,983 | 38031,642 | 94108,983 | 51601,265 | 1,065 | 2057,180 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1347,951 | 283,414 | 113,847 | 75031,125 | 0,000 | 75031,125 | 41140,610 | 1,084 | 2071,004 |
| | KC10 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1309,630 | 252,466 | 30,021 | 93272,904 | 37693,763 | 93272,904 | 51142,832 | 1,063 | 1975,502 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1321,150 | 252,433 | 30,021 | 74366,295 | 0,000 | 74366,295 | 40776,075 | 1,081 | 1989,273 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Ry | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | 4032,681 | 102744,097 | 1,064 | 7,285 | 0,292 | 62,764 | 78,474 | 0,925 | 0,000 | 0,000 | 1700,837 | 2178,995 | 1700,837 | 73,615 | 1 |
| | | Bawah | 4060,276 | 81916,685 | 1,083 | 4,485 | 8,040 | 80,133 | 101,667 | 0,925 | 0,000 | 0,000 | 1712,933 | 2191,091 | 1712,933 | 93,599 | 1 |
| | KC10 | Atas | 4032,681 | 102744,097 | 1,064 | 7,594 | 2,446 | 64,572 | 82,284 | 0,925 | 0,000 | 0,000 | 1640,201 | 1766,289 | 1640,201 | 77,560 | 1 |
| | | Bawah | 4060,276 | 81916,685 | 1,083 | 33,872 | 10,231 | 85,012 | 142,110 | 0,925 | 0,000 | 0,000 | 1652,262 | 1778,350 | 1652,262 | 54,323 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | 198,092 | 198,092 | 77,565 | 258,549 | 271,565 | 258,549 | 258,549 | 39,777 | 261,667 | 0,152 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 349,710 | 0,000 | 101,667 | 15,641 | 263,528 | 0,059 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC10 | Atas | 198,092 | 198,092 | 103,614 | 345,380 | 281,744 | 281,744 | 281,744 | 43,345 | 252,339 | 0,172 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 403,359 | 0,000 | 142,110 | 21,863 | 254,194 | 0,086 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5741,907 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7036,372 | Aman |
| | KC10 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5479,144 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6654,639 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | 1,409 | 0,134 | 27,606 | 400,239 | 117,565 | 117,565 |
| | | Bawah | 1,409 | 0,134 | 27,606 | 400,239 | 117,565 | 117,565 |
| | KC10 | Atas | 0,498 | 0,371 | 38,423 | 470,950 | 162,289 | 162,289 |
| | | Bawah | 0,498 | 0,371 | 38,423 | 470,950 | 162,289 | 162,289 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KC2 | Atas | 117,565 | 0 | 98,533 | 195,942 | 142,183 | 184,75 | 140 | P10-140 | AMAN |
| | | Bawah | 117,565 | 0 | 98,533 | 195,942 | 142,183 | 184,75 | 140 | P10-140 | AMAN |
| | KC10 | Atas | 162,289 | 0 | 98,533 | 270,482 | 103,000 | 184,75 | 100 | P10-100 | AMAN |
| | | Bawah | 162,289 | 0 | 98,533 | 270,482 | 103,000 | 184,75 | 100 | P10-100 | AMAN |

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0171 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 4,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 3,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,8 | m | Lg' ki bawah | = | 6,8 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 240 | mm | Lg' ka atas | = | 6,8 | m | Lg' ka bawah | = | 6,8 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 739 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 400 | mm |
| h kolom | = | 800 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KC1 | Atas | | | 0,503 | 2,1 | 38,500 | Ok | 481,800 | 72,527 | 144,278 | 91373,838 | 36926,306 | 91373,838 | 97600,417 | 1,011 | 694,203 |
| | | Bawah | | | 80213,333 | 2,1 | 38,500 | Ok | 540,600 | 72,527 | 144,278 | 90611,368 | 38618,174 | 90611,368 | 96785,989 | 1,012 | 764,763 |
| | KC4 | Atas | 9,870 | 3,8 | | | 69,667 | Ok | 1088,529 | 238,868 | 89,494 | 94423,584 | 38158,779 | 94423,584 | 3333,571 | 4,529 | 1688,424 |
| | | Bawah | 40,527 | 3,8 | | | 69,667 | Ok | 1121,937 | 238,868 | 89,494 | 94144,916 | 38046,163 | 94144,916 | 3323,733 | 5,002 | 1728,513 |
| | KC12 | Atas | | | 4,612 | 3 | 55,000 | Ok | 1018,306 | 215,585 | 10,259 | 94093,623 | 38025,434 | 94093,623 | 70353,877 | 1,035 | 1566,903 |
| | | Bawah | | | 40,527 | 3 | 55,000 | Ok | 1052,098 | 215,585 | 10,259 | 93800,956 | 37907,161 | 93800,956 | 70135,050 | 1,037 | 1607,454 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KC1 | Atas | 3949,530 | 171287,865 | 1,037 | 296,526 | 24,793 | 128,269 | 878,509 | 0,98 | 877,130 | 877,130 | 821,500 | 1188,011 | 821,500 | 478,046 | 1,3 |
| | | Bawah | 4100,730 | 170244,771 | 1,038 | 143,105 | 51,845 | 397,871 | 881,616 | 0,98 | 0,000 | 0,000 | 643,783 | 1249,751 | 643,783 | 581,960 | 1,3 |
| | KC4 | Atas | 3949,530 | 171287,865 | 1,037 | 81,049 | 1,447 | 23,323 | 565,570 | 0,98 | 297,490 | 877,130 | 1554,102 | 1769,642 | 1554,102 | 49,666 | 1,3 |
| | | Bawah | 4100,730 | 170244,771 | 1,038 | 28,594 | 20,089 | 36,888 | 416,954 | 0,98 | 320,853 | 0,000 | 1472,642 | 1804,720 | 1472,642 | 81,251 | 1,3 |
| | KC12 | Atas | 3949,530 | 171287,865 | 1,037 | 24,164 | 17,492 | 7,928 | 105,367 | 0,93 | 119,799 | 297,490 | 1352,545 | 1338,673 | 1338,673 | 13,837 | 1,3 |
| | | Bawah | 4100,730 | 170244,771 | 1,038 | 41,191 | 16,791 | 30,038 | 167,737 | 0,98 | 0,000 | 320,853 | 1374,864 | 1374,155 | 1374,155 | 7,131 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KC1 | Atas | 987,375 | 987,375 | 1158,773 | 1234,987 | 876,115 | 876,115 | 878,509 | 135,155 | 126,385 | 1,069 | 2,1 | 6720 | 3360 | 9 | 3421,202 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1875,756 | 0,000 | 881,616 | 135,633 | 99,044 | 1,369 | 2,1 | 6720 | 3360 | 9 | 3421,202 |
| | KC4 | Atas | 382,584 | 382,584 | 583,264 | 464,209 | 184,577 | 184,577 | 565,570 | 87,011 | 239,093 | 0,364 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 374,021 | 585,372 | 206,047 | 206,047 | 416,954 | 64,147 | 226,560 | 0,283 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC12 | Atas | 382,584 | 382,584 | 467,373 | 643,325 | 77,036 | 77,036 | 105,367 | 16,219 | 205,950 | 0,079 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 204,954 | 320,769 | 187,041 | 187,041 | 187,041 | 28,775 | 211,408 | 0,136 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KC1 | Atas | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 158,091 | 0,505 | Patah tarik | | 1248,987 | Aman |
| | | Bawah | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 158,091 | 0,505 | Patah tarik | | 907,155 | Aman |
| | KC4 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3282,727 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4115,807 | Aman |
| | KC12 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6758,497 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5957,072 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KC1 | Atas | 90,28 | 13,834 | 132,997 | 400,028 | 667,907 | 400,028 |
| | | Bawah | 90,28 | 13,834 | 132,997 | 400,028 | 667,907 | 400,028 |
| | KC4 | Atas | 0,395 | 0,169 | 23,742 | 223,301 | 100,309 | 100,309 |
| | | Bawah | 0,395 | 0,169 | 23,742 | 223,301 | 100,309 | 100,309 |
| | KC12 | Atas | 3,738 | 0,407 | 33,129 | 66,456 | 143,494 | 66,456 |
| | | Bawah | 3,738 | 0,407 | 33,129 | 66,456 | 143,494 | 66,456 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KC1 | Atas | 400,028 | 0 | 98,533 | 666,714 | 41,787 | 184,75 | 40 | P10-40 | AMAN |
| | | Bawah | 400,028 | 0 | 98,533 | 666,714 | 41,787 | 184,75 | 40 | P10-40 | AMAN |
| | KC4 | Atas | 100,309 | 0 | 98,533 | 167,181 | 166,644 | 184,75 | 165 | P10-165 | AMAN |
| | | Bawah | 100,309 | 0 | 98,533 | 167,181 | 166,644 | 184,75 | 165 | P10-165 | AMAN |
| | KC12 | Atas | 66,456 | 0 | 98,533 | 110,760 | 251,531 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 66,456 | 0 | 98,533 | 110,760 | 251,531 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KC1 | Atas | 109,099 | 246,333 | 98,533 | -64,502 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 109,099 | 246,333 | 98,533 | -64,502 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC4 | Atas | 27,357 | 246,333 | 98,533 | -200,739 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 27,357 | 246,333 | 98,533 | -200,739 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC12 | Atas | 18,124 | 246,333 | 98,533 | -216,126 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 18,124 | 246,333 | 98,533 | -216,126 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0.0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0.0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0.0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | | | 37,083 | 3,8 | 61,750 | Ok | 784,518 | 166,711 | 66,824 | 94127,548 | 38039,144 | 94127,548 | 62635,966 | 1,031 | 1208,159 |
| | | Bawah | | | 10,025 | 3,8 | 61,750 | Ok | 814,086 | 166,711 | 66,824 | 93795,485 | 37904,950 | 93795,485 | 62434,822 | 1,032 | 1243,641 |
| | KC13 | Atas | | | 37,083 | 3,1 | 50,375 | Ok | 785,934 | 152,498 | 3,091 | 93329,066 | 37716,459 | 93329,066 | 76139,021 | 1,025 | 1186,998 |
| | | Bawah | | | 4,035 | 3,1 | 50,375 | Ok | 815,786 | 1525,498 | 3,091 | 130201,731 | 52617,566 | 130201,731 | 108289,958 | 1,052 | 3419,740 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 2395,157 | 139874,987 | 1,027 | 3,769 | 16,633 | 22,954 | 71,675 | 1 | 260,817 | 0,000 | 1039,362 | 279,451 | 1039,362 | 36,465 | 1,3 |
| | | Bawah | 4683,381 | 168754,780 | 1,044 | 94,593 | 0,984 | 66,954 | 296,549 | 1 | 297,490 | 877,130 | 1212,556 | 310,498 | 1212,556 | 18,374 | 1,3 |
| | KC13 | Atas | 2395,157 | 139874,987 | 1,027 | 13,268 | 16,739 | 14,128 | 84,136 | 1 | 0,000 | 260,817 | 1026,820 | 998,231 | 998,231 | 2,138 | 1,3 |
| | | Bawah | 4683,381 | 168754,780 | 1,044 | 0,462 | 17,036 | 52,373 | 98,410 | 1 | 119,799 | 297,490 | 2523,260 | 2471,330 | 2471,330 | 52,631 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 469,730 | 469,730 | 408,278 | 765,893 | 117,829 | 117,829 | 117,829 | 18,128 | 159,902 | 0,113 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 463,400 | 264,143 | 381,573 | 381,573 | 381,573 | 58,704 | 186,547 | 0,315 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC13 | Atas | 469,730 | 469,730 | 17,435 | 23,782 | 90,845 | 23,782 | 84,136 | 12,944 | 153,574 | 0,084 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 568,439 | 542,494 | 238,340 | 238,340 | 238,340 | 36,668 | 380,205 | 0,096 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Keadaan seimbang Cc KN | Keadaan seimbang Cs KN | Keadaan seimbang Ts KN | Keadaan seimbang Pnb Ton | Keadaan seimbang Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6270,287 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3772,917 | Aman |
| | KC13 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6679,133 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah desak | 6171,833 | | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 2,262 | 0,52 | 39,638 | 128,052 | 169,401 | 128,052 |
| | | Bawah | 2,262 | 0,52 | 39,638 | 128,052 | 169,401 | 128,052 |
| | KC13 | Atas | 6,838 | 1,143 | 42,906 | 82,686 | 188,375 | 82,686 |
| | | Bawah | 6,838 | 1,143 | 42,906 | 82,686 | 188,375 | 82,686 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 123,052 | 0 | 98,533 | 213,420 | 130,540 | 184,75 | 130 | P10-130 | AMAN |
| | | Bawah | 123,052 | 0 | 98,533 | 213,420 | 130,540 | 184,75 | 130 | P10-130 | AMAN |
| | KC13 | Atas | 82,686 | 0 | 98,533 | 137,810 | 202,160 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 82,686 | 0 | 98,533 | 137,810 | 202,160 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KC5 | Atas | 22,984 | 246,333 | 98,533 | -208,027 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 22,984 | 246,333 | 98,533 | -208,027 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC13 | Atas | 14,841 | 246,333 | 98,533 | -221,598 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 14,841 | 246,333 | 98,533 | -221,598 | 282,744 | 369,5 | 260 | P10-260 | AMAN |

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 4,5 m | pb | = | 40 mm | h blk atas | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,85 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 800 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | | | 35,229 | 5,5 | 89,375 | Ok | 618,211 | 121,350 | 37,767 | 93426,688 | 37755,910 | 93426,688 | 42387,821 | 1,035 | 936,013 |
| | | Bawah | | | 37,083 | 5,5 | 89,375 | Ok | 648,163 | 121,350 | 37,767 | 93028,599 | 37595,034 | 93028,599 | 42304,651 | 1,036 | 971,956 |
| | KC14 | Atas | | | 35,229 | 5,5 | 89,375 | Ok | 609,514 | 108,480 | 11,729 | 92618,500 | 37429,303 | 92618,500 | 42515,955 | 1,034 | 904,985 |
| | | Bawah | | | 37,083 | 5,5 | 89,375 | Ok | 639,466 | 108,480 | 11,729 | 92244,758 | 37278,265 | 92244,758 | 42443,987 | 1,035 | 940,927 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 1840,998 | 85603,776 | 1,034 | 64,038 | 19,505 | 22,626 | 218,618 | 1 | 454,754 | 0,000 | 847,279 | 935,160 | 847,279 | 107,810 | 1,3 |
| | | Bawah | 1912,883 | 85248,638 | 1,036 | 58,231 | 22,851 | 1,146 | 189,778 | 1 | 260,817 | 0,000 | 848,560 | 966,610 | 848,560 | 106,399 | 1,3 |
| | KC14 | Atas | 1840,998 | 85603,776 | 1,034 | 52,317 | 20,882 | 47,001 | 220,899 | 1 | 0,000 | 454,754 | 824,833 | 803,156 | 803,156 | 0,179 | 1,3 |
| | | Bawah | 1912,883 | 85248,638 | 1,036 | 45,718 | 19,569 | 6,428 | 158,693 | 1 | 0,000 | 260,817 | 825,915 | 834,605 | 825,915 | 34,734 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 382,584 | 382,584 | 382,898 | 504,482 | 182,749 | 182,749 | 218,618 | 33,634 | 130,351 | 0,258 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 221,847 | 302,603 | 89,949 | 89,949 | 189,778 | 29,197 | 130,548 | 0,224 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC14 | Atas | 382,584 | 382,584 | 3,246 | 2,959 | 274,263 | 3,246 | 220,899 | 33,984 | 123,562 | 0,275 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 444,346 | 606,096 | 95,548 | 95,548 | 158,693 | 24,414 | 127,054 | 0,192 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4403,543 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4817,113 | Aman |
| | KC14 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4207,179 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5214,171 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 2,511 | 0,567 | 36,443 | 104,717 | 156,283 | 104,717 |
| | | Bawah | 2,511 | 0,567 | 36,443 | 104,717 | 156,283 | 104,717 |
| | KC14 | Atas | 7,733 | 1,358 | 36,894 | 97,331 | 154,500 | 97,331 |
| | | Bawah | 7,733 | 1,358 | 36,894 | 97,331 | 154,500 | 97,331 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 104,717 | 0 | 98,533 | 174,528 | 159,629 | 184,75 | 155 | P10-155 | AMAN |
| | | Bawah | 104,717 | 0 | 98,533 | 174,528 | 159,629 | 184,75 | 155 | P10-155 | AMAN |
| | KC14 | Atas | 97,331 | 0 | 98,533 | 162,218 | 171,742 | 184,75 | 170 | P10-170 | AMAN |
| | | Bawah | 97,331 | 0 | 98,533 | 162,218 | 171,742 | 184,75 | 170 | P10-170 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC6 | Atas | 18,795 | 246,333 | 98,533 | -215,008 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 18,795 | 246,333 | 98,533 | -215,008 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC14 | Atas | 17,470 | 246,333 | 98,533 | -217,217 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 17,470 | 246,333 | 98,533 | -217,217 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | | | 1,451 | 2,3 | 42,167 | Ok | 438,915 | 74,386 | 13,950 | 92237,344 | 37275,269 | 92237,344 | 89955,568 | 1,011 | 645,716 |
| | | Bawah | | | 35,229 | 2,3 | 42,167 | Ok | 472,707 | 74,386 | 13,950 | 91687,369 | 37053,011 | 91687,369 | 89419,199 | 1,012 | 686,266 |
| | KC15 | Atas | | | 1,451 | 2,3 | 42,167 | Ok | 417,317 | 60,612 | 15,501 | 91129,091 | 33827,398 | 91129,091 | 88874,732 | 1,010 | 597,760 |
| | | Bawah | | | 35,229 | 2,3 | 42,167 | Ok | 451,109 | 60,612 | 15,501 | 90620,868 | 33622,013 | 90620,868 | 88379,081 | 1,011 | 638,310 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 1243,475 | 179830,300 | 1,011 | 85,024 | 24,730 | 29,417 | 280,369 | 1 | 260,817 | 260,817 | 611,995 | 597,136 | 597,136 | 42,825 | 1,3 |
| | | Bawah | 1324,576 | 177798,280 | 1,012 | 0,142 | 18,890 | 0,267 | 43,231 | 1 | 454,754 | 0,000 | 638,113 | 632,618 | 632,618 | 30,481 | 1,3 |
| | KC15 | Atas | 1243,475 | 179830,300 | 1,011 | 43,110 | 12,835 | 65,121 | 196,068 | 1 | 260,817 | 260,817 | 574,854 | 566,930 | 566,930 | 105,386 | 1,3 |
| | | Bawah | 1324,576 | 177798,280 | 1,012 | 12,900 | 17,885 | 20,811 | 91,797 | 1 | 0,000 | 454,754 | 600,973 | 602,411 | 600,973 | 9,228 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 469,730 | 469,730 | 513,938 | 701,021 | 238,793 | 238,793 | 280,369 | 43,137 | 91,867 | 0,470 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 259,291 | 236,291 | 21,105 | 21,105 | 43,231 | 6,651 | 97,326 | 0,068 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC15 | Atas | 382,584 | 382,584 | 640,714 | 542,720 | 332,250 | 332,250 | 332,250 | 51,115 | 87,220 | 0,586 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 50,207 | 45,754 | 119,730 | 50,207 | 91,797 | 14,123 | 92,457 | 0,153 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 2427,448 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8906,979 | Aman |
| | KC15 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1774,715 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5732,050 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 2,188 | 0,482 | 24,724 | 73,550 | 106,644 | 73,550 |
| | | Bawah | 2,188 | 0,482 | 24,724 | 73,550 | 106,644 | 73,550 |
| | KC15 | Atas | 6,692 | 1,072 | 24,518 | 96,374 | 111,128 | 96,374 |
| | | Bawah | 6,692 | 1,072 | 24,518 | 96,374 | 111,128 | 96,374 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 73,550 | 0 | 98,533 | 122,583 | 227,272 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 73,550 | 0 | 98,533 | 122,583 | 227,272 | 184,75 | 180 | P10-180 | AMAN |
| | KC15 | Atas | 96,374 | 0 | 98,533 | 160,624 | 173,447 | 184,75 | 170 | P10-170 | AMAN |
| | | Bawah | 96,374 | 0 | 98,533 | 160,624 | 173,447 | 184,75 | 170 | P10-170 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KC7 | Atas | 20,059 | 246,333 | 98,533 | -212,902 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 20,059 | 246,333 | 98,533 | -212,902 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC15 | Atas | 26,284 | 246,333 | 98,533 | -202,527 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 26,284 | 246,333 | 98,533 | -202,527 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

INDONESIA

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 2,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| **Ø pokok** | = 22 mm | tk bawah | = 5 m | **pb** | = 40 mm | h blk atas | = 600 mm |
| **Ø sengkang** | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 190,375 | 13,710 | 0,855 | 87572,874 | 35390,247 | 87572,874 | 126732,209 | 1,003 | 250,386 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 224,187 | 13,710 | 0,855 | 87017,260 | 35165,711 | 87017,260 | 125928,145 | 1,004 | 290,936 |
| | KC16 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 155,846 | 14,184 | 10,871 | 88526,913 | 35775,797 | 88526,913 | 128112,358 | 1,003 | 209,710 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 189,638 | 14,184 | 10,871 | 87713,892 | 35447,236 | 87713,892 | 126936,265 | 1,003 | 250,260 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 460,096 | 254845,067 | 1,003 | 56,393 | 6,952 | 1,019 | 143,877 | 1 | 0,000 | 119,799 | 231,061 | 217,880 | 217,880 | 49,710 | 1,3 |
| | | Bawah | 541,196 | 252864,431 | 1,003 | 68,454 | 5,120 | 9,676 | 176,203 | 1 | 260,817 | 260,817 | 322,800 | 253,362 | 253,362 | 90,239 | 1,3 |
| | KC16 | Atas | 460,096 | 254845,067 | 1,003 | 37,967 | 4,613 | 8,782 | 105,191 | 1 | 119,799 | 0,000 | 195,303 | 224,130 | 195,303 | 52,973 | 1,3 |
| | | Bawah | 541,196 | 252864,431 | 1,003 | 22,774 | 2,133 | 97,776 | 159,179 | 1 | 260,817 | 260,817 | 287,042 | 259,671 | 259,671 | 77,485 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 282,038 | 282,038 | 114,739 | 241,134 | 70,792 | 70,792 | 143,877 | 22,135 | 33,520 | 0,660 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 467,765 | 442,114 | 117,392 | 117,892 | 176,203 | 27,108 | 38,979 | 0,695 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC16 | Atas | 196,092 | 196,092 | 79,682 | 104,048 | 81,509 | 81,509 | 105,191 | 16,183 | 30,047 | 0,539 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 413,377 | 350,577 | 436,912 | 413,877 | 413,877 | 63,673 | 38,948 | 1,594 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1482,978 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1370,605 | Aman |
| | KC16 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 2007,902 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 422,949 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 1,108 | 0,167 | 13,886 | 72,746 | 59,660 | 59,660 |
| | | Bawah | 1,108 | 0,167 | 13,886 | 72,746 | 59,660 | 59,660 |
| | KC16 | Atas | 1,801 | 0,227 | 11,063 | 117,970 | 48,594 | 48,594 |
| | | Bawah | 1,801 | 0,227 | 11,063 | 117,970 | 48,594 | 48,594 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 59,660 | 0 | 98,533 | 99,433 | 280,185 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 59,660 | 0 | 98,533 | 99,433 | 280,185 | 184,75 | 180 | P10-180 | AMAN |
| | KC16 | Atas | 48,594 | 0 | 98,533 | 80,980 | 343,989 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 48,594 | 0 | 98,533 | 80,980 | 343,989 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KC8 | Atas | 16,271 | 246,333 | 98,533 | -219,215 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 16,271 | 246,333 | 98,533 | -219,215 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC16 | Atas | 13,253 | 246,333 | 98,533 | -224,245 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 13,253 | 246,333 | 98,533 | -224,245 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-C

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 0 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 2,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 69,792 | 1,266 | 1,228 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 95,152 | 1,266 | 1,228 | | | | | | |
| | KC17 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 30,721 | 1,609 | 3,055 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 46,081 | 1,609 | 3,055 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | RV | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | | | | 0,894 | 0,155 | 0,021 | | 1 | 0,000 | 0,000 | 74,611 | 79,769 | 74,611 | 0,781 | 1 |
| | | Bawah | | | | 5,440 | 0,523 | 0,284 | | 1 | 0,000 | 119,799 | 124,283 | 95,897 | 95,897 | 7,364 | 1 |
| | KC17 | Atas | | | | 1,062 | 0,086 | 0,941 | | 1 | 0,000 | 0,000 | 33,947 | 46,778 | 33,947 | 0,015 | 1 |
| | | Bawah | | | | 4,360 | 0,446 | 10,357 | | 1 | 119,799 | 0,000 | 83,618 | 62,906 | 62,906 | 15,755 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | 119,799 | 119,799 | 6,722 | 22,405 | 1,190 | 1,190 | 1,190 | 0,183 | 11,479 | 0,016 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 292,038 | 292,038 | 182,878 | 289,185 | 7,454 | 7,454 | 7,454 | 1,147 | 14,753 | 0,078 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KC17 | Atas | 119,799 | 119,799 | 0,033 | 0,111 | 5,158 | 0,111 | 0,111 | 0,017 | 5,223 | 0,003 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 174,821 | 228,018 | 48,546 | 48,546 | 48,546 | 7,469 | 9,678 | 0,772 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Keadaan seimbang Cc KN | Keadaan seimbang Cs KN | Keadaan seimbang Ts KN | Keadaan seimbang Pnb Ton | Keadaan seimbang Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7671,238 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6772,492 | Aman |
| | KC17 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7859,312 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1170,040 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KA8 | Atas | 3,936 | 0,116 | 10,265 | 4,549 | 47,368 | 4,549 |
| | | Bawah | 3,936 | 0,116 | 10,265 | 4,549 | 47,368 | 4,549 |
| | KA32 | Atas | 1,393 | 0,074 | 8,767 | 25,609 | 38,351 | 25,609 |
| | | Bawah | 1,393 | 0,074 | 8,767 | 25,609 | 38,351 | 25,609 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | 4,549 | 0 | 98,533 | 7,582 | 3674,403 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 4,549 | 0 | 98,533 | 7,582 | 3674,403 | 184,75 | 180 | P10-180 | AMAN |
| | KC17 | Atas | 25,609 | 0 | 98,533 | 42,681 | 652,736 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 25,609 | 0 | 98,533 | 42,681 | 652,736 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KC9 | Atas | -3,113 | 246,333 | 98,533 | -251,521 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -3,113 | 246,333 | 98,533 | -251,521 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | KC17 | Atas | -17,522 | 246,333 | 98,533 | -275,536 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -17,522 | 246,333 | 98,533 | -275,536 | 282,744 | 369,500 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic1 | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 3,5 | m | Ic2 | = | 0,01707 | m^4 |
| fc' | = | 25 | MPa | tk | = | 1,2 | m | Ig atas | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 0 | m | Ig bawah | = | 0 | m^4 |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | pb | = | 40 | mm |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg ki bawah | = | 0 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg' ki bawah | = | 0 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg ka bawah | = | 0 | m |
| β | = | 0,85 | | d' | = | 61 | mm | Lg' ka bawah | = | 0 | m |
| | | | | | | | | d1 | = | 639 | mm |

| | | | |
|---|---|---|---|
| b1 kolom | = | 700 | mm |
| h1 kolom | = | 700 | mm |
| b2 kolom | = | 400 | mm |
| h2 kolom | = | 800 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 0 | mm |
| h blk bawah | = | 0 | mm |
| d2 | = | 739 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KD1 | Atas | | | 17,242 | 5,2 | 14,857 | Tidak | 1542,495 | 322,425 | 103,663 | | | | | | |
| | | Bawah | | | 334222,222 | 5,2 | 14,857 | Tidak | 1528,671 | 322,425 | 103,663 | | | | | | |
| | KD9 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2436,408 | 928,592 | 19,040 | | | | | | |
| | | Bawah | 334222,222 | 4,25 | | | 12,143 | Tidak | 2454,048 | 928,592 | 19,040 | | | | | | |
| | KD15 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2496,480 | 909,494 | 3,917 | | | | | | |
| | | Bawah | 334222,222 | 4,25 | | | 12,143 | Tidak | 2514,120 | 909,494 | 3,917 | | | | | | |
| | KD21 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2958,806 | 905,846 | 0,203 | | | | | | |
| | | Bawah | 334222,222 | 4,25 | | | 12,143 | Tidak | 2976,446 | 905,846 | 0,203 | | | | | | |
| | KD29 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2621,484 | 892,630 | 31,618 | | | | | | |
| | | Bawah | 334222,222 | 4,25 | | | 12,143 | Tidak | 2639,124 | 892,630 | 31,618 | | | | | | |
| | KD35 | Atas | | | 17,242 | 5,2 | 14,857 | Tidak | 1472,309 | 284,838 | 59,771 | | | | | | |
| | | Bawah | | | 334222,222 | 5,2 | 14,857 | Tidak | 1483,829 | 284,838 | 59,771 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KD1 | Atas | | | | 27,109 | 2,997 | 40,327 | | 0,925 | 198,092 | 0,000 | 2065,053 | 2393,551 | 2065,053 | 69,127 | 1 |
| | | Bawah | | | | 2,363 | 4,510 | 91,708 | | 0,925 | 0,000 | 0,000 | 1943,651 | 2379,035 | 1943,651 | 101,183 | 1 |
| | KD9 | Atas | | | | 8,511 | 3,429 | 48,818 | | 0,925 | 198,092 | 198,092 | 3747,024 | 3613,218 | 3613,218 | 62,602 | 1 |
| | | Bawah | | | | 11,002 | 2,619 | 115,708 | | 0,925 | 0,000 | 0,000 | 3551,772 | 3631,740 | 3551,772 | 111,044 | 1 |
| | KD15 | Atas | | | | 4,667 | 0,917 | 48,080 | | 0,925 | 198,092 | 198,092 | 3790,047 | 3592,724 | 3592,724 | 56,205 | 1 |
| | | Bawah | | | | 13,218 | 1,153 | 117,058 | | 0,925 | 0,000 | 0,000 | 3594,795 | 3611,246 | 3594,795 | 107,751 | 1 |
| | KD21 | Atas | | | | 3,758 | 0,076 | 48,434 | | 0,925 | 198,092 | 198,092 | 4271,659 | 4058,737 | 4058,737 | 55,091 | 1 |
| | | Bawah | | | | 13,262 | 3,544 | 117,728 | | 0,925 | 0,000 | 0,000 | 4076,407 | 4077,259 | 4076,407 | 106,901 | 1 |
| | KD29 | Atas | | | | 5,318 | 1,663 | 50,397 | | 0,925 | 198,092 | 198,092 | 3903,594 | 3822,615 | 3822,615 | 46,539 | 1 |
| | | Bawah | | | | 16,576 | 7,096 | 117,273 | | 0,925 | 0,000 | 0,000 | 3708,342 | 3841,137 | 3708,342 | 102,000 | 1 |
| | KD35 | Atas | | | | 10,883 | 4,133 | 50,302 | | 0,925 | 0,000 | 198,092 | 1951,891 | 2096,043 | 1951,891 | 44,237 | 1 |
| | | Bawah | | | | 24,735 | 7,820 | 93,125 | | 0,925 | 0,000 | 0,000 | 1857,100 | 2108,139 | 1857,100 | 70,583 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KD1 | Atas | 193,092 | 198,092 | 199,499 | 286,780 | 200,985 | 200,985 | 200,985 | 30,921 | 317,700 | 0,097 | 1 | 3200 | 1600 | 5 | 1900,663 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 392,390 | 392,390 | 392,390 | 60,368 | 299,023 | 0,202 | 1 | 3200 | 1600 | 5 | 1900,663 |
| | KD9 | Atas | 198,092 | 198,092 | 287,946 | 287,946 | 217,573 | 217,573 | 217,573 | 33,473 | 555,880 | 0,060 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 500,276 | 500,276 | 500,276 | 76,965 | 546,426 | 0,141 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD15 | Atas | 193,092 | 198,092 | 273,801 | 273,801 | 207,799 | 207,799 | 207,799 | 31,969 | 552,727 | 0,058 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 506,733 | 506,733 | 506,733 | 77,959 | 553,045 | 0,141 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD21 | Atas | 193,092 | 198,092 | 271,628 | 271,628 | 207,446 | 207,446 | 207,446 | 31,915 | 624,421 | 0,051 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 512,104 | 512,104 | 512,104 | 78,785 | 627,139 | 0,126 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD29 | Atas | 198,092 | 198,092 | 250,244 | 250,244 | 218,997 | 218,997 | 218,997 | 33,692 | 588,095 | 0,057 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 517,402 | 517,402 | 517,402 | 79,600 | 570,514 | 0,140 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD35 | Atas | 198,092 | 198,092 | 189,366 | 272,214 | 227,035 | 227,035 | 227,035 | 34,928 | 300,291 | 0,116 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 425,308 | 425,308 | 425,308 | 65,432 | 285,708 | 0,229 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KD1 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah desak | 8426,740 | | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6437,319 | Aman |
| | KD9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9984,871 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7863,661 | | Aman |
| | KD15 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10064,980 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7861,372 | | Aman |
| | KD21 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10298,899 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8192,060 | | Aman |
| | KD29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10083,665 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7891,260 | | Aman |
| | KD35 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8491,648 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5828,409 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KD1 | Atas | 0,868 | 0,033 | 25,844 | 659,306 | 109,491 | 109,491 |
| | | Bawah | 0,868 | 0,033 | 25,844 | 659,306 | 109,491 | 109,491 |
| | KD9 | Atas | 5,086 | 1,165 | 38,433 | 797,609 | 167,982 | 167,982 |
| | | Bawah | 5,086 | 1,165 | 38,433 | 797,609 | 167,982 | 167,982 |
| | KD15 | Atas | 3,053 | 1,512 | 41,212 | 793,925 | 177,884 | 177,884 |
| | | Bawah | 3,053 | 1,512 | 41,212 | 793,925 | 177,884 | 177,884 |
| | KD21 | Atas | 4,152 | 1,427 | 44,491 | 799,500 | 192,720 | 192,720 |
| | | Bawah | 4,152 | 1,427 | 44,491 | 799,500 | 192,720 | 192,720 |
| | KD29 | Atas | 1,252 | 0,879 | 47,843 | 818,222 | 203,178 | 203,178 |
| | | Bawah | 1,252 | 0,879 | 47,843 | 818,222 | 203,178 | 203,178 |
| | KD35 | Atas | 1,647 | 0,197 | 35,961 | 724,826 | 152,972 | 152,972 |
| | | Bawah | 1,647 | 0,197 | 35,961 | 724,826 | 152,972 | 152,972 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Dasar | KD1 | Atas | 109,491 | 0 | 98,533 | 182,485 | 152,669 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 109,491 | 0 | 98,533 | 182,485 | 152,669 | 184,75 | 150 | P10-150 | AMAN |
| | KD9 | Atas | 167,982 | 0 | 149,1 | 279,970 | 86,044 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 167,982 | 0 | 149,1 | 279,970 | 86,044 | 159,75 | 85 | P10-85 | AMAN |
| | KD15 | Atas | 177,884 | 0 | 149,1 | 296,473 | 81,255 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 177,884 | 0 | 149,1 | 296,473 | 81,255 | 159,75 | 80 | P10-80 | AMAN |
| | KD21 | Atas | 192,720 | 0 | 149,1 | 321,200 | 74,999 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 192,720 | 0 | 149,1 | 321,200 | 74,999 | 159,75 | 70 | P10-70 | AMAN |
| | KD29 | Atas | 203,178 | 0 | 149,1 | 338,630 | 71,139 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 203,178 | 0 | 149,1 | 338,630 | 71,139 | 159,75 | 70 | P10-70 | AMAN |
| | KD35 | Atas | 152,972 | 0 | 98,533 | 254,954 | 109,273 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 152,972 | 0 | 98,533 | 254,954 | 109,273 | 184,75 | 105 | P10-105 | AMAN |

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic1 | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 5 | m | Ic2 | = | 0,017 | m^4 |
| fc' | = | 25 | MPa | tk | = | 3,5 | m | Ig atas | = | 0,0072 | m^4 |
| **Ø pokok** | = | 22 | mm | tk bawah | = | 1,2 | m | Ig bawah | = | 0,0072 | m^4 |
| **Ø sengkang** | = | 10 | mm | Lg ki atas | = | 7,2 | m | **pb** | = | 40 | mm |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg ki bawah | = | 7,2 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg' ki bawah | = | 6,5 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg ka bawah | = | 7,2 | m |
| β | = | 0,85 | | d' | = | 61 | mm | Lg' ka bawah | = | 6,5 | m |
| | | | | | | | | d1 | = | 639 | mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| b1 kolom | = | 700 | mm | | | | | |
| h1 kolom | = | 700 | mm | | | | | |
| b2 kolom | = | 400 | mm | | | | | |
| h2 kolom | = | 800 | mm | | | | | |
| b blk atas | = | 400 | mm | | | | | |
| h blk atas | = | 600 | mm | | | | | |
| b blk bawah | = | 400 | mm | | | | | |
| h blk bawah | = | 600 | mm | | | | | |
| d2 | = | 739 | mm | | | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KD2 | Atas | | | 7,484 | 3,2 | 44,190 | Ok | 1401,817 | 322,614 | 93,356 | 94875,308 | 38341,332 | 94875,308 | 100903,679 | 1,035 | 2198,363 |
| | | Bawah | | | 17,242 | 3,2 | 44,190 | Ok | 1428,697 | 322,614 | 93,356 | 94693,164 | 38267,723 | 94693,164 | 100709,962 | 1,035 | 2230,619 |
| | KD10 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2185,484 | 929,521 | 19,167 | 145572,686 | 41315,495 | 145572,686 | 34353,892 | 1,226 | 4109,814 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2219,588 | 929,521 | 19,167 | 145256,308 | 41225,703 | 145256,308 | 34279,230 | 1,229 | 4150,739 |
| | KD16 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2245,697 | 909,690 | 3,821 | 144586,030 | 41035,469 | 144586,030 | 34121,050 | 1,230 | 4150,340 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2279,801 | 909,690 | 3,821 | 144286,462 | 40950,447 | 144286,462 | 34050,355 | 1,234 | 4191,265 |
| | KD22 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2708,562 | 906,133 | 0,025 | 140976,369 | 40010,998 | 140976,369 | 33269,201 | 1,278 | 4700,087 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2742,667 | 906,133 | 0,025 | 140754,796 | 39948,113 | 140754,796 | 33216,912 | 1,281 | 4741,013 |
| | KD30 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2370,584 | 893,458 | 31,454 | 143176,107 | 40635,313 | 143176,107 | 33788,320 | 1,242 | 4274,234 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2370,584 | 893,458 | 31,454 | 143176,107 | 40635,313 | 143176,107 | 33788,320 | 1,242 | 4274,234 |
| | KD36 | Atas | | | 7,484 | 3,2 | 44,190 | Ok | 1342,905 | 284,653 | 48,667 | 94104,709 | 38029,915 | 94104,709 | 100084,116 | 1,033 | 2066,931 |
| | | Bawah | | | 17,242 | 3,2 | 44,190 | Ok | 1365,177 | 284,653 | 48,667 | 93956,206 | 37969,901 | 93956,206 | 99926,177 | 1,033 | 2093,657 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KD2 | Atas | 21499,769 | 336520,258 | 1,109 | 72,515 | 35,454 | 5,811 | 264,707 | 0,95 | 469,730 | 0,000 | 1899,901 | 2202,748 | 1899,901 | 143,785 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 27,511 | 5,778 | 79,235 | 172,228 | 0,95 | 198,092 | 0,000 | 1876,514 | 2230,972 | 1876,514 | 115,328 | 1,3 |
| | KD10 | Atas | 21499,769 | 336520,258 | 1,109 | 25,211 | 3,685 | 35,448 | 117,512 | 0,95 | 469,730 | 469,730 | 3449,253 | 3351,257 | 3351,257 | 12,684 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 14,294 | 2,862 | 101,191 | 163,334 | 0,95 | 198,092 | 198,092 | 3381,839 | 3387,066 | 3381,839 | 88,929 | 1,3 |
| | KD16 | Atas | 21499,769 | 336520,258 | 1,109 | 13,019 | 2,085 | 33,708 | 79,192 | 0,95 | 469,730 | 469,730 | 3491,654 | 3329,205 | 3329,205 | 21,921 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 8,044 | 1,711 | 100,631 | 143,168 | 0,95 | 198,092 | 198,092 | 3424,241 | 3365,014 | 3365,014 | 95,632 | 1,3 |
| | KD22 | Atas | 21499,769 | 336520,258 | 1,109 | 14,028 | 1,955 | 34,767 | 83,690 | 0,95 | 469,730 | 469,730 | 3973,927 | 3795,535 | 3795,535 | 22,071 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 6,781 | 0,715 | 101,302 | 138,389 | 0,95 | 198,092 | 198,092 | 3906,515 | 3831,345 | 3831,345 | 98,288 | 1,3 |
| | KD30 | Atas | 21499,769 | 336520,258 | 1,109 | 18,228 | 3,465 | 39,995 | 104,262 | 0,95 | 469,730 | 469,730 | 3605,742 | 3559,351 | 3559,351 | 58,819 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 1,141 | 0,362 | 103,729 | 124,923 | 0,95 | 198,092 | 198,092 | 3502,519 | 3559,351 | 3502,519 | 109,367 | 1,3 |
| | KD36 | Atas | 21499,769 | 336520,258 | 1,109 | 88,227 | 30,479 | 3,993 | 288,394 | 0,95 | 0,000 | 469,730 | 1798,185 | 1913,337 | 1798,185 | 75,351 | 1,3 |
| | | Bawah | 21681,527 | 335970,955 | 1,110 | 32,600 | 3,803 | 74,114 | 173,771 | 0,95 | 0,000 | 198,092 | 1769,959 | 1936,723 | 1769,959 | 44,534 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KD2 | Atas | 382,584 | 382,584 | 472,070 | 611,681 | 137,774 | 137,774 | 264,707 | 40,724 | 292,293 | 0,139 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 171,618 | 246,701 | 367,740 | 246,701 | 246,701 | 37,954 | 288,694 | 0,131 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KD10 | Atas | 469,730 | 469,730 | 185,464 | 185,464 | 179,222 | 179,222 | 179,222 | 27,573 | 515,578 | 0,053 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 548,359 | 548,359 | 443,016 | 443,016 | 443,016 | 68,156 | 520,283 | 0,131 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD16 | Atas | 469,730 | 469,730 | 277,063 | 277,063 | 157,433 | 157,433 | 157,433 | 24,220 | 512,185 | 0,047 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 509,730 | 509,730 | 432,893 | 432,893 | 432,893 | 66,599 | 517,694 | 0,129 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD22 | Atas | 553,475 | 553,475 | 283,665 | 309,820 | 162,804 | 162,804 | 162,804 | 25,047 | 583,928 | 0,043 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 511,673 | 511,673 | 433,339 | 433,339 | 433,339 | 66,668 | 589,438 | 0,113 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD30 | Atas | 469,730 | 469,730 | 519,613 | 519,613 | 190,757 | 190,757 | 190,757 | 29,347 | 547,592 | 0,054 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 407,443 | 407,443 | 437,240 | 407,443 | 407,443 | 62,684 | 538,849 | 0,116 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD36 | Atas | 382,584 | 382,584 | 534,695 | 692,827 | 141,412 | 141,412 | 288,394 | 44,368 | 276,644 | 0,160 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 143,233 | 205,898 | 349,502 | 205,898 | 205,898 | 31,677 | 272,301 | 0,116 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KD2 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7918,493 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8112,768 | Aman |
| | KD10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10215,327 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8073,095 | | Aman |
| | KD16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10436,741 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8124,778 | | Aman |
| | KD22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10599,874 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8483,510 | | Aman |
| | KD30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10211,340 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8406,480 | | Aman |
| | KD36 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7406,314 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8491,300 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KD2 | Atas | 0,414 | 0,045 | 25,104 | 176,348 | 105,919 | 105,919 |
| | | Bawah | 0,414 | 0,045 | 25,104 | 176,348 | 105,919 | 105,919 |
| | KD10 | Atas | 2,075 | 1,186 | 38,55 | 214,565 | 165,334 | 165,334 |
| | | Bawah | 2,075 | 1,186 | 38,55 | 214,565 | 165,334 | 165,334 |
| | KD16 | Atas | 3,475 | 1,295 | 41,57 | 203,561 | 179,603 | 179,603 |
| | | Bawah | 3,475 | 1,295 | 41,57 | 203,561 | 179,603 | 179,603 |
| | KD22 | Atas | 2,555 | 1,279 | 44,905 | 205,566 | 192,627 | 192,627 |
| | | Bawah | 2,555 | 1,279 | 44,905 | 205,566 | 192,627 | 192,627 |
| | KD30 | Atas | 3,189 | 0,933 | 48,464 | 206,276 | 207,877 | 206,276 |
| | | Bawah | 3,189 | 0,933 | 48,464 | 206,276 | 207,877 | 206,276 |
| | KD36 | Atas | 1,215 | 0,049 | 35,198 | 170,446 | 149,159 | 149,159 |
| | | Bawah | 1,215 | 0,049 | 35,198 | 170,446 | 149,159 | 149,159 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Besment | KD2 | Atas | 105,919 | 0 | 98,533 | 176,531 | 157,817 | 184,75 | 155 | P10-155 | AMAN |
| | | Bawah | 105,919 | 0 | 98,533 | 176,531 | 157,817 | 184,75 | 155 | P10-155 | AMAN |
| | KD10 | Atas | 165,334 | 0 | 149,1 | 275,557 | 87,422 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 165,334 | 0 | 149,1 | 275,557 | 87,422 | 159,75 | 85 | P10-85 | AMAN |
| | KD16 | Atas | 179,603 | 0 | 149,1 | 299,338 | 80,477 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 179,603 | 0 | 149,1 | 299,338 | 80,477 | 159,75 | 80 | P10-80 | AMAN |
| | KD22 | Atas | 192,627 | 0 | 149,1 | 321,045 | 75,036 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 192,627 | 0 | 149,1 | 321,045 | 75,036 | 159,75 | 75 | P10-75 | AMAN |
| | KD30 | Atas | 206,276 | 0 | 149,1 | 343,793 | 70,071 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 206,276 | 0 | 149,1 | 343,793 | 70,071 | 159,75 | 70 | P10-70 | AMAN |
| | KD36 | Atas | 149,159 | 0 | 98,533 | 248,598 | 112,067 | 184,75 | 110 | P10-110 | AMAN |
| | | Bawah | 149,159 | 0 | 98,533 | 248,598 | 112,067 | 184,75 | 110 | P10-110 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Besment | KD2 | Atas | 3,652 | 246,333 | 98,533 | -240,246 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 3,652 | 246,333 | 98,533 | -240,246 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD10 | Atas | 5,701 | 372,750 | 149,1 | -363,248 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 5,701 | 372,750 | 149,1 | -363,248 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD16 | Atas | 6,193 | 372,750 | 149,1 | -362,428 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 6,193 | 372,750 | 149,1 | -362,428 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD22 | Atas | 6,642 | 372,750 | 149,1 | -361,680 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 6,642 | 372,750 | 149,1 | -361,680 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD30 | Atas | 7,113 | 372,750 | 149,1 | -360,895 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 7,113 | 372,750 | 149,1 | -360,895 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD36 | Atas | 5,143 | 246,333 | 98,533 | -237,761 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 5,143 | 246,333 | 98,533 | -237,761 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 4,5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 3,5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg ki bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ki bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KD3 | Atas | | | 2,146 | 2 | 41,905 | Ok | 1207,383 | 263,479 | 75,476 | 94371,806 | 38137,855 | 94371,806 | 105842,812 | 1,028 | 1870,426 |
| | | Bawah | | | 7,484 | 2 | 41,905 | Ok | 1245,783 | 263,479 | 75,476 | 94084,502 | 38021,748 | 94084,502 | 105520,586 | 1,029 | 1916,506 |
| | KD11 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1761,200 | 721,183 | 16,290 | 144802,481 | 41096,900 | 144802,481 | 17565,669 | 1,401 | 3267,333 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1812,944 | 721,183 | 16,290 | 144225,668 | 40933,193 | 144225,668 | 17495,697 | 1,414 | 3329,426 |
| | KD17 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1822,815 | 700,980 | 3,717 | 143563,699 | 40745,317 | 143563,699 | 17415,396 | 1,413 | 3308,946 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1874,559 | 700,980 | 3,717 | 143026,116 | 40592,744 | 143026,116 | 17350,182 | 1,426 | 3371,039 |
| | KD23 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2291,327 | 697,500 | 0,084 | 139348,200 | 39548,902 | 139348,200 | 16904,023 | 1,543 | 3865,592 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2343,071 | 697,500 | 0,084 | 138977,544 | 39443,704 | 138977,544 | 16859,059 | 1,559 | 3927,685 |
| | KD31 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1899,783 | 687,518 | 27,717 | 142408,381 | 40417,422 | 142408,381 | 17275,246 | 1,431 | 3379,768 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1951,527 | 687,518 | 27,717 | 141910,772 | 40276,194 | 141910,772 | 17214,883 | 1,444 | 3441,861 |
| | KD37 | Atas | 2,952 | 1,9 | | | 39,810 | Ok | 1114,030 | 225,126 | 27,446 | 93678,588 | 37857,709 | 93678,588 | 13229,077 | 1,246 | 1697,038 |
| | | Bawah | 3,742 | 1,9 | | | 39,810 | Ok | 1147,822 | 225,126 | 27,446 | 93419,746 | 37753,105 | 93419,746 | 13192,524 | 1,254 | 1737,588 |
| | KD43 | Atas | | | 6,160 | 3,5 | 73,333 | Ok | 115,699 | 19,825 | 57,789 | 131457,230 | 37309,338 | 131457,230 | 84249,151 | 1,003 | 170,559 |
| | | Bawah | | | 194803,810 | 3,5 | 73,333 | Ok | 174,499 | 19,825 | 57,789 | 127628,186 | 36222,603 | 127628,186 | 81795,169 | 1,005 | 241,119 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KD3 | Atas | 17559,662 | 272481,374 | 1,110 | 173,479 | 26,247 | 56,617 | 543,707 | 0,975 | 816,315 | 816,315 | 1767,259 | 1861,404 | 1767,259 | 36,864 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 90,683 | 13,533 | 368,493 | 880,971 | 0,975 | 469,730 | 0,000 | 1648,843 | 1901,724 | 1648,843 | 124,780 | 1,3 |
| | KD11 | Atas | 17559,662 | 272481,374 | 1,110 | 40,104 | 19,659 | 46,668 | 226,367 | 0,975 | 816,315 | 816,315 | 2829,356 | 2674,920 | 2674,920 | 100,917 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 46,565 | 29,912 | 69,817 | 303,849 | 0,975 | 469,730 | 469,730 | 2789,070 | 2729,251 | 2729,251 | 137,226 | 1,3 |
| | KD17 | Atas | 17559,662 | 272481,374 | 1,110 | 2,709 | 1,456 | 62,449 | 84,849 | 0,975 | 816,315 | 816,315 | 2872,839 | 2665,596 | 2665,596 | 71,477 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 9,114 | 2,003 | 100,681 | 150,040 | 0,975 | 469,730 | 469,730 | 2832,552 | 2719,927 | 2719,927 | 126,171 | 1,3 |
| | KD23 | Atas | 17559,662 | 272481,374 | 1,110 | 3,324 | 1,657 | 60,732 | 86,064 | 0,975 | 816,315 | 816,315 | 3361,122 | 3138,621 | 3138,621 | 67,837 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 12,214 | 1,483 | 98,390 | 156,994 | 0,975 | 469,730 | 469,730 | 3320,836 | 3192,952 | 3192,952 | 119,417 | 1,3 |
| | KD31 | Atas | 17559,662 | 272481,374 | 1,110 | 3,463 | 3,130 | 60,629 | 90,001 | 0,975 | 816,315 | 816,315 | 2939,520 | 2833,077 | 2833,077 | 64,241 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 5,418 | 0,045 | 97,737 | 130,219 | 0,975 | 469,730 | 469,730 | 2899,234 | 2887,409 | 2887,409 | 138,054 | 1,3 |
| | KD37 | Atas | 17559,662 | 272481,374 | 1,110 | 7,758 | 0,622 | 58,376 | 90,357 | 0,975 | 816,315 | 816,315 | 1628,968 | 1521,387 | 1521,387 | 33,719 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 6,532 | 4,847 | 96,946 | 144,031 | 0,975 | 0,000 | 469,730 | 1505,714 | 1556,869 | 1505,714 | 10,759 | 1,3 |
| | KD43 | Atas | 17559,662 | 272481,374 | 1,110 | 66,258 | 10,105 | 179,688 | 293,731 | 0,975 | 0,000 | 816,315 | 111,427 | 385,014 | 111,427 | 126,275 | 1,3 |
| | | Bawah | 17965,224 | 269428,101 | 1,114 | 33,708 | 5,319 | 412,129 | 525,374 | 0,975 | 0,000 | 0,000 | 0,000 | 446,754 | 0,000 | 422,589 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KD3 | Atas | 382,584 | 382,584 | 486,455 | 327,831 | 447,504 | 447,504 | 543,707 | 83,647 | 271,886 | 0,308 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 618,322 | 801,186 | 1657,097 | 801,186 | 801,186 | 123,259 | 253,668 | 0,486 | 2 | 6400 | 3200 | 9 | 3421,202 |
| | KD11 | Atas | 554,777 | 554,777 | 954,062 | 776,329 | 258,757 | 258,757 | 258,757 | 39,809 | 411,526 | 0,097 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 480,781 | 480,781 | 810,494 | 820,705 | 373,532 | 373,532 | 373,532 | 57,467 | 419,885 | 0,137 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD17 | Atas | 554,777 | 554,777 | 814,187 | 662,511 | 266,659 | 266,659 | 266,659 | 41,024 | 410,092 | 0,100 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 893,031 | 893,031 | 434,533 | 434,533 | 434,533 | 66,851 | 418,450 | 0,160 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD23 | Atas | 553,475 | 553,475 | 815,292 | 662,594 | 260,304 | 260,304 | 260,304 | 40,047 | 482,865 | 0,083 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 928,848 | 1014,493 | 427,620 | 427,620 | 427,620 | 65,788 | 491,223 | 0,134 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD31 | Atas | 469,730 | 469,730 | 696,391 | 519,892 | 261,564 | 261,564 | 261,564 | 40,241 | 435,858 | 0,092 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 954,692 | 954,692 | 416,232 | 416,232 | 416,232 | 64,036 | 444,217 | 0,144 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD37 | Atas | 382,584 | 382,584 | 1617,071 | 1089,773 | 253,978 | 253,978 | 253,978 | 39,074 | 234,060 | 0,167 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 193,756 | 251,058 | 419,121 | 251,058 | 251,058 | 38,624 | 231,648 | 0,167 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KD43 | Atas | 172,898 | 172,898 | 242,462 | 155,665 | 834,871 | 242,462 | 293,731 | 45,189 | 17,143 | 2,636 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1771,920 | 0,000 | 525,374 | 80,827 | 0,000 | #DIV/0! | 1,2 | 5880 | 2940 | 8 | 3041,069 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KD3 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 4300,011 | Aman |
| | | Bawah | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 128,752 | 0,411 | Patah tarik | | 3233,722 | Aman |
| | KD11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9467,781 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8495,269 | Aman |
| | KD17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9386,301 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7959,201 | Aman |
| | KD23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9279,151 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8009,712 | | Aman |
| | KD31 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9576,924 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8322,951 | Aman |
| | KD37 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 7249,418 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 7254,221 | Aman |
| | KD43 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 268,053 | Aman |
| | | Bawah | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | #DIV/0! | #DIV/0! |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KD3 | Atas | 0,01 | 0,081 | 22,595 | 305,657 | 94,995 | 94,995 |
| | | Bawah | 0,01 | 0,081 | 22,595 | 305,657 | 94,995 | 94,995 |
| | KD11 | Atas | 0,372 | 0,338 | 35,747 | 143,702 | 150,883 | 143,702 |
| | | Bawah | 0,372 | 0,338 | 35,747 | 143,702 | 150,883 | 143,702 |
| | KD17 | Atas | 0,199 | 0,387 | 38,485 | 159,362 | 162,252 | 159,362 |
| | | Bawah | 0,199 | 0,387 | 38,485 | 159,362 | 162,252 | 159,362 |
| | KD23 | Atas | 3,853 | 0,308 | 41,733 | 156,346 | 179,648 | 156,346 |
| | | Bawah | 3,853 | 0,308 | 41,733 | 156,346 | 179,648 | 156,346 |
| | KD31 | Atas | 4,789 | 0,079 | 45,175 | 154,045 | 194,846 | 154,045 |
| | | Bawah | 4,789 | 0,079 | 45,175 | 154,045 | 194,846 | 154,045 |
| | KD37 | Atas | 3,937 | 0,571 | 30,092 | 114,781 | 131,120 | 114,781 |
| | | Bawah | 3,937 | 0,571 | 30,092 | 114,781 | 131,120 | 114,781 |
| | KD43 | Atas | 12,881 | 1,631 | 122,027 | 186,160 | 527,751 | 186,160 |
| | | Bawah | 12,881 | 1,631 | 122,027 | 186,160 | 527,751 | 186,160 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KD3 | Atas | 94,995 | 0 | 98,533 | 158,324 | 175,966 | 184,75 | 175 | P10-175 | AMAN |
| | | Bawah | 94,995 | 0 | 98,533 | 158,324 | 175,966 | 184,75 | 175 | P10-175 | AMAN |
| | KD11 | Atas | 143,702 | 0 | 149,100 | 239,503 | 100,582 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 143,702 | 0 | 149,100 | 239,503 | 100,582 | 159,75 | 100 | P10-100 | AMAN |
| | KD17 | Atas | 159,362 | 0 | 149,100 | 265,603 | 90,698 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 159,362 | 0 | 149,100 | 265,603 | 90,698 | 159,75 | 90 | P10-90 | AMAN |
| | KD23 | Atas | 156,346 | 0 | 149,100 | 260,577 | 92,448 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 156,346 | 0 | 149,100 | 260,577 | 92,448 | 159,75 | 90 | P10-90 | AMAN |
| | KD31 | Atas | 154,045 | 0 | 149,100 | 256,741 | 93,829 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 154,045 | 0 | 149,100 | 256,741 | 93,829 | 159,75 | 90 | P10-90 | AMAN |
| | KD37 | Atas | 114,781 | 0 | 98,533 | 191,302 | 145,632 | 184,75 | 145 | P10-145 | AMAN |
| | | Bawah | 114,781 | 0 | 98,533 | 191,302 | 145,632 | 184,75 | 145 | P10-145 | AMAN |
| | KD43 | Atas | 186,160 | 0 | 149,100 | 310,267 | 77,642 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 186,160 | 0 | 149,100 | 310,267 | 77,642 | 159,75 | 75 | P10-75 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KD3 | Atas | 34,543 | 246,333 | 98,533 | -188,761 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 34,543 | 246,333 | 98,533 | -188,761 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD11 | Atas | 52,255 | 372,750 | 149,100 | -285,658 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 52,255 | 372,750 | 149,100 | -285,658 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD17 | Atas | 57,950 | 372,750 | 149,100 | -276,167 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 57,950 | 372,750 | 149,100 | -276,167 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD23 | Atas | 56,853 | 372,750 | 149,100 | -277,995 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 56,853 | 372,750 | 149,100 | -277,995 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD31 | Atas | 56,016 | 372,750 | 149,100 | -279,390 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 56,016 | 372,750 | 149,100 | -279,390 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD37 | Atas | 41,739 | 246,333 | 98,533 | -176,769 | 282,744 | 319,5 | 280 | P10-280 | AMAN |
| | | Bawah | 41,739 | 246,333 | 98,533 | -176,769 | 282,744 | 319,5 | 280 | P10-280 | AMAN |
| | KD43 | Atas | 67,695 | 372,750 | 149,100 | -259,926 | 186,853 | 369,5 | 185 | P10-185 | AMAN |
| | | Bawah | 67,695 | 372,750 | 149,100 | -259,926 | 186,853 | 369,5 | 185 | P10-185 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 4,5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg ki bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ki bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KD4 | Atas | | | 2,259 | 2 | 37,143 | Ok | 890,841 | 186,169 | 63,496 | 93976,477 | 37978,093 | 93976,477 | 118912,178 | 1,018 | 1366,880 |
| | | Bawah | | | 6,505 | 2 | 37,143 | Ok | 925,401 | 186,169 | 63,496 | 93639,289 | 37841,827 | 93639,289 | 118485,521 | 1,019 | 1408,352 |
| | KD12 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1359,047 | 521,233 | 10,133 | 143511,765 | 40730,578 | 143511,765 | 22159,112 | 1,206 | 2464,829 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1404,911 | 521,233 | 10,133 | 142876,344 | 40550,237 | 142876,344 | 22060,999 | 1,213 | 2519,866 |
| | KD18 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1394,475 | 492,218 | 3,258 | 141946,196 | 40286,248 | 141946,196 | 21917,378 | 1,209 | 2460,919 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1440,339 | 492,218 | 3,258 | 141357,157 | 40119,071 | 141357,157 | 21826,427 | 1,216 | 2515,956 |
| | KD24 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1869,471 | 489,438 | 0,515 | 136951,370 | 38868,649 | 136951,370 | 21146,146 | 1,282 | 3026,466 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1915,335 | 489,438 | 0,515 | 136588,854 | 38765,762 | 136588,854 | 21090,171 | 1,290 | 3081,503 |
| | KD32 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1477,857 | 484,060 | 23,565 | 140602,842 | 39904,986 | 140602,842 | 21709,956 | 1,220 | 2547,924 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1523,721 | 484,060 | 23,565 | 140072,036 | 39754,336 | 140072,036 | 21627,996 | 1,227 | 2602,961 |
| | KD38 | Atas | | | 3,107 | 1,9 | 35,286 | Ok | 893,827 | 160,365 | 59,547 | 92682,508 | 37455,170 | 92682,508 | 16659,545 | 1,140 | 1329,176 |
| | | Bawah | | | 3,253 | 1,9 | 35,286 | Ok | 923,779 | 160,365 | 59,547 | 92422,544 | 37350,113 | 92422,544 | 16612,817 | 1,145 | 1365,119 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KD4 | Atas | 13196,194 | 222504,314 | 1,100 | 11,889 | 33,155 | 64,418 | 179,678 | 1 | 553,475 | 0,000 | 1216,957 | 1397,544 | 1216,957 | 100,549 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 103,967 | 9,684 | 91,494 | 376,035 | 1 | 816,315 | 816,315 | 1421,113 | 1433,832 | 1421,113 | 2,671 | 1,3 |
| | KD12 | Atas | 13196,194 | 222504,314 | 1,100 | 8,298 | 13,057 | 112,495 | 185,837 | 1 | 553,475 | 553,475 | 2146,486 | 2016,853 | 2016,853 | 119,396 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 28,483 | 4,873 | 127,584 | 235,112 | 1 | 816,315 | 816,315 | 2276,416 | 2065,010 | 2065,010 | 165,726 | 1,3 |
| | KD18 | Atas | 13196,194 | 222504,314 | 1,100 | 32,915 | 8,277 | 107,552 | 231,791 | 1 | 553,475 | 553,475 | 2153,220 | 1994,711 | 1994,711 | 151,893 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 22,785 | 3,272 | 124,035 | 211,962 | 1 | 816,315 | 816,315 | 2283,150 | 2042,868 | 2042,868 | 155,039 | 1,3 |
| | KD24 | Atas | 13196,194 | 222504,314 | 1,100 | 43,984 | 6,436 | 109,499 | 262,689 | 1 | 553,475 | 553,475 | 2649,047 | 2479,017 | 2479,017 | 164,377 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 27,381 | 4,272 | 124,986 | 230,685 | 1 | 816,315 | 816,315 | 2778,976 | 2527,175 | 2527,175 | 161,490 | 1,3 |
| | KD32 | Atas | 13196,194 | 222504,314 | 1,100 | 12,324 | 2,567 | 115,194 | 172,176 | 1 | 553,475 | 553,475 | 2232,205 | 2158,986 | 2158,986 | 131,412 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 5,107 | 2,587 | 128,096 | 168,711 | 1 | 816,315 | 816,315 | 2362,135 | 2207,143 | 2207,143 | 137,018 | 1,3 |
| | KD38 | Atas | 13196,194 | 222504,314 | 1,100 | 53,145 | 21,890 | 55,793 | 253,667 | 1 | 0,000 | 553,475 | 1192,998 | 1356,999 | 1192,998 | 7,671 | 1,3 |
| | | Bawah | 13493,756 | 221703,930 | 1,103 | 22,408 | 22,062 | 117,664 | 248,793 | 1 | 816,315 | 816,315 | 1392,316 | 1388,449 | 1388,449 | 96,803 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KD4 | Atas | 469,730 | 469,730 | 946,393 | 1252,513 | 317,852 | 317,852 | 317,852 | 48,900 | 187,224 | 0,261 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 56,045 | 37,770 | 503,608 | 56,045 | 376,035 | 57,852 | 218,633 | 0,265 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KD12 | Atas | 553,475 | 553,475 | 700,872 | 700,872 | 494,902 | 494,902 | 494,902 | 76,139 | 310,285 | 0,245 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 1328,742 | 1081,210 | 570,877 | 570,877 | 570,877 | 87,827 | 317,694 | 0,276 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD18 | Atas | 553,475 | 553,475 | 828,277 | 828,277 | 494,970 | 494,970 | 494,970 | 76,149 | 306,879 | 0,248 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 1154,727 | 939,613 | 548,307 | 548,307 | 548,307 | 84,355 | 314,287 | 0,268 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD24 | Atas | 553,475 | 553,475 | 844,268 | 844,268 | 512,837 | 512,837 | 512,837 | 78,898 | 381,387 | 0,207 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 1132,435 | 920,339 | 558,177 | 558,177 | 558,177 | 85,873 | 388,796 | 0,221 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD32 | Atas | 469,730 | 469,730 | 790,767 | 724,009 | 499,450 | 499,450 | 499,450 | 76,839 | 332,152 | 0,231 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1136,588 | 848,522 | 546,082 | 546,082 | 546,082 | 84,013 | 339,560 | 0,247 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD38 | Atas | 469,730 | 469,730 | 71,335 | 94,409 | 313,117 | 94,409 | 253,667 | 39,026 | 183,538 | 0,213 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 2006,831 | 1352,440 | 540,882 | 540,882 | 540,882 | 83,213 | 213,607 | 0,390 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 1 | KD4 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5170,593 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5102,551 | Aman |
| | KD12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6108,551 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5509,827 | Aman |
| | KD18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6053,666 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5660,735 | Aman |
| | KD24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6907,671 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6610,368 | Aman |
| | KD32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6393,106 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6068,071 | Aman |
| | KD38 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 6196,526 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 3074,818 | Aman |

**5. Perencanaan Gaya Geser Kolom**

ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KD4 | Atas | 1,832 | 0,225 | 37,849 | 177,920 | 161,126 | 161,126 |
| | | Bawah | 1,832 | 0,225 | 37,849 | 177,920 | 161,126 | 161,126 |
| | KD12 | Atas | 5,375 | 5,871 | 60,311 | 273,277 | 265,115 | 265,115 |
| | | Bawah | 5,375 | 5,871 | 60,311 | 273,277 | 265,115 | 265,115 |
| | KD18 | Atas | 11,065 | 5,785 | 58,776 | 267,507 | 264,552 | 264,552 |
| | | Bawah | 11,065 | 5,785 | 58,776 | 267,507 | 264,552 | 264,552 |
| | KD24 | Atas | 0,470 | 1,786 | 59,482 | 274,619 | 252,193 | 252,193 |
| | | Bawah | 0,470 | 1,786 | 59,482 | 274,619 | 252,193 | 252,193 |
| | KD32 | Atas | 3,225 | 4,764 | 59,754 | 268,085 | 259,355 | 259,355 |
| | | Bawah | 3,225 | 4,764 | 59,754 | 268,085 | 259,355 | 259,355 |
| | KD38 | Atas | 5,635 | 1,034 | 39,23 | 203,731 | 171,768 | 171,768 |
| | | Bawah | 5,635 | 1,034 | 39,23 | 203,731 | 171,768 | 171,768 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KD4 | Atas | 161,126 | 0 | 98,533 | 268,543 | 103,744 | 184,75 | 100 | P10-100 | AMAN |
| | | Bawah | 161,126 | 0 | 98,533 | 268,543 | 103,744 | 184,75 | 100 | P10-100 | AMAN |
| | KD12 | Atas | 265,115 | 0 | 149,1 | 441,858 | 54,519 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 265,115 | 0 | 149,1 | 441,858 | 54,519 | 159,75 | 50 | P10-50 | AMAN |
| | KD18 | Atas | 264,552 | 0 | 149,1 | 440,920 | 54,635 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 264,552 | 0 | 149,1 | 440,920 | 54,635 | 159,75 | 50 | P10-50 | AMAN |
| | KD24 | Atas | 252,193 | 0 | 149,1 | 420,322 | 57,313 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 252,193 | 0 | 149,1 | 420,322 | 57,313 | 159,75 | 55 | P10-55 | AMAN |
| | KD32 | Atas | 259,355 | 0 | 149,1 | 432,259 | 55,730 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 259,355 | 0 | 149,1 | 432,259 | 55,730 | 159,75 | 55 | P10-55 | AMAN |
| | KD38 | Atas | 171,768 | 0 | 98,533 | 286,281 | 97,316 | 184,75 | 95 | P10-95 | AMAN |
| | | Bawah | 171,768 | 0 | 98,533 | 286,281 | 97,316 | 184,75 | 95 | P10-95 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KD4 | Atas | 45,446 | 246,333 | 98,533 | -170,591 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 45,446 | 246,333 | 98,533 | -170,591 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD12 | Atas | 74,776 | 372,750 | 149,1 | -248,124 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 74,776 | 372,750 | 149,1 | -248,124 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD18 | Atas | 74,617 | 372,750 | 149,1 | -248,388 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 74,617 | 372,750 | 149,1 | -248,388 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD24 | Atas | 71,131 | 372,750 | 149,1 | -254,198 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 71,131 | 372,750 | 149,1 | -254,198 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD32 | Atas | 73,151 | 372,750 | 149,1 | -250,831 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 73,151 | 372,750 | 149,1 | -250,831 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD38 | Atas | 48,448 | 246,333 | 98,533 | -165,587 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 48,448 | 246,333 | 98,533 | -165,587 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg ki bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ki bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KD5 | Atas | | | 6,505 | 2,5 | 46,429 | Ok | 708,595 | 126,540 | 37,964 | 92645,296 | 37440,132 | 92645,296 | 93782,225 | 1,018 | 1052,778 |
| | | Bawah | | | 6,848 | 2,5 | 46,429 | Ok | 743,155 | 126,540 | 37,964 | 92273,245 | 37289,777 | 92273,245 | 93405,609 | 1,018 | 1094,250 |
| | KD13 | Atas | 3,813 | 2 | | | 37,143 | Ok | 935,180 | 370,436 | 6,371 | 144141,938 | 40909,429 | 144141,938 | 23383,145 | 1,127 | 1714,914 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 981,044 | 370,436 | 6,371 | 143211,635 | 40645,397 | 143211,635 | 23232,229 | 1,133 | 1769,950 |
| | KD19 | Atas | 3,813 | 2 | | | 37,143 | Ok | 931,832 | 378,991 | 0,089 | 144666,516 | 41058,311 | 144666,516 | 23468,244 | 1,127 | 1724,584 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 977,696 | 378,991 | 0,089 | 143718,439 | 40789,234 | 143718,439 | 23314,444 | 1,133 | 1779,621 |
| | KD25 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1315,125 | 341,666 | 0,947 | 136835,523 | 38835,770 | 136835,523 | 22197,876 | 1,173 | 2124,816 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1360,989 | 341,666 | 0,947 | 136327,385 | 38691,554 | 136327,385 | 22115,445 | 1,179 | 2179,852 |
| | KD33 | Atas | 3,813 | 2 | | | 37,143 | Ok | 931,572 | 326,285 | 18,071 | 141804,032 | 40245,900 | 141804,032 | 23003,883 | 1,123 | 1639,942 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 977,436 | 326,285 | 18,071 | 140937,736 | 40000,034 | 140937,736 | 22863,350 | 1,129 | 1694,979 |
| | KD39 | Atas | | | 6,505 | 2,5 | 46,429 | Ok | 667,269 | 117,383 | 31,374 | 92526,387 | 37392,078 | 92526,387 | 9606,344 | 1,188 | 988,536 |
| | | Bawah | | | 6,848 | 2,5 | 46,429 | Ok | 697,221 | 117,383 | 31,374 | 92186,898 | 37254,882 | 92186,898 | 9571,098 | 1,197 | 1024,478 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KD5 | Atas | 9245,569 | 195441,718 | 1,078 | 126,150 | 34,230 | 63,895 | 448,238 | 1 | 553,475 | 0,000 | 962,988 | 1036,341 | 962,988 | 220,521 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 108,671 | 43,436 | 44,271 | 406,871 | 1 | 553,475 | 0,000 | 999,276 | 1072,629 | 999,276 | 199,191 | 1,3 |
| | KD13 | Atas | 9245,569 | 195441,718 | 1,078 | 10,507 | 0,763 | 111,590 | 154,371 | 1 | 553,475 | 553,475 | 1543,089 | 1397,655 | 1397,655 | 127,678 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 11,202 | 16,099 | 97,592 | 178,936 | 1 | 553,475 | 553,475 | 1591,246 | 1445,812 | 1445,812 | 86,884 | 1,3 |
| | KD19 | Atas | 9245,569 | 195441,718 | 1,078 | 10,753 | 1,358 | 109,508 | 154,106 | 1 | 553,475 | 553,475 | 1548,556 | 1376,738 | 1376,738 | 126,135 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 15,894 | 6,150 | 93,261 | 160,921 | 1 | 553,475 | 553,475 | 1596,714 | 1424,895 | 1424,895 | 117,569 | 1,3 |
| | KD25 | Atas | 9245,569 | 195441,718 | 1,078 | 18,820 | 9,394 | 112,849 | 199,597 | 1 | 553,475 | 553,475 | 1911,823 | 1743,608 | 1743,608 | 143,185 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 28,409 | 7,243 | 96,204 | 200,307 | 1 | 553,475 | 553,475 | 1959,980 | 1791,765 | 1791,765 | 134,473 | 1,3 |
| | KD33 | Atas | 9245,569 | 195441,718 | 1,078 | 21,524 | 0,077 | 106,802 | 174,520 | 1 | 553,475 | 553,475 | 1492,942 | 1396,648 | 1396,648 | 88,567 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 10,785 | 2,785 | 98,080 | 145,177 | 1 | 553,475 | 553,475 | 1541,099 | 1444,805 | 1444,805 | 88,936 | 1,3 |
| | KD39 | Atas | 9245,569 | 195441,718 | 1,078 | 100,903 | 34,908 | 86,801 | 446,494 | 1 | 0,000 | 553,475 | 909,981 | 955,655 | 909,981 | 4,325 | 1,3 |
| | | Bawah | 9543,131 | 194502,174 | 1,082 | 95,415 | 28,269 | 36,193 | 359,952 | 1 | 0,000 | 553,475 | 941,430 | 987,105 | 941,430 | 49,918 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KD5 | Atas | 382,584 | 382,584 | 478,501 | 569,056 | 436,758 | 436,758 | 448,238 | 68,960 | 148,152 | 0,465 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 461,080 | 610,220 | 345,651 | 345,651 | 406,871 | 62,596 | 153,735 | 0,407 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KD13 | Atas | 636,229 | 636,229 | 1030,327 | 1110,512 | 480,512 | 480,512 | 480,512 | 73,925 | 215,024 | 0,344 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 677,746 | 677,746 | 438,552 | 438,552 | 438,552 | 67,470 | 222,433 | 0,303 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD19 | Atas | 636,229 | 636,229 | 896,159 | 965,901 | 472,650 | 472,650 | 472,650 | 72,715 | 211,806 | 0,343 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 807,439 | 807,439 | 414,842 | 414,842 | 414,842 | 63,822 | 219,215 | 0,291 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD25 | Atas | 553,475 | 553,475 | 863,112 | 863,112 | 503,591 | 503,591 | 503,591 | 77,475 | 268,247 | 0,289 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 810,596 | 810,596 | 441,491 | 441,491 | 441,491 | 67,922 | 275,656 | 0,246 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD33 | Atas | 469,730 | 469,730 | 805,955 | 737,915 | 471,249 | 471,249 | 471,249 | 72,500 | 214,869 | 0,337 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 809,313 | 740,990 | 426,185 | 426,185 | 426,185 | 65,567 | 222,278 | 0,295 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD39 | Atas | 382,584 | 382,584 | 72,615 | 86,357 | 507,166 | 86,357 | 446,494 | 68,691 | 139,997 | 0,491 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 894,069 | 1183,264 | 281,879 | 281,879 | 359,952 | 55,377 | 144,835 | 0,382 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KD5 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 2285,338 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 2863,985 | Aman |
| | KD13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4371,379 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5028,380 | Aman |
| | KD19 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4378,782 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5242,371 | Aman |
| | KD25 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5283,894 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6088,272 | Aman |
| | KD33 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4469,437 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5174,189 | Aman |
| | KD39 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 2085,095 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 3166,417 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KD5 | Atas | 1,928 | 0,051 | 34,836 | 219,259 | 148,389 | 148,389 |
| | | Bawah | 1,928 | 0,051 | 34,836 | 219,259 | 148,389 | 148,389 |
| | KD13 | Atas | 6,36 | 11,155 | 47,997 | 235,657 | 219,978 | 219,978 |
| | | Bawah | 6,36 | 11,155 | 47,997 | 235,657 | 219,978 | 219,978 |
| | KD19 | Atas | 11,28 | 11,554 | 47,137 | 227,562 | 221,951 | 221,951 |
| | | Bawah | 11,28 | 11,554 | 47,137 | 227,562 | 221,951 | 221,951 |
| | KD25 | Atas | 15,746 | 7,039 | 49,305 | 242,329 | 231,005 | 231,005 |
| | | Bawah | 15,746 | 7,039 | 49,305 | 242,329 | 231,005 | 231,005 |
| | KD33 | Atas | 5,377 | 5,389 | 48,201 | 230,111 | 213,749 | 213,749 |
| | | Bawah | 5,377 | 5,389 | 48,201 | 230,111 | 213,749 | 213,749 |
| | KD39 | Atas | 6,308 | 1,088 | 35,571 | 206,781 | 157,164 | 157,164 |
| | | Bawah | 6,308 | 1,088 | 35,571 | 206,781 | 157,164 | 157,164 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KD5 | Atas | 148,389 | 0 | 98,533 | 247,315 | 112,649 | 184,75 | 110 | P10-110 | AMAN |
| | | Bawah | 148,389 | 0 | 98,533 | 247,315 | 112,649 | 184,75 | 110 | P10-110 | AMAN |
| | KD13 | Atas | 219,978 | 0 | 149,100 | 366,630 | 65,706 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 219,978 | 0 | 149,100 | 366,630 | 65,706 | 159,75 | 65 | P10-65 | AMAN |
| | KD19 | Atas | 221,951 | 0 | 149,100 | 369,919 | 65,122 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 221,951 | 0 | 149,100 | 369,919 | 65,122 | 159,75 | 65 | P10-65 | AMAN |
| | KD25 | Atas | 231,005 | 0 | 149,100 | 385,009 | 62,569 | 159,75 | 60 | P10-60 | AMAN |
| | | Bawah | 231,005 | 0 | 149,100 | 385,009 | 62,569 | 159,75 | 60 | P10-60 | AMAN |
| | KD33 | Atas | 213,749 | 0 | 149,100 | 356,248 | 67,621 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 213,749 | 0 | 149,100 | 356,248 | 67,621 | 159,75 | 65 | P10-65 | AMAN |
| | KD39 | Atas | 157,164 | 0 | 98,533 | 261,940 | 106,359 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 157,164 | 0 | 98,533 | 261,940 | 106,359 | 184,75 | 105 | P10-105 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KD5 | Atas | 41,853 | 246,333 | 98,533 | -176,578 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 41,853 | 246,333 | 98,533 | -176,578 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD13 | Atas | 62,045 | 372,750 | 149,100 | -269,341 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 62,045 | 372,750 | 149,100 | -269,341 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD19 | Atas | 62,602 | 372,750 | 149,100 | -268,414 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 62,602 | 372,750 | 149,100 | -268,414 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD25 | Atas | 65,155 | 372,750 | 149,100 | -264,158 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 65,155 | 372,750 | 149,100 | -264,158 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD33 | Atas | 60,288 | 372,750 | 149,100 | -272,270 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 60,288 | 372,750 | 149,100 | -272,270 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD39 | Atas | 44,328 | 246,333 | 98,533 | -172,453 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 44,328 | 246,333 | 98,533 | -172,453 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic1 | = 0,0200 m^4 | b1 kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ic2 | = 0,017 m^4 | h1 kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig atas | = 0,0072 m^4 | b2 kolom | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | Ig bawah | = 0,0072 m^4 | h2 kolom | = 800 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | pb | = 40 mm | b blk atas | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg ki bawah | = 7,2 m | h blk atas | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg' ki bawah | = 6,5 m | b blk bawah | = 400 mm |
| r | = 210 mm | Lg' ka atas | = 6,5 m | | = 7,2 m | h blk bawah | = 600 mm |
| β | = 0,85 | d' | = 61 mm | Lg' ka bawah | = 6,5 m | d2 | = 739 mm |
| | | | | d1 | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KD6 | Atas | | | 1,217 | 1,6 | 33,524 | Ok | 484,190 | 79,657 | 15,441 | 92013,106 | 37184,649 | 92013,106 | 128996,761 | 1,009 | 708,479 |
| | | Bawah | | | 6,505 | 1,6 | 33,524 | Ok | 522,590 | 79,657 | 15,441 | 91461,059 | 36961,554 | 91461,059 | 128222,826 | 1,009 | 754,559 |
| | KD14 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 353,166 | 204,607 | 4,534 | 152454,105 | 43268,534 | 152454,105 | 20439,314 | 1,060 | 751,170 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 404,910 | 204,607 | 4,534 | 149278,537 | 42367,266 | 149278,537 | 20013,570 | 1,067 | 813,263 |
| | KD20 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 371,370 | 209,717 | 0,094 | 151844,267 | 43095,454 | 151844,267 | 20357,554 | 1,063 | 781,191 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 423,114 | 209,717 | 0,094 | 148846,666 | 42244,695 | 148846,666 | 19955,670 | 1,070 | 843,284 |
| | KD26 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 713,790 | 163,887 | 0,140 | 135478,301 | 38450,572 | 135478,301 | 18163,391 | 1,106 | 1126,767 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 765,534 | 163,887 | 0,140 | 134521,052 | 38178,892 | 134521,052 | 18035,054 | 1,113 | 1188,860 |
| | KD34 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 365,230 | 124,032 | 18,137 | 141244,300 | 40087,041 | 141244,300 | 18936,431 | 1,055 | 636,727 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 416,974 | 124,032 | 18,137 | 138964,877 | 39440,110 | 138964,877 | 18630,832 | 1,061 | 698,820 |
| | KD40 | Atas | | | 1,217 | 1,6 | 33,524 | Ok | 448,138 | 59,181 | 10,889 | 90512,448 | 36578,198 | 90512,448 | 18024,564 | 1,057 | 632,455 |
| | | Bawah | | | 6,505 | 1,6 | 33,524 | Ok | 481,930 | 59,181 | 10,889 | 90073,304 | 36400,729 | 90073,304 | 17937,113 | 1,061 | 673,006 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KD6 | Atas | 4636,790 | 224918,017 | 1,033 | 91,853 | 39,754 | 60,624 | 366,522 | 1 | 469,730 | 0,000 | 657,802 | 656,892 | 656,892 | 8,270 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 23,954 | 30,565 | 32,306 | 159,472 | 1 | 553,475 | 553,475 | 787,332 | 697,212 | 697,212 | 78,039 | 1,3 |
| | KD14 | Atas | 4636,790 | 224918,017 | 1,033 | 25,902 | 7,918 | 129,861 | 220,433 | 1 | 469,730 | 469,730 | 717,186 | 604,704 | 604,704 | 167,335 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 23,959 | 9,207 | 79,655 | 165,051 | 1 | 553,475 | 553,475 | 794,966 | 659,036 | 659,036 | 113,853 | 1,3 |
| | KD20 | Atas | 4636,790 | 224918,017 | 1,033 | 21,135 | 1,974 | 127,162 | 192,406 | 1 | 469,730 | 469,730 | 741,666 | 610,536 | 610,536 | 155,803 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 11,889 | 1,218 | 78,248 | 116,146 | 1 | 553,475 | 553,475 | 819,446 | 664,867 | 664,867 | 93,155 | 1,3 |
| | KD26 | Atas | 4636,790 | 224918,017 | 1,033 | 18,852 | 18,685 | 116,165 | 216,628 | 1 | 469,730 | 469,730 | 1058,335 | 927,399 | 927,399 | 132,354 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 13,494 | 3,190 | 75,455 | 122,498 | 1 | 553,475 | 553,475 | 1136,115 | 981,730 | 981,730 | 90,666 | 1,3 |
| | KD34 | Atas | 4636,790 | 224918,017 | 1,033 | 19,694 | 3,987 | 146,865 | 214,859 | 1 | 469,730 | 469,730 | 645,250 | 589,901 | 589,901 | 129,831 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 24,792 | 1,553 | 82,410 | 151,786 | 1 | 553,475 | 553,475 | 723,029 | 644,232 | 644,232 | 59,611 | 1,3 |
| | KD40 | Atas | 4636,790 | 224918,017 | 1,033 | 68,078 | 19,615 | 83,563 | 296,731 | 1 | 480,781 | 469,730 | 665,756 | 578,419 | 578,419 | 146,193 | 1,3 |
| | | Bawah | 4971,792 | 222795,066 | 1,036 | 28,275 | 30,304 | 4,054 | 142,388 | 1 | 0,000 | 553,475 | 645,653 | 613,900 | 613,900 | 21,588 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KD6 | Atas | 469,730 | 469,730 | 82,489 | 118,578 | 392,808 | 118,578 | 366,522 | 56,388 | 101,060 | 0,558 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 1384,212 | 1136,424 | 192,930 | 192,930 | 192,930 | 29,682 | 107,263 | 0,277 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | KD14 | Atas | 553,475 | 553,475 | 866,761 | 946,681 | 580,927 | 580,927 | 580,927 | 89,373 | 93,031 | 0,961 | 1,1 | 5390 | 2695 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 690,445 | 744,178 | 369,375 | 369,375 | 369,375 | 56,827 | 101,390 | 0,560 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KD20 | Atas | 553,475 | 553,475 | 911,506 | 995,551 | 558,345 | 558,345 | 558,345 | 85,899 | 93,929 | 0,915 | 1,1 | 5390 | 2695 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 638,060 | 687,716 | 342,404 | 342,404 | 342,404 | 52,678 | 102,287 | 0,515 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KD26 | Atas | 553,475 | 553,475 | 864,376 | 944,076 | 527,307 | 527,307 | 527,307 | 81,124 | 142,677 | 0,569 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 670,116 | 670,116 | 334,429 | 334,429 | 334,429 | 51,451 | 151,035 | 0,341 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KD34 | Atas | 553,475 | 553,475 | 998,187 | 1090,225 | 641,698 | 641,698 | 641,698 | 98,723 | 90,754 | 1,088 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 553,475 | 553,475 | 518,680 | 518,680 | 373,784 | 373,784 | 373,784 | 57,505 | 99,113 | 0,580 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KD40 | Atas | 382,584 | 382,584 | 1177,786 | 1048,296 | 443,042 | 443,042 | 443,042 | 68,160 | 88,988 | 0,766 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 115,405 | 137,245 | 78,535 | 78,535 | 142,388 | 21,906 | 94,446 | 0,232 | 1,0 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| | KD6 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 1664,972 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 4866,523 | Aman |
| | KD14 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1086,371 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2170,526 | Aman |
| | KD20 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1164,710 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2477,836 | Aman |
| | KD26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2122,026 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4419,432 | Aman |
| | KD34 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 914,824 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2055,525 | Aman |
| | KD40 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 978,993 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5775,756 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KD6 | Atas | 1,336 | 0,008 | 24,266 | 127,148 | 103,328 | 103,328 |
| | | Bawah | 1,336 | 0,008 | 24,266 | 127,148 | 103,328 | 103,328 |
| | KD14 | Atas | 6,944 | 2,861 | 40,571 | 215,978 | 180,693 | 180,693 |
| | | Bawah | 6,944 | 2,861 | 40,571 | 215,978 | 180,693 | 180,693 |
| | KD20 | Atas | 2,547 | 3,373 | 40,053 | 204,716 | 174,439 | 174,439 |
| | | Bawah | 2,547 | 3,373 | 40,053 | 204,716 | 174,439 | 174,439 |
| | KD26 | Atas | 18,432 | 4,151 | 4,151 | 195,849 | 41,146 | 41,146 |
| | | Bawah | 18,432 | 4,151 | 4,151 | 195,849 | 41,146 | 41,146 |
| | KD34 | Atas | 13,787 | 1,697 | 40,584 | 230,791 | 186,711 | 186,711 |
| | | Bawah | 13,787 | 1,697 | 40,584 | 230,791 | 186,711 | 186,711 |
| | KD40 | Atas | 5,865 | 0,835 | 24,213 | 133,052 | 108,730 | 108,730 |
| | | Bawah | 5,865 | 0,835 | 24,213 | 133,052 | 108,730 | 108,730 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KD6 | Atas | 103,328 | 0 | 98,533 | 172,214 | 161,774 | 184,75 | 160 | P10-160 | AMAN |
| | | Bawah | 103,328 | 0 | 98,533 | 172,214 | 161,774 | 184,75 | 160 | P10-160 | AMAN |
| | KD14 | Atas | 180,693 | 0 | 149,100 | 301,156 | 79,991 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 180,693 | 0 | 149,100 | 301,156 | 79,991 | 159,75 | 75 | P10-75 | AMAN |
| | KD20 | Atas | 174,439 | 0 | 149,100 | 290,731 | 82,859 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 174,439 | 0 | 149,100 | 290,731 | 82,859 | 159,75 | 80 | P10-80 | AMAN |
| | KD26 | Atas | 41,146 | 0 | 149,100 | 68,577 | 351,280 | 159,75 | 155 | P10155 | AMAN |
| | | Bawah | 41,146 | 0 | 149,100 | 68,577 | 351,280 | 159,75 | 155 | P10-155 | AMAN |
| | KD34 | Atas | 186,711 | 0 | 149,100 | 311,185 | 77,413 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 186,711 | 0 | 149,100 | 311,185 | 77,413 | 159,75 | 75 | P10-75 | AMAN |
| | KD40 | Atas | 108,730 | 0 | 98,533 | 181,216 | 153,738 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 108,730 | 0 | 98,533 | 181,216 | 153,738 | 184,75 | 150 | P10-150 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KD6 | Atas | 37,574 | 246,333 | 98,533 | -183,710 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 37,574 | 246,333 | 98,533 | -183,710 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD14 | Atas | 65,707 | 372,750 | 149,100 | -283,239 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 65,707 | 372,750 | 149,100 | -283,239 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD20 | Atas | 63,432 | 372,750 | 149,100 | -267,030 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 63,432 | 372,750 | 149,100 | -267,030 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD26 | Atas | 14,962 | 372,750 | 149,100 | -347,813 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 14,962 | 372,750 | 149,100 | -347,813 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD34 | Atas | 67,895 | 372,750 | 149,100 | -259,592 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 67,895 | 372,750 | 149,100 | -259,592 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD40 | Atas | 39,538 | 246,333 | 98,533 | -180,437 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 39,538 | 246,333 | 98,533 | -180,437 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-D

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic1 | = 0,0200 m^4 | b1 kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 2,5 m | Ic2 | = 0,017 m^4 | h1 kolom | = 700 mm |
| f'c | = 25 MPa | tk | = 5 m | Ig atas | = 0,0072 m^4 | b2 kolom | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | Ig bawah | = 0,0072 m^4 | h2 kolom | = 800 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | pb | = 40 mm | b blk atas | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg ki bawah | = 7,2 m | h blk atas | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg' ki bawah | = 6,5 m | b blk bawah | = 400 mm |
| r | = 210 mm | Lg' ka atas | = 6,5 m | | = 7,2 m | h blk bawah | = 600 mm |
| β | = 0,85 | d' | = 61 mm | Lg' ka bawah | = 6,5 m | d2 | = 739 mm |
| | | | | d1 | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KD7 | Atas | | | 2,276 | 1,48 | 31,010 | Ok | 169,646 | 1,357 | 0,949 | 84180,972 | 34019,500 | 84180,972 | 127585,501 | 1,002 | 205,746 |
| | | Bawah | | | 1,217 | 1,48 | 31,010 | Ok | 208,046 | 1,357 | 0,949 | 84099,344 | 33986,513 | 84099,344 | 127461,785 | 1,003 | 251,826 |
| | KD27 | Atas | 282117,500 | 2,6 | | | 54,476 | Ok | 210,758 | 0,177 | 0,827 | 119299,944 | 33858,936 | 119299,944 | 8996,839 | 1,045 | 253,193 |
| | | Bawah | 3,613 | 2,6 | | | 54,476 | Ok | 262,502 | 0,177 | 0,827 | 119286,799 | 33855,205 | 119286,799 | 8995,848 | 1,057 | 315,286 |
| | KD41 | Atas | | | 2,276 | 1,48 | 31,010 | Ok | 139,561 | 2,425 | 11,882 | 84695,695 | 34227,512 | 84695,695 | 19712,165 | 1,014 | 171,353 |
| | | Bawah | | | 1,217 | 1,48 | 31,010 | Ok | 173,353 | 2,425 | 11,882 | 84510,503 | 34152,671 | 84510,503 | 19669,063 | 1,017 | 211,904 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KD7 | Atas | 630,292 | 156294,505 | 1,006 | 97,311 | 7,886 | 1,973 | 239,611 | 1 | 0,000 | 292,038 | 220,438 | 183,539 | 183,539 | 85,612 | 1,3 |
| | | Bawah | 779,016 | 156126,696 | 1,008 | 54,780 | 10,568 | 6,118 | 154,044 | 1 | 469,730 | 469,730 | 351,398 | 223,859 | 223,859 | 82,486 | 1,3 |
| | KD27 | Atas | 630,292 | 156294,505 | 1,006 | 3,419 | 1,002 | 1,974 | 12,297 | 1 | 0,000 | 0,000 | 221,482 | 224,955 | 221,482 | 6,251 | 1,3 |
| | | Bawah | 779,016 | 156126,696 | 1,008 | 9,121 | 2,334 | 13,762 | 41,211 | 1 | 469,730 | 469,730 | 407,337 | 279,286 | 279,286 | 5,593 | 1,3 |
| | KD41 | Atas | 630,292 | 156294,505 | 1,006 | 83,878 | 6,925 | 16,298 | 223,480 | 1 | 292,038 | 0,000 | 189,971 | 198,990 | 189,971 | 11,669 | 1,3 |
| | | Bawah | 779,016 | 156126,696 | 1,008 | 23,376 | 5,313 | 195,686 | 272,336 | 1 | 469,730 | 469,730 | 316,091 | 234,471 | 234,471 | 177,695 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KD7 | Atas | 292,038 | 292,038 | 272,590 | 391,848 | 118,743 | 118,743 | 239,611 | 36,863 | 28,237 | 1,306 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 686,463 | 686,463 | 94,311 | 94,311 | 154,044 | 23,699 | 34,440 | 0,688 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KD27 | Atas | 292,038 | 292,038 | 105,930 | 353,100 | 12,933 | 12,933 | 12,933 | 1,990 | 34,074 | 0,058 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 687,790 | 751,208 | 69,828 | 69,828 | 69,828 | 10,743 | 42,967 | 0,250 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KD41 | Atas | 198,092 | 198,092 | 29,003 | 34,149 | 163,795 | 34,149 | 223,480 | 34,381 | 29,226 | 1,176 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 1256,533 | 1125,395 | 852,005 | 852,005 | 852,005 | 131,078 | 36,073 | 3,634 | 2 | 6400 | 3200 | 9 | 3421,202 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KD7 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 452,689 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 1164,746 | Aman |
| | KD27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10430,098 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6016,396 | Aman |
| | KD41 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 520,723 | Aman |
| | | Bawah | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 128,752 | 0,411 | Patah tarik | | 240,288 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KD7 | Atas | 0,687 | 0,111 | 14,24 | 89,467 | 60,646 | 60,646 |
| | | Bawah | 0,687 | 0,111 | 14,24 | 89,467 | 60,646 | 60,646 |
| | KD27 | Atas | 1,17 | 0,216 | 27,003 | 18,809 | 114,868 | 18,809 |
| | | Bawah | 1,17 | 0,216 | 27,003 | 18,809 | 114,868 | 18,809 |
| | KD41 | Atas | 0,75 | 0,114 | 12,374 | 244,428 | 52,878 | 52,878 |
| | | Bawah | 0,75 | 0,114 | 12,374 | 244,428 | 52,878 | 52,878 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KD7 | Atas | 60,646 | 0 | 98,533 | 101,077 | 275,630 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 60,646 | 0 | 98,533 | 101,077 | 275,630 | 184,75 | 180 | P10-180 | AMAN |
| | KD27 | Atas | 18,809 | 0 | 149,100 | 31,349 | 768,442 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 18,809 | 0 | 149,100 | 31,349 | 768,442 | 159,75 | 155 | P10-155 | AMAN |
| | KD41 | Atas | 52,878 | 0 | 98,533 | 88,130 | 316,121 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 52,878 | 0 | 98,533 | 88,130 | 316,121 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KD7 | Atas | 22,053 | 246,333 | 98,533 | -209,578 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 22,053 | 246,333 | 98,533 | -209,578 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD27 | Atas | 6,840 | 372,750 | 149,100 | -361,350 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 6,840 | 372,750 | 149,100 | -361,350 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD41 | Atas | 19,228 | 246,333 | 98,533 | -214,286 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 19,228 | 246,333 | 98,533 | -214,286 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai Atap | KD8 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 10227,972 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 4527,996 | Aman |
| | KD28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11654,041 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10902,601 | Aman |
| | KD42 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5904,053 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 217,788 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KD8 | Atas | 2,678 | 0,386 | 12,386 | 14,669 | 55,238 | 14,669 |
| | | Bawah | 2,678 | 0,386 | 12,386 | 14,669 | 55,238 | 14,669 |
| | KD28 | Atas | 3,39 | 0,63 | 11,921 | 4,427 | 54,289 | 4,427 |
| | | Bawah | 3,39 | 0,63 | 11,921 | 4,427 | 54,289 | 4,427 |
| | KD42 | Atas | 1,388 | 0,917 | 11,78 | 72,188 | 51,896 | 51,896 |
| | | Bawah | 1,388 | 0,917 | 11,78 | 72,188 | 51,896 | 51,896 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KD8 | Atas | 14,669 | 0 | 98,533 | 24,449 | 1139,497 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 14,669 | 0 | 98,533 | 24,449 | 1139,497 | 184,75 | 180 | P10-180 | AMAN |
| | KD28 | Atas | 4,427 | 0 | 149,100 | 7,379 | 3264,829 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 4,427 | 0 | 149,100 | 7,379 | 3264,829 | 159,75 | 155 | P10-155 | AMAN |
| | KD42 | Atas | 51,896 | 0 | 98,533 | 86,494 | 322,101 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 51,896 | 0 | 98,533 | 86,494 | 322,101 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KD8 | Atas | -6,949 | 246,333 | 98,533 | -257,915 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -6,949 | 246,333 | 98,533 | -257,915 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KD28 | Atas | -2,097 | 372,750 | 149,100 | -376,245 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | -2,097 | 372,750 | 149,100 | -376,245 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KD42 | Atas | -24,582 | 246,333 | 98,533 | -287,304 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -24,582 | 246,333 | 98,533 | -287,304 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 3,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 1,2 m | Ig bawah | = | 0 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 0 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 0 m | b blk bawah | = | 0 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 0 m | h blk bawah | = | 0 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 0 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 0 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KN-m^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1411,824 | 282,792 | 61,170 | 93601,337 | 37826,490 | 93601,337 | 51322,916 | 1,069 | 2146,656 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1423,344 | 282,792 | 61,170 | 74631,836 | 0,000 | 74631,836 | 40921,675 | 1,069 | 2160,480 |
| | KE9 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1311,359 | 245,921 | 48,418 | 93042,281 | 37600,562 | 93042,281 | 51016,378 | 1,063 | 1967,103 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1311,359 | 245,921 | 48,418 | 74241,999 | 0,000 | 74241,993 | 40707,922 | 1,063 | 1967,103 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{2a}$ KNm | $Mkap_{1a}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | 4113,759 | 102339,294 | 1,066 | 9,715 | 0,039 | 67,628 | 86,590 | 0,925 | 0,000 | 0,000 | 1779,347 | 2036,261 | 1779,347 | 81,576 | 1 |
| | | Bawah | 4127,583 | 81629,596 | 1,084 | 2,215 | 7,716 | 97,021 | 108,873 | 0,925 | 0,000 | 0,000 | 1791,443 | 2048,357 | 1791,443 | 98,102 | 1 |
| | KE9 | Atas | 4113,759 | 102339,294 | 1,066 | 9,212 | 2,837 | 69,718 | 89,173 | 0,925 | 0,000 | 0,000 | 1635,143 | 1838,499 | 1635,143 | 84,006 | 1 |
| | | Bawah | 4127,583 | 81629,596 | 1,084 | 33,418 | 11,742 | 91,654 | 150,425 | 0,925 | 0,000 | 0,000 | 1635,143 | 1838,499 | 1635,143 | 61,295 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast mm^2 | As' = As perlu mm^2 | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | 198,092 | 198,092 | 79,990 | 266,634 | 294,279 | 266,634 | 266,634 | 41,021 | 273,746 | 0,150 | 1 | 3200 | 1600 | 5 | 1900,669 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 375,916 | 0,000 | 108,873 | 16,442 | 275,607 | 0,060 | 1 | 3200 | 1600 | 5 | 1900,669 |
| | KE9 | Atas | 198,092 | 198,092 | 101,869 | 339,563 | 304,409 | 304,409 | 304,409 | 46,832 | 251,560 | 0,186 | 1 | 3200 | 1600 | 5 | 1900,669 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 432,365 | 0,000 | 150,425 | 23,142 | 251,560 | 0,092 | 1 | 3200 | 1600 | 5 | 1900,669 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Keadaan seimbang Cc KN | Keadaan seimbang Cs KN | Keadaan seimbang Ts KN | Keadaan seimbang Pnb Ton | Keadaan seimbang Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5770,987 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7731,968 | Aman |
| | KE9 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5291,266 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6569,676 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | 0,747 | 0,105 | 26,098 | 415,008 | 110,506 | 110,506 |
| | | Bawah | 0,747 | 0,105 | 26,098 | 415,008 | 110,506 | 110,506 |
| | KE9 | Atas | 2,937 | 0,213 | 36,304 | 505,371 | 155,784 | 155,784 |
| | | Bawah | 2,937 | 0,213 | 36,304 | 505,371 | 155,784 | 155,784 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KE1 | Atas | 110,506 | 0 | 98,533 | 184,177 | 151,266 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 110,506 | 0 | 98,533 | 184,177 | 151,266 | 184,75 | 150 | P10-150 | AMAN |
| | KE9 | Atas | 155,784 | 0 | 98,533 | 259,641 | 107,301 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 155,784 | 0 | 98,533 | 259,641 | 107,301 | 184,75 | 105 | P10-105 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 3,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 1,2 m | **pb** | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | | | 7,829 | 3,8 | 45,917 | Ok | 1330,049 | 282,094 | 60,396 | 94110,059 | 38032,077 | 94110,059 | 84286,152 | 1,039 | 2047,409 |
| | | Bawah | | | 448812,698 | 3,8 | 45,917 | Ok | 1362,321 | 282,094 | 60,396 | 93960,075 | 37971,465 | 93960,075 | 84151,825 | 1,039 | 2074,136 |
| | KE10 | Atas | | | 7,829 | 3,8 | 45,917 | Ok | 1228,649 | 245,330 | 48,126 | 93574,043 | 37815,460 | 93574,043 | 83806,090 | 1,035 | 1866,907 |
| | | Bawah | | | 448812,698 | 3,8 | 45,917 | Ok | 1250,921 | 245,330 | 48,126 | 93419,148 | 37752,863 | 93419,148 | 83667,364 | 1,036 | 1893,633 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | 3914,316 | 168092,242 | 1,037 | 39,112 | 18,712 | 24,131 | 158,622 | 0,95 | 320,853 | 0,000 | 1753,712 | 1946,413 | 1753,712 | 77,406 | 1,3 |
| | | Bawah | 3967,769 | 167819,188 | 1,038 | 13,354 | 3,226 | 61,194 | 105,361 | 0,95 | 0,000 | 0,000 | 1716,136 | 1969,799 | 1716,136 | 48,929 | 1,3 |
| | KE10 | Atas | 3914,316 | 168092,242 | 1,037 | 53,366 | 18,842 | 19,432 | 189,118 | 0,95 | 0,000 | 320,853 | 1608,640 | 1749,807 | 1608,640 | 28,434 | 1,3 |
| | | Bawah | 3967,769 | 167819,188 | 1,038 | 0,415 | 0,680 | 62,465 | 70,604 | 0,95 | 0,000 | 0,000 | 1571,064 | 1773,193 | 1571,064 | 85,203 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | 382,584 | 382,584 | 392,163 | 613,766 | 161,015 | 161,015 | 161,015 | 24,772 | 269,802 | 0,092 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 26,765 | 89,216 | 274,424 | 89,216 | 105,361 | 16,209 | 264,021 | 0,061 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE10 | Atas | 382,584 | 382,584 | 153,830 | 169,089 | 157,433 | 157,433 | 189,118 | 29,095 | 247,483 | 0,118 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 48,122 | 160,407 | 263,503 | 160,407 | 160,407 | 24,678 | 241,702 | 0,102 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6572,433 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7006,902 | Aman |
| | KE10 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6212,032 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8427,603 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | 0,681 | 0,077 | 25,13 | 91,854 | 106,342 | 91,854 |
| | | Bawah | 0,681 | 0,077 | 25,13 | 91,854 | 106,342 | 91,854 |
| | KE10 | Atas | 1,061 | 0,172 | 34,915 | 120,526 | 147,938 | 120,526 |
| | | Bawah | 1,061 | 0,172 | 34,915 | 120,526 | 147,938 | 120,526 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | 91,854 | 0 | 98,533 | 153,090 | 181,983 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 91,854 | 0 | 98,533 | 153,090 | 181,983 | 184,75 | 180 | P10-180 | AMAN |
| | KE10 | Atas | 120,526 | 0 | 98,533 | 200,876 | 138,691 | 184,75 | 135 | P10-135 | AMAN |
| | | Bawah | 120,526 | 0 | 98,533 | 200,876 | 138,691 | 184,75 | 135 | P10-135 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KE2 | Atas | -9,502 | 246,333 | 98,533 | -262,170 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -9,502 | 246,333 | 98,533 | -262,170 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE10 | Atas | -12,468 | 246,333 | 98,533 | -267,114 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -12,468 | 246,333 | 98,533 | -267,114 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 3,5 m | pb | = 40 mm | h blk atas | = 800 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | | | 9,878 | 3,8 | 69,667 | Ok | 1180,229 | 237,598 | 53,147 | 93795,589 | 37804,992 | 93795,589 | 3311,400 | 5,665 | 1772,432 |
| | | Bawah | | | 40,842 | 3,8 | 69,667 | Ok | 1193,637 | 237,598 | 53,147 | 93547,042 | 37804,548 | 93547,042 | 3302,625 | 6,424 | 1812,521 |
| | KE11 | Atas | | | 4,812 | 3 | 55,000 | Ok | 1041,005 | 201,159 | 42,269 | 93293,010 | 37701,888 | 93293,010 | 69755,258 | 1,036 | 1571,060 |
| | | Bawah | | | 40,642 | 3 | 55,000 | Ok | 1074,798 | 201,159 | 42,269 | 93025,881 | 37593,935 | 93025,881 | 69555,526 | 1,037 | 1611,612 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 3343,492 | 73066,658 | 1,076 | 125,388 | 2,068 | 28,002 | 1045,730 | 0,975 | 373,517 | 1000,519 | 1655,274 | 1680,936 | 1655,274 | 84,754 | 1,3 |
| | | Bawah | 3424,133 | 72858,151 | 1,078 | 26,371 | 20,432 | 38,157 | 500,188 | 0,975 | 320,853 | 0,000 | 1546,593 | 1726,014 | 1546,593 | 80,248 | 1,3 |
| | KE11 | Atas | 3343,492 | 73066,658 | 1,076 | 27,255 | 22,589 | 20,817 | 140,927 | 0,975 | 119,799 | 373,517 | 1371,610 | 1481,802 | 1371,610 | 3,583 | 1,3 |
| | | Bawah | 3424,133 | 72658,151 | 1,078 | 31,547 | 19,333 | 32,326 | 156,755 | 0,975 | 0,000 | 320,853 | 1383,551 | 1517,285 | 1383,551 | 3,683 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 382,584 | 382,584 | 901,874 | 862,170 | 251,438 | 251,438 | 1045,730 | 160,882 | 254,658 | 0,632 | 2,1 | 6720 | 3360 | 9 | 3421,202 |
| | | Bawah | 382,584 | 382,584 | 293,095 | 459,716 | 209,403 | 209,403 | 500,188 | 76,952 | 237,937 | 0,323 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE11 | Atas | 382,584 | 382,584 | 390,294 | 493,040 | 139,768 | 139,768 | 140,927 | 21,681 | 211,017 | 0,103 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 305,471 | 478,085 | 189,193 | 189,193 | 189,193 | 29,107 | 212,854 | 0,137 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 158,091 | 0,505 | Patah tarik | | 2463,324 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3681,934 | Aman |
| | KE11 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6418,563 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5949,467 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 0,556 | 0,077 | 22,736 | 351,345 | 96,156 | 96,156 |
| | | Bawah | 0,556 | 0,077 | 22,736 | 351,345 | 96,156 | 96,156 |
| | KE11 | Atas | 3,972 | 0,648 | 31,434 | 75,027 | 136,874 | 75,027 |
| | | Bawah | 3,972 | 0,648 | 31,434 | 75,027 | 136,874 | 75,027 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 96,156 | 0 | 98,533 | 160,260 | 173,841 | 184,75 | 170 | P10-170 | AMAN |
| | | Bawah | 96,156 | 0 | 98,533 | 160,260 | 173,841 | 184,75 | 170 | P10-170 | AMAN |
| | KE11 | Atas | 75,027 | 0 | 98,533 | 125,045 | 222,797 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 75,027 | 0 | 98,533 | 125,045 | 222,797 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KE3 | Atas | 26,224 | 246,333 | 98,533 | -202,626 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 26,224 | 246,333 | 98,533 | -202,626 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE11 | Atas | 20,462 | 246,333 | 98,533 | -212,230 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 20,462 | 246,333 | 98,533 | -212,230 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah Ψ | Kolom tengah K | Kolom tepi Ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | | | 7,164 | 2,15 | 34,938 | Ok | 808,276 | 156,327 | 35,761 | 93300,569 | 37704,943 | 93300,569 | 109820,385 | 1,017 | 1220,054 |
| | | Bawah | | | 10,770 | 2,15 | 34,938 | Ok | 837,844 | 156,327 | 35,761 | 93000,396 | 37583,836 | 93000,396 | 109467,073 | 1,018 | 1255,536 |
| | KE12 | Atas | | | 22,334 | 2,85 | 46,313 | Ok | 800,564 | 134,078 | 31,811 | 92147,024 | 37238,788 | 92147,024 | 91822,686 | 1,023 | 1175,228 |
| | | Bawah | | | 4,835 | 2,85 | 46,313 | Ok | 830,636 | 134,078 | 31,811 | 91873,193 | 37128,107 | 91873,193 | 91579,515 | 1,023 | 1211,169 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{x,}$ KNm | $Mkap_{x,}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 2395,280 | 191643,061 | 1,020 | 5,852 | 18,636 | 24,844 | 82,100 | 1 | 320,853 | 0,000 | 1082,744 | 1163,029 | 1082,744 | 31,322 | 1,3 |
| | | Bawah | 2466,704 | 191046,589 | 1,020 | 147,006 | 2,154 | 65,419 | 412,035 | 1 | 373,517 | 1000,519 | 1257,619 | 1194,076 | 1194,076 | 67,595 | 1,3 |
| | KE12 | Atas | 2395,280 | 191643,061 | 1,020 | 26,161 | 10,952 | 12,740 | 99,704 | 1 | 0,000 | 320,853 | 1031,308 | 1115,001 | 1031,308 | 10,912 | 1,3 |
| | | Bawah | 2466,704 | 191046,589 | 1,020 | 10,602 | 18,956 | 59,669 | 130,451 | 1 | 119,798 | 373,517 | 1099,583 | 1146,451 | 1099,583 | 48,449 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{x,by}$ KNm | $Mkap_{x,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu tulangan $mm^2$ | n | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 469,730 | 469,730 | 212,171 | 364,613 | 129,217 | 129,217 | 129,217 | 19,880 | 183,499 | 0,122 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 1131,087 | 603,826 | 431,378 | 431,378 | 431,378 | 66,368 | 183,704 | 0,361 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE12 | Atas | 469,730 | 469,730 | 94,372 | 115,670 | 92,477 | 92,477 | 99,704 | 15,185 | 159,662 | 0,096 | 1 | 3200 | 1600 | 5 | 1900,669 |
| | | Bawah | 382,584 | 382,584 | 551,779 | 481,445 | 277,446 | 277,446 | 277,446 | 42,684 | 167,628 | 0,255 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Keadaan seimbang Cc KN | Keadaan seimbang Cs KN | Keadaan seimbang Ts KN | Keadaan seimbang Pnb Ton | Keadaan seimbang Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8156,375 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3307,711 | Aman |
| | KE12 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6517,486 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4443,338 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 0,96 | 0,159 | 37,948 | 143,742 | 160,557 | 143,742 |
| | | Bawah | 0,96 | 0,159 | 37,948 | 143,742 | 160,557 | 143,742 |
| | KE12 | Atas | 6,195 | 1,036 | 40,641 | 96,449 | 178,285 | 96,449 |
| | | Bawah | 6,195 | 1,036 | 40,641 | 96,449 | 178,285 | 96,449 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 143,742 | 0 | 98,533 | 239,571 | 116,290 | 184,75 | 115 | P10-115 | AMAN |
| | | Bawah | 143,742 | 0 | 98,533 | 239,571 | 116,290 | 184,75 | 115 | P10-115 | AMAN |
| | KE12 | Atas | 96,449 | 0 | 98,533 | 160,748 | 173,313 | 184,75 | 170 | P10-170 | AMAN |
| | | Bawah | 96,449 | 0 | 98,533 | 160,748 | 173,313 | 184,75 | 170 | P10-170 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KE4 | Atas | 25,800 | 248,333 | 98,533 | -203,333 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 25,800 | 248,333 | 98,533 | -203,333 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE12 | Atas | 17,311 | 248,333 | 98,533 | -217,481 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 17,311 | 248,333 | 98,533 | -217,481 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,4 m | Lg' ki bawah | = 6,4 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,4 m | Lg' ka bawah | = 6,4 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | | | 35,229 | 3,4 | 55,250 | Ok | 635,610 | 107,687 | 24,065 | 92234,913 | 37274,286 | 92234,913 | 68652,063 | 1,021 | 935,031 |
| | | Bawah | | | 6,742 | 3,4 | 55,250 | Ok | 665,562 | 107,687 | 24,065 | 91889,712 | 37134,782 | 91889,712 | 68395,124 | 1,022 | 970,974 |
| | KE13 | Atas | | | 35,229 | 4,7 | 76,375 | Ok | 609,812 | 104,513 | 22,293 | 92323,258 | 37309,999 | 92323,258 | 49710,764 | 1,029 | 898,995 |
| | | Bawah | | | 22,334 | 4,7 | 76,375 | Ok | 639,764 | 104,513 | 22,293 | 91960,744 | 37163,488 | 91960,744 | 49515,571 | 1,030 | 934,938 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{Xa}$ KNm | $Mkap_{Xu}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 1905,911 | 118362,027 | 1,025 | 72,796 | 12,329 | 23,612 | 221,138 | 1 | 296,238 | 0,000 | 826,543 | 881,535 | 826,543 | 108,722 | 1,3 |
| | | Bawah | 1834,026 | 117910,695 | 1,025 | 75,332 | 23,472 | 1,397 | 228,490 | 1 | 320,853 | 0,000 | 861,822 | 912,984 | 861,822 | 127,750 | 1,3 |
| | KE13 | Atas | 1905,911 | 118362,827 | 1,025 | 61,040 | 20,041 | 65,666 | 257,695 | 1 | 0,000 | 296,238 | 796,123 | 943,672 | 796,123 | 10,588 | 1,3 |
| | | Bawah | 1834,026 | 117910,695 | 1,025 | 56,268 | 12,384 | 7,139 | 166,175 | 1 | 0,000 | 320,853 | 831,401 | 875,121 | 831,401 | 43,599 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{Xa,by}$ KNm | $Mkap_{Xu,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 382,584 | 382,584 | 285,556 | 463,929 | 188,552 | 188,552 | 221,138 | 34,021 | 127,161 | 0,268 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 294,690 | 361,184 | 109,570 | 109,570 | 228,490 | 35,152 | 132,588 | 0,265 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE13 | Atas | 382,584 | 382,584 | 94,687 | 108,818 | 360,932 | 108,818 | 257,695 | 39,645 | 122,480 | 0,324 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 438,885 | 537,934 | 102,079 | 102,079 | 166,175 | 25,565 | 127,908 | 0,200 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 318,318 | 117,950 | 0,373 | Patah tarik | | 4292,948 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 318,318 | 117,950 | 0,373 | Patah tarik | | 4320,894 | Aman |
| | KE13 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3679,102 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5115,244 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 10227 | 0,291 | 34,665 | 115,289 | 10884,249 | 115,289 |
| | | Bawah | 1,227 | 0,291 | 34,665 | 115,289 | 147,187 | 115,289 |
| | KE13 | Atas | 7,006 | 1,141 | 35,027 | 108,684 | 155,668 | 108,684 |
| | | Bawah | 7,006 | 1,141 | 35,027 | 108,684 | 155,668 | 108,684 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 115,289 | 0 | 98,533 | 192,149 | 144,990 | 184,75 | 140 | P10-140 | AMAN |
| | | Bawah | 115,289 | 0 | 98,533 | 192,149 | 144,990 | 184,75 | 140 | P10-140 | AMAN |
| | KE13 | Atas | 108,684 | 0 | 98,533 | 181,141 | 153,801 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 108,684 | 0 | 98,533 | 181,141 | 153,801 | 184,75 | 150 | P10-150 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KE5 | Atas | 20,693 | 246,333 | 98,533 | -211,845 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 20,693 | 246,333 | 98,533 | -211,845 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE13 | Atas | 19,507 | 246,333 | 98,533 | -213,821 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 19,507 | 246,333 | 98,533 | -213,821 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | | | 1,451 | 2,25 | 41,250 | Ok | 450,135 | 76,211 | 13,298 | 92229,681 | 37272,172 | 92229,681 | 91946,941 | 1,011 | 662,100 |
| | | Bawah | | | 35,229 | 2,25 | 41,250 | Ok | 483,927 | 76,211 | 13,298 | 91692,982 | 37055,279 | 91692,982 | 91411,888 | 1,012 | 702,650 |
| | KE14 | Atas | | | 1,451 | 2,25 | 41,250 | Ok | 424,084 | 56,871 | 13,628 | 90608,685 | 36617,599 | 90608,685 | 90330,915 | 1,010 | 599,994 |
| | | Bawah | | | 35,229 | 2,25 | 41,250 | Ok | 457,876 | 56,871 | 13,628 | 90140,312 | 36427,609 | 90140,312 | 89863,977 | 1,011 | 640,445 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | RV | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 1261,994 | 182277,856 | 1,011 | 95,143 | 24,184 | 28,741 | 301,457 | 1 | 260,817 | 260,817 | 625,692 | 608,515 | 608,515 | 54,909 | 1,3 |
| | | Bawah | 1343,095 | 181275,865 | 1,012 | 2,983 | 11,809 | 0,688 | 34,167 | 1 | 296,238 | 0,000 | 629,618 | 643,997 | 629,618 | 15,258 | 1,3 |
| | KE14 | Atas | 1261,994 | 182277,856 | 1,011 | 74,828 | 11,344 | 140,573 | 344,988 | 1 | 260,817 | 260,817 | 578,032 | 562,240 | 562,240 | 218,273 | 1,3 |
| | | Bawah | 1343,095 | 181275,865 | 1,012 | 3,989 | 19,258 | 37,067 | 91,873 | 1 | 0,000 | 296,238 | 581,958 | 597,722 | 581,958 | 33,397 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 469,730 | 469,730 | 888,456 | 939,066 | 246,006 | 246,006 | 301,457 | 46,378 | 93,619 | 0,495 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 97,849 | 112,239 | 18,421 | 18,421 | 34,167 | 5,257 | 96,864 | 0,054 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE14 | Atas | 382,584 | 382,584 | 604,348 | 511,917 | 680,887 | 604,348 | 604,348 | 92,977 | 86,499 | 1,075 | 1,15 | 3680 | 1840 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 59,719 | 68,501 | 180,091 | 68,501 | 91,873 | 14,134 | 89,532 | 0,158 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 2258,379 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7109,941 | Aman |
| | KE14 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 718,741 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5663,493 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 0,743 | 0,207 | 23,903 | 76,278 | 101,390 | 76,278 |
| | | Bawah | 0,743 | 0,207 | 23,903 | 76,278 | 101,390 | 76,278 |
| | KE14 | Atas | 6,107 | 0,989 | 23,642 | 156,232 | 106,747 | 106,747 |
| | | Bawah | 6,107 | 0,989 | 23,642 | 156,232 | 106,747 | 106,747 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 76,278 | 0 | 98,533 | 127,130 | 219,143 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 76,278 | 0 | 98,533 | 127,130 | 219,143 | 184,75 | 180 | P10-180 | AMAN |
| | KE14 | Atas | 106,747 | 0 | 98,533 | 177,912 | 156,593 | 184,75 | 155 | P10-155 | AMAN |
| | | Bawah | 106,747 | 0 | 98,533 | 177,912 | 156,593 | 184,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KE6 | Atas | 20,803 | 246,333 | 98,533 | -211,661 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 20,803 | 246,333 | 98,533 | -211,661 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE14 | Atas | 29,113 | 246,333 | 98,533 | -197,812 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 29,113 | 246,333 | 98,533 | -197,812 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 2,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| **Ø pokok** | = 22 mm | tk bawah | = 5 m | **pb** | = 40 mm | h blk atas | = 600 mm |
| **Ø sengkang** | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 190,383 | 12,549 | 4,861 | 87261,558 | 35264,437 | 87261,558 | 126281,684 | 1,003 | 249,538 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 224,175 | 12,549 | 4,861 | 86749,353 | 35057,443 | 86749,353 | 125540,440 | 1,004 | 289,088 |
| | KE15 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 164,592 | 10,631 | 4,120 | 87193,655 | 35236,896 | 87193,655 | 126183,418 | 1,003 | 214,520 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 195,384 | 10,631 | 4,120 | 86625,138 | 35007,245 | 86625,138 | 125360,680 | 1,003 | 255,070 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 463,058 | 252465,101 | 1,003 | 59,509 | 6,803 | 0,028 | 149,534 | 1 | 0,000 | 119,799 | 229,850 | 233,485 | 229,850 | 53,535 | 1,3 |
| | | Bawah | 544,159 | 250901,120 | 1,003 | 76,438 | 5,502 | 8,381 | 198,238 | 1 | 260,817 | 260,817 | 321,589 | 268,976 | 268,976 | 103,114 | 1,3 |
| | KE15 | Atas | 463,058 | 252465,101 | 1,003 | 52,235 | 5,553 | 32,176 | 164,369 | 1 | 119,799 | 0,000 | 200,756 | 201,288 | 200,756 | 92,114 | 1,3 |
| | | Bawah | 544,159 | 250901,120 | 1,003 | 51,846 | 3,282 | 185,028 | 319,303 | 1 | 260,817 | 260,817 | 292,495 | 236,770 | 236,770 | 138,701 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^3$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 292,038 | 292,038 | 110,384 | 232,004 | 69,745 | 69,745 | 149,534 | 23,005 | 35,362 | 0,651 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 477,522 | 451,335 | 123,337 | 123,337 | 198,238 | 30,498 | 41,381 | 0,737 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KE15 | Atas | 196,092 | 196,092 | 78,315 | 102,263 | 196,922 | 102,263 | 164,369 | 25,287 | 30,896 | 0,819 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 418,730 | 354,688 | 835,002 | 418,730 | 418,730 | 64,420 | 36,426 | 1,769 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1518,938 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1254,727 | Aman |
| | KE15 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1070,097 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 370,750 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 0,15 | 0,029 | 13,471 | 79,039 | 56,766 | 56,766 |
| | | Bawah | 0,15 | 0,029 | 13,471 | 79,039 | 56,766 | 56,766 |
| | KE15 | Atas | 1,016 | 0,034 | 11,593 | 132,522 | 49,793 | 49,793 |
| | | Bawah | 1,016 | 0,034 | 11,593 | 132,522 | 49,793 | 49,793 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 56,766 | 0 | 98,533 | 94,610 | 294,468 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 56,766 | 0 | 98,533 | 94,610 | 294,468 | 184,75 | 180 | P10-180 | AMAN |
| | KE15 | Atas | 49,793 | 0 | 98,533 | 82,999 | 335,706 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 49,793 | 0 | 98,533 | 82,999 | 335,706 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KE7 | Atas | 15,482 | 246,333 | 98,533 | -220,531 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 15,482 | 246,333 | 98,533 | -220,531 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KE15 | Atas | 13,580 | 246,333 | 98,533 | -223,700 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 13,580 | 246,333 | 98,533 | -223,700 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-E

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 0 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 2,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 69,639 | 1,068 | 0,746 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 84,999 | 1,068 | 0,746 | | | | | | |
| | KE16 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 42,787 | 0,660 | 0,065 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 58,127 | 0,660 | 0,055 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu kN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | | | | 1,040 | 0,150 | 0,003 | | 1 | 0,000 | 0,000 | 74,242 | 77,676 | 74,242 | 0,934 | 1 |
| | | Bawah | | | | 6,808 | 0,492 | 0,301 | | 1 | 0,000 | 119,799 | 123,914 | 93,504 | 93,504 | 8,964 | 1 |
| | KE16 | Atas | | | | 0,230 | 0,033 | 0,462 | | 1 | 0,000 | 0,000 | 45,596 | 45,671 | 45,596 | 0,737 | 1 |
| | | Bawah | | | | 4,387 | 0,194 | 28,709 | | 1 | 119,799 | 0,000 | 85,270 | 61,599 | 25,460 | | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu tersakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | 119,799 | 119,799 | 6,615 | 22,049 | 1,262 | 1,262 | 1,262 | 0,194 | 11,422 | 0,017 | 1 | 3200 | 1600 | 5 | 1300,668 |
| | | Bawah | 292,038 | 292,038 | 183,186 | 289,672 | 8,929 | 8,929 | 8,929 | 1,374 | 14,385 | 0,095 | 1 | 3200 | 1600 | 5 | 1300,668 |
| | KE16 | Atas | 119,799 | 119,799 | 0,986 | 3,287 | 2,217 | 2,217 | 2,217 | 0,341 | 7,015 | 0,049 | 1 | 3200 | 1600 | 5 | 1300,668 |
| | | Bawah | 198,092 | 198,092 | 169,870 | 221,814 | 125,388 | 125,388 | 125,388 | 19,290 | 9,538 | 2,022 | 1 | 3200 | 1600 | 5 | 1300,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Cc KN | Cs KN | Ts KN | Prb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7655,831 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8520,468 | Aman |
| | KE16 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7192,034 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 314,136 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | 0,067 | 0,245 | 11,135 | 5,364 | 47,095 | 5,364 |
| | | Bawah | 0,087 | 0,245 | 11,135 | 5,364 | 47,095 | 5,364 |
| | KE16 | Atas | 1,03 | 0,378 | 7,982 | 67,160 | 35,003 | 35,003 |
| | | Bawah | 1,03 | 0,378 | 7,982 | 67,160 | 35,003 | 35,003 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | 5,364 | 0 | 98,533 | 8,340 | 3116,390 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 5,364 | 0 | 98,533 | 8,940 | 3116,390 | 184,75 | 180 | P10-180 | AMAN |
| | KE16 | Atas | 35,003 | 0 | 98,533 | 58,338 | 477,557 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 35,003 | 0 | 98,533 | 58,338 | 477,557 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanta: Atap | KE8 | Atas | -3,870 | 246,333 | 98,533 | -252,450 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -3,870 | 246,333 | 98,533 | -252,450 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | KE16 | Atas | -23,949 | 246,333 | 98,533 | -286,249 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -23,949 | 246,333 | 98,533 | -286,249 | 282,744 | 369,500 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 3,5 m | Ic2 | = | 0,017067 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 1,2 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 0 m | Ig bawah | = | 0 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg ki bawah | = | 0 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ki bawah | = | 0 m | b blk bawah | = | 0 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 0 m | h blk bawah | = | 0 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 0 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KF1 | Atas | | | 17,242 | 5,5 | 15,714 | Tidak | 1535,068 | 312,927 | 91,456 | | | | | | |
| | | Bawah | | | 334222,222 | 5,5 | 15,714 | Tidak | 1546,588 | 312,927 | 91,456 | | | | | | |
| | KF9 | Atas | 10,107 | 4,4 | | | 12,571 | Tidak | 2443,192 | 891,888 | 23,657 | | | | | | |
| | | Bawah | 334222,222 | 4,4 | | | 12,571 | Tidak | 2460,832 | 891,888 | 23,657 | | | | | | |
| | KF15 | Atas | 10,107 | 4,4 | | | 12,571 | Tidak | 2421,468 | 870,888 | 2,064 | | | | | | |
| | | Bawah | 334222,222 | 4,4 | | | 12,571 | Tidak | 2439,108 | 870,888 | 2,064 | | | | | | |
| | KF21 | Atas | 10,107 | 4,4 | | | 12,571 | Tidak | 2883,610 | 830,338 | 0,252 | | | | | | |
| | | Bawah | 334222,222 | 4,4 | | | 12,571 | Tidak | 2901,250 | 830,338 | 0,252 | | | | | | |
| | KF29 | Atas | 10,107 | 4,4 | | | 12,571 | Tidak | 2660,706 | 790,340 | 26,081 | | | | | | |
| | | Bawah | 334222,222 | 4,4 | | | 12,571 | Tidak | 2678,348 | 790,340 | 26,081 | | | | | | |
| | KF35 | Atas | | | 17,242 | 5,5 | 15,714 | Tidak | 1480,588 | 257,252 | 72,147 | | | | | | |
| | | Bawah | | | 334222,222 | 5,5 | 15,714 | Tidak | 1492,108 | 257,252 | 72,147 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc kN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KF1 | Atas | | | | 21,680 | 3,355 | 52,339 | | 0,925 | 198,092 | 0,000 | 2047,282 | 2324,510 | 2047,282 | 75,946 | 1 |
| | | Bawah | | | | 3,077 | 4,641 | 98,513 | | 0,925 | 0,000 | 0,000 | 1952,491 | 2336,606 | 1952,491 | 109,040 | 1 |
| | KF9 | Atas | | | | 7,844 | 3,359 | 52,291 | | 0,925 | 198,092 | 198,092 | 3715,608 | 3601,193 | 3601,193 | 65,602 | 1 |
| | | Bawah | | | | 10,091 | 2,800 | 124,281 | | 0,925 | 0,000 | 0,000 | 3520,356 | 3619,715 | 3520,356 | 120,950 | 1 |
| | KF15 | Atas | | | | 3,786 | 0,893 | 51,465 | | 0,925 | 198,092 | 198,092 | 3670,748 | 3465,643 | 3465,643 | 58,907 | 1 |
| | | Bawah | | | | 12,402 | 0,911 | 125,682 | | 0,925 | 0,000 | 0,000 | 3475,496 | 3484,165 | 3475,496 | 117,634 | 1 |
| | KF21 | Atas | | | | 3,919 | 0,164 | 51,832 | | 0,925 | 198,092 | 198,092 | 4113,420 | 3900,704 | 3900,704 | 58,762 | 1 |
| | | Bawah | | | | 12,361 | 3,220 | 126,324 | | 0,925 | 0,000 | 0,000 | 3918,167 | 3919,226 | 3918,167 | 116,873 | 1 |
| | KF29 | Atas | | | | 5,697 | 1,915 | 53,836 | | 0,925 | 198,092 | 198,092 | 3837,375 | 3733,141 | 3733,141 | 49,684 | 1 |
| | | Bawah | | | | 15,270 | 6,785 | 125,801 | | 0,925 | 0,000 | 0,000 | 3642,122 | 3751,663 | 3642,122 | 111,538 | 1 |
| | KF35 | Atas | | | | 11,206 | 4,288 | 53,803 | | 0,925 | 0,000 | 198,092 | 1931,619 | 2127,749 | 1931,619 | 47,714 | 1 |
| | | Bawah | | | | 23,300 | 7,658 | 99,904 | | 0,925 | 0,000 | 0,000 | 1836,828 | 2139,845 | 1836,828 | 78,492 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KF1 | Atas | 198,092 | 198,092 | 201,790 | 290,073 | 246,111 | 246,111 | 246,111 | 37,863 | 314,966 | 0,120 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 421,859 | 421,859 | 421,859 | 64,901 | 300,363 | 0,216 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF9 | Atas | 198,092 | 198,092 | 280,870 | 280,870 | 231,385 | 231,385 | 231,385 | 35,598 | 554,030 | 0,064 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 535,516 | 535,516 | 535,516 | 82,387 | 541,593 | 0,152 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF15 | Atas | 198,092 | 198,092 | 266,507 | 266,507 | 221,066 | 221,066 | 221,066 | 34,010 | 533,176 | 0,064 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 541,843 | 541,843 | 541,843 | 83,360 | 534,692 | 0,156 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF21 | Atas | 198,092 | 198,092 | 267,222 | 267,222 | 221,982 | 221,982 | 221,982 | 34,151 | 600,108 | 0,057 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 546,921 | 546,921 | 546,921 | 84,142 | 602,795 | 0,140 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF29 | Atas | 198,092 | 198,092 | 246,139 | 246,139 | 234,104 | 234,104 | 234,104 | 36,016 | 574,329 | 0,063 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 551,522 | 551,522 | 551,522 | 84,850 | 560,327 | 0,151 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF35 | Atas | 198,092 | 198,092 | 185,823 | 267,121 | 242,241 | 242,241 | 242,241 | 37,268 | 297,172 | 0,125 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 452,103 | 452,103 | 452,103 | 69,554 | 282,589 | 0,246 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KF1 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8393,660 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6120,596 | Aman |
| | KF9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9851,715 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7637,154 | | Aman |
| | KF15 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9866,857 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7563,991 | | Aman |
| | KF21 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10096,705 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7889,967 | | Aman |
| | KF29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9902,183 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7650,669 | | Aman |
| | KF35 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8263,616 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5476,991 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KF1 | Atas | 0,577 | 0,158 | 25,766 | 742,188 | 108,989 | 108,989 |
| | | Bawah | 0,577 | 0,158 | 25,766 | 742,188 | 108,989 | 108,989 |
| | KF9 | Atas | 0,72 | 2,148 | 38,153 | 852,112 | 163,254 | 163,254 |
| | | Bawah | 0,72 | 2,148 | 38,153 | 852,112 | 163,254 | 163,254 |
| | KF15 | Atas | 0,02 | 1,47 | 40,934 | 847,677 | 173,487 | 173,487 |
| | | Bawah | 0,02 | 1,47 | 40,934 | 847,677 | 173,487 | 173,487 |
| | KF21 | Atas | 2,323 | 1,825 | 44,116 | 854,336 | 189,643 | 189,643 |
| | | Bawah | 2,323 | 1,825 | 44,116 | 854,336 | 189,643 | 189,643 |
| | KF29 | Atas | 5,74 | 2,443 | 47,605 | 872,918 | 208,533 | 208,533 |
| | | Bawah | 5,74 | 2,443 | 47,605 | 872,918 | 208,533 | 208,533 |
| | KF35 | Atas | 4,611 | 0,334 | 35,759 | 771,493 | 155,380 | 155,380 |
| | | Bawah | 4,611 | 0,334 | 35,759 | 771,493 | 155,380 | 155,380 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Dasar | KF1 | Atas | 108,989 | 0 | 98,533 | 181,648 | 153,372 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 108,989 | 0 | 98,533 | 181,648 | 153,372 | 184,75 | 150 | P10-150 | AMAN |
| | KF9 | Atas | 163,254 | 0 | 149,100 | 272,090 | 88,536 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 163,254 | 0 | 149,100 | 272,090 | 88,536 | 159,75 | 85 | P10-85 | AMAN |
| | KF15 | Atas | 173,487 | 0 | 149,100 | 289,146 | 83,314 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 173,487 | 0 | 149,100 | 289,146 | 83,314 | 159,75 | 80 | P10-80 | AMAN |
| | KF21 | Atas | 189,643 | 0 | 149,100 | 316,071 | 76,216 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 189,643 | 0 | 149,100 | 316,071 | 76,216 | 159,75 | 75 | P10-75 | AMAN |
| | KF29 | Atas | 208,533 | 0 | 149,100 | 347,555 | 69,312 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 208,533 | 0 | 149,100 | 347,555 | 69,312 | 159,75 | 65 | P10-65 | AMAN |
| | KF35 | Atas | 155,380 | 0 | 98,533 | 258,967 | 107,580 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 155,380 | 0 | 98,533 | 258,967 | 107,580 | 184,75 | 105 | P10-105 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic1 | = 0,0200 m^4 | b1 kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ic2 | = 0,017 m^4 | h1 kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 3,5 m | Ig atas | = 0,0072 m^4 | b2 kolom | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 1,2 m | Ig bawah | = 0,0072 m^4 | h2 kolom | = 800 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | pb | = 40 mm | b blk atas | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg ki bawah | = 7,2 m | h blk atas | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg' ki bawah | = 6,5 m | b blk bawah | = 400 mm |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg ka bawah | = 7,2 m | h blk bawah | = 600 mm |
| β | = 0,85 | d' | = 61 mm | Lg' ka bawah | = 6,5 m | d2 | = 739 mm |
| | | | | d1 | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KF2 | Atas | | | 7,484 | 3,2 | 44,190 | Ok | 1408,180 | 313,060 | 80,339 | 94545,491 | 38208,045 | 94545,491 | 100552,905 | 1,035 | 2190,712 |
| | | Bawah | | | 17,242 | 3,2 | 44,190 | Ok | 1430,452 | 313,060 | 80,339 | 94398,628 | 38148,694 | 94398,628 | 100396,711 | 1,035 | 2217,438 |
| | KF10 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2191,817 | 892,773 | 23,717 | 144696,266 | 41066,755 | 144696,266 | 34147,065 | 1,224 | 4058,617 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2225,921 | 892,773 | 23,717 | 144388,446 | 40979,392 | 144388,446 | 34074,422 | 1,227 | 4099,542 |
| | KF16 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2169,902 | 870,928 | 2,004 | 144402,655 | 40983,424 | 144402,655 | 34077,775 | 1,220 | 3997,367 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2204,006 | 870,928 | 2,004 | 144094,398 | 40895,937 | 144094,398 | 34005,029 | 1,224 | 4038,292 |
| | KF22 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2632,318 | 830,504 | 0,046 | 139953,891 | 39720,805 | 139953,891 | 33027,905 | 1,264 | 4487,588 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2666,422 | 830,504 | 0,046 | 139734,439 | 39658,521 | 139734,439 | 32976,117 | 1,268 | 4528,513 |
| | KF30 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2409,338 | 791,439 | 25,994 | 140653,491 | 39919,361 | 140653,491 | 33193,005 | 1,239 | 4157,508 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2443,442 | 791,439 | 25,994 | 140407,614 | 39849,578 | 140407,614 | 33134,980 | 1,242 | 4198,433 |
| | KF36 | Atas | | | 7,484 | 3,2 | 44,190 | Ok | 1351,483 | 256,865 | 60,517 | 93153,705 | 37645,592 | 93153,705 | 99072,685 | 1,033 | 2032,764 |
| | | Bawah | | | 17,242 | 3,2 | 44,190 | Ok | 1373,755 | 256,865 | 60,517 | 93017,955 | 37590,732 | 93017,955 | 98928,309 | 1,033 | 2059,490 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KF2 | Atas | 20924,556 | 334071,340 | 1,107 | 63,352 | 31,879 | 1,111 | 228,564 | 0,95 | 469,730 | 0,000 | 1895,551 | 2144,726 | 1896,551 | 127,310 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 19,839 | 2,336 | 77,056 | 142,878 | 0,95 | 198,092 | 0,000 | 1868,325 | 2168,111 | 1868,325 | 102,692 | 1,3 |
| | KF10 | Atas | 20924,556 | 334071,340 | 1,107 | 25,454 | 3,810 | 38,982 | 122,369 | 0,95 | 469,730 | 469,730 | 3417,317 | 3338,431 | 3338,431 | 16,041 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 13,128 | 2,740 | 108,437 | 168,061 | 0,95 | 198,092 | 198,092 | 3349,904 | 3374,240 | 3349,904 | 97,618 | 1,3 |
| | KF16 | Atas | 20924,556 | 334071,340 | 1,107 | 12,375 | 2,455 | 36,905 | 81,886 | 0,95 | 469,730 | 469,730 | 3371,369 | 3201,288 | 3201,288 | 25,750 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 6,712 | 1,686 | 107,732 | 147,484 | 0,95 | 198,092 | 198,092 | 3303,956 | 3237,098 | 3237,098 | 104,291 | 1,3 |
| | KF22 | Atas | 20924,556 | 334071,340 | 1,107 | 18,281 | 0,975 | 37,899 | 95,666 | 0,95 | 469,730 | 469,730 | 3814,461 | 3636,156 | 3636,156 | 21,419 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 6,035 | 0,482 | 108,384 | 143,619 | 0,95 | 198,092 | 198,092 | 3747,047 | 3671,966 | 3671,966 | 106,446 | 1,3 |
| | KF30 | Atas | 20924,556 | 334071,340 | 1,107 | 19,232 | 2,343 | 43,096 | 107,287 | 0,95 | 469,730 | 469,730 | 3539,313 | 3469,991 | 3469,991 | 63,844 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 2,427 | 0,136 | 110,856 | 135,784 | 0,95 | 198,092 | 198,092 | 3471,900 | 3505,800 | 3471,900 | 118,310 | 1,3 |
| | KF36 | Atas | 20924,556 | 334071,340 | 1,107 | 86,600 | 31,853 | 3,531 | 286,870 | 0,95 | 0,000 | 469,730 | 1778,014 | 1942,937 | 1778,014 | 74,238 | 1,3 |
| | | Bawah | 21141,708 | 333515,568 | 1,108 | 32,021 | 3,632 | 79,217 | 177,657 | 0,95 | 0,000 | 198,092 | 1749,788 | 1966,322 | 1749,788 | 50,062 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KF2 | Atas | 382,584 | 382,584 | 470,883 | 610,143 | 104,659 | 104,659 | 228,564 | 35,164 | 291,777 | 0,121 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 172,156 | 247,474 | 346,919 | 247,474 | 247,474 | 38,073 | 287,435 | 0,132 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF10 | Atas | 469,730 | 469,730 | 209,691 | 209,691 | 194,452 | 194,452 | 194,452 | 29,916 | 513,605 | 0,058 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 538,142 | 538,142 | 472,097 | 472,097 | 472,097 | 72,630 | 515,370 | 0,141 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF16 | Atas | 469,730 | 469,730 | 294,204 | 294,204 | 170,573 | 170,573 | 170,573 | 26,242 | 492,506 | 0,053 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 502,502 | 502,502 | 461,292 | 461,292 | 461,292 | 70,968 | 498,015 | 0,143 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF22 | Atas | 553,475 | 553,475 | 259,125 | 283,018 | 179,395 | 179,395 | 179,395 | 27,599 | 559,409 | 0,049 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 521,613 | 521,613 | 462,056 | 462,056 | 462,056 | 71,085 | 564,918 | 0,126 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF30 | Atas | 469,730 | 469,730 | 520,755 | 520,755 | 203,657 | 203,657 | 203,657 | 31,332 | 533,845 | 0,059 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 406,962 | 406,962 | 468,286 | 406,962 | 406,962 | 62,610 | 534,138 | 0,117 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF36 | Atas | 382,584 | 382,584 | 508,086 | 658,348 | 139,206 | 139,206 | 286,870 | 44,134 | 273,541 | 0,161 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 155,294 | 223,235 | 370,147 | 223,235 | 223,235 | 34,344 | 269,198 | 0,128 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KF2 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8386,079 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8088,203 | Aman |
| | KF10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10051,154 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7862,087 | | Aman |
| | KF16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10222,217 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7829,665 | | Aman |
| | KF22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10362,437 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8187,410 | | Aman |
| | KF30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10036,115 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8385,535 | | Aman |
| | KF36 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7383,210 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8209,491 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KF2 | Atas | 0,904 | 0,070 | 25,162 | 164,151 | 106,703 | 106,703 |
| | | Bawah | 0,904 | 0,070 | 25,162 | 164,151 | 106,703 | 106,703 |
| | KF10 | Atas | 2,033 | 0,730 | 38,280 | 229,844 | 163,677 | 163,677 |
| | | Bawah | 2,033 | 0,730 | 38,280 | 229,844 | 163,677 | 163,677 |
| | KF16 | Atas | 1,621 | 0,567 | 41,171 | 217,884 | 175,216 | 175,216 |
| | | Bawah | 1,621 | 0,567 | 41,171 | 217,884 | 175,216 | 175,216 |
| | KF22 | Atas | 4,769 | 0,509 | 44,446 | 221,190 | 192,215 | 192,215 |
| | | Bawah | 4,769 | 0,509 | 44,446 | 221,190 | 192,215 | 192,215 |
| | KF30 | Atas | 2,879 | 1,179 | 47,979 | 210,558 | 205,773 | 205,773 |
| | | Bawah | 2,879 | 1,179 | 47,979 | 210,558 | 205,773 | 205,773 |
| | KF36 | Atas | 1,043 | 0,169 | 35,020 | 175,898 | 148,357 | 148,357 |
| | | Bawah | 1,043 | 0,169 | 35,020 | 175,898 | 148,357 | 148,357 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Besment | KF2 | Atas | 106,703 | 0 | 98,533 | 177,839 | 156,657 | 184,75 | 155 | P10-155 | AMAN |
| | | Bawah | 106,703 | 0 | 98,533 | 177,839 | 156,657 | 184,75 | 155 | P10-155 | AMAN |
| | KF10 | Atas | 163,677 | 0 | 149,100 | 272,795 | 88,307 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 163,677 | 0 | 149,100 | 272,795 | 88,307 | 159,75 | 85 | P10-85 | AMAN |
| | KF16 | Atas | 175,216 | 0 | 149,100 | 292,026 | 82,492 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 175,216 | 0 | 149,100 | 292,026 | 82,492 | 159,75 | 80 | P10-80 | AMAN |
| | KF22 | Atas | 192,215 | 0 | 149,100 | 320,359 | 75,196 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 192,215 | 0 | 149,100 | 320,359 | 75,196 | 159,75 | 75 | P10-75 | AMAN |
| | KF30 | Atas | 205,773 | 0 | 149,100 | 342,955 | 70,242 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 205,773 | 0 | 149,100 | 342,955 | 70,242 | 159,75 | 70 | P10-70 | AMAN |
| | KF36 | Atas | 148,357 | 0 | 98,533 | 247,261 | 112,673 | 184,75 | 110 | P10-110 | AMAN |
| | | Bawah | 148,357 | 0 | 98,533 | 247,261 | 112,673 | 184,75 | 110 | P10-110 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Besment | KF2 | Atas | 3,679 | 246,333 | 98,533 | -240,201 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 3,679 | 246,333 | 98,533 | -240,201 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KF10 | Atas | 5,644 | 372,750 | 149,1 | -363,343 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 5,644 | 372,750 | 149,1 | -363,343 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF16 | Atas | 6,042 | 372,750 | 149,1 | -362,680 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 6,042 | 372,750 | 149,1 | -362,680 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF22 | Atas | 6,628 | 372,750 | 149,1 | -361,703 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 6,628 | 372,750 | 149,1 | -361,703 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF30 | Atas | 7,096 | 372,750 | 149,1 | -360,924 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 7,096 | 372,750 | 149,1 | -360,924 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF36 | Atas | 5,116 | 246,333 | 98,533 | -237,807 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 5,116 | 246,333 | 98,533 | -237,807 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic1 | = 0,0200 m^4 | b1 kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ic2 | = 0,017 m^4 | h1 kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig atas | = 0,0072 m^4 | b2 kolom | = 400 mm |
| **Ø pokok** | = 22 mm | tk bawah | = 3,5 m | Ig bawah | = 0,0072 m^4 | h2 kolom | = 800 mm |
| **Ø sengkang** | = 10 mm | Lg ki atas | = 7,2 m | **pb** | = 40 mm | b blk atas | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg ki bawah | = 7,2 m | h blk atas | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg' ki bawah | = 6,5 m | b blk bawah | = 400 mm |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg ka bawah | = 7,2 m | h blk bawah | = 600 mm |
| β | = 0,85 | d' | = 61 mm | Lg' ka bawah | = 6,5 m | d2 | = 739 mm |
| | | | | d1 | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD kN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KF3 | Atas | | | 1,959 | 2 | 41,905 | Ok | 1213,581 | 253,737 | 60,509 | 93980,779 | 37979,832 | 93980,779 | 105404,256 | 1,028 | 1862,276 |
| | | Bawah | | | 7,484 | 2 | 41,905 | Ok | 1246,989 | 253,737 | 60,509 | 93739,116 | 37882,170 | 93739,116 | 105133,218 | 1,029 | 1902,366 |
| | KF11 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1768,153 | 884,047 | 20,375 | 143679,979 | 40778,319 | 143679,979 | 17429,501 | 1,386 | 3216,259 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1819,897 | 884,047 | 20,375 | 143124,173 | 40620,574 | 143124,173 | 17362,078 | 1,409 | 3278,352 |
| | KF17 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1746,808 | 862,831 | 1,782 | 143304,755 | 40671,825 | 143304,755 | 17383,984 | 1,388 | 3156,819 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1796,652 | 862,831 | 1,782 | 142748,836 | 40514,048 | 142748,836 | 17316,546 | 1,401 | 3218,912 |
| | KF23 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2217,748 | 622,091 | 0,051 | 138017,566 | 39171,250 | 138017,566 | 16742,606 | 1,506 | 3656,641 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2269,490 | 622,091 | 0,051 | 137655,458 | 39068,479 | 137655,458 | 16698,680 | 1,521 | 3718,734 |
| | KF31 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 1939,790 | 581,741 | 22,502 | 139099,851 | 39478,417 | 139099,851 | 16873,896 | 1,423 | 3258,534 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 1991,534 | 581,741 | 22,502 | 138667,812 | 39355,798 | 138667,812 | 16821,498 | 1,436 | 3320,626 |
| | KF37 | Atas | 2,952 | 2,15 | | | 45,048 | Ok | 1122,928 | 197,004 | 39,845 | 92505,714 | 37383,723 | 92505,714 | 10202,064 | 1,335 | 1662,600 |
| | | Bawah | 7,484 | 2,15 | | | 45,048 | Ok | 1156,620 | 197,004 | 39,845 | 92275,645 | 37290,747 | 92275,645 | 10176,691 | 1,347 | 1703,150 |
| | KF43 | Atas | | | 2,818 | 2,8 | 58,667 | Ok | 110,418 | 19,797 | 62,090 | 131963,293 | 37452,965 | 131963,293 | 105716,850 | 1,002 | 164,177 |
| | | Bawah | | | 80213,333 | 2,8 | 58,667 | Ok | 169,218 | 19,797 | 62,090 | 127859,881 | 36288,362 | 127859,881 | 102429,574 | 1,004 | 234,737 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KF3 | Atas | 16977,306 | 289753,157 | 1,099 | 89,538 | 4,554 | 45,891 | 277,380 | 0,975 | 816,315 | 816,315 | 1783,538 | 1794,822 | 1783,538 | 84,611 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 36,474 | 29,762 | 65,035 | 232,266 | 0,975 | 469,730 | 0,000 | 1639,880 | 1829,900 | 1639,880 | 124,617 | 1,3 |
| | KF11 | Atas | 16977,306 | 289753,157 | 1,099 | 21,161 | 8,972 | 80,447 | 178,977 | 0,975 | 816,315 | 816,315 | 2797,684 | 2660,385 | 2660,385 | 112,131 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 25,180 | 6,032 | 111,900 | 219,161 | 0,975 | 469,730 | 469,730 | 2757,377 | 2714,716 | 2714,716 | 146,575 | 1,3 |
| | KF17 | Atas | 16977,306 | 289753,157 | 1,099 | 6,820 | 2,162 | 76,685 | 114,033 | 0,975 | 816,315 | 816,315 | 2753,080 | 2537,710 | 2537,710 | 71,853 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 16,544 | 1,629 | 108,635 | 177,581 | 0,975 | 469,730 | 469,730 | 2712,783 | 2592,042 | 2592,042 | 131,340 | 1,3 |
| | KF23 | Atas | 16977,306 | 289753,157 | 1,099 | 17,322 | 5,508 | 76,199 | 156,317 | 0,975 | 816,315 | 816,315 | 3204,683 | 2982,043 | 2982,043 | 94,547 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 18,935 | 0,883 | 107,687 | 183,992 | 0,975 | 469,730 | 469,730 | 3164,386 | 3036,374 | 3036,374 | 132,369 | 1,3 |
| | KF31 | Atas | 16977,306 | 289753,157 | 1,099 | 3,043 | 3,460 | 75,895 | 106,563 | 0,975 | 816,315 | 816,315 | 2870,462 | 2742,116 | 2742,116 | 74,126 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 33,966 | 0,206 | 108,248 | 223,679 | 0,975 | 469,730 | 469,730 | 2830,175 | 2796,447 | 2796,447 | 148,275 | 1,3 |
| | KF37 | Atas | 16977,306 | 289753,157 | 1,099 | 57,750 | 22,757 | 79,126 | 314,802 | 0,975 | 816,315 | 816,315 | 1609,678 | 1553,173 | 1553,173 | 26,995 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 63,361 | 28,739 | 68,646 | 341,192 | 0,975 | 0,000 | 469,730 | 1485,423 | 1589,854 | 1485,423 | 12,094 | 1,3 |
| | KF43 | Atas | 16977,306 | 289753,157 | 1,099 | 65,210 | 11,978 | 201,908 | 316,553 | 0,975 | 0,000 | 816,315 | 111,427 | 397,504 | 111,427 | 141,959 | 1,3 |
| | | Bawah | 17376,877 | 285938,273 | 1,103 | 21,229 | 4,496 | 464,286 | 565,494 | 0,975 | 0,000 | 0,000 | 0,000 | 459,244 | 459,244 | 459,296 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KF3 | Atas | 382,584 | 382,584 | 463,654 | 312,465 | 291,539 | 291,539 | 291,539 | 44,852 | 271,314 | 0,165 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 626,884 | 812,280 | 342,695 | 342,695 | 342,695 | 52,722 | 252,289 | 0,209 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF11 | Atas | 554,777 | 554,777 | 975,819 | 794,033 | 369,517 | 369,517 | 369,517 | 56,849 | 409,290 | 0,139 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 792,598 | 792,598 | 502,753 | 502,753 | 502,753 | 77,347 | 417,649 | 0,185 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF17 | Atas | 554,777 | 554,777 | 796,134 | 647,822 | 331,550 | 331,550 | 331,550 | 51,008 | 390,417 | 0,131 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 904,246 | 904,246 | 475,349 | 475,349 | 475,349 | 73,131 | 398,776 | 0,183 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF23 | Atas | 553,475 | 553,475 | 937,892 | 762,069 | 344,007 | 344,007 | 344,007 | 52,924 | 458,778 | 0,115 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 848,632 | 927,972 | 473,094 | 473,094 | 473,094 | 72,784 | 467,135 | 0,156 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF31 | Atas | 469,730 | 469,730 | 730,903 | 545,657 | 325,587 | 325,587 | 325,587 | 50,090 | 421,864 | 0,119 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 932,676 | 932,676 | 490,522 | 490,522 | 490,522 | 75,465 | 430,223 | 0,175 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF37 | Atas | 382,584 | 382,584 | 1473,087 | 992,740 | 416,870 | 416,870 | 416,870 | 64,134 | 238,950 | 0,268 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 247,825 | 321,117 | 390,262 | 321,117 | 341,192 | 52,491 | 228,527 | 0,230 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF43 | Atas | 172,898 | 172,898 | 249,240 | 160,017 | 929,053 | 249,240 | 316,553 | 48,700 | 17,143 | 2,841 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1977,012 | 0,000 | 565,494 | 86,998 | 70,653 | 1,231 | 1,2 | 5980 | 2940 | 8 | 3041,069 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KF3 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 7288,145 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 6277,894 | Aman |
| | KF11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8447,064 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7382,206 | Aman |
| | KF17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8643,230 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7422,515 | Aman |
| | KF23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9011,550 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8050,608 | Aman |
| | KF31 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 8929,722 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 7601,744 | Aman |
| | KF37 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5027,805 | Aman |
| | | Bawah | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 774,843 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KF3 | Atas | 1,08 | 0,046 | 22,886 | 144,144 | 97,304 | 97,304 |
| | | Bawah | 1,08 | 0,046 | 22,886 | 144,144 | 97,304 | 97,304 |
| | KF11 | Atas | 2,384 | 0,964 | 35,54 | 198,243 | 152,783 | 152,783 |
| | | Bawah | 2,384 | 0,964 | 35,54 | 198,243 | 152,783 | 152,783 |
| | KF17 | Atas | 4,06 | 1,244 | 38,674 | 193,366 | 168,000 | 168,000 |
| | | Bawah | 4,06 | 1,244 | 38,674 | 193,366 | 168,000 | 168,000 |
| | KF23 | Atas | 2,418 | 2,356 | 41,818 | 185,705 | 180,648 | 180,648 |
| | | Bawah | 2,418 | 2,356 | 41,818 | 185,705 | 180,648 | 180,648 |
| | KF31 | Atas | 1,812 | 4,262 | 46,053 | 185,479 | 199,800 | 185,479 |
| | | Bawah | 1,812 | 4,262 | 46,053 | 185,479 | 199,800 | 185,479 |
| | KF37 | Atas | 3,908 | 0,852 | 30,159 | 172,287 | 131,666 | 131,666 |
| | | Bawah | 3,908 | 0,852 | 30,159 | 172,287 | 131,666 | 131,666 |
| | KF43 | Atas | 11,087 | 1,503 | 122,155 | 200,465 | 526,271 | 200,465 |
| | | Bawah | 11,087 | 1,503 | 122,155 | 200,465 | 526,271 | 200,465 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KF3 | Atas | 97,304 | 0 | 98,533 | 162,173 | 171,791 | 184,750 | 170 | P10-170 | AMAN |
| | | Bawah | 97,304 | 0 | 98,533 | 162,173 | 171,791 | 184,750 | 170 | P10-170 | AMAN |
| | KF11 | Atas | 152,783 | 0 | 149,100 | 254,639 | 94,804 | 159,750 | 90 | P10-90 | AMAN |
| | | Bawah | 152,783 | 0 | 149,100 | 254,639 | 94,804 | 159,750 | 90 | P10-90 | AMAN |
| | KF17 | Atas | 168,000 | 0 | 149,100 | 280,000 | 86,035 | 159,750 | 85 | P10-85 | AMAN |
| | | Bawah | 168,000 | 0 | 149,100 | 280,000 | 86,035 | 159,750 | 85 | P10-85 | AMAN |
| | KF23 | Atas | 180,648 | 0 | 149,100 | 301,081 | 80,011 | 159,750 | 80 | P10-80 | AMAN |
| | | Bawah | 180,648 | 0 | 149,100 | 301,081 | 80,011 | 159,750 | 80 | P10-80 | AMAN |
| | KF31 | Atas | 185,479 | 0 | 149,100 | 309,132 | 77,927 | 159,750 | 75 | P10-75 | AMAN |
| | | Bawah | 185,479 | 0 | 149,100 | 309,132 | 77,927 | 159,750 | 75 | P10-75 | AMAN |
| | KF37 | Atas | 131,666 | 0 | 98,533 | 219,443 | 126,956 | 184,750 | 125 | P10-125 | AMAN |
| | | Bawah | 131,666 | 0 | 98,533 | 219,443 | 126,956 | 184,750 | 125 | P10-125 | AMAN |
| | KF43 | Atas | 200,465 | 0 | 149,100 | 334,108 | 72,102 | 159,750 | 70 | P10-70 | AMAN |
| | | Bawah | 200,465 | 0 | 149,100 | 334,108 | 72,102 | 159,750 | 70 | P10-70 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KF3 | Atas | 35,383 | 248,333 | 98,533 | -187,362 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | 35,383 | 248,333 | 98,533 | -187,362 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | KF11 | Atas | 55,558 | 372,750 | 149,100 | -280,154 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | | Bawah | 55,558 | 372,750 | 149,100 | -280,154 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | KF17 | Atas | 61,091 | 372,750 | 149,100 | -270,832 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | | Bawah | 61,091 | 372,750 | 149,100 | -270,832 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | KF23 | Atas | 65,890 | 372,750 | 149,100 | -263,266 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | | Bawah | 65,890 | 372,750 | 149,100 | -263,266 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | KF31 | Atas | 67,447 | 372,750 | 149,100 | -260,338 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | | Bawah | 67,447 | 372,750 | 149,100 | -260,338 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | KF37 | Atas | 47,878 | 248,333 | 98,533 | -186,536 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | 47,878 | 248,333 | 98,533 | -186,536 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | KF43 | Atas | 72,898 | 372,750 | 149,100 | -251,256 | 186,853 | 319,500 | 185 | P10-185 | AMAN |
| | | Bawah | 72,898 | 372,750 | 149,100 | -251,256 | 186,853 | 319,500 | 185 | P10-185 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | : | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | : | 4,5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | : | 4,5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | : | 5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg kr atas | : | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' kr atas | : | 6,5 m | Lg kr bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | : | 7,2 m | Lg' kr bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | : | 6,5 m | Lg ka bawah | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | : | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KF4 | Atas | | | 6,848 | 2 | 37,143 | Ok | 896,532 | 176,237 | 49,565 | 93439,090 | 37760,922 | 93439,090 | 118232,201 | 1,018 | 1357,818 |
| | | Bawah | | | 2,146 | 2 | 37,143 | Ok | 926,100 | 176,237 | 49,565 | 93164,196 | 37649,831 | 93164,196 | 117884,366 | 1,019 | 1393,299 |
| | KF12 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1367,199 | 483,557 | 13,956 | 141983,017 | 40296,698 | 141983,017 | 21923,063 | 1,204 | 2414,330 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1413,063 | 483,557 | 13,956 | 141381,786 | 40126,061 | 141381,786 | 21830,230 | 1,211 | 2469,367 |
| | KF18 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1316,402 | 452,891 | 1,159 | 141478,246 | 40153,437 | 141478,246 | 21845,124 | 1,194 | 2304,308 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1362,266 | 452,891 | 1,159 | 140865,189 | 39979,444 | 140865,189 | 21750,464 | 1,200 | 2359,345 |
| | KF24 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1717,657 | 433,247 | 0,317 | 136396,690 | 38711,223 | 136396,690 | 21060,500 | 1,252 | 2754,384 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1763,521 | 433,247 | 0,317 | 136013,137 | 38602,366 | 136013,137 | 21001,277 | 1,259 | 2809,420 |
| | KF32 | Atas | 4,014 | 2,05 | | | 38,071 | Ok | 1435,285 | 417,251 | 18,670 | 138589,928 | 39333,694 | 138589,928 | 21399,149 | 1,207 | 2389,944 |
| | | Bawah | 3,813 | 2,05 | | | 38,071 | Ok | 1481,149 | 417,251 | 18,670 | 138085,314 | 39190,478 | 138085,314 | 21321,234 | 1,214 | 2444,980 |
| | KF38 | Atas | | | 6,848 | 2,1 | 39,000 | Ok | 863,771 | 142,555 | 74,664 | 92036,761 | 37194,208 | 92036,761 | 13542,389 | 1,168 | 1264,613 |
| | | Bawah | | | 3,0 1 | 2,1 | 39,000 | Ok | 893,723 | 142,555 | 74,664 | 91785,335 | 37092,601 | 91785,335 | 13505,394 | 1,174 | 1300,556 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Pv | $Mkap_{ka}$ KNm | $Mkap_{ka}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KF4 | Atas | 12485,396 | 218002,426 | 1,097 | 19,909 | 31,672 | 55,910 | 185,091 | 1 | 469,730 | 0,000 | 1199,477 | 1334,580 | 1199,477 | 98,902 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 92,943 | 7,088 | 79,195 | 328,779 | 1 | 816,315 | 816,315 | 1411,419 | 1365,627 | 1365,627 | 5,538 | 1,3 |
| | KF12 | Atas | 12485,396 | 218002,426 | 1,097 | 0,709 | 12,923 | 113,036 | 165,819 | 1 | 469,730 | 469,730 | 2089,432 | 2001,909 | 2001,909 | 112,557 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 31,832 | 5,530 | 125,736 | 242,691 | 1 | 816,315 | 816,315 | 2245,416 | 2050,066 | 2050,066 | 166,443 | 1,3 |
| | KF18 | Atas | 12485,396 | 218002,426 | 1,097 | 67,752 | 8,856 | 111,530 | 326,520 | 1 | 469,730 | 469,730 | 2003,896 | 1862,625 | 1862,625 | 192,263 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 34,964 | 4,354 | 122,757 | 243,817 | 1 | 816,315 | 816,315 | 2159,880 | 1910,783 | 1910,783 | 165,939 | 1,3 |
| | KF24 | Atas | 12485,396 | 218002,426 | 1,097 | 20,660 | 0,612 | 111,453 | 184,808 | 1 | 469,730 | 469,730 | 2404,587 | 2259,781 | 2259,781 | 136,684 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 42,389 | 3,058 | 123,271 | 263,571 | 1 | 816,315 | 816,315 | 2560,571 | 2307,938 | 2307,938 | 169,544 | 1,3 |
| | KF32 | Atas | 12485,396 | 218002,426 | 1,097 | 15,554 | 0,963 | 116,768 | 177,426 | 1 | 469,730 | 469,730 | 2091,301 | 2023,577 | 2023,577 | 136,656 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 11,326 | 0,677 | 126,006 | 176,827 | 1 | 816,315 | 816,315 | 2247,285 | 2071,734 | 2071,734 | 141,286 | 1,3 |
| | KF38 | Atas | 12485,396 | 218002,426 | 1,097 | 43,181 | 17,020 | 57,710 | 220,241 | 1 | 469,730 | 469,730 | 1202,781 | 1370,231 | 1202,781 | 18,306 | 1,3 |
| | | Bawah | 12776,967 | 217292,964 | 1,099 | 30,523 | 15,134 | 117,864 | 253,209 | 1 | 0,000 | 816,315 | 1215,074 | 1401,681 | 1215,074 | 88,991 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KF4 | Atas | 469,730 | 469,730 | 827,780 | 1189,934 | 288,982 | 288,982 | 288,982 | 44,459 | 184,535 | 0,241 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 114,846 | 77,397 | 437,652 | 114,846 | 328,779 | 50,581 | 210,096 | 0,241 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF12 | Atas | 553,475 | 553,475 | 596,635 | 651,647 | 489,065 | 489,065 | 489,065 | 75,241 | 307,986 | 0,244 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 1363,773 | 1109,715 | 567,321 | 567,321 | 567,321 | 87,280 | 315,395 | 0,277 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF18 | Atas | 553,475 | 553,475 | 793,794 | 866,986 | 548,864 | 548,864 | 548,864 | 84,441 | 286,558 | 0,295 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 1059,013 | 861,729 | 556,863 | 556,863 | 556,863 | 85,671 | 293,967 | 0,291 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF24 | Atas | 553,475 | 553,475 | 660,105 | 720,970 | 490,438 | 490,438 | 490,438 | 75,452 | 347,659 | 0,217 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 1265,160 | 1028,205 | 565,458 | 565,458 | 565,458 | 86,993 | 355,067 | 0,245 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF32 | Atas | 469,730 | 469,730 | 698,401 | 698,401 | 507,768 | 507,768 | 507,768 | 78,118 | 311,320 | 0,251 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1131,883 | 845,009 | 541,828 | 541,828 | 541,828 | 83,358 | 318,728 | 0,262 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF38 | Atas | 469,730 | 469,730 | 242,346 | 242,346 | 305,593 | 242,346 | 242,346 | 37,284 | 185,043 | 0,201 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 1008,888 | 974,350 | 542,969 | 542,969 | 542,969 | 83,534 | 186,934 | 0,447 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lanta 1 | KF4 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5565,558 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5589,124 | Aman |
| | KF12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6130,212 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5504,615 | Aman |
| | KF18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5179,575 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5237,138 | Aman |
| | KF24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6691,189 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6116,092 | Aman |
| | KF32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5968,577 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5791,886 | Aman |
| | KF38 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 6446,253 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 2451,382 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lanta 1 | KF4 | Atas | 0,098 | 0,192 | 38,238 | 158,400 | 160,904 | 158,400 |
| | | Bawah | 0,098 | 0,192 | 38,238 | 158,400 | 160,904 | 158,400 |
| | KF12 | Atas | 4,043 | 6,614 | 58,94 | 270,868 | 258,733 | 258,738 |
| | | Bawah | 4,043 | 6,614 | 58,94 | 270,868 | 258,733 | 258,738 |
| | KF18 | Atas | 7,294 | 5,899 | 59,392 | 233,520 | 263,299 | 263,299 |
| | | Bawah | 7,294 | 5,899 | 59,392 | 233,520 | 263,299 | 263,299 |
| | KF24 | Atas | 6,646 | 3,561 | 58,957 | 270,743 | 258,337 | 258,337 |
| | | Bawah | 6,646 | 3,561 | 58,957 | 270,743 | 258,337 | 258,337 |
| | KF32 | Atas | 9,064 | 5,268 | 60,420 | 259,127 | 268,813 | 268,813 |
| | | Bawah | 9,064 | 5,268 | 60,420 | 259,127 | 268,813 | 268,813 |
| | KF38 | Atas | 6,468 | 1,289 | 39,191 | 201,363 | 172,747 | 172,747 |
| | | Bawah | 6,468 | 1,289 | 39,191 | 201,363 | 172,747 | 172,747 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lanta 1 | KF4 | Atas | 158,400 | 0 | 98,533 | 264,001 | 105,523 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 158,400 | 0 | 98,533 | 264,001 | 105,523 | 184,75 | 105 | P10-105 | AMAN |
| | KF12 | Atas | 258,733 | 0 | 149,1 | 431,230 | 55,863 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 258,733 | 0 | 149,1 | 431,230 | 55,863 | 159,75 | 55 | P10-55 | AMAN |
| | KF18 | Atas | 263,299 | 0 | 149,1 | 438,832 | 54,895 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 263,299 | 0 | 149,1 | 438,832 | 54,895 | 159,75 | 50 | P10-50 | AMAN |
| | KF24 | Atas | 258,337 | 0 | 149,1 | 430,561 | 55,950 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 258,337 | 0 | 149,1 | 430,561 | 55,950 | 159,75 | 55 | P10-55 | AMAN |
| | KF32 | Atas | 263,813 | 0 | 149,1 | 448,021 | 53,769 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 263,813 | 0 | 149,1 | 448,021 | 53,769 | 159,75 | 50 | P10-50 | AMAN |
| | KF38 | Atas | 172,747 | 0 | 98,533 | 237,912 | 96,765 | 184,75 | 95 | P10-95 | AMAN |
| | | Bawah | 172,747 | 0 | 98,533 | 237,912 | 96,765 | 184,75 | 95 | P10-95 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lanta 1 | KF4 | Atas | 44,677 | 246,333 | 98,533 | -171,872 | 282,744 | 369,5 | 280 | P10-230 | AMAN |
| | | Bawah | 44,677 | 246,333 | 98,533 | -171,872 | 282,744 | 369,5 | 280 | P10-230 | AMAN |
| | KF12 | Atas | 72,977 | 372,750 | 149,1 | -251,121 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | | Bawah | 72,977 | 372,750 | 149,1 | -251,121 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | KF18 | Atas | 74,264 | 372,750 | 149,1 | -248,977 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | | Bawah | 74,264 | 372,750 | 149,1 | -248,977 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | KF24 | Atas | 72,864 | 372,750 | 149,1 | -251,310 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | | Bawah | 72,864 | 372,750 | 149,1 | -251,310 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | KF32 | Atas | 75,819 | 372,750 | 149,1 | -246,385 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | | Bawah | 75,819 | 372,750 | 149,1 | -246,385 | 186,853 | 319,5 | 185 | P10-135 | AMAN |
| | KF38 | Atas | 48,724 | 246,333 | 98,533 | -165,127 | 282,744 | 369,5 | 280 | P10-230 | AMAN |
| | | Bawah | 48,724 | 246,333 | 98,533 | -165,127 | 282,744 | 369,5 | 280 | P10-230 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg ki bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ki bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KF5 | Atas | | | 6,505 | 2,5 | 46,429 | Ok | 713,092 | 116,333 | 23,909 | 91950,621 | 37159,397 | 91950,621 | 93079,025 | 1,018 | 1041,843 |
| | | Bawah | | | 6,848 | 2,5 | 46,429 | Ok | 743,044 | 116,333 | 23,909 | 91650,815 | 37038,239 | 91650,815 | 92775,540 | 1,018 | 1077,786 |
| | KF13 | Atas | 3,813 | 2 | | | 37,143 | Ok | 970,794 | 331,496 | 6,632 | 141342,989 | 40115,050 | 141342,989 | 22929,091 | 1,128 | 1695,346 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1015,658 | 331,496 | 6,632 | 140540,880 | 39887,400 | 140540,880 | 22798,971 | 1,134 | 1749,183 |
| | KF19 | Atas | 3,813 | 2 | | | 37,143 | Ok | 833,856 | 339,127 | 0,881 | 144665,596 | 41058,050 | 144665,596 | 23468,095 | 1,113 | 1543,230 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 879,720 | 339,127 | 0,881 | 143610,771 | 40758,677 | 143610,771 | 23296,978 | 1,118 | 1598,267 |
| | KF25 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1191,834 | 303,124 | 0,601 | 136519,027 | 38745,944 | 136519,027 | 22146,533 | 1,153 | 1915,199 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1237,698 | 303,124 | 0,601 | 135968,391 | 38589,686 | 135968,391 | 22057,207 | 1,159 | 1970,236 |
| | KF33 | Atas | 3,813 | 2 | | | 37,143 | Ok | 904,995 | 289,777 | 14,136 | 140207,963 | 39792,914 | 140207,963 | 22744,964 | 1,117 | 1549,637 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 950,859 | 289,777 | 14,136 | 139367,099 | 39554,265 | 139367,099 | 22608,556 | 1,123 | 1604,674 |
| | KF39 | Atas | | | 6,505 | 2,5 | 46,429 | Ok | 668,608 | 106,589 | 45,696 | 91781,337 | 37090,986 | 91781,337 | 9528,991 | 1,186 | 972,872 |
| | | Bawah | | | 6,848 | 2,5 | 46,429 | Ok | 698,560 | 106,589 | 45,696 | 91468,260 | 36964,464 | 91468,260 | 9496,487 | 1,195 | 1008,814 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KF5 | Atas | 8718,128 | 193896,699 | 1,074 | 113,006 | 23,258 | 56,710 | 383,034 | 1 | 469,730 | 0,000 | 943,965 | 971,314 | 943,965 | 191,936 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 95,699 | 37,208 | 36,060 | 351,848 | 1 | 469,730 | 0,000 | 975,415 | 1002,764 | 975,415 | 173,166 | 1,3 |
| | KF13 | Atas | 8718,128 | 193896,699 | 1,074 | 7,546 | 1,143 | 112,347 | 148,297 | 1 | 469,730 | 469,730 | 1513,543 | 1395,259 | 1395,259 | 124,624 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 19,789 | 15,777 | 95,731 | 196,934 | 1 | 469,730 | 469,730 | 1560,650 | 1442,366 | 1442,366 | 76,577 | 1,3 |
| | KF19 | Atas | 8718,128 | 193896,699 | 1,074 | 0,768 | 1,828 | 110,692 | 131,247 | 1 | 469,730 | 469,730 | 1377,770 | 1235,332 | 1235,332 | 114,651 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 42,481 | 6,778 | 94,777 | 228,987 | 1 | 469,730 | 469,730 | 1425,928 | 1283,490 | 1283,490 | 146,485 | 1,3 |
| | KF25 | Atas | 8718,128 | 193896,699 | 1,074 | 29,614 | 8,711 | 113,590 | 224,501 | 1 | 469,730 | 469,730 | 1715,844 | 1572,230 | 1572,230 | 153,938 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 4,962 | 3,271 | 95,694 | 129,055 | 1 | 469,730 | 469,730 | 1764,001 | 1620,387 | 1620,387 | 105,786 | 1,3 |
| | KF33 | Atas | 8718,128 | 193896,699 | 1,074 | 2,332 | 1,332 | 106,943 | 129,674 | 1 | 469,730 | 469,730 | 1400,649 | 1313,882 | 1313,882 | 113,538 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 1,433 | 1,149 | 97,097 | 116,233 | 1 | 469,730 | 469,730 | 1448,806 | 1362,039 | 1362,039 | 100,694 | 1,3 |
| | KF39 | Atas | 8718,128 | 193896,699 | 1,074 | 97,644 | 27,713 | 87,554 | 419,275 | 1 | 0,000 | 469,730 | 887,026 | 1005,880 | 887,026 | 0,862 | 1,3 |
| | | Bawah | 9008,960 | 193033,739 | 1,077 | 79,416 | 23,031 | 35,379 | 303,456 | 1 | 0,000 | 469,730 | 918,476 | 1037,330 | 918,476 | 36,599 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KF5 | Atas | 382,584 | 382,584 | 427,565 | 554,014 | 381,259 | 381,259 | 383,034 | 58,928 | 145,225 | 0,406 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 414,596 | 595,982 | 291,004 | 291,004 | 351,848 | 54,130 | 150,064 | 0,361 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF13 | Atas | 636,229 | 636,229 | 951,804 | 1119,731 | 480,981 | 480,981 | 480,981 | 73,997 | 214,655 | 0,345 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 562,870 | 614,770 | 439,415 | 439,415 | 439,415 | 67,602 | 221,902 | 0,305 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF19 | Atas | 636,229 | 636,229 | 674,664 | 793,694 | 467,632 | 467,632 | 467,632 | 71,943 | 190,051 | 0,379 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 829,596 | 906,089 | 449,785 | 449,785 | 449,785 | 69,198 | 197,460 | 0,350 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF25 | Atas | 553,475 | 553,475 | 876,544 | 957,366 | 517,319 | 517,319 | 517,319 | 79,588 | 241,882 | 0,329 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 602,360 | 657,901 | 410,559 | 410,559 | 410,559 | 63,163 | 249,290 | 0,253 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF33 | Atas | 469,730 | 469,730 | 752,813 | 752,813 | 453,008 | 453,008 | 453,008 | 69,694 | 202,136 | 0,345 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 667,651 | 667,651 | 410,519 | 410,519 | 410,519 | 63,157 | 209,544 | 0,301 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF39 | Atas | 382,584 | 382,584 | 18,715 | 24,250 | 499,352 | 24,250 | 419,275 | 64,504 | 136,466 | 0,473 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 854,017 | 1227,650 | 256,161 | 256,161 | 303,456 | 46,686 | 141,304 | 0,330 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KF5 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 2880,037 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 3459,795 | Aman |
| | KF13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4357,318 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5005,603 | Aman |
| | KF19 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3874,512 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4271,604 | Aman |
| | KF25 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4601,336 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5950,493 | Aman |
| | KF33 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 4356,400 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5061,712 | Aman |
| | KF39 | Atas | | | | | | | | | | | | | | 2225,272 | Aman |
| | | Bawah | | | | | | | | | | | | | | 3919,118 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KF5 | Atas | 0,617 | 0,264 | 35,076 | 188,431 | 148,244 | 148,244 |
| | | Bawah | 0,617 | 0,264 | 35,076 | 188,431 | 148,244 | 148,244 |
| | KF13 | Atas | 0,966 | 6,781 | 47,372 | 235,999 | 207,097 | 207,097 |
| | | Bawah | 0,966 | 6,781 | 47,372 | 235,999 | 207,097 | 207,097 |
| | KF19 | Atas | 5,041 | 6,34 | 47,551 | 235,235 | 211,664 | 211,664 |
| | | Bawah | 5,041 | 6,34 | 47,551 | 235,235 | 211,664 | 211,664 |
| | KF25 | Atas | 14,224 | 0,852 | 48,863 | 237,918 | 221,054 | 221,054 |
| | | Bawah | 14,224 | 0,852 | 48,863 | 237,918 | 221,054 | 221,054 |
| | KF33 | Atas | 11,369 | 4,585 | 48,288 | 221,417 | 219,561 | 219,561 |
| | | Bawah | 11,369 | 4,585 | 48,288 | 221,417 | 219,561 | 219,561 |
| | KF39 | Atas | 7,443 | 1,56 | 35,492 | 185,316 | 158,520 | 158,520 |
| | | Bawah | 7,443 | 1,56 | 35,492 | 185,316 | 158,520 | 158,520 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KF5 | Atas | 148,244 | 0 | 98,533 | 247,074 | 112,759 | 184,75 | 110 | P10-110 | AMAN |
| | | Bawah | 148,244 | 0 | 98,533 | 247,074 | 112,759 | 184,75 | 110 | P10-110 | AMAN |
| | KF13 | Atas | 207,097 | 0 | 149,100 | 345,161 | 69,793 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 207,097 | 0 | 149,100 | 345,161 | 69,793 | 159,75 | 65 | P10-65 | AMAN |
| | KF19 | Atas | 211,664 | 0 | 149,100 | 352,774 | 68,287 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 211,664 | 0 | 149,100 | 352,774 | 68,287 | 159,75 | 65 | P10-65 | AMAN |
| | KF25 | Atas | 221,054 | 0 | 149,100 | 368,424 | 65,386 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 221,054 | 0 | 149,100 | 368,424 | 65,386 | 159,75 | 65 | P10-65 | AMAN |
| | KF33 | Atas | 219,561 | 0 | 149,100 | 365,936 | 65,831 | 159,75 | 65 | P1065 | AMAN |
| | | Bawah | 219,561 | 0 | 149,100 | 365,936 | 65,831 | 159,75 | 65 | P10-65 | AMAN |
| | KF39 | Atas | 158,520 | 0 | 98,533 | 264,199 | 105,450 | 184,75 | 105 | P10-105 | AMAN |
| | | Bawah | 158,520 | 0 | 98,533 | 264,199 | 105,450 | 184,75 | 105 | P10-105 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KF5 | Atas | 41,812 | 246,333 | 98,533 | -176,646 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 41,812 | 246,333 | 98,533 | -176,646 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KF13 | Atas | 58,412 | 372,750 | 149,100 | -275,397 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 58,412 | 372,750 | 149,100 | -275,397 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF19 | Atas | 59,700 | 372,750 | 149,100 | -273,250 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 59,700 | 372,750 | 149,100 | -273,250 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF25 | Atas | 62,349 | 372,750 | 149,100 | -268,836 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 62,349 | 372,750 | 149,100 | -268,836 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF33 | Atas | 61,928 | 372,750 | 149,100 | -269,537 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 61,928 | 372,750 | 149,100 | -269,537 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF39 | Atas | 44,711 | 246,333 | 98,533 | -171,816 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 44,711 | 246,333 | 98,533 | -171,816 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | : | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | : | 5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | : | 5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | : | 4,5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | : | 7,2 m | pb | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | : | 6,5 m | Lg ki bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | : | 7,2 m | Lg' ki bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | : | 6,5 m | | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | : | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KF6 | Atas | | | 1,217 | 1,6 | 33,524 | Ok | 487,681 | 80,467 | 2,965 | 92035,008 | 37193,500 | 92035,008 | 129027,466 | 1,009 | 713,964 |
| | | Bawah | | | 6,505 | 1,6 | 33,524 | Ok | 521,473 | 80,467 | 2,965 | 91547,432 | 36996,459 | 91547,432 | 128343,916 | 1,009 | 754,515 |
| | KF14 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 348,461 | 206,492 | 3,734 | 152997,987 | 43422,895 | 152997,987 | 20512,232 | 1,059 | 748,540 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 400,205 | 206,492 | 3,734 | 149749,738 | 42500,999 | 149749,738 | 20076,744 | 1,066 | 810,633 |
| | KF20 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 373,713 | 210,893 | 1,163 | 151827,748 | 43090,766 | 151827,748 | 20355,340 | 1,063 | 785,884 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 425,457 | 210,893 | 1,163 | 148848,216 | 42245,135 | 148848,216 | 19955,878 | 1,070 | 847,977 |
| | KF26 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 749,332 | 170,332 | 0,159 | 134924,149 | 38293,296 | 134924,149 | 18089,097 | 1,111 | 1171,730 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 801,076 | 170,332 | 0,159 | 134036,456 | 38041,357 | 134036,456 | 17970,085 | 1,118 | 1233,822 |
| | KF34 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 367,843 | 126,292 | 14,788 | 141441,112 | 40142,898 | 141441,112 | 18962,817 | 1,055 | 643,479 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 419,587 | 126,292 | 14,788 | 139160,115 | 39495,520 | 139160,115 | 18657,007 | 1,062 | 705,572 |
| | KF40 | Atas | | | 1,217 | 1,6 | 33,524 | Ok | 448,110 | 59,456 | 379,698 | 90541,765 | 36590,046 | 90541,765 | 18030,402 | 1,057 | 632,862 |
| | | Bawah | | | 6,505 | 1,6 | 33,524 | Ok | 481,902 | 59,456 | 673,053 | 90100,852 | 36411,862 | 90100,852 | 17942,599 | 1,061 | 673,412 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KF6 | Atas | 4696,459 | 224977,355 | 1,033 | 84,511 | 34,789 | 56,790 | 334,358 | 1 | 469,730 | 469,730 | 728,080 | 609,008 | 609,008 | 8,292 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 30,230 | 21,057 | 26,737 | 146,313 | 1 | 469,730 | 0,000 | 697,799 | 644,490 | 644,490 | 72,486 | 1,3 |
| | KF14 | Atas | 4696,459 | 224977,355 | 1,033 | 30,090 | 8,279 | 130,200 | 231,568 | 1 | 469,730 | 469,730 | 714,225 | 598,383 | 598,383 | 170,935 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 25,773 | 9,465 | 79,868 | 170,209 | 1 | 469,730 | 469,730 | 768,556 | 652,715 | 652,715 | 115,192 | 1,3 |
| | KF20 | Atas | 4696,459 | 224977,355 | 1,033 | 22,322 | 2,445 | 126,650 | 195,839 | 1 | 469,730 | 469,730 | 745,361 | 618,721 | 618,721 | 155,528 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 8,656 | 0,947 | 77,207 | 106,748 | 1 | 469,730 | 469,730 | 799,692 | 673,052 | 673,052 | 69,780 | 1,3 |
| | KF26 | Atas | 4696,459 | 224977,355 | 1,033 | 29,927 | 18,189 | 115,716 | 242,050 | 1 | 469,730 | 469,730 | 1097,172 | 966,315 | 966,315 | 140,699 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 36,359 | 2,258 | 74,806 | 175,214 | 1 | 469,730 | 469,730 | 1151,503 | 1020,646 | 1020,646 | 113,542 | 1,3 |
| | KF34 | Atas | 4696,459 | 224977,355 | 1,033 | 7,604 | 2,144 | 145,695 | 180,947 | 1 | 469,730 | 469,730 | 650,366 | 580,951 | 580,951 | 141,067 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 3,135 | 0,363 | 81,087 | 96,458 | 1 | 469,730 | 469,730 | 704,697 | 635,283 | 635,283 | 79,900 | 1,3 |
| | KF40 | Atas | 4696,459 | 224977,355 | 1,033 | 70,333 | 17,649 | 84,792 | 298,841 | 1 | 469,730 | 469,730 | 664,469 | 2127,676 | 664,469 | 150,182 | 1,3 |
| | | Bawah | 5025,931 | 222946,229 | 1,036 | 30,766 | 24,986 | 4,708 | 136,502 | 1 | 0,000 | 469,730 | 634,188 | 3395,249 | 634,188 | 23,469 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KF6 | Atas | 469,730 | 469,730 | 143,604 | 143,604 | 363,783 | 143,604 | 334,358 | 51,440 | 93,694 | 0,549 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 718,771 | 931,341 | 166,147 | 166,147 | 166,147 | 25,561 | 99,152 | 0,258 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | KF14 | Atas | 553,475 | 553,475 | 870,125 | 950,355 | 587,127 | 587,127 | 587,127 | 90,327 | 92,059 | 0,981 | 1,3 | 6370 | 3185 | 9 | 3421,202 |
| | | Bawah | 636,229 | 636,229 | 609,269 | 716,762 | 372,446 | 372,446 | 372,446 | 57,299 | 100,418 | 0,571 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KF20 | Atas | 553,475 | 553,475 | 1005,406 | 1098,110 | 557,935 | 557,935 | 557,935 | 85,836 | 95,188 | 0,902 | 1,2 | 5880 | 2940 | 7 | 2660,935 |
| | | Bawah | 636,229 | 636,229 | 468,705 | 551,399 | 334,353 | 334,353 | 334,353 | 51,439 | 103,546 | 0,497 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KF26 | Atas | 553,475 | 553,475 | 806,037 | 880,358 | 536,529 | 536,529 | 536,529 | 82,543 | 148,664 | 0,555 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 650,460 | 710,436 | 354,733 | 354,733 | 354,733 | 54,574 | 157,022 | 0,348 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KF34 | Atas | 553,475 | 553,475 | 929,839 | 1015,575 | 622,154 | 622,154 | 622,154 | 95,716 | 89,377 | 1,071 | 1,3 | 6370 | 3185 | 9 | 3421,202 |
| | | Bawah | 469,730 | 469,730 | 505,847 | 505,847 | 344,238 | 344,238 | 344,238 | 52,960 | 97,736 | 0,542 | 1,0 | 4900 | 2450 | 7 | 2660,935 |
| | KF40 | Atas | 382,584 | 382,584 | 1158,075 | 1037,212 | 448,508 | 448,508 | 448,508 | 69,001 | 102,226 | 0,675 | 1,0 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 108,255 | 140,270 | 78,313 | 78,313 | 136,502 | 21,000 | 97,567 | 0,215 | 1,0 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 3 | KF6 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 1712,616 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 5238,617 | Aman |
| | KF14 | Atas | 9D22 | 50,250 | 383,4 | 504,538 | 400 | 4847,614 | 1295,780 | 1368,481 | 477,491 | 167,674 | 0,351 | Patah tarik | | 1179,121 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2110,195 | Aman |
| | KF20 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1048,080 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2619,792 | Aman |
| | KF26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2202,856 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4314,625 | Aman |
| | KF34 | Atas | 9D22 | 50,250 | 383,4 | 504,538 | 400 | 4847,614 | 1295,780 | 1368,481 | 477,491 | 167,674 | 0,351 | Patah tarik | | 1046,151 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2288,733 | Aman |
| | KF40 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 1202,581 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 6138,767 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KF6 | Atas | 0,288 | 0,208 | 24,506 | 113,751 | 103,446 | 103,446 |
| | | Bawah | 0,288 | 0,208 | 24,506 | 113,751 | 103,446 | 103,446 |
| | KF14 | Atas | 4,358 | 0,482 | 40,952 | 218,085 | 177,080 | 177,080 |
| | | Bawah | 4,358 | 0,482 | 40,952 | 218,085 | 177,080 | 177,080 |
| | KF20 | Atas | 6,48 | 0,697 | 40,109 | 202,793 | 175,994 | 175,994 |
| | | Bawah | 6,48 | 0,697 | 40,109 | 202,793 | 175,994 | 175,994 |
| | KF26 | Atas | 4,321 | 1,336 | 32,877 | 202,560 | 144,023 | 144,023 |
| | | Bawah | 4,321 | 1,336 | 32,877 | 202,560 | 144,023 | 144,023 |
| | KF34 | Atas | 3,524 | 4,838 | 40,511 | 219,635 | 178,926 | 178,926 |
| | | Bawah | 3,524 | 4,838 | 40,511 | 219,635 | 178,926 | 178,926 |
| | KF40 | Atas | 6,212 | 1,377 | 24,003 | 132,957 | 108,781 | 108,781 |
| | | Bawah | 6,212 | 1,377 | 24,003 | 132,957 | 108,781 | 108,781 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KF6 | Atas | 103,446 | 0 | 98,533 | 172,410 | 161,590 | 184,75 | 160 | P10-160 | AMAN |
| | | Bawah | 103,446 | 0 | 98,533 | 172,410 | 161,590 | 184,75 | 160 | P10-160 | AMAN |
| | KF14 | Atas | 177,080 | 0 | 149,100 | 295,134 | 81,623 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 177,080 | 0 | 149,100 | 295,134 | 81,623 | 159,75 | 80 | P10-80 | AMAN |
| | KF20 | Atas | 175,994 | 0 | 149,100 | 293,323 | 82,127 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 175,994 | 0 | 149,100 | 293,323 | 82,127 | 159,75 | 80 | P10-80 | AMAN |
| | KF26 | Atas | 144,023 | 0 | 149,100 | 240,039 | 100,358 | 159,75 | 100 | P10100 | AMAN |
| | | Bawah | 144,023 | 0 | 149,100 | 240,039 | 100,358 | 159,75 | 100 | P10-100 | AMAN |
| | KF34 | Atas | 178,926 | 0 | 149,100 | 298,211 | 80,781 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 178,926 | 0 | 149,100 | 298,211 | 80,781 | 159,75 | 80 | P10-80 | AMAN |
| | KF40 | Atas | 108,781 | 0 | 98,533 | 181,302 | 153,665 | 184,75 | 150 | P10-150 | AMAN |
| | | Bawah | 108,781 | 0 | 98,533 | 181,302 | 153,665 | 184,75 | 150 | P10-150 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Larntai 3 | KF6 | Atas | 37,617 | 246,333 | 98,533 | -183,639 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 37,617 | 246,333 | 98,533 | -183,639 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KF14 | Atas | 64,393 | 372,750 | 149,100 | -265,429 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 64,393 | 372,750 | 149,100 | -265,429 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF20 | Atas | 63,998 | 372,750 | 149,100 | -266,087 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 63,998 | 372,750 | 149,100 | -266,087 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF26 | Atas | 52,372 | 372,750 | 149,100 | -285,463 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 52,372 | 372,750 | 149,100 | -285,463 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF34 | Atas | 65,064 | 372,750 | 149,100 | -264,310 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 65,064 | 372,750 | 149,100 | -264,310 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF40 | Atas | 39,557 | 246,333 | 98,533 | -180,405 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 39,557 | 246,333 | 98,533 | -180,405 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic1 | = | 0,0200 m^4 | b1 kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 2,5 m | Ic2 | = | 0,017 m^4 | h1 kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig atas | = | 0,0072 m^4 | b2 kolom | = | 400 mm |
| **Ø pokok** | = | 22 mm | tk bawah | = | 5 m | Ig bawah | = | 0,0072 m^4 | h2 kolom | = | 800 mm |
| **Ø sengkang** | = | 10 mm | Lg ka atas | = | 7,2 m | **pb** | = | 40 mm | b blk atas | = | 400 mm |
| Ø | = | 0,65 | Lg' ka atas | = | 6,5 m | Lg ka bawah | = | 7,2 m | h blk atas | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg' ka bawah | = | 6,5 m | b blk bawah | = | 400 mm |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | | = | 7,2 m | h blk bawah | = | 600 mm |
| β | = | 0,85 | d' | = | 61 mm | Lg' ka bawah | = | 6,5 m | d2 | = | 739 mm |
| | | | | | | d1 | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KF7 | Atas | | | 2,276 | 1,48 | 31,010 | Ok | 172,311 | 1,900 | 9,265 | 84347,861 | 34086,944 | 84347,861 | 127838,439 | 1,003 | 209,813 |
| | | Bawah | | | 1,217 | 1,48 | 31,010 | Ok | 206,103 | 1,900 | 9,265 | 84248,286 | 34046,703 | 84248,286 | 127687,521 | 1,003 | 250,364 |
| | KF27 | Atas | 282117,500 | 2,6 | | | 54,476 | Ok | 242,030 | 0,291 | 0,638 | 119328,720 | 33867,103 | 119328,720 | 8999,010 | 1,052 | 290,902 |
| | | Bawah | 3,613 | 2,6 | | | 54,476 | Ok | 293,774 | 0,291 | 0,638 | 119311,911 | 33862,332 | 119311,911 | 8997,742 | 1,054 | 352,994 |
| | KF41 | Atas | | | 2,276 | 1,48 | 31,010 | Ok | 139,960 | 2,829 | 3,741 | 84350,174 | 34289,940 | 84850,174 | 19748,119 | 1,014 | 172,478 |
| | | Bawah | | | 1,217 | 1,48 | 31,010 | Ok | 173,752 | 2,829 | 3,741 | 84635,965 | 34203,374 | 84635,965 | 19698,264 | 1,017 | 213,029 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KF7 | Atas | 673,193 | 156585,568 | 1,007 | 94,624 | 8,180 | 2,482 | 234,735 | 1 | 0,000 | 292,038 | 223,807 | 221,835 | 221,835 | 82,732 | 1,3 |
| | | Bawah | 816,387 | 156383,527 | 1,008 | 56,743 | 10,981 | 4,744 | 157,978 | 1 | 469,730 | 469,730 | 349,928 | 257,316 | 257,316 | 85,660 | 1,3 |
| | KF27 | Atas | 673,193 | 156585,568 | 1,007 | 4,262 | 0,988 | 1,881 | 14,165 | 1 | 0,000 | 0,000 | 254,437 | 257,117 | 254,437 | 6,892 | 1,3 |
| | | Bawah | 816,387 | 156383,527 | 1,008 | 11,563 | 2,620 | 13,288 | 47,197 | 1 | 469,730 | 469,730 | 440,293 | 311,448 | 311,448 | 3,216 | 1,3 |
| | KF41 | Atas | 673,193 | 156585,568 | 1,007 | 84,112 | 6,858 | 16,665 | 224,301 | 1 | 292,038 | 0,000 | 190,814 | 165,641 | 165,641 | 111,404 | 1,3 |
| | | Bawah | 816,387 | 156383,527 | 1,008 | 23,922 | 5,634 | 195,873 | 274,590 | 1 | 469,730 | 469,730 | 316,934 | 201,122 | 201,122 | 177,582 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KF7 | Atas | 292,038 | 292,038 | 262,960 | 378,005 | 118,369 | 118,369 | 234,735 | 36,121 | 34,128 | 1,058 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 711,633 | 711,633 | 91,035 | 91,035 | 157,978 | 24,304 | 39,587 | 0,614 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF27 | Atas | 292,038 | 292,038 | 136,851 | 456,171 | 13,413 | 13,413 | 14,165 | 2,179 | 39,144 | 0,056 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 463,405 | 506,133 | 70,702 | 70,702 | 70,702 | 10,877 | 47,915 | 0,227 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF41 | Atas | 198,092 | 198,092 | 181,439 | 213,631 | 165,512 | 165,512 | 224,301 | 34,508 | 25,483 | 1,354 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 822,846 | 736,969 | 853,700 | 822,846 | 822,846 | 126,592 | 30,942 | 4,091 | 2 | 6400 | 3200 | 9 | 3421,202 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KF7 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 603,079 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 1411,233 | Aman |
| | KF27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10499,415 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6482,373 | Aman |
| | KF41 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 431,392 | Aman |
| | | Bawah | 9D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 1295,780 | 1368,481 | 313,086 | 128,752 | 0,411 | Patah tarik | | 211,021 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KF7 | Atas | 0,25 | 0,048 | 14,064 | 89,264 | 59,382 | 59,382 |
| | | Bawah | 0,25 | 0,048 | 14,064 | 89,264 | 59,382 | 59,382 |
| | KF27 | Atas | 0,141 | 0,206 | 25,433 | 19,288 | 107,183 | 19,288 |
| | | Bawah | 0,141 | 0,206 | 25,433 | 19,288 | 107,183 | 19,288 |
| | KF41 | Atas | 1,27 | 0,157 | 12,132 | 237,988 | 52,453 | 52,453 |
| | | Bawah | 1,27 | 0,157 | 12,132 | 237,988 | 52,453 | 52,453 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KF7 | Atas | 59,382 | 0 | 98,533 | 98,970 | 281,498 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 59,382 | 0 | 98,533 | 98,970 | 281,498 | 184,75 | 180 | P10-180 | AMAN |
| | KF27 | Atas | 19,288 | 0 | 149,100 | 32,147 | 749,373 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 19,288 | 0 | 149,100 | 32,147 | 749,373 | 159,75 | 155 | P10-155 | AMAN |
| | KF41 | Atas | 52,453 | 0 | 98,533 | 87,421 | 318,683 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 52,453 | 0 | 98,533 | 87,421 | 318,683 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KF7 | Atas | 21,593 | 246,333 | 98,533 | -210,344 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 21,593 | 246,333 | 98,533 | -210,344 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KF27 | Atas | 7,014 | 372,750 | 149,100 | -361,060 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | 7,014 | 372,750 | 149,100 | -361,060 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF41 | Atas | 19,074 | 246,333 | 98,533 | -214,544 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 19,074 | 246,333 | 98,533 | -214,544 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-F

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic1 | : 0,0200 m^4 | b1 kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 0 m | Ic2 | : 0,017 m^4 | h1 kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 2,5 m | Ig atas | : 0,0072 m^4 | b2 kolom | = 400 mm |
| **Ø pokok** | = 22 mm | tk bawah | = 5 m | Ig bawah | : 0,0072 m^4 | h2 kolom | = 800 mm |
| **Ø sengkang** | = 10 mm | Lg ki atas | = 7,2 m | **pb** | : 40 mm | b blk atas | = 400 mm |
| **Ø** | = 0,65 | Lg' ki atas | = 6,5 m | Lg ki bawah | : 7,2 m | h blk atas | = 600 mm |
| **Øo** | = 1,25 | Lg ka atas | = 7,2 m | Lg' ki bawah | : 6,5 m | b blk bawah | = 400 mm |
| r | = 210 mm | Lg' ka atas | = 6,5 m | | : 7,2 m | h blk bawah | = 600 mm |
| **β** | = 0,85 | d' | = 61 mm | Lg' ka bawah | : 6,5 m | d2 | = 739 mm |
| | | | | d1 | : 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KF8 | Atas | | | 160426,667 | 1,48 | 13,390 | Tidak | 61,079 | 1,079 | 1,669 | 120621,101 | 34233,898 | 120621,101 | 423359,928 | | 75,021 |
| | | Bawah | | | 2,276 | 1,48 | 13,390 | Tidak | 76,439 | 1,079 | 1,669 | 120344,815 | 34155,484 | 120344,815 | 422390,210 | | 93,453 |
| | KF28 | Atas | 188078,333 | 10 | | | 90,476 | Ok | 165,964 | 0,056 | 0,104 | 119260,040 | 33847,611 | 119260,040 | 3260,540 | 1,104 | 199,246 |
| | | Bawah | 282117,500 | 10 | | | 90,476 | Ok | 189,484 | 0,056 | 0,104 | 119256,712 | 33846,666 | 119256,712 | 3260,449 | 1,120 | 227,470 |
| | KF42 | Atas | | | 160426,667 | 1,48 | 13,390 | Tidak | 29,670 | 1,053 | 0,218 | 121989,109 | 34622,157 | 121989,109 | 152262,237 | | 37,289 |
| | | Bawah | | | 2,276 | 1,48 | 13,390 | Tidak | 45,030 | 1,053 | 0,218 | 121063,491 | 34359,454 | 121063,491 | 151106,914 | | 55,721 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ka}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KF8 | Atas | 311,556 | 578882,705 | | 2,005 | 0,103 | 0,205 | | 1 | 0,000 | 0,000 | 65,266 | 72,276 | 65,266 | 2,560 | 1,3 |
| | | Bawah | 376,644 | 576757,573 | | 9,484 | 0,334 | 0,124 | | 1 | 0,000 | 292,038 | 163,165 | 88,404 | 88,404 | 8,402 | 1,3 |
| | KF28 | Atas | 311,556 | 578882,705 | 1,001 | 0,569 | 0,121 | 0,034 | 1,677 | 1 | 0,000 | 0,000 | 174,321 | 174,758 | 174,321 | 0,845 | 1,3 |
| | | Bawah | 376,644 | 576757,573 | 1,001 | 1,683 | 0,369 | 1,072 | 6,052 | 1 | 0,000 | 0,000 | 199,017 | 199,454 | 199,017 | 0,396 | 1,3 |
| | KF42 | Atas | 311,556 | 578882,705 | | 2,848 | 0,179 | 0,399 | | 1 | 0,000 | 0,000 | 32,259 | 33,175 | 32,259 | 2,173 | 1,3 |
| | | Bawah | 376,644 | 576757,573 | | 11,834 | 0,614 | 27,619 | | 1 | 292,038 | 0,000 | 130,158 | 49,303 | 49,303 | 41,847 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e' m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KF8 | Atas | 119,799 | 119,799 | 22,264 | 74,213 | 3,074 | 3,074 | 3,074 | 0,473 | 10,041 | 0,047 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 292,038 | 292,038 | 475,006 | 682,821 | 10,830 | 10,830 | 10,830 | 1,666 | 13,601 | 0,123 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KF28 | Atas | 172,898 | 172,898 | 93,686 | 312,286 | 0,867 | 0,867 | 1,677 | 0,258 | 26,819 | 0,010 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 74,159 | 247,195 | 6,657 | 6,657 | 6,657 | 1,024 | 30,618 | 0,033 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KF42 | Atas | 119,799 | 119,799 | 4,706 | 15,687 | 4,854 | 4,854 | 4,854 | 0,747 | 4,953 | 0,150 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 518,072 | 609,990 | 129,070 | 129,070 | 129,070 | 19,857 | 7,585 | 2,618 | 1 | 3200 | 1600 | 5 | 1900,668 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai Atap | KF8 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 10282,504 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 8336,270 | Aman |
| | KF28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11691,672 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11070,624 | Aman |
| | KF42 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 7645,768 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 94,531 | 0,299 | Patah tarik | | 193,209 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KF8 | Atas | 2,431 | 0,234 | 12,894 | 7,318 | 56,953 | 7,318 |
| | | Bawah | 2,431 | 0,234 | 12,894 | 7,318 | 56,953 | 7,318 |
| | KF28 | Atas | 9,412 | 0,653 | 11,285 | 4,386 | 57,965 | 4,386 |
| | | Bawah | 9,412 | 0,653 | 11,285 | 4,386 | 57,965 | 4,386 |
| | KF42 | Atas | 3,359 | 0,26 | 6,837 | 70,487 | 32,515 | 32,515 |
| | | Bawah | 3,359 | 0,26 | 6,837 | 70,487 | 32,515 | 32,515 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KF8 | Atas | 7,318 | 0 | 98,533 | 12,197 | 2284,223 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 7,318 | 0 | 98,533 | 12,197 | 2284,223 | 184,75 | 180 | P10-180 | AMAN |
| | KF28 | Atas | 4,386 | 0 | 149,100 | 7,311 | 3295,097 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 4,386 | 0 | 149,100 | 7,311 | 3295,097 | 159,75 | 155 | P10-155 | AMAN |
| | KF42 | Atas | 32,515 | 0 | 98,533 | 54,192 | 514,090 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 32,515 | 0 | 98,533 | 54,192 | 514,090 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kr | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KF8 | Atas | -3,466 | 246,333 | 98,533 | -252,111 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -3,466 | 246,333 | 98,533 | -252,111 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KF28 | Atas | -2,078 | 372,750 | 149,100 | -376,213 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | | Bawah | -2,078 | 372,750 | 149,100 | -376,213 | 186,853 | 319,5 | 185 | P10-185 | AMAN |
| | KF42 | Atas | -15,402 | 246,333 | 98,533 | -272,003 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -15,402 | 246,333 | 98,533 | -272,003 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 3,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 1,2 m | Ig bawah | = | 0 m^4 | b blk atas | = | 400 mm |
| **Ø pokok** | = | 22 mm | tk bawah | = | 0 m | **pb** | = | 40 mm | h blk atas | = | 600 mm |
| **Ø sengkang** | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 0 m | b blk bawah | = | 0 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 0 m | h blk bawah | = | 0 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 0 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 0 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1369,732 | 267,126 | 22,343 | 93471,771 | 37774,130 | 93471,771 | 51251,873 | 1,036 | 2051,880 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1365,252 | 187,126 | 22,343 | 71858,247 | 0,000 | 71858,247 | 39400,877 | 1,030 | 1905,704 |
| | KG10 | Atas | | | 448812,698 | 20 | 50,000 | Ok | 1317,457 | 198,513 | 120,990 | 91380,546 | 36929,017 | 91380,548 | 50105,225 | 1,062 | 1899,569 |
| | | Bawah | | | 334222,222 | 20 | 50,000 | Ok | 1326,977 | 198,513 | 120,990 | 72867,956 | 0,000 | 72867,956 | 39954,514 | 1,079 | 1912,393 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | 3950,449 | 101357,099 | 1,084 | 6,833 | 0,489 | 72,154 | 88,331 | 0,925 | 0,000 | 0,000 | 1701,801 | 1795,742 | 1701,901 | 92,791 | 1 |
| | | Bawah | 3818,097 | 79355,391 | 1,080 | 4,481 | 8,454 | 92,639 | 115,880 | 0,925 | 0,000 | 0,000 | 1608,997 | 1702,838 | 1608,997 | 106,843 | 1 |
| | KG10 | Atas | 3950,449 | 101357,099 | 1,084 | 5,431 | 1,876 | 73,842 | 88,803 | 0,925 | 0,000 | 0,000 | 1591,769 | 2099,927 | 1591,769 | 85,073 | 1 |
| | | Bawah | 3818,097 | 79355,391 | 1,080 | 42,437 | 12,549 | 97,405 | 167,110 | 0,925 | 0,000 | 0,000 | 1603,865 | 2112,023 | 1603,865 | 60,430 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | 198,092 | 198,092 | 76,820 | 256,398 | 310,525 | 256,398 | 256,398 | 39,446 | 261,831 | 0,151 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 402,866 | 0,000 | 115,880 | 17,828 | 247,538 | 0,072 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG10 | Atas | 198,092 | 198,092 | 103,012 | 343,375 | 317,809 | 317,809 | 317,809 | 48,894 | 244,887 | 0,200 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 466,836 | 0,000 | 167,110 | 25,709 | 246,748 | 0,104 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5760,162 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6854,138 | Aman |
| | KG10 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5117,966 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6398,296 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | 0,287 | 0,159 | 27,35 | 413,642 | 115,338 | 115,338 |
| | | Bawah | 0,287 | 0,159 | 27,35 | 413,642 | 115,338 | 115,338 |
| | KG10 | Atas | 7,541 | 0,397 | 38,023 | 538,798 | 168,032 | 168,032 |
| | | Bawah | 7,541 | 0,397 | 38,023 | 538,798 | 168,032 | 168,032 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KG2 | Atas | 115,338 | 0 | 98,533 | 192,231 | 144,929 | 184,75 | 140 | P10-140 | AMAN |
| | | Bawah | 115,338 | 0 | 98,533 | 192,231 | 144,929 | 184,75 | 140 | P10-140 | AMAN |
| | KG10 | Atas | 168,032 | 0 | 98,533 | 280,053 | 99,480 | 184,75 | 95 | P10-95 | AMAN |
| | | Bawah | 168,032 | 0 | 98,533 | 280,053 | 99,480 | 184,75 | 95 | P10-95 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 3,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 1,2 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 739 mm | | |

**1. Perhitungan Momen Rencana (Mc)**

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | | | 40,527 | 7 | 84,583 | Ok | 1271,511 | 266,416 | 18,116 | 93999,947 | 37987,578 | 93999,947 | 45701,804 | 1,070 | 1952,079 |
| | | Bawah | | | 448812,698 | 7 | 84,583 | Ok | 1293,783 | 266,416 | 18,116 | 93844,597 | 37924,797 | 93844,597 | 45626,275 | 1,071 | 1978,805 |
| | KG11 | Atas | | | 40,527 | 7 | 84,583 | Ok | 1233,634 | 198,254 | 113,216 | 91840,044 | 37114,710 | 91840,044 | 44651,682 | 1,066 | 1797,567 |
| | | Bawah | | | 448812,698 | 7 | 84,583 | Ok | 1255,906 | 198,254 | 113,216 | 91710,025 | 37062,167 | 91710,025 | 44599,468 | 1,067 | 1824,294 |

**2. Perhitungan Momen Lentur dan Aksial Kolom**

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | 3749,646 | 90353,486 | 1,068 | 31,180 | 18,680 | 25,925 | 148,658 | 0,95 | 367,049 | 0,000 | 1684,563 | 1690,911 | 1684,563 | 72,324 | 1,3 |
| | | Bawah | 3803,099 | 90214,743 | 1,069 | 9,434 | 2,700 | 65,232 | 102,415 | 0,95 | 0,000 | 0,000 | 1638,209 | 1714,296 | 1638,209 | 56,460 | 1,3 |
| | KG11 | Atas | 3749,646 | 90353,486 | 1,068 | 61,485 | 20,706 | 19,454 | 218,687 | 0,95 | 0,000 | 367,049 | 1573,222 | 1978,990 | 1573,222 | 34,984 | 1,3 |
| | | Bawah | 3803,099 | 90214,743 | 1,069 | 3,266 | 1,783 | 65,898 | 86,087 | 0,95 | 0,000 | 0,000 | 1526,868 | 2002,375 | 1526,868 | 72,850 | 1,3 |

**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | 382,584 | 382,584 | 389,557 | 571,527 | 161,238 | 161,238 | 161,238 | 24,806 | 259,163 | 0,096 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 30,303 | 101,011 | 286,715 | 101,011 | 102,415 | 15,756 | 252,032 | 0,063 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG11 | Atas | 382,584 | 382,584 | 181,776 | 195,879 | 168,007 | 168,007 | 218,687 | 33,644 | 242,034 | 0,139 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 46,687 | 155,624 | 282,073 | 155,624 | 155,624 | 23,942 | 234,903 | 0,102 | 1 | 3200 | 1600 | 5 | 1900,668 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6517,379 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6990,721 | Aman |
| | KG11 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5917,691 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 8430,088 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | 1,377 | 0,277 | 26,75 | 90,915 | 114,087 | 90,915 |
| | | Bawah | 1,377 | 0,277 | 26,75 | 90,915 | 114,087 | 90,915 |
| | KG11 | Atas | 1,109 | 0,418 | 37,15 | 129,073 | 157,633 | 129,073 |
| | | Bawah | 1,109 | 0,418 | 37,15 | 129,073 | 157,633 | 129,073 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | 90,915 | 0 | 98,533 | 151,524 | 183,863 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 90,915 | 0 | 98,533 | 151,524 | 183,863 | 184,75 | 180 | P10-180 | AMAN |
| | KG11 | Atas | 129,073 | 0 | 98,533 | 215,121 | 129,507 | 184,75 | 125 | P10-125 | AMAN |
| | | Bawah | 129,073 | 0 | 98,533 | 215,121 | 129,507 | 184,75 | 125 | P10-125 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KG3 | Atas | -9,405 | 246,333 | 98,533 | -262,008 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -9,405 | 246,333 | 98,533 | -262,008 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KG11 | Atas | -13,352 | 246,333 | 98,533 | -268,587 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | -13,352 | 246,333 | 98,533 | -268,587 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0171 m^4 | b1 kolom | = 400 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h1 kolom | = 800 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 3,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,8 m | Lg' ki bawah | = 6,8 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | b2 kolom | = 700 mm |
| r | = 240 mm | Lg' ka atas | = 6,8 m | Lg' ka bawah | = 6,8 m | h2 kolom | = 700 mm |
| β | = 0,85 | d' | = 61 mm | d1 | = 739 mm | d2 | = 639 mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | ôb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KG1 | Atas | | | 0,503 | 2,1 | 38,500 | Ok | 487,862 | 74,119 | 99,508 | 130198,997 | 36952,234 | 130198,997 | 139071,278 | 1,008 | 704,025 |
| | | Bawah | | | 80213,333 | 2,1 | 38,500 | Ok | 546,662 | 74,119 | 99,508 | 129117,275 | 36645,227 | 129117,275 | 137915,842 | 1,009 | 774,585 |
| | KG4 | Atas | 9,870 | 3,8 | | | 69,667 | Ok | 1108,960 | 223,109 | 13,627 | 133334,107 | 37842,021 | 133334,107 | 4707,285 | 2,230 | 1687,726 |
| | | Bawah | 40,527 | 3,8 | | | 69,667 | Ok | 1142,368 | 223,109 | 13,627 | 132969,241 | 37738,467 | 132969,241 | 4694,404 | 2,305 | 1727,816 |
| | KG12 | Atas | | | 4,612 | 3 | 55,000 | Ok | 1020,434 | 153,354 | 88,445 | 130091,205 | 36921,641 | 130091,205 | 97269,298 | 1,024 | 1469,887 |
| | | Bawah | | | 40,527 | 3 | 55,000 | Ok | 1054,226 | 153,354 | 88,445 | 129773,933 | 36831,595 | 129773,933 | 97032,073 | 1,025 | 1510,438 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | ôs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KG1 | Atas | 3861,638 | 241047,860 | 1,025 | 300,646 | 52,424 | 145,191 | 961,964 | 0,975 | 782,395 | 782,395 | 803,674 | 1008,014 | 803,674 | 499,661 | 1,3 |
| | | Bawah | 4012,838 | 239642,319 | 1,026 | 157,056 | 26,791 | 447,490 | 902,232 | 0,975 | 0,000 | 0,000 | 651,820 | 1069,754 | 651,820 | 647,153 | 1,3 |
| | KG4 | Atas | 3861,638 | 241047,860 | 1,025 | 83,306 | 0,752 | 35,018 | 353,487 | 0,975 | 286,938 | 782,395 | 1544,636 | 1455,906 | 1455,906 | 39,735 | 1,3 |
| | | Bawah | 4012,838 | 239642,319 | 1,026 | 29,899 | 20,407 | 40,367 | 246,919 | 0,975 | 367,049 | 0,000 | 1483,853 | 1490,984 | 1483,853 | 85,771 | 1,3 |
| | KG12 | Atas | 3861,638 | 241047,860 | 1,025 | 29,589 | 12,214 | 17,077 | 114,486 | 0,975 | 119,799 | 286,938 | 1287,997 | 1603,946 | 1287,997 | 9,018 | 1,3 |
| | | Bawah | 4012,838 | 239642,319 | 1,026 | 38,346 | 18,502 | 33,289 | 166,644 | 0,975 | 0,000 | 367,049 | 1318,061 | 1639,428 | 1318,061 | 1,613 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KG1 | Atas | 987,375 | 987,375 | 1029,101 | 1166,002 | 980,526 | 980,526 | 980,526 | 150,850 | 123,642 | 1,220 | 2,35 | 7520 | 3760 | 10 | 3801,336 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 2072,497 | 0,000 | 902,232 | 138,805 | 100,280 | 1,384 | 2,35 | 7520 | 3760 | 10 | 3801,336 |
| | KG4 | Atas | 382,584 | 382,584 | 450,258 | 376,451 | 235,337 | 235,337 | 353,487 | 54,383 | 223,986 | 0,243 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 446,417 | 654,948 | 222,363 | 222,363 | 246,919 | 37,987 | 228,285 | 0,166 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG12 | Atas | 382,584 | 382,584 | 590,979 | 824,014 | 115,617 | 115,617 | 115,617 | 17,787 | 198,153 | 0,090 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 99,112 | 145,409 | 199,504 | 145,409 | 166,644 | 25,638 | 202,779 | 0,126 | 1 | 3200 | 1600 | 5 | 1900,668 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KG1 | Atas | 10D22 | 122,500 | 383,4 | 504,538 | 400 | 4847,614 | 1439,756 | 1520,534 | 476,684 | 176,229 | 0,370 | Patah tarik | | 973,517 | Aman |
| | | Bawah | 10D22 | 122,500 | 383,4 | 504,538 | 400 | 4847,614 | 1439,756 | 1520,534 | 476,684 | 176,229 | 0,370 | Patah tarik | | 827,567 | Aman |
| | KG4 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4584,068 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5550,020 | Aman |
| | KG12 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6601,419 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6089,645 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KG1 | Atas | 84,287 | 12,214 | 138,082 | 427,900 | 681,270 | 427,900 |
| | | Bawah | 84,287 | 12,214 | 138,082 | 427,900 | 681,270 | 427,900 |
| | KG4 | Atas | 1,25 | 0,327 | 24,36 | 136,456 | 103,968 | 103,968 |
| | | Bawah | 1,25 | 0,327 | 24,36 | 136,456 | 103,968 | 103,968 |
| | KG12 | Atas | 4,24 | 0,977 | 33,371 | 64,150 | 145,636 | 64,150 |
| | | Bawah | 4,24 | 0,977 | 33,371 | 64,150 | 145,636 | 64,150 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KG1 | Atas | 427,900 | 0 | 98,533 | 713,166 | 39,065 | 184,75 | 35 | P10-35 | AMAN |
| | | Bawah | 427,900 | 0 | 98,533 | 713,166 | 39,065 | 184,75 | 35 | P10-35 | AMAN |
| | KG4 | Atas | 103,968 | 0 | 98,533 | 173,280 | 160,779 | 184,75 | 160 | P10-160 | AMAN |
| | | Bawah | 103,968 | 0 | 98,533 | 173,280 | 160,779 | 184,75 | 160 | P10-160 | AMAN |
| | KG12 | Atas | 64,150 | 0 | 98,533 | 106,917 | 260,574 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 64,150 | 0 | 98,533 | 106,917 | 260,574 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KG1 | Atas | 116,700 | 246,333 | 98,533 | -51,834 | 244,484 | 369,5 | 240 | P10-240 | AMAN |
| | | Bawah | 116,700 | 246,333 | 98,533 | -51,834 | 244,484 | 369,5 | 240 | P10-240 | AMAN |
| | KG4 | Atas | 28,355 | 246,333 | 98,533 | -199,075 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 28,355 | 246,333 | 98,533 | -199,075 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KG12 | Atas | 17,495 | 246,333 | 98,533 | -217,174 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 17,495 | 246,333 | 98,533 | -217,174 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 4,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 5 m | pb | = | 40 mm | h blk atas | = | 800 mm |
| Ø sengkan | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawa | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawa | = | 800 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawa | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | | | 37,083 | 3,8 | 61,750 | Ok | 804,673 | 150,028 | 0,887 | 92994,366 | 37581,199 | 92994,366 | 61931,302 | 1,031 | 1205,652 |
| | | Bawah | | | 10,025 | 3,8 | 61,750 | Ok | 834,241 | 150,028 | 0,887 | 92701,377 | 37462,795 | 92701,377 | 61736,181 | 1,032 | 1241,134 |
| | KG13 | Atas | | | 37,083 | 3,1 | 50,375 | Ok | 784,634 | 109,509 | 61,348 | 90864,936 | 36720,606 | 90864,936 | 74177,352 | 1,024 | 1116,775 |
| | | Bawah | | | 4,935 | 3,1 | 50,375 | Ok | 814,536 | 109,509 | 61,348 | 90624,299 | 36623,399 | 90624,299 | 73980,989 | 1,025 | 1152,718 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{x,x}$ KNm | $Mkap_{y,y}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_H$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 2322,428 | 136108,654 | 1,027 | 3,555 | 18,581 | 26,038 | 78,977 | 1 | 260,817 | 0,000 | 1043,008 | 1006,161 | 1006,161 | 42,695 | 1,3 |
| | | Bawah | 2393,852 | 135717,170 | 1,028 | 88,964 | 2,372 | 65,364 | 282,181 | 1 | 286,938 | 782,395 | 1199,823 | 1037,208 | 1037,208 | 15,697 | 1,3 |
| | KG13 | Atas | 2322,428 | 136108,654 | 1,027 | 15,377 | 10,484 | 16,100 | 76,787 | 1 | 0,000 | 260,817 | 979,422 | 1196,512 | 979,422 | 2,509 | 1,3 |
| | | Bawah | 2393,852 | 135717,170 | 1,028 | 1,051 | 6,011 | 47,198 | 67,113 | 1 | 119,799 | 286,938 | 1033,570 | 1227,961 | 1033,570 | 45,919 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu tulangan $mm^2$ | n | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 469,730 | 469,730 | 441,124 | 827,291 | 132,602 | 132,602 | 132,602 | 20,400 | 154,794 | 0,132 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 353,989 | 210,217 | 370,432 | 353,689 | 353,689 | 54,445 | 159,570 | 0,341 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG13 | Atas | 469,730 | 469,730 | 23,140 | 31,563 | 94,774 | 31,563 | 76,787 | 11,813 | 150,680 | 0,078 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 549,760 | 531,937 | 205,647 | 205,647 | 205,647 | 31,638 | 159,011 | 0,199 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6016,123 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 3501,962 | Aman |
| | KG13 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6762,915 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5126,783 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 0,592 | 0,149 | 40,449 | 124,741 | 170,664 | 124,741 |
| | | Bawah | 0,592 | 0,149 | 40,449 | 124,741 | 170,664 | 124,741 |
| | KG13 | Atas | 5,704 | 1,629 | 43,059 | 72,419 | 188,547 | 72,419 |
| | | Bawah | 5,704 | 1,629 | 43,059 | 72,419 | 188,547 | 72,419 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 124,741 | 0 | 98,533 | 207,902 | 134,004 | 184,75 | 130 | P10-130 | AMAN |
| | | Bawah | 124,741 | 0 | 98,533 | 207,902 | 134,004 | 184,75 | 130 | P10-130 | AMAN |
| | KG13 | Atas | 72,419 | 0 | 98,533 | 120,698 | 230,821 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 72,419 | 0 | 98,533 | 120,698 | 230,821 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KG5 | Atas | 22,389 | 246,333 | 98,533 | -209,018 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 22,389 | 246,333 | 98,533 | -209,018 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KG13 | Atas | 12,998 | 246,333 | 98,533 | -224,670 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 12,998 | 246,333 | 98,533 | -224,670 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 4,5 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | | | 35,229 | 5,5 | 89,375 | Ok | 833,953 | 103,931 | 8,718 | 91987,037 | 37174,114 | 91987,037 | 42325,404 | 1,035 | 927,033 |
| | | Bawah | | | 37,083 | 5,5 | 89,375 | Ok | 663,905 | 103,931 | 8,718 | 91650,003 | 37037,910 | 91650,003 | 42170,326 | 1,036 | 962,976 |
| | KG14 | Atas | | | 35,229 | 5,5 | 89,375 | Ok | 809,227 | 90,626 | 32,489 | 90525,730 | 36583,565 | 90525,730 | 41653,022 | 1,033 | 860,074 |
| | | Bawah | | | 37,083 | 5,5 | 89,375 | Ok | 639,179 | 90,626 | 32,489 | 90232,277 | 36464,974 | 90232,277 | 41517,997 | 1,034 | 896,016 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | 1787,107 | 83978,426 | 1,034 | 66,730 | 12,321 | 22,956 | 208,652 | 1 | 172,898 | 0,000 | 801,673 | 811,394 | 801,673 | 101,598 | 1,3 |
| | | Bawah | 1858,992 | 83688,324 | 1,035 | 59,558 | 21,798 | 3,204 | 192,669 | 1 | 260,817 | 0,000 | 846,799 | 842,843 | 842,843 | 106,008 | 1,3 |
| | KG14 | Atas | 1787,107 | 83978,426 | 1,034 | 55,122 | 12,963 | 48,241 | 210,386 | 1 | 0,000 | 172,898 | 751,241 | 860,799 | 751,241 | 1,027 | 1,3 |
| | | Bawah | 1858,992 | 83688,324 | 1,035 | 45,585 | 14,066 | 5,107 | 144,144 | 1 | 0,000 | 260,817 | 796,367 | 892,249 | 796,367 | 35,818 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | 382,584 | 382,584 | 218,962 | 444,529 | 179,419 | 179,419 | 208,652 | 32,100 | 123,334 | 0,260 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 228,062 | 311,080 | 98,881 | 98,881 | 192,669 | 29,641 | 129,668 | 0,229 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG14 | Atas | 382,584 | 382,584 | 8,915 | 13,463 | 274,101 | 13,463 | 210,386 | 32,367 | 115,576 | 0,280 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 469,730 | 469,730 | 434,187 | 592,238 | 84,083 | 84,083 | 144,144 | 22,176 | 122,518 | 0,181 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4377,287 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4756,274 | Aman |
| | KG14 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 4150,439 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5358,330 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | 1,341 | 0,022 | 37 | 102,903 | 156,831 | 102,903 |
| | | Bawah | 1,341 | 0,022 | 37 | 102,903 | 156,831 | 102,903 |
| | KG14 | Atas | 6,235 | 1,821 | 37,107 | 90,905 | 164,308 | 90,905 |
| | | Bawah | 6,235 | 1,821 | 37,107 | 90,905 | 164,308 | 90,905 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc | Vs min mm^2 | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KG6 | Atas | 102,903 | 0 | 98,533 | 171,505 | 162,443 | 184,75 | 160 | P10-160 | AMAN |
| | | Bawah | 102,903 | 0 | 98,533 | 171,505 | 162,443 | 184,75 | 160 | P10-160 | AMAN |
| | KG14 | Atas | 90,905 | 0 | 98,533 | 151,508 | 183,882 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 90,905 | 0 | 98,533 | 151,508 | 183,882 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KC8 | Atas | 18,470 | 248,333 | 98,533 | -215,550 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 18,470 | 248,333 | 98,533 | -215,550 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KC14 | Atas | 18,318 | 248,333 | 98,533 | -219,140 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 18,318 | 248,333 | 98,533 | -219,140 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| **Ø pokok** | = | 22 mm | tk bawah | = | 4,5 m | **pb** | = | 40 mm | h blk atas | = | 600 mm |
| **Ø sengkang** | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | | | 1,451 | 2,3 | 42,167 | Ok | 448,500 | 73,505 | 12,824 | 91984,749 | 37173,189 | 91984,749 | 89709,223 | 1,011 | 655,808 |
| | | Bawah | | | 35,229 | 2,3 | 42,167 | Ok | 482,292 | 73,505 | 12,824 | 91460,155 | 36961,188 | 91460,155 | 89197,605 | 1,012 | 696,358 |
| | KG15 | Atas | | | 1,451 | 2,3 | 42,167 | Ok | 420,814 | 52,327 | 9,247 | 90147,024 | 36430,521 | 90147,024 | 87916,959 | 1,010 | 588,700 |
| | | Bawah | | | 35,229 | 2,3 | 42,167 | Ok | 454,605 | 52,327 | 9,247 | 89704,506 | 36251,690 | 89704,506 | 87485,388 | 1,011 | 629,249 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | $\delta_s$ | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 1244,508 | 177626,181 | 1,011 | 81,150 | 24,070 | 32,781 | 273,698 | 1 | 260,817 | 260,817 | 621,134 | 601,966 | 601,966 | 36,365 | 1,3 |
| | | Bawah | 1325,608 | 176682,993 | 1,012 | 2,806 | 12,274 | 0,028 | 34,119 | 1 | 172,899 | 0,000 | 607,793 | 637,448 | 607,793 | 22,889 | 1,3 |
| | KG15 | Atas | 1244,508 | 177626,181 | 1,011 | 48,975 | 10,796 | 66,788 | 208,586 | 1 | 260,817 | 260,817 | 569,827 | 535,635 | 535,635 | 113,308 | 1,3 |
| | | Bawah | 1325,608 | 176682,993 | 1,012 | 13,945 | 12,079 | 22,142 | 82,496 | 1 | 0,000 | 172,899 | 556,484 | 571,116 | 556,484 | 9,754 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 469,730 | 469,730 | 539,907 | 736,443 | 248,161 | 248,161 | 273,698 | 42,107 | 92,610 | 0,455 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 121,672 | 183,753 | 15,952 | 15,952 | 34,119 | 5,249 | 93,507 | 0,056 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG15 | Atas | 382,584 | 382,584 | 641,587 | 543,460 | 343,269 | 343,269 | 343,269 | 52,811 | 82,405 | 0,641 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 382,584 | 382,584 | 24,966 | 37,704 | 120,322 | 37,704 | 82,496 | 12,692 | 85,613 | 0,148 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 2531,740 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7082,885 | Aman |
| | KG15 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1551,888 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 5792,592 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 0,511 | 0,065 | 25,251 | 69,959 | 106,659 | 69,959 |
| | | Bawah | 0,511 | 0,065 | 25,251 | 69,959 | 106,659 | 69,959 |
| | KG15 | Atas | 5,44 | 1,606 | 24,683 | 96,765 | 111,067 | 96,765 |
| | | Bawah | 5,44 | 1,606 | 24,683 | 96,765 | 111,067 | 96,765 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 69,959 | 0 | 98,533 | 116,597 | 238,940 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 69,959 | 0 | 98,533 | 116,597 | 238,940 | 184,75 | 180 | P10-180 | AMAN |
| | KG15 | Atas | 96,765 | 0 | 98,533 | 161,275 | 172,747 | 184,75 | 170 | P10-170 | AMAN |
| | | Bawah | 96,765 | 0 | 98,533 | 161,275 | 172,747 | 184,75 | 170 | P10-170 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KG7 | Atas | 19,080 | 246,333 | 98,533 | -214,534 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 19,080 | 246,333 | 98,533 | -214,534 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KG15 | Atas | 26,390 | 246,333 | 98,533 | -202,349 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 26,390 | 246,333 | 98,533 | -202,349 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 2,6 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 5 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 196,596 | 12,210 | 11,230 | 87066,051 | 35185,428 | 87066,051 | 125998,754 | 1,003 | 255,451 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 230,388 | 12,210 | 11,230 | 86594,400 | 34994,823 | 86594,400 | 125316,197 | 1,004 | 296,002 |
| | KG16 | Atas | | | 2,276 | 1,55 | 28,417 | Ok | 156,634 | 7,792 | 6,160 | 86424,734 | 34926,257 | 86424,734 | 125070,863 | 1,002 | 200,428 |
| | | Bawah | | | 1,451 | 1,55 | 28,417 | Ok | 190,426 | 7,792 | 6,160 | 85960,414 | 34738,614 | 85960,414 | 124398,716 | 1,003 | 240,978 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | RV | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 455,879 | 251069,417 | 1,003 | 56,205 | 6,732 | 0,569 | 142,495 | 1 | 0,000 | 119,799 | 236,018 | 266,412 | 236,018 | 50,081 | 1,3 |
| | | Bawah | 536,980 | 249714,913 | 1,003 | 84,327 | 6,094 | 13,049 | 172,626 | 1 | 260,817 | 260,817 | 327,757 | 301,894 | 301,894 | 87,743 | 1,3 |
| | KG16 | Atas | 455,879 | 251069,417 | 1,003 | 37,529 | 4,069 | 6,693 | 100,806 | 1 | 119,799 | 0,000 | 189,419 | 198,519 | 189,419 | 50,919 | 1,3 |
| | | Bawah | 536,980 | 249714,913 | 1,003 | 25,398 | 3,386 | 100,159 | 170,393 | 1 | 260,817 | 260,817 | 281,158 | 234,001 | 234,001 | 78,289 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk paka KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu tulangan $mm^2$ | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 292,038 | 292,038 | 117,377 | 246,680 | 68,474 | 68,474 | 142,495 | 21,922 | 36,310 | 0,604 | 1 | 3200 | 1600 | 5 1900,668 |
| | | Bawah | 469,730 | 469,730 | 461,839 | 436,513 | 128,748 | 128,748 | 172,626 | 26,558 | 46,445 | 0,572 | 1 | 3200 | 1600 | 5 1900,668 |
| | KG16 | Atas | 198,092 | 198,092 | 77,335 | 100,983 | 71,789 | 71,789 | 100,806 | 15,509 | 29,141 | 0,532 | 1 | 3200 | 1600 | 5 1900,668 |
| | | Bawah | 382,584 | 382,584 | 422,212 | 357,637 | 450,881 | 422,212 | 422,212 | 64,956 | 36,000 | 1,804 | 1 | 3200 | 1600 | 5 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1697,759 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 1840,452 | Aman |
| | KG16 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 2042,685 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 361,579 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 0,321 | 0,159 | 13,384 | 71,618 | 56,717 | 56,717 |
| | | Bawah | 0,321 | 0,159 | 13,384 | 71,618 | 56,717 | 56,717 |
| | KG16 | Atas | 0,071 | 0,636 | 12,105 | 118,868 | 51,583 | 51,583 |
| | | Bawah | 0,071 | 0,636 | 12,105 | 118,868 | 51,583 | 51,583 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 56,717 | 0 | 98,533 | 94,528 | 294,724 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 56,717 | 0 | 98,533 | 94,528 | 294,724 | 184,75 | 180 | P10-180 | AMAN |
| | KG16 | Atas | 51,583 | 0 | 98,533 | 85,972 | 324,055 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 51,583 | 0 | 98,533 | 85,972 | 324,055 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KG8 | Atas | 15,468 | 246,333 | 98,533 | -220,553 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 15,468 | 246,333 | 98,533 | -220,553 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | KG16 | Atas | 14,068 | 246,333 | 98,533 | -222,886 | 282,744 | 369,5 | 280 | P10-280 | AMAN |
| | | Bawah | 14,068 | 246,333 | 98,533 | -222,886 | 282,744 | 369,5 | 280 | P10-280 | AMAN |

## PERENCANAAN KOLOM PORTAL B-G

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0171 m^4 | b kolom | = | 400 mm |
| Fy polos | = | 240 MPa | tk atas | = | 0 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 800 mm |
| fc' | = | 25 MPa | tk | = | 2,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 5 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,8 m | Lg' ki bawah | = | 6,8 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 240 mm | Lg' ka atas | = | 6,8 m | Lg' ka bawah | = | 6,8 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 739 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 70,766 | 0,999 | 2,907 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 86,126 | 0,999 | 2,907 | | | | | | |
| | KG17 | Atas | | | 160426,667 | 2,7 | 21,375 | Tidak | 31,235 | 0,562 | 1,438 | | | | | | |
| | | Bawah | | | 2,276 | 2,7 | 21,375 | Tidak | 46,595 | 0,562 | 1,438 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | RV | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | | | | 0,810 | 0,126 | 0,147 | | 1 | 0,000 | 0,000 | 75,353 | 87,563 | 75,353 | 0,590 | 1 |
| | | Bawah | | | | 5,052 | 0,502 | 1,181 | | 1 | 0,000 | 119,799 | 125,025 | 103,691 | 103,691 | 6,934 | 1 |
| | KG17 | Atas | | | | 1,027 | 0,051 | 0,972 | | 1 | 0,000 | 0,000 | 33,387 | 39,426 | 33,387 | 0,046 | 1 |
| | | Bawah | | | | 4,454 | 0,318 | 11,198 | | 1 | 119,799 | 0,000 | 83,059 | 55,554 | 55,554 | 16,703 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,bv}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | 119,799 | 119,799 | 5,497 | 18,323 | 1,600 | 1,600 | 1,600 | 0,246 | 11,593 | 0,021 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 292,038 | 292,038 | 186,412 | 294,773 | 10,792 | 10,792 | 10,792 | 1,660 | 15,952 | 0,104 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | KG17 | Atas | 119,799 | 119,799 | 0,096 | 0,321 | 5,214 | 0,321 | 0,321 | 0,049 | 5,136 | 0,010 | 1 | 3200 | 1600 | 5 | 1900,668 |
| | | Bawah | 198,092 | 198,092 | 174,309 | 227,608 | 52,042 | 52,042 | 52,042 | 8,006 | 8,547 | 0,937 | 1 | 3200 | 1600 | 5 | 1900,668 |

### 4. Perhitungan Keruntuhan Kolom

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang cb mm | Keadaan seimbang fs' MPa | Keadaan seimbang fs' pakai MPa | Keadaan seimbang Cc KN | Keadaan seimbang Cs KN | Keadaan seimbang Ts KN | Keadaan seimbang Pnb Ton | Keadaan seimbang Mnb Ton-m | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7593,049 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 6399,893 | Aman |
| | KG17 | Atas | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 7765,107 | Aman |
| | | Bawah | 5D22 | 47,500 | 443,4 | 517,456 | 400 | 3203,565 | 719,878 | 760,267 | 316,318 | 117,950 | 0,373 | Patah tarik | | 876,162 | Aman |

### 5. Perencanaan Gaya Geser Kolom

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | 0,749 | 0,121 | 10,833 | 6,522 | 46,412 | 6,522 |
| | | Bawah | 0,749 | 0,121 | 10,833 | 6,522 | 46,412 | 6,522 |
| | KG17 | Atas | 0,026 | 1,269 | 4,554 | 27,560 | 20,487 | 20,487 |
| | | Bawah | 0,026 | 1,269 | 4,554 | 27,560 | 20,487 | 20,487 |

### 6. Perencanaan Tulangan Geser Kolom

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | 6,522 | 0 | 98,533 | 10,870 | 2562,929 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 6,522 | 0 | 98,533 | 10,870 | 2562,929 | 184,75 | 180 | P10-180 | AMAN |
| | KG17 | Atas | 20,487 | 0 | 98,533 | 34,144 | 815,941 | 184,75 | 180 | P10-180 | AMAN |
| | | Bawah | 20,487 | 0 | 98,533 | 34,144 | 815,941 | 184,75 | 180 | P10-180 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KG9 | Atas | -4,463 | 246,333 | 98,533 | -253,771 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -4,463 | 246,333 | 98,533 | -253,771 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | KG17 | Atas | -14,017 | 246,333 | 98,533 | -269,695 | 282,744 | 369,500 | 280 | P10-280 | AMAN |
| | | Bawah | -14,017 | 246,333 | 98,533 | -269,695 | 282,744 | 369,500 | 280 | P10-280 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 3,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 1,2 | m | Ig bawah | = | 0 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 0 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 0 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 0 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 0 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 0 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 0 | mm |
| h blk bawah | = | 0 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KH2 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2439,018 | 429,902 | 232,347 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2460,186 | 429,902 | 232,347 | | | | | | |
| | KH14 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2960,359 | 938,572 | 22,330 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 2977,999 | 938,572 | 22,330 | | | | | | |
| | KH20 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 2957,323 | 964,024 | 5,008 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 2974,963 | 964,024 | 5,008 | | | | | | |
| | KH26 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 3657,375 | 777,316 | 31,840 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 3675,015 | 777,316 | 31,840 | | | | | | |
| | KH34 | Atas | 10,107 | 4,25 | | | 12,143 | Tidak | 3494,262 | 557,402 | 15,117 | | | | | | |
| | | Bawah | 391829,861 | 4,25 | | | 12,143 | Tidak | 3511,902 | 557,402 | 15,117 | | | | | | |
| | KH42 | Atas | | | 20,213 | 1,82 | 5,200 | Tidak | 2567,776 | 256,829 | 31,890 | | | | | | |
| | | Bawah | | | 391829,861 | 1,82 | 5,200 | Tidak | 2588,944 | 256,829 | 31,890 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KH2 | Atas | | | | 29,792 | 2,051 | 56,987 | | 0,925 | 292,038 | 0,000 | 3169,945 | 3988,223 | 3169,945 | 89,948 | 1 |
| | | Bawah | | | | 4,420 | 4,650 | 122,060 | | 0,925 | 0,000 | 0,000 | 3034,592 | 4010,450 | 3034,592 | 135,768 | 1 |
| | KH14 | Atas | | | | 5,358 | 2,971 | 55,410 | | 0,925 | 292,038 | 292,038 | 4409,035 | 4187,664 | 4187,664 | 65,584 | 1 |
| | | Bawah | | | | 7,866 | 2,621 | 130,785 | | 0,925 | 0,000 | 0,000 | 4112,400 | 4206,186 | 4112,400 | 130,726 | 1 |
| | KH20 | Atas | | | | 3,855 | 0,841 | 54,311 | | 0,925 | 292,038 | 292,038 | 4432,572 | 4138,448 | 4138,448 | 60,689 | 1 |
| | | Bawah | | | | 9,094 | 0,830 | 132,544 | | 0,925 | 0,000 | 0,000 | 4135,936 | 4156,970 | 4135,936 | 128,957 | 1 |
| | KH26 | Atas | | | | 0,869 | 1,245 | 133,198 | | 0,925 | 292,038 | 292,038 | 4971,583 | 4790,154 | 4790,154 | 57,925 | 1 |
| | | Bawah | | | | 10,477 | 3,123 | 55,271 | | 0,925 | 0,000 | 0,000 | 4674,948 | 4808,676 | 4674,948 | 126,265 | 1 |
| | KH34 | Atas | | | | 12,758 | 0,236 | 57,045 | | 0,925 | 292,038 | 292,038 | 4569,405 | 4317,739 | 4317,739 | 73,149 | 1 |
| | | Bawah | | | | 7,522 | 4,982 | 132,285 | | 0,925 | 0,000 | 0,000 | 4272,769 | 4336,261 | 4272,769 | 126,444 | 1 |
| | KH42 | Atas | | | | 59,617 | 2,953 | 57,523 | | 0,925 | 0,000 | 292,038 | 3123,414 | 3099,773 | 3099,773 | 7,772 | 1 |
| | | Bawah | | | | 27,549 | 7,477 | 123,335 | | 0,925 | 0,000 | 0,000 | 2988,062 | 3122,000 | 2988,062 | 99,301 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KH2 | Atas | 198,092 | 198,092 | 253,925 | 298,977 | 272,781 | 272,781 | 272,781 | 41,966 | 487,684 | 0,086 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 522,176 | 0,000 | 0,000 | 0,000 | 466,860 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH14 | Atas | 198,092 | 198,092 | 364,179 | 296,038 | 241,467 | 241,467 | 241,467 | 37,149 | 644,256 | 0,058 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 560,308 | 0,000 | 0,000 | 0,000 | 632,677 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH20 | Atas | 198,092 | 198,092 | 348,840 | 283,569 | 233,037 | 233,037 | 233,037 | 35,852 | 636,684 | 0,056 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 567,105 | 0,000 | 0,000 | 0,000 | 636,298 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH26 | Atas | 198,092 | 198,092 | 342,815 | 278,672 | 561,651 | 342,815 | 342,815 | 52,741 | 736,947 | 0,072 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 246,418 | 0,000 | 0,000 | 0,000 | 719,223 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH34 | Atas | 198,092 | 198,092 | 399,506 | 324,755 | 253,233 | 253,233 | 253,233 | 38,959 | 664,267 | 0,059 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 568,726 | 0,000 | 0,000 | 0,000 | 657,349 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH42 | Atas | 198,092 | 198,092 | 46,252 | 54,458 | 307,295 | 54,458 | 54,458 | 8,378 | 476,888 | 0,018 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 554,784 | 0,000 | 0,000 | 0,000 | 459,702 | 0,000 | 1 | 4900 | 2450 | 7 | 2660,935 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KH2 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9190,091 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11944,758 | Aman |
| | KH14 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10071,007 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 12510,104 | | Aman |
| | KH20 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10117,187 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 12510,104 | | Aman |
| | KH26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 9619,315 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 12510,104 | | Aman |
| | KH34 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10037,519 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 12510,104 | | Aman |
| | KH42 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11483,627 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11944,758 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KH2 | Atas | 10,708 | 2,014 | 37,899 | 303,090 | 172,534 | 172,534 |
| | | Bawah | 10,708 | 2,014 | 37,899 | 303,090 | 172,534 | 172,534 |
| | KH14 | Atas | 3,308 | 2,563 | 37,36 | 268,297 | 163,077 | 163,077 |
| | | Bawah | 3,308 | 2,563 | 37,36 | 268,297 | 163,077 | 163,077 |
| | KH20 | Atas | 1,427 | 3,626 | 40,243 | 258,930 | 174,326 | 174,326 |
| | | Bawah | 1,427 | 3,626 | 40,243 | 258,930 | 174,326 | 174,326 |
| | KH26 | Atas | 5,692 | 3,265 | 43,338 | 380,906 | 191,424 | 191,424 |
| | | Bawah | 5,692 | 3,265 | 43,338 | 380,906 | 191,424 | 191,424 |
| | KH34 | Atas | 14,433 | 1,272 | 45,866 | 281,370 | 209,127 | 209,127 |
| | | Bawah | 14,433 | 1,272 | 45,866 | 281,370 | 209,127 | 209,127 |
| | KH42 | Atas | 45,053 | 3,7 | 53,469 | 60,509 | 275,760 | 60,509 |
| | | Bawah | 45,053 | 3,7 | 53,469 | 60,509 | 275,760 | 60,509 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | | | |
| Dasar | KH2 | Atas | 172,534 | 0 | 149,1 | 287,557 | 83,774 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 172,534 | 0 | 149,1 | 287,557 | 83,774 | 159,75 | 80 | P10-80 | AMAN |
| | KH14 | Atas | 163,077 | 0 | 149,1 | 271,794 | 88,632 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 163,077 | 0 | 149,1 | 271,794 | 88,632 | 159,75 | 85 | P10-85 | AMAN |
| | KH20 | Atas | 174,326 | 0 | 149,1 | 290,544 | 82,913 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 174,326 | 0 | 149,1 | 290,544 | 82,913 | 159,75 | 80 | P10-80 | AMAN |
| | KH26 | Atas | 191,424 | 0 | 149,1 | 319,041 | 75,507 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 191,424 | 0 | 149,1 | 319,041 | 75,507 | 159,75 | 75 | P10-75 | AMAN |
| | KH34 | Atas | 209,127 | 0 | 149,1 | 348,545 | 69,115 | 159,75 | 65 | P1065 | AMAN |
| | | Bawah | 209,127 | 0 | 149,1 | 348,546 | 69,115 | 159,75 | 65 | P10-65 | AMAN |
| | KH42 | Atas | 60,509 | 0 | 149,1 | 100,848 | 238,872 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 60,509 | 0 | 149,1 | 100,848 | 238,872 | 159,75 | 155 | P10-155 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F_y deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 | b kolom | = | 700 | mm |
| F_y polos | = | 240 | MPa | tk atas | = | 5 | m | Ig atas | = | 0,0072 | m^4 | h kolom | = | 700 | mm |
| f'c | = | 25 | MPa | tk | = | 3,5 | m | Ig bawah | = | 0,0072 | m^4 | b blk atas | = | 400 | mm |
| Ø pokok | = | 22 | mm | tk bawah | = | 1,2 | m | pb | = | 40 | mm | h blk atas | = | 600 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m | b blk bawah | = | 400 | mm |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m | h blk bawah | = | 600 | mm |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m | | | | |
| - | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m | | | | |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm | | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KH3 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2269,071 | 429,868 | 206,208 | 132603,484 | 37634,660 | 132603,484 | 134714,365 | 1,041 | 3410,674 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2310,231 | 429,866 | 206,208 | 132391,508 | 37574,499 | 132391,508 | 134499,014 | 1,041 | 3460,063 |
| | KH15 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2709,237 | 939,792 | 22,116 | 141627,774 | 40195,876 | 141627,774 | 33422,927 | 1,280 | 4754,752 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2743,341 | 939,792 | 22,116 | 141401,135 | 40131,552 | 141401,135 | 33369,443 | 1,284 | 4795,676 |
| | KH21 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 2705,794 | 964,979 | 4,943 | 142136,313 | 40340,206 | 142136,313 | 33542,938 | 1,282 | 4790,919 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 2739,898 | 964,979 | 4,943 | 141905,442 | 40274,682 | 141905,442 | 33488,455 | 1,285 | 4831,844 |
| | KH27 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 3408,372 | 777,984 | 31,992 | 134980,764 | 38309,364 | 134980,764 | 31854,291 | 1,347 | 5334,821 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 3442,476 | 777,984 | 31,992 | 134845,183 | 38270,885 | 134845,183 | 31822,295 | 1,351 | 5375,746 |
| | KH35 | Atas | 4,387 | 2,23 | | | 30,795 | Ok | 3235,662 | 556,548 | 15,408 | 131499,123 | 37321,228 | 131499,123 | 31032,653 | 1,310 | 4773,271 |
| | | Bawah | 10,107 | 2,23 | | | 30,795 | Ok | 3269,766 | 556,548 | 15,408 | 131384,226 | 37288,618 | 131384,226 | 31005,539 | 1,314 | 4814,196 |
| | KH43 | Atas | | | 8,773 | 3,35 | 46,262 | Ok | 2308,069 | 243,019 | 25,494 | 127053,733 | 36059,556 | 127053,733 | 129076,268 | 1,039 | 3158,513 |
| | | Bawah | | | 20,213 | 3,35 | 46,262 | Ok | 2349,229 | 243,019 | 25,494 | 126925,552 | 36023,186 | 126925,552 | 128946,047 | 1,040 | 3207,905 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KH3 | Atas | 26222,950 | 393643,442 | 1,114 | 62,999 | 29,397 | 4,238 | 226,900 | 0,95 | 469,730 | 469,730 | 3012,383 | 3699,960 | 3012,383 | 122,347 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 28,310 | 4,729 | 102,375 | 199,660 | 0,95 | 292,038 | 0,000 | 2932,589 | 3743,175 | 2932,589 | 139,921 | 1,3 |
| | KH15 | Atas | 26222,950 | 393643,442 | 1,114 | 13,504 | 2,260 | 40,616 | 90,276 | 0,95 | 469,730 | 469,730 | 4009,978 | 3924,368 | 3924,368 | 29,604 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 8,324 | 1,921 | 114,857 | 162,416 | 0,95 | 292,038 | 292,038 | 3978,264 | 3960,177 | 3960,177 | 110,558 | 1,3 |
| | KH21 | Atas | 26222,950 | 393643,442 | 1,114 | 12,312 | 5,125 | 38,314 | 92,269 | 0,95 | 469,730 | 469,730 | 4032,809 | 3875,072 | 3875,072 | 31,655 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 4,606 | 0,073 | 113,889 | 146,112 | 0,95 | 292,038 | 292,038 | 4001,095 | 3910,881 | 3910,881 | 114,395 | 1,3 |
| | KH27 | Atas | 26222,950 | 393643,442 | 1,114 | 0,519 | 11,062 | 42,185 | 82,405 | 0,95 | 469,730 | 469,730 | 4574,171 | 4530,040 | 4530,040 | 43,057 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 0,640 | 2,487 | 114,954 | 143,571 | 0,95 | 292,038 | 292,038 | 4542,457 | 4565,849 | 4542,457 | 117,889 | 1,3 |
| | KH35 | Atas | 26222,950 | 393643,442 | 1,114 | 38,908 | 6,829 | 47,337 | 181,168 | 0,95 | 469,730 | 469,730 | 4160,318 | 4046,534 | 4046,534 | 8,374 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 3,489 | 0,192 | 117,681 | 147,980 | 0,95 | 292,038 | 292,038 | 4128,604 | 4082,343 | 4082,343 | 117,070 | 1,3 |
| | KH43 | Atas | 26222,950 | 393643,442 | 1,114 | 78,699 | 25,722 | 1,243 | 252,478 | 0,95 | 469,730 | 469,730 | 2857,140 | 2785,717 | 2785,717 | 61,481 | 1,3 |
| | | Bawah | 26485,430 | 393130,792 | 1,116 | 62,886 | 8,260 | 104,127 | 293,655 | 0,95 | 0,000 | 292,038 | 2777,348 | 2828,935 | 2777,348 | 52,495 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KH3 | Atas | 382,584 | 382,584 | 663,433 | 594,193 | 114,815 | 114,815 | 226,900 | 34,908 | 463,444 | 0,075 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 266,684 | 314,000 | 464,666 | 314,000 | 314,000 | 48,308 | 451,168 | 0,107 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH15 | Atas | 469,730 | 469,730 | 313,814 | 313,814 | 187,139 | 187,139 | 187,139 | 28,791 | 603,749 | 0,048 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 674,533 | 548,322 | 493,157 | 493,157 | 493,157 | 75,870 | 609,258 | 0,125 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH21 | Atas | 469,730 | 469,730 | 322,028 | 322,028 | 179,228 | 179,228 | 179,228 | 27,573 | 596,165 | 0,046 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 669,806 | 544,479 | 483,247 | 483,247 | 483,247 | 74,346 | 601,674 | 0,124 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH27 | Atas | 553,475 | 553,475 | 413,834 | 451,991 | 189,337 | 189,337 | 189,337 | 29,129 | 696,929 | 0,042 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 626,378 | 509,177 | 486,090 | 486,090 | 486,090 | 74,783 | 698,840 | 0,107 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH35 | Atas | 469,730 | 469,730 | 99,183 | 99,183 | 246,839 | 99,183 | 181,168 | 27,872 | 622,544 | 0,045 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 798,067 | 648,742 | 498,125 | 498,125 | 498,125 | 76,635 | 628,053 | 0,122 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH43 | Atas | 382,584 | 382,584 | 767,143 | 687,080 | 114,863 | 114,863 | 252,478 | 38,843 | 428,572 | 0,091 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 230,231 | 271,080 | 512,037 | 271,080 | 293,655 | 45,178 | 427,284 | 0,106 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KH3 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | ######### | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9213,557 | Aman |
| | KH15 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10422,213 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8216,794 | | Aman |
| | KH21 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10474,775 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8238,653 | | Aman |
| | KH27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10641,416 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8632,984 | | Aman |
| | KH35 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10529,554 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8273,925 | | Aman |
| | KH43 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9618,925 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9246,383 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KH3 | Atas | 29,881 | 2,55 | 39,718 | 186,517 | 200,868 | 186,517 |
| | | Bawah | 29,881 | 2,55 | 39,718 | 186,517 | 200,868 | 186,517 |
| | KH15 | Atas | 13,333 | 6,622 | 38,094 | 234,585 | 180,948 | 180,948 |
| | | Bawah | 13,333 | 6,622 | 38,094 | 234,585 | 180,948 | 180,948 |
| | KH21 | Atas | 9,741 | 2,439 | 41,434 | 228,439 | 186,812 | 186,812 |
| | | Bawah | 9,741 | 2,439 | 41,434 | 228,439 | 186,812 | 186,812 |
| | KH27 | Atas | 23,858 | 3,815 | 44,715 | 232,906 | 216,860 | 216,860 |
| | | Bawah | 23,858 | 3,815 | 44,715 | 232,906 | 216,860 | 216,860 |
| | KH35 | Atas | 2,205 | 12,884 | 48,548 | 234,239 | 219,745 | 219,745 |
| | | Bawah | 2,205 | 12,884 | 48,548 | 234,239 | 219,745 | 219,745 |
| | KH43 | Atas | 15,4 | 2,647 | 56,67 | 188,322 | 256,963 | 188,322 |
| | | Bawah | 15,4 | 2,647 | 56,67 | 188,322 | 256,963 | 188,322 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Besment | KH3 | Atas | 186,517 | 0 | 149,1 | 310,862 | 77,494 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 186,517 | 0 | 149,1 | 310,862 | 77,494 | 159,75 | 75 | P10-75 | AMAN |
| | KH15 | Atas | 180,948 | 0 | 149,1 | 301,579 | 79,879 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 180,948 | 0 | 149,1 | 301,579 | 79,879 | 159,75 | 75 | P10-75 | AMAN |
| | KH21 | Atas | 186,812 | 0 | 149,1 | 311,353 | 77,371 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 186,812 | 0 | 149,1 | 311,353 | 77,371 | 159,75 | 75 | P10-75 | AMAN |
| | KH27 | Atas | 216,860 | 0 | 149,1 | 361,433 | 66,651 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 216,860 | 0 | 149,1 | 361,433 | 66,651 | 159,75 | 65 | P10-65 | AMAN |
| | KH35 | Atas | 219,745 | 0 | 149,1 | 366,242 | 65,776 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 219,745 | 0 | 149,1 | 366,242 | 65,776 | 159,75 | 65 | P10-65 | AMAN |
| | KH43 | Atas | 188,322 | 0 | 149,1 | 313,869 | 76,751 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 188,322 | 0 | 149,1 | 313,869 | 76,751 | 159,75 | 75 | P10-75 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Besment | KH3 | Atas | 6,432 | 372,750 | 149,1 | -362,031 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,432 | 372,750 | 149,1 | -362,031 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH15 | Atas | 6,240 | 372,750 | 149,1 | -362,351 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,240 | 372,750 | 149,1 | -362,351 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH21 | Atas | 6,442 | 372,750 | 149,1 | -362,014 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,442 | 372,750 | 149,1 | -362,014 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH27 | Atas | 7,478 | 372,750 | 149,1 | -360,287 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 7,478 | 372,750 | 149,1 | -360,287 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH35 | Atas | 7,577 | 372,750 | 149,1 | -360,121 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 7,577 | 372,750 | 149,1 | -360,121 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH43 | Atas | 6,494 | 372,750 | 149,1 | -361,927 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 6,494 | 372,750 | 149,1 | -361,927 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 4,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 3,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

**1. Perhitungan Momen Rencana (Mc)**

| Lantai | elemen | Ujung | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran | PD | PL | PE | $EI_1$ | $EI_2$ | EI pakai | Pc | δb | Pu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | ψ | K | ψ | K | | momen | KN | KN | KN | KNm^2 | KNm^2 | KNm^2 | KN | | KN |
| Ground Floor | KH1 | Atas | | | 1,245 | 2,3 | 48,190 | Ok | 29,587 | 1,159 | 141,539 | 122267,762 | 34701,243 | 122267,762 | 119243,092 | 1,000 | 37,359 |
| | | Bawah | | | 94039,167 | 2,3 | 48,190 | Ok | 88,387 | 1,159 | 141,539 | 120266,512 | 34133,261 | 120266,512 | 117291,349 | 1,001 | 107,919 |
| | KH4 | Atas | 376156,667 | 4,5 | | | 40,714 | Ok | 1939,056 | 361,312 | 162,417 | 132408,077 | 37579,201 | 132408,077 | 17876,563 | 1,333 | 2904,966 |
| | | Bawah | 12,386 | 4,5 | | | 40,714 | Ok | 1968,456 | 361,312 | 162,417 | 132232,756 | 37529,443 | 132232,756 | 17852,893 | 1,339 | 2940,246 |
| | KH5 | Atas | 9,801 | 3,25 | | | 29,405 | Ok | 1898,756 | 361,227 | 168,639 | 132653,423 | 37648,833 | 132653,423 | 34335,732 | 1,147 | 2856,470 |
| | | Bawah | 14,450 | 3,25 | | | 29,405 | Ok | 1928,156 | 361,227 | 168,639 | 132471,515 | 37597,206 | 132471,515 | 34288,648 | 1,149 | 2891,750 |
| | KH16 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2162,353 | 773,415 | 17,217 | 142190,168 | 40355,490 | 142190,168 | 17248,775 | 1,519 | 3832,288 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2214,097 | 773,415 | 17,217 | 141754,999 | 40231,984 | 141754,999 | 17195,986 | 1,535 | 3894,380 |
| | KH22 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2161,575 | 775,288 | 3,633 | 142241,719 | 40370,122 | 142241,719 | 17255,029 | 1,519 | 3834,351 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2213,319 | 775,288 | 3,633 | 141805,648 | 40246,359 | 141805,648 | 17202,130 | 1,535 | 3896,444 |
| | KH28 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2792,780 | 594,070 | 31,173 | 134041,782 | 38042,869 | 134041,782 | 16260,313 | 1,686 | 4301,848 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2844,524 | 594,070 | 31,173 | 133805,325 | 37975,759 | 133805,325 | 16231,629 | 1,705 | 4363,941 |
| | KH36 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2661,702 | 415,353 | 14,698 | 130468,464 | 37028,713 | 130468,464 | 15826,841 | 1,600 | 3858,607 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2713,446 | 415,353 | 14,698 | 130274,053 | 36973,536 | 130274,053 | 15803,258 | 1,617 | 3920,700 |
| | KH44 | Atas | 3,426 | 2,3 | | | 48,190 | Ok | 1894,424 | 194,355 | 22,292 | 126866,177 | 36006,335 | 126866,177 | 12226,062 | 1,482 | 2584,277 |
| | | Bawah | 8,773 | 2,3 | | | 48,190 | Ok | 1953,224 | 194,355 | 22,292 | 126650,689 | 35945,176 | 126650,689 | 12205,296 | 1,503 | 2654,837 |
| | KH50 | Atas | | | 2,946 | 2,8 | 58,667 | Ok | 72,800 | 9,875 | 46,112 | 129121,347 | 36646,383 | 129121,347 | 103440,144 | 1,002 | 103,160 |
| | | Bawah | | | 94039,167 | 2,8 | 58,667 | Ok | 131,600 | 9,875 | 46,112 | 124913,737 | 35452,206 | 124913,737 | 100069,394 | 1,003 | 173,720 |

**2. Perhitungan Momen Lentur dan Aksial Kolom**

| Lantai | elemen | Ujung | ΣPu | ΣPc | δs | MD | ML | ME | Mc | Rv | $Mkap_{ka}$ | $Mkap_{ki}$ | Nuk1 | Nuk2 | Nuk pakai | Mmaks | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KN | KN | | KNm | KNm | KNm | KNm | | KNm | KNm | KN | KN | KN | KNm | |
| Ground Floor | KH1 | Atas | 24313,326 | 353712,552 | 1,118 | 199,632 | 30,067 | 103,621 | 665,057 | 0,975 | 553,475 | 553,475 | 183,382 | 626,747 | 183,382 | 335,959 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 111,652 | 16,509 | 437,951 | 820,561 | 0,975 | 0,000 | 0,000 | 94,023 | 688,487 | 94,023 | 582,428 | 1,3 |
| | KH4 | Atas | 24313,326 | 353712,552 | 1,118 | 66,297 | 10,625 | 7,367 | 222,721 | 0,975 | 0,000 | 0,000 | 2415,386 | 3097,538 | 2415,386 | 48,138 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 41,895 | 31,636 | 91,297 | 314,618 | 0,975 | 469,730 | 469,730 | 2574,493 | 3128,408 | 2574,493 | 158,917 | 1,3 |
| | KH5 | Atas | 24313,326 | 353712,552 | 1,118 | 5,852 | 24,161 | 76,845 | 166,506 | 0,975 | 553,475 | 553,475 | 2524,081 | 3081,266 | 2524,081 | 82,631 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 66,088 | 10,642 | 7,222 | 204,695 | 0,975 | 0,000 | 0,000 | 2403,852 | 3112,136 | 2403,852 | 88,078 | 1,3 |
| | KH16 | Atas | 24313,326 | 353712,552 | 1,118 | 15,476 | 4,742 | 85,467 | 161,608 | 0,975 | 553,475 | 553,475 | 3233,655 | 3154,868 | 3154,868 | 109,739 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 30,953 | 5,384 | 117,542 | 249,185 | 0,975 | 469,730 | 469,730 | 3265,124 | 3209,199 | 3209,199 | 157,358 | 1,3 |
| | KH22 | Atas | 24313,326 | 353712,552 | 1,118 | 9,613 | 2,509 | 84,947 | 136,425 | 0,975 | 0,000 | 0,000 | 3083,706 | 3098,965 | 3083,706 | 100,229 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 23,611 | 9,084 | 115,794 | 236,652 | 0,975 | 469,730 | 469,730 | 3266,274 | 3153,296 | 3153,296 | 149,670 | 1,3 |
| | KH28 | Atas | 24313,326 | 353712,552 | 1,118 | 4,117 | 19,518 | 88,619 | 183,633 | 0,975 | 553,475 | 553,475 | 3707,291 | 3687,119 | 3687,119 | 91,690 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 26,498 | 11,819 | 118,777 | 266,192 | 0,975 | 469,730 | 469,730 | 3738,760 | 3741,450 | 3738,760 | 142,549 | 1,3 |
| | KH36 | Atas | 24313,326 | 353712,552 | 1,118 | 28,943 | 3,940 | 87,676 | 205,371 | 0,975 | 553,475 | 553,475 | 3382,006 | 3292,639 | 3292,639 | 55,104 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 17,758 | 3,135 | 119,200 | 206,336 | 0,975 | 469,730 | 469,730 | 3413,475 | 3346,971 | 3346,971 | 96,282 | 1,3 |
| | KH44 | Atas | 24313,326 | 353712,552 | 1,118 | 65,216 | 18,370 | 99,737 | 366,153 | 0,975 | 553,475 | 553,475 | 2344,317 | 2286,844 | 2286,844 | 47,804 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 46,378 | 21,521 | 90,877 | 312,518 | 0,975 | 469,730 | 469,730 | 2383,194 | 2348,584 | 2348,584 | 54,978 | 1,3 |
| | KH50 | Atas | 24313,326 | 353712,552 | 1,118 | 56,367 | 5,799 | 209,050 | 392,767 | 0,975 | 0,000 | 0,000 | 571,326 | 164,795 | 280,479 | 157,184 | 1,3 |
| | | Bawah | 24843,937 | 348140,582 | 1,123 | 11,004 | 0,675 | 488,465 | 603,921 | 0,975 | 0,000 | 0,000 | 148,549 | 342,219 | 148,549 | 495,693 | 1,3 |

**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KH1 | Atas | 0,000 | 987,375 | 587,958 | 552,885 | 676,392 | 587,958 | 665,057 | 102,316 | 28,213 | 3,627 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 1973,963 | 1973,963 | 1973,963 | 303,687 | 14,485 | 20,994 | 2 | 9800 | 4900 | 11 | 4181,470 |
| | KH4 | Atas | 119,799 | 0,000 | 9,571 | 31,903 | 111,710 | 31,903 | 222,721 | 34,265 | 371,598 | 0,092 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1027,734 | 920,474 | 460,655 | 460,655 | 460,655 | 70,870 | 396,076 | 0,179 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH5 | Atas | 382,584 | 382,584 | 741,026 | 608,375 | 354,263 | 354,263 | 354,263 | 54,502 | 388,320 | 0,140 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 119,799 | 0,000 | 21,240 | 70,801 | 110,899 | 70,801 | 204,695 | 31,492 | 369,823 | 0,085 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH16 | Atas | 554,777 | 554,777 | 677,605 | 679,463 | 380,190 | 380,190 | 380,190 | 58,491 | 465,364 | 0,121 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 824,175 | 824,175 | 531,830 | 531,830 | 531,830 | 81,820 | 493,723 | 0,166 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH22 | Atas | 554,777 | 554,777 | 152,924 | 509,748 | 369,506 | 369,506 | 369,506 | 56,847 | 474,416 | 0,120 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 837,857 | 837,857 | 520,665 | 520,665 | 520,665 | 80,102 | 485,122 | 0,165 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH28 | Atas | 553,475 | 553,475 | 645,226 | 645,226 | 397,017 | 397,017 | 397,017 | 61,079 | 567,249 | 0,108 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 986,389 | 968,097 | 539,096 | 539,096 | 539,096 | 82,938 | 575,194 | 0,144 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH36 | Atas | 469,730 | 469,730 | 579,044 | 530,160 | 402,766 | 402,766 | 402,766 | 61,964 | 506,560 | 0,122 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 989,731 | 989,731 | 522,578 | 522,578 | 522,578 | 80,397 | 514,919 | 0,156 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH44 | Atas | 382,584 | 382,584 | 712,023 | 584,564 | 506,661 | 506,661 | 506,661 | 77,948 | 351,822 | 0,222 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 716,256 | 641,503 | 452,977 | 452,977 | 452,977 | 69,689 | 361,321 | 0,193 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH50 | Atas | 0,000 | 172,898 | 171,662 | 94,948 | 943,284 | 171,662 | 392,767 | 60,426 | 25,353 | 2,383 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 2063,816 | 2063,816 | 2063,816 | 317,510 | 22,954 | 13,893 | 1,2 | 5880 | 2940 | 8 | 3041,069 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KH1 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 214,109 | Aman |
| | | Bawah | 11D22 | 35,800 | 383,4 | 504,538 | 400 | 4847,614 | 1583,732 | 1672,588 | 475,876 | 184,765 | 0,388 | Patah tarik | | 46,825 | Aman |
| | KH4 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9579,794 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7522,385 | Aman |
| | KH5 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9412,595 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9755,345 | Aman |
| | KH16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8308,695 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7380,592 | | Aman |
| | KH22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8903,377 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7391,590 | | Aman |
| | KH28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8616,384 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7795,149 | | Aman |
| | KH36 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8288,966 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7559,576 | | Aman |
| | KH44 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8596,023 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7212,236 | Aman |
| | KH50 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 301,058 | Aman |
| | | Bawah | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 51,908 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KH1 | Atas | 13,683 | 2,197 | 123,459 | 599,777 | 535,202 | 535,202 |
| | | Bawah | 13,683 | 2,197 | 123,459 | 599,777 | 535,202 | 535,202 |
| | KH4 | Atas | 33,019 | 3,496 | 39,264 | 155,313 | 203,250 | 155,313 |
| | | Bawah | 33,019 | 3,496 | 39,264 | 155,313 | 203,250 | 155,313 |
| | KH5 | Atas | 26,788 | 3,682 | 43,244 | 127,036 | 213,618 | 127,036 |
| | | Bawah | 26,788 | 3,682 | 43,244 | 127,036 | 213,618 | 127,036 |
| | KH16 | Atas | 24,87 | 3,265 | 35,837 | 207,277 | 180,057 | 180,057 |
| | | Bawah | 24,87 | 3,265 | 35,837 | 207,277 | 180,057 | 180,057 |
| | KH22 | Atas | 12,337 | 1,761 | 39,327 | 202,311 | 179,976 | 179,976 |
| | | Bawah | 12,337 | 1,761 | 39,327 | 202,311 | 179,976 | 179,976 |
| | KH28 | Atas | 20,844 | 3,757 | 42,458 | 212,753 | 204,155 | 204,155 |
| | | Bawah | 20,844 | 3,757 | 42,458 | 212,753 | 204,155 | 204,155 |
| | KH36 | Atas | 4,912 | 11,535 | 47,12 | 210,305 | 215,173 | 210,305 |
| | | Bawah | 4,912 | 11,535 | 47,12 | 210,305 | 215,173 | 210,305 |
| | KH44 | Atas | 6,528 | 3,758 | 56,419 | 218,100 | 247,760 | 218,100 |
| | | Bawah | 6,528 | 3,758 | 56,419 | 218,100 | 247,760 | 218,100 |
| | KH50 | Atas | 22,038 | 3,844 | 104,48 | 558,314 | 465,992 | 465,992 |
| | | Bawah | 22,038 | 3,844 | 104,48 | 558,314 | 465,992 | 465,992 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KH1 | Atas | 535,202 | 0 | 149,1 | 892,003 | 27,006 | 159,75 | 25 | P10-25 | AMAN |
| | | Bawah | 535,202 | 0 | 149,1 | 892,003 | 27,006 | 159,75 | 25 | P10-25 | AMAN |
| | KH4 | Atas | 155,313 | 0 | 149,1 | 258,855 | 93,063 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 155,313 | 0 | 149,1 | 258,855 | 93,063 | 159,75 | 90 | P10-90 | AMAN |
| | KH5 | Atas | 127,036 | 0 | 149,1 | 211,726 | 113,778 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 127,036 | 0 | 149,1 | 211,726 | 113,778 | 159,75 | 110 | P10-110 | AMAN |
| | KH16 | Atas | 180,057 | 0 | 149,1 | 300,095 | 80,274 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 180,057 | 0 | 149,1 | 300,095 | 80,274 | 159,75 | 80 | P10-80 | AMAN |
| | KH22 | Atas | 179,976 | 0 | 149,1 | 299,961 | 80,310 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 179,976 | 0 | 149,1 | 299,961 | 80,310 | 159,75 | 80 | P10-80 | AMAN |
| | KH28 | Atas | 204,155 | 0 | 149,1 | 340,258 | 70,799 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 204,155 | 0 | 149,1 | 340,258 | 70,799 | 159,75 | 70 | P10-70 | AMAN |
| | KH36 | Atas | 210,305 | 0 | 149,1 | 350,509 | 68,728 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 210,305 | 0 | 149,1 | 350,509 | 68,728 | 159,75 | 65 | P10-65 | AMAN |
| | KH44 | Atas | 218,100 | 0 | 149,1 | 363,499 | 66,272 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 218,100 | 0 | 149,1 | 363,499 | 66,272 | 159,75 | 65 | P10-65 | AMAN |
| | KH50 | Atas | 465,992 | 0 | 149,1 | 776,654 | 31,017 | 159,75 | 30 | P10-30 | AMAN |
| | | Bawah | 465,992 | 0 | 149,1 | 776,654 | 31,017 | 159,75 | 30 | P10-30 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KH1 | Atas | 194,619 | 372,750 | 149,1 | -48,385 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 194,619 | 372,750 | 149,1 | -48,385 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH4 | Atas | 56,477 | 372,750 | 149,1 | -278,621 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 56,477 | 372,750 | 149,1 | -278,621 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH5 | Atas | 46,195 | 372,750 | 149,1 | -295,759 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,195 | 372,750 | 149,1 | -295,759 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH16 | Atas | 65,475 | 372,750 | 149,1 | -263,624 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 65,475 | 372,750 | 149,1 | -263,624 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH22 | Atas | 65,446 | 372,750 | 149,1 | -263,673 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 65,446 | 372,750 | 149,1 | -263,673 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH28 | Atas | 74,238 | 372,750 | 149,1 | -249,020 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 74,238 | 372,750 | 149,1 | -249,020 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH36 | Atas | 76,475 | 372,750 | 149,1 | -245,292 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 76,475 | 372,750 | 149,1 | -245,292 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH44 | Atas | 79,309 | 372,750 | 149,1 | -240,568 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 79,309 | 372,750 | 149,1 | -240,568 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH50 | Atas | 169,452 | 372,750 | 149,1 | -90,331 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 169,452 | 372,750 | 149,1 | -90,331 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 4,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| **Ø pokok** | = | 22 mm | tk bawah | = | 5 m | **pb** | = | 40 mm | h blk atas | = | 600 mm |
| **Ø sengkang** | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KH6 | Atas | | | 417951,852 | 4,5 | 35,357 | Ok | 1499,976 | 264,142 | 126,451 | 131760,343 | 37395,365 | 131760,343 | 152096,906 | 1,023 | 2222,598 |
| | | Bawah | | | 10,990 | 4,5 | 35,357 | Ok | 1526,436 | 264,142 | 126,451 | 131565,852 | 37340,109 | 131565,852 | 151872,165 | 1,023 | 2254,350 |
| | KH7 | Atas | | | 16,056 | 5 | 39,286 | Ok | 1460,803 | 263,853 | 134,790 | 132047,607 | 37476,895 | 132047,607 | 14440,595 | 1,302 | 2175,128 |
| | | Bawah | | | 417951,852 | 5 | 39,286 | Ok | 1487,263 | 263,853 | 134,790 | 131843,737 | 37419,034 | 131843,737 | 14418,300 | 1,308 | 2206,880 |
| | KH17 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1611,103 | 570,342 | 12,729 | 141999,812 | 40301,465 | 141999,812 | 23035,643 | 1,235 | 2845,871 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1656,967 | 570,342 | 12,729 | 141487,261 | 40155,996 | 141487,261 | 22952,495 | 1,241 | 2900,908 |
| | KH23 | Atas | 4,014 | 2 | | | 37,143 | Ok | 1597,302 | 566,179 | 1,661 | 142023,346 | 40308,144 | 142023,346 | 23039,461 | 1,232 | 2822,649 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 1643,166 | 566,179 | 1,661 | 141506,056 | 40161,330 | 141506,056 | 22955,545 | 1,239 | 2877,686 |
| | KH29 | Atas | 4,014 | 2 | | | 37,143 | Ok | 2160,110 | 436,185 | 30,469 | 133379,795 | 37854,999 | 133379,795 | 21637,278 | 1,305 | 3290,028 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2205,974 | 436,185 | 30,469 | 133119,932 | 37781,235 | 133119,932 | 21595,122 | 1,313 | 3345,065 |
| | KH37 | Atas | 4,014 | 2 | | | 37,143 | Ok | 2076,789 | 314,767 | 10,495 | 130175,273 | 36945,501 | 130175,273 | 21117,430 | 1,279 | 2995,774 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2122,653 | 314,767 | 10,495 | 129960,119 | 36884,438 | 129960,119 | 21082,527 | 1,286 | 3050,811 |
| | KH45 | Atas | | | 8,028 | 2,3 | 42,714 | Ok | 1486,830 | 151,865 | 41,442 | 126839,407 | 35998,737 | 126839,407 | 139560,828 | 1,023 | 2025,980 |
| | | Bawah | | | 3,426 | 2,3 | 42,714 | Ok | 1538,750 | 151,865 | 41,442 | 126593,968 | 35929,078 | 126593,968 | 139290,772 | 1,024 | 2089,484 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KH6 | Atas | 18378,028 | 394928,141 | 1,077 | 11,929 | 2,821 | 14,685 | 51,275 | 1 | 0,000 | 0,000 | 1852,324 | 2383,418 | 1852,324 | 33,868 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 38,282 | 24,739 | 108,923 | 271,086 | 1 | 553,475 | 553,475 | 2052,299 | 2411,201 | 2052,299 | 89,755 | 1,3 |
| | KH7 | Atas | 18378,028 | 394928,141 | 1,077 | 53,448 | 41,442 | 79,442 | 348,207 | 1 | 553,475 | 553,475 | 1983,081 | 2377,007 | 1983,081 | 159,491 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 12,122 | 2,797 | 14,678 | 57,140 | 1 | 0,000 | 0,000 | 1838,672 | 2404,790 | 1838,672 | 0,891 | 1,3 |
| | KH17 | Atas | 18378,028 | 394928,141 | 1,077 | 17,180 | 10,325 | 114,674 | 201,980 | 1 | 553,475 | 553,475 | 2462,709 | 2343,979 | 2343,979 | 144,697 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 36,328 | 11,902 | 119,444 | 262,036 | 1 | 553,475 | 553,475 | 2510,867 | 2392,136 | 2392,136 | 170,160 | 1,3 |
| | KH23 | Atas | 18378,028 | 394928,141 | 1,077 | 63,263 | 4,549 | 113,544 | 305,567 | 1 | 553,475 | 553,475 | 2443,947 | 2278,631 | 2278,631 | 180,786 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 54,623 | 1,332 | 119,386 | 281,871 | 1 | 553,475 | 553,475 | 2492,004 | 2326,788 | 2326,788 | 180,453 | 1,3 |
| | KH29 | Atas | 18378,028 | 394928,141 | 1,077 | 29,884 | 12,706 | 116,361 | 247,369 | 1 | 553,475 | 553,475 | 2898,302 | 2854,080 | 2854,080 | 142,521 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 34,688 | 16,561 | 123,788 | 280,213 | 1 | 553,475 | 553,475 | 2946,459 | 2902,237 | 2902,237 | 152,273 | 1,3 |
| | KH37 | Atas | 18378,028 | 394928,141 | 1,077 | 1,234 | 0,920 | 119,450 | 140,619 | 1 | 553,475 | 553,475 | 2683,326 | 2555,213 | 2555,213 | 112,413 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 6,956 | 1,543 | 124,805 | 164,220 | 1 | 553,475 | 553,475 | 2731,483 | 2603,370 | 2603,370 | 126,211 | 1,3 |
| | KH45 | Atas | 18378,028 | 394928,141 | 1,077 | 33,552 | 14,693 | 82,295 | 206,206 | 1 | 553,475 | 553,475 | 1891,772 | 1893,636 | 1891,772 | 57,846 | 1,3 |
| | | Bawah | 18725,184 | 394166,927 | 1,079 | 29,684 | 10,799 | 139,167 | 252,738 | 1 | 553,475 | 553,475 | 1947,339 | 1949,202 | 1947,339 | 117,300 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KH6 | Atas | 119,799 | 0,000 | 11,452 | 38,173 | 77,165 | 38,173 | 51,275 | 7,889 | 284,973 | 0,028 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1128,592 | 926,562 | 523,649 | 523,649 | 523,649 | 80,561 | 315,738 | 0,255 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH7 | Atas | 469,730 | 469,730 | 1606,294 | 1470,689 | 433,291 | 433,291 | 433,291 | 66,660 | 305,089 | 0,218 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 119,799 | 0,000 | 0,232 | 0,774 | 77,313 | 0,774 | 57,140 | 8,791 | 282,873 | 0,031 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH17 | Atas | 553,475 | 553,475 | 769,176 | 769,176 | 510,511 | 510,511 | 510,511 | 78,540 | 360,612 | 0,218 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 905,023 | 906,169 | 552,201 | 552,201 | 552,201 | 84,954 | 368,021 | 0,231 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH23 | Atas | 553,475 | 553,475 | 837,626 | 837,626 | 548,087 | 548,087 | 548,087 | 84,321 | 350,559 | 0,241 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 836,537 | 837,596 | 560,174 | 560,174 | 560,174 | 86,181 | 357,967 | 0,241 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH29 | Atas | 553,475 | 571,326 | 812,182 | 819,208 | 533,436 | 533,436 | 533,436 | 82,067 | 439,089 | 0,187 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 571,326 | 867,755 | 875,262 | 573,721 | 573,721 | 573,721 | 88,265 | 446,498 | 0,198 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH37 | Atas | 469,730 | 480,781 | 762,750 | 702,750 | 503,847 | 503,847 | 503,847 | 77,515 | 393,110 | 0,197 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 480,781 | 856,373 | 789,008 | 533,105 | 533,105 | 533,105 | 82,018 | 400,518 | 0,205 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH45 | Atas | 469,730 | 480,781 | 534,753 | 492,687 | 396,254 | 396,254 | 396,254 | 60,962 | 291,042 | 0,209 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 389,330 | 1042,635 | 859,953 | 626,998 | 626,998 | 626,998 | 96,461 | 299,590 | 0,322 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 1 | KH6 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11220,180 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5915,633 | Aman |
| | KH7 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6660,300 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11132,079 | Aman |
| | KH17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6674,990 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6403,290 | Aman |
| | KH23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6205,850 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6201,490 | Aman |
| | KH29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7344,226 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7106,794 | Aman |
| | KH37 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7117,685 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6952,822 | Aman |
| | KH45 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6852,084 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4715,237 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KH6 | Atas | 40,204 | 5,74 | 72,614 | 147,416 | 353,220 | 147,416 |
| | | Bawah | 40,204 | 5,74 | 72,614 | 147,416 | 353,220 | 147,416 |
| | KH7 | Atas | 40,553 | 5,678 | 72,724 | 125,752 | 353,983 | 125,752 |
| | | Bawah | 40,553 | 5,678 | 72,724 | 125,752 | 353,983 | 125,752 |
| | KH17 | Atas | 32,078 | 0,577 | 59,836 | 272,490 | 285,599 | 272,490 |
| | | Bawah | 32,078 | 0,577 | 59,836 | 272,490 | 285,599 | 272,490 |
| | KH23 | Atas | 6,165 | 0,877 | 60,132 | 284,170 | 259,949 | 259,949 |
| | | Bawah | 6,165 | 0,877 | 60,132 | 284,170 | 259,949 | 259,949 |
| | KH29 | Atas | 19,171 | 1,023 | 59,566 | 283,886 | 271,381 | 271,381 |
| | | Bawah | 19,171 | 1,023 | 59,566 | 283,886 | 271,381 | 271,381 |
| | KH37 | Atas | 2,346 | 9,979 | 61,324 | 265,885 | 270,502 | 265,885 |
| | | Bawah | 2,346 | 9,979 | 61,324 | 265,885 | 270,502 | 265,885 |
| | KH45 | Atas | 11,334 | 3,771 | 66,335 | 262,372 | 294,467 | 262,372 |
| | | Bawah | 11,334 | 3,771 | 66,335 | 262,372 | 294,467 | 262,372 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KH6 | Atas | 147,416 | 0 | 149,1 | 245,694 | 99,048 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 147,416 | 0 | 149,1 | 245,694 | 99,048 | 159,75 | 95 | P10-95 | AMAN |
| | KH7 | Atas | 125,752 | 0 | 149,1 | 209,586 | 114,940 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 125,752 | 0 | 149,1 | 209,586 | 114,940 | 159,75 | 110 | P10-110 | AMAN |
| | KH17 | Atas | 272,490 | 0 | 149,1 | 454,151 | 53,044 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 272,490 | 0 | 149,1 | 454,151 | 53,044 | 159,75 | 50 | P10-50 | AMAN |
| | KH23 | Atas | 259,949 | 0 | 149,1 | 433,248 | 55,603 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 259,949 | 0 | 149,1 | 433,248 | 55,603 | 159,75 | 55 | P10-55 | AMAN |
| | KH29 | Atas | 271,381 | 0 | 149,1 | 452,302 | 53,260 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 271,381 | 0 | 149,1 | 452,302 | 53,260 | 159,75 | 50 | P10-50 | AMAN |
| | KH37 | Atas | 265,885 | 0 | 149,1 | 443,142 | 54,361 | 159,75 | 50 | P10-50 | AMAN |
| | | Bawah | 265,885 | 0 | 149,1 | 443,142 | 54,361 | 159,75 | 50 | P10-50 | AMAN |
| | KH45 | Atas | 262,372 | 0 | 149,1 | 437,287 | 55,089 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 262,372 | 0 | 149,1 | 437,287 | 55,089 | 159,75 | 55 | P10-55 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 1 | KH6 | Atas | 41,579 | 372,750 | 149,1 | -303,452 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 41,579 | 372,750 | 149,1 | -303,452 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH7 | Atas | 35,468 | 372,750 | 149,1 | -313,636 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 35,468 | 372,750 | 149,1 | -313,636 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH17 | Atas | 76,856 | 372,750 | 149,1 | -244,656 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 76,856 | 372,750 | 149,1 | -244,656 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH23 | Atas | 73,319 | 372,750 | 149,1 | -250,552 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 73,319 | 372,750 | 149,1 | -250,552 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH29 | Atas | 76,543 | 372,750 | 149,1 | -245,178 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 76,543 | 372,750 | 149,1 | -245,178 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH37 | Atas | 74,993 | 372,750 | 149,1 | -247,761 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 74,993 | 372,750 | 149,1 | -247,761 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH45 | Atas | 74,002 | 372,750 | 149,1 | -249,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 74,002 | 372,750 | 149,1 | -249,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | : | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 5 m | Ig atas | : | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 4,5 m | Ig bawah | : | 0,0072 m^4 | b blk atas | = | 400 mm |
| **Ø pokok** | = | 22 mm | tk bawah | = | 4,5 m | **pb** | : | 40 mm | h blk atas | = | 600 mm |
| **Ø sengkang** | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | : | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | : | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | : | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | : | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | : | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran | PD | PL | PE | $EI_1$ | $EI_2$ | EI pakai | Pc | δb | Pu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | ψ | K | ψ | K | | momen | KN | KN | KN | KNm^2 | KNm^2 | KNm^2 | KN | | KN |
| Lantai 2 | KH8 | Atas | | | 417951,852 | 5 | 39,286 | Ok | 1154,473 | 180,006 | 73,031 | 130460,155 | 37026,354 | 130460,155 | 66030,571 | 1,041 | 1673,377 |
| | | Bawah | | | 16,056 | 5 | 39,286 | Ok | 1180,933 | 180,006 | 73,031 | 130231,808 | 36961,547 | 130231,808 | 65914,997 | 1,041 | 1705,129 |
| | KH9 | Atas | | | 15,253 | 4,9 | 38,500 | Ok | 1115,186 | 179,737 | 80,725 | 130801,612 | 37123,265 | 130801,612 | 67554,495 | 1,038 | 1625,802 |
| | | Bawah | | | 417951,852 | 4,9 | 38,500 | Ok | 1141,646 | 179,737 | 80,725 | 130558,959 | 37054,396 | 130558,959 | 67429,163 | 1,039 | 1657,554 |
| | KH18 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1130,207 | 364,579 | 7,580 | 140336,265 | 39829,328 | 140336,265 | 177573,083 | 1,017 | 1939,575 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1176,071 | 364,579 | 7,580 | 139654,245 | 39635,761 | 139654,245 | 176710,077 | 1,018 | 1994,612 |
| | KH24 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1033,457 | 376,336 | 0,418 | 142524,818 | 40450,469 | 142524,818 | 23120,811 | 1,140 | 1842,286 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1079,321 | 376,336 | 0,418 | 141721,754 | 40222,548 | 141721,754 | 22990,536 | 1,145 | 1897,323 |
| | KH30 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1573,604 | 297,996 | 29,536 | 132598,782 | 37633,326 | 132598,782 | 21510,579 | 1,204 | 2365,118 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1619,468 | 297,996 | 29,536 | 132261,624 | 37537,636 | 132261,624 | 21455,884 | 1,210 | 2420,155 |
| | KH38 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1524,242 | 213,231 | 10,140 | 129404,565 | 36726,764 | 129404,565 | 20992,404 | 1,189 | 2170,260 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1570,107 | 213,231 | 10,140 | 129132,113 | 36649,438 | 129132,113 | 20948,206 | 1,195 | 2225,298 |
| | KH46 | Atas | | | 7,627 | 2,65 | 49,214 | Ok | 1105,211 | 114,876 | 41,224 | 126959,910 | 36037,937 | 126959,910 | 121243,342 | 1,020 | 1510,055 |
| | | Bawah | | | 8,028 | 2,65 | 49,214 | Ok | 1159,131 | 114,876 | 41,224 | 126628,743 | 35939,948 | 126628,743 | 120927,087 | 1,020 | 1573,559 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung | ΣPu | ΣPc | δs | MD | ML | ME | Mc | Rv | $Mkap_{ka}$ | $Mkap_{ki}$ | Nuk1 | Nuk2 | Nuk pakai | Mmaks | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KN | KN | | KNm | KNm | KNm | KNm | | KNm | KNm | KN | KN | KN | KNm | |
| Lantai 2 | KH8 | Atas | 13126,474 | 498025,256 | 1,042 | 1,859 | 5,376 | 12,568 | 30,590 | 1 | 0,000 | 0,000 | 1401,203 | 1707,933 | 1401,203 | 13,279 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 81,749 | 39,802 | 45,527 | 334,119 | 1 | 553,475 | 553,475 | 1601,178 | 1735,716 | 1601,178 | 161,465 | 1,3 |
| | KH9 | Atas | 13126,474 | 498025,256 | 1,042 | 145,593 | 40,033 | 70,713 | 510,951 | 1 | 553,475 | 553,475 | 1531,861 | 1698,714 | 1531,861 | 244,493 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 1,848 | 5,409 | 12,584 | 30,676 | 1 | 0,000 | 0,000 | 1387,452 | 1726,497 | 1387,452 | 15,202 | 1,3 |
| | KH18 | Atas | 13126,474 | 498025,256 | 1,042 | 9,456 | 8,465 | 112,459 | 164,296 | 1 | 553,475 | 553,475 | 1741,718 | 1601,361 | 1601,361 | 132,304 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 2,763 | 8,214 | 96,552 | 130,974 | 1 | 553,475 | 553,475 | 1789,875 | 1649,519 | 1649,519 | 102,401 | 1,3 |
| | KH24 | Atas | 13126,474 | 498025,256 | 1,042 | 27,379 | 0,182 | 111,069 | 189,411 | 1 | 553,475 | 553,475 | 1652,475 | 1482,038 | 1482,038 | 142,851 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 43,165 | 5,748 | 94,867 | 224,894 | 1 | 553,475 | 553,475 | 1700,632 | 1530,195 | 1530,195 | 138,596 | 1,3 |
| | KH30 | Atas | 13126,474 | 498025,256 | 1,042 | 15,251 | 10,306 | 123,447 | 200,429 | 1 | 553,475 | 553,475 | 2137,372 | 2089,231 | 2089,231 | 135,515 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 13,042 | 10,817 | 101,010 | 171,963 | 1 | 553,475 | 553,475 | 2185,529 | 2137,388 | 2137,388 | 110,130 | 1,3 |
| | KH38 | Atas | 13126,474 | 498025,256 | 1,042 | 17,427 | 1,485 | 125,376 | 184,948 | 1 | 553,475 | 553,475 | 1996,539 | 1866,935 | 1866,935 | 101,240 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 20,139 | 2,802 | 104,479 | 172,640 | 1 | 553,475 | 553,475 | 2044,697 | 1915,093 | 1915,093 | 78,136 | 1,3 |
| | KH46 | Atas | 13126,474 | 498025,256 | 1,042 | 91,180 | 22,072 | 72,580 | 341,267 | 1 | 553,475 | 553,475 | 1453,284 | 1454,232 | 1453,284 | 1,491 | 1,3 |
| | | Bawah | 13473,630 | 496375,950 | 1,044 | 71,810 | 20,793 | 34,878 | 252,456 | 1 | 553,475 | 553,475 | 1508,850 | 1509,798 | 1508,850 | 23,154 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung | $Mkap_{ka,by}$ | $Mkap_{ki,by}$ | $Muk_1$ | $Muk_2$ | $Muk_3$ | Muk pakai | Muk | Mn | Pn | e | % | Ast | As' = As perlu | n tulangan | As = As' ada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KNm | KNm | KNm | KNm | KNm | KNm | terpakai KNm | Ton-m | Ton | m | | $mm^2$ | $mm^2$ | | mm2 |
| Lantai 2 | KH8 | Atas | 119,799 | 0,000 | 3,176 | 10,588 | 60,382 | 10,588 | 30,590 | 4,706 | 215,570 | 0,022 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1492,521 | 1366,521 | 318,842 | 318,842 | 334,119 | 51,403 | 246,335 | 0,209 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH9 | Atas | 382,584 | 382,584 | 1463,458 | 1201,484 | 491,902 | 491,902 | 510,951 | 78,608 | 236,671 | 0,334 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 119,799 | 0,000 | 2,447 | 8,156 | 60,513 | 8,156 | 30,676 | 4,719 | 213,454 | 0,022 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH18 | Atas | 382,584 | 382,584 | 876,250 | 719,392 | 491,145 | 491,145 | 491,145 | 75,561 | 246,363 | 0,307 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 704,736 | 645,241 | 417,044 | 417,044 | 417,044 | 64,161 | 253,772 | 0,253 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH24 | Atas | 636,229 | 636,229 | 979,817 | 947,210 | 495,429 | 495,429 | 495,429 | 76,220 | 228,006 | 0,334 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 824,202 | 824,202 | 449,800 | 449,800 | 449,800 | 69,200 | 235,415 | 0,294 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH30 | Atas | 553,475 | 553,475 | 923,335 | 923,335 | 545,312 | 545,312 | 545,312 | 83,894 | 321,420 | 0,261 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 750,374 | 750,374 | 449,294 | 449,294 | 449,294 | 69,122 | 328,829 | 0,210 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH38 | Atas | 469,730 | 469,730 | 911,659 | 834,695 | 548,437 | 548,437 | 548,437 | 84,067 | 287,221 | 0,293 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 703,609 | 644,209 | 462,900 | 462,900 | 462,900 | 71,215 | 294,630 | 0,242 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH46 | Atas | 382,584 | 382,584 | 94,043 | 77,208 | 423,751 | 94,043 | 341,267 | 52,503 | 223,582 | 0,235 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1517,545 | 1389,432 | 243,721 | 243,721 | 252,456 | 38,839 | 232,131 | 0,167 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KH8 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11372,387 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6869,029 | Aman |
| | KH9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4529,830 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11365,146 | Aman |
| | KH18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4970,359 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5961,156 | Aman |
| | KH24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4518,218 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5192,375 | Aman |
| | KH30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5801,955 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6836,147 | Aman |
| | KH38 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5214,696 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6182,127 | Aman |
| | KH46 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6321,664 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7785,630 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KH8 | Atas | 39,803 | 5,873 | 59,917 | 93,515 | 299,611 | 93,515 |
| | | Bawah | 39,803 | 5,873 | 59,917 | 93,515 | 299,611 | 93,515 |
| | KH9 | Atas | 43,114 | 6,841 | 58,39 | 138,879 | 297,691 | 138,879 |
| | | Bawah | 43,114 | 6,841 | 58,39 | 138,879 | 297,691 | 138,879 |
| | KH18 | Atas | 26,63 | 3,874 | 47,969 | 232,869 | 233,499 | 232,869 |
| | | Bawah | 26,63 | 3,874 | 47,969 | 232,869 | 233,499 | 232,869 |
| | KH24 | Atas | 11,8 | 6,22 | 48,043 | 242,366 | 220,702 | 220,702 |
| | | Bawah | 11,8 | 6,22 | 48,043 | 242,366 | 220,702 | 220,702 |
| | KH30 | Atas | 31,771 | 1,505 | 49,204 | 255,027 | 241,597 | 241,597 |
| | | Bawah | 31,771 | 1,505 | 49,204 | 255,027 | 241,597 | 241,597 |
| | KH38 | Atas | 6,472 | 10,406 | 49,284 | 258,804 | 224,715 | 224,715 |
| | | Bawah | 6,472 | 10,406 | 49,284 | 258,804 | 224,715 | 224,715 |
| | KH46 | Atas | 11,508 | 4,31 | 56,047 | 152,236 | 252,006 | 152,236 |
| | | Bawah | 11,508 | 4,31 | 56,047 | 152,236 | 252,006 | 152,236 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KH8 | Atas | 93,515 | 0 | 149,1 | 155,859 | 154,562 | 159,75 | 150 | P10-150 | AMAN |
| | | Bawah | 93,515 | 0 | 149,1 | 155,859 | 154,562 | 159,75 | 150 | P10-150 | AMAN |
| | KH9 | Atas | 138,879 | 0 | 149,1 | 231,465 | 104,075 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 138,879 | 0 | 149,1 | 231,465 | 104,075 | 159,75 | 100 | P10-100 | AMAN |
| | KH18 | Atas | 232,869 | 0 | 149,1 | 388,115 | 62,069 | 159,75 | 60 | P10-60 | AMAN |
| | | Bawah | 232,869 | 0 | 149,1 | 388,115 | 62,069 | 159,75 | 60 | P10-60 | AMAN |
| | KH24 | Atas | 220,702 | 0 | 149,1 | 367,836 | 65,491 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 220,702 | 0 | 149,1 | 367,836 | 65,491 | 159,75 | 65 | P10-65 | AMAN |
| | KH30 | Atas | 241,597 | 0 | 149,1 | 402,661 | 59,826 | 159,75 | 55 | P10-55 | AMAN |
| | | Bawah | 241,597 | 0 | 149,1 | 402,661 | 59,826 | 159,75 | 55 | P10-55 | AMAN |
| | KH38 | Atas | 224,715 | 0 | 149,1 | 374,525 | 64,321 | 159,75 | 60 | P10-60 | AMAN |
| | | Bawah | 224,715 | 0 | 149,1 | 374,525 | 64,321 | 159,75 | 60 | P10-60 | AMAN |
| | KH46 | Atas | 152,236 | 0 | 149,1 | 253,727 | 94,944 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 152,236 | 0 | 149,1 | 253,727 | 94,944 | 159,75 | 90 | P10-90 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 2 | KH8 | Atas | 26,376 | 372,750 | 149,1 | -328,790 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 26,376 | 372,750 | 149,1 | -328,790 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH9 | Atas | 39,171 | 372,750 | 149,1 | -307,465 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 39,171 | 372,750 | 149,1 | -307,465 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH18 | Atas | 65,681 | 372,750 | 149,1 | -263,282 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 65,681 | 372,750 | 149,1 | -263,282 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH24 | Atas | 62,249 | 372,750 | 149,1 | -269,001 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 62,249 | 372,750 | 149,1 | -269,001 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH30 | Atas | 68,143 | 372,750 | 149,1 | -259,179 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 68,143 | 372,750 | 149,1 | -259,179 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH38 | Atas | 63,381 | 372,750 | 149,1 | -267,115 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 63,381 | 372,750 | 149,1 | -267,115 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH46 | Atas | 42,938 | 372,750 | 149,1 | -301,186 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 42,938 | 372,750 | 149,1 | -301,186 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 4,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,7 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,3 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,9 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.lr | Perbesara momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KH10 | Atas | | | 376156,667 | 5 | 45,238 | Ok | 756,358 | 106,868 | 29,093 | 129497,576 | 36753,161 | 129497,576 | 58095,265 | 1,029 | 1078,618 |
| | | Bawah | | | 15,253 | 5 | 45,238 | Ok | 785,758 | 106,868 | 29,093 | 129145,451 | 36653,224 | 129145,451 | 57937,294 | 1,030 | 1113,898 |
| | KH11 | Atas | | | 2,194 | 2,6 | 23,524 | Ok | 715,377 | 106,836 | 35,454 | 130029,381 | 36904,095 | 130029,381 | 9805,985 | 1,193 | 1029,390 |
| | | Bawah | | | 376156,667 | 2,6 | 23,524 | Ok | 744,777 | 106,836 | 35,454 | 129640,402 | 36793,698 | 129640,402 | 9776,651 | 1,201 | 1064,670 |
| | KH19 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 441,582 | 201,707 | 4,010 | 147066,500 | 41739,459 | 147066,500 | 19124,047 | 1,074 | 852,630 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 493,326 | 201,707 | 4,010 | 144772,439 | 41088,374 | 144772,439 | 18825,735 | 1,081 | 914,722 |
| | KH25 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 423,496 | 208,788 | 1,161 | 148727,920 | 42210,993 | 148727,920 | 19340,093 | 1,072 | 842,256 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 475,240 | 208,788 | 1,161 | 146244,043 | 41506,035 | 146244,043 | 19017,097 | 1,079 | 904,349 |
| | KH31 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 983,487 | 159,592 | 29,319 | 131090,405 | 37205,228 | 131090,405 | 17046,568 | 1,146 | 1411,532 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 1015,231 | 159,592 | 29,319 | 130543,397 | 37049,980 | 130543,397 | 16975,437 | 1,154 | 1473,624 |
| | KH39 | Atas | 3,613 | 1,98 | | | 41,486 | Ok | 949,882 | 112,619 | 9,009 | 127967,165 | 36318,810 | 127967,165 | 16640,432 | 1,139 | 1320,049 |
| | | Bawah | 3,813 | 1,98 | | | 41,486 | Ok | 1001,626 | 112,619 | 9,009 | 127547,432 | 36199,684 | 127547,432 | 16585,851 | 1,147 | 1382,142 |
| | KH47 | Atas | | | 1,463 | 1,9 | 39,810 | Ok | 694,124 | 75,905 | 39,143 | 127334,980 | 36139,388 | 127334,980 | 150329,158 | 1,010 | 954,397 |
| | | Bawah | | | 7,627 | 1,9 | 39,810 | Ok | 752,924 | 75,905 | 39,143 | 126742,115 | 35971,125 | 126742,115 | 149629,233 | 1,011 | 1024,957 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPü KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KH10 | Atas | 7488,871 | 290381,546 | 1,041 | 74,367 | 0,424 | 20,735 | 196,824 | 1 | 0,000 | 0,000 | 906,387 | 1028,578 | 906,387 | 42,964 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 19,110 | 30,890 | 37,923 | 157,383 | 1 | 553,475 | 553,475 | 1092,230 | 1059,448 | 1059,448 | 80,904 | 1,3 |
| | KH11 | Atas | 7488,871 | 290381,546 | 1,041 | 45,022 | 45,574 | 79,370 | 317,301 | 1 | 469,730 | 469,730 | 994,848 | 1012,230 | 994,848 | 57,361 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 74,140 | 0,383 | 20,747 | 211,858 | 1 | 0,000 | 0,000 | 894,194 | 1043,100 | 894,194 | 94,840 | 1,3 |
| | KH19 | Atas | 7488,871 | 290381,546 | 1,041 | 30,862 | 14,400 | 126,140 | 245,608 | 1 | 469,730 | 469,730 | 806,978 | 692,295 | 692,295 | 172,739 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 20,851 | 9,533 | 76,598 | 156,601 | 1 | 553,475 | 553,475 | 884,758 | 746,627 | 746,627 | 107,950 | 1,3 |
| | KH25 | Atas | 7488,871 | 290381,546 | 1,041 | 32,714 | 1,757 | 129,132 | 223,201 | 1 | 469,730 | 469,730 | 795,423 | 668,774 | 668,774 | 167,847 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 20,529 | 1,885 | 77,256 | 138,246 | 1 | 553,475 | 553,475 | 873,202 | 723,106 | 723,106 | 101,729 | 1,3 |
| | KH31 | Atas | 7488,871 | 290381,546 | 1,041 | 66,001 | 23,586 | 89,094 | 319,062 | 1 | 469,730 | 469,730 | 1310,757 | 1302,373 | 1302,373 | 144,625 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 35,183 | 16,570 | 69,010 | 204,418 | 1 | 553,475 | 553,475 | 1388,537 | 1356,704 | 1356,704 | 98,149 | 1,3 |
| | KH39 | Atas | 7488,871 | 290381,546 | 1,041 | 7,716 | 5,816 | 87,993 | 129,607 | 1 | 469,730 | 469,730 | 1247,150 | 1153,464 | 1153,464 | 71,254 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 13,491 | 3,986 | 68,976 | 118,891 | 1 | 553,475 | 553,475 | 1324,930 | 1207,795 | 1207,795 | 48,487 | 1,3 |
| | KH47 | Atas | 7488,871 | 290381,546 | 1,041 | 86,109 | 4,957 | 38,523 | 251,882 | 1 | 469,730 | 469,730 | 940,055 | 972,931 | 940,055 | 128,711 | 1,3 |
| | | Bawah | 7878,362 | 288747,298 | 1,044 | 12,383 | 14,650 | 24,592 | 88,866 | 1 | 553,475 | 553,475 | 1025,243 | 1034,671 | 1025,243 | 18,642 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KH10 | Atas | 119,799 | 0,000 | 14,279 | 47,597 | 165,618 | 47,597 | 196,824 | 30,281 | 139,444 | 0,217 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 999,903 | 820,910 | 211,777 | 211,777 | 211,777 | 32,581 | 162,992 | 0,200 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH11 | Atas | 469,730 | 469,730 | 527,228 | 527,228 | 428,480 | 428,480 | 428,480 | 65,920 | 153,054 | 0,431 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 119,799 | 0,000 | 25,652 | 85,508 | 165,387 | 85,508 | 211,858 | 32,594 | 137,568 | 0,237 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH19 | Atas | 553,475 | 553,475 | 896,344 | 978,991 | 577,313 | 577,313 | 577,313 | 88,817 | 106,507 | 0,834 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 655,811 | 706,849 | 353,615 | 353,615 | 353,615 | 54,402 | 114,866 | 0,474 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH25 | Atas | 553,475 | 553,475 | 906,864 | 990,481 | 578,549 | 578,549 | 578,549 | 89,008 | 102,888 | 0,865 | 1,2 | 5880 | 2940 | 8 | 3041,069 |
| | | Bawah | 636,229 | 636,229 | 643,495 | 693,574 | 348,010 | 348,010 | 348,010 | 53,540 | 111,247 | 0,481 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH31 | Atas | 553,475 | 553,475 | 867,662 | 947,665 | 468,261 | 468,261 | 468,261 | 72,040 | 200,365 | 0,360 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 666,397 | 666,397 | 344,183 | 344,183 | 344,183 | 52,951 | 208,724 | 0,254 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH39 | Atas | 553,475 | 553,475 | 866,714 | 946,630 | 383,779 | 383,779 | 383,779 | 59,043 | 177,456 | 0,333 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 644,164 | 589,783 | 308,050 | 308,050 | 308,050 | 47,392 | 185,815 | 0,255 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH47 | Atas | 382,584 | 382,584 | 1169,642 | 1047,572 | 257,416 | 257,416 | 257,416 | 39,602 | 144,624 | 0,274 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 193,678 | 159,008 | 131,671 | 131,671 | 131,671 | 20,257 | 157,730 | 0,128 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 3 | KH10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6688,598 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7058,601 | Aman |
| | KH11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3242,960 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6278,869 | Aman |
| | KH19 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1330,059 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2817,770 | Aman |
| | KH25 | Atas | 8D22 | 60,571 | 383,4 | 504,538 | 400 | 4847,614 | 1151,805 | 1216,428 | 478,299 | 159,119 | 0,333 | Patah tarik | | 1261,199 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2750,034 | Aman |
| | KH31 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4138,514 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5944,237 | Aman |
| | KH39 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4542,908 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5917,599 | Aman |
| | KH47 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5558,645 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8696,348 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KH10 | Atas | 43,408 | 6,323 | 46,832 | 92,864 | 248,912 | 92,864 |
| | | Bawah | 43,408 | 6,323 | 46,832 | 92,864 | 248,912 | 92,864 |
| | KH11 | Atas | 39,292 | 5,798 | 44,637 | 145,531 | 234,820 | 145,531 |
| | | Bawah | 39,292 | 5,798 | 44,637 | 145,531 | 234,820 | 145,531 |
| | KH19 | Atas | 42,357 | 2,815 | 40,555 | 211,575 | 217,762 | 211,575 |
| | | Bawah | 42,357 | 2,815 | 40,555 | 211,575 | 217,762 | 211,575 |
| | KH25 | Atas | 25,025 | 3,132 | 40,622 | 210,582 | 200,177 | 200,177 |
| | | Bawah | 25,025 | 3,132 | 40,622 | 210,582 | 200,177 | 200,177 |
| | KH31 | Atas | 22,602 | 1,524 | 33,277 | 184,648 | 165,096 | 165,096 |
| | | Bawah | 22,602 | 1,524 | 33,277 | 184,648 | 165,096 | 165,096 |
| | KH39 | Atas | 5,195 | 11,311 | 40,254 | 157,234 | 186,398 | 157,234 |
| | | Bawah | 5,195 | 11,311 | 40,254 | 157,234 | 186,398 | 157,234 |
| | KH47 | Atas | 6,433 | 3,584 | 41,517 | 88,429 | 184,889 | 88,429 |
| | | Bawah | 6,433 | 3,584 | 41,517 | 88,429 | 184,889 | 88,429 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KH10 | Atas | 92,864 | 0 | 149,1 | 154,773 | 155,646 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 92,864 | 0 | 149,1 | 154,773 | 155,646 | 159,75 | 155 | P10-155 | AMAN |
| | KH11 | Atas | 145,531 | 0 | 149,1 | 242,552 | 99,318 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 145,531 | 0 | 149,1 | 242,552 | 99,318 | 159,75 | 95 | P10-95 | AMAN |
| | KH19 | Atas | 211,575 | 0 | 149,1 | 352,624 | 68,316 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 211,575 | 0 | 149,1 | 352,624 | 68,316 | 159,75 | 65 | P10-65 | AMAN |
| | KH25 | Atas | 200,177 | 0 | 149,1 | 333,629 | 72,205 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 200,177 | 0 | 149,1 | 333,629 | 72,205 | 159,75 | 70 | P10-70 | AMAN |
| | KH31 | Atas | 165,096 | 0 | 149,1 | 275,160 | 87,548 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 165,096 | 0 | 149,1 | 275,160 | 87,548 | 159,75 | 85 | P10-85 | AMAN |
| | KH39 | Atas | 157,234 | 0 | 149,1 | 262,057 | 91,926 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 157,234 | 0 | 149,1 | 262,057 | 91,926 | 159,75 | 90 | P10-90 | AMAN |
| | KH47 | Atas | 88,429 | 0 | 149,1 | 147,381 | 163,452 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 88,429 | 0 | 149,1 | 147,381 | 163,452 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 3 | KH10 | Atas | 33,769 | 372,750 | 149,1 | -316,469 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 33,769 | 372,750 | 149,1 | -316,469 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH11 | Atas | 52,920 | 372,750 | 149,1 | -284,549 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 52,920 | 372,750 | 149,1 | -284,549 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH19 | Atas | 76,936 | 372,750 | 149,1 | -244,523 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 76,936 | 372,750 | 149,1 | -244,523 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH25 | Atas | 72,792 | 372,750 | 149,1 | -251,430 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 72,792 | 372,750 | 149,1 | -251,430 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH31 | Atas | 60,035 | 372,750 | 149,1 | -272,692 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 60,035 | 372,750 | 149,1 | -272,692 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH39 | Atas | 57,176 | 372,750 | 149,1 | -277,457 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 57,176 | 372,750 | 149,1 | -277,457 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | KH47 | Atas | 32,156 | 372,750 | 149,1 | -319,157 | 781,989 | 319,5 | 315 | P10-315 | AMAN |
| | | Bawah | 32,156 | 372,750 | 149,1 | -319,157 | 781,989 | 319,5 | 315 | P10-315 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 2,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KH12 | Atas | | | 2,751 | 1,7 | 35,619 | Ok | 246,202 | 6,200 | 2,962 | 121201,907 | 34398,739 | 121201,907 | 159922,523 | 1,003 | 305,362 |
| | | Bawah | | | 2,194 | 1,7 | 35,619 | Ok | 305,002 | 6,200 | 2,962 | 120827,448 | 34292,462 | 120827,448 | 159428,434 | 1,004 | 375,922 |
| | KH32 | Atas | | | 10,838 | 2,4 | 50,286 | Ok | 359,126 | 1,495 | 26,160 | 119563,212 | 33933,655 | 119563,212 | 10582,092 | 1,067 | 433,343 |
| | | Bawah | | | 3,613 | 2,4 | 50,286 | Ok | 410,870 | 1,495 | 26,160 | 119521,755 | 33921,889 | 119521,755 | 10578,422 | 1,078 | 495,436 |
| | KH40 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 373,111 | 12,937 | 10,192 | 121927,096 | 34604,557 | 121927,096 | 14094,772 | 1,054 | 468,432 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 424,855 | 12,937 | 10,192 | 121605,532 | 34513,293 | 121605,532 | 14057,599 | 1,062 | 530,525 |
| | KH48 | Atas | | | 2,194 | 1,55 | 32,476 | Ok | 315,576 | 26,296 | 30,063 | 125508,206 | 35620,924 | 125508,206 | 181630,811 | 1,004 | 420,765 |
| | | Bawah | | | 1,463 | 1,55 | 32,476 | Ok | 374,376 | 26,296 | 30,063 | 124566,734 | 35353,722 | 124566,734 | 180268,349 | 1,004 | 491,325 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ks}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KH12 | Atas | 1627,903 | 366230,198 | 1,007 | 110,676 | 9,000 | 5,779 | 276,474 | 1 | 0,000 | 382,584 | 318,584 | 277,463 | 277,463 | 93,996 | 1,3 |
| | | Bawah | 1893,208 | 364332,805 | 1,008 | 26,788 | 10,682 | 6,499 | 91,433 | 1 | 469,730 | 469,730 | 458,287 | 339,203 | 339,203 | 50,634 | 1,3 |
| | KH32 | Atas | 1627,903 | 366230,198 | 1,007 | 46,126 | 2,293 | 74,635 | 192,115 | 1 | 382,584 | 0,000 | 432,214 | 488,524 | 432,214 | 123,801 | 1,3 |
| | | Bawah | 1893,208 | 364332,805 | 1,008 | 16,503 | 14,254 | 69,961 | 146,490 | 1 | 469,730 | 469,730 | 564,508 | 542,855 | 542,855 | 85,339 | 1,3 |
| | KH40 | Atas | 1627,903 | 366230,198 | 1,007 | 39,952 | 1,816 | 101,360 | 204,139 | 1 | 382,584 | 382,584 | 512,474 | 448,157 | 448,157 | 63,603 | 1,3 |
| | | Bawah | 1893,208 | 364332,805 | 1,008 | 75,108 | 0,433 | 82,475 | 263,491 | 1 | 469,730 | 469,730 | 591,206 | 502,488 | 502,488 | 11,695 | 1,3 |
| | KH48 | Atas | 1627,903 | 366230,198 | 1,007 | 14,183 | 1,042 | 60,048 | 97,894 | 1 | 382,584 | 382,584 | 466,089 | 485,230 | 466,089 | 79,477 | 1,3 |
| | | Bawah | 1893,208 | 364332,805 | 1,008 | 38,083 | 5,282 | 39,454 | 139,803 | 1 | 469,730 | 469,730 | 552,230 | 546,970 | 546,970 | 88,318 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KH12 | Atas | 292,038 | 292,038 | 415,253 | 520,252 | 149,932 | 149,932 | 276,474 | 42,534 | 42,687 | 0,996 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 489,760 | 489,760 | 66,639 | 66,639 | 91,433 | 14,067 | 52,185 | 0,270 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH32 | Atas | 292,038 | 292,038 | 378,224 | 473,860 | 364,307 | 364,307 | 364,307 | 56,047 | 66,494 | 0,843 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 594,320 | 649,119 | 326,131 | 326,131 | 326,131 | 50,174 | 83,516 | 0,601 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH40 | Atas | 382,584 | 0,000 | 851,386 | 592,269 | 469,568 | 469,568 | 469,568 | 72,241 | 68,947 | 1,048 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 226,218 | 247,076 | 425,713 | 247,076 | 263,491 | 40,537 | 77,306 | 0,524 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH48 | Atas | 198,092 | 198,092 | 479,627 | 339,493 | 268,188 | 268,188 | 268,188 | 41,260 | 71,706 | 0,575 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 704,801 | 631,244 | 211,240 | 211,240 | 211,240 | 32,498 | 84,149 | 0,386 | 1 | 4900 | 2450 | 7 | 2660,935 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KH12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 908,751 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5638,997 | Aman |
| | KH32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1156,899 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1945,787 | Aman |
| | KH40 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 847,101 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2409,223 | Aman |
| | KH48 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2082,601 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3773,412 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KH12 | Atas | 26,956 | 2,687 | 17,611 | 83,615 | 105,091 | 83,615 |
| | | Bawah | 26,956 | 2,687 | 17,611 | 83,615 | 105,091 | 83,615 |
| | KH32 | Atas | 19,756 | 1,318 | 24,716 | 156,918 | 125,935 | 125,935 |
| | | Bawah | 19,756 | 1,318 | 24,716 | 156,918 | 125,935 | 125,935 |
| | KH40 | Atas | 24,422 | 1,251 | 7,612 | 166,604 | 58,927 | 58,927 |
| | | Bawah | 24,422 | 1,251 | 7,612 | 166,604 | 58,927 | 58,927 |
| | KH48 | Atas | 24,018 | 2,143 | 18,471 | 108,961 | 105,047 | 105,047 |
| | | Bawah | 24,018 | 2,143 | 18,471 | 108,961 | 105,047 | 105,047 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol : Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KH12 | Atas | 83,615 | 0 | 149,1 | 139,359 | 172,862 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 83,615 | 0 | 149,1 | 139,359 | 172,862 | 159,75 | 155 | P10-155 | AMAN |
| | KH32 | Atas | 125,935 | 0 | 149,1 | 209,892 | 114,773 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 125,935 | 0 | 149,1 | 209,892 | 114,773 | 159,75 | 110 | P10-110 | AMAN |
| | KH40 | Atas | 58,927 | 0 | 149,1 | 98,212 | 245,284 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 58,927 | 0 | 149,1 | 98,212 | 245,284 | 159,75 | 155 | P10-155 | AMAN |
| | KH48 | Atas | 105,047 | 0 | 149,1 | 175,079 | 137,594 | 159,75 | 135 | P10-135 | AMAN |
| | | Bawah | 105,047 | 0 | 149,1 | 175,079 | 137,594 | 159,75 | 135 | P10-135 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KH12 | Atas | 30,406 | 372,750 | 149,1 | -322,074 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 30,406 | 372,750 | 149,1 | -322,074 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH32 | Atas | 45,795 | 372,750 | 149,1 | -296,426 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 45,795 | 372,750 | 149,1 | -296,426 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH40 | Atas | 21,428 | 372,750 | 149,1 | -337,037 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 21,428 | 372,750 | 149,1 | -337,037 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KH48 | Atas | 38,199 | 372,750 | 149,1 | -309,085 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 38,199 | 372,750 | 149,1 | -309,085 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-H

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 0 m | Ig atas | = 0,0016 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 2,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 300 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 400 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,7 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,3 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,9 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KH13 | Atas | | | 188078,333 | 2,8 | 28,000 | Ok | 77,028 | 0,811 | 0,944 | 106812,573 | 7572,416 | 106812,573 | 188250,495 | 1,001 | 93,731 |
| | | Bawah | | | 2,751 | 2,8 | 28,000 | Ok | 106,428 | 0,811 | 0,944 | 119835,882 | 34011,042 | 119835,882 | 211203,265 | 1,001 | 129,011 |
| | KH33 | Atas | | | 32,514 | 3,9 | 39,000 | Ok | 148,179 | 0,356 | 4,376 | 106242,847 | 7532,025 | 106242,847 | 134433,305 | 1,002 | 178,384 |
| | | Bawah | | | 10,838 | 3,9 | 39,000 | Ok | 171,699 | 0,356 | 4,376 | 119397,809 | 33886,711 | 119397,809 | 151078,802 | 1,002 | 206,608 |
| | KH41 | Atas | 16,257 | 2,8 | | | 28,000 | Ok | 112,760 | 0,081 | 0,105 | 106123,998 | 7523,600 | 106123,998 | 187036,925 | 1,001 | 135,442 |
| | | Bawah | 5,419 | 2,8 | | | 28,000 | Ok | 136,280 | 0,081 | 0,105 | 119280,452 | 33853,404 | 119280,452 | 210224,353 | 1,001 | 163,666 |
| | KH49 | Atas | | | 32,514 | 2,5 | 25,000 | Ok | 57,134 | 0,221 | 3,371 | 106346,056 | 7539,342 | 106346,056 | 209919,682 | 1,001 | 68,914 |
| | | Bawah | | | 2,194 | 2,5 | 25,000 | Ok | 86,534 | 0,221 | 3,371 | 119435,887 | 33897,518 | 119435,887 | 235758,094 | 1,001 | 104,194 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $ω_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KH13 | Atas | 476,472 | 719640,407 | 1,001 | 2,542 | 0,168 | 0,478 | 6,602 | 1 | 0,000 | 0,000 | 81,731 | 85,696 | 81,731 | 3,287 | 1 |
| | | Bawah | 603,480 | 808264,514 | 1,001 | 10,699 | 0,576 | 0,427 | 25,832 | 1 | 0,000 | 382,584 | 219,724 | 116,566 | 116,566 | 9,160 | 1 |
| | KH33 | Atas | 476,472 | 719640,407 | 1,001 | 45,404 | 0,540 | 14,825 | 119,108 | 1 | 119,799 | 0,000 | 189,505 | 174,341 | 174,341 | 62,499 | 1 |
| | | Bawah | 603,480 | 808264,514 | 1,001 | 43,766 | 2,484 | 0,565 | 104,781 | 1 | 382,584 | 0,000 | 287,781 | 199,037 | 199,037 | 55,200 | 1 |
| | KH41 | Atas | 476,472 | 719640,407 | 1,001 | 23,250 | 0,943 | 25,671 | 81,456 | 1 | 119,799 | 119,799 | 185,570 | 118,924 | 118,924 | 4,499 | 1 |
| | | Bawah | 603,480 | 808264,514 | 1,001 | 28,227 | 1,284 | 33,530 | 101,699 | 1 | 382,584 | 382,584 | 357,426 | 143,620 | 143,620 | 8,619 | 1 |
| | KH49 | Atas | 476,472 | 719640,407 | 1,001 | 46,251 | 0,453 | 9,448 | 115,084 | 1 | 0,000 | 119,799 | 93,766 | 74,381 | 74,381 | 31,999 | 1 |
| | | Bawah | 603,480 | 808264,514 | 1,001 | 10,638 | 3,106 | 21,428 | 53,414 | 1 | 382,584 | 382,584 | 305,340 | 105,251 | 105,251 | 12,430 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KH13 | Atas | 119,799 | 119,799 | 17,522 | 58,406 | 4,853 | 4,853 | 6,602 | 1,016 | 12,574 | 0,081 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 418,811 | 524,710 | 13,632 | 13,632 | 25,832 | 3,974 | 17,933 | 0,222 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH33 | Atas | 172,898 | 172,898 | 109,569 | 187,112 | 110,506 | 110,506 | 119,108 | 18,324 | 26,822 | 0,683 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 266,903 | 334,391 | 50,936 | 50,936 | 104,781 | 16,120 | 30,621 | 0,526 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH41 | Atas | 0,000 | 0,000 | 75,852 | 22,756 | 133,221 | 75,852 | 81,456 | 12,532 | 18,296 | 0,685 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 0,000 | 589,858 | 410,336 | 171,813 | 171,813 | 171,813 | 26,433 | 22,095 | 1,196 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KH49 | Atas | 119,799 | 0,000 | 103,539 | 103,539 | 88,721 | 88,721 | 115,084 | 17,705 | 11,443 | 1,547 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 198,092 | 198,092 | 252,332 | 178,607 | 104,429 | 104,429 | 104,429 | 16,066 | 16,192 | 0,992 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai Atap | KH13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9864,743 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6594,818 | Aman |
| | KH33 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1591,051 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2394,505 | Aman |
| | KH41 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1584,740 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 707,082 | Aman |
| | KH49 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 506,657 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 914,238 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KH13 | Atas | 25,687 | 0,085 | 0,43 | 16,217 | 28,867 | 16,217 |
| | | Bawah | 25,687 | 0,085 | 0,43 | 16,217 | 28,867 | 16,217 |
| | KH33 | Atas | 20,205 | 0,942 | 11,436 | 111,944 | 70,236 | 70,236 |
| | | Bawah | 20,205 | 0,942 | 11,436 | 111,944 | 70,236 | 70,236 |
| | KH41 | Atas | 2,76 | 0,124 | 1,529 | 126,634 | 9,450 | 9,450 |
| | | Bawah | 2,76 | 0,124 | 1,529 | 126,634 | 9,450 | 9,450 |
| | KH49 | Atas | 21,872 | 2,844 | 9,831 | 109,756 | 67,242 | 67,242 |
| | | Bawah | 21,872 | 2,844 | 9,831 | 109,756 | 67,242 | 67,242 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KH13 | Atas | 16,217 | 0 | 149,1 | 27,029 | 891,271 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 16,217 | 0 | 149,1 | 27,029 | 891,271 | 159,75 | 155 | P10-155 | AMAN |
| | KH33 | Atas | 70,236 | 0 | 149,1 | 117,059 | 205,791 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 70,236 | 0 | 149,1 | 117,059 | 205,791 | 159,75 | 155 | P10-155 | AMAN |
| | KH41 | Atas | 9,450 | 0 | 149,1 | 15,750 | 1529,510 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 9,450 | 0 | 149,1 | 15,750 | 1529,510 | 159,75 | 155 | P10-155 | AMAN |
| | KH49 | Atas | 67,242 | 0 | 149,1 | 112,070 | 214,953 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 67,242 | 0 | 149,1 | 112,070 | 214,953 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai Atap | KH13 | Atas | -6,178 | 372,750 | 149,1 | -383,047 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -6,178 | 372,750 | 149,1 | -383,047 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KH33 | Atas | -26,756 | 372,750 | 149,1 | -417,344 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -26,756 | 372,750 | 149,1 | -417,344 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KH41 | Atas | -3,600 | 372,750 | 149,1 | -378,750 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -3,600 | 372,750 | 149,1 | -378,750 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | KH49 | Atas | -25,616 | 372,750 | 149,1 | -415,443 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -25,616 | 372,750 | 149,1 | -415,443 | 161,568 | 319,500 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 3,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 1,2 m | Ig bawah | = 0 m^4 | b blk atas | = 400 mm |
| **Ø pokok** | = 22 mm | tk bawah | = 0 m | **pb** | = 40 mm | h blk atas | = 600 mm |
| **Ø sengkang** | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 0 m | b blk bawah | = 0 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 0 m | h blk bawah | = 0 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 0 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 0 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KI1 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2487,968 | 176,455 | 363,039 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2505,608 | 176,455 | 363,039 | | | | | | |
| | KI13 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3874,392 | 583,170 | 133,497 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3892,032 | 583,170 | 133,497 | | | | | | |
| | KI21 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3278,222 | 631,352 | 141,133 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3295,862 | 631,352 | 141,133 | | | | | | |
| | KI29 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3600,590 | 523,359 | 174,281 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3618,230 | 523,359 | 174,281 | | | | | | |
| | KI37 | Atas | 10,107 | 4,3 | | | 12,286 | Tidak | 3381,357 | 287,862 | 198,132 | | | | | | |
| | | Bawah | 391829,861 | 4,3 | | | 12,286 | Tidak | 3402,525 | 287,862 | 198,132 | | | | | | |
| | KI49 | Atas | | | 20,213 | 6 | 17,143 | Tidak | 2324,255 | 89,618 | 43,743 | | | | | | |
| | | Bawah | | | 391829,861 | 6 | 17,143 | Tidak | 2341,895 | 89,618 | 43,743 | | | | | | |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KI1 | Atas | | | | 24,127 | 0,651 | 71,184 | | 0,925 | 292,038 | 0,000 | 2955,223 | 4322,408 | 2955,223 | 99,585 | 1 |
| | | Bawah | | | | 9,715 | 1,236 | 127,589 | | 0,925 | 0,000 | 0,000 | 2816,166 | 4340,930 | 2816,166 | 127,450 | 1 |
| | KI13 | Atas | | | | 12,758 | 1,301 | 56,838 | | 0,925 | 292,038 | 292,038 | 4995,598 | 5241,128 | 4995,598 | 72,198 | 1 |
| | | Bawah | | | | 22,441 | 1,870 | 135,765 | | 0,925 | 0,000 | 0,000 | 4698,962 | 5259,650 | 4698,962 | 122,091 | 1 |
| | KI21 | Atas | | | | 7,459 | 0,602 | 55,989 | | 0,925 | 292,038 | 292,038 | 4420,210 | 4697,811 | 4420,210 | 66,972 | 1 |
| | | Bawah | | | | 21,583 | 3,135 | 136,925 | | 0,925 | 0,000 | 0,000 | 4123,575 | 4716,333 | 4123,575 | 122,858 | 1 |
| | KI29 | Atas | | | | 9,085 | 0,006 | 56,115 | | 0,925 | 292,038 | 292,038 | 4645,304 | 5062,127 | 4645,304 | 49,293 | 1 |
| | | Bawah | | | | 20,190 | 4,435 | 138,251 | | 0,925 | 0,000 | 0,000 | 4348,668 | 5080,649 | 4348,668 | 123,898 | 1 |
| | KI37 | Atas | | | | 6,161 | 0,494 | 39,204 | | 0,925 | 292,038 | 292,038 | 4167,838 | 4684,834 | 4167,838 | 48,649 | 1 |
| | | Bawah | | | | 20,817 | 5,249 | 140,325 | | 0,925 | 0,000 | 0,000 | 3874,906 | 4707,061 | 3874,906 | 124,344 | 1 |
| | KI49 | Atas | | | | 20,038 | 0,451 | 72,507 | | 0,925 | 0,000 | 292,038 | 2692,145 | 2718,287 | 2692,145 | 55,301 | 1 |
| | | Bawah | | | | 36,002 | 5,762 | 133,590 | | 0,925 | 0,000 | 0,000 | 2553,089 | 2736,809 | 2553,089 | 102,749 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasar | KI1 | Atas | 0,000 | 198,092 | 239,073 | 194,341 | 324,990 | 239,073 | 239,073 | 36,781 | 454,650 | 0,081 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 547,372 | 547,372 | 547,372 | 84,211 | 433,256 | 0,194 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI13 | Atas | 0,000 | 198,092 | 370,830 | 215,129 | 253,482 | 253,482 | 253,482 | 38,997 | 768,554 | 0,051 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 595,740 | 595,740 | 595,740 | 91,652 | 722,917 | 0,127 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI21 | Atas | 0,000 | 198,092 | 352,068 | 204,245 | 243,618 | 243,618 | 243,618 | 37,480 | 680,032 | 0,055 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 601,039 | 601,039 | 601,039 | 92,468 | 634,396 | 0,146 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI29 | Atas | 0,000 | 198,092 | 284,026 | 164,772 | 245,229 | 245,229 | 245,229 | 37,727 | 714,662 | 0,053 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 606,510 | 606,510 | 606,510 | 93,309 | 669,026 | 0,139 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI37 | Atas | 0,000 | 198,092 | 280,636 | 162,805 | 171,645 | 171,645 | 171,645 | 26,407 | 641,206 | 0,041 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 616,734 | 616,734 | 616,734 | 94,882 | 596,139 | 0,159 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI49 | Atas | 0,000 | 198,092 | 190,708 | 155,025 | 326,043 | 190,708 | 190,708 | 29,340 | 414,176 | 0,071 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 0,000 | 0,000 | 604,930 | 604,930 | 604,930 | 93,066 | 392,783 | 0,237 | 1 | 4900 | 2450 | 7 | 2660,935 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Dasar | KI1 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9861,682 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7179,366 | Aman |
| | KI13 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10312,083 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8166,192 | | Aman |
| | KI21 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10158,405 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7763,434 | | Aman |
| | KI29 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10239,485 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7892,375 | | Aman |
| | KI37 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10664,752 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7502,129 | | Aman |
| | KI49 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10114,565 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6278,580 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Dasar | KI1 | Atas | 18,628 | 0,143 | 23,359 | 873,829 | 117,817 | 117,817 |
| | | Bawah | 18,628 | 0,143 | 23,359 | 873,829 | 117,817 | 117,817 |
| | KI13 | Atas | 17,618 | 3,201 | 26,396 | 943,579 | 132,723 | 132,723 |
| | | Bawah | 17,618 | 3,201 | 26,396 | 943,579 | 132,723 | 132,723 |
| | KI21 | Atas | 18,581 | 2,468 | 28,582 | 938,508 | 142,146 | 142,146 |
| | | Bawah | 18,581 | 2,468 | 28,582 | 938,508 | 142,146 | 142,146 |
| | KI29 | Atas | 16,428 | 2,754 | 30,872 | 946,377 | 149,804 | 149,804 |
| | | Bawah | 16,428 | 2,754 | 30,872 | 946,377 | 149,804 | 149,804 |
| | KI37 | Atas | 13,95 | 3,507 | 32,955 | 875,977 | 156,741 | 156,741 |
| | | Bawah | 13,95 | 3,507 | 32,955 | 875,977 | 156,741 | 156,741 |
| | KI49 | Atas | 1,959 | 1,848 | 33,119 | 884,042 | 143,097 | 143,097 |
| | | Bawah | 1,959 | 1,848 | 33,119 | 884,042 | 143,097 | 143,097 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc | Vs min mm^2 | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Dasar | KI1 | Atas | 117,817 | 0 | 149,1 | 196,362 | 122,680 | 159,75 | 120 | P10-120 | AMAN |
| | | Bawah | 117,817 | 0 | 149,1 | 196,362 | 122,680 | 159,75 | 120 | P10-120 | AMAN |
| | KI13 | Atas | 132,723 | 0 | 149,1 | 221,205 | 108,902 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 132,723 | 0 | 149,1 | 221,205 | 108,902 | 159,75 | 105 | P10-105 | AMAN |
| | KI21 | Atas | 142,146 | 0 | 149,1 | 236,910 | 101,683 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 142,146 | 0 | 149,1 | 236,910 | 101,683 | 159,75 | 100 | P10-100 | AMAN |
| | KI29 | Atas | 149,804 | 0 | 149,1 | 249,673 | 96,486 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 149,804 | 0 | 149,1 | 249,673 | 96,486 | 159,75 | 95 | P10-95 | AMAN |
| | KI37 | Atas | 156,741 | 0 | 149,1 | 261,235 | 92,215 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 156,741 | 0 | 149,1 | 261,235 | 92,215 | 159,75 | 90 | P10-90 | AMAN |
| | KI49 | Atas | 143,097 | 0 | 149,1 | 238,495 | 101,007 | 159,75 | 100 | P10-100 | AMAN |
| | | Bawah | 143,097 | 0 | 149,1 | 238,495 | 101,007 | 159,75 | 100 | P10-100 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 3,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 1,2 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KI2 | Atas | | | 12,386 | 3,5 | 48,333 | Ok | 2340,169 | 175,967 | 341,174 | 124924,993 | 35455,401 | 124924,993 | 121474,486 | 1,041 | 3089,750 |
| | | Bawah | | | 20,213 | 3,5 | 48,333 | Ok | 2381,329 | 175,967 | 341,174 | 124831,233 | 35428,790 | 124831,233 | 121383,315 | 1,041 | 3139,142 |
| | KI14 | Atas | 4,387 | 2,5 | | | 34,524 | Ok | 3678,680 | 582,731 | 124,183 | 130622,134 | 37072,326 | 130622,134 | 24526,893 | 1,505 | 5346,786 |
| | | Bawah | 10,107 | 2,5 | | | 34,524 | Ok | 3712,784 | 582,731 | 124,183 | 130527,430 | 37045,448 | 130527,430 | 24509,110 | 1,511 | 5387,710 |
| | KI22 | Atas | 4,387 | 2,5 | | | 34,524 | Ok | 3079,101 | 630,725 | 130,792 | 133559,379 | 37905,956 | 133559,379 | 25078,419 | 1,406 | 4704,081 |
| | | Bawah | 10,107 | 2,5 | | | 34,524 | Ok | 3113,205 | 630,725 | 130,792 | 133421,116 | 37866,715 | 133421,116 | 25052,457 | 1,411 | 4745,006 |
| | KI30 | Atas | 4,387 | 2,5 | | | 34,524 | Ok | 3403,432 | 522,841 | 163,121 | 130310,009 | 36983,741 | 130310,009 | 24468,285 | 1,448 | 4920,664 |
| | | Bawah | 10,107 | 2,5 | | | 34,524 | Ok | 3437,536 | 522,841 | 163,121 | 130210,233 | 36955,423 | 130210,233 | 24449,550 | 1,454 | 4961,589 |
| | KI38 | Atas | 20,644 | 3,6 | | | 19,714 | Tidak | 3205,963 | 287,326 | 186,039 | 125955,554 | 35747,888 | 125955,554 | 11405,599 | 0,000 | 4306,877 |
| | | Bawah | 12,687 | 3,6 | | | 19,714 | Tidak | 3226,543 | 287,326 | 186,039 | 125915,079 | 35736,401 | 125915,079 | 11401,934 | 0,000 | 4331,573 |
| | KI39 | Atas | 8,773 | 3,3 | | | 18,071 | Tidak | 3163,320 | 284,840 | 180,530 | 125985,433 | 35756,368 | 125985,433 | 13576,825 | 0,000 | 4251,728 |
| | | Bawah | 20,644 | 3,3 | | | 18,071 | Tidak | 3183,900 | 284,840 | 180,530 | 125944,245 | 35744,678 | 125944,245 | 13572,387 | 0,000 | 4276,424 |
| | KI50 | Atas | | | 20,644 | 4,3 | 23,548 | Ok | 2196,518 | 88,842 | 42,429 | 122363,872 | 34728,520 | 122363,872 | 96847,527 | 1,046 | 2777,969 |
| | | Bawah | | | 25,374 | 4,3 | 23,548 | Ok | 2210,630 | 88,842 | 42,429 | 122344,409 | 34722,996 | 122344,409 | 96832,122 | 1,046 | 2794,903 |
| | KI51 | Atas | | | 17,547 | 3,9 | 21,357 | Tidak | 2156,242 | 86,538 | 36,920 | 122340,275 | 34721,823 | 122340,275 | 106760,014 | 0,000 | 2725,951 |
| | | Bawah | | | 20,644 | 3,9 | 21,357 | Tidak | 2170,354 | 86,538 | 36,920 | 122320,595 | 34716,237 | 122320,595 | 106742,841 | 0,000 | 2742,886 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KI2 | Atas | 32123,806 | 424138,049 | 1,132 | 52,277 | 4,640 | 12,745 | 153,600 | 0,95 | 553,475 | 553,475 | 2852,263 | 4074,874 | 2852,263 | 78,437 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 1,133 | 30,241 | 0,060 | 108,057 | 202,483 | 0,95 | 292,038 | 0,000 | 2740,648 | 4118,092 | 2740,648 | 146,418 | 1,3 |
| | KI14 | Atas | 32123,806 | 424138,049 | 1,132 | 59,077 | 0,182 | 38,399 | 223,083 | 0,95 | 553,475 | 553,475 | 4684,802 | 4996,050 | 4684,802 | 7,377 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 1,133 | 18,151 | 1,261 | 118,737 | 199,730 | 0,95 | 292,038 | 292,038 | 4621,265 | 5031,859 | 4621,265 | 107,415 | 1,3 |
| | KI22 | Atas | 32123,806 | 424138,049 | 1,132 | 45,555 | 2,937 | 35,212 | 181,530 | 0,95 | 553,475 | 553,475 | 4105,638 | 4444,644 | 4105,638 | 2,691 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 1,133 | 12,398 | 1,598 | 117,835 | 180,696 | 0,95 | 292,038 | 292,038 | 4042,101 | 4480,453 | 4042,101 | 110,649 | 1,3 |
| | KI30 | Atas | 32123,806 | 424138,049 | 1,132 | 32,980 | 5,092 | 36,950 | 155,845 | 0,95 | 553,475 | 553,475 | 4332,907 | 4807,595 | 4332,907 | 73,570 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 1,133 | 4,878 | 1,487 | 118,113 | 159,367 | 0,95 | 292,038 | 292,038 | 4269,370 | 4843,504 | 4269,370 | 128,593 | 1,3 |
| | KI38 | Atas | 32123,806 | 424138,049 | 0,000 | 13,806 | 3,930 | 32,322 | 0,000 | 0,95 | 119,799 | 0,000 | 3690,715 | 4449,317 | 3690,715 | 19,652 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 0,000 | 20,542 | 4,620 | 134,772 | 0,000 | 0,95 | 292,038 | 292,038 | 3800,537 | 4470,926 | 3800,537 | 117,231 | 1,3 |
| | KI39 | Atas | 32123,806 | 424138,049 | 0,000 | 101,958 | 22,326 | 55,206 | 0,000 | 0,95 | 553,475 | 553,475 | 3830,889 | 4378,794 | 3830,889 | 34,228 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 0,000 | 37,506 | 6,425 | 52,217 | 0,000 | 0,95 | 119,799 | 0,000 | 3664,939 | 4400,403 | 3664,939 | 95,551 | 1,3 |
| | KI50 | Atas | 32123,806 | 424138,049 | 1,132 | 25,034 | 4,484 | 46,663 | 127,342 | 0,95 | 0,000 | 119,799 | 2422,390 | 2577,830 | 2422,390 | 25,887 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 1,133 | 25,859 | 0,232 | 97,225 | 179,473 | 0,95 | 0,000 | 292,038 | 2469,933 | 2592,647 | 2469,933 | 74,469 | 1,3 |
| | KI51 | Atas | 32123,806 | 424138,049 | 0,000 | 45,591 | 1,925 | 1,074 | 0,000 | 0,95 | 553,475 | 553,475 | 2565,240 | 2509,983 | 2509,983 | 38,242 | 1,3 |
| | | Bawah | 32379,233 | 423943,717 | 0,000 | 15,341 | 2,250 | 46,078 | 0,000 | 0,95 | 0,000 | 119,799 | 2392,498 | 2524,801 | 2392,498 | 65,203 | 1,3 |

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**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Besment | KI2 | Atas | 382,584 | 382,584 | 567,176 | 465,646 | 113,292 | 113,292 | 153,600 | 23,631 | 439,810 | 0,054 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 278,423 | 226,328 | 485,655 | 279,423 | 278,423 | 42,834 | 421,638 | 0,102 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI14 | Atas | 469,730 | 469,730 | 108,576 | 99,410 | 223,498 | 108,576 | 223,083 | 34,320 | 720,739 | 0,048 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 732,546 | 424,971 | 519,078 | 519,078 | 519,078 | 79,958 | 710,964 | 0,112 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI22 | Atas | 469,730 | 469,730 | 40,114 | 36,726 | 198,807 | 40,114 | 181,530 | 27,928 | 631,637 | 0,044 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 764,268 | 443,374 | 509,603 | 509,603 | 509,603 | 78,400 | 621,862 | 0,126 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI30 | Atas | 553,475 | 553,475 | 637,090 | 637,090 | 195,166 | 195,166 | 195,166 | 30,025 | 666,601 | 0,045 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 497,963 | 288,883 | 502,758 | 497,963 | 497,963 | 76,810 | 656,826 | 0,117 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI38 | Atas | 0,000 | 0,000 | 20,924 | 6,277 | 154,375 | 20,924 | 20,924 | 3,219 | 567,802 | 0,006 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 670,463 | 386,954 | 592,463 | 592,463 | 592,463 | 91,148 | 584,698 | 0,156 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI39 | Atas | 382,584 | 382,584 | 428,822 | 352,058 | 362,363 | 362,363 | 362,363 | 55,748 | 599,367 | 0,095 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 107,304 | 32,191 | 265,439 | 107,304 | 107,304 | 16,508 | 563,837 | 0,029 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI50 | Atas | 0,000 | 0,000 | 37,594 | 11,278 | 226,979 | 37,594 | 127,342 | 19,591 | 372,675 | 0,053 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 198,092 | 317,282 | 257,916 | 435,741 | 317,282 | 317,282 | 48,813 | 379,990 | 0,128 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI51 | Atas | 382,584 | 382,584 | 601,078 | 493,479 | 54,403 | 54,403 | 54,403 | 8,370 | 386,151 | 0,022 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 91,863 | 27,559 | 211,998 | 91,863 | 91,863 | 14,133 | 368,077 | 0,038 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Besment | KI2 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10545,907 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9348,074 | Aman |
| | KI14 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10424,697 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8502,351 | | Aman |
| | KI22 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10550,288 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8182,017 | | Aman |
| | KI30 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 10519,464 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8399,208 | | Aman |
| | KI38 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 12218,814 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7564,272 | | Aman |
| | KI39 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8954,654 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 11139,441 | | Aman |
| | KI50 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10578,707 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8695,660 | Aman |
| | KI51 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11376,481 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10942,769 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Besment | KI2 | Atas | 31,763 | 4,914 | 22,272 | 148,973 | 132,053 | 132,053 |
| | | Bawah | 31,763 | 4,914 | 22,272 | 148,973 | 132,053 | 132,053 |
| | KI14 | Atas | 26,902 | 6,382 | 24,369 | 255,917 | 137,298 | 137,298 |
| | | Bawah | 26,902 | 6,382 | 24,369 | 255,917 | 137,298 | 137,298 |
| | KI22 | Atas | 22,512 | 9,717 | 25,837 | 238,322 | 142,356 | 142,356 |
| | | Bawah | 22,512 | 9,717 | 25,837 | 238,322 | 142,356 | 142,356 |
| | KI30 | Atas | 32,297 | 8,517 | 27,759 | 239,010 | 159,443 | 159,443 |
| | | Bawah | 32,297 | 8,517 | 27,759 | 239,010 | 159,443 | 159,443 |
| | KI38 | Atas | 8,552 | 2,312 | 28,476 | 211,513 | 131,006 | 131,006 |
| | | Bawah | 8,552 | 2,312 | 28,476 | 211,513 | 131,006 | 131,006 |
| | KI39 | Atas | 40,479 | 5,27 | 28,492 | 161,954 | 167,703 | 161,954 |
| | | Bawah | 40,479 | 5,27 | 28,492 | 161,954 | 167,703 | 161,954 |
| | KI50 | Atas | 45,99 | 4,627 | 30,772 | 153,318 | 182,390 | 153,318 |
| | | Bawah | 45,99 | 4,627 | 30,772 | 153,318 | 182,390 | 153,318 |
| | KI51 | Atas | 29,241 | 6,655 | 30,756 | 50,437 | 166,866 | 50,437 |
| | | Bawah | 29,241 | 6,655 | 30,756 | 50,437 | 166,866 | 50,437 |

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 | MPa | Ec = Eg | = | 23500 | MPa | Ic | = | 0,0200 | m^4 |
| Fy polos | = | 240 | MPa | tk atas | = | 4,5 | m | Ig atas | = | 0,0072 | m^4 |
| fc' | = | 25 | MPa | tk | = | 5 | m | Ig bawah | = | 0,0072 | m^4 |
| Ø pokok | = | 22 | mm | tk bawah | = | 3,5 | m | pb | = | 40 | mm |
| Ø sengkang | = | 10 | mm | Lg ki atas | = | 7,2 | m | Lg ki bawah | = | 7,2 | m |
| Ø | = | 0,65 | | Lg' ki atas | = | 6,5 | m | Lg' ki bawah | = | 6,5 | m |
| Øo | = | 1,25 | | Lg ka atas | = | 7,2 | m | Lg ka bawah | = | 7,2 | m |
| r | = | 210 | mm | Lg' ka atas | = | 6,5 | m | Lg' ka bawah | = | 6,5 | m |
| β | = | 0,85 | | d' | = | 61 | mm | d | = | 639 | mm |

| | | | |
|---|---|---|---|
| b kolom | = | 700 | mm |
| h kolom | = | 700 | mm |
| b blk atas | = | 400 | mm |
| h blk atas | = | 600 | mm |
| b blk bawah | = | 400 | mm |
| h blk bawah | = | 600 | mm |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran | PD | PL | PE | $EI_1$ | $EI_2$ | EI pakai | Pc | δb | Pu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | ψ | K | ψ | K | | momen | kN | KN | KN | KNm^2 | KNm^2 | KNm^2 | KN | | KN |
| Ground Floor | Kl3 | Atas | | | 376156,667 | 4,5 | 40,714 | Ok | 1954,462 | 147,790 | 290,734 | 124955,445 | 35464,043 | 124955,445 | 144241,705 | 1,028 | 2581,818 |
| | | Bawah | | | 12,386 | 5,5 | 49,762 | Ok | 1980,334 | 147,790 | 290,734 | 124884,230 | 35443,832 | 124884,230 | 117948,681 | 1,035 | 2612,865 |
| | Kl4 | Atas | | | 15,253 | 5 | 45,238 | Ok | 1915,534 | 146,315 | 284,512 | 125010,651 | 35479,712 | 125010,651 | 129874,889 | 1,031 | 2532,745 |
| | | Bawah | | | 376156,667 | 5 | 45,238 | Ok | 1941,406 | 146,315 | 284,512 | 124937,342 | 35458,906 | 124937,342 | 129798,727 | 1,031 | 2563,791 |
| | Kl15 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2962,653 | 495,417 | 105,171 | 131192,210 | 37234,121 | 131192,210 | 15914,637 | 1,725 | 4347,851 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 3014,397 | 495,417 | 105,171 | 131007,197 | 37181,612 | 131007,197 | 15892,194 | 1,745 | 4409,944 |
| | Kl23 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2542,132 | 530,079 | 108,977 | 133785,147 | 37970,032 | 133785,147 | 16229,181 | 1,586 | 3898,685 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2593,876 | 530,079 | 108,977 | 133529,664 | 37897,523 | 133529,664 | 16198,189 | 1,603 | 3960,778 |
| | Kl31 | Atas | 3,813 | 2,05 | | | 42,952 | Ok | 2802,111 | 426,744 | 137,011 | 130223,084 | 36959,070 | 130223,084 | 15797,075 | 1,650 | 4045,324 |
| | | Bawah | 4,387 | 2,05 | | | 42,952 | Ok | 2853,855 | 426,744 | 137,011 | 130041,887 | 36907,644 | 130041,887 | 15775,094 | 1,668 | 4107,416 |
| | Kl40 | Atas | 14,450 | 3,1 | | | 28,048 | Ok | 2626,499 | 241,041 | 153,840 | 126107,548 | 35791,026 | 126107,548 | 35876,682 | 1,179 | 3537,464 |
| | | Bawah | 8,773 | 3,1 | | | 28,048 | Ok | 2655,899 | 241,041 | 153,840 | 126035,792 | 35770,661 | 126035,792 | 35856,268 | 1,181 | 3572,744 |
| | Kl41 | Atas | 7,627 | 3 | | | 27,143 | Ok | 2583,825 | 239,778 | 145,326 | 126179,986 | 35811,585 | 126179,986 | 38330,329 | 1,163 | 3484,235 |
| | | Bawah | 14,450 | 3 | | | 27,143 | Ok | 2613,225 | 239,778 | 145,326 | 126106,337 | 35790,682 | 126106,337 | 38307,956 | 1,165 | 3519,515 |
| | Kl52 | Atas | | | 14,450 | 3,6 | 32,571 | Ok | 1658,483 | 86,698 | 35,873 | 122829,524 | 34860,678 | 122829,524 | 177234,573 | 1,021 | 2368,896 |
| | | Bawah | | | 17,547 | 3,6 | 32,571 | Ok | 1881,415 | 86,698 | 35,873 | 122786,996 | 34848,608 | 122786,996 | 177173,208 | 1,021 | 2396,415 |
| | Kl53 | Atas | | | 15,253 | 3,5 | 31,667 | Ok | 1815,929 | 85,300 | 27,359 | 122853,693 | 34867,536 | 122853,693 | 182334,288 | 1,020 | 2315,595 |
| | | Bawah | | | 14,450 | 3,5 | 31,667 | Ok | 1838,861 | 85,300 | 27,359 | 122809,897 | 34855,108 | 122809,897 | 182269,289 | 1,020 | 2343,113 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung | ΣPu | ΣPc | δs | MD | ML | ME | Mc | Rv | $Mkap_{ka}$ | $Mkap_{ki}$ | Nuk1 | Nuk2 | Nuk pakai | Mmaks | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kolom | KN | KN | | KNm | KNm | KNm | KNm | | KNm | KNm | KN | KN | KN | KNm | |
| Ground Floor | Kl3 | Atas | 29112,613 | 755833,358 | 1,063 | 3,157 | 0,336 | 17,677 | 27,927 | 0,975 | 0,000 | 0,000 | 2207,365 | 3428,447 | 2207,365 | 12,213 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 110,682 | 16,076 | 89,563 | 407,634 | 0,975 | 553,475 | 553,475 | 2385,629 | 3455,613 | 2385,629 | 209,992 | 1,3 |
| | Kl4 | Atas | 29112,613 | 755833,358 | 1,063 | 29,676 | 4,628 | 53,945 | 140,778 | 0,975 | 554,777 | 554,777 | 2316,396 | 3359,892 | 2316,396 | 88,883 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 3,367 | 0,353 | 17,321 | 29,576 | 0,975 | 0,000 | 0,000 | 2192,107 | 3387,057 | 2192,107 | 25,699 | 1,3 |
| | Kl15 | Atas | 29112,613 | 755833,358 | 1,063 | 5,954 | 16,078 | 98,795 | 184,383 | 0,975 | 554,777 | 554,777 | 3782,428 | 4072,692 | 3782,428 | 125,110 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 13,340 | 14,853 | 129,107 | 244,996 | 0,975 | 553,475 | 553,475 | 3836,403 | 4127,023 | 3836,403 | 158,876 | 1,3 |
| | Kl23 | Atas | 29112,613 | 755833,358 | 1,063 | 20,881 | 6,896 | 93,777 | 189,841 | 0,975 | 554,777 | 554,777 | 3377,276 | 3683,525 | 3377,276 | 73,213 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 2,730 | 2,070 | 124,497 | 159,601 | 0,975 | 553,475 | 553,475 | 3431,251 | 3737,856 | 3431,251 | 129,116 | 1,3 |
| | Kl31 | Atas | 29112,613 | 755833,358 | 1,063 | 55,449 | 1,617 | 95,034 | 283,107 | 0,975 | 554,777 | 554,777 | 3541,752 | 3965,744 | 3541,752 | 154,577 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 83,613 | 1,996 | 125,455 | 416,649 | 0,975 | 553,475 | 553,475 | 3595,728 | 4020,075 | 3595,728 | 215,407 | 1,3 |
| | Kl40 | Atas | 29112,613 | 755833,358 | 1,063 | 0,790 | 1,040 | 0,050 | 4,713 | 0,975 | 119,799 | 0,000 | 3027,270 | 3657,045 | 3027,270 | 0,330 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 61,861 | 16,164 | 141,953 | 365,919 | 0,975 | 553,475 | 553,475 | 3192,886 | 3687,915 | 3192,886 | 82,343 | 1,3 |
| | Kl41 | Atas | 29112,613 | 755833,358 | 1,063 | 82,217 | 19,704 | 111,497 | 380,760 | 0,975 | 554,777 | 554,777 | 3116,237 | 3575,152 | 3116,237 | 35,750 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 15,855 | 2,304 | 30,902 | 82,299 | 0,975 | 119,799 | 0,000 | 3012,006 | 3606,022 | 3012,006 | 48,432 | 1,3 |
| | Kl52 | Atas | 29112,613 | 755833,358 | 1,063 | 14,647 | 2,600 | 11,105 | 52,677 | 0,975 | 0,000 | 119,799 | 2058,793 | 2193,107 | 2058,793 | 0,698 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 17,795 | 2,147 | 86,689 | 148,025 | 0,975 | 553,475 | 553,475 | 2217,617 | 2217,185 | 2217,185 | 70,048 | 1,3 |
| | Kl53 | Atas | 29112,613 | 755833,358 | 1,063 | 35,388 | 1,246 | 52,973 | 144,803 | 0,975 | 554,777 | 554,777 | 2147,745 | 2111,198 | 2111,198 | 20,567 | 1,3 |
| | | Bawah | 29486,581 | 477882,174 | 1,105 | 5,841 | 0,947 | 22,224 | 41,915 | 0,975 | 0,000 | 119,799 | 2036,722 | 2135,277 | 2036,722 | 28,785 | 1,3 |

**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{Ka,by}$ KNm | $Mkap_{Ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Floor | KI3 | Atas | 0,000 | 119,799 | 2,263 | 7,542 | 77,911 | 7,542 | 27,927 | 4,296 | 339,595 | 0,013 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1446,758 | 1187,773 | 509,261 | 509,261 | 509,261 | 78,348 | 367,020 | 0,213 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI4 | Atas | 382,584 | 382,584 | 1189,857 | 975,654 | 262,588 | 262,588 | 262,588 | 40,398 | 356,369 | 0,113 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 119,799 | 9,233 | 30,777 | 78,754 | 30,777 | 30,777 | 4,735 | 337,247 | 0,014 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI15 | Atas | 554,777 | 554,777 | 727,888 | 727,888 | 438,073 | 438,073 | 438,073 | 67,396 | 581,912 | 0,116 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 889,970 | 814,837 | 571,852 | 571,852 | 571,852 | 87,977 | 590,216 | 0,149 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI23 | Atas | 554,777 | 554,777 | 597,860 | 597,860 | 423,029 | 423,029 | 423,029 | 65,081 | 519,581 | 0,125 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1015,163 | 929,462 | 527,927 | 527,927 | 527,927 | 81,220 | 527,885 | 0,154 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI31 | Atas | 553,475 | 553,475 | 689,916 | 689,044 | 459,062 | 459,062 | 459,062 | 70,625 | 544,885 | 0,130 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 959,679 | 959,679 | 616,800 | 616,800 | 616,800 | 94,892 | 553,189 | 0,172 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI40 | Atas | 0,000 | 0,000 | 0,548 | 0,164 | 2,132 | 0,548 | 4,713 | 0,725 | 466,734 | 0,002 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1584,444 | 1450,683 | 678,129 | 678,129 | 678,129 | 104,329 | 491,213 | 0,212 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI41 | Atas | 469,730 | 469,730 | 676,837 | 618,918 | 575,304 | 575,304 | 575,304 | 88,508 | 479,421 | 0,185 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 78,949 | 23,685 | 148,955 | 78,949 | 82,299 | 12,661 | 463,365 | 0,027 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI52 | Atas | 0,000 | 0,000 | 1,354 | 0,406 | 64,750 | 1,354 | 52,877 | 8,104 | 318,737 | 0,026 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1515,796 | 1244,453 | 385,033 | 385,033 | 385,033 | 59,236 | 341,105 | 0,174 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI53 | Atas | 382,584 | 382,584 | 639,232 | 524,155 | 260,952 | 260,952 | 260,952 | 40,147 | 324,800 | 0,124 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 80,037 | 24,011 | 100,468 | 80,037 | 80,037 | 12,313 | 313,342 | 0,039 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Ground Floor | KI3 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11612,242 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8766,589 | Aman |
| | KI4 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9060,128 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11575,891 | Aman |
| | KI15 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8418,588 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7697,372 | | Aman |
| | KI23 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8200,355 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7603,360 | | Aman |
| | KI31 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 8103,413 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7276,058 | | Aman |
| | KI40 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11903,722 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 6617,998 | | Aman |
| | KI41 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 7051,547 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11229,479 | Aman |
| | KI52 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11274,639 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7641,347 | Aman |
| | KI53 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8812,223 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10919,530 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Ground Floor | KI3 | Atas | 32,875 | 6,839 | 24,756 | 122,088 | 145,675 | 122,088 |
| | | Bawah | 32,875 | 6,839 | 24,756 | 122,088 | 145,675 | 122,088 |
| | KI4 | Atas | 26,644 | 7,026 | 20,775 | 66,674 | 122,609 | 66,674 |
| | | Bawah | 26,644 | 7,026 | 20,775 | 66,674 | 122,609 | 66,674 |
| | KI15 | Atas | 29,647 | 13,183 | 21,343 | 229,528 | 134,612 | 134,612 |
| | | Bawah | 29,647 | 13,183 | 21,343 | 229,528 | 134,612 | 134,612 |
| | KI23 | Atas | 17,634 | 14,8 | 22,914 | 216,127 | 130,295 | 130,295 |
| | | Bawah | 17,634 | 14,8 | 22,914 | 216,127 | 130,295 | 130,295 |
| | KI31 | Atas | 27,713 | 11,607 | 24,922 | 244,514 | 145,958 | 145,958 |
| | | Bawah | 27,713 | 11,607 | 24,922 | 244,514 | 145,958 | 145,958 |
| | KI40 | Atas | 39,768 | 4,362 | 25,599 | 155,191 | 153,852 | 153,852 |
| | | Bawah | 39,768 | 4,362 | 25,599 | 155,191 | 153,852 | 153,852 |
| | KI41 | Atas | 46,956 | 9,551 | 25,597 | 149,455 | 165,790 | 149,455 |
| | | Bawah | 46,956 | 9,551 | 25,597 | 149,455 | 165,790 | 149,455 |
| | KI52 | Atas | 54,213 | 6,942 | 33,741 | 99,479 | 205,925 | 99,479 |
| | | Bawah | 54,213 | 6,942 | 33,741 | 99,479 | 205,925 | 99,479 |
| | KI53 | Atas | 32,511 | 5,97 | 33,743 | 77,498 | 182,126 | 77,498 |
| | | Bawah | 32,511 | 5,97 | 33,743 | 77,498 | 182,126 | 77,498 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KI3 | Atas | 122,088 | 0 | 149,1 | 203,480 | 118,389 | 159,75 | 115 | P10-115 | AMAN |
| | | Bawah | 122,088 | 0 | 149,1 | 203,480 | 118,389 | 159,75 | 115 | P10-115 | AMAN |
| | KI4 | Atas | 66,674 | 0 | 149,1 | 111,123 | 216,784 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 66,674 | 0 | 149,1 | 111,123 | 216,784 | 159,75 | 155 | P10-155 | AMAN |
| | KI15 | Atas | 134,612 | 0 | 149,1 | 224,354 | 107,374 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 134,612 | 0 | 149,1 | 224,354 | 107,374 | 159,75 | 105 | P10-105 | AMAN |
| | KI23 | Atas | 130,295 | 0 | 149,1 | 217,158 | 110,932 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 130,295 | 0 | 149,1 | 217,158 | 110,932 | 159,75 | 110 | P10-110 | AMAN |
| | KI31 | Atas | 145,958 | 0 | 149,1 | 243,264 | 99,027 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 145,958 | 0 | 149,1 | 243,264 | 99,027 | 159,75 | 95 | P10-95 | AMAN |
| | KI40 | Atas | 153,852 | 0 | 149,1 | 256,421 | 93,946 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 153,852 | 0 | 149,1 | 256,421 | 93,946 | 159,75 | 90 | P10-90 | AMAN |
| | KI41 | Atas | 149,455 | 0 | 149,1 | 249,092 | 96,710 | 159,75 | 95 | P10-95 | AMAN |
| | | Bawah | 149,455 | 0 | 149,1 | 249,092 | 96,710 | 159,75 | 95 | P10-95 | AMAN |
| | KI52 | Atas | 99,479 | 0 | 149,1 | 165,799 | 145,295 | 159,75 | 145 | P10-145 | AMAN |
| | | Bawah | 99,479 | 0 | 149,1 | 165,799 | 145,295 | 159,75 | 145 | P10-145 | AMAN |
| | KI53 | Atas | 77,498 | 0 | 149,1 | 129,163 | 186,507 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 77,498 | 0 | 149,1 | 129,163 | 186,507 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Ground Floor | KI3 | Atas | 44,396 | 372,750 | 149,1 | -298,757 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,396 | 372,750 | 149,1 | -298,757 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI4 | Atas | 24,245 | 372,750 | 149,1 | -332,342 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 24,245 | 372,750 | 149,1 | -332,342 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI15 | Atas | 48,950 | 372,750 | 149,1 | -291,167 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 48,950 | 372,750 | 149,1 | -291,167 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI23 | Atas | 47,380 | 372,750 | 149,1 | -293,784 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 47,380 | 372,750 | 149,1 | -293,784 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI31 | Atas | 53,076 | 372,750 | 149,1 | -284,290 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 53,076 | 372,750 | 149,1 | -284,290 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI40 | Atas | 55,946 | 372,750 | 149,1 | -279,506 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 55,946 | 372,750 | 149,1 | -279,506 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI41 | Atas | 54,347 | 372,750 | 149,1 | -282,171 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 54,347 | 372,750 | 149,1 | -282,171 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI52 | Atas | 36,174 | 372,750 | 149,1 | -312,459 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 36,174 | 372,750 | 149,1 | -312,459 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI53 | Atas | 28,181 | 372,750 | 149,1 | -325,782 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 28,181 | 372,750 | 149,1 | -325,782 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 4,5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah | | Kolom tepi | | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | EI1 KNm^2 | EI2 KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ψ | K | Ψ | K | | | | | | | | | | | |
| Lantai 1 | KI5 | Atas | | | 417951,852 | 2,64 | 20,743 | Tidak | 1627,398 | 128,522 | 216,576 | 125196,791 | 35532,541 | 125196,791 | 283665,881 | 0,000 | 2158,513 |
| | | Bawah | | | 15,253 | 2,64 | 20,743 | Tidak | 1650,330 | 128,522 | 216,576 | 125118,015 | 35510,183 | 125118,015 | 283487,393 | 0,000 | 2186,031 |
| | KI6 | Atas | | | 16,056 | 2 | 15,714 | Tidak | 1585,863 | 126,071 | 208,237 | 125234,286 | 35543,182 | 125234,286 | 374551,105 | 0,000 | 2104,749 |
| | | Bawah | | | 417951,852 | 2 | 15,714 | Tidak | 1608,795 | 126,071 | 208,237 | 125152,993 | 35520,110 | 125152,993 | 374307,973 | 0,000 | 2132,268 |
| | KI16 | Atas | 4,014 | 2 | | | 37,143 | Ok | 2304,238 | 371,654 | 76,945 | 130809,342 | 37125,459 | 130809,342 | 21220,291 | 1,322 | 3359,732 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2350,102 | 371,654 | 76,945 | 130604,972 | 37067,456 | 130604,972 | 21187,137 | 1,330 | 3414,769 |
| | KI24 | Atas | 4,014 | 2 | | | 37,143 | Ok | 2031,218 | 404,728 | 78,383 | 133214,467 | 37808,065 | 133214,467 | 21610,458 | 1,281 | 3085,026 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2077,082 | 404,728 | 78,383 | 132941,240 | 37730,520 | 132941,240 | 21566,134 | 1,289 | 3140,063 |
| | KI32 | Atas | 4,014 | 2 | | | 37,143 | Ok | 2238,181 | 330,291 | 101,971 | 129912,816 | 36871,012 | 129912,816 | 21074,854 | 1,307 | 3214,283 |
| | | Bawah | 3,813 | 2 | | | 37,143 | Ok | 2284,045 | 330,291 | 101,971 | 129717,225 | 36815,501 | 129717,225 | 21043,124 | 1,314 | 3269,320 |
| | KI42 | Atas | 16,056 | 2 | | | 15,714 | Tidak | 2081,943 | 193,968 | 111,029 | 126205,866 | 35818,930 | 126205,866 | 114380,881 | 0,000 | 2808,680 |
| | | Bawah | 7,627 | 2 | | | 15,714 | Tidak | 2108,403 | 193,968 | 111,029 | 126123,417 | 35795,530 | 126123,417 | 114306,158 | 0,000 | 2840,432 |
| | KI43 | Atas | 8,028 | 2 | | | 15,714 | Tidak | 2037,646 | 192,084 | 101,996 | 126283,378 | 35840,929 | 126283,378 | 114451,130 | 0,000 | 2752,510 |
| | | Bawah | 16,056 | 2 | | | 15,714 | Tidak | 2064,106 | 192,084 | 101,996 | 126198,280 | 35816,777 | 126198,280 | 114374,006 | 0,000 | 2784,262 |
| | KI54 | Atas | | | 16,056 | 2,64 | 20,743 | Tidak | 1520,462 | 85,166 | 30,012 | 123525,373 | 35058,170 | 123525,373 | 279878,849 | 0,000 | 1960,820 |
| | | Bawah | | | 15,253 | 2,64 | 20,743 | Tidak | 1540,454 | 85,166 | 30,012 | 123471,650 | 35042,922 | 123471,650 | 279757,125 | 0,000 | 1984,810 |
| | KI55 | Atas | | | 16,056 | 2,64 | 20,743 | Tidak | 1477,830 | 83,330 | 20,979 | 123552,956 | 35065,998 | 123552,956 | 279941,345 | 0,000 | 1906,724 |
| | | Bawah | | | 16,056 | 2,64 | 20,743 | Tidak | 1497,822 | 83,330 | 20,979 | 123497,361 | 35050,219 | 123497,361 | 279815,380 | 0,000 | 1930,714 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | Mkap,ka KNm | Mkap,ki KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KI5 | Atas | 23351,037 | 1510774,794 | 0,000 | 17,787 | 2,634 | 0,525 | 0,000 | 1 | 0,000 | 0,000 | 1843,716 | 2753,335 | 1843,716 | 21,230 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 66,223 | 12,228 | 65,903 | 0,000 | 1 | 554,777 | 554,777 | 2040,392 | 2777,414 | 2040,392 | 137,863 | 1,3 |
| | KI6 | Atas | 23351,037 | 1510774,794 | 0,000 | 42,949 | 7,915 | 67,049 | 0,000 | 1 | 554,777 | 554,777 | 1970,128 | 2672,126 | 1970,128 | 118,196 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 17,594 | 2,659 | 0,518 | 0,000 | 1 | 0,000 | 0,000 | 1821,609 | 2696,205 | 1821,609 | 13,134 | 1,3 |
| | KI16 | Atas | 23351,037 | 1510774,794 | 1,024 | 30,798 | 22,539 | 117,039 | 270,089 | 1 | 554,777 | 554,777 | 2982,284 | 3132,856 | 2982,284 | 175,725 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 1,025 | 37,480 | 24,292 | 117,604 | 294,034 | 1 | 554,777 | 554,777 | 3030,441 | 3181,013 | 3030,441 | 185,297 | 1,3 |
| | KI24 | Atas | 23351,037 | 1510774,794 | 1,024 | 6,017 | 5,857 | 112,443 | 152,454 | 1 | 554,777 | 554,777 | 2730,341 | 2886,952 | 2730,341 | 118,746 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 1,025 | 6,170 | 6,563 | 112,579 | 155,080 | 1 | 554,777 | 554,777 | 2778,498 | 2935,109 | 2778,498 | 117,887 | 1,3 |
| | KI32 | Atas | 23351,037 | 1510774,794 | 1,024 | 77,521 | 0,498 | 114,222 | 329,141 | 1 | 554,777 | 554,777 | 2869,493 | 3125,174 | 2869,493 | 198,770 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 1,025 | 84,452 | 2,194 | 114,715 | 353,500 | 1 | 554,777 | 554,777 | 2917,650 | 3173,331 | 2917,650 | 206,896 | 1,3 |
| | KI42 | Atas | 23351,037 | 1510774,794 | 0,000 | 8,607 | 0,527 | 15,633 | 0,000 | 1 | 119,799 | 0,000 | 2408,342 | 2856,028 | 2408,342 | 24,819 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 48,487 | 16,342 | 133,645 | 0,000 | 1 | 554,777 | 554,777 | 2590,087 | 2883,811 | 2590,087 | 86,884 | 1,3 |
| | KI43 | Atas | 23351,037 | 1510774,794 | 0,000 | 53,306 | 17,142 | 133,218 | 0,000 | 1 | 554,777 | 554,777 | 2513,814 | 2769,600 | 2513,814 | 82,780 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 13,747 | 1,701 | 17,075 | 0,000 | 1 | 119,799 | 0,000 | 2387,635 | 2797,383 | 2387,635 | 31,465 | 1,3 |
| | KI54 | Atas | 23351,037 | 1510774,794 | 0,000 | 10,125 | 1,810 | 4,773 | 0,000 | 1 | 0,000 | 119,799 | 1704,545 | 1811,960 | 1704,545 | 3,582 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 1,148 | 3,323 | 68,313 | 0,000 | 1 | 554,777 | 554,777 | 1879,498 | 1832,951 | 1832,951 | 70,208 | 1,3 |
| | KI55 | Atas | 23351,037 | 1510774,794 | 0,000 | 6,517 | 1,882 | 66,146 | 0,000 | 1 | 554,777 | 554,777 | 1811,815 | 1727,330 | 1727,330 | 62,420 | 1,3 |
| | | Bawah | 23682,669 | 1509844,430 | 0,000 | 4,998 | 0,651 | 6,173 | 0,000 | 1 | 0,000 | 119,799 | 1678,845 | 1748,321 | 1678,845 | 1,752 | 1,3 |

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**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KI5 | Atas | 0,000 | 119,799 | 5,578 | 18,593 | 23,647 | 18,593 | 18,593 | 2,961 | 283,649 | 0,010 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1349,645 | 1106,677 | 359,166 | 359,166 | 359,166 | 55,256 | 313,906 | 0,176 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI6 | Atas | 469,730 | 469,730 | 1456,454 | 1331,821 | 335,013 | 335,013 | 335,013 | 51,540 | 303,097 | 0,170 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 119,799 | 4,180 | 13,935 | 23,441 | 13,935 | 13,935 | 2,144 | 280,248 | 0,008 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI16 | Atas | 553,475 | 553,475 | 816,140 | 815,108 | 547,568 | 547,568 | 547,568 | 84,241 | 458,813 | 0,184 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 861,063 | 861,063 | 558,797 | 558,797 | 558,797 | 85,969 | 466,222 | 0,184 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI24 | Atas | 553,475 | 553,475 | 841,412 | 840,348 | 484,728 | 484,728 | 484,728 | 74,574 | 420,052 | 0,178 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 554,777 | 554,777 | 835,778 | 835,778 | 486,201 | 486,201 | 486,201 | 74,800 | 427,461 | 0,175 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI32 | Atas | 553,475 | 553,475 | 921,575 | 820,536 | 561,652 | 561,652 | 561,652 | 86,408 | 441,460 | 0,196 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 855,162 | 854,081 | 572,781 | 572,781 | 572,781 | 88,120 | 448,869 | 0,196 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI42 | Atas | 0,000 | 0,000 | 30,959 | 9,288 | 75,249 | 30,959 | 30,959 | 4,763 | 370,514 | 0,013 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1258,731 | 1151,017 | 629,379 | 629,379 | 629,379 | 96,928 | 398,475 | 0,243 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI43 | Atas | 469,730 | 469,730 | 1172,590 | 1072,248 | 633,486 | 633,486 | 633,486 | 97,459 | 386,741 | 0,252 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 3611,186 | 385,408 | 1168,267 | 87,935 | 87,935 | 87,935 | 13,529 | 367,328 | 0,037 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI54 | Atas | 0,000 | 0,000 | 6,764 | 2,029 | 32,578 | 6,764 | 6,764 | 1,041 | 262,288 | 0,004 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1481,876 | 1215,104 | 291,609 | 291,609 | 291,609 | 44,863 | 281,893 | 0,159 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI55 | Atas | 469,730 | 469,730 | 1574,114 | 1439,412 | 286,632 | 286,632 | 286,632 | 44,097 | 265,743 | 0,166 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 3,804 | 1,141 | 31,858 | 3,804 | 3,804 | 0,585 | 259,264 | 0,002 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 1 | KI5 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11679,531 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7587,766 | Aman |
| | KI6 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7723,371 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11743,448 | Aman |
| | KI16 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7417,624 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7400,045 | Aman |
| | KI24 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7553,807 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7611,279 | Aman |
| | KI32 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7149,446 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7136,865 | Aman |
| | KI42 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11606,927 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6156,331 | Aman |
| | KI43 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5977,398 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10983,223 | Aman |
| | KI54 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11840,233 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7974,589 | Aman |
| | KI55 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7817,128 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11885,045 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 1 | KI5 | Atas | 26,177 | 7,504 | 44,926 | 96,861 | 224,054 | 96,861 |
| | | Bawah | 26,177 | 7,504 | 44,926 | 96,861 | 224,054 | 96,861 |
| | KI6 | Atas | 26,526 | 7,442 | 44,816 | 89,474 | 223,894 | 89,474 |
| | | Bawah | 26,526 | 7,442 | 44,816 | 89,474 | 223,894 | 89,474 |
| | KI16 | Atas | 36,366 | 20,258 | 37,147 | 283,683 | 215,473 | 215,473 |
| | | Bawah | 36,366 | 20,258 | 37,147 | 283,683 | 215,473 | 215,473 |
| | KI24 | Atas | 16,797 | 18,933 | 35,749 | 248,956 | 187,662 | 187,662 |
| | | Bawah | 16,797 | 18,933 | 35,749 | 248,956 | 187,662 | 187,662 |
| | KI32 | Atas | 30,967 | 13,532 | 34,793 | 290,880 | 192,855 | 192,855 |
| | | Bawah | 30,967 | 13,532 | 34,793 | 290,880 | 192,855 | 192,855 |
| | KI42 | Atas | 40,511 | 3,803 | 32,089 | 169,317 | 181,304 | 169,317 |
| | | Bawah | 40,511 | 3,803 | 32,089 | 169,317 | 181,304 | 169,317 |
| | KI43 | Atas | 36,708 | 7,768 | 32,083 | 184,980 | 181,448 | 181,448 |
| | | Bawah | 36,708 | 7,768 | 32,083 | 184,980 | 181,448 | 181,448 |
| | KI54 | Atas | 58,947 | 7,404 | 36,496 | 76,506 | 222,952 | 76,506 |
| | | Bawah | 58,947 | 7,404 | 36,496 | 76,506 | 222,952 | 76,506 |
| | KI55 | Atas | 18,271 | 4,167 | 36,502 | 74,471 | 176,868 | 74,471 |
| | | Bawah | 18,271 | 4,167 | 36,502 | 74,471 | 176,868 | 74,471 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
| Lantai 1 | KI5 | Atas | 96,861 | 0 | 149,1 | 161,436 | 149,222 | 159,75 | 145 | P10-145 | AMAN |
| | | Bawah | 96,861 | 0 | 149,1 | 161,436 | 149,222 | 159,75 | 145 | P10-145 | AMAN |
| | KI6 | Atas | 89,474 | 0 | 149,1 | 149,123 | 161,543 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 89,474 | 0 | 149,1 | 149,123 | 161,543 | 159,75 | 155 | P10-155 | AMAN |
| | KI16 | Atas | 215,473 | 0 | 149,1 | 359,121 | 67,080 | 159,75 | 65 | P10-65 | AMAN |
| | | Bawah | 215,473 | 0 | 149,1 | 359,121 | 67,080 | 159,75 | 65 | P10-65 | AMAN |
| | KI24 | Atas | 187,662 | 0 | 149,1 | 312,771 | 77,021 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 187,662 | 0 | 149,1 | 312,771 | 77,021 | 159,75 | 75 | P10-75 | AMAN |
| | KI32 | Atas | 192,855 | 0 | 149,1 | 321,424 | 74,947 | 159,75 | 70 | P10-70 | AMAN |
| | | Bawah | 192,855 | 0 | 149,1 | 321,424 | 74,947 | 159,75 | 70 | P10-70 | AMAN |
| | KI42 | Atas | 169,317 | 0 | 149,1 | 282,196 | 85,366 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 169,317 | 0 | 149,1 | 282,196 | 85,366 | 159,75 | 85 | P10-85 | AMAN |
| | KI43 | Atas | 181,448 | 0 | 149,1 | 302,414 | 79,659 | 159,75 | 75 | P10-75 | AMAN |
| | | Bawah | 181,448 | 0 | 149,1 | 302,414 | 79,659 | 159,75 | 75 | P10-75 | AMAN |
| | KI54 | Atas | 76,506 | 0 | 149,1 | 127,510 | 188,925 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 76,506 | 0 | 149,1 | 127,510 | 188,925 | 159,75 | 155 | P10-155 | AMAN |
| | KI55 | Atas | 74,471 | 0 | 149,1 | 124,118 | 194,088 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 74,471 | 0 | 149,1 | 124,118 | 194,088 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
| Lantai 1 | KI5 | Atas | 27,320 | 372,750 | 149,1 | -327,217 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 27,320 | 372,750 | 149,1 | -327,217 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI6 | Atas | 25,236 | 372,750 | 149,1 | -330,690 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 25,236 | 372,750 | 149,1 | -330,690 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI16 | Atas | 60,774 | 372,750 | 149,1 | -271,459 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 60,774 | 372,750 | 149,1 | -271,459 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI24 | Atas | 52,930 | 372,750 | 149,1 | -284,533 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 52,930 | 372,750 | 149,1 | -284,533 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI32 | Atas | 54,395 | 372,750 | 149,1 | -282,092 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 54,395 | 372,750 | 149,1 | -282,092 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI42 | Atas | 47,756 | 372,750 | 149,1 | -293,156 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 47,756 | 372,750 | 149,1 | -293,156 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI43 | Atas | 51,178 | 372,750 | 149,1 | -287,454 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 51,178 | 372,750 | 149,1 | -287,454 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI54 | Atas | 21,579 | 372,750 | 149,1 | -336,786 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 21,579 | 372,750 | 149,1 | -336,786 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI55 | Atas | 21,005 | 372,750 | 149,1 | -337,742 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 21,005 | 372,750 | 149,1 | -337,742 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 4,5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | | | 417951,852 | 5 | 39,286 | Ok | 1295,468 | 107,435 | 137,749 | 125479,977 | 35612,913 | 125479,977 | 150114,367 | 1,018 | 1726,458 |
| | | Bawah | | | 16,056 | 5 | 39,286 | Ok | 1318,400 | 107,435 | 137,749 | 125376,921 | 35583,664 | 125376,921 | 149991,079 | 1,018 | 1753,976 |
| | KI8 | Atas | | | 15,253 | 5 | 39,286 | Ok | 11254,047 | 104,964 | 130,056 | 119970,018 | 34049,112 | 119970,018 | 143522,686 | 1,172 | 13672,799 |
| | | Bawah | | | 417951,852 | 5 | 39,286 | Ok | 1276,979 | 104,964 | 130,056 | 125427,540 | 35598,030 | 125427,540 | 150051,636 | 1,018 | 1700,317 |
| | KI17 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1665,828 | 249,866 | 46,165 | 130072,286 | 36916,272 | 130072,286 | 21100,723 | 1,212 | 2398,779 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1711,692 | 249,866 | 46,165 | 129807,615 | 36841,155 | 129807,615 | 21057,788 | 1,218 | 2453,816 |
| | KI25 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1521,205 | 278,990 | 46,416 | 132223,271 | 37526,751 | 132223,271 | 21449,663 | 1,195 | 2271,830 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1567,069 | 278,990 | 46,416 | 131883,423 | 37430,297 | 131883,423 | 21394,531 | 1,201 | 2326,867 |
| | KI33 | Atas | 3,813 | 2 | | | 37,143 | Ok | 1672,669 | 233,123 | 66,319 | 129369,886 | 36716,921 | 129369,886 | 20986,778 | 1,211 | 2380,200 |
| | | Bawah | 4,014 | 2 | | | 37,143 | Ok | 1718,533 | 233,123 | 66,319 | 129121,796 | 36646,510 | 129121,796 | 20946,532 | 1,218 | 2435,236 |
| | KI44 | Atas | 16,056 | 3,2 | | | 25,143 | Ok | 1536,040 | 146,192 | 68,388 | 126347,164 | 35859,032 | 126347,164 | 44730,055 | 1,077 | 2077,155 |
| | | Bawah | 8,028 | 3,2 | | | 25,143 | Ok | 1562,500 | 146,192 | 68,388 | 126233,767 | 35826,848 | 126233,767 | 44689,909 | 1,078 | 2108,907 |
| | KI45 | Atas | 7,627 | 3,1 | | | 24,357 | Ok | 1492,314 | 144,375 | 60,001 | 126457,484 | 35890,342 | 126457,484 | 47704,026 | 1,070 | 2021,777 |
| | | Bawah | 16,056 | 3,1 | | | 24,357 | Ok | 1518,774 | 144,375 | 60,001 | 126339,124 | 35856,750 | 126339,124 | 47659,377 | 1,071 | 2053,529 |
| | KI56 | Atas | | | 16,056 | 3,6 | 28,286 | Ok | 1178,696 | 82,913 | 19,847 | 124574,237 | 35355,851 | 124574,237 | 206987,238 | 1,012 | 1547,096 |
| | | Bawah | | | 16,056 | 3,6 | 28,286 | Ok | 1198,688 | 82,913 | 19,847 | 124489,085 | 35331,684 | 124489,085 | 206845,753 | 1,012 | 1571,086 |
| | KI57 | Atas | | | 15,253 | 3,6 | 28,286 | Ok | 1135,494 | 81,009 | 11,461 | 124646,684 | 35376,413 | 124646,684 | 207107,612 | 1,011 | 1492,207 |
| | | Bawah | | | 16,056 | 3,6 | 28,286 | Ok | 1155,486 | 81,009 | 11,461 | 124557,204 | 35351,017 | 124557,204 | 206958,935 | 1,011 | 1516,198 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ke}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | 29588,300 | 863703,148 | 1,056 | 20,576 | 3,258 | 9,615 | 66,074 | 1 | 0,000 | 0,000 | 1473,048 | 2051,594 | 1473,048 | 30,408 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 61,908 | 11,821 | 49,480 | 223,389 | 1 | 554,777 | 554,777 | 1669,724 | 2075,673 | 1669,724 | 115,744 | 1,3 |
| | KI8 | Atas | 29588,300 | 863703,148 | 1,056 | 44,504 | 8,823 | 68,663 | 210,421 | 1 | 554,777 | 554,777 | 12099,559 | 12473,197 | 12099,559 | 121,556 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 20,563 | 3,292 | 9,589 | 65,312 | 1 | 0,000 | 0,000 | 1451,040 | 1997,275 | 1451,040 | 6,587 | 1,3 |
| | KI17 | Atas | 29588,300 | 863703,148 | 1,056 | 36,670 | 22,610 | 115,986 | 281,419 | 1 | 554,777 | 554,777 | 2184,076 | 2205,372 | 2184,076 | 181,165 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 23,356 | 21,423 | 97,668 | 221,087 | 1 | 554,777 | 554,777 | 2232,233 | 2253,529 | 2232,233 | 145,373 | 1,3 |
| | KI25 | Atas | 29588,300 | 863703,148 | 1,056 | 26,614 | 8,034 | 111,616 | 212,070 | 1 | 554,777 | 554,777 | 2062,802 | 2085,152 | 2062,802 | 85,663 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 14,758 | 6,885 | 93,344 | 156,201 | 1 | 554,777 | 554,777 | 2110,959 | 2133,309 | 2110,959 | 77,784 | 1,3 |
| | KI33 | Atas | 29588,300 | 863703,148 | 1,056 | 80,590 | 1,653 | 113,866 | 336,990 | 1 | 554,777 | 554,777 | 2173,679 | 2279,621 | 2173,679 | 201,379 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 68,808 | 0,142 | 95,172 | 278,740 | 1 | 554,777 | 554,777 | 2221,836 | 2327,779 | 2221,836 | 167,841 | 1,3 |
| | KI44 | Atas | 29588,300 | 863703,148 | 1,056 | 8,072 | 0,868 | 25,111 | 49,285 | 1 | 119,799 | 0,000 | 1784,979 | 2053,573 | 1784,979 | 34,072 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 76,136 | 19,321 | 112,184 | 348,630 | 1 | 554,777 | 554,777 | 1966,724 | 2081,356 | 1966,724 | 40,297 | 1,3 |
| | KI45 | Atas | 29588,300 | 863703,148 | 1,056 | 80,470 | 20,068 | 130,187 | 384,490 | 1 | 554,777 | 554,777 | 1891,121 | 1970,528 | 1891,121 | 54,563 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 12,227 | 1,117 | 5,266 | 37,324 | 1 | 119,799 | 0,000 | 1764,942 | 1998,311 | 1764,942 | 17,315 | 1,3 |
| | KI56 | Atas | 29588,300 | 863703,148 | 1,056 | 7,493 | 1,161 | 15,576 | 37,318 | 1 | 0,000 | 119,799 | 1343,325 | 1408,047 | 1343,325 | 9,392 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 25,581 | 0,134 | 47,044 | 110,117 | 1 | 554,777 | 554,777 | 1518,278 | 1429,038 | 1429,038 | 22,288 | 1,3 |
| | KI57 | Atas | 29588,300 | 863703,148 | 1,056 | 29,610 | 0,242 | 68,206 | 144,904 | 1 | 554,777 | 554,777 | 1449,925 | 1325,464 | 1325,464 | 40,233 | 1,3 |
| | | Bawah | 17919,932 | 869595,540 | 1,033 | 3,330 | 0,892 | 4,194 | 14,224 | 1 | 0,000 | 119,799 | 1316,955 | 1346,456 | 1316,955 | 1,455 | 1,3 |

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**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{Ka,by}$ KNm | $Mkap_{Ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Muk terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | 0,000 | 119,799 | 8,697 | 28,990 | 65,409 | 28,990 | 66,074 | 10,165 | 226,623 | 0,045 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1281,598 | 1171,927 | 285,231 | 285,231 | 285,231 | 43,882 | 256,881 | 0,171 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI8 | Atas | 382,584 | 382,584 | 1477,421 | 1211,451 | 344,378 | 344,378 | 344,378 | 52,981 | 1861,471 | 0,028 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 119,799 | 2,149 | 7,162 | 65,322 | 7,162 | 65,312 | 10,048 | 223,237 | 0,045 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI17 | Atas | 636,229 | 636,229 | 962,302 | 1035,886 | 549,385 | 549,385 | 549,385 | 84,521 | 336,012 | 0,252 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 746,475 | 745,531 | 457,224 | 457,224 | 457,224 | 70,342 | 343,420 | 0,205 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI25 | Atas | 636,229 | 636,229 | 909,049 | 978,560 | 505,168 | 505,168 | 505,168 | 77,718 | 317,354 | 0,245 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 797,955 | 796,946 | 414,770 | 414,770 | 414,770 | 63,811 | 324,763 | 0,196 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI33 | Atas | 553,475 | 553,475 | 914,522 | 913,365 | 564,592 | 564,592 | 564,592 | 86,860 | 334,412 | 0,260 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 762,216 | 761,252 | 472,120 | 472,120 | 472,120 | 72,634 | 341,821 | 0,212 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI44 | Atas | 0,000 | 0,000 | 63,836 | 19,151 | 114,853 | 63,836 | 63,836 | 9,821 | 274,612 | 0,036 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 976,877 | 801,940 | 571,403 | 571,403 | 571,403 | 87,908 | 302,573 | 0,291 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI45 | Atas | 469,730 | 469,730 | 1228,458 | 1123,335 | 652,350 | 652,350 | 652,350 | 100,362 | 290,942 | 0,345 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 33,566 | 10,070 | 36,128 | 33,565 | 37,324 | 5,742 | 271,530 | 0,021 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI56 | Atas | 0,000 | 0,000 | 41,308 | 12,392 | 74,506 | 41,308 | 41,308 | 6,355 | 206,665 | 0,031 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 1138,528 | 1041,101 | 224,586 | 224,586 | 224,586 | 34,552 | 219,852 | 0,157 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI57 | Atas | 382,584 | 382,584 | 1503,122 | 1232,525 | 317,810 | 317,810 | 317,810 | 48,894 | 203,918 | 0,240 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 4,863 | 1,459 | 22,048 | 4,863 | 14,224 | 2,188 | 202,608 | 0,011 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 2 | KI7 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10778,439 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7705,642 | Aman |
| | KI8 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah desak | 11173,556 | | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10772,442 | Aman |
| | KI17 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5986,456 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6951,680 | Aman |
| | KI25 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6118,322 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7192,986 | Aman |
| | KI33 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5826,476 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6787,421 | Aman |
| | KI44 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11010,780 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5253,159 | Aman |
| | KI45 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4353,848 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11390,221 | Aman |
| | KI56 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11140,539 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8019,326 | Aman |
| | KI57 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6221,212 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11660,751 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | 27,989 | 7,423 | 32,265 | 90,078 | 172,780 | 90,078 |
| | | Bawah | 27,989 | 7,423 | 32,265 | 90,078 | 172,780 | 90,078 |
| | KI8 | Atas | 31,301 | 8,391 | 33,813 | 105,049 | 183,691 | 105,049 |
| | | Bawah | 31,301 | 8,391 | 33,813 | 105,049 | 183,691 | 105,049 |
| | KI17 | Atas | 41,129 | 19,016 | 26,93 | 259,105 | 176,258 | 176,258 |
| | | Bawah | 41,129 | 19,016 | 26,93 | 259,105 | 176,258 | 176,258 |
| | KI25 | Atas | 26,357 | 18,236 | 26,503 | 235,881 | 158,135 | 158,135 |
| | | Bawah | 26,357 | 18,236 | 26,503 | 235,881 | 158,135 | 158,135 |
| | KI33 | Atas | 35,722 | 13,827 | 26,749 | 265,824 | 164,372 | 164,372 |
| | | Bawah | 35,722 | 13,827 | 26,749 | 265,824 | 164,372 | 164,372 |
| | KI44 | Atas | 28,421 | 2,341 | 23,279 | 162,882 | 130,072 | 130,072 |
| | | Bawah | 28,421 | 2,341 | 23,279 | 162,882 | 130,072 | 130,072 |
| | KI45 | Atas | 48,8 | 9,233 | 23,277 | 176,840 | 158,698 | 158,698 |
| | | Bawah | 48,8 | 9,233 | 23,277 | 176,840 | 158,698 | 158,698 |
| | KI56 | Atas | 57,906 | 6,753 | 27,572 | 68,178 | 183,894 | 68,178 |
| | | Bawah | 57,906 | 6,753 | 27,572 | 68,178 | 183,894 | 68,178 |
| | KI57 | Atas | 19,316 | 4,821 | 27,575 | 85,137 | 141,159 | 85,137 |
| | | Bawah | 19,316 | 4,821 | 27,575 | 85,137 | 141,159 | 85,137 |

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**6. Perencanaan Tulangan Geser Kolom**

Daerah Sendi Plastis

| Lantai | elemen | Ujung kolom | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | 90,078 | 0 | 149,1 | 150,130 | 160,459 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 90,078 | 0 | 149,1 | 150,130 | 160,459 | 159,75 | 155 | P10-155 | AMAN |
| | KI8 | Atas | 105,049 | 0 | 149,1 | 175,081 | 137,592 | 159,75 | 135 | P10-135 | AMAN |
| | | Bawah | 105,049 | 0 | 149,1 | 175,081 | 137,592 | 159,75 | 135 | P10-135 | AMAN |
| | KI17 | Atas | 176,258 | 0 | 149,1 | 293,764 | 82,004 | 159,75 | 80 | P10-80 | AMAN |
| | | Bawah | 176,258 | 0 | 149,1 | 293,764 | 82,004 | 159,75 | 80 | P10-80 | AMAN |
| | KI25 | Atas | 158,135 | 0 | 149,1 | 263,559 | 91,402 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 158,135 | 0 | 149,1 | 263,559 | 91,402 | 159,75 | 90 | P10-90 | AMAN |
| | KI33 | Atas | 164,372 | 0 | 149,1 | 273,954 | 87,934 | 159,75 | 85 | P10-85 | AMAN |
| | | Bawah | 164,372 | 0 | 149,1 | 273,954 | 87,934 | 159,75 | 85 | P10-85 | AMAN |
| | KI44 | Atas | 130,072 | 0 | 149,1 | 216,787 | 111,122 | 159,75 | 110 | P10-110 | AMAN |
| | | Bawah | 130,072 | 0 | 149,1 | 216,787 | 111,122 | 159,75 | 110 | P10-110 | AMAN |
| | KI45 | Atas | 158,698 | 0 | 149,1 | 264,497 | 91,078 | 159,75 | 90 | P10-90 | AMAN |
| | | Bawah | 158,698 | 0 | 149,1 | 264,497 | 91,078 | 159,75 | 90 | P10-90 | AMAN |
| | KI56 | Atas | 68,178 | 0 | 149,1 | 113,630 | 212,003 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 68,178 | 0 | 149,1 | 113,630 | 212,003 | 159,75 | 155 | P10-155 | AMAN |
| | KI57 | Atas | 85,137 | 0 | 149,1 | 141,895 | 169,772 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 85,137 | 0 | 149,1 | 141,895 | 169,772 | 159,75 | 155 | P10-155 | AMAN |

Daerah Luar Sendi Plastis

| Lantai | elemen | Ujung kolom | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 2 | KI7 | Atas | 25,407 | 372,750 | 149,1 | -330,406 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 25,407 | 372,750 | 149,1 | -330,406 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI8 | Atas | 29,629 | 372,750 | 149,1 | -323,368 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 29,629 | 372,750 | 149,1 | -323,368 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI17 | Atas | 49,714 | 372,750 | 149,1 | -289,894 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 49,714 | 372,750 | 149,1 | -289,894 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI25 | Atas | 44,602 | 372,750 | 149,1 | -298,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,602 | 372,750 | 149,1 | -298,413 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI33 | Atas | 46,361 | 372,750 | 149,1 | -295,481 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 46,361 | 372,750 | 149,1 | -295,481 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI44 | Atas | 36,687 | 372,750 | 149,1 | -311,605 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 36,687 | 372,750 | 149,1 | -311,605 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI45 | Atas | 44,761 | 372,750 | 149,1 | -298,148 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,761 | 372,750 | 149,1 | -298,148 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI56 | Atas | 19,230 | 372,750 | 149,1 | -340,701 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 19,230 | 372,750 | 149,1 | -340,701 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI57 | Atas | 24,013 | 372,750 | 149,1 | -332,728 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 24,013 | 372,750 | 149,1 | -332,728 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

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## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fy deform | = 400 MPa | Ec = Eg | = 23500 MPa | Ic | = 0,0200 m^4 | b kolom | = 700 mm |
| Fy polos | = 240 MPa | tk atas | = 5 m | Ig atas | = 0,0072 m^4 | h kolom | = 700 mm |
| fc' | = 25 MPa | tk | = 5 m | Ig bawah | = 0,0072 m^4 | b blk atas | = 400 mm |
| Ø pokok | = 22 mm | tk bawah | = 4,5 m | pb | = 40 mm | h blk atas | = 600 mm |
| Ø sengkang | = 10 mm | Lg ki atas | = 7,2 m | Lg ki bawah | = 7,2 m | b blk bawah | = 400 mm |
| Ø | = 0,65 | Lg' ki atas | = 6,5 m | Lg' ki bawah | = 6,5 m | h blk bawah | = 600 mm |
| Øo | = 1,25 | Lg ka atas | = 7,2 m | Lg ka bawah | = 7,2 m | | |
| r | = 210 mm | Lg' ka atas | = 6,5 m | Lg' ka bawah | = 6,5 m | | |
| β | = 0,85 | d' | = 61 mm | d | = 639 mm | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KI9 | Atas | | | 376156,667 | 5 | 45,238 | Ok | 947,699 | 85,703 | 68,359 | 126012,880 | 35764,158 | 126012,880 | 130916,115 | 1,015 | 1274,364 |
| | | Bawah | | | 15,253 | 5 | 45,238 | Ok | 973,571 | 85,703 | 68,359 | 125842,702 | 35715,859 | 125842,702 | 130739,315 | 1,016 | 1305,410 |
| | KI10 | Atas | | | 14,450 | 3,95 | 44,786 | Ok | 909,453 | 84,175 | 61,998 | 126162,783 | 35806,702 | 126162,783 | 132395,809 | 1,014 | 1226,024 |
| | | Bawah | | | 376156,667 | 4,95 | 44,786 | Ok | 935,325 | 84,175 | 61,998 | 125981,954 | 35755,380 | 125981,954 | 132206,046 | 1,015 | 1257,070 |
| | KI18 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 958,430 | 124,579 | 19,375 | 128741,436 | 36538,559 | 128741,436 | 17260,189 | 1,137 | 1349,442 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 1010,174 | 124,579 | 19,375 | 128291,399 | 36410,832 | 128291,399 | 17199,853 | 1,145 | 1411,535 |
| | KI26 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 959,405 | 152,361 | 19,104 | 130648,150 | 37079,710 | 130648,150 | 17515,820 | 1,140 | 1395,064 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 1011,149 | 152,361 | 19,104 | 130117,331 | 36929,056 | 130117,331 | 17444,654 | 1,147 | 1457,156 |
| | KI34 | Atas | 3,613 | 1,95 | | | 40,857 | Ok | 1074,509 | 136,009 | 36,517 | 128511,773 | 36473,377 | 128511,773 | 17229,399 | 1,155 | 1507,025 |
| | | Bawah | 3,813 | 1,95 | | | 40,857 | Ok | 1126,253 | 136,009 | 36,517 | 128117,247 | 36361,405 | 128117,247 | 17176,505 | 1,164 | 1569,118 |
| | KI46 | Atas | 14,450 | 3 | | | 27,143 | Ok | 955,887 | 98,112 | 31,876 | 126869,419 | 36007,255 | 126869,419 | 38539,761 | 1,055 | 1304,044 |
| | | Bawah | 7,627 | 3 | | | 27,143 | Ok | 985,287 | 98,112 | 31,876 | 126655,747 | 35946,612 | 126655,747 | 38474,853 | 1,057 | 1339,324 |
| | KI47 | Atas | 5,419 | 2,7 | | | 24,429 | Ok | 913,020 | 96,867 | 24,891 | 127109,513 | 36075,397 | 127109,513 | 47669,994 | 1,042 | 1250,611 |
| | | Bawah | 14,450 | 2,7 | | | 24,429 | Ok | 942,420 | 96,867 | 24,891 | 126879,559 | 36010,133 | 126879,559 | 47583,755 | 1,043 | 1285,891 |
| | KI58 | Atas | | | 14,450 | 3,5 | 31,667 | Ok | 812,155 | 80,407 | 9,298 | 126615,709 | 35935,249 | 126615,709 | 187917,715 | 1,009 | 1103,237 |
| | | Bawah | | | 15,253 | 3,5 | 31,667 | Ok | 835,087 | 80,407 | 9,298 | 126425,210 | 35881,183 | 126425,210 | 187634,984 | 1,009 | 1130,756 |
| | KI59 | Atas | | | 2,194 | 2,2 | 19,905 | Tidak | 769,795 | 78,992 | 2,313 | 126867,649 | 36006,753 | 126867,649 | 299554,872 | 0,000 | 1050,141 |
| | | Bawah | | | 14,450 | 2,2 | 19,905 | Tidak | 792,727 | 78,992 | 2,313 | 126660,558 | 35947,977 | 126660,558 | 299065,896 | 0,000 | 1077,660 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KI9 | Atas | 11459,952 | 888999,674 | 1,020 | 16,673 | 3,934 | 24,072 | 72,878 | 1 | 0,000 | 0,000 | 1085,072 | 1372,180 | 1085,072 | 39,097 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 62,336 | 11,762 | 34,889 | 206,872 | 1 | 554,777 | 554,777 | 1267,575 | 1399,346 | 1267,575 | 100,209 | 1,3 |
| | KI10 | Atas | 11459,952 | 888999,674 | 1,020 | 21,204 | 7,459 | 83,052 | 154,397 | 1 | 469,730 | 469,730 | 1174,834 | 1303,701 | 1174,834 | 108,521 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 16,346 | 3,975 | 24,060 | 72,461 | 1 | 0,000 | 0,000 | 1070,475 | 1330,867 | 1070,475 | 13,548 | 1,3 |
| | KI18 | Atas | 11459,952 | 888999,674 | 1,020 | 38,965 | 23,258 | 119,430 | 280,081 | 1 | 469,730 | 469,730 | 1268,684 | 1218,534 | 1218,534 | 180,903 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 33,586 | 21,044 | 75,180 | 227,021 | 1 | 554,777 | 554,777 | 1346,828 | 1272,866 | 1272,866 | 137,620 | 1,3 |
| | KI26 | Atas | 11459,952 | 888999,674 | 1,020 | 17,432 | 1,539 | 118,936 | 173,718 | 1 | 469,730 | 469,730 | 1298,879 | 1247,591 | 1247,591 | 139,393 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 13,631 | 5,352 | 72,639 | 124,518 | 1 | 554,777 | 554,777 | 1377,023 | 1301,922 | 1301,922 | 58,523 | 1,3 |
| | KI34 | Atas | 11459,952 | 888999,674 | 1,020 | 62,038 | 7,481 | 117,880 | 297,397 | 1 | 469,730 | 469,730 | 1402,568 | 1424,415 | 1402,568 | 178,202 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 71,122 | 2,978 | 73,536 | 261,834 | 1 | 554,777 | 554,777 | 1480,713 | 1478,747 | 1478,747 | 146,302 | 1,3 |
| | KI46 | Atas | 11459,952 | 888999,674 | 1,020 | 25,899 | 2,912 | 35,393 | 105,231 | 1 | 119,799 | 0,000 | 1123,471 | 1240,578 | 1123,471 | 63,983 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 59,527 | 17,450 | 87,183 | 273,470 | 1 | 554,777 | 554,777 | 1292,907 | 1271,448 | 1271,448 | 30,553 | 1,3 |
| | KI47 | Atas | 11459,952 | 888999,674 | 1,020 | 73,772 | 14,611 | 127,803 | 341,938 | 1 | 469,730 | 469,730 | 1191,906 | 1164,924 | 1164,924 | 56,858 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 10,371 | 1,723 | 10,081 | 38,894 | 1 | 119,799 | 0,000 | 1108,023 | 1195,794 | 1108,023 | 0,910 | 1,3 |
| | KI58 | Atas | 11459,952 | 888999,674 | 1,020 | 3,697 | 0,893 | 26,863 | 39,230 | 1 | 0,000 | 119,799 | 953,962 | 976,242 | 953,962 | 31,862 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 1,021 | 8,744 | 1,195 | 32,999 | 58,038 | 1 | 554,777 | 554,777 | 1116,606 | 1000,320 | 1000,320 | 24,166 | 1,3 |
| | KI59 | Atas | 11459,952 | 888999,674 | 0,000 | 57,629 | 6,900 | 81,367 | 0,000 | 1 | 469,730 | 469,730 | 1022,751 | 900,941 | 900,941 | 145,810 | 1,3 |
| | | Bawah | 11833,920 | 887525,861 | 0,000 | 23,274 | 3,412 | 17,718 | 0,000 | 1 | 0,000 | 119,799 | 932,077 | 925,020 | 925,020 | 2,248 | 1,3 |

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**3. Perencanaan Tulangan Kolom**

| Lantai | elemen | Ujung kolom | $Mkap_{x,by}$ KNm | $Mkap_{x,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada $mm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KI9 | Atas | 0,000 | 119,799 | 11,554 | 38,513 | 122,740 | 38,513 | 72,878 | 11,212 | 166,934 | 0,067 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 1103,390 | 904,754 | 224,337 | 224,337 | 224,337 | 34,513 | 195,012 | 0,177 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI10 | Atas | 469,730 | 469,730 | 1243,678 | 1243,678 | 378,915 | 378,915 | 378,915 | 58,295 | 190,744 | 0,323 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 119,799 | 4,569 | 15,230 | 122,494 | 15,230 | 72,481 | 11,148 | 164,698 | 0,068 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI18 | Atas | 553,475 | 553,475 | 827,209 | 903,481 | 566,940 | 566,940 | 566,940 | 87,222 | 197,467 | 0,465 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 636,229 | 636,229 | 738,042 | 794,477 | 378,368 | 378,368 | 378,368 | 58,210 | 195,825 | 0,297 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI26 | Atas | 553,475 | 553,475 | 1025,816 | 1120,402 | 519,451 | 519,451 | 519,451 | 79,916 | 191,937 | 0,416 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 636,229 | 636,229 | 505,110 | 543,734 | 325,016 | 325,016 | 325,016 | 50,002 | 200,296 | 0,250 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI34 | Atas | 553,475 | 553,475 | 799,838 | 873,587 | 568,091 | 568,091 | 568,091 | 87,399 | 215,780 | 0,405 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 744,500 | 743,558 | 386,656 | 386,656 | 386,656 | 59,486 | 227,499 | 0,261 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI46 | Atas | 0,000 | 0,000 | 92,875 | 27,862 | 178,902 | 92,875 | 105,231 | 16,189 | 172,642 | 0,094 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 515,091 | 471,013 | 446,994 | 446,994 | 446,994 | 68,768 | 195,607 | 0,352 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI47 | Atas | 553,475 | 553,475 | 1433,553 | 1565,734 | 629,575 | 629,575 | 629,575 | 96,858 | 179,219 | 0,540 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 2,182 | 0,648 | 55,039 | 2,182 | 38,894 | 5,984 | 170,465 | 0,035 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI58 | Atas | 0,000 | 0,000 | 78,037 | 23,411 | 117,644 | 78,037 | 78,037 | 12,006 | 146,763 | 0,082 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 661,595 | 542,492 | 149,032 | 149,032 | 149,032 | 22,928 | 153,995 | 0,149 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI59 | Atas | 382,584 | 382,584 | 1318,717 | 1181,089 | 409,497 | 409,497 | 409,497 | 63,000 | 138,606 | 0,455 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 0,000 | 0,000 | 2,084 | 0,625 | 102,436 | 2,084 | 2,084 | 0,321 | 142,311 | 0,002 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | $fs'$ MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 3 | KI9 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10207,411 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7588,269 | Aman |
| | KI10 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4706,285 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 10194,095 | Aman |
| | KI18 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2894,367 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5134,041 | Aman |
| | KI26 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3403,398 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 6023,915 | Aman |
| | KI34 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3537,097 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 5793,004 | Aman |
| | KI46 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9543,691 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4254,945 | Aman |
| | KI47 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2296,198 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11027,865 | Aman |
| | KI58 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9839,052 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 9209,616 | Aman |
| | KI59 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2997,136 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 11895,401 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 3 | KI9 | Atas | 16,667 | 6,015 | 26,952 | 67,549 | 137,015 | 67,549 |
| | | Bawah | 16,667 | 6,015 | 26,952 | 67,549 | 137,015 | 67,549 |
| | KI10 | Atas | 12,552 | 5,49 | 29,147 | 102,585 | 141,362 | 102,585 |
| | | Bawah | 12,552 | 5,49 | 29,147 | 102,585 | 141,362 | 102,585 |
| | KI18 | Atas | 14,832 | 18,796 | 23,622 | 214,843 | 134,522 | 134,522 |
| | | Bawah | 14,832 | 18,796 | 23,622 | 214,843 | 134,522 | 134,522 |
| | KI26 | Atas | 3,539 | 19,119 | 21,381 | 191,924 | 113,590 | 113,590 |
| | | Bawah | 3,539 | 19,119 | 21,381 | 191,924 | 113,590 | 113,590 |
| | KI34 | Atas | 16,746 | 11,659 | 18,178 | 216,988 | 106,173 | 106,173 |
| | | Bawah | 16,746 | 11,659 | 18,178 | 216,988 | 106,173 | 106,173 |
| | KI46 | Atas | 64,575 | 6,55 | 21,636 | 125,506 | 185,552 | 125,506 |
| | | Bawah | 64,575 | 6,55 | 21,636 | 125,506 | 185,552 | 125,506 |
| | KI47 | Atas | 22,406 | 6,397 | 21,637 | 151,925 | 121,119 | 121,119 |
| | | Bawah | 22,406 | 6,397 | 21,637 | 151,925 | 121,119 | 121,119 |
| | KI58 | Atas | 53,482 | 7,76 | 24,537 | 51,606 | 167,360 | 51,606 |
| | | Bawah | 53,482 | 7,76 | 24,537 | 51,606 | 167,360 | 51,606 |
| | KI59 | Atas | 33,499 | 5,187 | 24,536 | 93,541 | 143,672 | 93,541 |
| | | Bawah | 33,499 | 5,187 | 24,536 | 93,541 | 143,672 | 93,541 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
| Lantai 3 | KI9 | Atas | 67,549 | 0 | 149,1 | 112,581 | 213,977 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 67,549 | 0 | 149,1 | 112,581 | 213,977 | 159,75 | 155 | P10-155 | AMAN |
| | KI10 | Atas | 102,585 | 0 | 149,1 | 170,976 | 140,896 | 159,75 | 140 | P10-140 | AMAN |
| | | Bawah | 102,585 | 0 | 149,1 | 170,976 | 140,896 | 159,75 | 140 | P10-140 | AMAN |
| | KI18 | Atas | 134,522 | 0 | 149,1 | 224,203 | 107,446 | 159,75 | 105 | P10-105 | AMAN |
| | | Bawah | 134,522 | 0 | 149,1 | 224,203 | 107,446 | 159,75 | 105 | P10-105 | AMAN |
| | KI26 | Atas | 113,590 | 0 | 149,1 | 189,317 | 127,246 | 159,75 | 125 | P10-125 | AMAN |
| | | Bawah | 113,590 | 0 | 149,1 | 189,317 | 127,246 | 159,75 | 125 | P10-125 | AMAN |
| | KI34 | Atas | 106,173 | 0 | 149,1 | 176,955 | 136,135 | 159,75 | 135 | P10-135 | AMAN |
| | | Bawah | 106,173 | 0 | 149,1 | 176,955 | 136,135 | 159,75 | 135 | P10-135 | AMAN |
| | KI46 | Atas | 125,506 | 0 | 149,1 | 209,176 | 115,165 | 159,75 | 115 | P10-115 | AMAN |
| | | Bawah | 125,506 | 0 | 149,1 | 209,176 | 115,165 | 159,75 | 115 | P10-115 | AMAN |
| | KI47 | Atas | 121,119 | 0 | 149,1 | 201,864 | 119,337 | 159,75 | 115 | P10-115 | AMAN |
| | | Bawah | 121,119 | 0 | 149,1 | 201,864 | 119,337 | 159,75 | 115 | P10-115 | AMAN |
| | KI58 | Atas | 51,606 | 0 | 149,1 | 86,011 | 280,079 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 51,606 | 0 | 149,1 | 86,011 | 280,079 | 159,75 | 155 | P10-155 | AMAN |
| | KI59 | Atas | 93,541 | 0 | 149,1 | 155,902 | 154,519 | 159,75 | 150 | P10-150 | AMAN |
| | | Bawah | 93,541 | 0 | 149,1 | 155,902 | 154,519 | 159,75 | 150 | P10-150 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
| Lantai 3 | KI9 | Atas | 24,563 | 372,750 | 149,1 | -331,811 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 24,563 | 372,750 | 149,1 | -331,811 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI10 | Atas | 37,304 | 372,750 | 149,1 | -310,577 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 37,304 | 372,750 | 149,1 | -310,577 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI18 | Atas | 48,917 | 372,750 | 149,1 | -291,222 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 48,917 | 372,750 | 149,1 | -291,222 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI26 | Atas | 41,305 | 372,750 | 149,1 | -303,908 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 41,305 | 372,750 | 149,1 | -303,908 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI34 | Atas | 38,608 | 372,750 | 149,1 | -308,403 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 38,608 | 372,750 | 149,1 | -308,403 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI46 | Atas | 45,638 | 372,750 | 149,1 | -296,686 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 45,638 | 372,750 | 149,1 | -296,686 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI47 | Atas | 44,043 | 372,750 | 149,1 | -299,345 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 44,043 | 372,750 | 149,1 | -299,345 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI58 | Atas | 18,766 | 372,750 | 149,1 | -341,473 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 18,766 | 372,750 | 149,1 | -341,473 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI59 | Atas | 34,015 | 372,750 | 149,1 | -316,058 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 34,015 | 372,750 | 149,1 | -316,058 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | = | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | = | 240 MPa | tk atas | = | 2,5 m | Ig atas | = | 0,0072 m^4 | h kolom | = | 700 mm |
| fc' | = | 25 MPa | tk | = | 5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 400 mm |
| Ø pokok | = | 22 mm | tk bawah | = | 5 m | pb | = | 40 mm | h blk atas | = | 600 mm |
| Ø sengkang | = | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | = | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | = | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | = | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | = | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.lf/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KI11 | Atas | | | 2,194 | 1,53 | 32,057 | Ok | 371,653 | 24,168 | 21,158 | 124187,478 | 35246,084 | 124187,478 | 182068,777 | 0,000 | 484,652 |
| | | Bawah | | | 1,463 | 1,53 | 32,057 | Ok | 423,397 | 24,168 | 21,158 | 123604,207 | 35080,544 | 123604,207 | 181213,655 | 1,005 | 546,745 |
| | KI19 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 272,465 | 11,182 | 0,854 | 122408,579 | 34741,208 | 122408,579 | 14150,432 | 1,039 | 344,849 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 324,209 | 11,182 | 0,854 | 121913,181 | 34600,608 | 121913,181 | 14093,164 | 1,046 | 406,942 |
| | KI27 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 298,787 | 12,963 | 0,039 | 122584,937 | 34791,261 | 122584,937 | 14170,819 | 1,043 | 379,285 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 350,531 | 12,963 | 0,039 | 122102,075 | 34654,218 | 122102,075 | 14115,000 | 1,051 | 441,378 |
| | KI35 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 374,079 | 21,242 | 14,983 | 123582,339 | 35074,337 | 123582,339 | 14286,118 | 1,055 | 482,882 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 425,823 | 21,242 | 14,983 | 123070,865 | 34929,174 | 123070,865 | 14226,992 | 1,063 | 544,975 |
| | KI48 | Atas | 5,419 | 2,1 | | | 44,000 | Ok | 308,060 | 33,854 | 8,315 | 127372,292 | 36149,977 | 127372,292 | 14724,237 | 1,046 | 423,838 |
| | | Bawah | 3,613 | 2,1 | | | 44,000 | Ok | 366,860 | 33,854 | 8,315 | 126143,373 | 35801,193 | 126143,373 | 14582,174 | 1,055 | 494,398 |
| | KI60 | Atas | | | 2,194 | 1,53 | 32,057 | Ok | 285,090 | 31,708 | 0,467 | 127463,778 | 36175,942 | 127463,778 | 186872,096 | 1,003 | 392,841 |
| | | Bawah | | | 1,463 | 1,53 | 32,057 | Ok | 336,834 | 31,708 | 0,467 | 126274,074 | 35838,288 | 126274,074 | 185127,894 | 1,004 | 454,934 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ki}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KI11 | Atas | 2508,348 | 426272,479 | 1,009 | 2,760 | 5,169 | 37,302 | 57,366 | 1 | 292,038 | 292,038 | 497,383 | 504,476 | 497,383 | 42,524 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 4,485 | 4,255 | 16,234 | 36,942 | 1 | 469,730 | 469,730 | 601,468 | 558,807 | 558,807 | 13,127 | 1,3 |
| | KI19 | Atas | 2508,348 | 426272,479 | 1,009 | 20,741 | 9,422 | 57,239 | 130,138 | 1 | 292,038 | 292,038 | 379,600 | 301,416 | 301,416 | 87,378 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 7,185 | 14,198 | 11,563 | 61,730 | 1 | 469,730 | 469,730 | 483,685 | 355,747 | 355,747 | 36,290 | 1,3 |
| | KI27 | Atas | 2508,348 | 426272,479 | 1,009 | 12,667 | 2,133 | 59,926 | 97,688 | 1 | 292,038 | 292,038 | 409,108 | 327,501 | 327,501 | 77,737 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 4,794 | 0,920 | 14,279 | 28,415 | 1 | 469,730 | 469,730 | 513,193 | 381,833 | 381,833 | 23,030 | 1,3 |
| | KI35 | Atas | 2508,348 | 426272,479 | 1,009 | 26,860 | 1,569 | 63,844 | 133,755 | 1 | 292,038 | 292,038 | 496,858 | 478,016 | 478,016 | 92,919 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 18,913 | 10,266 | 16,339 | 85,515 | 1 | 469,730 | 469,730 | 600,943 | 532,347 | 532,347 | 34,047 | 1,3 |
| | KI48 | Atas | 2508,348 | 426272,479 | 1,009 | 1,595 | 1,379 | 72,797 | 84,013 | 1 | 292,038 | 292,038 | 440,780 | 393,933 | 393,933 | 72,526 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 53,681 | 9,586 | 20,987 | 169,480 | 1 | 469,730 | 469,730 | 552,274 | 455,673 | 455,673 | 26,505 | 1,3 |
| | KI60 | Atas | 2508,348 | 426272,479 | 1,009 | 24,293 | 9,315 | 37,883 | 116,002 | 1 | 292,038 | 292,038 | 414,409 | 334,599 | 334,599 | 15,434 | 1,3 |
| | | Bawah | 2889,372 | 423358,879 | 1,011 | 14,324 | 0,911 | 12,459 | 47,718 | 1 | 469,730 | 469,730 | 518,494 | 388,931 | 388,931 | 29,584 | 1,3 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ki,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KI11 | Atas | 292,038 | 292,038 | 664,587 | 664,587 | 164,994 | 164,994 | 164,994 | 25,384 | 76,520 | 0,332 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 469,730 | 469,730 | 329,983 | 329,983 | 77,360 | 77,360 | 77,360 | 11,902 | 85,970 | 0,138 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI19 | Atas | 292,038 | 0,000 | 543,613 | 378,166 | 272,075 | 272,075 | 272,075 | 41,858 | 46,372 | 0,903 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 427,405 | 466,814 | 71,017 | 71,017 | 71,017 | 10,926 | 54,730 | 0,200 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI27 | Atas | 292,038 | 0,000 | 593,546 | 412,902 | 267,229 | 267,229 | 267,229 | 41,112 | 50,385 | 0,816 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 332,878 | 363,571 | 65,972 | 65,972 | 65,972 | 10,149 | 58,743 | 0,173 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI35 | Atas | 292,038 | 292,038 | 636,514 | 636,514 | 297,995 | 297,995 | 297,995 | 45,845 | 73,541 | 0,623 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 390,572 | 426,585 | 99,262 | 99,262 | 99,262 | 15,271 | 81,900 | 0,186 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI48 | Atas | 382,584 | 382,584 | 682,536 | 788,876 | 308,870 | 308,870 | 308,870 | 47,518 | 60,605 | 0,784 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 553,475 | 553,475 | 389,822 | 425,765 | 154,576 | 154,576 | 169,480 | 26,074 | 70,103 | 0,372 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI60 | Atas | 198,092 | 198,092 | 276,047 | 224,396 | 194,397 | 194,397 | 194,397 | 29,907 | 51,477 | 0,581 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 382,584 | 382,584 | 879,968 | 788,130 | 68,325 | 68,325 | 68,325 | 10,511 | 59,835 | 0,176 | 1 | 4900 | 2450 | 7 | 2660,935 |

**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | | |
| Lantai 4 | KI11 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 4558,618 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 8457,926 | Aman |
| | KI19 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1046,567 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7064,399 | Aman |
| | KI27 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1213,980 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7661,347 | Aman |
| | KI35 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1835,842 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7354,052 | Aman |
| | KI48 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 1288,702 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 3964,284 | Aman |
| | KI60 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 2051,165 | Aman |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | 7595,784 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln = 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai 4 | KI11 | Atas | 8,916 | 1,973 | 7,058 | 55,080 | 41,077 | 41,077 |
| | | Bawah | 8,916 | 1,973 | 7,058 | 55,080 | 41,077 | 41,077 |
| | KI19 | Atas | 15,653 | 0,608 | 0,876 | 77,975 | 20,753 | 20,753 |
| | | Bawah | 15,653 | 0,608 | 0,876 | 77,975 | 20,753 | 20,753 |
| | KI27 | Atas | 20,696 | 0,696 | 0,461 | 75,727 | 24,398 | 24,398 |
| | | Bawah | 20,696 | 0,696 | 0,461 | 75,727 | 24,398 | 24,398 |
| | KI35 | Atas | 5,84 | 3,037 | 14,534 | 90,286 | 70,364 | 70,364 |
| | | Bawah | 5,84 | 3,037 | 14,534 | 90,286 | 70,364 | 70,364 |
| | KI48 | Atas | 0,036 | 1,375 | 1,967 | 108,716 | 9,743 | 9,743 |
| | | Bawah | 0,036 | 1,375 | 1,967 | 108,716 | 9,743 | 9,743 |
| | KI60 | Atas | 2,614 | 2,028 | 5,398 | 59,709 | 27,546 | 27,546 |
| | | Bawah | 2,614 | 2,028 | 5,398 | 59,709 | 27,546 | 27,546 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Daerah Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KI11 | Atas | 41,077 | 0 | 149,1 | 68,462 | 351,872 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 41,077 | 0 | 149,1 | 68,462 | 351,872 | 159,75 | 155 | P10-155 | AMAN |
| | KI19 | Atas | 20,753 | 0 | 149,1 | 34,589 | 696,463 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 20,753 | 0 | 149,1 | 34,589 | 696,463 | 159,75 | 155 | P10-155 | AMAN |
| | KI27 | Atas | 24,398 | 0 | 149,1 | 40,663 | 592,425 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 24,398 | 0 | 149,1 | 40,663 | 592,425 | 159,75 | 155 | P10-155 | AMAN |
| | KI35 | Atas | 70,364 | 0 | 149,1 | 117,273 | 205,417 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 70,364 | 0 | 149,1 | 117,273 | 205,417 | 159,75 | 155 | P10-155 | AMAN |
| | KI48 | Atas | 9,743 | 0 | 149,1 | 16,238 | 1483,521 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 9,743 | 0 | 149,1 | 16,238 | 1483,521 | 159,75 | 155 | P10-155 | AMAN |
| | KI60 | Atas | 27,546 | 0 | 149,1 | 45,910 | 524,723 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 27,546 | 0 | 149,1 | 45,910 | 524,723 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Daerah Luar Sendi Plastis | | | | | | | | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vu b Kn | Vc Kn | Vs min Kn | Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | |
| Lantai 4 | KI11 | Atas | 14,937 | 372,750 | 149,1 | -347,855 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 14,937 | 372,750 | 149,1 | -347,855 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI19 | Atas | 7,547 | 372,750 | 149,1 | -360,172 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 7,547 | 372,750 | 149,1 | -360,172 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI27 | Atas | 8,872 | 372,750 | 149,1 | -357,963 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 8,872 | 372,750 | 149,1 | -357,963 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI35 | Atas | 25,587 | 372,750 | 149,1 | -330,105 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 25,587 | 372,750 | 149,1 | -330,105 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI48 | Atas | 3,543 | 372,750 | 149,1 | -366,845 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 3,543 | 372,750 | 149,1 | -366,845 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | KI60 | Atas | 10,017 | 372,750 | 149,1 | -356,056 | 161,568 | 319,5 | 160 | P10-160 | AMAN |
| | | Bawah | 10,017 | 372,750 | 149,1 | -356,056 | 161,568 | 319,5 | 160 | P10-160 | AMAN |

UNIVERSITAS ISLAM INDONESIA

## PERENCANAAN KOLOM PORTAL B-I

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fy deform | : | 400 MPa | Ec = Eg | = | 23500 MPa | Ic | = | 0,0200 m^4 | b kolom | = | 700 mm |
| Fy polos | : | 240 MPa | tk atas | = | 0 m | Ig atas | = | 0,0016 m^4 | h kolom | = | 700 mm |
| fc' | : | 25 MPa | tk | = | 2,5 m | Ig bawah | = | 0,0072 m^4 | b blk atas | = | 300 mm |
| Ø pokok | : | 22 mm | tk bawah | = | 5 m | pb | = | 40 mm | h blk atas | = | 400 mm |
| Ø sengkang | : | 10 mm | Lg ki atas | = | 7,2 m | Lg ki bawah | = | 7,2 m | b blk bawah | = | 400 mm |
| Ø | : | 0,65 | Lg' ki atas | = | 6,5 m | Lg' ki bawah | = | 6,5 m | h blk bawah | = | 600 mm |
| Øo | : | 1,25 | Lg ka atas | = | 7,2 m | Lg ka bawah | = | 7,2 m | | | |
| r | : | 210 mm | Lg' ka atas | = | 6,5 m | Lg' ka bawah | = | 6,5 m | | | |
| β | : | 0,85 | d' | = | 61 mm | d | = | 639 mm | | | |

### 1. Perhitungan Momen Rencana (Mc)

| Lantai | elemen | Ujung kolom | Kolom tengah ψ | Kolom tengah K | Kolom tepi ψ | Kolom tepi K | k.l/r | Perbesaran momen | PD KN | PL KN | PE KN | $EI_1$ KNm^2 | $EI_2$ KNm^2 | EI pakai KNm^2 | Pc KN | δb | Pu KN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KI12 | Atas | | | 32,514 | 2,5 | 25,0 | Ok | 74,510 | 0,853 | 2,740 | 106876,653 | 7576,959 | 106876,653 | 210967,044 | 1,001 | 90,777 |
| | | Bawah | | | 2,194 | 2,5 | 25,0 | Ok | 98,030 | 0,853 | 2,740 | 119920,901 | 34035,172 | 119920,901 | 236715,478 | 1,001 | 119,001 |
| | KI20 | Atas | 16,257 | 2,8 | | | 28,0 | Ok | 63,088 | 0,499 | 0,323 | 106629,621 | 7559,445 | 106629,621 | 187928,054 | 1,001 | 76,504 |
| | | Bawah | 5,419 | 2,8 | | | 28,0 | Ok | 86,608 | 0,499 | 0,323 | 119689,455 | 33969,484 | 119689,455 | 210945,195 | 1,001 | 104,728 |
| | KI28 | Atas | 16,257 | 2,8 | | | 28,0 | Ok | 66,844 | 0,256 | 0,101 | 106343,362 | 7539,151 | 106343,362 | 187423,540 | 1,001 | 80,622 |
| | | Bawah | 5,419 | 2,8 | | | 28,0 | Ok | 90,364 | 0,256 | 0,101 | 119457,991 | 33903,792 | 119457,991 | 210537,255 | 1,001 | 108,846 |
| | KI36 | Atas | | | 32,514 | 2,5 | 25,0 | Ok | 71,230 | 0,501 | 0,489 | 106568,285 | 7555,097 | 106568,285 | 210358,346 | 1,001 | 86,278 |
| | | Bawah | | | 2,194 | 2,5 | 25,0 | Ok | 94,750 | 0,501 | 0,489 | 119652,054 | 33958,869 | 119652,054 | 236184,792 | 1,001 | 114,502 |

### 2. Perhitungan Momen Lentur dan Aksial Kolom

| Lantai | elemen | Ujung kolom | ΣPu KN | ΣPc KN | δs | MD KNm | ML KNm | ME KNm | Mc KNm | Rv | $Mkap_{ka}$ KNm | $Mkap_{ka}$ KNm | Nuk1 KN | Nuk2 KN | Nuk pakai KN | Mmaks KNm | $\omega_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KI12 | Atas | 334,181 | 796676,984 | 1,001 | 24,620 | 1,709 | 5,305 | 64,819 | 1 | 119,799 | 0,000 | 112,675 | 90,639 | 90,639 | 31,945 | 1 |
| | | Bawah | 447,077 | 894382,720 | 1,001 | 18,384 | 0,729 | 9,571 | 53,080 | 1 | 292,038 | 292,038 | 267,368 | 115,335 | 115,335 | 7,151 | 1 |
| | KI20 | Atas | 334,181 | 796676,984 | 1,001 | 15,785 | 1,984 | 10,891 | 51,409 | 1 | 119,799 | 119,799 | 133,854 | 68,123 | 68,123 | 29,197 | 1 |
| | | Bawah | 447,077 | 894382,720 | 1,001 | 8,146 | 1,037 | 4,351 | 25,229 | 1 | 292,038 | 292,038 | 255,004 | 92,819 | 92,819 | 13,553 | 1 |
| | KI28 | Atas | 334,181 | 796676,984 | 1,001 | 9,741 | 0,143 | 12,171 | 35,038 | 1 | 119,799 | 119,799 | 137,542 | 70,879 | 70,879 | 3,624 | 1 |
| | | Bawah | 447,077 | 894382,720 | 1,001 | 7,145 | 2,471 | 4,611 | 26,449 | 1 | 292,038 | 292,038 | 258,692 | 95,575 | 95,575 | 0,944 | 1 |
| | KI36 | Atas | 334,181 | 796676,984 | 1,001 | 16,760 | 0,479 | 5,425 | 44,503 | 1 | 0,000 | 119,799 | 108,861 | 77,371 | 77,371 | 9,718 | 1 |
| | | Bawah | 447,077 | 894382,720 | 1,001 | 8,508 | 2,257 | 4,870 | 29,312 | 1 | 292,038 | 292,038 | 263,555 | 102,067 | 102,067 | 12,261 | 1 |

### 3. Perencanaan Tulangan Kolom

| Lantai | elemen | Ujung kolom | $Mkap_{ka,by}$ KNm | $Mkap_{ka,by}$ KNm | $Muk_1$ KNm | $Muk_2$ KNm | $Muk_3$ KNm | Muk pakai KNm | Mu terpakai KNm | Mn Ton-m | Pn Ton | e m | % | Ast $mm^2$ | As' = As perlu $mm^2$ | n tulangan | As = As' ada mm2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | KI12 | Atas | 0,000 | 119,799 | 117,464 | 117,464 | 49,926 | 49,926 | 64,819 | 9,972 | 13,944 | 0,715 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 141,694 | 141,694 | 60,267 | 60,267 | 60,267 | 9,272 | 17,744 | 0,523 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI20 | Atas | 0,000 | 0,000 | 151,051 | 45,315 | 64,400 | 64,400 | 64,400 | 9,908 | 10,480 | 0,945 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 0,000 | 217,255 | 151,134 | 27,916 | 27,916 | 27,916 | 4,295 | 14,280 | 0,301 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI28 | Atas | 0,000 | 0,000 | 175,462 | 52,639 | 61,496 | 61,496 | 61,496 | 9,461 | 10,904 | 0,868 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 0,000 | 172,898 | 70,064 | 29,463 | 29,463 | 29,463 | 4,533 | 14,704 | 0,308 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | KI36 | Atas | 0,000 | 0,000 | 141,617 | 98,516 | 40,886 | 40,886 | 44,503 | 6,847 | 11,903 | 0,575 | 1 | 4900 | 2450 | 7 | 2660,935 |
| | | Bawah | 292,038 | 292,038 | 432,150 | 432,150 | 31,757 | 31,757 | 31,757 | 4,886 | 15,703 | 0,311 | 1 | 4900 | 2450 | 7 | 2660,935 |

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**4. Perhitungan Keruntuhan Kolom**

| Lantai | elemen | Ujung kolom | Pakai tulangan | Jbd mm | Keadaan seimbang | | | | | | | e m | Keruntuhan kolom | patah desak Pn KN | patah tarik Pn KN | Kontrol Pn > Nu/Ø |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | cb mm | fs' MPa | fs' pakai MPa | Cc KN | Cs KN | Ts KN | Pnb Ton | Mnb Ton-m | | | | |
| Lantai Atap | Kl12 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | 1482,562 | Aman |
| | Kl20 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | 2422,432 | Aman |
| | Kl28 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | 979,226 | Aman |
| | Kl36 | Atas | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | | |
| | | Bawah | 7D22 | 74,333 | 383,4 | 504,538 | 400 | 4847,614 | 1007,829 | 1064,374 | 479,107 | 150,564 | 0,314 | Patah tarik | 5072,805 | Aman |
| | | | | | | | | | | | | | | | 1108,703 | Aman |
| | | | | | | | | | | | | | | | 4943,661 | Aman |
| | | | | | | | | | | | | | | | 2083,829 | Aman |
| | | | | | | | | | | | | | | | 4895,050 | Aman |

**5. Perencanaan Gaya Geser Kolom**

Ln : 6,5 m

| Lantai | elemen | Ujung kolom | VD KN | VL KN | VE KN | Vuk1 KN | Vuk2 KN | Vuk pakai KN |
|---|---|---|---|---|---|---|---|---|
| Lantai Atap | Kl12 | Atas | 7,415 | 0,264 | 5,486 | 62,543 | 31,104 | 31,104 |
| | | Bawah | 7,415 | 0,264 | 5,486 | 62,543 | 31,104 | 31,104 |
| | Kl20 | Atas | 2,743 | 0,013 | 0,394 | 46,158 | 4,549 | 4,549 |
| | | Bawah | 2,743 | 0,013 | 0,394 | 46,158 | 4,549 | 4,549 |
| | Kl28 | Atas | 3,266 | 0,014 | 0,084 | 45,480 | 3,797 | 3,797 |
| | | Bawah | 3,266 | 0,014 | 0,084 | 45,480 | 3,797 | 3,797 |
| | Kl36 | Atas | 2,314 | 1,335 | 1,215 | 38,130 | 8,934 | 8,934 |
| | | Bawah | 2,314 | 1,335 | 1,215 | 38,130 | 8,934 | 8,934 |

**6. Perencanaan Tulangan Geser Kolom**

| Lantai | elemen | Ujung kolom | Vu b Kn | Vc Kn | Vs min Kn | Daerah Sendi Plastis Vs Kn | S mm | d/4 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | Kl12 | Atas | 31,104 | 0 | 149,1 | 51,840 | 464,693 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 31,104 | 0 | 149,1 | 51,840 | 464,693 | 159,75 | 155 | P10-155 | AMAN |
| | Kl20 | Atas | 4,549 | 0 | 149,1 | 7,581 | 3177,653 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 4,549 | 0 | 149,1 | 7,581 | 3177,653 | 159,75 | 155 | P10-155 | AMAN |
| | Kl28 | Atas | 3,797 | 0 | 149,1 | 6,328 | 3806,857 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 3,797 | 0 | 149,1 | 6,328 | 3806,857 | 159,75 | 155 | P10-155 | AMAN |
| | Kl36 | Atas | 8,934 | 0 | 149,1 | 14,891 | 1617,769 | 159,75 | 155 | P10-155 | AMAN |
| | | Bawah | 8,934 | 0 | 149,1 | 14,891 | 1617,769 | 159,75 | 155 | P10-155 | AMAN |

| Lantai | elemen | Ujung kolom | Vu b Kn | Vc Kn | Vs min Kn | Daerah Luar Sendi Plastis Vs Kn | S mm | d/2 mm | S pakai mm | Digunakan tulangan | Kontrol Vu b/Φ<Vc+Vs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lantai Atap | Kl12 | Atas | -11,849 | 372,750 | 149,1 | -392,499 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -11,849 | 372,750 | 149,1 | -392,499 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | Kl20 | Atas | -1,733 | 372,750 | 149,1 | -375,638 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -1,733 | 372,750 | 149,1 | -375,638 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | Kl28 | Atas | -1,446 | 372,750 | 149,1 | -375,161 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -1,446 | 372,750 | 149,1 | -375,161 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | Kl36 | Atas | -3,404 | 372,750 | 149,1 | -378,423 | 161,568 | 319,500 | 160 | P10-160 | AMAN |
| | | Bawah | -3,404 | 372,750 | 149,1 | -378,423 | 161,568 | 319,500 | 160 | P10-160 | AMAN |

## Pertemuan Balok Kolom Lantai Basement

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fc' (Mpa) | 25 | D tulangan (mm) | 10 | $\phi_v$ | 1,25 | z (m) | 0,54315 |
| fy (Mpa) | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 55 | | |
| kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | | | |

### A. Pertemuan Balok Kolom Luar

**1.Perhitungan gaya dalam**

| Keterangan | | (JB1)1 | (JB2)1 | (JB3)2 | (JB4)2 | (JB5)2 | (JB6)2 | (JB7)2 | (JB8)1 | (JB9)1 | (JB10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,2 |
| ln ki | (m) | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 0 | 7,2 | 0 | 7,2 | 0 | 7,2 | 7,2 | 7,2 |
| tinggi, a | (m) | 3,50 | 3,5 | 0 | 6,45 | 0 | 6,45 | 0 | 6,5 | 6,5 | 6,5 |
| tinggi, b | (m) | 1,80 | 1,8 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 |
| Mnak, ki | (Knm) | 0,000 | 0,000 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 |
| Mnak, ka | (Knm) | 145,363 | 145,363 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 158,474 |
| Mkap, ki | (Knm) | 0,000 | 0,000 | 0 | 145,363 | 0 | 145,363 | 0 | 225,96 | 225,96 | 145,363 |
| Mkap,ka | (Knm) | 181,704 | 181,704 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 198,093 |
| Vkol | (Kn) | 53,166 | 53,166 | 0,000 | 181,704 | 0,000 | 181,704 | 0,000 | 282,450 | 282,450 | 181,704 |
| Cki | (Kn) | 0,000 | 0,000 | 0,000 | 53,578 | 0,000 | 53,578 | 0,000 | 82,644 | 82,644 | 111,128 |
| Tka | (Kn) | 234,176 | 234,176 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 255,297 |
| Vj,h | (Kn) | 181,010 | 181,010 | 0,000 | 234,176 | 0,000 | 234,176 | 0,000 | 364,015 | 364,015 | 234,176 |
| Vj,v | (Kn) | 181,010 | 181,010 | 0,000 | 180,598 | 0,000 | 180,598 | 0,000 | 281,371 | 281,371 | 378,346 |
| | | | 181,010 | 0,000 | 361,195 | 0,000 | 361,195 | 0,000 | 281,371 | 281,371 | 378,346 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,369 | 0,369 | 0,000 | 0,564 | 0,000 | 0,564 | 0,000 | 0,574 | 0,574 | 0,772 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | Ok | Ok | Ok | OK | Ok | Ok | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3529,420 | 3396,036 | 1984,405 | 2229,680 | 2073,132 | 2215,656 | 1976,671 | 3446,688 | 3103,950 | 4452,220 |
| Nu/Ag | (N/mm²) | 7,203 | 6,931 | 6,201 | 6,968 | 6,479 | 6,924 | 6,177 | 7,034 | 6,335 | 9,086 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 708,415 | 687,607 | 410,425 | 450,924 | 425,520 | 448,707 | 409,083 | 695,582 | 639,682 | 838,342 |
| Vs,h | (Kn) | -527,405 | -506,597 | -410,425 | -270,326 | -425,520 | -268,109 | -409,083 | -414,211 | -358,311 | -459,996 |
| Ajh | (mm²) | -2197,521 | -2110,822 | -1710,104 | -1126,359 | -1773,002 | -1117,122 | -1704,512 | -1725,878 | -1492,963 | -1916,650 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | -6,995 | -6,719 | -5,443 | -3,585 | -5,644 | -3,556 | -5,426 | -5,494 | -4,752 | -6,101 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 160,758 | 158,787 | 0,000 | 158,693 | 0,000 | 158,376 | 0,000 | 247,990 | 240,118 | 364,516 |
| Vs,v | (Kn) | 20,252 | 22,223 | 0,000 | 202,502 | 0,000 | 202,819 | 0,000 | 33,381 | 41,254 | 13,830 |
| Aj,v | (mm²) | 84,384 | 92,596 | 0,000 | 843,759 | 0,000 | 845,079 | 0,000 | 139,088 | 171,890 | 57,624 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 11,000 | 2,000 | 11,000 | 2,000 | 2,000 | 4,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 863,940 | 157,080 | 863,940 | 157,080 | 157,080 | 314,160 | 157,080 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 680,000 | 59,000 | 680,000 | 59,000 | 680,000 | 580,000 | 186,667 | 580,000 |

### B. Pertemuan Balok Kolom Dalam

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 0,00 |
| ln ki | (m) | 0,00 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0,00 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 0 | 7,20 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0 | 6,50 |
| tinggi, a | (m) | 3,50 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,8 | 1,80 |
| Mnak, ki | (Knm) | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 0,000 |
| Mnak, ka | (Knm) | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 0 | 145,363 |
| Mkap, ki | (Knm) | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 |
| Mkap,ka | (Knm) | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 0,000 | 181,704 |
| Vkol | (Kn) | 53,166 | 114,614 | 115,759 | 112,864 | 112,864 | 112,864 | 115,520 | 114,928 | 57,961 | 53,166 |
| Cki | (Kn) | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 |
| Tka | (Kn) | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 0,000 | 234,176 |
| Vj,h | (Kn) | 181,010 | 374,859 | 373,714 | 376,609 | 376,609 | 376,609 | 373,954 | 374,545 | 197,336 | 181,010 |
| Vj,v | (Kn) | 181,010 | 374,859 | 747,428 | 753,218 | 753,218 | 753,218 | 747,907 | 374,545 | 197,336 | 181,010 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,369 | 0,765 | 1,168 | 1,177 | 1,177 | 1,177 | 1,169 | 0,764 | 0,403 | 0,369 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3529,420 | 3396,036 | 1984,405 | 2229,680 | 2073,132 | 2215,656 | 1976,671 | 3446,688 | 3103,950 | 4452,220 |
| Nu/Ag | (N/mm²) | 7,203 | 6,931 | 6,201 | 6,968 | 6,479 | 6,924 | 6,177 | 7,034 | 6,335 | 9,086 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 708,415 | 687,607 | 410,425 | 450,924 | 425,520 | 448,707 | 409,083 | 695,582 | 639,682 | 838,342 |
| Vs,h | (Kn) | -527,405 | -312,748 | -36,711 | -74,315 | -48,911 | -72,098 | -35,129 | -321,037 | -442,347 | -657,332 |
| Ajh | (mm²) | -2197,521 | -1303,115 | -152,962 | -309,644 | -203,797 | -300,406 | -146,372 | -1337,655 | -1843,110 | -2738,883 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | -6,995 | -4,148 | -0,487 | -0,986 | -0,649 | -0,956 | -0,466 | -4,258 | -5,867 | -8,718 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 160,758 | 328,837 | 316,928 | 330,930 | 323,561 | 330,270 | 316,770 | 330,110 | 168,403 | 174,393 |
| Vs,v | (Kn) | 20,252 | 46,022 | 430,500 | 422,288 | 429,658 | 422,948 | 431,137 | 44,435 | 28,933 | 6,617 |
| Aj,v | (mm²) | 84,384 | 191,760 | 1793,749 | 1759,534 | 1790,241 | 1762,285 | 1796,405 | 185,146 | 120,553 | 27,569 |
| jumlah tul | | 2,000 | 3,000 | 23,000 | 23,000 | 23,000 | 23,000 | 23,000 | 3,000 | 2,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 235,620 | 1806,420 | 1806,420 | 1806,420 | 1806,420 | 1806,420 | 235,620 | 157,080 | 157,080 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 285,000 | 21,364 | 21,364 | 21,364 | 21,364 | 21,364 | 285,000 | 580,000 | 580,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | JB1ki | JB3ki | JB13ki | JB14ki | JB15ki | JB16ki | JB17ki | JB18ki | JB19ki | JB20ki |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,45 | 6,45 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 145,363 | 145,363 | 145,363 | 225,960 | 225,960 | 145,363 | 145,363 | 145,363 | 145,363 | 225,960 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 181,704 | 181,704 | 181,704 | 282,450 | 282,450 | 181,704 | 181,704 | 181,704 | 181,704 | 282,450 |
| Vkol | (Kn) | 111,128 | 111,577 | 111,577 | 140,606 | 140,606 | 111,128 | 111,128 | 111,128 | 111,128 | 140,606 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 234,176 | 234,176 | 234,176 | 364,015 | 364,015 | 234,176 | 234,176 | 234,176 | 234,176 | 364,015 |
| Vj,h | (Kn) | 378,346 | 377,896 | 377,896 | 478,707 | 478,707 | 378,346 | 378,346 | 378,346 | 378,346 | 478,707 |
| Vj,v | (Kn) | 378,346 | 377,896 | 377,896 | 478,707 | 478,707 | 378,346 | 378,346 | 378,346 | 378,346 | 478,707 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,772 | 0,771 | 0,771 | 0,977 | 0,977 | 0,772 | 0,772 | 0,772 | 0,772 | 0,977 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4252,873 | 4151,003 | 4100,893 | 4740,247 | 5196,602 | 4224,000 | 4340,177 | 4191,224 | 4038,337 | 4831,861 |
| Nu/Ag | (N/mm²) | 8,679 | 8,471 | 8,369 | 9,674 | 10,603 | 8,620 | 8,858 | 8,554 | 8,242 | 9,861 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 812,037 | 798,260 | 791,395 | 874,953 | 929,897 | 808,156 | 823,660 | 803,727 | 782,740 | 886,281 |
| Vs,h | (Kn) | -433,691 | -420,363 | -413,498 | -396,246 | -451,190 | -429,810 | -445,315 | -425,382 | -404,395 | -407,574 |
| Ajh | (mm²) | -1807,046 | -1751,514 | -1722,910 | -1651,025 | -1879,959 | -1790,875 | -1855,478 | -1772,424 | -1684,978 | -1698,225 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | -5,752 | -5,575 | -5,484 | -5,255 | -5,984 | -5,701 | -5,906 | -5,642 | -5,363 | -5,406 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 358,359 | 354,791 | 353,245 | 472,464 | 490,259 | 357,467 | 361,055 | 356,455 | 351,733 | 476,044 |
| Vs,v | (Kn) | 19,987 | 23,106 | 24,651 | 6,243 | -11,552 | 20,879 | 17,290 | 21,891 | 26,613 | 2,663 |
| Aj,v | (mm²) | 83,278 | 96,273 | 102,714 | 26,012 | -48,132 | 86,994 | 72,043 | 91,212 | 110,887 | 11,095 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 |
| As pasang > Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 0,00 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 0,00 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 145,363 | 145,363 | 145,363 | 145,363 | 0,000 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 181,704 | 181,704 | 181,704 | 181,704 | 0,000 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 |
| Vkol | (Kn) | 111,128 | 111,128 | 111,128 | 111,128 | 57,961 | 53,166 | 111,128 | 111,128 | 111,128 | 111,128 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 234,176 | 234,176 | 234,176 | 234,176 | 0,000 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 |
| Vj,h | (Kn) | 378,346 | 378,346 | 378,346 | 378,346 | 197,336 | 181,010 | 378,346 | 378,346 | 378,346 | 378,346 |
| Vj,v | (Kn) | 378,346 | 378,346 | 378,346 | 378,346 | 197,336 | 181,010 | 378,346 | 378,346 | 378,346 | 378,346 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,772 | 0,772 | 0,772 | 0,772 | 0,403 | 0,369 | 0,772 | 0,772 | 0,772 | 0,772 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | Ok | OK | OK | OK | Ok | Ok | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4252,873 | 4151,003 | 4100,893 | 4740,247 | 5195,602 | 4224,000 | 4340,177 | 4191,224 | 4038,337 | 4831,861 |
| Nu/Ag | (N/mm²) | 8,679 | 8,471 | 8,369 | 9,674 | 10,603 | 8,620 | 8,858 | 8,554 | 8,242 | 9,861 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 812,037 | 798,260 | 791,395 | 874,953 | 929,897 | 808,156 | 823,660 | 803,727 | 782,740 | 886,281 |
| Vs,h | (Kn) | -433,691 | -419,914 | -413,049 | -496,607 | -732,561 | -627,146 | -445,315 | -425,382 | -404,395 | -507,935 |
| Ajh | (mm²) | -1807,046 | -1749,642 | -1721,038 | -2069,197 | -3052,339 | -2613,108 | -1855,478 | -1772,424 | -1684,978 | -2116,398 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | -5,752 | -5,569 | -5,478 | -6,586 | -9,716 | -8,318 | -5,906 | -5,642 | -5,363 | -6,737 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 358,359 | 355,213 | 353,665 | 373,412 | 202,098 | 171,021 | 361,055 | 356,455 | 351,733 | 376,241 |
| Vs,v | (Kn) | 19,987 | 23,133 | 24,681 | 4,934 | -4,762 | 9,989 | 17,290 | 21,891 | 26,613 | 2,104 |
| Aj,v | (mm²) | 83,278 | 96,388 | 102,836 | 20,558 | -19,841 | 41,620 | 72,043 | 91,212 | 110,887 | 8,769 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 |
| As pasang > Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | JB21 | JB22 | JB23 | JB24 | JB25 | JB26 | JB27 | JB28 | JB29 | JB30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,45 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 225,960 | 145,363 | 145,363 | 145,363 | 145,363 | 225,960 | 225,960 | 145,363 | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 282,450 | 181,704 | 181,704 | 181,704 | 181,704 | 282,450 | 282,450 | 181,704 | 181,704 | 181,704 |
| Vkol | (Kn) | 140,606 | 111,128 | 111,128 | 111,128 | 111,128 | 140,606 | 140,606 | 111,128 | 111,128 | 111,540 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 364,015 | 234,176 | 234,176 | 234,176 | 234,176 | 364,015 | 364,015 | 234,176 | 234,176 | 234,176 |
| Vj,h | (Kn) | 478,707 | 378,346 | 378,346 | 378,346 | 378,346 | 478,707 | 478,707 | 378,346 | 378,346 | 377,933 |
| Vj,v | (Kn) | 478,707 | 378,346 | 378,346 | 378,346 | 378,346 | 478,707 | 478,707 | 378,346 | 378,346 | 377,933 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,977 | 0,772 | 0,772 | 0,772 | 0,772 | 0,977 | 0,977 | 0,772 | 0,772 | 0,771 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4739,800 | 4504,620 | 5055,398 | 4741,064 | 4528,235 | 5372,300 | 4957,241 | 4564,730 | 4903,088 | 4315,167 |
| Nu/Ag | (N/mm²) | 9,673 | 9,193 | 10,317 | 9,676 | 9,241 | 10,964 | 10,117 | 9,316 | 10,006 | 8,806 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 874,897 | 845,120 | 913,332 | 875,055 | 848,158 | 950,363 | 901,554 | 852,830 | 894,989 | 820,347 |
| Vs,h | (Kn) | -396,190 | -466,775 | -534,987 | -496,709 | -469,812 | -471,656 | -422,847 | -474,484 | -516,644 | -442,414 |
| Ajh | (mm²) | -1650,793 | -1944,896 | -2229,111 | -2069,621 | -1957,550 | -1965,233 | -1761,861 | -1977,018 | -2152,682 | -1843,391 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | -5,255 | -6,191 | -7,095 | -6,588 | -6,231 | -6,256 | -5,608 | -6,293 | -6,852 | -5,868 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 472,447 | 366,134 | 383,145 | 373,437 | 366,864 | 497,164 | 480,944 | 367,991 | 378,441 | 359,890 |
| Vs,v | (Kn) | 6,260 | 12,211 | -4,800 | 4,909 | 11,482 | -18,457 | -2,237 | 10,355 | -0,095 | 18,043 |
| Aj,v | (mm²) | 26,085 | 50,881 | -19,998 | 20,453 | 47,842 | -76,902 | -9,320 | 43,146 | -0,397 | 75,180 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 0,00 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 0,00 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 0,00 | 6,50 | 6,50 |
| l ka | (m) | 0,00 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 0,00 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 0,00 | 6,50 | 6,50 | 6,50 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 0,000 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 0,000 | 145,363 | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 0,000 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 0,000 | 181,704 | 181,704 | 181,704 |
| Vkol | (Kn) | 57,961 | 53,166 | 111,128 | 111,128 | 111,128 | 111,128 | 57,961 | 53,166 | 111,128 | 111,128 |
| Cki | (Kn) | 255,297 | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 0,000 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 0,000 | 234,176 | 234,176 | 234,176 |
| Vj,h | (Kn) | 197,336 | 181,010 | 378,346 | 378,346 | 378,346 | 378,346 | 197,336 | 436,307 | 378,346 | 378,346 |
| Vj,v | (Kn) | 197,336 | 181,010 | 378,346 | 378,346 | 378,346 | 378,346 | 197,336 | 436,307 | 378,346 | 378,346 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,403 | 0,369 | 0,772 | 0,772 | 0,772 | 0,772 | 0,403 | 0,890 | 0,772 | 0,772 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4739,800 | 4504,620 | 5055,398 | 4741,064 | 4528,235 | 5372,300 | 4957,241 | 4564,730 | 4903,088 | 4315,167 |
| Nu/Ag | (N/mm²) | 9,673 | 9,193 | 10,317 | 9,676 | 9,241 | 10,964 | 10,117 | 9,316 | 10,006 | 8,806 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 874,897 | 845,120 | 913,332 | 875,055 | 848,158 | 950,363 | 901,554 | 852,830 | 894,989 | 820,347 |
| Vs,h | (Kn) | -677,561 | -664,111 | -534,987 | -496,709 | -469,812 | -572,017 | -704,218 | -416,523 | -516,644 | -442,002 |
| Ajh | (mm²) | -2823,173 | -2767,127 | -2229,111 | -2069,621 | -1957,550 | -2383,406 | -2934,241 | -1735,512 | -2152,682 | -1841,674 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | -8,986 | -8,808 | -7,095 | -6,588 | -6,231 | -7,587 | -9,340 | -5,524 | -6,852 | -5,862 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 194,755 | 175,167 | 383,145 | 373,437 | 366,864 | 392,933 | 198,258 | 424,366 | 378,441 | 360,283 |
| Vs,v | (Kn) | 2,581 | 5,842 | -4,800 | 4,909 | 11,482 | -14,587 | -0,922 | 11,941 | -0,095 | 18,063 |
| Aj,v | (mm²) | 10,753 | 24,343 | -19,998 | 20,453 | 47,842 | -60,780 | -3,842 | 49,755 | -0,397 | 75,262 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JB31)1 | (JB32)1 | (JB33)1 | (JB34)1 | (JB35)1 | (JB36)2 | (JB37)2 | (JB38)2 | (JB39)2 | (JB40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 0,00 | 7,20 | 0,00 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 0,00 | 6,45 | 0,00 | 6,45 | 0,00 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ln ka | (m) | 6,45 | 6,50 | 6,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 0,000 | 158,474 | 0,000 | 158,474 | 0,000 |
| Mnak, ka | (Knm) | 145,363 | 225,960 | 225,960 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 | 198,093 | 0,000 | 198,093 | 0,000 |
| Mkap,ka | (Knm) | 181,704 | 282,450 | 282,450 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 111,540 | 140,606 | 140,606 | 57,961 | 57,961 | 0,000 | 58,411 | 0,000 | 58,411 | 0,000 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 | 255,297 | 0,000 | 255,297 | 0,000 |
| Tka | (Kn) | 234,176 | 364,015 | 364,015 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vj,h | (Kn) | 377,933 | 478,707 | 478,707 | 197,336 | 197,336 | 0,000 | 196,887 | 0,000 | 196,887 | 0,000 |
| Vj,v | (Kn) | 377,933 | 478,707 | 478,707 | 197,336 | 197,336 | 0,000 | 393,773 | 0,000 | 393,773 | 0,000 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,771 | 0,977 | 0,977 | 0,403 | 0,403 | 0,000 | 0,615 | 0,000 | 0,615 | 0,000 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4193,167 | 4654,293 | 4308,823 | 3466,090 | 3444,890 | 1899,064 | 2094,199 | 1894,897 | 2060,483 | 1810,589 |
| Nu/Ag | (N/mm²) | 8,557 | 9,499 | 8,794 | 7,074 | 7,030 | 5,935 | 6,544 | 5,922 | 6,439 | 5,658 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 803,991 | 864,190 | 819,505 | 698,613 | 695,300 | 395,362 | 429,027 | 394,612 | 423,401 | 379,115 |
| Vs,h | (Kn) | -426,057 | -385,483 | -340,798 | -501,277 | -497,965 | -395,362 | -232,140 | -394,612 | -226,515 | -379,115 |
| Ajh | (mm²) | -1775,238 | -1606,178 | -1419,991 | -2088,653 | -2074,852 | -1647,343 | -967,250 | -1644,217 | -943,812 | -1579,646 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | -5,651 | -5,113 | -4,520 | -6,648 | -6,604 | -5,244 | -3,079 | -5,234 | -3,004 | -5,028 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 356,126 | 469,105 | 455,605 | 174,237 | 173,895 | 0,000 | 169,672 | 0,000 | 168,842 | 0,000 |
| Vs,v | (Kn) | 21,807 | 9,602 | 23,102 | 23,099 | 23,440 | 0,000 | 224,101 | 0,000 | 224,931 | 0,000 |
| Aj,v | (mm²) | 90,863 | 40,007 | 96,259 | 96,246 | 97,669 | 0,000 | 933,755 | 0,000 | 937,213 | 0,000 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 12,000 | 2,000 | 12,000 | 2,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 157,080 | 942,480 | 157,080 | 942,480 | 157,080 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 580,000 | 680,000 | 52,727 | 680,000 | 52,727 | 680,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 0,00 | 7,20 | 3,60 | 3,60 | 3,60 | 3,60 | 3,60 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 0,00 | 6,50 | 3,20 | 3,20 | 3,20 | 3,20 | 3,20 |
| l ka | (m) | 7,20 | 7,20 | 0,00 | 7,20 | 3,60 | 3,60 | 3,60 | 3,60 | 3,60 | 3,60 |
| ln ka | (m) | 6,50 | 6,50 | 0,00 | 6,50 | 3,05 | 3,20 | 3,20 | 3,20 | 3,20 | 3,05 |
| tinggi, a | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 145,363 | 145,363 | 0,000 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 181,704 | 181,704 | 0,000 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 |
| Vkol | (Kn) | 111,128 | 111,128 | 57,961 | 53,166 | 114,614 | 112,864 | 112,864 | 112,864 | 112,864 | 115,520 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 234,176 | 234,176 | 0,000 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 |
| Vj,h | (Kn) | 378,346 | 378,346 | 197,336 | 181,010 | 374,859 | 376,609 | 376,609 | 376,609 | 376,609 | 373,954 |
| Vj,v | (Kn) | 378,346 | 378,346 | 197,336 | 181,010 | 374,859 | 753,218 | 753,218 | 753,218 | 753,218 | 747,907 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,772 | 0,772 | 0,403 | 0,369 | 0,765 | 0,769 | 0,769 | 0,769 | 0,769 | 0,763 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4193,167 | 4654,293 | 4308,823 | 3466,090 | 3444,890 | 1899,064 | 2094,199 | 1894,897 | 2060,483 | 1810,589 |
| Nu/Ag | (N/mm²) | 8,557 | 9,499 | 8,794 | 7,074 | 7,030 | 5,935 | 6,544 | 5,922 | 6,439 | 5,658 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 803,991 | 864,190 | 819,505 | 698,613 | 695,300 | 395,362 | 429,027 | 394,612 | 423,401 | 379,115 |
| Vs,h | (Kn) | -425,645 | -435,844 | -622,169 | -517,603 | -320,441 | -18,753 | -52,417 | -18,003 | -46,792 | -5,161 |
| Ajh | (mm²) | -1773,521 | -2024,350 | -2592,371 | -2156,679 | -1335,171 | -78,138 | -218,406 | -75,012 | -194,967 | -21,506 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | -5,645 | -6,444 | -8,252 | -6,865 | -4,250 | -0,249 | -0,695 | -0,239 | -0,621 | -0,068 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 356,515 | 370,757 | 187,813 | 159,822 | 330,332 | 315,366 | 324,552 | 315,170 | 322,965 | 309,007 |
| Vs,v | (Kn) | 21,831 | 7,589 | 9,523 | 21,188 | 44,527 | 437,852 | 428,666 | 438,048 | 430,253 | 438,901 |
| Aj,v | (mm²) | 90,962 | 31,620 | 39,680 | 88,283 | 185,531 | 1824,385 | 1786,109 | 1825,202 | 1792,722 | 1828,752 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 3,000 | 24,000 | 23,000 | 24,000 | 23,000 | 24,000 |
| As pasang | (mm²) | 157,080 | 157,080 | 157,080 | 157,080 | 235,620 | 1884,960 | 1806,420 | 1884,960 | 1806,420 | 1884,960 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 580,000 | 580,000 | 580,000 | 285,000 | 20,000 | 21,364 | 20,000 | 21,364 | 20,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JB41)1 | (JB42)1 |
|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 0,00 | 0,00 |
| ln ka | (m) | 0,00 | 0,00 |
| tinggi, a | (m) | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 0,000 | 0,000 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 0,000 | 0,000 |
| Vkol | (Kn) | 57,961 | 57,961 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 0,000 | 0,000 |
| Vj,h | (Kn) | 197,336 | 197,336 |
| Vj,v | (Kn) | 197,336 | 197,336 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,403 | 0,403 |
| Vj,h< $1,5\sqrt{f'c}$ | | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 3072,654 | 2780,745 |
| Nu/Ag | ($N/mm^2$) | 6,271 | 5,675 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 634,333 | 582,071 |
| Vs,h | (Kn) | -436,997 | -384,735 |
| Ajh | ($mm^2$) | -1820,820 | -1603,063 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jmi sengkang | (lapis) | -5,796 | -5,103 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 167,899 | 163,197 |
| Vs,v | (Kn) | 29,437 | 34,139 |
| Aj,v | ($mm^2$) | 122,653 | 142,247 |
| jumlah tul | | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 157,080 | 157,080 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 580,000 | 580,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 0,00 |
| ln ka | (m) | 6,50 | 0,00 |
| tinggi, a | (m) | 3,50 | 3,50 |
| tinggi, b | (m) | 1,80 | 1,80 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 145,363 | 0,000 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 181,704 | 0,000 |
| Vkol | (Kn) | 114,928 | 57,961 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 234,176 | 0,000 |
| Vj,h | (Kn) | 374,545 | 197,336 |
| Vj,v | (Kn) | 374,545 | 197,336 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,764 | 0,403 |
| Vj,h< $1,5\sqrt{f'c}$ | | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 3072,654 | 2780,745 |
| Nu/Ag | ($N/mm^2$) | 6,271 | 5,675 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 634,333 | 582,071 |
| Vs,h | (Kn) | -259,788 | -384,735 |
| Ajh | ($mm^2$) | -1082,449 | -1603,063 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jmi sengkang | (lapis) | -3,446 | -5,103 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 318,674 | 163,197 |
| Vs,v | (Kn) | 55,871 | 34,139 |
| Aj,v | ($mm^2$) | 232,797 | 142,247 |
| jumlah tul | | 3,000 | 2,000 |
| As pasang | ($mm^2$) | 235,620 | 157,080 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 285,000 | 580,000 |

## Pertemuan Balok Kolom Lantai Ground

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fc' (Mpa) | 25 | D tulangan (mm) | 10 | Øs | 1,25 | z (m) | 0,54315 |
| fy (Mpa) | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 55 | | |
| kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | | | |

### A. Pertemuan Balok Kolom Luar

**1.Perhitungan gaya dalam**

| Keterangan | | (JG)1 | (JG2)1 | (JG3)2 | (JG4)2 | (JG5)2 | (JG6)2 | (JG7)2 | (JG8)1 | (JG9)1 | (JG10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 1,00 | 0 | 0 | 0 | 0 | 0 | 1,00 | 1,00 | 7,2 |
| ln ki | (m) | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 | 0,65 | 0,65 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 36 | 7,2 | 36 | 7,2 | 36 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 35,2 | 6,45 | 35,2 | 6,45 | 35,2 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 0 | 0 | 0 | 0 | 0 | 233,63 | 233,63 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 265,131 | 378,969 | 256,683 | 379,969 | 293,639 | 378,969 | 443,821 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 331,414 | 473,711 | 320,854 | 474,961 | 367,049 | 473,711 | 554,776 | 473,711 |
| Vkol | (Kn) | 160,426 | 160,426 | 55,826 | 87,095 | 54,048 | 87,325 | 61,829 | 160,426 | 175,216 | 139,706 |
| Cki | (Kn) | 376,372 | 376,372 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,509 | 427,119 | 610,509 | 413,509 | 612,120 | 473,045 | 610,509 | 714,984 | 610,509 |
| Vj,h | (Kn) | 826,455 | 826,455 | 371,293 | 523,413 | 359,462 | 524,795 | 411,215 | 826,455 | 916,140 | 847,175 |
| Vj,v | (Kn) | 826,455 | 826,455 | 742,585 | 1046,827 | 718,924 | 1049,589 | 822,431 | 826,455 | 916,140 | 847,175 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,687 | 1,687 | 1,160 | 1,636 | 1,123 | 1,640 | 1,285 | 1,687 | 1,870 | 1,729 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3030,650 | 2855,409 | 1728,773 | 1915,676 | 1811,593 | 1900,792 | 1725,672 | 2927,736 | 2581,011 | 3667,730 |
| Nu/Ag | (N/mm²) | 6,185 | 5,827 | 5,402 | 5,986 | 5,661 | 5,940 | 5,393 | 5,975 | 5,267 | 7,485 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 627,081 | 595,875 | 363,445 | 398,339 | 379,303 | 395,673 | 362,838 | 608,948 | 543,423 | 729,364 |
| Vs,h | (Kn) | 199,374 | 230,580 | 7,848 | 125,074 | -19,841 | 129,122 | 48,378 | 217,506 | 372,716 | 117,810 |
| Ajh | (mm²) | 830,723 | 960,749 | 32,699 | 521,143 | -82,673 | 538,007 | 201,574 | 906,276 | 1552,984 | 490,876 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 2,644 | 3,058 | 0,104 | 1,659 | -0,263 | 1,713 | 0,642 | 2,885 | 4,943 | 1,563 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 700,338 | 688,515 | 303,011 | 439,384 | 297,077 | 439,567 | 335,432 | 693,394 | 742,710 | 761,954 |
| Vs,v | (Kn) | 126,117 | 137,940 | 439,574 | 607,442 | 421,847 | 610,022 | 486,999 | 133,060 | 173,430 | 85,220 |
| Aj,v | (mm²) | 525,487 | 574,749 | 1831,560 | 2531,010 | 1757,695 | 2541,757 | 2029,161 | 554,417 | 722,625 | 355,084 |
| jumlah tul | | 7,000 | 8,000 | 24,000 | 33,000 | 23,000 | 33,000 | 26,000 | 8,000 | 10,000 | 5,000 |
| As pasang | (mm²) | 549,780 | 628,320 | 1884,960 | 2591,820 | 1806,420 | 2591,820 | 2042,040 | 628,320 | 785,400 | 392,700 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 88,333 | 74,286 | 20,000 | 11,563 | 21,364 | 11,563 | 17,600 | 74,286 | 55,556 | 137,500 |

### B. Pertemuan Balok Kolom Dalam

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,00 |
| ln ki | (m) | 0,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 1,65 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 1 | 7,20 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0,65 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 | 3,50 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 233,630 |
| Mnak, ka | (Knm) | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 378,969 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 292,038 |
| Mkap,ka | (Knm) | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 473,711 |
| Vkol | (Kn) | 119,925 | 110,443 | 109,330 | 107,525 | 107,525 | 107,525 | 111,008 | 108,240 | 132,988 | 144,729 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 376,372 |
| Tka | (Kn) | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 610,509 |
| Vj,h | (Kn) | 627,943 | 637,425 | 638,538 | 640,344 | 640,344 | 640,344 | 636,861 | 639,628 | 614,881 | 842,152 |
| Vj,v | (Kn) | 627,943 | 637,425 | 1277,077 | 1280,687 | 1280,687 | 1280,687 | 1273,721 | 639,628 | 614,881 | 842,152 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,282 | 1,301 | 1,995 | 2,001 | 2,001 | 2,001 | 1,990 | 1,305 | 1,255 | 1,719 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3030,650 | 2855,409 | 1728,773 | 1915,676 | 1811,593 | 1900,792 | 1725,672 | 2927,736 | 2581,011 | 3667,730 |
| Nu/Ag | (N/mm²) | 6,185 | 5,827 | 5,402 | 5,986 | 5,661 | 5,940 | 5,393 | 5,975 | 5,267 | 7,485 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 627,081 | 595,875 | 363,445 | 398,339 | 379,303 | 395,673 | 362,838 | 608,948 | 543,423 | 729,364 |
| Vs,h | (Kn) | 0,862 | 41,551 | 275,094 | 242,005 | 261,040 | 244,671 | 274,023 | 30,680 | 71,457 | 112,787 |
| Ajh | (mm²) | 3,593 | 173,127 | 1146,223 | 1008,353 | 1087,668 | 1019,461 | 1141,763 | 127,832 | 297,739 | 469,947 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 0,011 | 0,551 | 3,649 | 3,210 | 3,462 | 3,245 | 3,634 | 0,407 | 0,948 | 1,496 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 532,119 | 531,036 | 521,109 | 537,543 | 529,211 | 536,351 | 519,493 | 536,647 | 498,481 | 757,437 |
| Vs,v | (Kn) | 95,824 | 106,390 | 755,968 | 743,145 | 751,476 | 744,336 | 754,228 | 102,981 | 116,400 | 84,715 |
| Aj,v | (mm²) | 399,267 | 443,291 | 3149,866 | 3096,436 | 3131,149 | 3101,400 | 3142,619 | 429,087 | 485,001 | 352,979 |
| jumlah tul | | 6,000 | 6,000 | 41,000 | 40,000 | 40,000 | 40,000 | 41,000 | 6,000 | 7,000 | 5,000 |
| As pasang | (mm²) | 471,240 | 471,240 | 3220,140 | 3141,600 | 3141,600 | 3141,600 | 3220,140 | 471,240 | 549,780 | 392,700 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 108,000 | 108,000 | 7,250 | 7,692 | 7,692 | 7,692 | 7,250 | 108,000 | 88,333 | 137,500 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JG11)1 | (JG12)1 | (JG13)1 | (JG14)1 | (JG15)1 | (JG16)1 | (JG17)1 | (JG18)1 | (JG19)1 | (JG20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ki | (m) | 6,50 | 6,45 | 6,45 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,500 | 6,500 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 5,000 | 5,000 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,63 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 378,969 | 443,821 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 473,711 | 554,776 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 139,706 | 140,119 | 140,119 | 139,706 | 154,496 | 139,706 | 139,706 | 139,706 | 139,706 | 139,706 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,5088373 | 610,50884 | 610,50884 | 714,98366 | 610,50884 | 610,50884 | 610,5088 | 610,50884 | 610,50884 |
| Vj,h | (Kn) | 847,175 | 846,762 | 846,762 | 847,175 | 936,860 | 847,175 | 847,175 | 847,175 | 847,175 | 847,175 |
| Vj,v | (Kn) | 847,175 | 846,762 | 846,762 | 847,175 | 936,860 | 847,175 | 847,175 | 847,175 | 847,175 | 847,175 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,5 $\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | (N/mm²) | 1,729 | 1,728 | 1,728 | 1,729 | 1,912 | 1,729 | 1,729 | 1,729 | 1,729 | 1,729 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3333,328 | 3329,656 | 3279,756 | 3841,813 | 4248,709 | 3549,550 | 3474,195 | 3370,996 | 3218,965 | 3896,525 |
| Nu/Ag | (N/mm²) | 6,803 | 6,795 | 6,693 | 7,840 | 8,671 | 7,244 | 7,090 | 6,880 | 6,569 | 7,952 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 677,604 | 677,014 | 668,940 | 754,906 | 811,478 | 711,502 | 699,875 | 683,630 | 658,970 | 762,757 |
| Vs,h | (Kn) | 169,571 | 169,748 | 177,822 | 92,268 | 125,382 | 135,672 | 147,300 | 163,544 | 188,205 | 84,417 |
| Ajh | (mm²) | 706,545 | 707,284 | 740,925 | 384,451 | 522,423 | 565,302 | 613,749 | 681,435 | 784,187 | 351,739 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 2,249 | 2,251 | 2,358 | 1,224 | 1,663 | 1,799 | 1,954 | 2,169 | 2,496 | 1,120 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 738,828 | 738,214 | 734,765 | 773,993 | 887,050 | 753,781 | 748,570 | 741,433 | 730,919 | 777,777 |
| Vs,v | (Kn) | 108,347 | 108,548 | 111,997 | 73,181 | 49,810 | 93,393 | 98,605 | 105,742 | 116,256 | 69,397 |
| Aj,v | (mm²) | 451,444 | 452,281 | 466,653 | 304,921 | 207,540 | 389,138 | 410,852 | 440,590 | 484,398 | 289,156 |
| jumlah tul | | 6,000 | 6,000 | 6,000 | 5,000 | 4,000 | 5,000 | 6,000 | 6,000 | 7,000 | 4,000 |
| As pasang | (mm²) | 471,240 | 471,240 | 471,240 | 392,700 | 314,160 | 392,700 | 471,240 | 471,240 | 549,780 | 314,160 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 108,000 | 108,000 | 108,000 | 137,500 | 186,667 | 137,500 | 108,000 | 108,000 | 88,333 | 186,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 1,65 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 2,00 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,500 | 6,500 | 6,500 | 6,500 | 1,650 | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 |
| tinggi, a | (m) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 139,706 | 139,706 | 139,706 | 139,706 | 147,854 | 144,729 | 139,706 | 139,706 | 139,706 | 139,706 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,5088373 | 610,50884 | 610,50884 | 610,50884 | 610,50884 | 610,50884 | 610,5088 | 610,50884 | 610,50884 |
| Vj,h | (Kn) | 847,175 | 847,175 | 847,175 | 847,175 | 839,027 | 842,152 | 847,175 | 847,175 | 847,175 | 847,175 |
| Vj,v | (Kn) | 847,175 | 847,175 | 847,175 | 847,175 | 839,027 | 842,152 | 847,175 | 847,175 | 847,175 | 847,175 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,5 $\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | (N/mm²) | 1,729 | 1,729 | 1,729 | 1,729 | 1,712 | 1,719 | 1,729 | 1,729 | 1,729 | 1,729 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3333,328 | 3329,656 | 3279,756 | 3841,813 | 4248,709 | 3549,550 | 3474,195 | 3370,996 | 3218,965 | 3896,525 |
| Nu/Ag | (N/mm²) | 6,803 | 6,795 | 6,693 | 7,840 | 8,671 | 7,244 | 7,090 | 6,880 | 6,569 | 7,952 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 677,604 | 677,0135203 | 668,93961 | 754,90643 | 811,47805 | 711,50217 | 699,87477 | 683,6302 | 658,96985 | 762,75735 |
| Vs,h | (Kn) | 169,571 | 170,161 | 178,235 | 92,268 | 27,549 | 130,649 | 147,300 | 163,544 | 188,205 | 84,417 |
| Ajh | (mm²) | 706,545 | 709,005 | 742,646 | 384,451 | 114,786 | 544,373 | 613,749 | 681,435 | 784,187 | 351,739 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 2,249 | 2,257 | 2,364 | 1,224 | 0,365 | 1,733 | 1,954 | 2,169 | 2,496 | 1,120 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 738,828 | 738,574 | 735,123 | 773,993 | 794,419 | 749,312 | 748,570 | 741,433 | 730,919 | 777,777 |
| Vs,v | (Kn) | 108,347 | 108,600 | 112,051 | 73,181 | 44,608 | 92,839 | 98,605 | 105,742 | 116,256 | 69,397 |
| Aj,v | (mm²) | 451,444 | 452,502 | 466,881 | 304,921 | 185,868 | 386,831 | 410,852 | 440,590 | 484,398 | 289,156 |
| jumlah tul | | 6,000 | 6,000 | 6,000 | 4,000 | 3,000 | 5,000 | 6,000 | 6,000 | 7,000 | 4,000 |
| As pasang | (mm²) | 471,240 | 471,240 | 471,240 | 314,160 | 235,620 | 392,700 | 471,240 | 471,240 | 549,780 | 314,160 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 108,000 | 108,000 | 108,000 | 186,667 | 285,000 | 137,500 | 108,000 | 108,000 | 88,333 | 186,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JG21)1 | (JG22)1 | (JG23)1 | (JG24)1 | (JG25)1 | (JG26)1 | (JG27)1 | (JG28)1 | (JG29)1 | (JG30)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 6,500 | 6,500 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,45 |
| tinggi, a | (m) | 5,000 | 5,000 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 233,63 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,63 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 443,821 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 554,776 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 154,496 | 139,706 | 139,706 | 139,706 | 139,706 | 139,706 | 154,496 | 139,706 | 139,706 | 140,376 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 610,5088373 | 610,50884 | 610,50884 | 610,50884 | 610,50884 | 714,98366 | 610,5088 | 610,50884 | 610,50884 |
| Vj,h | (Kn) | 936,860 | 847,175 | 847,175 | 847,175 | 847,175 | 847,175 | 936,860 | 847,175 | 847,175 | 846,505 |
| Vj,v | (Kn) | 936,860 | 847,175 | 847,175 | 847,175 | 847,175 | 847,175 | 936,860 | 847,175 | 847,175 | 846,505 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | ($N/mm^2$) | 1,912 | 1,729 | 1,729 | 1,729 | 1,729 | 1,729 | 1,912 | 1,729 | 1,729 | 1,728 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3955,993 | 3780,980 | 4142,987 | 3927,733 | 3718,457 | 4360,508 | 4103,592 | 3793,010 | 4005,276 | 3441,872 |
| Nu/Ag | ($N/mm^2$) | 8,073 | 7,716 | 8,455 | 8,016 | 7,589 | 8,899 | 8,375 | 7,741 | 8,174 | 7,024 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 771,200 | 746,080 | 797,165 | 767,200 | 736,899 | 826,344 | 791,766 | 747,834 | 778,127 | 694,828 |
| Vs,h | (Kn) | 165,660 | 101,094 | 50,009 | 79,975 | 110,276 | 20,831 | 145,094 | 99,341 | 69,047 | 151,677 |
| Ajh | ($mm^2$) | 690,248 | 421,227 | 208,372 | 333,229 | 459,484 | 86,795 | 604,557 | 413,920 | 287,697 | 631,988 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 2,197 | 1,341 | 0,663 | 1,061 | 1,463 | 0,276 | 1,924 | 1,318 | 0,916 | 2,012 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 864,664 | 769,786 | 794,822 | 779,935 | 765,463 | 809,865 | 875,952 | 770,618 | 785,298 | 745,744 |
| Vs,v | (Kn) | 72,196 | 77,388 | 52,353 | 67,239 | 81,712 | 37,310 | 60,908 | 76,556 | 61,877 | 100,760 |
| Aj,v | ($mm^2$) | 300,817 | 322,451 | 218,137 | 280,163 | 340,467 | 155,457 | 253,783 | 318,984 | 257,819 | 419,834 |
| jumlah tul | | 4,000 | 5,000 | 3,000 | 4,000 | 5,000 | 2,000 | 4,000 | 5,000 | 4,000 | 6,000 |
| As pasang | ($mm^2$) | 314,160 | 392,700 | 235,620 | 314,160 | 392,700 | 157,080 | 314,160 | 392,700 | 314,160 | 471,240 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 186,667 | 137,500 | 285,000 | 186,667 | 137,500 | 580,000 | 186,667 | 137,500 | 186,667 | 108,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 1,65 | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 1,65 | 6,50 | 6,50 |
| l ka | (m) | 2,00 | 7,20 | 7,20 | 7,20 | 7,20 | 7,20 | 2,00 | 7,20 | 7,20 | 7,20 |
| ln ka | (m) | 1,650 | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 | 1,650 | 6,500 | 6,500 | 6,500 |
| tinggi, a | (m) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 233,630 | 223,630 | 223,630 | 223,630 | 223,630 | 223,630 | 223,630 | 223,630 | 223,630 | 223,630 |
| Mnak, ka | (Knm) | 378,969 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 279,538 | 279,538 | 279,538 | 279,538 | 279,538 | 279,538 | 279,538 | 279,538 | 279,538 |
| Mkap,ka | (Knm) | 473,711 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 147,854 | 157,023 | 152,215 | 152,215 | 152,215 | 152,215 | 161,757 | 142,233 | 137,425 | 137,425 |
| Cki | (Kn) | 376,372 | 360,262 | 360,262 | 360,262 | 360,262 | 360,262 | 360,262 | 360,262 | 360,262 | 360,262 |
| Tka | (Kn) | 610,509 | 714,9836601 | 714,98366 | 714,98366 | 714,98366 | 714,98366 | 714,98366 | 610,5088 | 610,50884 | 610,50884 |
| Vj,h | (Kn) | 839,027 | 918,222 | 923,030 | 923,030 | 923,030 | 923,030 | 913,488 | 828,537 | 833,345 | 833,345 |
| Vj,v | (Kn) | 839,027 | 918,222 | 923,030 | 923,030 | 923,030 | 923,030 | 913,488 | 828,537 | 833,345 | 833,345 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | ($N/mm^2$) | 1,712 | 1,874 | 1,884 | 1,884 | 1,884 | 1,884 | 1,864 | 1,691 | 1,701 | 1,701 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3955,993 | 3780,980 | 4142,987 | 3927,733 | 3718,457 | 4360,508 | 4103,592 | 3793,010 | 4005,276 | 3441,872 |
| Nu/Ag | ($N/mm^2$) | 8,073 | 7,716 | 8,455 | 8,016 | 7,589 | 8,899 | 8,375 | 7,741 | 8,174 | 7,024 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 771,200 | 746,0801863 | 797,16543 | 767,19957 | 736,89858 | 826,34373 | 791,76598 | 747,8339 | 778,12745 | 694,82765 |
| Vs,h | (Kn) | 67,827 | 172,142 | 125,865 | 155,831 | 186,132 | 96,687 | 121,722 | 80,704 | 55,218 | 138,518 |
| Ajh | ($mm^2$) | 282,611 | 717,259 | 524,438 | 649,295 | 775,550 | 402,861 | 507,176 | 336,265 | 230,075 | 577,157 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 0,900 | 2,283 | 1,669 | 2,067 | 2,469 | 1,282 | 1,614 | 1,070 | 0,732 | 1,837 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 774,370 | 834,344 | 865,990 | 849,771 | 834,002 | 882,380 | 854,100 | 753,665 | 772,479 | 734,152 |
| Vs,v | (Kn) | 64,657 | 83,878 | 57,040 | 73,260 | 89,029 | 40,650 | 59,389 | 74,872 | 60,866 | 99,194 |
| Aj,v | ($mm^2$) | 269,404 | 349,493 | 237,669 | 305,249 | 370,952 | 169,377 | 247,452 | 311,967 | 253,610 | 413,308 |
| jumlah tul | | 4,000 | 5,000 | 5,000 | 4,000 | 5,000 | 3,000 | 4,000 | 4,000 | 4,000 | 6,000 |
| As pasang | ($mm^2$) | 314,160 | 392,700 | 392,700 | 314,160 | 392,700 | 235,620 | 314,160 | 314,160 | 314,160 | 471,240 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 186,667 | 137,500 | 137,500 | 186,667 | 137,500 | 285,000 | 186,667 | 186,667 | 186,667 | 108,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JG31)1 | (JG32)1 | (JG33)1 | (JG34)1 | (JG35)1 | (JG36)2 | (JG37)2 | (JG38)2 | (JG39)2 | (JG40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 36 | 7,2 | 36 | 7,2 | 36 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,50 | 35,20 | 6,45 | 35,20 | 6,45 | 35,20 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 1,00 | 1,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ln ka | (m) | 6,450 | 6,500 | 6,5 | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 |
| tinggi, a | (m) | 5,000 | 5,000 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,63 | 233,630 | 233,630 | 138,318 | 233,630 | 138,318 | 233,630 | 177,171 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 443,821 | 378,969 | 378,969 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 172,898 | 292,038 | 172,898 | 292,038 | 221,464 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 554,776 | 473,711 | 473,711 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 140,376 | 139,706 | 154,496 | 173,316 | 173,316 | 29,124 | 53,693 | 29,124 | 53,693 | 37,305 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 222,827 | 376,372 | 222,827 | 376,372 | 285,418 |
| Tka | (Kn) | 610,509 | 610,5088373 | 714,98366 | 610,50884 | 610,50884 | 0 | 0 | 0 | 0 | 0 |
| Vj,h | (Kn) | 846,505 | 847,175 | 936,860 | 813,565 | 813,565 | 193,702 | 322,678 | 193,702 | 322,678 | 248,112 |
| Vj,v | (Kn) | 846,505 | 847,175 | 936,860 | 813,565 | 813,565 | 387,404 | 645,357 | 387,404 | 645,357 | 496,225 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | ($N/mm^2$) | 1,728 | 1,729 | 1,912 | 1,660 | 1,660 | 0,605 | 1,008 | 0,605 | 1,008 | 0,775 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (kn) | 3316,483 | 3787,711 | 3554,769 | 2915,620 | 2871,469 | 1605,169 | 1737,976 | 1612,771 | 1703,789 | 1498,175 |
| Nu/Ag | ($N/mm^2$) | 6,768 | 7,730 | 7,255 | 5,950 | 5,860 | 5,016 | 5,431 | 5,040 | 5,324 | 4,682 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 674,891 | 747,062 | 712,300 | 606,778 | 598,802 | 338,398 | 365,241 | 339,991 | 358,523 | 315,113 |
| Vs,h | (Kn) | 171,613 | 100,113 | 224,559 | 206,787 | 214,762 | -144,695 | -42,563 | -146,289 | -35,845 | -67,000 |
| Ajh | ($mm^2$) | 715,055 | 417,136 | 935,663 | 861,612 | 894,843 | -602,898 | -177,345 | -609,538 | -149,354 | -279,168 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 2,276 | 1,328 | 2,978 | 2,743 | 2,848 | -1,919 | -0,565 | -1,940 | -0,475 | -0,889 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 737,080 | 770,252 | 833,979 | 681,775 | 678,843 | 155,087 | 263,708 | 155,271 | 262,329 | 195,332 |
| Vs,v | (Kn) | 109,425 | 76,923 | 102,881 | 131,790 | 134,722 | 232,317 | 381,649 | 232,133 | 383,028 | 300,893 |
| Aj,v | ($mm^2$) | 455,937 | 320,511 | 428,671 | 549,123 | 561,341 | 967,989 | 1590,203 | 967,222 | 1595,948 | 1253,720 |
| jumlah tul | | 2,000 | 5,000 | 6,000 | 7,000 | 8,000 | 13,000 | 21,900 | 13,000 | 21,000 | 16,000 |
| As pasang | ($mm^2$) | 157,080 | 392,700 | 471,240 | 549,780 | 628,320 | 1021,020 | 1649,340 | 1021,020 | 1649,340 | 1256,640 |
| As pasang >Aj,v | | Tdk Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 580,000 | 137,500 | 108,000 | 88,333 | 74,286 | 47,500 | 24,500 | 47,500 | 24,500 | 36,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 1 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 0,65 | 6,50 | 3,20 | 3,20 | 3,20 | 3,20 | 3,20 |
| l ka | (m) | 7,20 | 7,20 | 2,00 | 7,20 | 3,60 | 3,60 | 3,60 | 3,60 | 3,60 | 3,60 |
| ln ka | (m) | 6,500 | 6,500 | 1,650 | 6,500 | 3,050 | 3,200 | 3,200 | 3,200 | 3,200 | 3,050 |
| tinggi, a | (m) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| tinggi, b | (m) | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 |
| Mnak, ki | (Knm) | 223,630 | 223,630 | 223,630 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 279,538 | 279,538 | 279,538 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 137,425 | 137,425 | 145,573 | 119,925 | 110,443 | 107,525 | 107,525 | 107,525 | 107,525 | 111,008 |
| Cki | (Kn) | 360,262 | 360,262 | 360,262 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 610,509 | 610,5088373 | 610,50884 | 492,57111 | 492,57111 | 492,57111 | 492,57111 | 492,57111 | 492,57111 | 492,57111 |
| Vj,h | (Kn) | 833,345 | 833,345 | 825,198 | 627,943 | 637,425 | 640,344 | 640,344 | 640,344 | 640,344 | 636,861 |
| Vj,v | (Kn) | 833,345 | 833,345 | 825,198 | 627,943 | 637,425 | 1280,687 | 1280,687 | 1280,687 | 1280,687 | 1273,721 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Vj,h | ($N/mm^2$) | 1,701 | 1,701 | 1,684 | 1,282 | 1,301 | 1,307 | 1,307 | 1,307 | 1,307 | 1,300 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3316,483 | 3787,711 | 3554,769 | 2915,620 | 2871,469 | 1605,169 | 1737,976 | 1612,771 | 1703,789 | 1498,175 |
| Nu/Ag | ($N/mm^2$) | 6,768 | 7,730 | 7,255 | 5,950 | 5,860 | 5,016 | 5,431 | 5,040 | 5,324 | 4,682 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 674,891 | 747,0619162 | 712,30044 | 606,77794 | 598,80244 | 338,39758 | 365,24106 | 339,9913 | 358,52319 | 315,11268 |
| Vs,h | (Kn) | 158,454 | 86,284 | 112,897 | 21,165 | 38,623 | 301,946 | 275,103 | 300,352 | 281,820 | 321,748 |
| Ajh | ($mm^2$) | 660,225 | 359,515 | 470,405 | 88,189 | 160,929 | 1258,109 | 1146,261 | 1251,468 | 1174,252 | 1340,617 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 2,102 | 1,144 | 1,497 | 0,281 | 0,512 | 4,005 | 3,649 | 3,984 | 3,738 | 4,267 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 725,622 | 757,678 | 734,579 | 526,223 | 531,871 | 512,689 | 523,319 | 513,297 | 520,583 | 501,383 |
| Vs,v | (Kn) | 107,724 | 75,667 | 90,619 | 101,721 | 105,554 | 767,999 | 757,368 | 767,390 | 760,105 | 772,339 |
| Aj,v | ($mm^2$) | 448,849 | 315,279 | 377,579 | 423,836 | 439,809 | 3199,994 | 3155,702 | 3197,459 | 3167,103 | 3218,079 |
| jumlah tul | | 6,000 | 5,000 | 5,000 | 6,000 | 6,000 | 41,000 | 41,000 | 41,000 | 41,000 | 41,000 |
| As pasang | ($mm^2$) | 471,240 | 392,700 | 392,700 | 471,240 | 471,240 | 3220,140 | 3220,140 | 3220,140 | 3220,140 | 3220,140 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 108,000 | 137,500 | 137,500 | 108,000 | 108,000 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (JG41)1 | (JG42)1 |
|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 1,00 | 1,00 |
| ln ka | (m) | 0,65 | 0,65 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 3,50 | 3,50 |
| Mnak, ki | (Knm) | 233,630 | 158,474 |
| Mnak, ka | (Knm) | 378,969 | 305,760 |
| Mkap, ki | (Knm) | 292,038 | 198,093 |
| Mkap,ka | (Knm) | 473,711 | 382,200 |
| Vkol | (Kn) | 173,316 | 132,988 |
| Cki | (Kn) | 376,372 | 255,297 |
| Tka | (Kn) | 610,509 | 492,571 |
| Vj,h | (Kn) | 813,565 | 614,881 |
| Vj,v | (Kn) | 813,565 | 614,881 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,660 | 1,255 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 2556,448 | 2386,144 |
| Nu/Ag | ($N/mm^2$) | 5,217 | 4,870 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 538,479 | 502,863 |
| Vs,h | (Kn) | 275,086 | 112,018 |
| Ajh | ($mm^2$) | 1146,190 | 466,740 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 3,648 | 1,486 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 657,921 | 488,699 |
| Vs,v | (Kn) | 155,643 | 126,181 |
| Aj,v | ($mm^2$) | 648,514 | 525,756 |
| jumlah tul | | 9,000 | 7,000 |
| As pasang | ($mm^2$) | 706,860 | 549,780 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 63,750 | 88,333 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 1,00 |
| ln ka | (m) | 6,50 | 0,65 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 3,50 | 3,50 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 382,200 | 382,200 |
| Vkol | (Kn) | 108,240 | 132,988 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 492,571 | 492,571 |
| Vj,h | (Kn) | 639,628 | 614,881 |
| Vj,v | (Kn) | 639,628 | 614,881 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,305 | 1,255 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 2556,448 | 2386,144 |
| Nu/Ag | ($N/mm^2$) | 5,217 | 4,870 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 538,479 | 502,863 |
| Vs,h | (Kn) | 101,149 | 112,018 |
| Ajh | ($mm^2$) | 421,454 | 466,740 |
| Sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 1,342 | 1,486 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 517,261 | 488,699 |
| Vs,v | (Kn) | 122,367 | 126,181 |
| Aj,v | ($mm^2$) | 509,864 | 525,756 |
| jumlah tul | | 7,000 | 7,000 |
| As pasang | ($mm^2$) | 549,780 | 549,780 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 88,333 | 88,333 |

**Pertemuan Balok Kolom Lantai 1**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 20 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 60 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (1J1)1 | (1J2)1 | (1J3)1 | (1J4)1 | (1J5)1 | (1J6)1 | (1J7)2 | (1J8)2 | (1J9)2 | (1J10)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,50 | 1,50 | 1,50 | 1,50 | 1 | 14,4 | 14,4 | 3,60 | 15,90 | 3,60 |
| ln ki | (m) | 1,15 | 1,15 | 1,15 | 1,15 | 0,65 | 13,7 | 13,65 | 3,20 | 15,50 | 3,20 |
| l ka | (m) | 14,40 | 14,40 | 14,40 | 14,40 | 7,2 | 7,2 | 36 | 7,2 | 36 | 7,2 |
| ln ka | (m) | 13,70 | 13,65 | 13,65 | 13,70 | 6,5 | 6,5 | 35,2 | 6,45 | 35,2 | 6,45 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 359,635 | 366,888 | 233,63 | 233,63 | 233,63 | 359,635 | 375,784 | 451,81 | 375,782 |
| Mnak, ka | (Knm) | 378,969 | 701,704 | 615,421 | 443,821 | 378,969 | 378,969 | 126,25 | 653,052 | 300,055 | 653,052 |
| Mkap, ki | (Knm) | 292,038 | 449,544 | 458,610 | 292,038 | 292,038 | 292,038 | 449,544 | 469,730 | 564,763 | 469,728 |
| Mkap,ka | (Knm) | 473,711 | 877,130 | 769,276 | 554,776 | 473,711 | 473,711 | 157,813 | 816,315 | 375,069 | 816,315 |
| Vkol | (Kn) | 246,074 | 423,272 | 394,725 | 269,931 | 143,539 | 122,564 | 93,674 | 212,164 | 141,905 | 212,163 |
| Cki | (Kn) | 376,372 | 579,362 | 591,047 | 376,372 | 376,372 | 376,372 | 579,362 | 605,378 | 727,854 | 605,375 |
| Tka | (Kn) | 610,509 | 1130,426 | 991,427 | 714,984 | 610,509 | 610,509 | 203,385 | 1052,049 | 483,381 | 1052,049 |
| Vj,h | (Kn) | 740,807 | 1286,517 | 1187,749 | 821,424 | 843,341 | 864,316 | 689,074 | 1445,263 | 1069,329 | 1445,261 |
| Vj,v | (Kn) | 740,807 | 1286,517 | 1187,749 | 821,424 | 843,341 | 864,316 | 1378,148 | 2890,527 | 2138,658 | 2890,521 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,512 | 2,626 | 2,424 | 1,676 | 1,721 | 1,764 | 2,153 | 4,516 | 3,342 | 4,516 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 89,123 | 289,624 | 339,030 | 116,338 | 2471,380 | 2181,044 | 1243,924 | 1407,629 | 1254,883 | 1391,935 |
| Nu/Ag | (N/mm²) | 0,182 | 0,591 | 0,692 | 0,237 | 5,044 | 4,451 | 3,887 | 4,399 | 3,922 | 4,350 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 520,993 | 456,295 | 251,268 | 293,970 | 254,351 | 290,149 |
| Vs,h | (Kn) | 740,807 | 1286,517 | 1187,749 | 821,424 | 322,348 | 408,021 | 437,805 | 1151,293 | 814,978 | 1155,112 |
| Ajh | (mm²) | 3086,696 | 5360,486 | 4948,952 | 3422,599 | 1343,118 | 1700,089 | 1824,189 | 4797,056 | 3395,740 | 4812,966 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,825 | 17,063 | 15,753 | 10,894 | 4,275 | 5,412 | 5,807 | 15,269 | 10,809 | 15,320 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 449,874 | 802,327 | 745,521 | 500,655 | 676,145 | 672,476 | 520,589 | 1121,457 | 809,333 | 1118,620 |
| Vs,v | (Kn) | 290,933 | 484,190 | 442,227 | 320,768 | 167,196 | 191,840 | 857,559 | 1769,069 | 1329,325 | 1771,901 |
| Aj,v | (mm²) | 727,333 | 1210,475 | 1105,569 | 801,921 | 417,991 | 479,600 | 2143,898 | 4422,674 | 3323,312 | 4429,753 |
| jumlah tul | | 4,000 | 7,000 | 7,000 | 7,000 | 4,000 | 4,000 | 18,000 | 20,000 | 14,000 | 16,000 |
| As pasang | (mm²) | 1256,640 | 2199,120 | 2199,120 | 2199,120 | 1256,640 | 1256,640 | 5654,880 | 6283,200 | 4398,240 | 5026,560 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 173,333 | 76,667 | 76,667 | 76,667 | 173,333 | 173,333 | 20,000 | 15,789 | 32,308 | 25,333 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 3,6 | 14,4 | 3,6 | 1 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 |
| ln ki | (m) | 0,00 | 2,9 | 13,7 | 2,9 | 0,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 |
| l ka | (m) | 3,60 | 14,4 | 3,6 | 0 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 |
| ln ka | (m) | 2,90 | 13,7 | 2,9 | 0 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 0,000 | 451,810 | 451,810 | 451,810 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 789,900 | 789,900 | 789,900 | 0,000 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 0,000 | 564,763 | 564,763 | 564,763 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 987,375 | 987,375 | 987,375 | 0,000 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 343,198 | 486,895 | 509,411 | 196,304 | 107,302 | 98,817 | 97,822 | 96,206 | 96,206 | 96,206 |
| Cki | (Kn) | 0,000 | 727,854 | 727,854 | 727,854 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 1272,508 | 1272,508 | 1272,508 | 0,000 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 |
| Vj,h | (Kn) | 929,310 | 1513,467 | 1490,950 | 531,550 | 640,567 | 649,051 | 650,047 | 651,662 | 651,662 | 651,662 |
| Vj,v | (Kn) | 929,310 | 1513,467 | 1490,950 | 531,550 | 640,567 | 649,051 | 1300,094 | 1303,324 | 1303,324 | 1303,324 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,897 | 3,089 | 3,043 | 1,085 | 1,307 | 1,325 | 2,031 | 2,036 | 2,036 | 2,036 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 89,123 | 289,624 | 339,030 | 116,338 | 2471,380 | 2181,044 | 1243,924 | 1407,629 | 1254,883 | 1391,935 |
| Nu/Ag | (N/mm²) | 0,182 | 0,591 | 0,692 | 0,237 | 5,044 | 4,451 | 3,887 | 4,399 | 3,922 | 4,350 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 520,993 | 456,295 | 251,268 | 293,970 | 254,351 | 290,149 |
| Vs,h | (Kn) | 929,310 | 1513,467 | 1490,950 | 531,550 | 119,574 | 192,756 | 398,778 | 357,692 | 397,311 | 361,513 |
| Ajh | (mm²) | 3872,124 | 6306,111 | 6212,292 | 2214,792 | 498,224 | 803,150 | 1661,577 | 1490,384 | 1655,462 | 1506,305 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 12,325 | 20,073 | 19,774 | 7,050 | 1,586 | 2,557 | 5,289 | 4,744 | 5,269 | 4,795 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 564,347 | 943,863 | 935,833 | 323,978 | 513,572 | 504,991 | 491,104 | 505,660 | 493,217 | 504,381 |
| Vs,v | (Kn) | 364,963 | 569,604 | 555,117 | 207,572 | 126,995 | 144,061 | 808,990 | 797,665 | 810,107 | 798,943 |
| Aj,v | (mm²) | 912,407 | 1424,010 | 1387,792 | 518,930 | 317,488 | 360,151 | 2022,474 | 1994,161 | 2025,267 | 1997,357 |
| jumlah tul | | 3,000 | 5,000 | 5,000 | 3,000 | 2,000 | 2,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| As pasang | (mm²) | 942,480 | 1570,800 | 1570,800 | 942,480 | 628,320 | 628,320 | 2513,280 | 2513,280 | 2513,280 | 2513,280 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 270,000 | 125,000 | 125,000 | 270,000 | 560,000 | 560,000 | 77,143 | 77,143 | 77,143 | 77,143 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (1J11)2 | (1J12)1 | (1J13)1 | (1J14)1 | (1J15)1 | (1J16)1 | (1J17)1 | (1J18)1 | (1J19)1 | (1J20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 14,40 | 14,40 | 1,00 | 7,20 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,20 |
| ln ki | (m) | 13,65 | 13,70 | 0,65 | 6,50 | 6,5 | 6,45 | 6,45 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 36,00 | 7,20 | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 35,20 | 6,50 | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 366,888 | 233,630 | 233,63 | 233,63 | 233,63 | 375,784 | 375,782 | 233,630 | 233,63 | 233,63 |
| Mnak, ka | (Knm) | 225,507 | 443,821 | 443,821 | 378,969 | 378,969 | 653,052 | 653,052 | 443,821 | 443,821 | 378,969 |
| Mkap, ki | (Knm) | 458,610 | 292,038 | 292,038 | 292,038 | 292,038 | 469,730 | 469,728 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 281,884 | 554,776 | 554,776 | 473,711 | 473,711 | 816,315 | 816,315 | 554,776 | 554,776 | 473,711 |
| Vkol | (Kn) | 113,783 | 135,797 | 156,772 | 125,000 | 125,000 | 210,527 | 210,527 | 138,233 | 138,233 | 125,000 |
| Cki | (Kn) | 591,047 | 376,372 | 376,372 | 376,372 | 376,372 | 605,378 | 605,375 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 363,286 | 714,984 | 714,984 | 610,509 | 610,509 | 1052,049 | 1052,049 | 714,984 | 714,984 | 610,509 |
| Vj,h | (Kn) | 840,549 | 955,558 | 934,583 | 861,881 | 861,881 | 1446,900 | 1446,897 | 953,122 | 953,122 | 861,881 |
| Vj,v | (Kn) | 1681,099 | 955,558 | 934,583 | 861,881 | 861,881 | 1446,900 | 1446,897 | 953,122 | 953,122 | 861,881 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,627 | 1,950 | 1,907 | 1,759 | 1,759 | 2,953 | 2,953 | 1,945 | 1,945 | 1,759 |
| Vj,h< 1 $5\sqrt{f'c}$ | | OK | Ok | OK | Ok | Ok | OK | OK | OK | OK | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1739,000 | 2244,726 | 2161,542 | 2911,510 | 2503,393 | 2520,036 | 2470,300 | 2862,885 | 3302,826 | 2856,190 |
| Nu/Ag | ($N/mm^2$) | 3,872 | 4,581 | 4,411 | 5,942 | 5,109 | 5,143 | 5,041 | 5,843 | 6,740 | 5,829 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 249,871 | 471,247 | 451,617 | 606,040 | 527,642 | 531,065 | 520,767 | 597,239 | 672,684 | 596,018 |
| Vs,h | (Kn) | 590,678 | 484,311 | 482,966 | 255,841 | 334,239 | 915,835 | 926,130 | 355,883 | 280,438 | 265,863 |
| Ajh | ($mm^2$) | 2461,160 | 2017,963 | 2012,359 | 1066,002 | 1392,662 | 3815,980 | 3858,875 | 1482,846 | 1168,491 | 1107,762 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P 10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 7,834 | 6,423 | 6,406 | 3,393 | 4,433 | 12,147 | 12,283 | 4,720 | 3,719 | 3,526 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 634,510 | 748,434 | 725,659 | 721,975 | 693,261 | 1165,792 | 1159,916 | 794,623 | 828,852 | 718,083 |
| Vs,v | (Kn) | 1046,589 | 207,124 | 208,924 | 139,905 | 168,619 | 281,108 | 286,982 | 158,500 | 124,270 | 143,798 |
| Aj,v | ($mm^2$) | 2616,473 | 517,810 | 522,310 | 349,763 | 421,549 | 702,769 | 717,454 | 396,249 | 310,674 | 359,494 |
| jumlah tul | | 11,000 | 2,000 | 2,000 | 2,000 | 2,000 | 3,000 | 3,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 3455,760 | 628,320 | 628,320 | 628,320 | 628,320 | 942,480 | 942,480 | 628,320 | 628,320 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 48,000 | 560,000 | 560,000 | 560,000 | 560,000 | 270,000 | 270,000 | 560,000 | 560,000 | 560,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 3,60 | 3,6 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 |
| ln ki | (m) | 3,20 | 3,05 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 |
| l ka | (m) | 3,60 | 7,2 | 1 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 |
| ln ka | (m) | 3,05 | 6,5 | 0,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 305,760 | 305,760 | 305,760 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 382,200 | 382,200 | 382,200 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 |
| Vkol | (Kn) | 99,323 | 96,847 | 118,989 | 142,727 | 138,233 | 138,233 | 138,233 | 138,233 | 146,771 | 142,727 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 492,571 | 492,571 | 492,571 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 |
| Vj,h | (Kn) | 648,546 | 651,022 | 628,879 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 948,628 |
| Vj,v | (Kn) | 1297,092 | 651,022 | 628,879 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 948,628 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,027 | 1,829 | 1,283 | 1,936 | 1,945 | 1,945 | 1,945 | 1,945 | 1,928 | 1,936 |
| Vj,h< 1 $5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1239,000 | 2244,726 | 2161,542 | 2911,510 | 2503,393 | 2520,036 | 2470,300 | 2862,885 | 3302,826 | 2856,190 |
| Nu/Ag | ($N/mm^2$) | 3,872 | 4,581 | 4,411 | 5,942 | 5,109 | 5,143 | 5,041 | 5,843 | 6,740 | 5,829 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 249,871 | 471,247 | 451,617 | 606,040 | 527,642 | 531,065 | 520,767 | 597,239 | 672,684 | 596,018 |
| Vs,h | (Kn) | 398,675 | 179,775 | 177,262 | 342,588 | 425,481 | 422,057 | 432,355 | 355,883 | 271,900 | 352,610 |
| Ajh | ($mm^2$) | 1661,145 | 749,062 | 738,593 | 1427,451 | 1772,837 | 1758,572 | 1801,479 | 1482,846 | 1132,918 | 1469,210 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 5,288 | 2,384 | 2,351 | 4,544 | 5,643 | 5,593 | 5,734 | 4,720 | 3,606 | 4,677 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 489,571 | 509,908 | 488,295 | 794,641 | 766,652 | 767,947 | 764,077 | 794,623 | 821,428 | 790,357 |
| Vs,v | (Kn) | 807,521 | 141,114 | 140,584 | 153,987 | 186,470 | 185,175 | 189,045 | 158,500 | 123,156 | 158,271 |
| Aj,v | ($mm^2$) | 2018,801 | 352,784 | 351,461 | 384,967 | 466,175 | 462,938 | 472,613 | 396,249 | 307,891 | 395,677 |
| jumlah tul | | 8,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 2513,280 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 77,143 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (1-J21)1 | (1-J22)1 | (1-J23)1 | (1-J24)1 | (1-J25)1 | (1-J26)1 | (1-J27)1 | (1-J28)1 | (1-J29)1 | (1-J30)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,63 | 375,784 | 375,782 | 233,630 | 233,63 | 233,63 | 233,63 | 375,784 | 375,782 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 653,052 | 653,052 | 443,821 | 443,821 | 378,969 | 378,969 | 653,052 | 653,052 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 469,730 | 469,728 | 292,038 | 292,038 | 292,038 | 292,038 | 469,730 | 469,728 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 816,315 | 816,315 | 554,776 | 554,776 | 473,711 | 473,711 | 816,315 | 816,315 | 554,776 |
| Vkol | (Kn) | 125,000 | 209,933 | 209,932 | 138,233 | 138,233 | 125,000 | 125,000 | 209,933 | 209,932 | 138,233 |
| Cki | (Kn) | 376,372 | 605,378 | 605,375 | 376,372 | 376,372 | 376,372 | 376,372 | 605,378 | 605,375 | 376,372 |
| Tka | (Kn) | 610,509 | 1052,049 | 1052,049 | 714,984 | 714,984 | 610,509 | 610,509 | 1052,049 | 1052,049 | 714,984 |
| Vj,h | (Kn) | 861,881 | 1447,495 | 1447,492 | 953,122 | 953,122 | 861,881 | 861,881 | 1447,495 | 1447,492 | 953,122 |
| Vj,v | (Kn) | 861,881 | 1447,495 | 1447,492 | 953,122 | 953,122 | 861,881 | 861,881 | 1447,495 | 1447,492 | 953,122 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,759 | 2,954 | 2,954 | 1,945 | 1,945 | 1,759 | 1,759 | 2,954 | 2,954 | 1,945 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | Ok | Ok | Ok | OK | OK | OK | Ok | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 2624,265 | 2515,919 | 2359,394 | 2877,583 | 3135,546 | 3038,910 | 3302,975 | 3081,537 | 2809,182 | 3341,867 |
| Nu/Ag | ($N/mm^2$) | 5,356 | 5,135 | 4,815 | 5,873 | 6,399 | 6,202 | 6,741 | 6,289 | 5,733 | 6,820 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 552,022 | 530,220 | 497,037 | 599,913 | 645,038 | 628,514 | 672,709 | 635,856 | 587,367 | 678,975 |
| Vs,h | (Kn) | 309,858 | 917,274 | 950,455 | 353,209 | 308,084 | 233,367 | 189,172 | 811,639 | 860,125 | 274,148 |
| Ajh | ($mm^2$) | 1291,075 | 3821,976 | 3960,228 | 1471,705 | 1283,683 | 972,362 | 788,217 | 3381,828 | 3583,854 | 1142,282 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 4,110 | 12,166 | 12,606 | 4,685 | 4,086 | 3,095 | 2,500 | 10,765 | 11,408 | 3,636 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 701,765 | 1165,785 | 1147,287 | 795,766 | 815,837 | 730,939 | 749,518 | 1232,620 | 1200,435 | 831,890 |
| Vs,v | (Kn) | 160,115 | 281,710 | 300,205 | 157,356 | 137,285 | 130,942 | 112,363 | 214,875 | 247,056 | 121,232 |
| Aj,v | ($mm^2$) | 400,288 | 704,274 | 750,511 | 393,390 | 343,212 | 327,355 | 280,907 | 537,187 | 617,641 | 303,080 |
| jumlah tul | | 2,000 | 3,000 | 3,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 3,000 | 2,000 |
| As pasang | ($mm^2$) | 628,320 | 942,480 | 942,480 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 942,480 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 560,000 | 270,000 | 270,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 270,000 | 560,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 |
| Vkol | (Kn) | 138,233 | 138,233 | 138,233 | 138,233 | 146,771 | 142,727 | 138,233 | 138,233 | 138,233 | 138,233 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 |
| Vj,h | (Kn) | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 |
| Vj,v | (Kn) | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,945 | 1,945 | 1,945 | 1,945 | 1,928 | 1,936 | 1,945 | 1,945 | 1,945 | 1,945 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 2624,265 | 2515,919 | 2359,394 | 2877,583 | 3135,546 | 3038,910 | 3302,975 | 3081,537 | 2809,182 | 3341,867 |
| Nu/Ag | ($N/mm^2$) | 5,356 | 5,135 | 4,815 | 5,873 | 6,399 | 6,202 | 6,741 | 6,289 | 5,733 | 6,820 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 552,022 | 530,220 | 497,037 | 599,913 | 645,038 | 628,514 | 672,709 | 635,856 | 587,367 | 678,975 |
| Vs,h | (Kn) | 401,100 | 422,902 | 456,085 | 353,209 | 299,546 | 320,114 | 280,414 | 317,267 | 365,756 | 274,148 |
| Ajh | ($mm^2$) | 1671,250 | 1762,092 | 1900,356 | 1471,705 | 1248,110 | 1333,810 | 1168,391 | 1321,944 | 1523,982 | 1142,282 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 5,320 | 5,609 | 6,049 | 4,685 | 3,973 | 4,246 | 3,719 | 4,208 | 4,851 | 3,636 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 776,057 | 767,627 | 755,448 | 795,766 | 808,529 | 804,507 | 828,864 | 811,635 | 790,444 | 831,890 |
| Vs,v | (Kn) | 177,066 | 185,496 | 197,674 | 157,356 | 136,055 | 144,121 | 124,258 | 141,487 | 162,678 | 121,232 |
| Aj,v | ($mm^2$) | 442,664 | 463,739 | 494,185 | 393,390 | 340,138 | 360,302 | 310,645 | 353,718 | 406,695 | 303,080 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (1J31)1 | (1J32)1 | (1J33)1 | (1J34)1 | (1J35)1 | (1J36)1 | (1J37)1 | (1J38)1 | (1J39)1 | (1J40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 36,00 |
| ln ki | (m) | 6,50 | 6,50 | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 35,20 |
| l ka | (m) | 7,20 | 7,20 | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 1 | 6 | 6 |
| ln ka | (m) | 6,50 | 6,50 | 6,50 | 6,45 | 6,45 | 6,5 | 6,5 | 0,65 | 5,3 | 5,6 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,63 | 233,63 | 233,63 | 375,784 | 375,782 | 233,630 | 233,63 | 233,63 | 233,63 | 126,25 |
| Mnak, ka | (Knm) | 443,821 | 378,969 | 378,969 | 653,052 | 653,052 | 443,821 | 443,821 | 378,969 | 378,969 | 84,542 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 469,730 | 469,728 | 292,038 | 292,038 | 292,038 | 292,038 | 157,813 |
| Mkap,ka | (Knm) | 554,776 | 473,711 | 473,711 | 816,315 | 816,315 | 554,776 | 554,776 | 473,711 | 473,711 | 105,678 |
| Vkol | (Kn) | 133,233 | 125,000 | 125,000 | 210,966 | 210,965 | 138,233 | 138,233 | 155,072 | 126,702 | 40,471 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 605,378 | 605,375 | 376,372 | 376,372 | 376,372 | 376,372 | 203,385 |
| Tka | (Kn) | 714,984 | 610,509 | 610,509 | 1052,049 | 1052,049 | 714,984 | 714,984 | 610,509 | 610,509 | 136,195 |
| Vj,h | (Kn) | 953,122 | 861,881 | 861,881 | 1446,462 | 1446,459 | 953,122 | 953,122 | 831,808 | 860,178 | 299,109 |
| Vj,v | (Kn) | 953,122 | 861,881 | 861,881 | 1446,462 | 1446,459 | 953,122 | 953,122 | 831,808 | 860,178 | 598,218 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,945 | 1,759 | 1,759 | 2,952 | 2,952 | 1,945 | 1,945 | 1,698 | 1,755 | 0,935 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3266,326 | 2987,100 | 3171,114 | 2603,008 | 2441,633 | 2955,006 | 2825,881 | 2366,230 | 2312,736 | 1221,368 |
| Nu/Ag | ($N/mm^2$) | 6,666 | 6,096 | 6,472 | 5,312 | 4,983 | 6,031 | 5,767 | 4,829 | 4,720 | 3,817 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 666,750 | 619,473 | 651,015 | 547,813 | 514,738 | 613,805 | 590,454 | 498,532 | 486,708 | 244,802 |
| Vs,h | (Kn) | 286,372 | 242,408 | 210,966 | 898,648 | 931,720 | 339,317 | 362,668 | 333,276 | 373,470 | 54,307 |
| Ajh | ($mm^2$) | 1193,219 | 1010,033 | 878,607 | 3744,367 | 3882,168 | 1413,821 | 1511,117 | 1388,650 | 1556,126 | 226,281 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 3,798 | 3,215 | 2,797 | 11,919 | 12,357 | 4,500 | 4,810 | 4,420 | 4,953 | 0,720 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 826,013 | 727,293 | 740,240 | 1175,236 | 1156,179 | 801,790 | 791,744 | 659,759 | 678,504 | 225,131 |
| Vs,v | (Kn) | 127,109 | 134,587 | 121,640 | 271,225 | 290,280 | 151,332 | 161,379 | 172,050 | 181,674 | 373,088 |
| Aj,v | ($mm^2$) | 317,774 | 336,468 | 304,101 | 678,063 | 725,699 | 378,330 | 403,447 | 430,125 | 454,185 | 932,719 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 3,000 | 3,000 | 2,000 | 2,000 | 2,000 | 2,000 | 6,000 |
| As pasang | ($mm^2$) | 628,320 | 628,320 | 628,320 | 942,480 | 942,480 | 628,320 | 628,320 | 628,320 | 628,320 | 1884,960 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 560,000 | 560,000 | 560,000 | 270,000 | 270,000 | 560,000 | 560,000 | 560,000 | 560,000 | 116,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 3,6 |
| ln ki | (m) | 6,50 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 3,05 |
| l ka | (m) | 2,00 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 3,6 | 3,6 |
| ln ka | (m) | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 3,05 | 3,2 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 443,821 | 361,482 | 361,482 | 361,482 | 361,482 | 361,482 | 361,482 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 554,776 | 451,853 | 451,853 | 451,853 | 451,853 | 451,853 | 451,853 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 146,771 | 125,926 | 121,432 | 121,432 | 121,432 | 121,432 | 126,386 | 97,775 | 98,817 | 97,822 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 714,984 | 582,338 | 582,338 | 582,338 | 582,338 | 582,338 | 582,338 | 492,571 | 492,571 | 492,571 |
| Vj,h | (Kn) | 944,585 | 832,783 | 837,278 | 837,278 | 837,278 | 837,278 | 830,324 | 650,094 | 649,051 | 650,047 |
| Vj,v | (Kn) | 944,585 | 832,783 | 837,278 | 837,278 | 837,278 | 837,278 | 830,324 | 650,094 | 649,051 | 1300,094 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,928 | 1,700 | 1,709 | 1,709 | 1,709 | 1,709 | 1,695 | 1,327 | 1,325 | 1,327 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 3266,326 | 2987,100 | 3171,114 | 2603,008 | 2441,633 | 2955,006 | 2825,881 | 2366,230 | 2312,736 | 1221,368 |
| Nu/Ag | ($N/mm^2$) | 6,666 | 6,096 | 6,472 | 5,312 | 4,983 | 6,031 | 5,767 | 4,829 | 4,720 | 3,817 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 666,750 | 619,473 | 651,015 | 547,813 | 514,738 | 613,805 | 590,454 | 498,532 | 486,708 | 244,802 |
| Vs,h | (Kn) | 277,835 | 213,311 | 186,263 | 289,464 | 322,539 | 223,472 | 239,870 | 151,561 | 162,343 | 405,245 |
| Ajh | ($mm^2$) | 1157,645 | 888,795 | 776,095 | 1206,101 | 1343,913 | 931,135 | 999,456 | 631,505 | 676,429 | 1688,521 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 3,685 | 2,829 | 2,470 | 3,839 | 4,278 | 2,964 | 3,181 | 2,010 | 2,153 | 5,375 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 818,614 | 702,740 | 719,110 | 680,280 | 669,250 | 704,339 | 689,737 | 515,629 | 511,968 | 489,271 |
| Vs,v | (Kn) | 125,971 | 130,043 | 118,168 | 156,998 | 168,027 | 132,939 | 140,587 | 134,464 | 137,083 | 810,822 |
| Aj,v | ($mm^2$) | 314,927 | 325,108 | 295,420 | 392,494 | 420,069 | 332,347 | 351,467 | 336,161 | 342,707 | 2027,056 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 8,000 |
| As pasang | ($mm^2$) | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 2513,280 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 77,143 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (1J41)2 | (1J42)2 | (1J43)2 | (1J44)2 | (1J45)1 | (1J46)1 | (1J47)1 | (1J48)1 | (1J49)1 | (1J50)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 36,00 | 7,20 | 36,00 | 7,2 | 7,2 | 6 | 6,00 | 6,00 | 6,00 |
| ln ki | (m) | 6,45 | 35,20 | 6,45 | 35,20 | 6,5 | 6,5 | 5,3 | 5,25 | 5,25 | 5,30 |
| l ka | (m) | 6,00 | 6,00 | 6,00 | 6,00 | 6 | 1 | 0 | 0 | 0 | 0 |
| ln ka | (m) | 5,25 | 5,60 | 5,25 | 5,60 | 5,3 | 0,65 | 0 | 0 | 0 | 0 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 375,784 | 156,660 | 375,784 | 156,66 | 233,630 | 233,63 | 233,63 | 375,784 | 375,782 | 233,630 |
| Mnak, ka | (Knm) | 653,052 | 84,542 | 653,052 | 84,542 | 443,821 | 443,821 | 0 | 0 | 0 | 0,000 |
| Mkap, ki | (Knm) | 469,730 | 195,825 | 469,730 | 195,825 | 292,038 | 292,038 | 292,038 | 469,730 | 469,728 | 292,038 |
| Mkap,ka | (Knm) | 816,315 | 105,678 | 816,315 | 105,678 | 554,776 | 554,776 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 214,757 | 46,200 | 214,757 | 46,200 | 140,226 | 173,451 | 92,570 | 150,314 | 150,313 | 92,570 |
| Cki | (Kn) | 605,378 | 252,375 | 605,378 | 252,375 | 376,372 | 376,372 | 376,372 | 605,378 | 605,375 | 376,372 |
| Tka | (Kn) | 1052,049 | 136,195 | 1052,049 | 136,195 | 714,984 | 714,984 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vj,h | (Kn) | 1442,670 | 342,370 | 1442,670 | 342,370 | 951,129 | 917,904 | 283,801 | 455,064 | 455,062 | 283,801 |
| Vj,v | (Kn) | 2885,340 | 684,739 | 2885,340 | 684,739 | 951,129 | 917,904 | 283,801 | 455,064 | 455,062 | 283,801 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 4,508 | 1,070 | 4,508 | 1,070 | 1,941 | 1,873 | 0,579 | 0,929 | 0,929 | 0,579 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1365,756 | 1212,097 | 1301,464 | 1142,443 | 2025,449 | 1976,309 | 5,899 | 46,570 | 37,718 | 19,646 |
| Nu/Ag | ($N/mm^2$) | 4,268 | 3,788 | 4,067 | 3,570 | 4,134 | 4,033 | 0,012 | 0,095 | 0,077 | 0,040 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 283,660 | 242,094 | 267,057 | 220,688 | 417,516 | 404,498 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 1159,010 | 100,276 | 1175,613 | 121,682 | 533,612 | 513,406 | 283,801 | 455,064 | 455,062 | 283,801 |
| Ajh | ($mm^2$) | 4829,207 | 417,817 | 4898,388 | 507,009 | 2223,385 | 2139,194 | 1182,505 | 1896,101 | 1896,091 | 1182,505 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P 10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 15,372 | 1,330 | 15,592 | 1,614 | 7,077 | 6,809 | 3,764 | 6,035 | 6,035 | 3,764 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 1111,894 | 257,295 | 1100,300 | 254,314 | 727,940 | 698,829 | 170,417 | 274,769 | 274,438 | 170,736 |
| Vs,v | (Kn) | 1773,446 | 427,444 | 1785,040 | 430,425 | 223,189 | 219,075 | 113,384 | 180,296 | 180,624 | 113,065 |
| Aj,v | ($mm^2$) | 4433,615 | 1068,611 | 4462,600 | 1076,063 | 557,973 | 547,687 | 283,460 | 450,739 | 451,559 | 282,663 |
| jumlah tul | | 16,000 | 5,000 | 16,000 | 4,000 | 2,000 | 2,000 | 2,000 | 3,000 | 3,000 | 2,000 |
| As pasang | ($mm^2$) | 5026,560 | 1570,800 | 5026,560 | 1256,640 | 628,320 | 628,320 | 628,320 | 942,480 | 942,480 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 25,333 | 150,000 | 25,333 | 206,667 | 560,000 | 560,000 | 560,000 | 270,000 | 270,000 | 560,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 3,60 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 0 | 7,2 | 7,2 | 7,2 |
| ln ki | (m) | 3,20 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0 | 6,5 | 6,5 | 6,5 |
| l ka | (m) | 3,60 | 3,6 | 3,6 | 3,6 | 7,2 | 1 | 7,2 | 7,2 | 7,2 | 0 |
| ln ka | (m) | 3,20 | 3,2 | 3,2 | 3,05 | 6,5 | 0,65 | 6,5 | 6,5 | 6,5 | 0 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 0,000 | 95,839 | 95,839 | 95,839 |
| Mnak, ka | (Knm) | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 138,406 | 138,406 | 138,406 | 0,000 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 | 119,799 | 119,799 | 119,799 |
| Mkap,ka | (Knm) | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 173,008 | 173,008 | 173,008 | 0,000 |
| Vkol | (Kn) | 96,206 | 96,206 | 96,206 | 99,323 | 96,847 | 118,989 | 53,659 | 90,815 | 90,815 | 37,156 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 | 154,394 | 154,394 | 154,394 |
| Tka | (Kn) | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 222,968 | 222,968 | 222,968 | 0,000 |
| Vj,h | (Kn) | 651,662 | 651,662 | 651,662 | 648,546 | 651,022 | 628,879 | 169,309 | 286,547 | 286,547 | 117,238 |
| Vj,v | (Kn) | 1303,324 | 1303,324 | 1303,324 | 1297,092 | 651,022 | 628,879 | 169,309 | 286,547 | 286,547 | 117,238 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,330 | 1,330 | 1,330 | 1,324 | 1,329 | 1,283 | 0,346 | 0,585 | 0,585 | 0,239 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1365,756 | 1212,097 | 1301,464 | 1142,443 | 2025,449 | 1976,309 | 5,899 | 46,570 | 37,718 | 19,646 |
| Nu/Ag | ($N/mm^2$) | 4,268 | 3,788 | 4,067 | 3,570 | 4,134 | 4,033 | 0,012 | 0,095 | 0,077 | 0,040 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 283,660 | 242,094 | 267,057 | 220,688 | 417,516 | 404,498 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 368,002 | 409,568 | 384,605 | 427,858 | 233,505 | 224,382 | 169,309 | 286,547 | 286,547 | 117,238 |
| Ajh | ($mm^2$) | 1533,341 | 1706,535 | 1602,522 | 1782,742 | 972,939 | 934,924 | 705,456 | 1193,947 | 1193,947 | 488,492 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 4,881 | 5,432 | 5,101 | 5,675 | 3,097 | 2,976 | 2,246 | 3,800 | 3,800 | 1,555 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 502,249 | 489,732 | 497,012 | 481,743 | 498,255 | 478,786 | 101,667 | 173,018 | 172,811 | 70,531 |
| Vs,v | (Kn) | 801,075 | 813,592 | 806,313 | 815,348 | 152,767 | 150,094 | 67,642 | 113,530 | 113,737 | 46,707 |
| Aj,v | ($mm^2$) | 2002,689 | 2033,980 | 2015,781 | 2038,371 | 381,917 | 375,235 | 169,106 | 283,824 | 284,342 | 116,768 |
| jumlah tul | | 8,000 | 8,000 | 8,000 | 8,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 2513,280 | 2513,280 | 2513,280 | 2513,280 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 | 628,320 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 77,143 | 77,143 | 77,143 | 77,143 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 | 560,000 |

**Pertemuan Balok Kolom Lantai 2**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 16 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 58 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (2J1)1 | (2J2)1 | (2J3)2 | (2J4)2 | (2J5)2 | (2J6)2 | (2J7)2 | (2J8)1 | (2J9)1 | (2J10)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 1,00 | 0 | 0 | 0 | 0 | 0 | 1,00 | 1,00 | 7,2 |
| ln ki | (m) | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 | 0,65 | 0,65 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 36 | 7,2 | 36 | 7,2 | 36 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 35,2 | 6,45 | 35,2 | 6,45 | 35,2 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 0 | 0 | 0 | 0 | 0 | 233,63 | 233,63 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 215,585 | 443,821 | 256,683 | 378,969 | 215,585 | 443,821 | 443,821 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 269,481 | 554,776 | 320,854 | 473,711 | 269,481 | 554,776 | 554,776 | 473,711 |
| Vkol | (Kn) | 151,513 | 151,513 | 42,872 | 96,333 | 51,045 | 82,257 | 42,872 | 165,482 | 165,482 | 131,944 |
| Cki | (Kn) | 376,372 | 376,372 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,509 | 347,302 | 714,984 | 413,509 | 610,509 | 347,302 | 714,984 | 714,984 | 610,509 |
| Vj,h | (Kn) | 835,367 | 835,367 | 304,430 | 618,650 | 362,464 | 528,252 | 304,430 | 925,874 | 925,874 | 854,936 |
| Vj,v | (Kn) | 835,367 | 835,367 | 608,859 | 1237,301 | 724,929 | 1056,504 | 608,859 | 925,874 | 925,874 | 854,936 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,705 | 1,705 | 0,951 | 1,933 | 1,133 | 1,651 | 0,951 | 1,890 | 1,890 | 1,745 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1916,320 | 1646,766 | 972,051 | 1093,868 | 970,538 | 1076,975 | 961,432 | 1698,957 | 1738,265 | 2113,220 |
| Nu/Ag | ($N/mm^2$) | 3,911 | 3,361 | 3,038 | 3,418 | 3,033 | 3,366 | 3,004 | 5,309 | 5,432 | 6,604 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 388,013 | 303,070 | 156,427 | 204,437 | 155,738 | 198,474 | 151,523 | 321,274 | 334,332 | 439,812 |
| Vs,h | (Kn) | 447,354 | 532,297 | 148,002 | 414,213 | 206,727 | 329,778 | 152,907 | 604,599 | 591,542 | 415,124 |
| Ajh | ($mm^2$) | 1863,975 | 2217,906 | 616,677 | 1725,889 | 861,361 | 1374,074 | 637,111 | 2519,164 | 2464,758 | 1729,684 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 5,933 | 7,060 | 1,963 | 5,494 | 2,742 | 4,374 | 2,028 | 8,019 | 7,846 | 5,506 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 631,900 | 613,519 | 219,648 | 455,780 | 261,452 | 388,065 | 219,244 | 752,152 | 756,701 | 738,795 |
| Vs,v | (Kn) | 203,467 | 221,849 | 389,211 | 781,520 | 463,477 | 668,439 | 389,615 | 173,722 | 169,173 | 116,141 |
| Aj,v | ($mm^2$) | 508,667 | 554,621 | 973,028 | 1953,801 | 1158,693 | 1671,096 | 974,038 | 434,305 | 422,932 | 290,352 |
| jumlah tul | | 4,000 | 4,000 | 9,000 | 18,000 | 10,000 | 14,000 | 9,000 | 4,000 | 4,000 | 5,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 1809,562 | 3619,123 | 2010,624 | 2814,874 | 1809,562 | 804,250 | 804,250 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 69,500 | 24,235 | 60,000 | 36,615 | 69,500 | 178,667 | 178,667 | 130,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,00 |
| ln ki | (m) | 0,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 1,65 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 1 | 7,20 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0,65 | 6,50 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 292,038 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 365,048 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 554,776 |
| Vkol | (Kn) | 151,513 | 137,297 | 136,519 | 134,006 | 134,006 | 134,006 | 138,083 | 135,244 | 163,687 | 164,423 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 470,465 |
| Tka | (Kn) | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 714,984 |
| Vj,h | (Kn) | 835,367 | 849,584 | 850,361 | 852,874 | 852,874 | 852,874 | 848,797 | 851,636 | 823,193 | 1021,026 |
| Vj,v | (Kn) | 835,367 | 849,584 | 1700,722 | 1705,749 | 1705,749 | 1705,749 | 1697,595 | 851,636 | 823,193 | 1021,026 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,705 | 1,734 | 2,657 | 2,665 | 2,665 | 2,665 | 2,652 | 1,738 | 1,680 | 2,084 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1916,320 | 1646,766 | 972,051 | 1093,868 | 970,538 | 1076,975 | 961,432 | 1698,957 | 1738,265 | 2113,220 |
| Nu/Ag | ($N/mm^2$) | 3,911 | 3,361 | 3,038 | 3,418 | 3,033 | 3,366 | 3,004 | 3,467 | 3,547 | 4,313 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 388,013 | 303,070 | 156,427 | 204,437 | 155,738 | 198,474 | 151,523 | 321,274 | 334,332 | 439,812 |
| Vs,h | (Kn) | 447,354 | 546,514 | 693,934 | 648,437 | 697,137 | 654,400 | 697,274 | 530,362 | 488,862 | 581,214 |
| Ajh | ($mm^2$) | 1118,385 | 1366,285 | 1734,834 | 1621,093 | 1742,841 | 1636,001 | 1743,186 | 1325,905 | 1222,154 | 1453,036 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 3,560 | 4,349 | 5,522 | 5,160 | 5,548 | 5,208 | 5,549 | 4,220 | 3,890 | 4,625 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 631,900 | 623,960 | 613,541 | 628,341 | 615,193 | 626,540 | 611,286 | 629,096 | 610,726 | 788,751 |
| Vs,v | (Kn) | 203,467 | 225,624 | 1087,181 | 1077,408 | 1090,556 | 1079,209 | 1086,309 | 222,541 | 212,467 | 232,276 |
| Aj,v | ($mm^2$) | 508,667 | 564,060 | 2717,953 | 2693,519 | 2726,390 | 2698,022 | 2715,772 | 556,352 | 531,167 | 580,689 |
| jumlah tul | | 5,000 | 6,000 | 14,000 | 14,000 | 14,000 | 14,000 | 14,000 | 3,000 | 3,000 | 3,000 |
| As pasang | ($mm^2$) | 1005,312 | 1206,374 | 2814,874 | 2814,874 | 2814,874 | 2814,874 | 2814,874 | 603,187 | 603,187 | 603,187 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 130,000 | 100,800 | 36,615 | 36,615 | 36,615 | 36,615 | 36,615 | 276,000 | 276,000 | 276,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (2J11)1 | (2J12)1 | (2J13)1 | (2J14)1 | (2J15)1 | (2J16)1 | (2J17)1 | (2J18)1 | (2J19)1 | (2J20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,45 | 6,45 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,63 | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 233,63 | 233,63 | 233,63 |
| Mnak, ka | (Knm) | 378,969 | 443,821 | 473,711 | 443,821 | 443,821 | 378,969 | 378,969 | 443,821 | 473,711 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 554,776 | 592,139 | 554,776 | 554,776 | 473,711 | 473,711 | 554,776 | 592,139 | 554,776 |
| Vkol | (Kn) | 131,944 | 146,303 | 152,740 | 145,913 | 145,913 | 131,944 | 131,944 | 145,913 | 152,350 | 145,913 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 714,984 | 763,136 | 714,984 | 714,984 | 610,509 | 610,509 | 714,984 | 763,136 | 714,984 |
| Vj,h | (Kn) | 854,936 | 945,053 | 986,767 | 945,443 | 945,443 | 854,936 | 854,936 | 945,443 | 987,157 | 945,443 |
| Vj,v | (Kn) | 854,936 | 945,053 | 986,767 | 945,443 | 945,443 | 854,936 | 854,936 | 945,443 | 987,157 | 945,443 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,5$\sqrt{f'c}$ | (N/mm$^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm$^2$) | 1,745 | 1,929 | 2,014 | 1,929 | 1,929 | 1,745 | 1,745 | 1,929 | 2,015 | 1,929 |
| Vj,h< 1,5$\sqrt{f'c}$ | | OK | OK | OK | Ok | OK | OK | OK | OK | OK | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1658,519 | 1770,043 | 1751,063 | 1969,501 | 2388,053 | 2104,420 | 1745,064 | 1779,622 | 1598,333 | 1897,220 |
| Nu/Ag | (N/mm$^2$) | 3,385 | 3,612 | 3,574 | 4,019 | 4,874 | 4,295 | 3,561 | 3,632 | 3,262 | 3,872 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 307,263 | 344,526 | 338,474 | 402,661 | 503,276 | 437,628 | 336,539 | 347,540 | 285,138 | 382,615 |
| Vs,h | (Kn) | 547,673 | 600,527 | 648,293 | 542,782 | 442,166 | 417,308 | 518,397 | 597,902 | 702,019 | 562,827 |
| Ajh | (mm$^2$) | 2281,969 | 2502,194 | 2701,219 | 2261,591 | 1842,360 | 1738,784 | 2159,988 | 2491,260 | 2925,079 | 2345,114 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm$^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 7,264 | 7,965 | 8,598 | 7,199 | 5,864 | 5,535 | 6,875 | 7,930 | 9,311 | 7,465 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 628,711 | 703,585 | 733,112 | 719,270 | 751,573 | 659,831 | 634,751 | 704,615 | 721,095 | 713,691 |
| Vs,v | (Kn) | 226,225 | 241,467 | 253,654 | 226,173 | 193,870 | 195,105 | 220,185 | 240,828 | 266,062 | 231,752 |
| Aj,v | (mm$^2$) | 565,563 | 603,668 | 634,136 | 565,432 | 484,674 | 487,764 | 550,463 | 602,069 | 665,156 | 579,379 |
| jumlah tul | | 3,000 | 4,000 | 4,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 4,000 | 3,000 |
| As pasang | (mm$^2$) | 603,187 | 804,250 | 804,250 | 603,187 | 603,187 | 603,187 | 603,187 | 603,187 | 804,250 | 603,187 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 276,000 | 178,667 | 178,667 | 276,000 | 276,000 | 276,000 | 276,000 | 276,000 | 178,667 | 276,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,50 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 365,048 | 365,048 | 365,048 | 365,048 | 365,048 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 |
| Vkol | (Kn) | 158,493 | 158,493 | 158,493 | 158,493 | 167,505 | 150,657 | 145,913 | 145,913 | 145,913 | 145,913 |
| Cki | (Kn) | 470,465 | 470,465 | 470,465 | 470,465 | 470,465 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 |
| Vj,h | (Kn) | 1026,956 | 1026,956 | 1026,956 | 1026,956 | 1017,944 | 940,699 | 945,443 | 945,443 | 945,443 | 945,443 |
| Vj,v | (Kn) | 1026,956 | 1026,956 | 1026,956 | 1026,956 | 1017,944 | 940,699 | 945,443 | 945,443 | 945,443 | 945,443 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,5$\sqrt{f'c}$ | (N/mm$^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm$^2$) | 2,096 | 2,096 | 2,096 | 2,096 | 2,077 | 1,920 | 1,929 | 1,929 | 1,929 | 1,929 |
| Vj,h< 1,5$\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1658,519 | 1770,043 | 1751,063 | 1969,501 | 2388,053 | 2104,420 | 1745,064 | 1779,622 | 1598,333 | 1897,220 |
| Nu/Ag | (N/mm$^2$) | 3,385 | 3,612 | 3,574 | 4,019 | 4,874 | 4,295 | 3,561 | 3,632 | 3,262 | 3,872 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 307,263 | 344,526 | 338,474 | 402,661 | 503,276 | 437,628 | 336,539 | 347,540 | 285,138 | 382,615 |
| Vs,h | (Kn) | 719,693 | 682,430 | 688,482 | 624,295 | 514,668 | 503,071 | 608,904 | 597,902 | 660,305 | 562,827 |
| Ajh | (mm$^2$) | 2998,720 | 2843,459 | 2868,675 | 2601,231 | 2144,449 | 2096,129 | 2537,100 | 2491,260 | 2751,270 | 2345,114 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm$^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,545 | 9,051 | 9,131 | 8,280 | 6,826 | 6,672 | 8,076 | 7,930 | 8,758 | 7,465 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 755,213 | 764,562 | 762,971 | 781,283 | 809,208 | 726,021 | 701,948 | 704,615 | 690,623 | 713,691 |
| Vs,v | (Kn) | 271,744 | 262,394 | 263,985 | 245,673 | 208,736 | 214,677 | 243,495 | 240,828 | 254,819 | 231,752 |
| Aj,v | (mm$^2$) | 679,359 | 655,986 | 659,963 | 614,183 | 521,841 | 536,694 | 608,737 | 602,069 | 637,048 | 579,379 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | (mm$^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (2J21)1 | (2J22)1 | (2J23)1 | (2J24)1 | (2J25)1 | (2J26)1 | (2J27)1 | (2J28)1 | (2J29)1 | (2J30)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,45 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,630 | 233,630 | 233,63 | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 233,63 |
| Mnak, ka | (Knm) | 443,821 | 378,969 | 378,969 | 443,821 | 473,711 | 443,821 | 443,821 | 378,969 | 378,969 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 473,711 | 473,711 | 554,776 | 592,139 | 554,776 | 554,776 | 473,711 | 473,711 | 554,776 |
| Vkol | (Kn) | 145,913 | 131,944 | 131,944 | 145,913 | 152,350 | 145,913 | 145,913 | 131,944 | 131,944 | 146,654 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 610,509 | 610,509 | 714,984 | 763,136 | 714,984 | 714,984 | 610,509 | 610,509 | 714,984 |
| Vj,h | (Kn) | 945,443 | 854,936 | 854,936 | 945,443 | 987,157 | 945,443 | 945,443 | 854,936 | 854,936 | 944,702 |
| Vj,v | (Kn) | 945,443 | 854,936 | 854,936 | 945,443 | 987,157 | 945,443 | 945,443 | 854,936 | 854,936 | 944,702 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,929 | 1,745 | 1,745 | 1,929 | 2,015 | 1,929 | 1,929 | 1,745 | 1,745 | 1,928 |
| Vj,h< 1 .5 $\sqrt{f'c}$ | | OK | Ok | Ok | Ok | Ok | Ok | Ok | OK | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1320,750 | 2289,560 | 2447,708 | 2179,869 | 1970,045 | 2417,552 | 2433,305 | 2189,310 | 2348,558 | 1695,052 |
| Nu/Ag | ($N/mm^2$) | 2,695 | 4,673 | 4,995 | 4,449 | 4,021 | 4,934 | 4,966 | 4,468 | 4,793 | 3,459 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 144,403 | 481,495 | 516,022 | 456,015 | 402,808 | 509,619 | 512,974 | 458,263 | 494,657 | 319,948 |
| Vs,h | (Kn) | 801,040 | 373,441 | 338,914 | 489,428 | 584,349 | 435,824 | 432,469 | 396,673 | 360,279 | 624,753 |
| Ajh | ($mm^2$) | 3337,666 | 1556,004 | 1412,142 | 2039,284 | 2434,787 | 1815,933 | 1801,955 | 1652,803 | 1501,161 | 2603,140 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 10,624 | 4,953 | 4,495 | 6,491 | 7,750 | 5,780 | 5,736 | 5,261 | 4,778 | 8,286 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 669,200 | 672,752 | 683,789 | 735,506 | 751,049 | 753,850 | 755,066 | 665,755 | 676,869 | 697,541 |
| Vs,v | (Kn) | 276,243 | 182,184 | 171,147 | 209,937 | 236,108 | 191,593 | 190,377 | 189,181 | 178,067 | 247,161 |
| Aj,v | ($mm^2$) | 690,607 | 455,461 | 427,868 | 524,842 | 590,270 | 478,982 | 475,943 | 472,952 | 445,167 | 617,902 |
| jumlah tul | | 4,000 | 3,000 | 3,000 | 4,000 | 3,000 | 4,000 | 4,000 | 3,000 | 3,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 603,187 | 603,187 | 804,250 | 603,187 | 804,250 | 804,250 | 603,187 | 603,187 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 276,000 | 276,000 | 178,667 | 276,000 | 178,667 | 178,667 | 276,000 | 276,000 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,50 |
| l ka | (m) | 2,00 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 361,482 | 361,482 | 361,482 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,036 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 451,853 | 451,853 | 451,853 |
| Vkol | (Kn) | 154,925 | 150,657 | 145,913 | 145,913 | 145,913 | 145,913 | 154,925 | 132,922 | 128,178 | 128,178 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 582,338 | 582,338 | 582,338 |
| Vj,h | (Kn) | 936,431 | 940,699 | 945,443 | 945,443 | 945,443 | 945,443 | 936,431 | 825,787 | 830,531 | 830,531 |
| Vj,v | (Kn) | 936,431 | 940,699 | 945,443 | 945,443 | 945,443 | 945,443 | 936,431 | 825,787 | 830,531 | 830,531 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,911 | 1,920 | 1,929 | 1,929 | 1,929 | 1,929 | 1,911 | 1,685 | 1,695 | 1,695 |
| Vj,h< 1 .5 $\sqrt{f'c}$ | | OK | OK | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1320,750 | 2289,560 | 2447,708 | 2179,869 | 1970,045 | 2417,552 | 2433,305 | 2189,310 | 2348,558 | 1695,052 |
| Nu/Ag | ($N/mm^2$) | 2,695 | 4,673 | 4,995 | 4,449 | 4,021 | 4,934 | 4,966 | 4,468 | 4,793 | 3,459 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 144,403 | 481,495 | 516,022 | 456,015 | 402,808 | 509,619 | 512,974 | 458,263 | 494,657 | 319,948 |
| Vs,h | (Kn) | 792,028 | 459,204 | 429,421 | 489,428 | 542,635 | 435,824 | 423,457 | 367,524 | 335,874 | 510,583 |
| Ajh | ($mm^2$) | 3300,115 | 1913,349 | 1789,253 | 2039,284 | 2260,978 | 1815,933 | 1764,404 | 1531,350 | 1399,475 | 2127,430 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 10,505 | 6,090 | 5,695 | 6,491 | 7,197 | 5,780 | 5,616 | 4,874 | 4,455 | 6,772 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 662,821 | 740,239 | 756,177 | 735,506 | 719,312 | 753,850 | 747,868 | 643,056 | 657,548 | 613,241 |
| Vs,v | (Kn) | 273,610 | 200,460 | 189,265 | 209,937 | 226,131 | 191,593 | 188,562 | 182,731 | 172,984 | 217,291 |
| Aj,v | ($mm^2$) | 684,024 | 501,151 | 473,164 | 524,842 | 565,328 | 478,982 | 471,406 | 456,827 | 432,460 | 543,227 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (2J31)1 | (2J32)1 | (2J33)1 | (2J34)1 | (2J35)1 | (2J36)2 | (2J37)2 | (2J38)2 | (2J39)2 | (2J40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 36 | 7,2 | 37,60 | 7,20 | 37,6 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 35,2 | 6,45 | 36,80 | 6,45 | 36,8 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| ln ka | (m) | 6,45 | 6,5 | 6,5 | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 138,318 | 233,63 | 138,318 | 233,63 | 138,318 |
| Mnak, ka | (Knm) | 473,711 | 443,821 | 443,821 | 378,969 | 378,969 | 0 | 0 | 0 | 0 | 0 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 172,898 | 292,038 | 172,898 | 292,038 | 172,898 |
| Mkap,ka | (Knm) | 592,139 | 554,776 | 554,776 | 473,711 | 473,711 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 153,141 | 145,913 | 145,913 | 163,687 | 163,687 | 27,506 | 50,710 | 27,480 | 50,710 | 27,480 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 222,827 | 376,372 | 222,827 | 376,372 | 222,827 |
| Tka | (Kn) | 763,136 | 714,984 | 714,984 | 610,509 | 610,509 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vj,h | (Kn) | 986,366 | 945,443 | 945,443 | 823,193 | 823,193 | 195,320 | 325,661 | 195,347 | 325,661 | 195,347 |
| Vj,v | (Kn) | 986,366 | 945,443 | 945,443 | 823,193 | 823,193 | 390,640 | 651,322 | 390,693 | 651,322 | 390,693 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,013 | 1,929 | 1,929 | 1,680 | 1,680 | 0,610 | 1,018 | 0,610 | 1,018 | 0,610 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1602,346 | 1328,806 | 2099,276 | 1818,750 | 1794,142 | 940,219 | 1024,761 | 935,625 | 1009,037 | 887,861 |
| Nu/Ag | ($N/mm^2$) | 3,270 | 2,712 | 4,284 | 3,712 | 3,662 | 2,938 | 3,202 | 2,924 | 3,153 | 2,775 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 286,666 | 150,355 | 436,346 | 359,591 | 352,060 | 141,217 | 178,790 | 138,884 | 172,423 | 111,785 |
| Vs,h | (Kn) | 699,700 | 795,088 | 509,097 | 463,603 | 471,133 | 54,103 | 146,871 | 56,462 | 153,238 | 83,562 |
| Ajh | ($mm^2$) | 2915,415 | 3312,865 | 2121,236 | 1931,677 | 1963,054 | 225,430 | 611,962 | 235,259 | 638,492 | 348,176 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,280 | 10,545 | 6,752 | 6,149 | 6,249 | 0,718 | 1,948 | 0,749 | 2,032 | 1,108 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 720,840 | 669,822 | 729,286 | 616,135 | 614,461 | 140,148 | 287,112 | 140,054 | 286,472 | 138,888 |
| Vs,v | (Kn) | 265,526 | 275,821 | 216,157 | 207,058 | 208,712 | 250,493 | 414,210 | 250,639 | 414,850 | 251,805 |
| Aj,v | ($mm^2$) | 663,815 | 689,053 | 540,393 | 517,646 | 521,780 | 626,232 | 1035,525 | 626,598 | 1037,126 | 629,513 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 6,000 | 4,000 | 6,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1206,374 | 804,250 | 1206,374 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 120,800 | 212,000 | 120,800 | 212,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 1 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 0,65 | 6,5 | 3,2 | 3,2 | 3,2 | 3,2 | 3,20 |
| l ka | (m) | 7,20 | 7,2 | 2 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ka | (m) | 6,50 | 6,5 | 1,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 |
| tinggi, a | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 361,482 | 361,482 | 361,482 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 451,853 | 451,853 | 451,853 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 128,178 | 128,178 | 135,518 | 113,263 | 104,307 | 101,551 | 101,551 | 101,551 | 101,551 | 104,841 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 582,338 | 582,338 | 582,338 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 |
| Vj,h | (Kn) | 830,531 | 830,531 | 823,191 | 634,606 | 643,561 | 646,317 | 646,317 | 646,317 | 646,317 | 643,028 |
| Vj,v | (Kn) | 830,531 | 830,531 | 823,191 | 634,606 | 643,561 | 1292,635 | 1292,635 | 1292,635 | 1292,635 | 1286,056 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,695 | 1,695 | 1,680 | 1,295 | 1,313 | 1,319 | 1,319 | 1,319 | 1,319 | 1,312 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1602,346 | 1328,806 | 2099,276 | 1818,750 | 1794,142 | 940,219 | 1024,761 | 935,625 | 1009,037 | 887,861 |
| Nu/Ag | ($N/mm^2$) | 3,270 | 2,712 | 4,284 | 3,712 | 3,662 | 2,938 | 3,202 | 2,924 | 3,153 | 2,775 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 286,666 | 150,355 | 436,346 | 359,591 | 352,060 | 141,217 | 178,790 | 138,884 | 172,423 | 111,785 |
| Vs,h | (Kn) | 543,865 | 680,176 | 386,845 | 275,015 | 291,501 | 505,100 | 467,527 | 507,433 | 473,894 | 531,243 |
| Ajh | ($mm^2$) | 2266,105 | 2834,068 | 1611,855 | 1145,895 | 1214,587 | 2104,584 | 1948,029 | 2114,303 | 1974,559 | 2213,514 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 7,213 | 9,021 | 5,131 | 3,647 | 3,866 | 6,699 | 6,201 | 6,730 | 6,285 | 7,046 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 606,955 | 538,410 | 634,985 | 474,983 | 480,393 | 463,750 | 470,580 | 463,379 | 469,310 | 457,182 |
| Vs,v | (Kn) | 223,576 | 242,122 | 188,207 | 159,623 | 163,168 | 828,884 | 822,054 | 829,255 | 823,324 | 828,874 |
| Aj,v | ($mm^2$) | 558,940 | 605,304 | 470,517 | 399,057 | 407,920 | 2072,210 | 2055,135 | 2073,138 | 2058,311 | 2072,185 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 11,000 | 11,000 | 11,000 | 11,000 | 11,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 2211,686 | 2211,686 | 2211,686 | 2211,686 | 2211,686 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 52,400 | 52,400 | 52,400 | 52,400 | 52,400 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (2J41)1 | (2J42)1 |
|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 1,00 | 1,00 |
| ln ka | (m) | 0,65 | 0,65 |
| tinggi, a | (m) | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,63 |
| Mnak, ka | (Knm) | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 |
| Vkol | (Kn) | 183,087 | 183,087 |
| Cki | (Kn) | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 |
| Vj,h | (Kn) | 908,268 | 908,268 |
| Vj,v | (Kn) | 908,268 | 908,268 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,854 | 1,854 |
| Vj,h< $1.5\sqrt{f'c}$ | | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 1541,824 | 1565,459 |
| Nu/Ag | ($N/mm^2$) | 3,147 | 3,195 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 262,673 | 272,295 |
| Vs,h | (Kn) | 645,595 | 635,973 |
| Ajh | ($mm^2$) | 2689,978 | 2649,889 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 8,562 | 8,435 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 659,278 | 661,031 |
| Vs,v | (Kn) | 248,990 | 247,237 |
| Aj,v | ($mm^2$) | 622,474 | 618,093 |
| jumlah tul | | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 212,000 | 212,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 1,00 |
| ln ka | (m) | 6,50 | 0,65 |
| tinggi, a | (m) | 4,50 | 4,50 |
| tinggi, b | (m) | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 382,200 | 382,200 |
| Vkol | (Kn) | 102,227 | 125,600 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 492,571 | 492,571 |
| Vj,h | (Kn) | 645,641 | 622,269 |
| Vj,v | (Kn) | 645,641 | 622,269 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,318 | 1,270 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 1541,824 | 1565,459 |
| Nu/Ag | ($N/mm^2$) | 3,147 | 3,195 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 262,673 | 272,295 |
| Vs,h | (Kn) | 382,968 | 349,974 |
| Ajh | ($mm^2$) | 1595,701 | 1458,226 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 5,079 | 4,642 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 468,647 | 452,883 |
| Vs,v | (Kn) | 176,994 | 169,386 |
| Aj,v | ($mm^2$) | 442,485 | 423,466 |
| jumlah tul | | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 212,000 | 212,000 |

**Pertemuan Balok Kolom Lantai 3**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 16 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 58 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (3J1)1 | (3J2)1 | (3J3)2 | (3J4)2 | (3J5)2 | (3J6)2 | (3J7)2 | (3J8)1 | (3J9)1 | (3J10)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 1,00 | 0 | 0 | 0 | 0 | 0 | 1,00 | 1,00 | 7,2 |
| ln ki | (m) | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 | 0,65 | 0,65 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 36 | 7,2 | 36 | 7,2 | 36 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 35,2 | 6,45 | 35,2 | 6,45 | 35,2 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 134,27 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 0 | 0 | 0 | 0 | 0 | 233,63 | 233,63 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 443,821 | 363,803 | 443,821 | 256,683 | 473,711 | 138,318 | 443,821 | 443,821 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 554,776 | 454,754 | 554,776 | 320,854 | 592,139 | 172,898 | 554,776 | 554,776 | 473,711 |
| Vkol | (Kn) | 143,539 | 156,772 | 68,539 | 91,263 | 48,358 | 97,409 | 1,777 | 156,772 | 156,772 | 125,000 |
| Cki | (Kn) | 376,372 | 376,372 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 714,984 | 586,077 | 714,984 | 413,509 | 763,136 | 222,827 | 714,984 | 714,984 | 610,509 |
| Vj,h | (Kn) | 843,341 | 934,583 | 517,537 | 623,721 | 365,151 | 665,726 | 221,049 | 934,583 | 934,583 | 861,881 |
| Vj,v | (Kn) | 843,341 | 934,583 | 1035,075 | 1247,441 | 730,302 | 1331,453 | 442,098 | 934,583 | 934,583 | 861,881 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,721 | 1,907 | 1,617 | 1,949 | 1,141 | 2,080 | 0,691 | 1,907 | 1,907 | 1,759 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1350,940 | 1105,590 | 686,161 | 754,486 | 702,426 | 754,236 | 695,445 | 1111,270 | 1299,070 | 1299,210 |
| Nu/Ag | (N/mm²) | 2,757 | 2,256 | 2,144 | 2,358 | 2,195 | 2,357 | 2,173 | 2,268 | 2,651 | 2,651 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 165,611 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 127,007 | 127,127 |
| Vs,h | (Kn) | 677,731 | 934,583 | 517,537 | 623,721 | 365,151 | 665,726 | 221,049 | 934,583 | 807,576 | 734,753 |
| Ajh | (mm²) | 2823,878 | 3894,097 | 2156,406 | 2598,836 | 1521,463 | 2773,860 | 921,038 | 3894,097 | 3364,901 | 3061,473 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 8,989 | 12,395 | 6,864 | 8,272 | 4,843 | 8,829 | 2,932 | 12,395 | 10,711 | 9,745 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 599,009 | 645,098 | 354,912 | 433,056 | 251,152 | 462,200 | 151,845 | 645,532 | 659,859 | 608,538 |
| Vs,v | (Kn) | 244,332 | 289,485 | 680,163 | 814,385 | 479,150 | 889,252 | 290,253 | 289,052 | 274,724 | 253,343 |
| Aj,v | (mm²) | 610,830 | 723,713 | 1700,408 | 2035,963 | 1197,875 | 2173,131 | 725,632 | 722,629 | 686,810 | 633,357 |
| jumlah tul | | 4,000 | 4,000 | 9,000 | 12,000 | 6,000 | 12,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 1809,562 | 2412,749 | 1206,374 | 2412,749 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 69,500 | 46,182 | 120,800 | 46,182 | 212,000 | 178,667 | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 1,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,00 |
| ln ki | (m) | 0,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 1,65 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 1 | 7,20 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0,65 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 306,067 |
| Mnak, ka | (Knm) | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 508,983 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 382,584 |
| Mkap,ka | (Knm) | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 636,229 |
| Vkol | (Kn) | 107,302 | 98,817 | 97,822 | 96,206 | 96,206 | 96,206 | 99,323 | 96,847 | 118,989 | 172,198 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 493,066 |
| Tka | (Kn) | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 819,958 |
| Vj,h | (Kn) | 640,567 | 649,051 | 650,047 | 651,662 | 651,662 | 651,662 | 648,546 | 651,022 | 628,879 | 1140,826 |
| Vj,v | (Kn) | 640,567 | 649,051 | 1300,094 | 1303,324 | 1303,324 | 1303,324 | 1297,092 | 651,022 | 628,879 | 1140,826 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,307 | 1,325 | 2,031 | 2,036 | 2,036 | 2,036 | 2,027 | 1,329 | 1,283 | 2,328 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1350,940 | 1105,590 | 686,161 | 754,486 | 702,426 | 754,236 | 695,445 | 1111,270 | 1299,070 | 1299,210 |
| Nu/Ag | (N/mm²) | 2,757 | 2,256 | 2,144 | 2,358 | 2,195 | 2,357 | 2,173 | 2,268 | 2,651 | 2,651 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 165,611 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 127,007 | 127,127 |
| Vs,h | (Kn) | 474,956 | 649,051 | 650,047 | 651,662 | 651,662 | 651,662 | 648,546 | 651,022 | 501,872 | 1013,699 |
| Ajh | (mm²) | 1978,984 | 2704,379 | 2708,529 | 2715,259 | 2715,259 | 2715,259 | 2702,274 | 2712,591 | 2091,135 | 4223,746 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 6,299 | 8,608 | 8,621 | 8,643 | 8,643 | 8,643 | 8,602 | 8,634 | 6,656 | 13,445 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 454,982 | 448,009 | 445,783 | 452,456 | 448,215 | 452,436 | 445,506 | 449,671 | 444,018 | 805,489 |
| Vs,v | (Kn) | 185,585 | 201,042 | 854,311 | 850,868 | 855,109 | 850,889 | 851,586 | 201,351 | 184,861 | 335,337 |
| Aj,v | (mm²) | 463,961 | 502,605 | 2135,778 | 2127,170 | 2137,772 | 2127,221 | 2128,964 | 503,377 | 462,153 | 838,342 |
| jumlah tul | | 4,000 | 4,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 4,000 | 4,000 | 5,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 2412,749 | 2412,749 | 2412,749 | 2412,749 | 2412,749 | 804,250 | 804,250 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 46,182 | 46,182 | 46,182 | 46,182 | 46,182 | 178,667 | 178,667 | 130,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (3J11)1 | (3J12)1 | (3J13)1 | (3J14)1 | (3J15)1 | (3J16)1 | (3J17)1 | (3J18)1 | (3J19)1 | (3J20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,45 | 6,45 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,63 | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 233,63 | 233,63 | 233,63 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 473,711 | 443,821 | 443,821 | 378,969 | 443,821 | 443,821 | 473,711 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 592,139 | 554,776 | 554,776 | 473,711 | 554,776 | 554,776 | 592,139 | 554,776 |
| Vkol | (Kn) | 138,233 | 138,602 | 144,701 | 138,233 | 138,233 | 125,000 | 138,233 | 138,233 | 144,332 | 138,233 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 763,136 | 714,984 | 714,984 | 610,509 | 714,984 | 714,984 | 763,136 | 714,984 |
| Vj,h | (Kn) | 953,122 | 952,753 | 994,806 | 953,122 | 953,122 | 861,881 | 953,122 | 953,122 | 995,175 | 953,122 |
| Vj,v | (Kn) | 953,122 | 952,753 | 994,806 | 953,122 | 953,122 | 861,881 | 953,122 | 953,122 | 995,175 | 953,122 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,945 | 1,944 | 2,030 | 1,945 | 1,945 | 1,759 | 1,945 | 1,945 | 2,031 | 1,945 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4252,873 | 813,303 | 811,179 | 902,932 | 1394,859 | 1324,370 | 841,197 | 843,282 | 848,051 | 904,288 |
| Nu/Ag | ($N/mm^2$) | 8,679 | 1,660 | 1,655 | 1,843 | 2,847 | 2,703 | 1,717 | 1,721 | 1,731 | 1,845 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 812,037 | 0,000 | 0,000 | 0,000 | 192,332 | 147,107 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 141,086 | 952,753 | 994,806 | 953,122 | 760,791 | 714,773 | 953,122 | 953,122 | 995,175 | 953,122 |
| Ajh | ($mm^2$) | 587,857 | 3969,803 | 4145,024 | 3971,343 | 3169,961 | 2978,221 | 3971,343 | 3971,343 | 4146,564 | 3971,343 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 1,871 | 12,636 | 13,194 | 12,641 | 10,090 | 9,480 | 12,641 | 12,641 | 13,199 | 12,641 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 902,772 | 634,907 | 662,758 | 642,127 | 680,402 | 610,308 | 637,324 | 637,486 | 666,000 | 642,232 |
| Vs,v | (Kn) | 50,350 | 317,846 | 332,048 | 310,996 | 272,721 | 251,573 | 315,799 | 315,637 | 329,175 | 310,890 |
| Aj,v | ($mm^2$) | 125,876 | 794,615 | 830,119 | 777,489 | 681,802 | 628,932 | 789,497 | 789,092 | 822,939 | 777,225 |
| jumlah tul | | 2,000 | 4,000 | 5,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 5,000 | 4,000 |
| As pasang | ($mm^2$) | 402,125 | 804,250 | 1005,312 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1005,312 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 568,000 | 178,667 | 130,000 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 130,000 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,50 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 | 306,067 |
| Mnak, ka | (Knm) | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 | 508,983 |
| Mkap, ki | (Knm) | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 | 382,584 |
| Mkap,ka | (Knm) | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 | 636,229 |
| Vkol | (Kn) | 166,310 | 166,310 | 166,310 | 166,310 | 176,101 | 172,198 | 166,310 | 166,310 | 166,310 | 166,310 |
| Cki | (Kn) | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 | 493,066 |
| Tka | (Kn) | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 | 819,958 |
| Vj,h | (Kn) | 1146,714 | 1146,714 | 1146,714 | 1146,714 | 1136,923 | 1140,826 | 1146,714 | 1146,714 | 1146,714 | 1146,714 |
| Vj,v | (Kn) | 1146,714 | 1146,714 | 1146,714 | 1146,714 | 1136,923 | 1140,826 | 1146,714 | 1146,714 | 1146,714 | 1146,714 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,340 | 2,340 | 2,340 | 2,340 | 2,320 | 2,328 | 2,340 | 2,340 | 2,340 | 2,340 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 4252,873 | 813,303 | 811,179 | 902,932 | 1394,859 | 1324,370 | 841,197 | 843,282 | 848,051 | 904,288 |
| Nu/Ag | ($N/mm^2$) | 8,679 | 1,660 | 1,655 | 1,843 | 2,847 | 2,703 | 1,717 | 1,721 | 1,731 | 1,845 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 812,037 | 0,000 | 0,000 | 0,000 | 192,332 | 147,107 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 334,677 | 1146,714 | 1146,714 | 1146,714 | 944,591 | 993,719 | 1146,714 | 1146,714 | 1146,714 | 1146,714 |
| Ajh | ($mm^2$) | 1394,488 | 4777,974 | 4777,974 | 4777,974 | 3935,795 | 4140,494 | 4777,974 | 4777,974 | 4777,974 | 4777,974 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 4,439 | 15,209 | 15,209 | 15,209 | 12,528 | 13,180 | 15,209 | 15,209 | 15,209 | 15,209 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 1086,137 | 764,161 | 763,962 | 772,551 | 811,610 | 807,832 | 766,772 | 766,967 | 767,414 | 772,678 |
| Vs,v | (Kn) | 60,577 | 382,553 | 382,752 | 374,163 | 325,312 | 332,994 | 379,942 | 379,746 | 379,300 | 374,036 |
| Aj,v | ($mm^2$) | 151,443 | 956,382 | 956,879 | 935,407 | 813,280 | 832,484 | 949,854 | 949,366 | 948,250 | 935,089 |
| jumlah tul | | 2,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| As pasang | ($mm^2$) | 402,125 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 568,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (3J21)1 | (3J22)1 | (3J23)1 | (3J24)1 | (3J25)1 | (3J26)1 | (3J27)1 | (3J28)1 | (3J29)1 | (3J30)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,45 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,630 | 233,630 | 233,63 | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 233,63 |
| Mnak, ka | (Knm) | 443,821 | 378,969 | 443,821 | 443,821 | 473,711 | 443,821 | 443,821 | 378,969 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 473,711 | 554,776 | 554,776 | 592,139 | 554,776 | 554,776 | 473,711 | 554,776 | 554,776 |
| Vkol | (Kn) | 138,233 | 125,000 | 138,233 | 138,233 | 144,332 | 138,233 | 138,233 | 125,000 | 138,233 | 138,935 |
| Cki | (kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 610,509 | 714,984 | 714,984 | 763,136 | 714,984 | 714,984 | 610,509 | 714,984 | 714,984 |
| Vj,h | (Kn) | 953,122 | 861,881 | 953,122 | 953,122 | 995,175 | 953,122 | 953,122 | 861,881 | 953,122 | 952,420 |
| Vj,v | (Kn) | 953,122 | 861,881 | 953,122 | 953,122 | 995,175 | 953,122 | 953,122 | 861,881 | 953,122 | 952,420 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,945 | 1,759 | 1,945 | 1,945 | 2,031 | 1,945 | 1,945 | 1,759 | 1,945 | 1,944 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1454,122 | 1461,890 | 1390,370 | 1188,870 | 1233,700 | 1471,703 | 1568,316 | 1376,120 | 1394,759 | 698,922 |
| Nu/Ag | ($N/mm^2$) | 2,968 | 2,983 | 2,837 | 2,426 | 2,518 | 3,003 | 3,201 | 2,808 | 2,846 | 1,426 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 223,378 | 227,133 | 189,773 | 0,000 | 43,528 | 231,790 | 273,435 | 181,413 | 192,275 | 0,000 |
| Vs,h | (Kn) | 729,744 | 634,748 | 768,349 | 953,122 | 951,648 | 721,333 | 679,688 | 680,468 | 760,847 | 952,420 |
| Ajh | ($mm^2$) | 3040,602 | 2644,781 | 3180,621 | 3971,343 | 3965,198 | 3005,553 | 2832,032 | 2835,282 | 3170,197 | 3968,418 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,679 | 8,419 | 10,124 | 12,641 | 12,622 | 9,567 | 9,015 | 9,025 | 10,091 | 12,632 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 685,013 | 619,983 | 680,052 | 664,375 | 697,330 | 686,381 | 693,898 | 613,949 | 680,394 | 625,792 |
| Vs,v | (Kn) | 268,110 | 241,897 | 273,070 | 288,748 | 297,846 | 266,742 | 259,225 | 247,932 | 272,728 | 326,628 |
| Aj,v | ($mm^2$) | 670,274 | 604,743 | 682,675 | 721,870 | 744,615 | 666,854 | 648,062 | 619,829 | 681,821 | 816,570 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 5,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 130,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,50 |
| l ka | (m) | 2,00 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 6,5 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 306,067 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 508,983 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 361,482 | 361,482 | 361,482 |
| Mkap, ki | (Knm) | 382,584 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 636,229 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 451,853 | 451,853 | 451,853 |
| Vkol | (Kn) | 176,101 | 142,727 | 138,233 | 138,233 | 138,233 | 138,233 | 146,771 | 125,926 | 121,432 | 121,432 |
| Cki | (Kn) | 493,066 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 819,958 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 582,338 | 582,338 | 582,338 |
| Vj,h | (Kn) | 1136,923 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 832,783 | 837,278 | 837,278 |
| Vj,v | (Kn) | 1136,923 | 948,628 | 953,122 | 953,122 | 953,122 | 953,122 | 944,585 | 832,783 | 837,278 | 837,278 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,320 | 1,936 | 1,945 | 1,945 | 1,945 | 1,945 | 1,928 | 1,700 | 1,709 | 1,709 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 1454,122 | 1461,890 | 1390,370 | 1188,870 | 1233,700 | 1471,703 | 1568,316 | 1376,120 | 1394,759 | 698,922 |
| Nu/Ag | ($N/mm^2$) | 2,968 | 2,983 | 2,837 | 2,426 | 2,518 | 3,003 | 3,201 | 2,808 | 2,846 | 1,426 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 223,378 | 227,133 | 189,773 | 0,000 | 43,528 | 231,790 | 273,435 | 181,413 | 192,275 | 0,000 |
| Vs,h | (Kn) | 913,545 | 721,495 | 763,349 | 953,122 | 909,595 | 721,333 | 671,150 | 651,371 | 645,002 | 837,278 |
| Ajh | ($mm^2$) | 3806,436 | 3006,230 | 3180,621 | 3971,343 | 3789,978 | 3005,553 | 2796,458 | 2714,044 | 2687,510 | 3488,657 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 12,116 | 9,569 | 10,124 | 12,641 | 12,064 | 9,567 | 8,901 | 8,639 | 8,555 | 11,105 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 817,111 | 682,384 | 680,052 | 664,375 | 667,863 | 686,381 | 687,682 | 593,222 | 597,697 | 550,137 |
| Vs,v | (Kn) | 319,812 | 266,244 | 273,070 | 288,748 | 285,260 | 266,742 | 256,903 | 239,562 | 239,580 | 287,140 |
| Aj,v | ($mm^2$) | 799,530 | 665,610 | 682,675 | 721,870 | 713,150 | 666,854 | 642,257 | 598,904 | 598,951 | 717,851 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (3J31)1 | (3J32)1 | (3J33)1 | (3J34)1 | (3J35)1 | (3J36)2 | (3J37)2 | (3J38)2 | (3J39)2 | (3J40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 36 | 7,2 | 36,00 | 7,20 | 36 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 35,2 | 6,45 | 35,20 | 6,45 | 35,2 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| ln ka | (m) | 6,45 | 6,5 | 6,5 | 0,65 | 0,65 | 0 | 0 | 0 | 0 | 0 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,63 | 233,63 | 233,630 | 233,630 | 243,996 | 233,63 | 177,171 | 233,63 | 95,839 |
| Mnak, ka | (Knm) | 473,711 | 443,821 | 443,821 | 378,969 | 443,821 | 0 | 0 | 0 | 0 | 0 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 304,995 | 292,038 | 221,464 | 292,038 | 119,799 |
| Mkap,ka | (Knm) | 592,139 | 554,776 | 554,776 | 473,711 | 554,776 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 145,081 | 138,233 | 138,233 | 155,072 | 173,451 | 45,968 | 48,041 | 33,379 | 48,041 | 18,056 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 393,071 | 376,372 | 285,418 | 376,372 | 154,394 |
| Tka | (Kn) | 763,136 | 714,984 | 714,984 | 610,509 | 714,984 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vj,h | (Kn) | 994,426 | 953,122 | 953,122 | 831,808 | 917,904 | 347,103 | 328,330 | 252,039 | 328,330 | 136,338 |
| Vj,v | (Kn) | 994,426 | 953,122 | 953,122 | 831,808 | 917,904 | 694,206 | 656,660 | 504,078 | 656,660 | 272,677 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 2,029 | 1,945 | 1,945 | 1,698 | 1,873 | 1,085 | 1,026 | 0,788 | 1,026 | 0,426 |
| Vj,h< 1 .5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 704,364 | 1352,017 | 1334,726 | 1257,000 | 1219,273 | 638,570 | 672,946 | 640,871 | 673,053 | 623,203 |
| Nu/Ag | ($N/mm^2$) | 1,437 | 2,759 | 2,724 | 2,565 | 2,488 | 1,996 | 2,103 | 2,003 | 2,103 | 1,948 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 166,317 | 154,583 | 83,480 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 994,426 | 786,805 | 798,539 | 748,329 | 917,904 | 347,103 | 328,330 | 252,039 | 328,330 | 136,338 |
| Ajh | ($mm^2$) | 4143,442 | 3278,354 | 3327,248 | 3118,036 | 3824,601 | 1446,262 | 1368,043 | 1050,163 | 1368,043 | 568,076 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 13,189 | 10,435 | 10,591 | 9,925 | 12,174 | 4,604 | 4,355 | 3,343 | 4,355 | 1,808 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 653,834 | 677,068 | 675,723 | 584,439 | 642,104 | 235,968 | 224,617 | 171,414 | 224,621 | 92,424 |
| Vs,v | (Kn) | 340,592 | 276,054 | 277,399 | 247,370 | 275,800 | 458,238 | 432,044 | 332,664 | 432,039 | 180,253 |
| Aj,v | ($mm^2$) | 851,480 | 690,135 | 693,498 | 618,424 | 689,501 | 1145,594 | 1080,109 | 831,661 | 1080,098 | 450,632 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 6,000 | 6,000 | 6,000 | 6,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1206,374 | 1206,374 | 1206,374 | 1206,374 | 804,250 |
| As pasang >Aj,v | | Tdk Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 120,800 | 120,800 | 120,800 | 120,800 | 212,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 1 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 0,65 | 6,5 | 3,2 | 3,2 | 3,2 | 3,2 | 3,20 |
| l ka | (m) | 7,20 | 7,2 | 2 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ka | (m) | 6,50 | 6,5 | 1,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 361,482 | 361,482 | 361,482 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 451,853 | 451,853 | 451,853 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 121,432 | 121,432 | 128,386 | 107,302 | 98,817 | 96,206 | 96,206 | 96,206 | 96,206 | 99,323 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 582,338 | 582,338 | 582,338 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 |
| Vj,h | (Kn) | 837,278 | 837,278 | 830,324 | 640,567 | 649,051 | 651,662 | 651,662 | 651,662 | 651,662 | 648,546 |
| Vj,v | (Kn) | 837,278 | 837,278 | 830,324 | 640,567 | 649,051 | 1303,324 | 1303,324 | 1303,324 | 1303,324 | 1297,092 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,709 | 1,709 | 1,695 | 1,307 | 1,325 | 1,330 | 1,330 | 1,330 | 1,330 | 1,324 |
| Vj,h< 1 .5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 704,364 | 1352,017 | 1334,726 | 1257,000 | 1219,273 | 638,570 | 672,946 | 640,871 | 673,053 | 623,203 |
| Nu/Ag | ($N/mm^2$) | 1,437 | 2,759 | 2,724 | 2,565 | 2,488 | 1,996 | 2,103 | 2,003 | 2,103 | 1,948 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 166,317 | 154,583 | 83,480 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 837,278 | 670,960 | 675,741 | 557,087 | 649,051 | 651,662 | 651,662 | 651,662 | 651,662 | 648,546 |
| Ajh | ($mm^2$) | 3488,657 | 2795,668 | 2815,587 | 2321,196 | 2704,379 | 2715,259 | 2715,259 | 2715,259 | 2715,259 | 2702,274 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 11,105 | 8,899 | 8,962 | 7,389 | 8,608 | 8,643 | 8,643 | 8,643 | 8,643 | 8,602 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 550,509 | 594,776 | 588,664 | 450,070 | 454,032 | 443,014 | 445,814 | 443,201 | 445,823 | 439,649 |
| Vs,v | (Kn) | 286,768 | 242,502 | 241,660 | 190,497 | 195,019 | 860,310 | 857,510 | 860,123 | 857,502 | 857,442 |
| Aj,v | ($mm^2$) | 716,921 | 606,254 | 604,149 | 476,242 | 487,547 | 2150,776 | 2143,776 | 2150,307 | 2143,754 | 2143,605 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 2412,749 | 2412,749 | 2412,749 | 2412,749 | 2412,749 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 46,182 | 46,182 | 46,182 | 46,182 | 46,182 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (3J41)1 | (3J42)1 |
|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 1,00 | 1,00 |
| ln ka | (m) | 0,65 | 0,65 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 233,63 | 233,63 |
| Mnak, ka | (Knm) | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 |
| Vkol | (Kn) | 173,451 | 173,451 |
| Cki | (Kn) | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 |
| Vj,h | (Kn) | 917,904 | 917,904 |
| Vj,v | (Kn) | 917,904 | 917,904 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,873 | 1,873 |
| Vj,h< 1 ..5 $\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 1028,894 | 1128,191 |
| Nu/Ag | ($N/mm^2$) | 2,100 | 2,302 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 917,904 | 917,904 |
| Ajh | ($mm^2$) | 3824,601 | 3824,601 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 12,174 | 12,174 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 627,839 | 635,279 |
| Vs,v | (Kn) | 290,066 | 282,625 |
| Aj,v | ($mm^2$) | 725,164 | 706,563 |
| jumlah tul | | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 212,000 | 212,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 1,00 |
| ln ka | (m) | 6,50 | 0,65 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 4,50 | 4,50 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 382,200 | 382,200 |
| Vkol | (Kn) | 96,847 | 118,939 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 492,571 | 492,571 |
| Vj,h | (Kn) | 651,022 | 628,879 |
| Vj,v | (Kn) | 651,022 | 628,879 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,329 | 1,283 |
| Vj,h< 1 ..5 $\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 1028,894 | 1128,191 |
| Nu/Ag | ($N/mm^2$) | 2,100 | 2,302 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 651,022 | 628,879 |
| Ajh | ($mm^2$) | 2712,591 | 2620,331 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 8,634 | 8,341 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 445,293 | 435,246 |
| Vs,v | (Kn) | 205,729 | 193,634 |
| Aj,v | ($mm^2$) | 514,321 | 484,084 |
| jumlah tul | | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 212,000 | 212,000 |

**Pertemuan Balok Kolom Lantai 4**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 16 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 58 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (4J1)1 | (4J2)1 | (4J3)2 | (4J4)2 | (4J5)2 | (4J6)2 | (4J7)2 | (4J8)1 | (4J9)1 | (4J10)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 2,00 | 2,00 | 2 | 2 | 2 | 2 | 2 | 2,00 | 2,00 | 7,2 |
| ln ki | (m) | 1,65 | 1,65 | 1,6 | 1,6 | 1,6 | 1,6 | 1,6 | 1,65 | 1,65 | 6,5 |
| l ka | (m) | 7,20 | 21,6 | 36 | 7,2 | 36 | 7,2 | 36 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 20,9 | 35,2 | 6,45 | 35,2 | 6,45 | 35,2 | 6,45 | 6,5 | 6,5 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 138,318 | 233,630 | 138,318 | 233,630 | 138,318 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 215,585 | 378,969 | 215,585 | 378,969 | 215,585 | 378,969 | 146,933 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 172,898 | 292,038 | 172,898 | 292,038 | 172,898 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 269,481 | 473,711 | 269,481 | 473,711 | 269,481 | 473,711 | 183,666 | 473,711 |
| Vkol | (Kn) | 123,020 | 118,099 | 68,842 | 125,138 | 68,842 | 125,138 | 68,842 | 123,589 | 78,040 | 118,750 |
| Cki | (Kn) | 376,372 | 376,372 | 222,827 | 376,372 | 222,827 | 376,372 | 222,827 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,509 | 347,302 | 610,509 | 347,302 | 610,509 | 347,302 | 610,509 | 236,705 | 610,509 |
| Vj,h | (Kn) | 863,861 | 868,782 | 501,286 | 861,743 | 501,286 | 861,743 | 501,286 | 863,291 | 535,036 | 868,131 |
| Vj,v | (Kn) | 863,861 | 868,782 | 1002,573 | 1723,485 | 1002,573 | 1723,485 | 1002,573 | 863,291 | 535,036 | 868,131 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,763 | 1,773 | 1,567 | 2,693 | 1,567 | 2,693 | 1,567 | 1,762 | 1,092 | 1,772 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 813,305 | 639,319 | 381,132 | 420,297 | 391,720 | 435,822 | 390,385 | 607,284 | 753,880 | 716,726 |
| Nu/Ag | (N/mm²) | 1,660 | 1,305 | 1,191 | 1,313 | 1,224 | 1,362 | 1,220 | 1,239 | 1,539 | 1,463 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 863,861 | 868,782 | 501,286 | 861,743 | 501,286 | 861,743 | 501,286 | 863,291 | 535,036 | 868,131 |
| Ajh | (mm²) | 3599,420 | 3619,924 | 2088,693 | 3590,595 | 2088,693 | 3590,595 | 2088,693 | 3597,048 | 2229,319 | 3617,210 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 11,457 | 11,523 | 6,649 | 11,429 | 6,649 | 11,429 | 6,649 | 11,450 | 7,096 | 11,514 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 575,670 | 566,610 | 324,654 | 562,319 | 325,317 | 563,991 | 325,234 | 560,772 | 353,949 | 571,671 |
| Vs,v | (Kn) | 288,191 | 302,172 | 677,919 | 1161,166 | 677,255 | 1159,494 | 677,339 | 302,520 | 181,088 | 296,459 |
| Aj,v | (mm²) | 720,477 | 755,429 | 1694,797 | 2902,916 | 1693,138 | 2898,735 | 1693,348 | 756,299 | 452,719 | 741,149 |
| jumlah tul | | 4,000 | 4,000 | 9,000 | 15,000 | 9,000 | 15,000 | 9,000 | 4,000 | 4,000 | 4,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 1809,562 | 3015,936 | 1809,562 | 3015,936 | 1809,562 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 69,500 | 32,857 | 69,500 | 32,857 | 69,500 | 178,667 | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 2,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,00 |
| ln ki | (m) | 1,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 1,65 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2 | 36,00 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 1,65 | 35,30 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 554,776 |
| Vkol | (Kn) | 123,020 | 123,567 | 122,868 | 120,605 | 120,605 | 120,605 | 124,275 | 121,720 | 125,676 | 128,767 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 714,984 |
| Vj,h | (Kn) | 863,861 | 863,313 | 864,013 | 866,275 | 866,275 | 866,275 | 862,606 | 865,161 | 861,205 | 962,589 |
| Vj,v | (Kn) | 863,861 | 863,313 | 1728,026 | 1732,550 | 1732,550 | 1732,550 | 1725,211 | 865,161 | 861,205 | 962,589 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,763 | 1,762 | 2,700 | 2,707 | 2,707 | 2,707 | 2,696 | 1,766 | 1,758 | 1,964 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 813,305 | 639,319 | 381,132 | 420,297 | 391,720 | 435,822 | 390,385 | 607,284 | 753,880 | 716,726 |
| Nu/Ag | (N/mm²) | 1,660 | 1,305 | 1,191 | 1,313 | 1,224 | 1,362 | 1,220 | 1,239 | 1,539 | 1,463 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 863,861 | 863,313 | 864,013 | 866,275 | 866,275 | 866,275 | 862,606 | 865,161 | 861,205 | 962,589 |
| Ajh | (mm²) | 3599,420 | 3597,139 | 3600,054 | 3609,479 | 3609,479 | 3609,479 | 3594,190 | 3604,837 | 3588,353 | 4010,786 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 11,457 | 11,450 | 11,459 | 11,489 | 11,489 | 11,489 | 11,441 | 11,475 | 11,422 | 12,767 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 575,670 | 563,044 | 559,571 | 565,277 | 562,182 | 566,958 | 559,657 | 561,986 | 569,722 | 633,873 |
| Vs,v | (Kn) | 288,191 | 300,270 | 1168,455 | 1167,273 | 1170,368 | 1165,592 | 1165,554 | 303,175 | 291,482 | 328,716 |
| Aj,v | (mm²) | 720,477 | 750,674 | 2921,138 | 2918,184 | 2925,920 | 2913,981 | 2913,886 | 757,937 | 728,706 | 821,790 |
| jumlah tul | | 4,000 | 4,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 4,000 | 4,000 | 5,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 3015,936 | 3015,936 | 3015,936 | 3015,936 | 3015,936 | 804,250 | 804,250 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 32,857 | 32,857 | 32,857 | 32,857 | 32,857 | 178,667 | 178,667 | 130,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (4J11)1 | (4J12)1 | (4J13)1 | (4J14)1 | (4J15)1 | (4J16)1 | (4J17)1 | (4J18)1 | (4J19)1 | (4J20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 5,00 | 5,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 378,969 | 378,969 | 146,933 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 473,711 | 473,711 | 183,666 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 237,500 | 237,500 | 237,500 | 237,500 | 73,771 | 118,750 | 237,500 | 237,500 | 237,500 | 237,500 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 610,509 | 610,509 | 610,509 | 236,705 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 |
| Vj,h | (Kn) | 749,381 | 749,381 | 749,381 | 749,381 | 539,306 | 868,131 | 749,381 | 749,381 | 749,381 | 749,381 |
| Vj,v | (Kn) | 749,381 | 749,381 | 749,381 | 749,381 | 539,306 | 868,131 | 749,381 | 749,381 | 749,381 | 749,381 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,529 | 1,529 | 1,529 | 1,529 | 1,101 | 1,772 | 1,529 | 1,529 | 1,529 | 1,529 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 317,098 | 313,333 | 310,154 | 387,451 | 834,782 | 729,817 | 318,478 | 334,138 | 325,216 | 379,955 |
| Nu/Ag | ($N/mm^2$) | 0,647 | 0,639 | 0,633 | 0,791 | 1,704 | 1,489 | 0,650 | 0,682 | 0,664 | 0,775 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 749,381 | 749,381 | 749,381 | 749,381 | 539,306 | 868,131 | 749,381 | 749,381 | 749,381 | 749,381 |
| Ajh | ($mm^2$) | 3122,419 | 3122,419 | 3122,419 | 3122,419 | 2247,109 | 3617,210 | 3122,419 | 3122,419 | 3122,419 | 3122,419 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,939 | 9,939 | 9,939 | 9,939 | 7,153 | 11,514 | 9,939 | 9,939 | 9,939 | 9,939 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 469,026 | 468,796 | 468,602 | 473,330 | 360,335 | 572,599 | 469,111 | 470,069 | 469,523 | 472,872 |
| Vs,v | (Kn) | 280,354 | 280,584 | 280,779 | 276,050 | 178,971 | 295,532 | 280,270 | 279,312 | 279,857 | 276,509 |
| Aj,v | ($mm^2$) | 700,885 | 701,461 | 701,947 | 690,126 | 447,428 | 738,829 | 700,674 | 698,279 | 699,644 | 691,272 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,50 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 5,00 | 5,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 |
| Vkol | (Kn) | 262,643 | 262,643 | 262,643 | 262,643 | 139,432 | 135,591 | 262,643 | 262,643 | 262,643 | 262,643 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 |
| Vj,h | (Kn) | 828,713 | 828,713 | 828,713 | 828,713 | 951,923 | 955,764 | 828,713 | 828,713 | 828,713 | 828,713 |
| Vj,v | (Kn) | 828,713 | 828,713 | 828,713 | 828,713 | 951,923 | 955,764 | 828,713 | 828,713 | 828,713 | 828,713 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,691 | 1,691 | 1,691 | 1,691 | 1,943 | 1,951 | 1,691 | 1,691 | 1,691 | 1,691 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 317,098 | 313,333 | 310,154 | 387,451 | 834,782 | 729,817 | 318,478 | 334,138 | 325,216 | 379,955 |
| Nu/Ag | ($N/mm^2$) | 0,647 | 0,639 | 0,633 | 0,791 | 1,704 | 1,489 | 0,650 | 0,682 | 0,664 | 0,775 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 828,713 | 828,713 | 828,713 | 828,713 | 951,923 | 955,764 | 828,713 | 828,713 | 828,713 | 828,713 |
| Ajh | ($mm^2$) | 3452,970 | 3452,970 | 3452,970 | 3452,970 | 3966,347 | 3982,352 | 3452,970 | 3452,970 | 3452,970 | 3452,970 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 10,991 | 10,991 | 10,991 | 10,991 | 12,625 | 12,676 | 10,991 | 10,991 | 10,991 | 10,991 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 518,679 | 518,425 | 518,210 | 523,439 | 636,023 | 630,400 | 518,773 | 519,832 | 519,229 | 522,932 |
| Vs,v | (Kn) | 310,033 | 310,288 | 310,503 | 305,274 | 315,900 | 325,364 | 309,940 | 308,881 | 309,484 | 305,781 |
| Aj,v | ($mm^2$) | 775,084 | 775,720 | 776,258 | 763,185 | 789,750 | 813,411 | 774,850 | 772,202 | 773,711 | 764,453 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 5,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1005,312 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 130,000 | 178,667 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (4J21)1 | (4J22)1 | (4J23)1 | (4J24)1 | (4J25)1 | (4J26)1 | (4J27)1 | (4J28)1 | (4J29)1 | (4J30)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,20 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,50 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,45 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 146,933 | 378,969 | 378,969 | 378,969 | 378,969 | 378,969 | 146,933 | 378,969 | 378,969 | 378,969 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 183,666 | 473,711 | 473,711 | 473,711 | 473,711 | 473,711 | 183,666 | 473,711 | 473,711 | 473,711 |
| Vkol | (Kn) | 73,771 | 118,750 | 118,750 | 118,750 | 118,750 | 118,750 | 73,771 | 118,750 | 118,750 | 238,639 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 236,705 | 610,509 | 610,509 | 610,509 | 610,509 | 610,509 | 236,705 | 610,509 | 610,509 | 610,509 |
| Vj,h | (Kn) | 539,306 | 868,131 | 868,131 | 868,131 | 868,131 | 868,131 | 539,306 | 868,131 | 868,131 | 748,242 |
| Vj,v | (Kn) | 539,306 | 868,131 | 868,131 | 868,131 | 868,131 | 868,131 | 539,306 | 868,131 | 868,131 | 748,242 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,101 | 1,772 | 1,772 | 1,772 | 1,772 | 1,772 | 1,101 | 1,772 | 1,772 | 1,527 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 842,818 | 815,732 | 752,842 | 642,276 | 674,177 | 836,834 | 930,145 | 746,603 | 774,718 | 310,626 |
| Nu/Ag | ($N/mm^2$) | 1,720 | 1,665 | 1,536 | 1,311 | 1,376 | 1,708 | 1,898 | 1,524 | 1,581 | 0,634 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 539,306 | 868,131 | 868,131 | 868,131 | 868,131 | 868,131 | 539,306 | 868,131 | 868,131 | 748,242 |
| Ajh | ($mm^2$) | 2247,109 | 3617,210 | 3617,210 | 3617,210 | 3617,210 | 3617,210 | 2247,109 | 3617,210 | 3617,210 | 3117,673 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 7,153 | 11,514 | 11,514 | 11,514 | 11,514 | 11,514 | 7,153 | 11,514 | 11,514 | 9,924 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 360,689 | 578,687 | 574,231 | 566,395 | 568,656 | 580,183 | 364,533 | 573,788 | 575,781 | 467,918 |
| Vs,v | (Kn) | 178,617 | 289,443 | 293,900 | 301,736 | 299,475 | 287,948 | 174,773 | 294,342 | 292,350 | 280,323 |
| Aj,v | ($mm^2$) | 446,543 | 723,608 | 734,750 | 754,339 | 748,687 | 719,869 | 436,932 | 735,855 | 730,874 | 700,808 |
| jumlah tul | | 3,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 603,187 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 276,000 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,20 |
| ln ki | (m) | 6,50 | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,50 |
| l ka | (m) | 2,00 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2 | 7,2 | 7,2 | 7,20 |
| ln ka | (m) | 1,65 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 1,65 | 6,5 | 6,5 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 | 443,821 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 | 554,776 |
| Vkol | (Kn) | 139,432 | 135,591 | 131,321 | 131,321 | 131,321 | 131,321 | 139,432 | 135,591 | 131,321 | 262,643 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 | 714,984 |
| Vj,h | (Kn) | 951,923 | 955,764 | 960,034 | 960,034 | 960,034 | 960,034 | 951,923 | 955,764 | 960,034 | 828,713 |
| Vj,v | (Kn) | 951,923 | 955,764 | 960,034 | 960,034 | 960,034 | 960,034 | 951,923 | 955,764 | 960,034 | 828,713 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,943 | 1,951 | 1,959 | 1,959 | 1,959 | 1,959 | 1,943 | 1,951 | 1,959 | 1,691 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 842,818 | 815,732 | 752,842 | 642,276 | 674,177 | 836,834 | 930,145 | 746,603 | 774,718 | 310,626 |
| Nu/Ag | ($N/mm^2$) | 1,720 | 1,665 | 1,536 | 1,311 | 1,376 | 1,708 | 1,898 | 1,524 | 1,581 | 0,634 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 951,923 | 955,764 | 960,034 | 960,034 | 960,034 | 951,923 | 955,764 | 960,034 | 828,713 | |
| Ajh | ($mm^2$) | 3966,347 | 3982,352 | 4000,142 | 4000,142 | 4000,142 | 4000,142 | 3966,347 | 3982,352 | 4000,142 | 3452,970 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 12,625 | 12,676 | 12,733 | 12,733 | 12,733 | 12,733 | 12,625 | 12,676 | 12,733 | 10,991 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 571,219 | 573,522 | 576,079 | 576,071 | 576,073 | 576,086 | 571,226 | 573,517 | 576,081 | 497,249 |
| Vs,v | (Kn) | 380,704 | 382,242 | 383,955 | 383,963 | 383,961 | 383,948 | 380,697 | 382,248 | 383,953 | 331,464 |
| Aj,v | ($mm^2$) | 951,759 | 955,605 | 959,887 | 959,908 | 959,902 | 959,870 | 951,742 | 955,619 | 959,882 | 828,660 |
| jumlah tul | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| As pasang | ($mm^2$) | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 | 130,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (4J31)1 | (4J32)1 | (4J33)1 | (4J34)1 | (4J35)1 | (4J36)2 | (4J37)2 | (4J38)2 | (4J39)2 | (4J40)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 36 | 7,2 | 36,00 | 7,20 | 36 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 35,2 | 6,45 | 35,20 | 6,45 | 35,2 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ln ka | (m) | 6,45 | 6,5 | 6,5 | 1,65 | 1,65 | 1,6 | 1,6 | 1,6 | 1,6 | 1,6 |
| tinggi, a | (m) | 0,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 233,630 | 233,630 | 138,318 | 233,630 | 138,318 | 233,630 | 138,318 |
| Mnak, ka | (Knm) | 378,969 | 378,969 | 146,933 | 378,969 | 378,969 | 215,585 | 378,969 | 215,585 | 378,969 | 215,585 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 292,038 | 292,038 | 172,898 | 292,038 | 172,898 | 292,038 | 172,898 |
| Mkap,ka | (Knm) | 473,711 | 473,711 | 183,666 | 473,711 | 473,711 | 269,481 | 473,711 | 269,481 | 473,711 | 269,481 |
| Vkol | (Kn) | 238,639 | 118,750 | 73,771 | 125,676 | 125,676 | 71,915 | 128,539 | 71,915 | 128,539 | 71,915 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 376,372 | 376,372 | 222,827 | 376,372 | 222,827 | 376,372 | 222,827 |
| Tka | (Kn) | 610,509 | 610,509 | 236,705 | 610,509 | 610,509 | 347,302 | 610,509 | 347,302 | 610,509 | 347,302 |
| Vj,h | (Kn) | 748,242 | 868,131 | 539,306 | 861,205 | 861,205 | 498,213 | 858,342 | 498,213 | 858,342 | 498,213 |
| Vj,v | (Kn) | 748,242 | 868,131 | 539,306 | 861,205 | 861,205 | 996,426 | 1716,683 | 996,426 | 1716,683 | 996,426 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,527 | 1,772 | 1,101 | 1,758 | 1,758 | 1,557 | 2,682 | 1,557 | 2,682 | 1,557 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 315,645 | 830,167 | 795,372 | 668,850 | 653,132 | 360,208 | 392,399 | 368,257 | 379,698 | 366,320 |
| Nu/Ag | ($N/mm^2$) | 0,644 | 1,694 | 1,623 | 1,365 | 1,333 | 1,126 | 1,226 | 1,151 | 1,187 | 1,145 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 748,242 | 868,131 | 539,306 | 861,205 | 861,205 | 498,213 | 858,342 | 498,213 | 858,342 | 498,213 |
| Ajh | ($mm^2$) | 3117,673 | 3617,210 | 2247,109 | 3588,353 | 3588,353 | 2075,888 | 3576,424 | 2075,888 | 3576,424 | 2075,888 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 9,924 | 11,514 | 7,153 | 11,422 | 11,422 | 6,608 | 11,384 | 6,608 | 11,384 | 6,608 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 468,225 | 579,710 | 358,600 | 563,745 | 562,640 | 321,360 | 557,107 | 321,862 | 555,744 | 321,741 |
| Vs,v | (Kn) | 280,017 | 288,420 | 180,706 | 297,460 | 298,565 | 675,066 | 1159,577 | 674,565 | 1160,939 | 674,685 |
| Aj,v | ($mm^2$) | 700,042 | 721,050 | 451,765 | 743,650 | 746,413 | 1687,665 | 2898,942 | 1686,412 | 2902,349 | 1686,713 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 12,000 | 15,000 | 12,000 | 15,000 | 12,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 2412,749 | 3015,936 | 2412,749 | 3015,936 | 2412,749 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 46,182 | 32,857 | 46,182 | 32,857 | 46,182 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,00 | 7 | 7 | 2 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ki | (m) | 6,50 | 6,5 | 6,5 | 1,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,20 |
| l ka | (m) | 7,20 | 7,2 | 2 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ka | (m) | 6,50 | 6,5 | 1,65 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 |
| tinggi, a | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 | 233,630 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 443,821 | 443,821 | 443,821 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 292,038 | 292,038 | 292,038 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 554,776 | 554,776 | 554,776 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 | 382,200 |
| Vkol | (Kn) | 130,063 | 130,063 | 138,174 | 92,886 | 93,877 | 92,930 | 91,396 | 91,396 | 91,396 | 94,357 |
| Cki | (Kn) | 376,372 | 376,372 | 376,372 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 714,984 | 714,984 | 714,984 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 | 492,571 |
| Vj,h | (Kn) | 961,292 | 961,292 | 953,181 | 654,982 | 653,992 | 654,938 | 656,472 | 656,472 | 656,472 | 653,512 |
| Vj,v | (Kn) | 961,292 | 961,292 | 953,181 | 654,982 | 653,992 | 1309,876 | 1312,945 | 1312,945 | 1312,945 | 1307,024 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,962 | 1,962 | 1,945 | 1,337 | 1,335 | 2,047 | 2,051 | 2,051 | 2,051 | 2,042 |
| Vj,h< 1 ,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 315,645 | 830,167 | 795,372 | 668,850 | 653,132 | 360,208 | 392,399 | 368,257 | 379,698 | 366,320 |
| Nu/Ag | ($N/mm^2$) | 0,644 | 1,694 | 1,623 | 1,365 | 1,333 | 1,126 | 1,226 | 1,151 | 1,187 | 1,145 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 961,292 | 961,292 | 953,181 | 654,982 | 653,992 | 654,938 | 656,472 | 656,472 | 656,472 | 653,512 |
| Ajh | ($mm^2$) | 4005,383 | 4005,383 | 3971,588 | 2729,093 | 2724,966 | 2728,908 | 2735,302 | 2735,302 | 2735,302 | 2722,966 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 12,750 | 12,750 | 12,642 | 8,687 | 8,674 | 8,686 | 8,707 | 8,707 | 8,707 | 8,667 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 601,545 | 641,921 | 633,797 | 428,751 | 427,264 | 422,452 | 426,083 | 424,102 | 425,041 | 422,031 |
| Vs,v | (Kn) | 359,747 | 319,371 | 319,384 | 226,231 | 226,728 | 887,424 | 886,861 | 888,843 | 887,904 | 884,992 |
| Aj,v | ($mm^2$) | 899,368 | 798,428 | 798,460 | 565,577 | 566,820 | 2218,560 | 2217,154 | 2222,106 | 2219,759 | 2212,481 |
| jumlah tul | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| As pasang | ($mm^2$) | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 1005,312 | 2412,749 | 2412,749 | 2412,749 | 2412,749 | 2412,749 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 155,000 | 155,000 | 155,000 | 155,000 | 155,000 | 46,182 | 46,182 | 46,182 | 46,182 | 46,182 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (4,J41)1 | (4,J42)1 |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 2,00 |
| ln ka | (m) | 6,50 | 1,65 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 233,630 |
| Mnak, ka | (Knm) | 378,969 | 146,933 |
| Mkap, ki | (Knm) | 292,038 | 292,038 |
| Mkap,ka | (Knm) | 473,711 | 183,666 |
| Vkol | (Kn) | 121,720 | 76,456 |
| Ckt | (Kn) | 376,372 | 376,372 |
| Tka | (Kn) | 610,509 | 236,705 |
| Vj,h | (Kn) | 865,161 | 536,621 |
| Vj,v | (Kn) | 865,161 | 536,621 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,766 | 1,095 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 587,606 | 689,654 |
| Nu/Ag | ($N/mm^2$) | 1,199 | 1,407 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 865,161 | 536,621 |
| Ajh | ($mm^2$) | 3604,837 | 2235,920 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 11,475 | 7,117 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 560,596 | 352,183 |
| Vs,v | (Kn) | 304,564 | 184,438 |
| Aj,v | ($mm^2$) | 761,411 | 461,094 |
| jumlah tul | | 4,000 | 3,000 |
| As pasang | ($mm^2$) | 804,250 | 603,187 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 212,000 | 326,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 7,00 | 7,00 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 7,20 | 7,20 |
| ln ka | (m) | 6,50 | 6,50 |
| tinggi, a | (m) | 5,00 | 5,00 |
| tinggi, b | (m) | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 305,760 | 305,760 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 382,200 | 382,200 |
| Vkol | (Kn) | 89,137 | 89,137 |
| Ckt | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 492,571 | 492,571 |
| Vj,h | (Kn) | 658,732 | 658,732 |
| Vj,v | (Kn) | 658,732 | 658,732 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,344 | 1,344 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 587,606 | 689,654 |
| Nu/Ag | ($N/mm^2$) | 1,199 | 1,407 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 658,732 | 658,732 |
| Ajh | ($mm^2$) | 2744,716 | 2744,716 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 8,737 | 8,737 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 426,837 | 432,325 |
| Vs,v | (Kn) | 231,895 | 226,407 |
| Aj,v | ($mm^2$) | 579,737 | 566,018 |
| jumlah tul | | 3,000 | 3,000 |
| As pasang | ($mm^2$) | 603,187 | 603,187 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 326,000 | 326,000 |

## Pertemuan Balok Kolom Lantai Atap

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 16 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 58 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

### A. Pertemuan Balok Kolom Luar

**1.Perhitungan gaya dalam**

| Keterangan | | (AJ1)1 | (AJ2)1 | (AJ3)2 | (AJ4)2 | (AJ5)2 | (AJ6)2 | (AJ7)2 | (AJ8)1 | (AJ9)1 | (AJ10)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 2,50 | 2,50 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,50 | 2,50 | 7,2 |
| ln ki | (m) | 2,15 | 2,15 | 2,1 | 2,1 | 2,1 | 2,1 | 2,1 | 2,15 | 2,15 | 6,5 |
| l ka | (m) | 7,20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,5 | 6,5 |
| tinggi, a | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 95,839 | 158,474 | 95,839 | 158,474 | 95,839 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 225,960 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 225,96 | 225,960 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 119,799 | 198,093 | 119,799 | 198,093 | 119,799 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 282,450 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 282,450 | 282,450 |
| Vkol | (Kn) | 101,399 | 42,997 | 26,622 | 44,021 | 26,622 | 44,021 | 26,622 | 42,997 | 101,399 | 99,361 |
| Cki | (Kn) | 255,297 | 255,297 | 154,394 | 255,297 | 154,394 | 255,297 | 154,394 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 364,015 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 364,015 | 364,015 |
| Vj,h | (Kn) | 517,914 | 212,301 | 127,772 | 211,277 | 127,772 | 211,277 | 127,772 | 212,301 | 517,914 | 519,951 |
| Vj,v | (Kn) | 517,914 | 212,301 | 255,544 | 422,554 | 255,544 | 422,554 | 255,544 | 212,301 | 517,914 | 519,951 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,057 | 0,433 | 0,399 | 0,660 | 0,399 | 0,660 | 0,399 | 0,433 | 1,057 | 1,061 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 317,604 | 226,287 | 170,416 | 151,784 | 166,455 | 145,864 | 165,464 | 218,786 | 312,535 | 248,953 |
| Nu/Ag | (N/mm²) | 0,648 | 0,462 | 0,533 | 0,474 | 0,520 | 0,456 | 0,517 | 0,447 | 0,638 | 0,508 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 517,914 | 212,301 | 127,772 | 211,277 | 127,772 | 211,277 | 127,772 | 212,301 | 517,914 | 519,951 |
| Ajh | (mm²) | 2157,975 | 884,585 | 532,384 | 880,320 | 532,384 | 880,320 | 532,384 | 884,585 | 2157,975 | 2166,464 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 6,869 | 2,816 | 1,695 | 2,802 | 1,695 | 2,802 | 1,695 | 2,816 | 6,869 | 6,896 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 324,176 | 131,302 | 79,385 | 130,775 | 79,322 | 130,618 | 79,306 | 131,172 | 323,962 | 322,538 |
| Vs,v | (Kn) | 193,738 | 80,999 | 176,159 | 291,779 | 176,222 | 291,935 | 176,233 | 81,129 | 193,952 | 197,414 |
| Aj,v | (mm²) | 484,344 | 202,496 | 440,398 | 729,447 | 440,556 | 729,838 | 440,596 | 202,821 | 484,880 | 493,534 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 212,000 | 212,000 | 212,000 | 212,000 | 212,000 | 178,667 | 178,667 | 178,667 |

### B. Pertemuan Balok Kolom Dalam

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 2,50 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,50 |
| ln ki | (m) | 2,15 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 2,15 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 2,5 | 0,00 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 2,15 | 0,00 |
| tinggi, a | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 0,000 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 0,000 |
| Vkol | (Kn) | 101,399 | 103,191 | 102,960 | 100,914 | 100,914 | 100,914 | 103,831 | 102,047 | 102,266 | 42,997 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 0,000 |
| Vj,h | (Kn) | 517,914 | 516,122 | 516,353 | 518,399 | 518,399 | 518,399 | 515,482 | 517,266 | 517,046 | 212,301 |
| Vj,v | (Kn) | 517,914 | 516,122 | 1032,706 | 1036,798 | 1036,798 | 1036,798 | 1030,964 | 517,266 | 517,046 | 212,301 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,057 | 1,053 | 1,614 | 1,620 | 1,620 | 1,620 | 1,611 | 1,056 | 1,055 | 0,433 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 317,604 | 226,287 | 170,416 | 151,784 | 166,455 | 145,864 | 165,464 | 218,786 | 312,535 | 248,953 |
| Nu/Ag | (N/mm²) | 0,648 | 0,462 | 0,533 | 0,474 | 0,520 | 0,456 | 0,517 | 0,447 | 0,638 | 0,508 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 517,914 | 516,122 | 516,353 | 518,399 | 518,399 | 518,399 | 515,482 | 517,266 | 517,046 | 212,301 |
| Ajh | (mm²) | 2157,975 | 2150,507 | 2151,471 | 2159,995 | 2159,995 | 2159,995 | 2147,841 | 2155,273 | 2154,360 | 884,585 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 6,869 | 6,845 | 6,848 | 6,875 | 6,875 | 6,875 | 6,837 | 6,860 | 6,858 | 2,816 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 324,176 | 319,207 | 320,811 | 320,875 | 321,826 | 320,491 | 319,951 | 319,598 | 323,419 | 131,695 |
| Vs,v | (Kn) | 193,738 | 196,915 | 711,895 | 715,923 | 714,972 | 716,306 | 711,013 | 197,668 | 193,627 | 80,606 |
| Aj,v | (mm²) | 484,344 | 492,287 | 1779,737 | 1789,807 | 1787,430 | 1790,766 | 1777,532 | 494,170 | 484,068 | 201,514 |
| jumlah tul | | 4,000 | 4,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 4,000 | 4,000 | 4,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 1809,562 | 1809,562 | 1809,562 | 1809,562 | 1809,562 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 69,500 | 69,500 | 69,500 | 69,500 | 69,500 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (AJ11)1 | (AJ12)1 | (AJ13)1 | (AJ14)1 | (AJ15)1 | (AJ16)1 | (AJ17)1 | (AJ18)1 | (AJ19)1 | (AJ20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 0 | 0 | 0 | 0,00 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 0 | 0 | 0 | 0,00 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 7,2 | 7,2 | 0 | 0 | 7,2 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 6,5 | 6,5 | 0 | 0 | 6,5 | 6,5 | 6,5 |
| tinggi, a | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 | 158,474 | 158,474 | 0 | 0 | 0 | 0 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 225,96 | 225,960 | 225,96 | 225,960 | 225,96 | 0 | 0 | 305,76 | 225,96 | 225,960 |
| Mkap, ki | (Knm) | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 | 0,000 | 0,000 | 0,000 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 0,000 | 0,000 | 382,200 | 282,450 | 282,450 |
| Vkol | (Kn) | 99,361 | 99,361 | 99,361 | 99,361 | 58,402 | 0,000 | 0,000 | 79,027 | 99,361 | 149,042 |
| Cki | (Kn) | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 | 0,000 | 0,000 | 0,000 | 255,297 | 255,297 |
| Tka | (Kn) | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 0,000 | 0,000 | 492,571 | 364,015 | 364,015 |
| Vj,h | (Kn) | 519,951 | 519,951 | 519,951 | 519,951 | 305,613 | 0,000 | 0,000 | 413,544 | 519,951 | 470,271 |
| Vj,v | (Kn) | 519,951 | 519,951 | 519,951 | 519,951 | 305,613 | 0,000 | 0,000 | 413,544 | 519,951 | 470,271 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,061 | 1,061 | 1,061 | 1,061 | 0,624 | 0,000 | 0,000 | 0,844 | 1,061 | 0,960 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 245,955 | 255,952 | 267,933 | 308,603 | 268,534 | 195,798 | 227,464 | 296,339 | 321,650 | 237,733 |
| Nu/Ag | ($N/mm^2$) | 0,502 | 0,522 | 0,547 | 0,630 | 0,548 | 0,400 | 0,464 | 0,605 | 0,656 | 0,485 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 519,951 | 519,951 | 519,951 | 519,951 | 305,613 | 0,000 | 0,000 | 413,544 | 519,951 | 470,271 |
| Ajh | ($mm^2$) | 2166,464 | 2166,464 | 2166,464 | 2166,464 | 1273,390 | 0,000 | 0,000 | 1723,100 | 2166,464 | 1959,461 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 6,896 | 6,896 | 6,896 | 6,896 | 4,053 | 0,000 | 0,000 | 5,485 | 6,896 | 6,237 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 322,410 | 322,835 | 323,343 | 325,069 | 190,067 | 0,000 | 0,000 | 258,130 | 325,623 | 291,289 |
| Vs,v | (Kn) | 197,541 | 197,117 | 196,608 | 194,882 | 115,546 | 0,000 | 0,000 | 155,414 | 194,328 | 178,982 |
| Aj,v | ($mm^2$) | 493,852 | 492,792 | 491,520 | 487,205 | 288,865 | 0,000 | 0,000 | 388,534 | 485,820 | 447,455 |
| jumlah tul | | 2,000 | 4,000 | 3,000 | 4,000 | 2,000 | 2,000 | 2,000 | 3,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 402,125 | 804,250 | 603,187 | 804,250 | 402,125 | 402,125 | 402,125 | 603,187 | 804,250 | 804,250 |
| As pasang >Aj,v | | Tdk Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 568,000 | 178,667 | 276,000 | 178,667 | 568,000 | 568,000 | 568,000 | 276,000 | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 2,5 | 0 | 2,5 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2,50 |
| ln ki | (m) | 0,00 | 2,15 | 0 | 2,15 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 2,15 |
| l ka | (m) | 2,50 | 0 | 2,5 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 2,5 | 7,20 |
| ln ka | (m) | 2,15 | 0 | 2,15 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 2,15 | 6,50 |
| tinggi, a | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 0,000 | 158,474 | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 225,960 | 0,000 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 225,960 | 303,837 |
| Mkap, ki | (Knm) | 0,000 | 198,093 | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 282,450 | 0,000 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 282,450 | 379,796 |
| Vkol | (Kn) | 61,307 | 42,997 | 61,307 | 101,399 | 99,361 | 99,361 | 99,361 | 99,361 | 102,266 | 182,291 |
| Cki | (Kn) | 0,000 | 255,297 | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 364,015 | 0,000 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 364,015 | 489,473 |
| Vj,h | (Kn) | 302,708 | 212,301 | 302,708 | 517,914 | 519,951 | 519,951 | 519,951 | 519,951 | 517,046 | 562,480 |
| Vj,v | (Kn) | 302,708 | 212,301 | 302,708 | 517,914 | 519,951 | 519,951 | 519,951 | 519,951 | 517,046 | 562,480 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,618 | 0,433 | 0,618 | 1,057 | 1,061 | 1,061 | 1,061 | 1,061 | 1,055 | 1,148 |
| Vj,h< 1 5 $\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 245,955 | 255,952 | 267,933 | 308,603 | 268,534 | 195,798 | 227,464 | 296,339 | 321,650 | 237,733 |
| Nu/Ag | ($N/mm^2$) | 0,502 | 0,522 | 0,547 | 0,630 | 0,548 | 0,400 | 0,464 | 0,605 | 0,656 | 0,485 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 302,708 | 212,301 | 302,708 | 517,914 | 519,951 | 519,951 | 519,951 | 519,951 | 517,046 | 562,480 |
| Ajh | ($mm^2$) | 1261,285 | 884,585 | 1261,285 | 2157,975 | 2166,464 | 2166,464 | 2166,464 | 2166,464 | 2154,360 | 2343,667 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 4,015 | 2,816 | 4,015 | 6,869 | 6,896 | 6,896 | 6,896 | 6,896 | 6,858 | 7,460 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 187,703 | 131,816 | 188,246 | 323,796 | 323,369 | 320,281 | 321,626 | 324,549 | 323,804 | 348,404 |
| Vs,v | (Kn) | 115,006 | 80,484 | 114,463 | 194,113 | 196,583 | 199,670 | 198,326 | 195,402 | 193,242 | 214,076 |
| Aj,v | ($mm^2$) | 287,514 | 201,211 | 286,156 | 485,296 | 491,457 | 499,175 | 495,815 | 488,506 | 483,106 | 535,190 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 402,125 | 402,125 | 402,125 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 568,000 | 568,000 | 568,000 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (AJ21)1 | (AJ22)1 | (AJ23)1 | (AJ24)1 | (AJ25)1 | (AJ26)2 | (AJ27)2 | (AJ28)2 | (AJ29)2 | (AJ30)2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 7,2 | 0 | 0 | 0 | 0 | 0 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 6,5 | 0 | 0 | 0 | 0 | 0 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 2,15 | 2,15 | 2,1 | 2,1 | 2,1 | 2,1 | 2,1 |
| tinggi, a | (m) | 2,50 | 2,50 | 0,00 | 0,00 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 233,630 | 158,474 | 158,474 | 158,474 | 158,474 | 0 | 0 | 0 | 0 | 0 |
| Mnak, ka | (Knm) | 233,630 | 305,76 | 225,96 | 225,960 | 225,96 | 84,542 | 225,960 | 84,542 | 225,960 | 84,542 |
| Mkap, ki | (Knm) | 292,038 | 198,093 | 198,093 | 198,093 | 198,093 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Mkap,ka | (Knm) | 292,038 | 382,200 | 282,450 | 282,450 | 282,450 | 105,678 | 282,450 | 105,678 | 282,450 | 105,678 |
| Vkol | (Kn) | 120,769 | 119,987 | 149,042 | 153,400 | 102,266 | 23,484 | 62,767 | 23,484 | 62,767 | 23,484 |
| Cki | (Kn) | 376,372 | 255,297 | 255,297 | 255,297 | 255,297 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Tka | (Kn) | 376,372 | 492,571 | 364,015 | 364,015 | 364,015 | 136,195 | 364,015 | 136,195 | 364,015 | 136,195 |
| Vj,h | (Kn) | 631,975 | 627,882 | 470,271 | 465,913 | 517,046 | 112,711 | 301,249 | 112,711 | 301,249 | 112,711 |
| Vj,v | (Kn) | 631,975 | 627,882 | 470,271 | 465,913 | 517,046 | 225,422 | 602,498 | 225,422 | 602,498 | 225,422 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 1,290 | 1,281 | 0,960 | 0,951 | 1,055 | 0,352 | 0,941 | 0,352 | 0,941 | 0,352 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 291,459 | 327,051 | 268,547 | 215,511 | 251,039 | 129,685 | 113,634 | 144,098 | 121,909 | 132,965 |
| Nu/Ag | (N/mm²) | 0,595 | 0,667 | 0,548 | 0,440 | 0,512 | 0,405 | 0,355 | 0,450 | 0,381 | 0,416 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 631,975 | 627,882 | 470,271 | 465,913 | 517,046 | 112,711 | 301,249 | 112,711 | 301,249 | 112,711 |
| Ajh | (mm²) | 2633,227 | 2616,174 | 1959,461 | 1941,305 | 2154,360 | 469,629 | 1255,203 | 469,629 | 1255,203 | 469,629 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 8,382 | 8,328 | 6,237 | 6,179 | 6,858 | 1,495 | 3,995 | 1,495 | 3,995 | 1,495 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 394,221 | 393,492 | 292,472 | 287,745 | 320,824 | 69,454 | 185,028 | 69,657 | 185,340 | 69,500 |
| Vs,v | (Kn) | 237,754 | 234,390 | 177,799 | 178,169 | 196,223 | 155,968 | 417,469 | 155,765 | 417,158 | 155,922 |
| Aj,v | (mm²) | 594,384 | 585,974 | 444,497 | 445,421 | 490,557 | 389,921 | 1043,673 | 389,413 | 1042,894 | 389,805 |
| jumlah tul | | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 7,000 | 3,000 | 7,000 | 3,000 |
| As pasang | (mm²) | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 804,250 | 1407,437 | 603,187 | 1407,437 | 603,187 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 178,667 | 178,667 | 178,667 | 178,667 | 178,667 | 212,000 | 98,000 | 326,000 | 98,000 | 326,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 0 | 7,2 | 2,5 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ki | (m) | 6,50 | 0 | 6,5 | 2,15 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,20 |
| l ka | (m) | 0,00 | 7,2 | 2,5 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,60 |
| ln ka | (m) | 0,00 | 6,5 | 2,15 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 |
| tinggi, a | (m) | 2,50 | 2,50 | 0,00 | 0,00 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 0,000 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 0,000 | 303,837 | 303,837 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 0,000 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 0,000 | 379,796 | 379,796 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 | 181,704 |
| Vkol | (Kn) | 40,959 | 78,530 | 185,094 | 120,851 | 80,994 | 81,803 | 79,757 | 79,757 | 79,757 | 81,634 |
| Cki | (Kn) | 255,297 | 0,000 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 | 255,297 |
| Tka | (Kn) | 0,000 | 489,473 | 489,473 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 | 234,176 |
| Vj,h | (Kn) | 214,338 | 410,943 | 559,677 | 368,622 | 408,479 | 407,670 | 409,716 | 409,716 | 409,716 | 407,839 |
| Vj,v | (Kn) | 214,338 | 410,943 | 559,677 | 368,622 | 408,479 | 815,340 | 819,432 | 819,432 | 819,432 | 815,679 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1,5\sqrt{f'c}$ | (N/mm²) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | (N/mm²) | 0,437 | 0,839 | 1,142 | 0,752 | 0,834 | 1,274 | 1,280 | 1,280 | 1,280 | 1,274 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 291,459 | 327,051 | 268,547 | 215,511 | 251,039 | 129,685 | 113,634 | 144,098 | 121,909 | 132,965 |
| Nu/Ag | (N/mm²) | 0,595 | 0,667 | 0,548 | 0,440 | 0,512 | 0,405 | 0,355 | 0,450 | 0,381 | 0,416 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 214,338 | 410,943 | 559,677 | 368,622 | 408,479 | 407,670 | 409,716 | 409,716 | 409,716 | 407,839 |
| Ajh | (mm²) | 893,075 | 1712,263 | 2331,987 | 1535,924 | 1701,997 | 1698,626 | 1707,150 | 1707,150 | 1707,150 | 1699,331 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | (mm²) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 2,843 | 5,450 | 7,423 | 4,889 | 5,418 | 5,407 | 5,434 | 5,434 | 5,434 | 5,409 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 133,702 | 257,537 | 348,075 | 227,658 | 253,459 | 251,211 | 251,649 | 253,210 | 252,073 | 251,482 |
| Vs,v | (Kn) | 80,636 | 153,406 | 211,601 | 140,964 | 155,021 | 564,130 | 567,783 | 566,222 | 567,359 | 564,197 |
| Aj,v | (mm²) | 201,589 | 383,515 | 529,003 | 352,409 | 387,552 | 1410,324 | 1419,457 | 1415,556 | 1418,397 | 1410,491 |
| jumlah tul | | 3,000 | 3,000 | 2,000 | 2,000 | 2,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| As pasang | (mm²) | 603,187 | 603,187 | 402,125 | 402,125 | 402,125 | 1608,499 | 1608,499 | 1608,499 | 1608,499 | 1608,499 |
| As pasang >Aj,v | | Ok | Ok | Tdk Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 276,000 | 276,000 | 568,000 | 568,000 | 568,000 | 81,714 | 81,714 | 81,714 | 81,714 | 81,714 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (A-J31)1 | (A-J32)1 |
|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 |
| l ka | (m) | 2,00 | 2,00 |
| ln ka | (m) | 2,50 | 2,50 |
| tinggi, a | (m) | 2,15 | 2,15 |
| tinggi, b | (m) | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 305,76 | 225,96 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 382,200 | 282,450 |
| Vkol | (Kn) | 102,834 | 87,208 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 492,571 | 364,015 |
| Vj,h | (Kn) | 645,035 | 532,104 |
| Vj,v | (Kn) | 645,035 | 532,104 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 1,316 | 1,086 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 256,132 | 255,554 |
| Nu/Ag | ($N/mm^2$) | 0,523 | 0,522 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 645,035 | 532,104 |
| Ajh | ($mm^2$) | 2687,646 | 2217,102 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 8,555 | 7,057 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 400,508 | 330,363 |
| Vs,v | (Kn) | 244,527 | 201,741 |
| Aj,v | ($mm^2$) | 611,318 | 504,353 |
| jumlah tul | | 4,000 | 4,000 |
| As pasang | ($mm^2$) | 804,250 | 804,250 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 178,667 | 178,667 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | |
|---|---|---|---|
| l ki | (m) | 3,60 | 7,20 |
| ln ki | (m) | 3,05 | 6,50 |
| l ka | (m) | 7,20 | 2,50 |
| ln ka | (m) | 6,50 | 2,15 |
| tinggi, a | (m) | 2,50 | 0,00 |
| tinggi, b | (m) | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 158,474 | 158,474 |
| Mnak, ka | (Knm) | 145,363 | 145,363 |
| Mkap, ki | (Knm) | 198,093 | 198,093 |
| Mkap,ka | (Knm) | 181,704 | 181,704 |
| Vkol | (Kn) | 81,216 | 120,599 |
| Cki | (Kn) | 255,297 | 255,297 |
| Tka | (Kn) | 234,176 | 234,176 |
| Vj,h | (Kn) | 408,257 | 368,875 |
| Vj,v | (Kn) | 408,257 | 368,875 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | |
|---|---|---|---|
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,833 | 0,753 |
| Vj,h< 1,5 $\sqrt{f'c}$ | | OK | OK |

**3. Penulangan geser horizontal**

| | | | |
|---|---|---|---|
| Nu | (Kn) | 256,132 | 255,554 |
| Nu/Ag | ($N/mm^2$) | 0,523 | 0,522 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 |
| Vs,h | (Kn) | 408,257 | 368,875 |
| Ajh | ($mm^2$) | 1701,072 | 1536,978 |
| sengkang rangkap | | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 |
| jml sengkang | (lapis) | 5,415 | 4,892 |

**4. Penulangan geser vertikal**

| | | | |
|---|---|---|---|
| Vc,v | (Kn) | 253,490 | 229,020 |
| Vs,v | (Kn) | 154,767 | 139,855 |
| Aj,v | ($mm^2$) | 386,917 | 349,636 |
| jumlah tul | | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 402,125 | 402,125 |
| As pasang >Aj,v | | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | |
|---|---|---|---|
| s | (mm) | 568,000 | 568,000 |

**Pertemuan Balok Kolom Ring**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| fy (Mpa) tulangan | 400 | D tulangan (mm) | 22 | Øo | 1,25 | z (m) | 0,54315 |
| fy (Mpa) sengkang | 240 | D sengkang (mm) | 10 | d (mm) | 639 | pb (mm) | 40 |
| fc' (Mpa) | 25 | kolom b1 (mm) | 700 | kolom b2 (mm) | 400 | d' (mm) | 61 |
| | | kolom h1(mm) | 700 | kolom h2 (mm) | 800 | | |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (RJ1)1 | (RJ2)1 | (RJ3)2 | (RJ4)2 | (RJ5)2 | (RJ6)2 | (RJ7)2 | (RJ8)1 | (RJ9)1 | (RJ10)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0,00 | 0,00 | 7,2 |
| ln ki | (m) | 0,00 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0,00 | 0,00 | 6,5 |
| l ka | (m) | 7,20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,2 | 7,2 |
| ln ka | (m) | 6,50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,5 | 6,5 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 95,839 |
| Mnak, ki | (Knm) | 0,000 | 0,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0,000 | 84,542 |
| Mnak, ka | (knm) | 84,542 | 0,000 | 0 | 0 | 0 | 0 | 0 | 0 | 84,542 | 95,839 |
| Mkap, ki | (Knm) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 105,678 |
| Mkap,ka | (Knm) | 105,678 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 105,678 | 119,799 |
| Vkol | (Kn) | 65,553 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 65,553 | 3,648 |
| Cki | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 136,195 |
| Tka | (Kn) | 136,195 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 136,195 | 154,394 |
| Vj,h | (Kn) | 70,642 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 70,642 | 286,940 |
| Vj,v | (Kn) | 70,642 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 70,642 | 286,940 |
| **2. Kontrol tegangan geser horizontal minimal** | | | | | | | | | | | |
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,144 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,144 | 0,586 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | Ok | OK | OK | OK | OK | Ok | OK | OK |
| **3. Penulangan geser horizontal** | | | | | | | | | | | |
| Nu | (Kn) | 63,201 | 226,287 | 61,571 | 53,306 | 61,928 | 53,306 | 60,744 | 68,406 | 64,199 | 56,001 |
| Nu/Ag | ($N/mm^2$) | 0,129 | 0,462 | 0,192 | 0,167 | 0,194 | 0,167 | 0,190 | 0,140 | 0,131 | 0,114 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 70,642 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 70,642 | 286,940 |
| Ajh | ($mm^2$) | 294,343 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 294,343 | 1195,585 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 0,937 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,937 | 3,806 |
| **4. Penulangan geser vertikal** | | | | | | | | | | | |
| Vc,v | (Kn) | 42,750 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 42,756 | 173,476 |
| Vs,v | (Kn) | 27,892 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 27,887 | 113,464 |
| Aj,v | ($mm^2$) | 69,731 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 69,717 | 283,661 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |
| **5. Kontrol jarak tulangan vertikal** | | | | | | | | | | | |
| s | (mm) | 556,000 | 556,000 | 656,000 | 656,000 | 656,000 | 656,000 | 656,000 | 556,000 | 556,000 | 556,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 7,2 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 0,00 |
| ln ki | (m) | 0,00 | 6,5 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0,00 |
| l ka | (m) | 7,20 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 7,2 | 0 | 0,00 |
| ln ka | (m) | 6,50 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 6,5 | 0 | 0,00 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| Mnak, ki | (Knm) | 0,000 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 0,000 |
| Mnak, ka | (Knm) | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 0,000 | 0,000 |
| Mkap, ki | (Knm) | 0,000 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 0,000 |
| Mkap,ka | (Knm) | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 0,000 | 0,000 |
| Vkol | (Kn) | 65,553 | 144,163 | 145,762 | 142,050 | 142,050 | 142,050 | 145,324 | 144,738 | 74,312 | 0,000 |
| Cki | (Kn) | 0,000 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 0,000 |
| Tka | (Kn) | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 0,000 | 0,000 |
| Vj,h | (Kn) | 70,642 | 146,426 | 144,827 | 148,539 | 148,539 | 148,539 | 145,265 | 145,851 | 80,082 | 0,000 |
| Vj,v | (Kn) | 70,642 | 146,426 | 289,654 | 297,078 | 297,078 | 297,078 | 290,529 | 145,851 | 80,082 | 0,000 |
| **2. Kontrol tegangan geser horizontal minimal** | | | | | | | | | | | |
| $1,5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,144 | 0,299 | 0,453 | 0,464 | 0,464 | 0,464 | 0,454 | 0,298 | 0,163 | 0,000 |
| Vj,h< $1,5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |
| **3. Penulangan geser horizontal** | | | | | | | | | | | |
| Nu | (Kn) | 63,201 | 226,287 | 61,571 | 53,306 | 61,928 | 53,306 | 60,744 | 68,406 | 64,199 | 56,001 |
| Nu/Ag | ($N/mm^2$) | 0,129 | 0,462 | 0,192 | 0,167 | 0,194 | 0,167 | 0,190 | 0,140 | 0,131 | 0,114 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 70,642 | 146,426 | 144,827 | 148,539 | 148,539 | 148,539 | 145,265 | 145,851 | 80,082 | 0,000 |
| Ajh | ($mm^2$) | 294,343 | 610,107 | 603,446 | 618,912 | 618,912 | 618,912 | 605,269 | 607,714 | 333,675 | 0,000 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 0,937 | 1,942 | 1,921 | 1,970 | 1,970 | 1,970 | 1,927 | 1,934 | 1,062 | 0,000 |
| **4. Penulangan geser vertikal** | | | | | | | | | | | |
| Vc,v | (Kn) | 42,750 | 90,560 | 88,011 | 90,113 | 90,273 | 90,113 | 88,262 | 88,325 | 48,469 | 0,000 |
| Vs,v | (Kn) | 27,892 | 55,865 | 201,643 | 206,965 | 206,805 | 206,965 | 202,267 | 57,526 | 31,613 | 0,000 |
| Aj,v | ($mm^2$) | 69,731 | 139,664 | 504,108 | 517,412 | 517,012 | 517,412 | 505,669 | 143,815 | 79,033 | 0,000 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |
| **5. Kontrol jarak tulangan vertikal** | | | | | | | | | | | |
| s | (mm) | 556,000 | 556,000 | 656,000 | 656,000 | 656,000 | 656,000 | 656,000 | 556,000 | 556,000 | 556,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (RJ11)1 | (RJ12)1 | (RJ13)1 | (RJ14)1 | (RJ15)1 | (RJ16)1 | (RJ17)1 | (RJ18)1 | (RJ19)1 | (RJ20)1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 7,2 | 7,2 | 0 | 0 | 0 | 0,00 | 7,20 | 7,2 |
| ln ki | (m) | 6,50 | 6,50 | 6,5 | 6,5 | 0 | 0 | 0 | 0,00 | 6,50 | 6,5 |
| l ka | (m) | 7,20 | 7,2 | 7,2 | 0 | 7,2 | 0 | 0 | 7,2 | 0 | 7,2 |
| ln ka | (m) | 6,50 | 6,5 | 6,5 | 0 | 6,5 | 0 | 0 | 6,5 | 0 | 6,5 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| Mnak, ki | (Knm) | 95,839 | 95,839 | 95,839 | 95,839 | 0 | 0 | 0 | 0 | 95,839 | 95,839 |
| Mnak, ka | (Knm) | 84,542 | 84,542 | 84,542 | 0,000 | 84,542 | 0 | 0 | 84,542 | 0 | 84,542 |
| Mkap, ki | (Knm) | 119,799 | 119,799 | 119,799 | 119,799 | 0,000 | 0,000 | 0,000 | 0,000 | 119,799 | 119,799 |
| Mkap,ka | (Knm) | 105,678 | 105,678 | 105,678 | 0,000 | 105,678 | 0,000 | 0,000 | 105,678 | 0,000 | 105,678 |
| Vkol | (Kn) | 139,865 | 139,865 | 139,865 | 74,312 | 65,553 | 0,000 | 0,000 | 65,553 | 74,312 | 139,865 |
| Cki | (Kn) | 154,394 | 154,394 | 154,394 | 154,394 | 0,000 | 0,000 | 0,000 | 0,000 | 154,394 | 154,394 |
| Tka | (Kn) | 136,195 | 136,195 | 136,195 | 0,000 | 136,195 | 0,000 | 0,000 | 136,195 | 0,000 | 136,195 |
| Vj,h | (Kn) | 150,724 | 150,724 | 150,724 | 80,082 | 70,642 | 0,000 | 0,000 | 70,642 | 80,082 | 150,724 |
| Vj,v | (Kn) | 150,724 | 150,724 | 150,724 | 80,082 | 70,642 | 0,000 | 0,000 | 70,642 | 80,082 | 150,724 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,308 | 0,308 | 0,308 | 0,163 | 0,144 | 0,000 | 0,000 | 0,144 | 0,163 | 0,308 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 56,700 | 57,100 | 59,922 | 57,354 | 129,773 | 125,532 | 149,260 | 128,878 | 63,628 | 101,592 |
| Nu/Ag | ($N/mm^2$) | 0,116 | 0,117 | 0,122 | 0,117 | 0,265 | 0,256 | 0,305 | 0,263 | 0,130 | 0,207 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 150,724 | 150,724 | 150,724 | 80,082 | 70,642 | 0,000 | 0,000 | 70,642 | 80,082 | 150,724 |
| Ajh | ($mm^2$) | 628,018 | 628,018 | 628,018 | 333,675 | 294,343 | 0,000 | 0,000 | 294,343 | 333,675 | 628,018 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 1,999 | 1,999 | 1,999 | 1,062 | 0,937 | 0,000 | 0,000 | 0,937 | 1,062 | 1,999 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 91,132 | 91,137 | 91,172 | 48,424 | 43,134 | 0,000 | 0,000 | 43,129 | 48,465 | 91,685 |
| Vs,v | (Kn) | 59,592 | 59,587 | 59,552 | 31,658 | 27,509 | 0,000 | 0,000 | 27,514 | 31,617 | 59,040 |
| Aj,v | ($mm^2$) | 148,980 | 148,968 | 148,881 | 79,145 | 68,771 | 0,000 | 0,000 | 68,784 | 79,042 | 147,599 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 0 | 0 | 0 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 0,00 |
| ln ki | (m) | 0,00 | 0 | 0 | 0 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 0,00 |
| l ka | (m) | 0,00 | 0 | 0 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 0 | 0,00 |
| ln ka | (m) | 0,00 | 0 | 0 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 0 | 0,00 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| Mnak, ki | (Knm) | 0,000 | 0,000 | 0,000 | 0,000 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 0,000 |
| Mnak, ka | (Knm) | 0,000 | 0,000 | 0,000 | 134,274 | 134,274 | 134,274 | 134,274 | 134,274 | 0,000 | 0,000 |
| Mkap, ki | (Knm) | 0,000 | 0,000 | 0,000 | 0,000 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 0,000 |
| Mkap,ka | (Knm) | 0,000 | 0,000 | 0,000 | 167,843 | 167,843 | 167,843 | 167,843 | 167,843 | 0,000 | 0,000 |
| Vkol | (Kn) | 0,000 | 0,000 | 0,000 | 104,114 | 178,426 | 178,426 | 178,426 | 178,426 | 74,312 | 0,000 |
| Cki | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 0,000 |
| Tka | (Kn) | 0,000 | 0,000 | 0,000 | 216,312 | 216,312 | 216,312 | 216,312 | 216,312 | 0,000 | 0,000 |
| Vj,h | (Kn) | 0,000 | 0,000 | 0,000 | 112,198 | 192,280 | 192,280 | 192,280 | 192,280 | 80,082 | 0,000 |
| Vj,v | (Kn) | 0,000 | 0,000 | 0,000 | 112,198 | 192,280 | 192,280 | 192,280 | 192,280 | 80,082 | 0,000 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,000 | 0,000 | 0,000 | 0,229 | 0,392 | 0,392 | 0,392 | 0,392 | 0,163 | 0,000 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 56,700 | 57,100 | 59,922 | 57,354 | 129,773 | 125,532 | 149,260 | 128,878 | 63,628 | 101,592 |
| Nu/Ag | ($N/mm^2$) | 0,116 | 0,117 | 0,122 | 0,117 | 0,265 | 0,256 | 0,305 | 0,263 | 0,130 | 0,207 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 0,000 | 0,000 | 0,000 | 112,198 | 192,280 | 192,280 | 192,280 | 192,280 | 80,082 | 0,000 |
| Ajh | ($mm^2$) | 0,000 | 0,000 | 0,000 | 467,491 | 801,166 | 801,166 | 801,166 | 801,166 | 333,675 | 0,000 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang (lapis) | | 0,000 | 0,000 | 0,000 | 1,488 | 2,550 | 2,550 | 2,550 | 2,550 | 1,062 | 0,000 |

**4. Penulangan geser vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 0,000 | 0,000 | 0,000 | 67,844 | 117,405 | 117,338 | 117,711 | 117,391 | 48,465 | 0,000 |
| Vs,v | (Kn) | 0,000 | 0,000 | 0,000 | 44,354 | 74,875 | 74,942 | 74,569 | 74,889 | 31,617 | 0,000 |
| Aj,v | ($mm^2$) | 0,000 | 0,000 | 0,000 | 110,885 | 187,187 | 187,354 | 186,423 | 187,222 | 79,042 | 0,000 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 | 556,000 |

**A. Pertemuan Balok Kolom Luar**

**1.Perhitungan gaya dalam**

| Keterangan | | (RJ21)1 | (RJ22)1 | (RJ23)2 | (RJ24)2 | (RJ25)2 | (RJ26)2 | (RJ27)2 | (RJ28)1 |
|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 7,20 | 7,20 | 0 | 0 | 0 | 0 | 0 | 7,20 |
| ln ki | (m) | 6,50 | 6,50 | 0 | 0 | 0 | 0 | 0 | 6,50 |
| l ka | (m) | 7,20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ln ka | (m) | 6,50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| tinggi, a | (m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| tinggi, b | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| Mnak, ki | (Knm) | 95,839 | 95,839 | 0 | 0 | 0 | 0 | 0 | 95,839 |
| Mnak, ka | (Knm) | 84,542 | 0,000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mkap, ki | (Knm) | 119,799 | 119,799 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 119,799 |
| Mkap,ka | (Knm) | 105,678 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vkol | (Kn) | 139,865 | 74,312 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 74,312 |
| Cki | (Kn) | 154,394 | 154,394 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 154,394 |
| Tka | (Kn) | 136,195 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vj,h | (Kn) | 150,724 | 80,082 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 80,082 |
| Vj,v | (Kn) | 150,724 | 80,082 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 80,082 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,308 | 0,163 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,163 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | Ok | OK | OK | OK | Ok | Ok | Ok |

**3. Penulangan geser horizontal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 101,540 | 45,691 | 24,657 | 25,015 | 38,933 | 26,375 | 26,370 | 48,328 |
| Nu/Ag | ($N/mm^2$) | 0,207 | 0,093 | 0,077 | 0,078 | 0,122 | 0,082 | 0,082 | 0,099 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 150,724 | 80,082 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 80,082 |
| Ajh | ($mm^2$) | 628,018 | 333,675 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 333,675 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 1,999 | 1,062 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 1,062 |

**4. Penulangan geser vertikal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 91,684 | 48,348 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 48,365 |
| Vs,v | (Kn) | 59,040 | 31,734 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 31,717 |
| Aj,v | ($mm^2$) | 147,601 | 79,335 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 79,292 |
| jumlah tul | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 556,000 | 556,000 | 656,000 | 656,000 | 656,000 | 656,000 | 656,000 | 556,000 |

**B. Pertemuan Balok Kolom Dalam**

**1.Perhitungan gaya dalam**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| l ki | (m) | 0,00 | 0 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 |
| ln ki | (m) | 0,00 | 0 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 |
| l ka | (m) | 0,00 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 3,6 | 0 |
| ln ka | (m) | 0,00 | 3,05 | 3,2 | 3,2 | 3,2 | 3,2 | 3,05 | 0 |
| tinggi, a | (m) | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 | 2,50 |
| tinggi, b | (m) | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Mnak, ki | (Knm) | 0,000 | 0,000 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 | 95,839 |
| Mnak, ka | (Knm) | 0,000 | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 84,542 | 0,000 |
| Mkap, ki | (Knm) | 0,000 | 0,000 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 | 119,799 |
| Mkap,ka | (Knm) | 0,000 | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 105,678 | 0,000 |
| Vkol | (Kn) | 0,000 | 23,284 | 48,587 | 47,350 | 47,350 | 47,350 | 48,441 | 26,395 |
| Cki | (Kn) | 0,000 | 0,000 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 | 154,394 |
| Tka | (Kn) | 0,000 | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 136,195 | 0,000 |
| Vj,h | (Kn) | 0,000 | 112,911 | 242,002 | 243,239 | 243,239 | 243,239 | 242,147 | 127,999 |
| Vj,v | (Kn) | 0,000 | 112,911 | 484,003 | 486,478 | 486,478 | 486,478 | 484,295 | 127,999 |

**2. Kontrol tegangan geser horizontal minimal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $1.5\sqrt{f'c}$ | ($N/mm^2$) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Vj,h | ($N/mm^2$) | 0,000 | 0,230 | 0,756 | 0,760 | 0,760 | 0,760 | 0,757 | 0,261 |
| Vj,h< $1.5\sqrt{f'c}$ | | OK | OK | OK | OK | OK | OK | OK | OK |

**3. Penulangan geser horizontal**

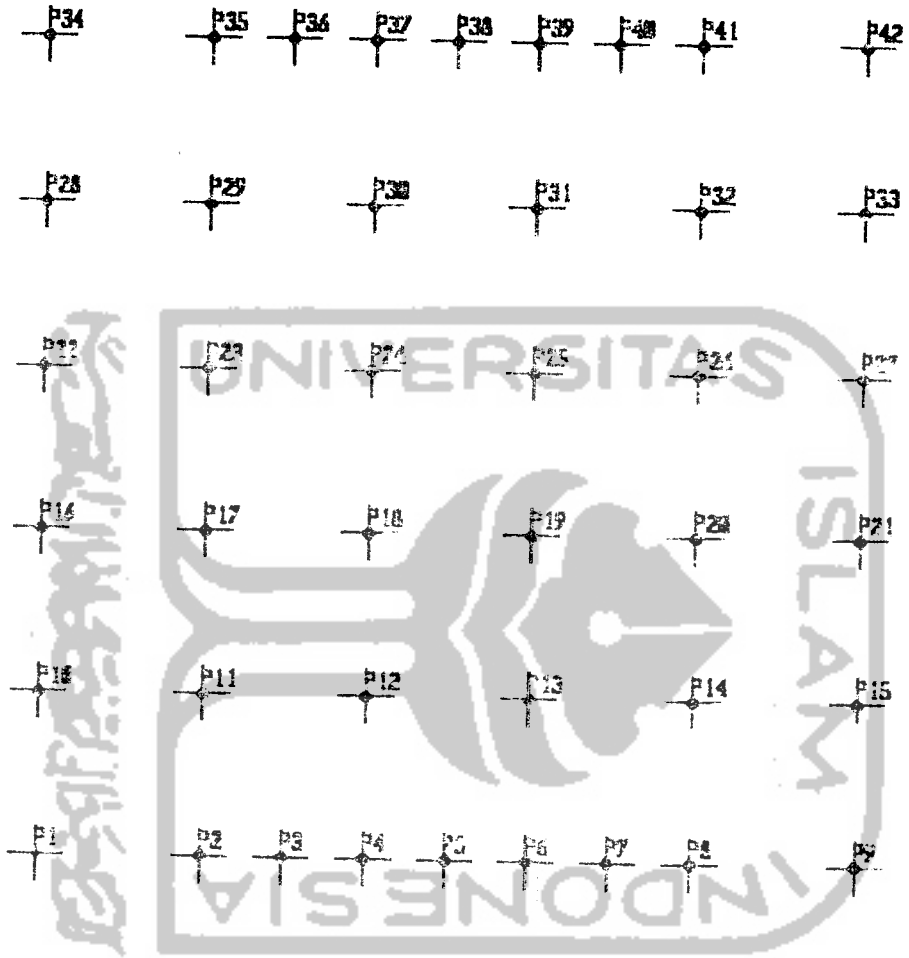
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nu | (Kn) | 101,540 | 45,691 | 24,657 | 25,015 | 38,933 | 26,375 | 26,370 | 48,328 |
| Nu/Ag | ($N/mm^2$) | 0,207 | 0,093 | 0,077 | 0,078 | 0,122 | 0,082 | 0,082 | 0,099 |
| 0,1fc' | (Mpa) | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Vc,h | (Kn) | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| Vs,h | (Kn) | 0,000 | 112,911 | 242,002 | 243,239 | 243,239 | 243,239 | 242,147 | 127,999 |
| Ajh | ($mm^2$) | 0,000 | 470,463 | 1008,340 | 1013,495 | 1013,495 | 1013,495 | 1008,948 | 533,329 |
| sengkang rangkap | | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 | P-10 |
| A tersedia | ($mm^2$) | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 | 314,160 |
| jml sengkang | (lapis) | 0,000 | 1,498 | 3,210 | 3,226 | 3,226 | 3,226 | 3,212 | 1,698 |

**4. Penulangan geser vertikal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vc,v | (Kn) | 0,000 | 68,168 | 145,947 | 146,704 | 147,127 | 146,745 | 146,087 | 77,304 |
| Vs,v | (Kn) | 0,000 | 44,743 | 338,056 | 339,774 | 339,351 | 339,733 | 338,208 | 50,695 |
| Aj,v | ($mm^2$) | 0,000 | 111,858 | 845,141 | 849,435 | 848,377 | 849,331 | 845,521 | 126,737 |
| jumlah tul | | 2,000 | 2,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 2,000 |
| As pasang | ($mm^2$) | 760,267 | 760,267 | 1140,401 | 1140,401 | 1140,401 | 1140,401 | 1140,401 | 760,267 |
| As pasang >Aj,v | | Ok | Ok | Ok | Ok | Ok | Ok | Ok | Ok |

**5. Kontrol jarak tulangan vertikal**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| s | (mm) | 556,000 | 556,000 | 317,000 | 317,000 | 317,000 | 317,000 | 317,000 | 556,000 |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P9

## TABEL GAYA AKSIAL DAN MOMEN RENCANA PADA PONDASI

| pondasi | P (Kn) | | | | | Mx (Knm) | | | | | My (Knm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PD | PL | PD+PL | PD+PL+0.5PE | Pakai | MD | ML | MD+ML | MD+ML+0.5ME | Pakai | MD | ML | MD+ML | MD+ML+0.5ME | Pakai |
| P1 | 2499.953 | 424.540 | 2924.493 | 2925.410 | 2925.410 | -7.589 | -2.544 | -10.133 | -54.178 | 54.178 | 5.380 | 1.727 | 7.107 | -35.785 | 35.785 |
| P2 | 2318.958 | 498.850 | 2817.807 | 2816.941 | 2817.807 | -6.065 | -4.852 | -10.917 | -60.081 | 60.081 | -12.211 | 0.693 | -11.518 | -57.880 | 57.880 |
| P3 | 1347.951 | 283.414 | 1631.365 | 1688.289 | 1688.289 | -4.485 | -8.040 | -12.525 | -52.592 | 52.592 | -1.566 | -0.092 | -1.659 | -17.218 | 17.218 |
| P4 | 1542.495 | 322.425 | 186+.920 | 1916.752 | 1916.752 | -2.363 | -4.510 | -6.873 | -52.727 | 52.727 | -1.088 | -0.047 | -1.135 | -16.158 | 16.158 |
| P5 | 1423.344 | 282.792 | 1706.136 | 1736.721 | 1736.721 | -2.215 | -7.716 | -9.932 | -53.442 | 53.442 | -0.860 | -0.099 | -0.959 | -16.023 | 16.023 |
| P6 | 1546.589 | 312.927 | 1859.515 | 1905.243 | 1905.243 | -3.077 | -4.641 | -7.718 | -56.974 | 56.974 | -0.607 | -0.140 | -0.747 | -15.708 | 15.708 |
| P7 | 1365.252 | 267.125 | 1632.377 | 1621.206 | 1632.377 | -1.481 | -8.454 | -12.935 | -59.256 | 59.256 | 0.823 | -0.156 | -0.133 | -15.536 | 15.536 |
| P8 | 2460.166 | 429.992 | 2890.089 | 3006.261 | 3006.261 | -4.420 | -4.650 | -9.071 | -70.101 | 70.101 | 5.590 | -1.312 | 4.278 | -41.171 | 41.171 |
| P9 | 2505.608 | 176.455 | 2682.064 | 2863.583 | 2863.583 | 9.715 | 1.236 | 10.951 | -52.844 | 52.844 | -13.001 | -2.202 | -15.203 | -57.032 | 57.032 |
| P10 | 3003.575 | 661.510 | 3665.085 | 3585.683 | 3665.085 | 4.496 | -1.208 | 3.287 | -43.578 | 43.578 | -4.559 | 4.924 | 0.365 | -46.208 | 46.208 |
| P11 | 2453.571 | 993.274 | 3446.845 | 3446.531 | 3446.845 | 6.914 | -2.558 | 4.357 | -48.401 | 48.401 | -12.817 | 3.470 | -9.347 | -58.717 | 58.717 |
| P12 | 2454.048 | 928.592 | 3382.640 | 3373.120 | 3382.640 | 11.002 | -2.619 | 8.383 | -49.471 | 49.471 | 8.594 | 0.769 | -7.826 | -57.153 | 57.153 |
| P13 | 2460.833 | 891.888 | 3352.721 | 3340.892 | 3352.721 | 10.091 | -2.800 | 7.291 | -54.850 | 54.850 | -4.265 | -2.373 | -6.638 | -55.680 | 55.680 |
| P14 | 2977.999 | 938.572 | 3916.571 | 3903.406 | 3916.571 | 7.866 | -2.621 | 5.246 | -60.147 | 60.147 | -2.721 | -5.225 | -7.946 | -56.561 | 56.561 |
| P15 | 3892.031 | 583.170 | 4475.201 | 4541.950 | 4541.950 | 22.441 | 1.870 | 24.311 | -43.572 | 43.572 | -12.910 | -6.703 | -19.613 | -65.279 | 65.279 |
| P16 | 2907.633 | 591.049 | 3498.682 | 3422.242 | 3498.682 | 4.794 | 0.236 | 5.030 | -42.105 | 42.105 | -2.798 | 5.318 | 2.520 | -47.774 | 47.774 |
| P17 | 2566.646 | 963.717 | 3530.364 | 3539.650 | 3539.650 | 9.061 | 0.556 | 9.618 | -43.820 | 43.820 | -10.936 | 3.816 | -7.120 | -60.458 | 60.458 |
| P18 | 2514.120 | 909.494 | 3423.614 | 3425.573 | 3425.573 | 13.218 | 1.153 | 14.371 | -44.158 | 44.158 | -7.181 | 1.087 | -6.093 | -59.338 | 59.338 |
| P19 | 2439.108 | 870.888 | 3309.996 | 3311.028 | 3311.028 | 12.402 | 0.911 | 13.313 | -49.528 | 49.528 | -3.672 | -1.804 | -5.476 | -58.411 | 58.411 |
| P20 | 2974.964 | 964.024 | 3938.987 | 3936.483 | 3938.987 | 9.094 | 0.830 | 9.924 | -56.348 | 56.348 | -1.646 | -5.062 | -6.708 | -59.192 | 59.192 |
| P21 | 3295.863 | 631.352 | 3927.215 | 3997.781 | 3997.781 | 21.583 | 3.135 | 24.718 | -43.744 | 43.744 | -11.163 | -7.202 | -18.364 | -67.603 | 67.603 |
| P22 | 3145.697 | 586.741 | 3732.428 | 3647.766 | 3732.428 | 6.805 | 1.125 | 7.930 | -39.403 | 39.403 | -0.953 | 5.064 | 4.110 | -50.078 | 50.078 |
| P23 | 3202.474 | 932.756 | 4135.230 | 4151.820 | 4151.820 | 10.073 | 2.366 | 12.439 | -41.286 | 41.286 | -10.717 | 3.596 | -7.121 | -64.568 | 64.568 |
| P24 | 2976.447 | 905.846 | 3882.293 | 3882.395 | 3882.395 | 13.262 | 3.544 | 16.806 | -42.058 | 42.058 | -3.228 | 0.883 | -7.346 | -64.685 | 64.685 |
| P25 | 2901.250 | 830.338 | 3731.589 | 3731.715 | 3731.715 | 12.361 | 3.220 | 15.581 | -47.581 | 47.581 | -2.929 | -2.146 | -5.076 | -62.067 | 62.067 |
| P26 | 3675.015 | 777.318 | 4452.332 | 4468.251 | 4468.251 | 10.477 | 3.123 | 13.601 | -52.998 | 52.998 | -1.909 | -5.190 | -6.999 | -63.486 | 63.486 |
| P27 | 3518.290 | 525.559 | 4114.589 | 4223.729 | 4223.729 | 20.190 | 4.435 | 24.626 | -44.500 | 44.500 | -12.823 | -7.100 | -19.925 | -72.908 | 72.908 |
| P28 | 3051.147 | 693.076 | 3744.223 | 3663.342 | 3744.223 | 7.140 | 3.181 | 10.321 | -37.086 | 37.086 | -5.446 | 5.267 | -0.178 | -57.898 | 57.898 |
| P29 | 3025.948 | 969.826 | 3995.774 | 4014.710 | 4014.710 | 12.587 | 5.579 | 18.166 | -35.266 | 35.266 | -11.914 | 3.328 | -8.586 | -69.800 | 69.800 |
| P30 | 2639.123 | 892.630 | 3531.753 | 3547.562 | 3547.562 | 16.576 | 7.096 | 23.672 | -34.964 | 34.964 | -5.515 | 0.429 | -5.086 | -66.316 | 66.316 |
| P31 | 2678.348 | 790.340 | 3468.688 | 3481.728 | 3481.728 | 15.270 | 6.785 | 22.054 | -40.846 | 40.846 | 1.527 | -2.378 | -0.851 | -61.757 | 61.757 |
| P32 | 3511.903 | 557.402 | 4069.305 | 4061.747 | 4069.305 | 7.522 | 4.982 | 12.504 | -53.638 | 53.638 | 12.535 | -3.233 | 9.302 | -50.860 | 50.860 |
| P33 | 3402.525 | 287.862 | 3690.387 | 3789.453 | 3789.453 | 20.817 | 5.249 | 26.066 | -44.096 | 44.096 | 7.033 | -3.392 | 3.641 | -52.661 | 52.661 |
| P34 | 2391.813 | 463.938 | 2855.752 | 2685.925 | 2855.752 | 18.389 | 5.145 | 23.534 | -21.190 | 23.534 | 9.151 | 3.076 | 12.227 | -47.171 | 47.171 |
| P35 | 2350.112 | 500.870 | 2850.982 | 2726.451 | 2850.982 | 23.922 | 7.879 | 31.801 | -18.147 | 31.801 | -7.412 | 1.378 | -6.034 | -70.313 | 70.313 |
| P36 | 1321.150 | 252.466 | 1573.616 | 1588.626 | 1588.626 | 33.872 | 10.231 | 44.103 | 1.597 | 44.103 | 0.250 | -0.202 | 0.048 | -21.587 | 21.587 |
| P37 | 1483.828 | 284.838 | 1768.667 | 1738.781 | 1768.667 | 24.735 | 7.820 | 32.555 | -14.007 | 32.555 | 1.347 | 0.162 | 1.509 | -19.386 | 19.386 |
| P38 | 1322.878 | 245.921 | 1568.799 | 1544.589 | 1568.799 | 33.418 | 11.742 | 45.160 | -0.667 | 45.160 | 2.638 | 0.228 | 2.866 | -18.086 | 18.086 |
| P39 | 1492.108 | 257.252 | 1749.360 | 1713.286 | 1749.360 | 23.300 | 7.658 | 30.958 | -18.994 | 30.958 | 4.301 | 0.367 | 4.668 | -16.119 | 16.119 |
| P40 | 1328.977 | 198.513 | 1527.490 | 1466.995 | 1527.490 | 42.437 | 12.549 | 54.985 | 6.283 | 54.985 | 6.899 | 0.494 | 7.393 | -14.026 | 14.026 |
| P41 | 2588.945 | 256.829 | 2845.773 | 2861.718 | 2861.718 | 27.549 | 7.477 | 35.026 | -26.642 | 35.026 | 39.844 | 3.602 | 43.446 | -19.944 | 43.446 |
| P42 | 2341.896 | 89.618 | 2431.514 | 2409.642 | 2431.514 | 36.002 | 5.762 | 41.764 | -25.031 | 41.764 | 2.077 | 0.419 | 2.496 | -55.693 | 55.693 |

## PERENCANAAN PENULANGAN PONDASI

| | | | | | |
|---|---|---|---|---|---|
| fc' | 25 MPa | $\gamma$ beton | 24 KN/m$^3$ | h sumuran | 1,5 m |
| fy | 400 MPa | h tnh urug | 1 m | b kolom | 700 mm |
| $\gamma$ tanah | 18 KN/m$^3$ | h pelat | 0,8 m | h kolom | 700 mm |
| pb | 70 mm | $\emptyset_{tul\ pokok}$ | 16 mm | | |

| Tipe Pondasi | Pt1 | Pt2 | Pt3 |
|---|---|---|---|
| P (KN) | 3531,753 | 1864,92 | 4475,201 |
| Mx (KNm) | 23,672 | 6,873 | 24,311 |
| My (KNm) | 5,086 | 1,135 | 19,613 |
| **Pondasi sumuran :** | | | |
| $\sigma_{ijin\ bwh\ sumuran\ (KN/m^3)}$ | 450 | 450 | 450 |
| Coba $\emptyset_{sumuran\ (m)}$ | 3 | 3 | 3 |
| A perlu (m^2) | 9,146 | 5,108 | 11,432 |
| $\emptyset_{sumuran\ (m)}$ | 3,413 | 2,550 | 3,815 |
| **Pondasi Telapak :** | | | |
| Coba nilai B (m) | 1,5 | 2 | 2 |
| Aperlu (m^2) | 3,149 | 1,695 | 3,877 |
| B pondasi (m) | 1,775 | 1,302 | 1,969 |
| Ambil nilai B (m) | 2,3 | 2,3 | 2,3 |
| Kontrol : A ada > A perlu | Aman | Aman | Aman |
| Kontrol : $\sigma < \sigma_{netto}$ | Aman | Aman | Aman |
| d (mm) | 722 | 722 | 722 |
| *Tinjauan beban sementara :* | | | |
| ex | 0,006 | 0,003 | 0,005 |
| ey | 0,001 | 0,001 | 0,004 |
| Kontrol : $\sigma < 1,5.\sigma_{sumuran}$ | Aman | Aman | Aman |
| ***Perhit.Geser beton 2 arah :*** | | | |
| Pu (Kn) | 3547,562 | 1916,752 | 4541,95 |
| Mux (Knm) | 34,964 | 52,727 | 43,572 |
| Muy (Knm) | 66,316 | 16,158 | 65,279 |
| B1 (mm) | 1422 | 1422 | 1422 |
| B2 (mm) | 1422 | 1422 | 1422 |
| qu max (Kn/m^2) | 720,562 | 396,305 | 912,270 |
| qu min (Kn/m^2) | 620,672 | 328,365 | 804,913 |
| qu terjadi (Kn/m^2) | 670,617 | 362,335 | 858,592 |
| Vu/0.6 | 3652,531 | 1973,467 | 4676,342 |
| Vc1 | 123202,080 | 123202,080 | 123202,080 |
| Vc2 | 82134,720 | 82134,720 | 82134,720 |
| Kontrol : Vc2≥Vu/0,6 | OK | OK | OK |
| ***Perhit.Geser beton 1 arah :*** | | | |
| ***A rah X :*** | | | |
| G | 78 | 78 | 78 |
| qux max | 687,859 | 388,337 | 880,079 |
| qux min | 653,375 | 336,333 | 837,105 |
| qum | 686,689 | 386,573 | 878,621 |
| qux terjadi | 670,617 | 362,335 | 858,592 |
| Vu/0,6 | 200,514 | 108,338 | 256,719 |
| Vc | 1383,833 | 1383,833 | 1383,833 |
| Kontrol : Vc≥Vu/0,6 | Ok | Ok | Ok |
| ***Arah Y :*** | | | |
| quy max | 703,320 | 370,303 | 890,783 |
| quy min | 637,914 | 354,367 | 826,400 |
| qum | 701,101 | 369,763 | 888,600 |
| qux terjadi | 670,617 | 362,335 | 858,592 |
| Vu/0,6 | 120,309 | 65,003 | 154,031 |
| Vc | 1383,833 | 1383,833 | 1383,833 |
| Kontrol : Vc≥Vu/0,6 | Ok | Ok | Ok |
| Kuat tumpuan Pondasi | | | |
| syarat $\sqrt{\frac{Pu}{0,7Pn}} < 3$ | 2 | 2 | 2 |
| 0.7*Pn | 14577,500 | 14577,500 | 14577,500 |
| Kuat tumpuan Kolom | | | |
| 0.7Pn | 7288,750 | 7288,750 | 7288,750 |
| kontrol :0.7Pn pondasi>0.7PnKolom | Ok | Ok | Ok |
| qu max pakai | 720,562 | 396,305 | 912,270 |
| Mu/0.8 | 288,225 | 158,522 | 364,908 |
| Asperlu | 1108,897 | 609,887 | 1403,925 |
| As min | 2527,000 | 2527,000 | 2527,000 |
| 1.33As perlu | 1474,834 | 811,150 | 1867,220 |
| Pakai As | 1474,834 | 811,150 | 1867,220 |
| Jarak tul | 136,329 | 247,873 | 107,680 |
| Pakai jarak tul | 135 | 245 | 105 |
| As ada | 1489,351 | 820,663 | 1914,880 |
| Maka | D16-135 | D16-245 | D16-105 |
| Mn | 421,774 | 234,472 | 539,213 |
| Mn>1.33Mn/0.8 | Ok | Ok | Ok |
| Susut : Dtul | 12 | 12 | 12 |
| s | 70,686 | 70,686 | 70,686 |
| Pakai | P12-70 | P12-70 | P12-70 |

# LAMPIRAN GAMBAR