BAB V

PERHITUNGAN DAN ANALISIS

5.1 Perhitungan Beban

5.1.1 Perhitungan Beban Atap dan Lantai

a. Beban mati lantai :

- Berat plat 12 cm= 0,12.2400   = 288 kg/m^2
- Berat pasir 5 cm = 0,05.1600   = 80 kg/m^2
- Berat spesi/cm tebal, 3cm = 3.21   = 63 kg/m^2
- Berat tegel/cm tebal, 2cm = 2.24   = 48 kg/m^2
- Berat penggantung   = 7 kg/m^2
- Berat plafon   = 11 kg/m^2

              497 kg/m^2

b. Beban mati atap :

- Berat plat 10 cm = 0,1.2400   = 240 kg/m^2
- Berat penggantung   = 7 kg/m^2
- Berat plafon   = 11 kg/m^2

              258 kg/m^2

c. Berat tembok ½ bata = 250 kg/m^2

d. Beban hidup lantai = 250 kg/m^2

f. Beban hidup atap = 100 kg/m^2

g. Dimensi balok diambil 40/80

h. Dimensi kolom

Tabel 5.1 Dimensi kolom

Tingkat	Eksterior	Interior
1 - 3	40/75	40/85
4 - 6	40/65	40/75
7 - 8	40/60	40/65
9 - 10	40/50	40/60

5.2 Perhitungan Kebutuhan Dimensi Dinding Geser

5.2.1 Perhitungan Tebal Dinding Geser

Untuk menghindari terjadinya bahaya tekuk (*buckling*), perlakuan dinding geser sebagai kolom merupakan anggapan yang terbaik (T. Paulay dan R. L William 1980), maka dimensi dinding geser perlu dibatasi. Batasan tebal dinding geser (*bw*) dapat ddidekati dengan persamaan,

$$bw = \frac{hs}{20}$$

$$\geq 150 \text{ mm}$$

$$bw = \frac{5,25}{20} = 0,2625m = 26,25cm$$

bw diambil = 30 cm

5.2.2 Perhitungan Lebar Dinding Geser

Untuk menjamin bahwa dinding geser tetap berperilaku geser geser, menurut T. Paulay dan M.J.N. Priestly (1992), perbandingan antara tinggi total bangunan dan lebar dinding geser dapat diambil 8.

hw $= 3,75.9 + 5,25 = 39$ m

$\frac{hw}{lw} = 8$, dari Gambar 3.5, dengan anggapan perencanaan daktilitas penuh ($\mu_\Delta = 4$) didapat rasio daktilitas (μ_o)=11

Menurut Winter dan Nilson (1993), gaya geser pada dinding geser seringkali mencapai keadaan kritisnya, khususnya apabila hanya dipakai tulangan yang terdistribusi secara seragam, sehingga harus diketahui batasan tebal dinding geser kritis (bc) yang nilainya didekati dengan persamaan,

$bc = 0.017.lw\sqrt{\mu_\phi}$

$= 0,017.lw\sqrt{11}$

$bc = 0,057.lw$

$\frac{bc}{lw} = 0,057$

Dari Gambar 3.6 diperoleh untuk $\frac{bc}{lw} = 0,057$ dengan $\mu_\Delta = 4$

maka $\frac{hw}{lw} = 7$, lw $= \frac{39}{7} = 5,57$ m

lw diambil 5,5 m

5.3 Konversi Berat Tembok
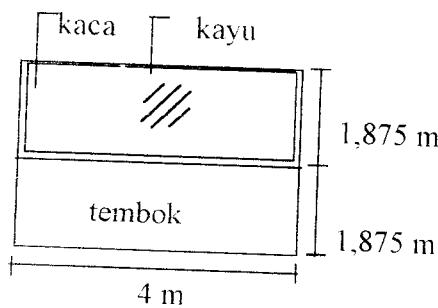
Gambar 5.1 Tembok dengan jendela
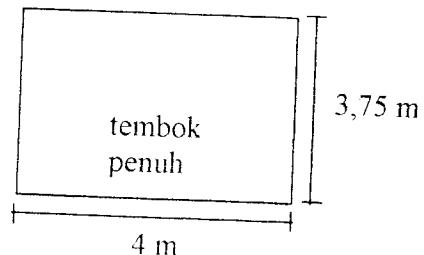
Gambar 5.2 Tembok penuh

a. Perhitungan gambar 5.1

kaca $= 4 \times 1,875 \times 10$ kg/m^2 $= 75$ kg

kayu $= [(4 \times 2) + (1,875 \times 2)] \times 0,12 \times 0.20 \times 1000$ kg/m^3 $= 282$ kg

tembok $= 4 \times 1,875 \times 250$ kg/m^2 $= 1875$ kg

$\overline{ 2232 \text{ kg}}$

b. Perhitungan gambar 5.2

Tembok penuh $= 4 \times 3,75 \times 250 = 3750$ kg

Nilai konversi tembok $= \dfrac{2232 kg}{3750 kg} = 0,5952 \approx 0,6$

Diambil nilai konversi berat tembok 0,6

5.4 Perhitungan Gaya Gempa Statik Ekivalen

Pada perencanaan ini perhitungan gaya gempa didasarkan pada PPTGUG 1987 dengan perhitungan sebagai berikut,

5.4.1 Struktur 16 Portal Tanpa Dinding Geser

1. Berat atap

   a. Beban tetap (mati)

- Berat pelat	$= 258.60.18$	$= 278640$ kg
- Berat tembok	$= 468. (1,875 - 0,8).250.0,6$	$= 75465$ kg
- Berat kolom eksterior	$= 34.1,875.0,4.0,5.2400$	$= 30600$ kg
- Berat kolom interior	$= 14.1,875.0,4.0,6.2400$	$= 15120$ kg
- Berat balok	$= 468.0,4.0,8.2400$	$= 359424$ kg
		759249 kg

   b. Beban hidup

   - Beban hidup atap $= 100$ kg/m^2

   - Koeefisien reduksi $= 0,3$

   - Beban hidup $= 0,3.18.60.100 = 32400$ kg

   Berat total atap $= 759249 + 32 400 = 791649$ kg

2. Berat lantai 9

   a. Beban tetap (mati)

- Berat pelat	$= 497.60.18$	$= 536760$ kg
- Berat tembok	$= 468. (3,75 - 0,8).250.0,6$	$= 207090$ kg
- Berat kolom eksterior	$= 34.3,75.0,4.0,5.2400$	$= 30600$ kg
- Berat kolom interior	$= 14. 3,75.0,4.0,6.2400$	$= 30240$ kg

- Berat balok $\quad\quad\quad$ =468.0,4.0,8.2400 $\quad\quad\quad$ 359424 kg

$$\overline{1194714 \ kg}$$

b. Beban hidup

- Beban hidup lantai = 250 kg/m²

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai 9 = 1194714 + 81000 = 1275714 kg

3. Berat lantai 8 = Berat lantai 7

a. Beban tetap (mati)

- Berat pelat $\quad\quad\quad$ = 497.60. 18 $\quad\quad\quad\quad$ = 536760 kg

- Berat tembok $\quad\quad\quad$ = 468. (3,75 – 0,8).250.0,6 $\quad\quad$ = 207090 kg

- Berat kolom eksterior $\quad$ = 34.3,75.0,4.0,6.2400 $\quad\quad$ = 73440 kg

- Berat kolom interior $\quad\quad$ = 14. 3,75.0,4.0,65.2400 $\quad\quad$ = 32760 kg

- Berat balok $\quad\quad\quad$ =468.0,4.0,8.2400 $\quad\quad\quad\quad$ = 359424 kg

$$\overline{1209474 \ kg}$$

b. Beban hidup

- Beban hidup lantai = 250 kg/m²

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1209474 + 81000 = 1290474 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	= 207090	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,65.2400	79560	kg
- Berat kolom interior	= 14. 3,75.0,4.0,75.2400	= 37800	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1220634	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1220634 + 81000 = 1301634 kg

5. Berat lantai 3   Berat lantai 2

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	= 207090	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,75.2400	= 91800	kg
- Berat kolom interior	= 14. 3,75.0,4.0,85.2400	= 42840	kg
- Berat balok	=468.0,4.0,8.2400	359424	kg
		1237914	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1237914 + 81000 = 1318914 kg

6. Berat lantai 1

   a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (4,5 – 0,8).250.0,6	= 259740	kg
- Berat kolom eksterior	= 34.4,5.0,4.0,75.2400	= 110160	kg
- Berat kolom interior	= 14. 4,5.0,4.0,85.2400	= 51408	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1317492	kg

   b. Beban hidup

  - Beban hidup = 0,3.18.60.250 = 81000 kg

  Berat total lantai = 1317492 + 81000 = 1398492 kg

7. Perhitungan gaya gempa statik ekivalen

$$T = 0,06 . H^{3/4} = 0,06 . (39)^{3/4} = 0,9364$$

  Daerah gempa 3, tanah lunak

  T = 0,9364 dt

  C = 0,07

  I = 1

  K = 1

  Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12589533 kg

$$V = C.I.K.W$$

$$= 0.07.1.1.\ 12589533\ kg = 881267.31\ kg$$

$$H - 39\ m\ ,\ B = 18\ m$$

$$\frac{H}{B} = \frac{39}{18} = 2.17 < 3.0$$

$$Fi = \frac{WixHi}{\Sigma WixHi}\,xV$$

Tabel 5.2 Beban gempa statik ekivalen struktur 16 portal tanpa dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	791649	30874311	101749,6103	33916,53	6359,350642
9	35,25	1275714	44968918,5	148199,9042	49399,96	9262,494011
8	31,5	1290474	40649931	133966,2167	44655,40	8372,888541
7	27,75	1290474	35810653,5	118017,8575	39339,28	7376,116096
6	24	1301634	31239216	102952,1939	34317,39	6434,51212
5	20,25	1301634	26358088,5	86865,91362	28955,30	5429,119601
4	16,5	1301634	21476961	70779,63332	23593,21	4423,727082
3	12,75	1318914	16816153,5	55419,44126	18473,14	3463,715079
2	9	1318914	11870226	39119,60559	13039,86	2444,97535
1	5,25	1398492	7342083	24196,62365	8065,541	1512,288978
		12589533	267406542	881267	293755,6	55079,1875

5.4.2 Struktur 15 Portal Tanpa Dinding Geser

1. Berat atap

   a. Beban tetap (mati)

   - Berat pelat   258.56. 18   260064   kg

   - Berat tembok   = 438. (1,875 – 0,8).250.0,6   = 70627,5   kg

   - Berat kolom eksterior   = 32.1,875.0,4.0,5.2400   28800   kg

- Berat kolom interior $13.1,875.0,4.0,6.2400$ 14040   kg

- Berat balok $438.0,4.0,8.2400$ 336384   kg

                                                    709915,5 kg

b. Beban hidup

- Beban hidup atap $= 100 \ kg/m^2$

- Koeefisien reduksi $0,3$

- Beban hidup $= 0,3.18.56.100 = 302240 \ kg$

Berat total atap $= 709915,5 + 302240 = 740155,5 \ kg$

2. Berat lantai 9

   a. Beban tetap (mati)

     - Berat pelat $497.56.18$ 500976   kg

     - Berat tembok $= 438.(3,75 - 0,8).250.0,6$ $=$ 193815   kg

     - Berat kolom eksterior $32.3,75.0,4.0,5.2400$ 57600   kg

     - Berat kolom interior $= 13.3,75.0,4.0,6.2400$ 28080   kg

     - Berat balok $= 438.0,4.0,8.2400$ 336384   kg

                                                    1116855   kg

b. Beban hidup

- Beban hidup lantai $= 250 \ kg/m^2$

- Beban hidup $= 0,3.18.56.250 = 75600 \ kg$

Berat total lantai 9 $= 1116855 + 75600 = 1192455 \ kg$

3. Berat lantai 8 $=$ Berat lantai 7

a. Beban tetap (mati)

- Berat pelat	= 497.56.18	500976	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,6.2400	= 69120	kg
- Berat kolom interior	= 13. 3,75.0,4.0,65.2400	30420	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1130715	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1130715 + 75600 = 1206315 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat tembok	= 48. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,65.2400	= 74880	kg
- Berat kolom interior	= 13. 3,75.0,4.0,75.2400	= 35100	kg
- Berat balok	=438.0,4.0,8.2400	336384	kg
		1141155	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1141155 + 75600 = 1216755 kg

5. Berat lantai 3 = Berat lantai 2

   a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,75.2400	= 86400	kg
- Berat kolom interior	= 13. 3,75.0,4.0,85.2400	= 39780	kg
- Berat balok	= 438.0,4.0,8.2400	= 336384	kg
		1157355	kg

   b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1157355 + 75600 = 1232955 kg

6. Berat lantai 1

   a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat tembok	= 438. (4,5 – 0,8).250.0,6	= 243090	kg
- Berat kolom eksterior	= 32.4,5.0,4.0,75.2400	= 103680	kg
- Berat kolom interior	= 13. 4,5.0,4.0,85.2400	= 43736	kg
- Berat balok	= 438.0,4.0,8.2400	= 336384	kg
		1157355	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1157355 + 75600 = 1307466 kg

7. Perhitungan gaya gempa statik ekivalen

$T = 0,06 . H^{3/4} = 0,06 . (39)^{3/4} = 0,9364$

Daerah gempa 3, tanah lunak

T = 0,9364 dt

C = 0,07

I = 1

K = 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 11617681,5 kg

V = C.I.K.W

= 0,07.1.1. 11617681,5 kg = 813237,7 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} xV$$

Tabel 5.3 Beban gempa statik ekivalen struktur 15 portal tanpa dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	740155.5	28866064.5	95623.48135	31874.4938	5976.46758
9	35.25	1192455	42034038.75	139244.5139	46414.838	8702.78212
8	31.5	1130715	35617522.5	117988.7719	39329.5906	7374.29824
7	27.75	1130715	31377341.25	103942.4895	34647.4965	6496.40559
6	24	1216755	29202120	96736.71925	32245.5731	6046.04495
5	20.25	1216755	24639288.75	81621.60686	27207.2023	5101.35043
4	16.5	1216755	20076457.5	66506.49448	22168.8315	4156.65591
3	12.75	1232955	15720176.25	52075.61219	17358.5374	3254.72576
2	9	1232955	11096595	36759.25567	12253.0852	2297.45348
1	5.25	1307466	6864196.5	22738.75491	7579.58497	1421.17218
		11617681.5	245493801	813237.7	271079.233	50827.3563

5.4.3 Struktur 16 Portal Dengan 2 Dinding Geser

1. Berat atap

   a. Beban tetap (mati)

- Berat pelat	= 258.60.18	= 278640 kg
- Berat tembok	= 468. (1,875 – 0,8).250.0,6	= 75465 kg
- Berat shear wall	= 2.5,5.1,875.0,3.2400	= 14850 kg
- Berat kolom eksterior	= 34.1,875.0,4.0,5.2400	= 30600 kg
- Berat kolom interior	= 14.1,875.0,4.0,6.2400	= 15120 kg
- Berat balok	=468.0,4.0,8.2400	= 359424 kg

   774099 kg

   b. Beban hidup

   - Beban hidup atap = 100 kg/m^2

- Koeefisien reduksi = 0,3

- Beban hidup = 0,3.18.60.100 = 32400 kg

Berat total atap = 774099 + 32 400 = 806499 kg

2. Berat lantai 9

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	468. (3,75 0,8).250.0,6	207090	kg
- Berat shear wall	= 2,5.5.3,75.0,3.2400	29700	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,5.2400	= 30600	kg
- Berat kolom interior	= 14. 3,75.0,4.0,6.2400	= 30240	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1224414	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai 9 = 1224414 + 81000 = 1305414 kg

3. Berat lantai 8 = Berat lantai 7

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	= 207090	kg
- Berat shear wall	= 2,5.5.3,75.0,3.2400	= 29700	kg

- Berat kolom eksterior	34.3,75.0,4.0,6.2400	73440	kg
- Berat kolom interior	= 14. 3,75.0,4.0,65.2400	32760	kg
- Berat balok	=468.0,4.0,8.2400	359424	kg
		1239174	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1239174 + 81000 = 1320174 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18		536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	=	207090	kg
- Berat shear wall	= 2.5,5.3,75.0,3.2400	=	29700	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,65.2400	=	79560	kg
- Berat kolom interior	= 14. 3,75.0,4.0,75.2400	=	37800	kg
- Berat balok	=468.0,4.0,8.2400	=	359424	kg
			1250334	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1250334 + 81000 = 1331334 kg

5. Berat lantai 3 = Berat lantai 2

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (3,75 − 0,8).250.0,6	= 207090	kg
- Berat shear wall	= 2.5,5.3,75.0,3.2400	= 29700	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,75.2400	= 91800	kg
- Berat kolom interior	= 14. 3,75.0,4.0,85.2400	= 42840	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1267614	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1267614 + 81000 = 1348614 kg

6. Berat lantai 1

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	= 536760	kg
- Berat tembok	= 468. (4,5 − 0,8).250.0,6	= 259740	kg
- Berat shear wall	= 2.5,5.4,5.0,3.2400	= 35640	kg
- Berat kolom eksterior	= 34.4,5.0,4.0,75.2400	= 110160	kg
- Berat kolom interior	= 14. 4,5.0,4.0,85.2400	= 51408	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1353132	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1353132 + 81000 = 1434132 kg

7. Perhitungan gaya gempa statik ekivalen

$$T = \frac{0,09.Hn}{\sqrt{B}} = \frac{0,09.39}{\sqrt{18}} = 0,827 dt$$

Daerah gempa 3, tanah lunak

T = 0,827dt

C = 0,07

I = 1

K = 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12877623 kg

V = C.I.K.W

= 0,07.1.1. 12877623 kg = 901433,61 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} x V$$

Tabel 5.4 Beban gempa statik ekivalen struktur 16 portal dengan 2 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	806499	31453461	103694.6853	34564.8951	6480.91783
9	35.25	1305414	46015843.5	151703.4456	50567.8152	9481.46535
8	31.5	1320174	41585481	137097.5793	45699.1931	8568.59871
7	27.75	1320174	36634828.5	120776.4389	40258.813	7548.52743
6	24	1331334	31952016	105338.3042	35112.7681	6583.64401
5	20.25	1331334	26959513.5	88879.19418	29626.3981	5554.94964
4	16.5	1331334	21967011	72420.08415	24140.028	4526.25526
3	12.75	1348614	17194828.5	56687.31749	18895.7725	3542.95734
2	9	1348614	12137526	40014.57705	13338.1924	2500.91107
1	5.25	1434132	7529193	24821.98377	8273.99459	1551.37399
		12877623	273429702	901433.61	300477.87	56339.6006

5.4.4 Struktur 15 Portal Dengan 3 Dinding Geser

1. Berat atap :

   a. Beban tetap (mati)

   - Berat pelat $258.56.18$ 260064   kg

   - Berat tembok $= 438. (1,875 - 0,8).250.0,6$ $=$ 70627,5   kg

   - Berat shear wall $= 3.5,5.1,875.0,3.2400$ $=$ 22275   kg

   - Berat kolom eksterior $= 32.1,875.0,4.0,5.2400$ $=$ 28800   kg

   - Berat kolom interior $= 13.1,875.0,4.0,6.2400$ $=$ 14040   kg

   - Berat balok $=438.0,4.0,8.2400$ $=$ 336384   kg

   _____

   732190,5 kg

   b. Beban hidup

   - Beban hidup atap $= 100$ kg/m^2

   - Koeefisien reduksi $= 0,3$

- Beban hidup = 0,3.18.56.100 = 302240 kg

Berat total atap = 732190,5 + 302240 = 762430,5 kg

2. Berat lantai 9

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	=	500976	kg
- Berat shear wall	= 3.5,5.3,75.0,3.2400	=	44550	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	=	193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,5.2400	=	57600	kg
- Berat kolom interior	= 13. 3,75.0,4.0,6.2400	=	28080	kg
- Berat balok	= 438.0,4.0,8.2400	=	336384	kg
			1161405	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai 9 = 1161405 + 75600 = 1237005 kg

3. Berat lantai 8 = Berat lantai 7

a. Beban tetap (mati)

- Berat pelat	= 497.56 18	=	500976	kg
- Berat shear wall	= 3.5,5.3,75.0,3.2400	=	44550	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	=	193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,6.2400	=	69120	kg

- Berat kolom interior	= 13. 3,75.0,4.0,65.2400	= 30420	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1175265	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1175265 + 75600 = 1250865 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

a. Beban tetap (mati)

- Berat pelat	497.56. 18	500976	kg
- Berat shear wall	= 3.5,5.3,75.0,3.2400	44550	kg
- Berat tembok	= 48. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,65.2400	= 74880	kg
- Berat kolom interior	= 13. 3,75.0,4.0,75.2400	= 35100	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1185705	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1185705 + 75600 = 1261305 kg

5. Berat lantai 3 = Berat lantai 2

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat shear wall	3.5,5.3,75.0,3.2400	44550	kg
- Berat tembok	438. (3,75 – 0,8).250.0,6	193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,75.2400	= 86400	kg
- Berat kolom interior	= 13. 3,75.0,4.0,85.2400	= 39780	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1201905	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1201905 + 75600 = 1277505 kg

6. Berat lantai 1

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat shear wall	3.5,5.4,5.0,3.2400	53460	kg
- Berat tembok	438. (4,5 – 0,8).250.0,6	243090	kg
- Berat kolom eksterior	= 32.4,5.0,4.0,75.2400	= 103680	kg
- Berat kolom interior	= 13. 4,5.0,4.0,85.2400	= 43736	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1285326	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1285326 + 75600 = 1360926 kg

7. Perhitungan gaya gempa statik ekivalen

$$T = \frac{0,09.Hn}{\sqrt{B}} = \frac{0,09.39}{\sqrt{18}} = 0,827 dt$$

Daerah gempa 3, tanah lunak

T = 0,827dt

C = 0,07

I = 1

K = 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12201016,5 kg

V = C.I.K.W

$= 0,07.1.1.$ 12201016,5 kg $=$ 854071,155 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$F_i = \frac{WixHi}{\Sigma WixHi} xV$$

Tabel 5.5 Beban gempa statik ekivalen struktur 15 portal dengan 3 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	762430,5	29734789,5	98049,64172	32683,2139	6128,10261
9	35,25	1237005	43604426,25	143784,3833	47928,1278	8986,52396
8	31,5	1250865	39402247,5	129927,8157	43309,2719	8120,48848
7	27,75	1250865	34711503,75	114460,2186	38153,4062	7153,76366
6	24	1261305	30271320	99818,83612	33272,9454	6238,67726
5	20,25	1261305	25541426,25	84222,14298	28074,0477	5263,88394
4	16,5	1261305	20811532,5	68625,44984	22875,1499	4289,09061
3	12,75	1277505	16288188,75	53709,84957	17903,2832	3356,8656
2	9	1277505	11497545	37912,83499	12637,6117	2369,55219
1	5,25	1360926	7144861,5	23559,98216	7853,32739	1472,49889
		12201016,5	259007841	854071,155	284690,385	53379,4472

5.4.5 Struktur 16 Portal Dengan 4 Dinding Geser

1. Berat atap

   a. Beban tetap (mati)

- Berat pelat	258.60. 18		278640 kg
- Berat tembok	= 468. (1,875 – 0,8).250.0,6		75465 kg
- Berat shear wall	= 4.5.1,875.0,3.2400		29700 kg
- Berat kolom eksterior	= 34.1,875.0,4.0,5.2400	=	30600 kg
- Berat kolom interior	= 14.1,875.0,4.0,6.2400	=	15120 kg
- Berat balok	=468.0,4.0,8.2400	=	359424 kg
			788949 kg

   b. Beban hidup

   - Beban hidup atap = 100 kg/m^2

   - Koeefisien reduksi = 0,3

- Beban hidup = 0,3.18.60.100 = 32400 kg

Berat total atap = 788949 + 32 400 = 821349 kg

2. Berat lantai 9

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18		536760 kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6		207090 kg
- Berat shear wall	= 4.5,5.3,75.0,3.2400		59400 kg
- Berat kolom eksterior	= 34.3,75.0,4.0,5.2400	=	30600 kg
- Berat kolom interior	= 14. 3,75.0,4.0,6.2400	=	30240 kg
- Berat balok	=468.0,4.0,8.2400	=	359424 kg
			1254114 kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai 9 = 1254114 + 81000 = 1335114 kg

3. Berat lantai 8 = Berat lantai 7

a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	=	536760 kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	=	207090 kg
- Berat shear wall	= 4.5,5.3,75.0,3.2400	=	59400 kg
- Berat kolom eksterior	= 34.3,75.0,4.0,6.2400	=	73440 kg

- Berat kolom interior	= 14. 3,75.0,4.0,65.2400	32760	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1268874	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1268874 + 81000 = 1349874 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

   a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	= 207090	kg
- Berat shear wall	= 4.5,5.3,75.0,3.2400	= 59400	kg
- Berat kolom eksterior	= 34.3,75.0,4.0,65.2400	= 79560	kg
- Berat kolom interior	= 14. 3,75.0,4.0,75.2400	= 37800	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1280034	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1280034 + 81000 = 1361034 kg

5. Berat lantai 3 = Berat lantai 2

   a. Beban tetap (mati)

- Berat pelat	= 497.60. 18	536760	kg
- Berat tembok	= 468. (3,75 – 0,8).250.0,6	207090	kg
- Berat shear wall	= 4.5,5.3,75.0,3.2400	59400	kg
- Berat kolom eksterior	34.3,75.0,4.0,75.2400	91800	kg
- Berat kolom interior	= 14. 3,75.0,4.0,85.2400	42840	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1297314	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1297314 + 81000 = 1378314 kg

6. Berat lantai 1

a. Beban tetap (mati)

- Berat pelat	497.60. 18	536760	kg
- Berat tembok	= 468. (4,5 – 0,8).250.0,6	259740	kg
- Berat shear wall	4.5,5.4,5.0,3.2400	71280	kg
- Berat kolom eksterior	= 34.4,5.0,4.0,75.2400	= 110160	kg
- Berat kolom interior	= 14. 4,5.0,4.0,85.2400	= 51408	kg
- Berat balok	=468.0,4.0,8.2400	= 359424	kg
		1388772	kg

b. Beban hidup

- Beban hidup = 0,3.18.60.250 = 81000 kg

Berat total lantai = 1388772 + 81000 = 1496772 kg

7. Perhitungan gaya gempa statik ekivalen

$$T = \frac{0,09.Hn}{\sqrt{B}} = \frac{0,09.39}{\sqrt{18}} = 0,827dt$$

Daerah gempa 3, tanah lunak

T = 0,827dt

C = 0,07

I = 1

K = 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 13165713 kg

V = C.I.K.W

= 0,07.1.1. 13165713 kg = 921599,91 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi}.xV$$

Tabel 5.6 Beban gempa statik ekivalen struktur 16 portal dengan 4 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	821349	32032611	105639.4671	35213.1557	6602.46669
9	35.25	1335114	47062768.5	155207.0102	51735.6701	9700.43814
8	31.5	1349874	42521031	140228.939	46742.9797	8764.30869
7	27.75	1349874	37459003.5	123535.0177	41178.3392	7720.93861
6	24	1361034	32664816	107724.3986	35908.1329	6732.77491
5	20.25	1361034	27560938.5	90892.46129	30297.4871	5680.77883
4	16.5	1361034	22457061	74060.52401	24686.8413	4628.78275
3	12.75	1378314	17573503.5	57955.17401	19318.3913	3622.19838
2	9	1378314	12404826	40909.53459	13636.5115	2556.84591
1	5.25	1469772	7716303	25447.3835	8482.46117	1590.46147
		13165713	279452862	921599.91	307199.97	57599.9944

5.4.6 Struktur 15 Portal Dengan 5 Dinding Geser

1. Berat atap :

   a. Beban tetap (mati)

   - Berat pelat $= 258.56.18$ $= 260064$ kg

   - Berat tembok $= 438. (1,875 - 0,8).250.0,6$ $= 70627,5$ kg

   - Berat shear wall $= 5.5.5.1,875.0,3.2400$ $= 37125$ kg

   - Berat kolom eksterior $= 32.1,875.0,4.0,5.2400$ $= 28800$ kg

   - Berat kolom interior $= 13.1,875.0,4.0,6.2400$ $= 14040$ kg

   - Berat balok $= 438.0,4.0,8.2400$ $= 336384$ kg

   _____

   747040,5 kg

   b. Beban hidup

   - Beban hidup atap $= 100$ kg/m^2

   - Koeefisien reduksi $= 0,3$

- Beban hidup = 0,3.18.56.100 = 302240 kg

Berat total atap = 747040,5 + 302240 = 777280,5 kg

2. Berat lantai 9

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat shear wall	= 5.5,5.3,75.0,3.2400	= 74250	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,5.2400	= 57600	kg
- Berat kolom interior	= 13. 3,75.0,4.0,6.2400	= 28080	kg
- Berat balok	= 438.0,4.0,8.2400	= 336384	kg
		1191105	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai 9 = 1191105 + 75600 = 1266705 kg

3. Berat lantai 8 = Berat lantai 7

a. Beban tetap (mati)

- Berat pelat	= 497.56 18	= 500976	kg
- Berat shear wall	= 5.5,5.3,75.0,3.2400	= 74250	kg
- Berat tembok	= 438. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,6.2400	= 69120	kg

- Berat kolom interior	= 13. 3,75.0,4.0,65.2400	= 30420	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1204965	kg

b. Beban hidup

- Beban hidup lantai = 250 kg/m^2

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1204965 + 75600 = 1280565 kg

4. Berat lantai 6 = Berat lantai 5 = Berat lantai 4

a. Beban tetap (mati)

- Berat pelat	= 497.56. 18	= 500976	kg
- Berat shear wall	= 5.5,5.3,75.0,3.2400	= 74250	kg
- Berat tembok	= 48. (3,75 – 0,8).250.0,6	= 193815	kg
- Berat kolom eksterior	= 32.3,75.0,4.0,65.2400	= 74880	kg
- Berat kolom interior	= 13. 3,75.0,4.0,75.2400	= 35100	kg
- Berat balok	=438.0,4.0,8.2400	= 336384	kg
		1215405	kg

b. Beban hidup

- Beban hidup = 0,3.18.56.250 = 75600 kg

Berat total lantai = 1215405 + 75600 = 1291005 kg

5. Berat lantai 3 = Berat lantai 2

a. Beban tetap (mati)

- Berat pelat $= 497.56.18$ 500976 kg

- Berat shear wall $= 5.5,5.3,75.0,3.2400$ 74250 kg

- Berat tembok $= 438. (3,75 - 0,8).250.0,6$ $= 193815$ kg

- Berat kolom eksterior $= 32.3,75.0,4.0,75.2400$ $= 86400$ kg

- Berat kolom interior $= 13. 3,75.0,4.0,85.2400$ $= 39780$ kg

- Berat balok $=438.0,4.0,8.2400$ $= 336384$ kg

                                                      1231605 kg

b. Beban hidup

- Beban hidup $= 0,3.18.56.250 = 75600$ kg

Berat total lantai $= 1231605 + 75600 = 1307205$ kg

6. Berat lantai 1

   a. Beban tetap (mati)

- Berat pelat $497.56. 18$ 500976 kg

- Berat shear wall $= 5.5,5.4,5.0,3.2400$ $= 89100$ kg

- Berat tembok $= 438. (4,5 - 0,8).250.0,6$ $= 243090$ kg

- Berat kolom eksterior $= 32.4,5.0,4.0,75.2400$ $= 103680$ kg

- Berat kolom interior $= 13. 4,5.0,4.0,85.2400$ $= 43736$ kg

- Berat balok $=438.0,4.0,8.2400$ $= 336384$ kg

                                                      1320966 kg

b. Beban hidup

- Beban hidup $= 0,3.18.56.250 = 75600$ kg

Berat total lantai   1320966 + 75600   1396566 kg

7. Perhitungan gaya gempa statik ekivalen

$$T = \frac{0,09.Hn}{\sqrt{B}} = \frac{0,09.39}{\sqrt{18}} = 0,827dt$$

Daerah gempa 3, tanah lunak

T = 0,827dt

C = 0,07

I = 1

K= 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12489106,5 kg

V = C.I.K.W

   = 0,07.1.1.12489106,5 kg = 874237,455 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi}xV$$

## Tabel 5.7 Beban gempa statik ekivalen struktur 15 portal dengan 5 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	777280.5	30313939.5	99994.26942	33331.4231	6249.64184
9	35.25	1266705	44651351.25	147287.991	49095.997	9205.49943
8	31.5	1280565	40337797.5	133059.2017	44353.0672	8316.20011
7	27.75	1280565	35535678.75	117218.8206	39072.9402	7326.17629
6	24	1291005	30984120	102204.9425	34068.3142	6387.80891
5	20.25	1291005	26142851.25	86235.42022	28745.1401	5389.71376
4	16.5	1291005	21301582.5	70265.89796	23421.966	4391.61862
3	12.75	1307205	16666863.75	54977.70635	18325.9021	3436.10665
2	9	1307205	11764845	38807.79272	12935.9309	2425.48705
1	5.25	1396566	7331971.5	24185.41257	8061.80419	1511.58829
		12489106.5	265031001	874237.455	291412.485	54639.8409

5.5 Perhitungan Beban Pada Portal

$$heq = \frac{8}{l^2}\left(\frac{1}{8}.a.l^2 - \frac{1}{6}.a.d^2\right)$$

$$= \frac{8}{9^2}\left(\frac{1}{8}.2.9^2 - \frac{1}{6}.2.2^2\right)$$

$$1,87 \text{ m}$$

$$heq = 2/3.a$$

$$= 2/3.2$$
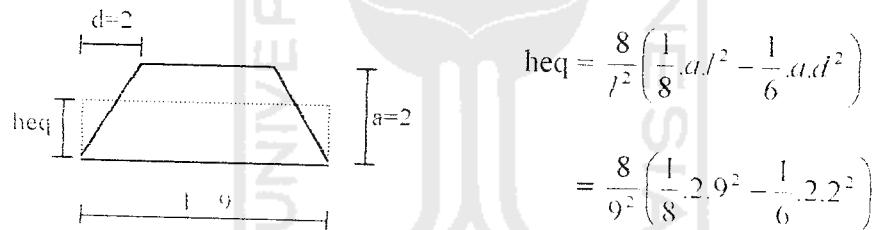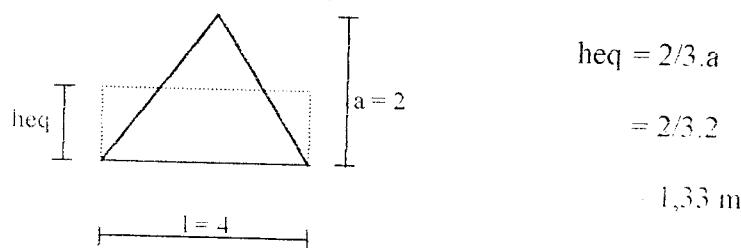
$$1,33 \text{ m}$$

Untuk perhitungan beban pada portal, disini hanya ditampilkan pembebanan pada portal dengan bentang 15 bentang. Untuk portal dengan 14 bentang, secara umum sama, perbedaannya hanya pada jumlah portalnya (terdiri dari portal

A.B.C,D,E.F,G,H,I,J,K,L,M,N,O) dan panjang bentangnya (14 x 4 m) dengan portal O sebagai portal luar (eksterior).

5.5.1 Portal A dan P

Portal A dan P

- Beban mati atap   = Berat pelat atap = 1,87.258 = 482,46 kg/m

- Beban hidup atap = 1,87.100.0,75 = 140,25 kg/m

- Beban mati lantai = Berat pelat lantai = 1,87.497 = 929,4 kg/m

                             Berat tembok = 3,75.0,6.250 = 562,5 kg/m

                                                      1491,9 kg/m

- Beban hidup lantai = 1,87.250.0,75 = 318,75 kg/m

5.5.2 Portal B sampai N

- Beban mati atap   = Berat pelat atap = 2.1,87.258 = 964,92 kg/m

- Beban hidup atap   2.1,87.100.0,75 = 280,5 kg/m

- Beban mati lantai = Berat pelat lantai = 2.1,87.497 = 1858,87 kg/m

                           berat tembok   = 3,75.0,6.250 = 562,5kg/m

                                                 2421,28 kg/m

- Beban hidup lantai = 2.1,87.250.0,75 = 701,25 kg/m

5.5.3 Portal 1 DAN 3

- Beban mati atap   = Berat pelat atap = 1,33.258 = 343,14 kg/m

- Beban hidup atap = 1,33.100.0,75 = 99,75 kg/m

- Beban mati lantai = Berat pelat lantai = 1,33.497   = 661   kg/m

$$\text{Berat tembok} = 3,75.0,6.250 \qquad = \underline{562,5 \text{ kg/m}}$$

$$1223,5 \text{ kg/m}$$

- Beban hidup lantai = $1,33.250.0,75 = 249,38$ kg/m

5.5.4 Portal 2

- Beban mati atap = Berat pelat atap = $2.1,33.258 = 686,28$ kg/m

- Beban hidup atap = $2.1,33.100.0,75 = 199,5$ kg/m

- Beban mati lantai = Berat pelat lantai = $2.1,33.497 = 1322$ kg/m

$$\text{Berat tembok} = 3,75.0,6.250 \qquad = 562,5 \text{ kg/m}$$

$$1884,5 \text{ kg/m}$$

- Beban hidup lantai = $2.1,33.250.0,75 = 498,75$ kg/m

5.6 Gambar Pembebanan Pada Struktur

5.6.1 Portal A dan P
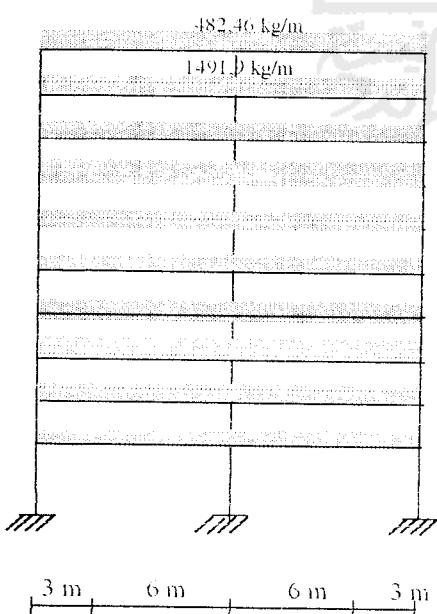
Gambar 5.3 Beban mati portal A dan P   **Gambar 5.4** Beban hidup portal A dan P
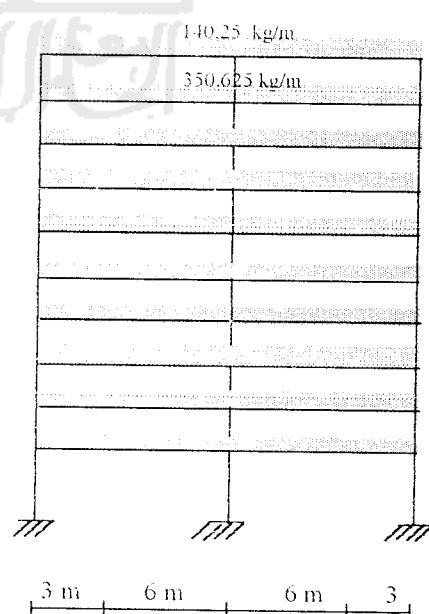
5.6.2 Portal B sampai N

964.92 kg/m
2421.28 kg/m

289.5 kg/m
701.25 kg/m

| 3 m | 6 m | 6 m | 3 |

| 3 m | 6 m | 6 m | 3 |
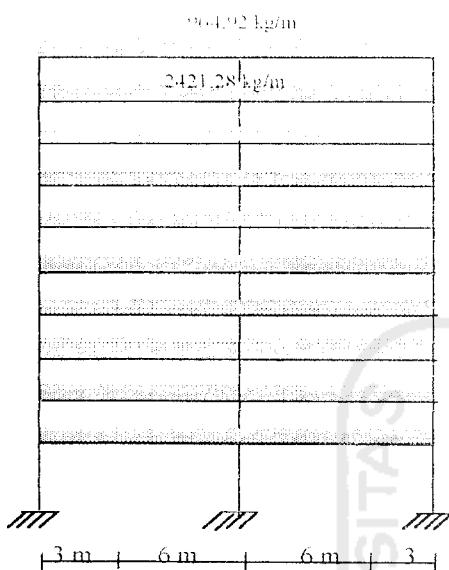
Gambar 5.5 Beban mati portal B sampai N   **Gambar 5.6** Beban hidup portal B sampai N
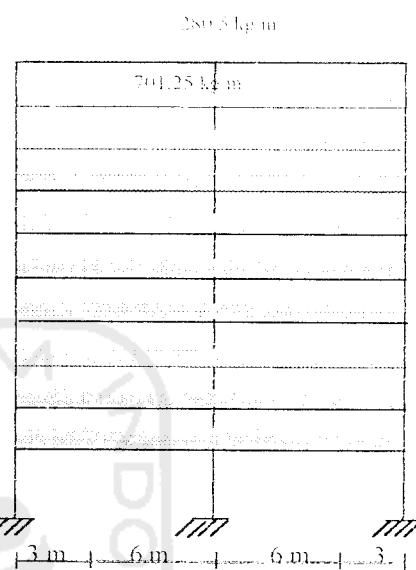
5.6.3 Portal 1 dan 3

343.14 kg/m
223.5 kg/m

4m x 15
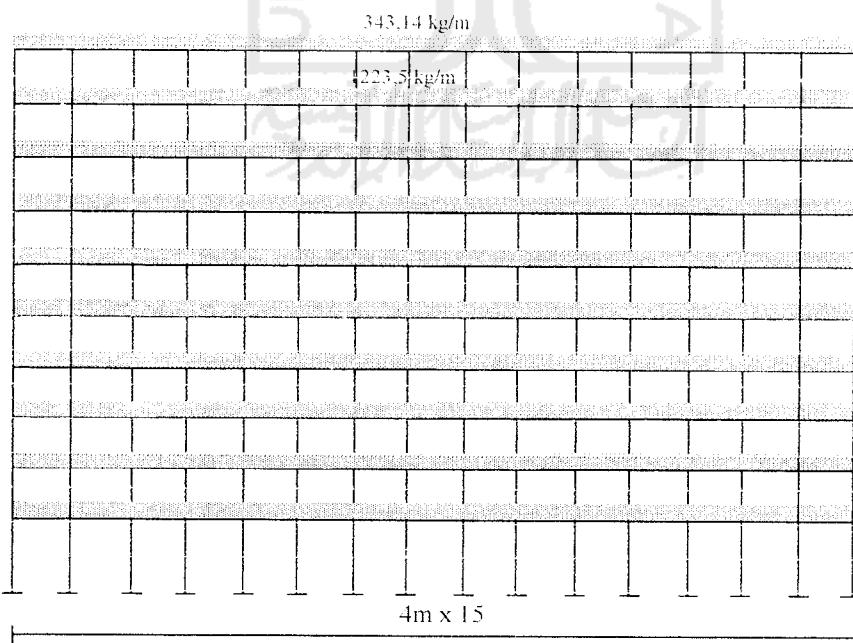
Gambar 5.7 Beban mati portal 1 dan 3

99,75 kg/m

249,38 kg/m

4m x 15
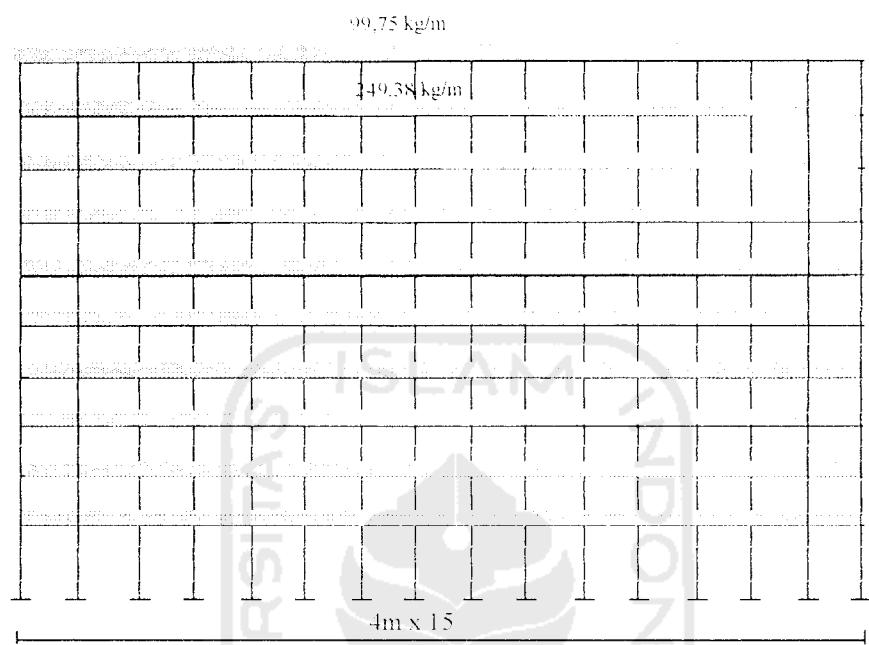
Gambar 5.8 Beban hidup portal 1 dan 3

5.6.4 Portal 2

686,28 kg/m

1884,5 kg/m

4m x 15
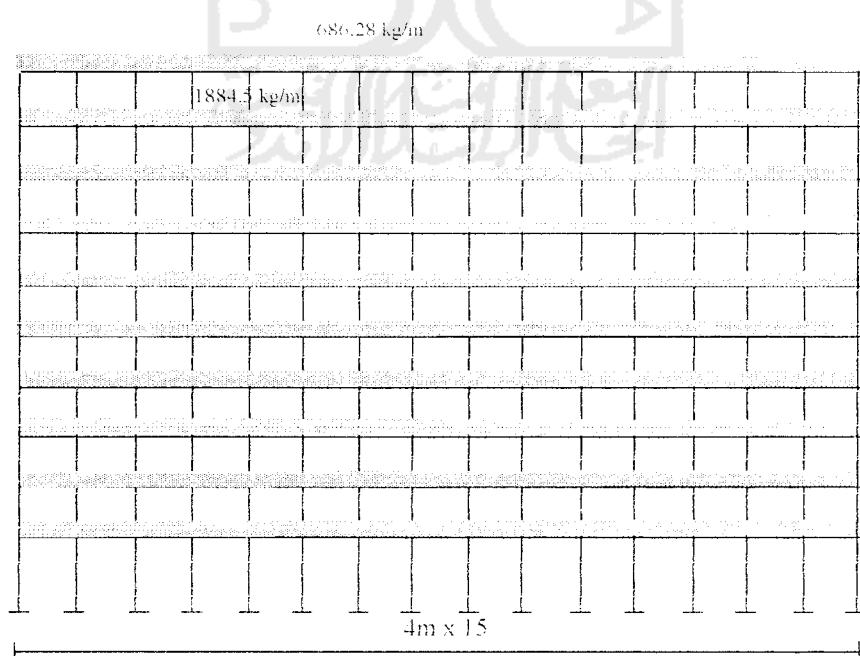
Gambar 5.9 Beban mati portal 2
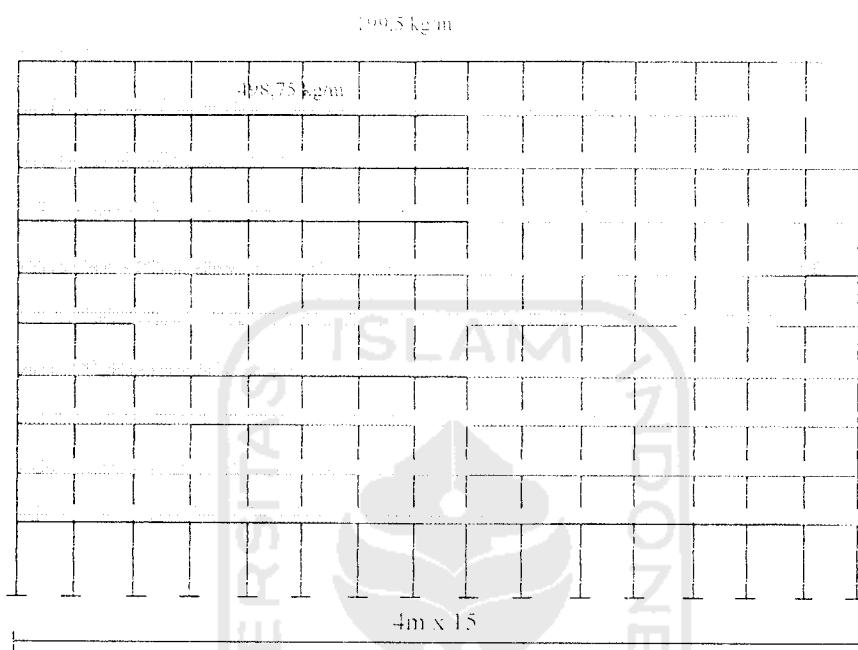
Gambar 5.10 Beban hidup portal 2

5.7 Simpangan Horisontal Struktur

Berdasarkan kombinasi gaya-gaya gempa dan beban gravitasi yang terjadi, dengan menggunakan program komputer SAP 90 dapat diketahui simpangan horisontal struktur yang terjadi dari masing-masing variasi jumlah dinding geser. Dalam tugas akhir ini, digunakan kombinasi pembebanan yang memperhitungkan dua arah gempa pada sumbu yang berbeda, yakni 100 % pada arah sumbu utama yang ditinjau dan 30 % pada arah tegak lurus dari sumbu yang ditinjau. Pada tabel dan

grafik berikut ini, dapat dilihat perbedaan simpangan horisontal yang terjadi pada

masing-masing struktur.

5.7.1 Simpangan Horisontal Struktur Akibat Beban Gempa Arah Y Awal

Tabel 5.8 Struktur 15 portal tanpa dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL C	PORTAL E	PORTAL H
1	0,9796	0,9547	0,9498	0,9478
2	1,8012	1,7805	1,7716	1,7679
3	2,5917	2,5769	2,5646	2,5592
4	3,4294	3,4059	3,3903	3,3832
5	4,2003	4,1682	4,1498	4,1412
6	4,8864	4,8472	4,8265	4,8165
7	5,5138	5,4807	5,4577	5,4465
8	6,0183	5,9911	5,9661	5,9539
9	6,4463	6,3999	6,3732	6,3602
10	6,673	6,6240	6,5962	6,5827

Tabel 5.9 Struktur 16 portal tanpa dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL E	PORTAL F	PORTAL H
1	1,062	1,0297	1,0284	1,0272
2	1,9526	1,9203	1,9178	1,9156
3	2,8104	2,7807	2,7771	2,7739
4	3,7209	3,6781	3,6733	3,6691
5	4,5604	4,505	4,4993	4,494
6	5,3097	5,2437	5,2371	5,231
7	5,9974	5,9351	5,9277	5,9208
8	6,5341	6,4877	6,4796	6,4721
9	7,0043	6,9241	6,9154	6,9075
10	7,2464	7,1524	7,1534	7,1451

Tabel 5.10 Struktur 16 portal dengan 2 dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL E	PORTAL F	PORTAL H
1	0,8514	0,3324	0,5218	0,7356
2	1,5671	0,7858	1,0353	1,3783
3	2,2589	1,3393	1,5907	2,0073
4	2,9977	1,9565	2,2199	2,677
5	3,6854	2,5882	2,8461	3,3113
6	4,3054	3,2081	3,444	3,8937
7	4,8788	3,8051	4,0377	4,4528
8	5,3392	4,3598	4,5561	4,91
9	5,722	4,8877	5,0232	5,2738
10	5,9192	5,3662	5,3322	5,4693

Tabel 5.11 Struktur 15 portal dengan 3 dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL C	PORTAL E	PORTAL H
1	0,2309	0,587	0,6585	0,2974
2	0,5567	1,1064	1,2342	0,7037
3	0,9637	1,6213	1,7966	1,1991
4	1,4262	2,1776	2,3941	1,7514
5	1,9096	2,7121	2,9593	2,3167
6	2,3935	3,209	3,4775	2,8712
7	2,8686	3,692	3,9736	3,4051
8	3,3185	4,0939	4,3788	3,9011
9	3,7534	4,4203	4,699	4,3729
10	4,1528	4,5982	4,8699	4,8001

Tabel 5.12 Struktur 16 portal dengan 4 dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL E	PORTAL F	PORTAL H
1	0,2203	0,4290	0,2784	0,5449
2	0,5315	0,8537	0,6595	1,0328
3	0,9204	1,3140	1,1244	1,5253
4	1,3625	1,8374	1,6432	2,0684
5	1,8248	2,3611	2,1749	2,6011
6	2,2881	2,8643	2,6972	3,1053
7	2,7430	3,3637	3,2005	3,6039
8	3,1741	3,8019	3,6685	4,0253
9	3,5908	4,1956	4,1136	4,3737
10	3,9732	4,4538	4,5164	4,5657

Tabel 5.13 Struktur 15 portal dengan 5 dinding geser

TINGKAT	SIMPANGAN HORISONTAL ARAH SUMBU Y (cm)			
	PORTAL A	PORTAL C	PORTAL E	PORTAL H
1	0,1993	0,4215	0,2338	0,2273
2	0,4812	0,8056	0,5558	0,5416
3	0,833	1,2005	0,9494	0,927
4	1,2327	1,6448	1,39	1,3599
5	1,6502	2,0894	1,8431	1,8069
6	2,0676	2,5174	2,2889	2,2485
7	2,4755	2,9489	2,718	2,675
8	2,8617	3,3176	3,1172	3,073
9	3,2279	3,5909	3,4894	3,4447
10	3,5605	3,7507	3,8224	3,7774

5.7.2 Cek Periode Getar dengan Metode Rayleigh

Waktu getar struktur yang sebenarnya untuk tiap arah dapat dihitung berdasarkan besar simpangan tadi dengan rumus *T Rayleigh*, dengan menggunakan persamaan (3.5).

Tabel 5.14 Struktur 15 portal tanpa dinding geser

TINGKAT	Wi (ton)	di y (cm)	di y²	Fi y (ton)	Wi.di²	Fiy.diy
10	52,86821	6,618975	43,81083	5,976	2316,2	39,55499
9	85,17536	6,3949	40,89475	8,702	3483,225	55,64842
8	80,76536	5,98235	35,78851	7,374	2890,472	44,11385
7	80,76536	5,474675	29,97207	6,496	2420,705	35,56349
6	86,91107	4,84415	23,46579	6,046	2039,437	29,28773
5	86,91107	4,164875	17,34618	5,101	1507,575	21,24503
4	86,91107	3,4022	11,57496	4,156	1005,993	14,13954
3	88,06821	2,5731	6,620844	3,254	583,0859	8,372867
2	88,06821	1,7803	3,169468	2,297	279,1294	4,089349
1	93,39043	0,957975	0,917716	1,421	85,7059	1,361282
					16611,53	253,3766

$$Ty = 6,3 . \sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy} \right)} = 1,6295 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0414

Tabel 5.15 Struktur 16 portal tanpa dinding geser

TINGKAT	Wi (ton)	di y (cm)	di y²	Fi y (ton)	Wi.di²	Fiy.diy
10	52,7766	7,174325	51,47094	6,359	2716,461	45,62153
9	85,0476	6,937825	48,13342	9,262	4093,631	64,25814
8	86,0316	6,493375	42,16392	8,372	3627,429	54,36254
7	86,0316	5,94525	35,346	7,376	3040,873	43,85216
6	86,7756	5,255375	27,61897	6,434	2396,652	33,81308
5	86,7756	4,514675	20,38229	5,429	1768,685	24,51017
4	86,7756	3,68535	13,5818	4,423	1178,569	16,3003
3	87,9276	2,785525	7,75915	3,463	682,2434	9,646273
2	87,9276	1,926575	3,711691	2,444	326,3601	4,708549
1	93,2328	1,036825	1,075006	1,512	100,2258	1,567679
					19931,13	298,6404

$$Ty = 6,3 . \sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy} \right)} = 1,6441 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0412

Tabel 5.16 Struktur 16 portal 2 dinding geser

TINGKAT	Wi (ton)	diy (cm)	diy^2	Fiy (ton)	$Wi.di^2$	Fiy.diy
10	53,7666	5,521725	30,48945	6,48	1639,314	35,78078
9	87,0276	5,226675	27,31813	9,481	2377,431	49,55411
8	88,0116	4,791275	22,95632	8,568	2020,422	41,05164
7	88,0116	4,2936	18,435	7,548	1622,494	32,40809
6	88,7556	3,7128	13,78488	6,583	1223,486	24,44136
5	88,7556	3,10775	9,65811	5,554	857,2114	17,26044
4	88,7556	2,462775	6,065261	4,526	538,3259	11,14652
3	89,9076	1,79905	3,236581	3,542	290,9932	6,372235
2	89,9076	1,191625	1,41997	2,5	127,6661	2,979063
1	95,6088	0,6103	0,372466	1,551	35,61104	0,946575
					10732,95	221,9408

$$Ty = 6,3.\sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy}\right)} = 1,3995 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0455

Tabel 5.17 Struktur 15 portal 3 dinding geser

TINGKAT	Wi (ton)	diy (cm)	diy^2	Fiy (ton)	$Wi.di^2$	Fiy.diy
10	54,45929	4,60525	21,20833	6,128	1154,99	28,22097
9	88,3575	4,3114	18,58817	8,986	1642,404	38,74224
8	89,3475	3,923075	15,39052	8,12	1375,104	31,85537
7	89,3475	3,484825	12,14401	7,153	1085,037	24,92695
6	90,09321	2,9878	8,926949	6,238	804,2575	18,6379
5	90,09321	2,474425	6,122779	5,263	551,6208	13,0229
4	90,09321	1,937325	3,753228	4,289	338,1404	8,309187
3	91,25036	1,395175	1,946513	3,356	177,62	4,682207
2	91,25036	0,90025	0,81045	2,369	73,95386	2,132692
1	97,209	0,44345	0,196648	1,472	19,11595	0,652758
					7222,244	171,1832

$$Ty = 6,3.\sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy}\right)} = 1,3072 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0471

Tabel 5.18 Struktur 16 portal 4 dinding geser

TINGKAT	Wi (ton)	diy (cm)	diy²	Fiy (ton)	Wi.di²	Fiy.diy
10	54,7566	4,377275	19,16054	6,602	1049,166	28,89877
9	89,0076	4,068425	16,55208	9,7	1473,261	39,46372
8	89,9916	3,66745	13,45019	8,764	1210,404	32,14153
7	89,9916	3,227775	10,41853	7,72	937,5803	24,91842
6	90,7356	2,738725	7,500615	6,732	680,5728	18,4371
5	90,7356	2,240475	5,019728	5,68	455,4681	12,7259
4	90,7356	1,727875	2,985552	4,628	270,8959	7,996606
3	91,8876	1,221025	1,490902	3,622	136,9954	4,422553
2	91,8876	0,769375	0,591938	2,556	54,39175	1,966523
1	97,9848	0,36815	0,135534	1,59	13,28031	0,585359
					6282,015	171,5565

$$Ty = 6,3.\sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy}\right)} = 1,2178 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0486

Tabel 5.19 Struktur 15 portal 5 dinding geser

TINGKAT	Wi (ton)	diy (cm)	diy²	Fiy (ton)	Wi.di²	Fiy.diy
10	51,81867	3,72775	13,89612	6,249	720,0784	23,29471
9	84,447	3,438225	11,82139	9,205	998,281	31,64886
8	85,371	3,092375	9,562783	8,316	816,3844	25,71619
7	85,371	2,70435	7,313509	7,326	624,3616	19,81207
6	86,067	2,2806	5,201136	6,387	447,6462	14,56619
5	86,067	1,8474	3,412887	5,389	293,7369	9,955639
4	86,067	1,40685	1,979227	4,391	170,3461	6,177478
3	87,147	0,977475	0,955457	3,436	83,26524	3,358604
2	87,147	0,59605	0,355276	2,425	30,9612	1,445421
1	93,1044	0,270475	0,073157	1,511	6,811213	0,408688
					4191,872	136,3839

$$Ty = 6,3.\sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy}\right)} = 1,1157 \text{ detik}$$

Koefisien Gempa Dasar (C) = 0,0504

Dari hasil perhitungan di atas, didapatkan bahwa nilai periode getar arah sumbu Y semua struktur, melebihi batas yang ditetapkan, yakni sebesar 80% - 120% dari asumsi periode getar awal. Maka perlu diadakan koreksi terhadap nilai periode getar awal dengan nilai periode getar yang baru, yang didapat dari perhitungan dengan metode Rayleigh diatas.

5.7.3 Perhitungan Gaya Gempa Statik Ekivalen Terkoreksi

1. Perhitungan gaya gempa statik ekivalen struktur 15 portal tanpa dinding geser

   Daerah gempa 3, tanah lunak

   T = 1,6295 dt

   C = 0,0414

   I = 1

   K = 1

   Dari hasil perhitungan, didapatkan berat total bangunan (W)= 11617681,5 kg

   V = C.I.K.W = 0,0414.1.1. 11617681,5 kg = 480972,014 kg

   H = 39 m , B = 18 m

   $$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} xV$$

Tabel 5.20 Beban gempa statik ekivalen struktur 15 portal tanpa dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	740155,5	28866064,5	56554,45931	18851,4864	3534,65371
9	35,25	1192455	42034038,75	82353,18445	27451,0615	5147,07403
8	31,5	1130715	35617522,5	69781,9312	23260,6437	4361,3707
7	27,75	1130715	31377341,25	61474,55843	20491,5195	3842,1599
6	24	1216755	29202120	57212,86001	19070,9533	3575,80375
5	20,25	1216755	24639288,75	48273,35063	16091,1169	3017,08441
4	16,5	1216755	20076457,5	39333,84126	13111,2804	2458,36508
3	12,75	1232955	15720176,25	30799,00511	10266,335	1924,93782
2	9	1232955	11096595	21740,4742	7246,82473	1358,77964
1	5,25	1307466	6864196,5	13448,34942	4482,78314	840,521838
		11617681,5	245493801	480972,014	160324,005	30060,7509

2. Perhitungan gaya gempa statik ekivalen struktur 16 portal tanpa dinding geser

Daerah gempa 3, tanah lunak

T = 1,6441 dt

C = 0,0412

I = 1

K= 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12589533 kg

V = C.I.K.W = 0,0412.1.1.12589533 kg = 518688,75 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{3}{1}$$

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{}{\Sigma}$$

$$Fi = \frac{WixHi}{\Sigma WixHi}x V$$

Tabel 5.2

Tabel 5.21 Beban gempa statik ekivalen struktur 16 portal tanpa dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	791649	30874311	59886,93343	19962,3111	3742,93334
9	35,25	1275714	44968918,5	87226,25838	29075,4195	5451,64115
8	31,5	1290474	40649931	78848,7138	26282,9046	4928,04461
7	27,75	1290474	35810653,5	69461,96216	23153,9874	4341,37263
6	24	1301634	31239216	60594,74004	20198,2467	3787,17125
5	20,25	1301634	26358088,5	51126,81191	17042,2706	3195,42574
4	16,5	1301634	21476961	41658,88378	13886,2946	2603,68024
3	12,75	1318914	16816153,5	32618,31058	10872,7702	2038,64441
2	9	1318914	11870226	23024,68982	7674,89661	1439,04311
1	5,25	1398492	7342083	14241,4461	4747,1487	890,090381
		12589533	267406542	518688,75	172896,25	32418,0469

3. Perhitungan gaya gempa statik ekivalen struktur 16 portal dengan 2 dinding geser

Daerah gempa 3, tanah lunak

T = 1,3995 dt

C = 0,0455

I = 1

K= 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12877623 kg

V = C.I.K.W = 0,0414.1.1. 12877623 kg = 585931,85 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} x V$$

Tabel 5.22 Beban gempa statik ekivalen struktur 16 portal dengan 2 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	806499	31453461	67401,54584	22467,1819	4212,59661
9	35,25	1305414	46015843,5	98607,24023	32869,0801	6162,95251
8	31,5	1320174	41585481	89113,4271	29704,4757	5569,58919
7	27,75	1320174	36634828,5	78504,68578	26168,2286	4906,54286
6	24	1331334	31952016	68469,89815	22823,2994	4279,36863
5	20,25	1331334	26959513,5	57771,47656	19257,1589	3610,71729
4	16,5	1331334	21967011	47073,05498	15691,0183	2942,06594
3	12,75	1348614	17194828,5	36846,75659	12282,2522	2302,92229
2	9	1348614	12137526	26009,47524	8669,82508	1625,5922
1	5,25	1434132	7529193	16134,28955	5378,09652	1008,3931
		12877623	273429702	585931,85	195310,617	36620,7406

4. Perhitungan gaya gempa statik ekivalen struktur 15 portal dengan 3 dinding geser

Daerah gempa 3, tanah lunak

T = 1,3072 dt

C = 0,0471

I = 1

K= 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12201016,5 kg

V = C.I.K.W = 0,0471.1.1. 12201016,5 kg = 574667,88 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} x V$$

Tabel 5.23 Beban gempa statik ekivalen struktur 15 portal dengan 3 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	762430,5	29734789,5	65973,40211	21991,134	4123,33763
9	35,25	1237005	43604426,25	96746,34982	32248,7833	6046,64686
8	31,5	1250865	39402247,5	87422,85929	29140,9531	5463,92871
7	27,75	1250865	34711503,75	77015,37604	25671,792	4813,461
6	24	1261305	30271320	67163,81721	22387,9391	4197,73858
5	20,25	1261305	25541426,25	56669,47077	18889,8236	3541,84192
4	16,5	1261305	20811532,5	46175,12433	15391,7081	2885,94527
3	12,75	1277505	16288188,75	36139,05611	12046,352	2258,69101
2	9	1277505	11497545	25509,92196	8503,30732	1594,37012
1	5,25	1360926	7144861,5	15852,50236	5284,16745	990,781398
		12201016,5	259007841	574667,88	191555,96	35916,7425

5. Perhitungan gaya gempa statik ekivalen struktur 16 portal dengan 4 dinding geser

Daerah gempa 3, tanah lunak

T = 1,2178 dt

C = 0,0486

I = 1

K = 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 13165713 kg

V = C.I.K.W = 0,0486.1.1. 13165713 kg = 639853,65 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} x V$$

Tabel 5.24 Beban gempa statik ekivalen struktur 16 portal dengan 4 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	821349	32032611	73343,97265	24447,9909	4583,99829
9	35,25	1335114	47062768,5	107758,0097	35919,3366	6734,8756
8	31,5	1349874	42521031	97358,94881	32452,9829	6084,9343
7	27,75	1349874	37459003,5	85768,59776	28589,5326	5360,53736
6	24	1361034	32664816	74791,51079	24930,5036	4674,46942
5	20,25	1361034	27560938,5	63105,33723	21035,1124	3944,08358
4	16,5	1361034	22457061	51419,16367	17139,7212	3213,69773
3	12,75	1378314	17573503,5	40237,44927	13412,4831	2514,84058
2	9	1378314	12404826	28402,90537	9467,63512	1775,18159
1	5,25	1469772	7716303	17667,75478	5889,25159	1104,23467
		13165713	279452862	639853,65	213284,55	39990,8531

6. Perhitungan gaya gempa statik ekivalen struktur 15 portal dengan 5 dinding geser

Daerah gempa 3, tanah lunak

T = 1,1157 dt

C = 0,0504

I = 1

K= 1

Dari hasil perhitungan, didapatkan berat total bangunan (W)= 12489106,5 kg

V = C.1.K.W = 0,0504.1.1. 12489106,5 kg = 629450,97 kg

H = 39 m , B = 18 m

$$\frac{H}{B} = \frac{39}{18} = 2,17 < 3,0$$

$$Fi = \frac{WixHi}{\Sigma WixHi} xV$$

Tabel 5.25 Beban gempa statik ekivalen struktur 15 portal dengan 5 dinding geser

lantai tingkat	hi (m)	wi (kg)	wi*hi (kgm)	Fi (kg)	Fix=1/3*Fi (kg)	Fiy=1/16*Fi (kg)
Atap	39	777280,5	30313939,5	71995,87426	23998,6248	4499,74214
9	35,25	1266705	44651351,25	106047,3539	35349,118	6627,95962
8	31,5	1280565	40337797,5	95802,62561	31934,2085	5987,6641
7	27,75	1280565	35535678,75	84397,55113	28132,517	5274,84695
6	24	1291005	30984120	73587,55887	24529,1863	4599,22243
5	20,25	1291005	26142851,25	62089,5028	20696,5009	3880,59392
4	16,5	1291005	21301582,5	50591,44672	16863,8156	3161,96542
3	12,75	1307205	16666863,75	39583,94873	13194,6496	2473,9968
2	9	1307205	11764845	27941,61087	9313,87029	1746,35068
1	5,25	1396566	7331971,5	17413,49712	5804,49904	1088,34357
		12489106,5	265031001	629450,97	209816,99	39340,6856

Dari hasil perhitungan ini, maka input SAP90 mengalami perubahan dengan memasukkan nilai Fi yang baru ini. Selanjutnnya didapatkan nilai Simpangan horisontal struktur yang baru dari hasil perhitungan SAP90.

5.7.4 Simpangan Horisontal Struktur

Tabel 5.26 Struktur 15 portal tanpa dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1	0,5778	0,5583	0,5595	0,5624	0,5778
2	1,0651	1,0454	1,0476	1,0529	1,0651
3	1,5330	1,5139	1,5171	1,5244	1,533
4	2,0279	2,0005	2,0047	2,0139	2,0279
5	2,4839	2,4489	2,454	2,4649	2,4839
6	2,8900	2,8488	2,8547	2,867	2,8901
7	3,2605	3,2206	3,2272	3,2409	3,2606
8	3,5599	3,5221	3,5293	3,5441	3,5599
9	3,8122	3,7613	3,769	3,7848	3,8122
10	3,9487	3,896	3,9039	3,9204	3,9488

Tabel 5.27 Struktur 16 portal tanpa dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal F	Portal H	Portal L	Portal P
1	0,6234	0,603	0,6023	0,6038	0,6234
2	1,149	1,1285	1,1272	1,13	1,149
3	1,6542	1,6348	1,6328	1,6369	1,6542
4	2,1895	2,1615	2,1589	2,1642	2,1895
5	2,6836	2,6476	2,6445	2,651	2,6837
6	3,125	3,0824	3,0788	3,0863	3,1251
7	3,5292	3,488	3,484	3,4924	3,5292
8	3,853	3,8142	3,8098	3,819	3,853
9	4,1219	4,0696	4,0649	4,0747	4,1219
10	4,2669	4,2128	4,2079	4,218	4,2669

Tabel 5.28 Struktur 16 portal dengan 2 dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal F	Portal H	Portal I	Portal P
1	0,552	0,3375	0,4762	0,215	0,5521
2	1,0185	0,6729	0,8958	0,5109	1,0185
3	1,4684	1,0343	1,3051	0,8708	1,4685
4	1,9482	1,4427	1,7397	1,2717	1,9483
5	2,3953	1,8498	2,1521	1,6823	2,3954
6	2,7986	2,2388	2,5311	2,0853	2,7987
7	3,1708	2,6241	2,8938	2,4732	3,1709
8	3,4709	2,962	3,1922	2,834	3,471
9	3,719	3,2651	3,4277	3,1771	3,7191
10	3,8493	3,4676	3,5574	3,4883	3,8494

Tabel 5.29 Struktur 15 portal dengan 3 dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1	0,1547	0,1992	0,4413	0,3932	0,1551
2	0,3747	0,4736	0,8303	0,7444	0,3749
3	0,6486	0,8071	1,2092	1,0913	0,6487
4	0,9597	1,1784	1,6106	1,465	0,9598
5	1,2849	1,5588	1,9910	1,8247	1,285
6	1,6106	1,9320	2,3401	2,1595	1,6107
7	1,9301	2,2911	2,6733	2,4838	1,9303
8	2,2330	2,6251	2,947	2,7553	2,233
9	2,5257	2,9425	3,1616	2,9741	2,5259
10	2,7944	3,2302	3,279	3,0961	2,7942

Tabel 5.30 Struktur 16 portal dengan 4 dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal F	Portal H	Portal L	Portal P
1	0,1594	0,2013	0,3941	0,3101	0,1598
2	0,3859	0,4789	0,7498	0,6197	0,3861
3	0,6682	0,8165	1,1076	0,9542	0,6683
4	0,9889	1,1927	1,5013	1,3337	0,9891
5	1,3245	1,5787	1,888	1,7138	1,3247
6	1,6608	1,9578	2,2543	2,0787	1,6609
7	1,9908	2,3228	2,6155	2,4412	1,991
8	2,3037	2,6626	2,9221	2,7599	2,3037
9	2,606	2,9855	3,1739	3,0448	2,6063
10	2,8834	3,2778	3,3146	3,2333	2,8832

Tabel 5.31 Struktur 15 portal dengan 5 dinding geser

Tingkat	Simpangan Horisontal Arah Sumbu Y (cm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1	0,143	0,1628	0,1675	0,302	0,1434
2	0,3465	0,3901	0,4003	0,58	0,3468
3	0,5999	0,6677	0,6838	0,8646	0,6
4	0,8875	0,9791	1,0008	1,1841	0,8877
5	1,1882	1,301	1,327	1,5042	1,1884
6	1,4887	1,619	1,6481	1,8127	1,4889
7	1,7823	1,926	1,9569	2,1231	1,7826
8	2,0604	2,2125	2,2444	2,3886	2,0606
9	2,3243	2,4804	2,5126	2,5854	2,3246
10	2,5637	2,7201	2,7525	2,7027	2,5634

Cek Periode Getar yang Baru dengan Metode Rayleigh :

Tabel 5.32 Struktur 15 portal tanpa dinding geser

Tingkat	Wi (ton)	di y (cm)	di y^2	Fi y (ton)	Wi.di^2	Fiy.diy
10	52,86821	3,92356	15,39432	3,534	813,8704	13,86586
9	85,17536	3,7879	14,34819	5,147	1222,112	19,49632
8	80,76536	3,54306	12,55327	4,361	1013,87	15,45128
7	80,76536	3,24196	10,5103	3,842	848,8685	12,45561
6	86,91107	2,87012	8,237589	3,575	715,9377	10,26068
5	86,91107	2,46712	6,086681	3,017	529	7,443301
4	86,91107	2,01498	4,060144	2,458	352,8715	4,952821
3	88,06821	1,52428	2,32343	1,924	204,6203	2,932715
2	88,06821	1,05522	1,113489	1,358	98,06301	1,432989
1	93,39043	0,56716	0,32167	0,84	30,04094	0,476414
					5829,254	88,768

$$T_y = 6,3.\sqrt{\left(\frac{\sum Wi.di.y^2}{g.\sum Fiy.diy}\right)} = 1,630819 \text{ detik}$$

Batasan nilai periode getar yang diharapkan mendekati nilai 80% – 120% dari periode getar awal. Dari perhitungan, nilai periode getar yang diharapkan adalah

antara 1,3036 - 1,9554 detik. Jadi nilai periode getar Ty 1,630819 detik telah memenuhi.

Tabel 5.33 Struktur 16 portal dengan 4 dinding geser

Tingkat	Wi (ton)	diy (cm)	diy^2	Fiy (ton)	Wi.di^2	Fiy.diy
10	54,7566	3,11846	9,724793	4,583	532,4966	14,2919
9	89,0076	2,8833	8,313419	6,735	739,9575	19,41903
8	89,9916	2,5904	6,710172	6,085	603,8591	15,76258
7	89,9916	2,27226	5,163166	5,361	464,6415	12,18159
6	90,7356	1,9225	3,696006	4,674	335,3593	8,985765
5	90,7356	1,56594	2,452168	3,944	222,4989	6,176067
4	90,7356	1,20114	1,442737	3,214	130,9076	3,860464
3	91,8876	0,84296	0,710582	2,515	65,29363	2,120044
2	91,8876	0,52408	0,27466	1,775	25,23783	0,930242
1	97,9848	0,24494	0,059996	1,104	5,878657	0,270414
					3126,131	83,99809

$$Ty = 6,3.\sqrt{\left(\frac{\sum Wi.diy^2}{g.\sum Fiy.diy}\right)} = 1,227712 \text{ detik}$$

Nilai periode getar yang diharapkan adalah antara 0,9742 – 1,4614. Maka nilai Ty 1,227712 telah memenuhi.

Untuk struktur – struktur yang lain periode getar dihitung sebagai berikut :

Tabel 5.34 Kontrol periode getar struktur dengan metode Rayleigh

Struktur	Ty (detik)	Batasan nilai Ty (detik)	
		Minimum	Maksimum
16 portal	1,6457	1,3153	1,9729
16 portal 2 dinding geser	1,4177	1,1196	1,6794
15 portal 3 dinding geser	1,2856	1,0458	1,5686
15 portal 5 dinding geser	1,2277	0,8926	1,3388

Gambar 5.12 Grafik simpangan horisontal tingkat, struktur 16 portal tanpa shear wall


Gambar 5.11 Grafik simpangan horisontal tingkat, struktur 15 portal tanpa shear wall

Gambar 5.14 Grafik simpangan horisontal tingkat, struktur 15 portal dengan 3 shear wall
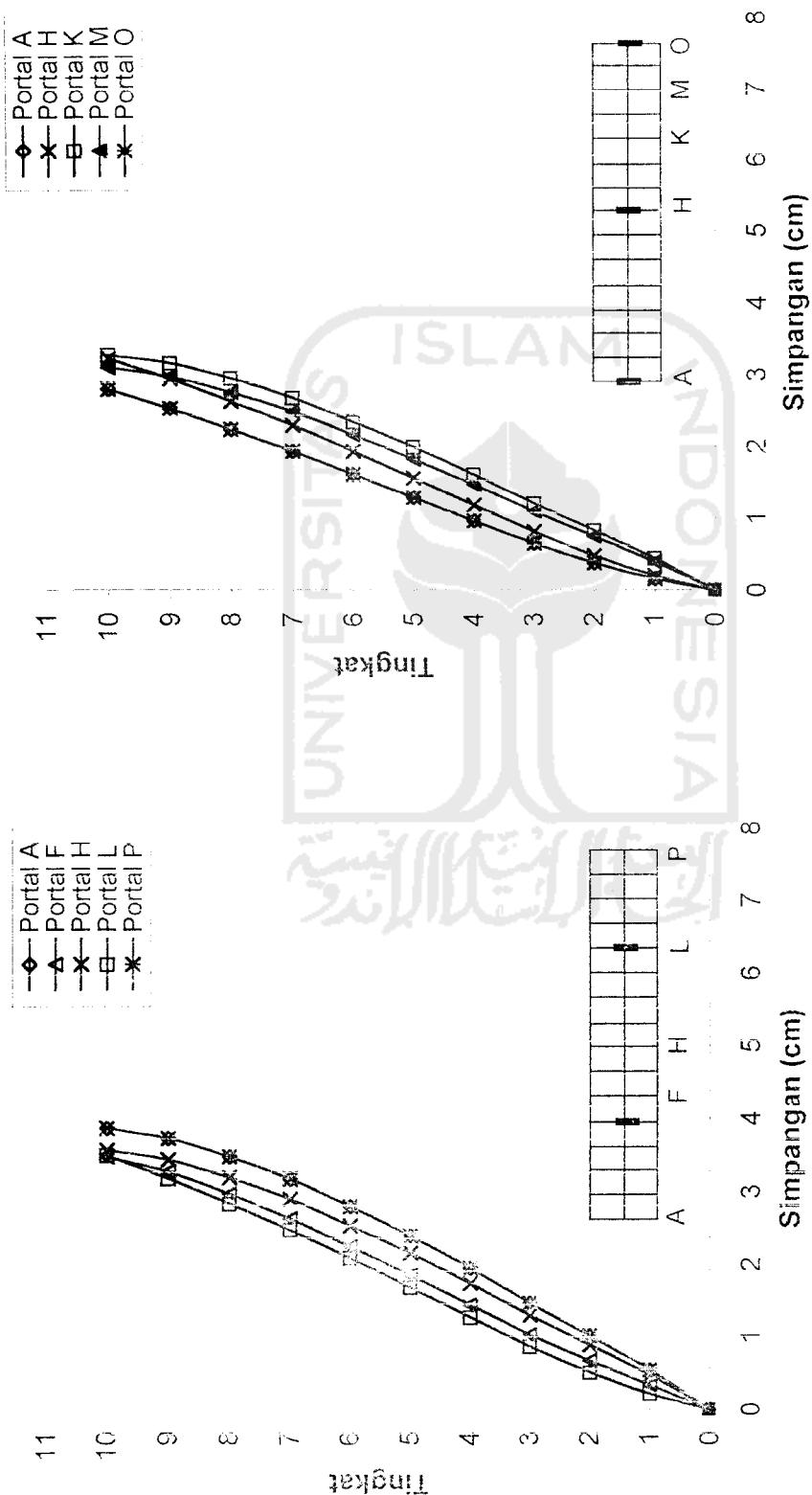
Gambar 5.13 Grafik simpangan horisontal tingkat, struktur 16 portal dengan 2 shear wall

Legend (top graph):
Portal A
Portal H
Portal K
Portal M
Portal O

Gambar 5.16 Grafik simpangan horisontal tingkat, struktur 15 portal dengan 5 shear wall

Legend (bottom graph):
Portal A
Portal F
Portal H
Portal L
Portal P

Gambar 5.15 Grafik simpangan horisontal tingkat, struktur 16 portal dengan 4 shear wall

Simpangan (cm)

Tingkat

5.8 Gaya Geser Struktur

Tabel 5.35 Gaya geser tingkat 1 struktur 15 portal tanpa dinding geser

Portal	Gaya Geser (Ton)
A	28,175192
B	30,728426
C	30,41545
D	30,317011
E	30,259561
F	30,223187
G	30,20295
H	30,196445
I	30,20295
J	30,223187
K	30,25956
L	30,317012
M	30,415451
N	30,728426
O	28,175191

Tabel 5.36 Gaya geser tingkat 1 struktur 16 portal tanpa dinding geser

Portal	Gaya Geser (Ton)
A	30,380639
B	33,13418
C	32,79654
D	32,689216
E	32,625256
F	32,583212
G	32,557568
H	32,545391
I	32,545391
J	32,557568
K	32,583212
L	32,625255
M	32,689216
N	32,79654
O	33,134179
P	30,380638

Tabel 5.37 Gaya geser tingkat 1 struktur 16 portal dengan 2 dinding geser

Portal	Gaya Geser (Ton)
A	26,940944
B	28,024342
C	24,661292
D	17,853029
E	128,867298
F	17,343544
G	23,487149
H	25,766402
I	25,766403
J	23,487148
K	17,343544
L	128,867298
M	17,853029
N	24,661292
O	28,024342
P	26,940944

Tabel 5.38 Gaya geser tingkat 1 struktur 15 portal dengan 3 dinding geser

Portal	Gaya Geser (Ton)
A	87,099158
B	15,519656
C	21,256802
D	23,654848
E	23,910611
F	21,935576
G	16,233735
H	119,504224
I	16,233735
J	21,935576
K	23,910611
L	23,654849
M	21,256802
N	15,519656
O	87,099158

Tabel 5.39 Gaya geser tingkat 1 struktur 16 portal dengan 4 dinding geser

Portal	Gaya Geser (Ton)
A	89,543544
B	15,509243
C	20,338493
D	20,576043
E	15,954231
F	120,499026
G	16,272806
H	21,226611
I	21,226611
J	16,272806
K	120,499026
L	15,954231
M	20,576043
N	20,338494
O	15,509243
P	89,543544

Tabel 5.40 Gaya geser tingkat 1 struktur 15 portal dengan 5 dinding geser

| Portal	Gaya Geser (Ton)
A	80,47436
B	13,321043
C	16,259162
D	13,404285
E	99,689179
F	11,918103
G	11,898829
H	96,15508
I	11,898828
J	11,918102
K	99,689178
L	13,404285
M	16,259162
N	13,321043
O	80,47436
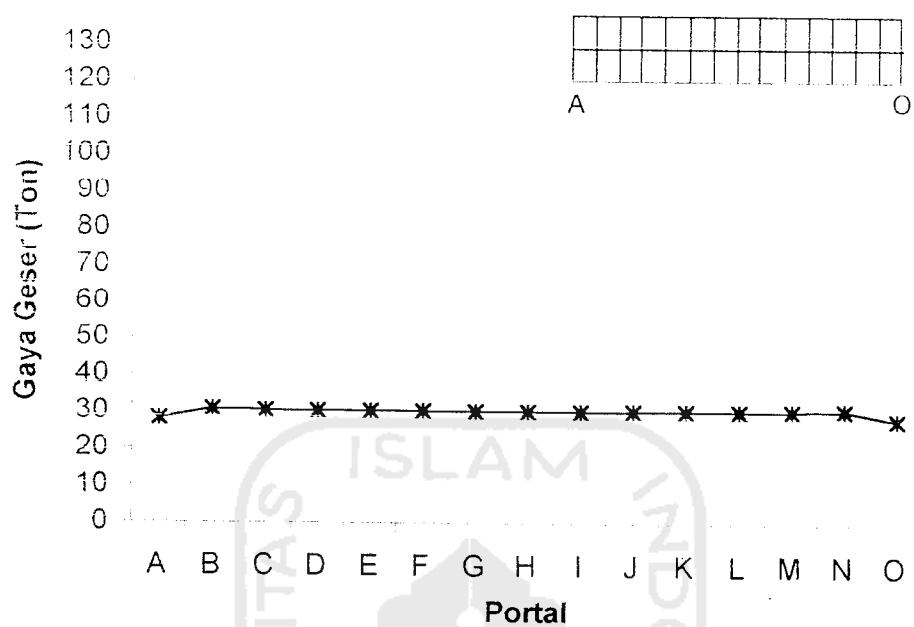
**Gambar 5.17** Grafik Gaya Geser struktur 15 portal tanpa dinding geser
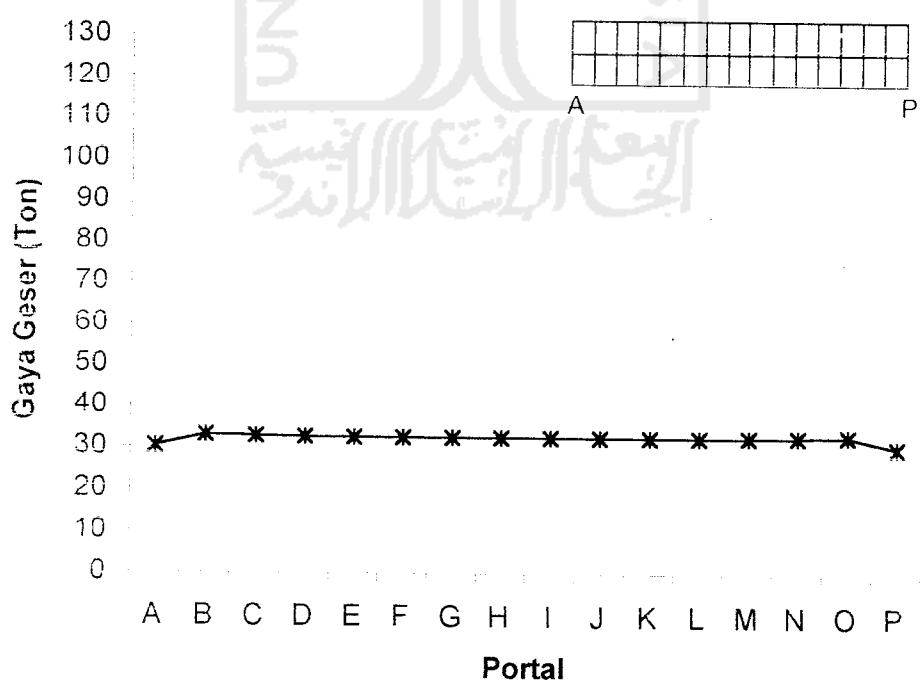
**Gambar 5.18** Grafik Gaya Geser struktur 16 portal tanpa dinding geser
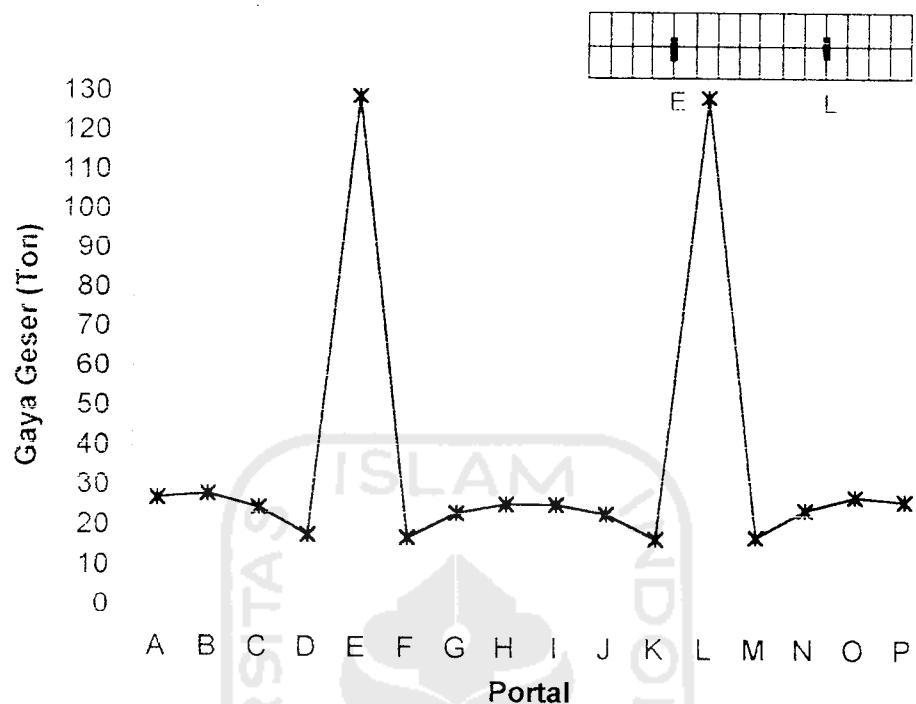
Gambar 5.19 Grafik Gaya Geser struktur 16 portal 2 dinding geser
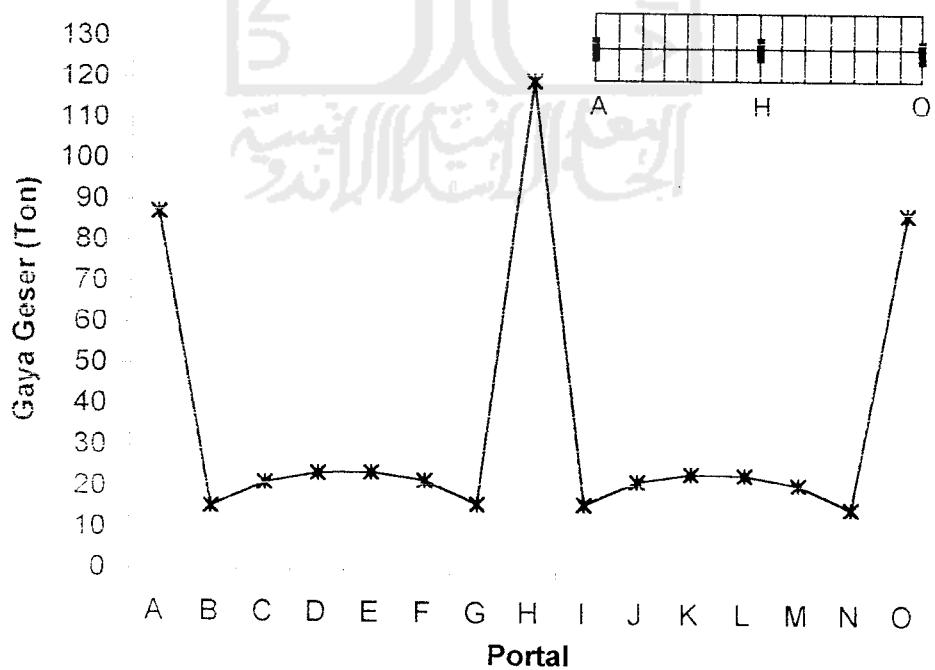
Gambar 5.20 Grafik Gaya Geser struktur 15 portal 3 dinding geser
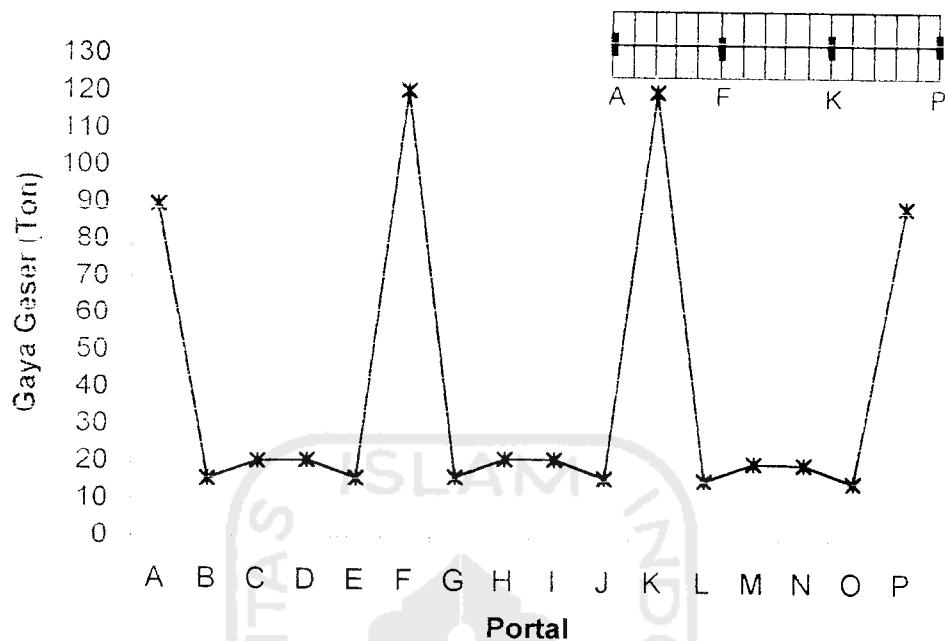
Gambar 5.21 Grafik Gaya Geser struktur 16 portal 4 dinding geser
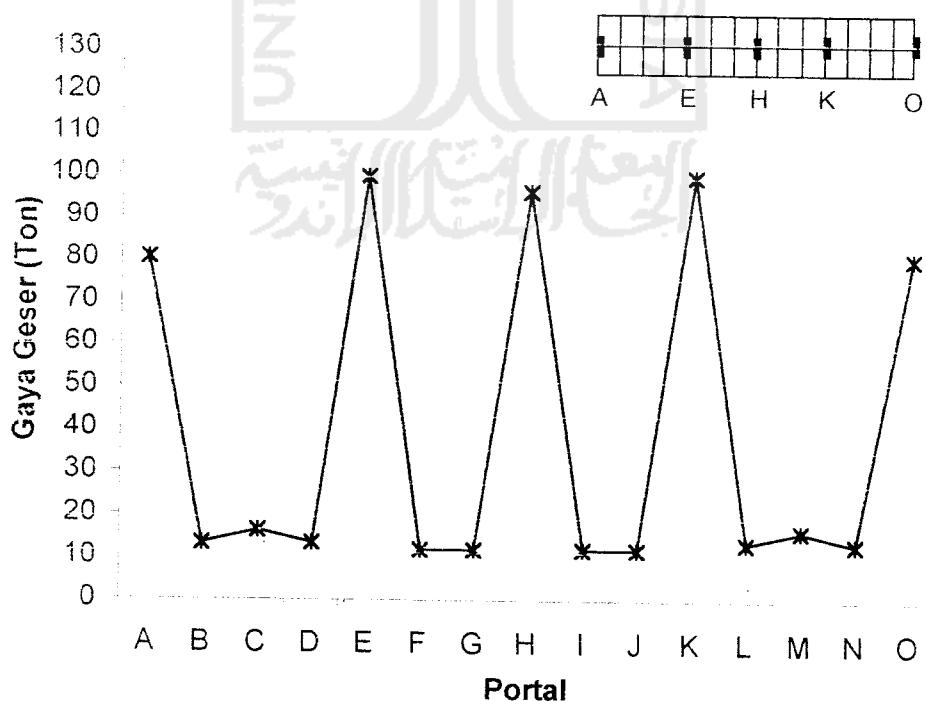
Gambar 5.22 Grafik Gaya Geser struktur 15 portal 5 dinding geser

5.9 Momen Tumpuan Balok

5.9.1 Momen Tumpuan Balok Searah Sumbu Y

Tabel 5.41 Momen tumpuan balok, struktur 15 portal tanpa dinding geser

Balok	Momen Tumpuan (Tm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1 ki	42,761	54,482	54,539	54,673	42,737
2 ki	40,305	51,254	51,309	51,429	40,267
3 ki	37,692	48,809	48,861	48,961	37,645
4 ki	34,675	45,938	45,984	46,066	34,622
5 ki	31,309	42,160	42,201	42,268	31,251
6 ki	27,979	38,522	38,556	38,609	27,918
7 ki	24,290	34,151	34,177	34,218	24,228
8 ki	21,052	31,032	31,051	31,083	20,994
9 ki	17,651	27,928	27,939	27,956	17,595
10 ki	7,370	10,426	10,422	10,439	7,398
1 ka	44,295	52,409	52,469	52,616	44,316
2 ka	45,668	54,821	54,878	55,007	45,703
3 ka	44,779	53,701	53,754	53,868	44,820
4 ka	42,986	51,475	51,523	51,624	43,032
5 ka	41,581	50,146	50,187	50,275	41,632
6 ka	38,869	47,287	47,322	47,400	38,921
7 ka	35,547	43,954	43,982	44,051	35,600
8 ka	30,734	38,523	38,542	38,606	30,782
9 ka	24,204	30,977	30,987	31,045	24,247
10 ka	11,425	14,581	14,584	14,632	11,453

Tabel 5.42 Momen tumpuan balok, struktur 16 portal tanpa dinding geser

Balok	Momen Tumpuan (Tm)				
	Portal A	Portal F	Portal H	Portal L	Portal P
1 ki	44,706	56,615	56,581	56,652	44,681
2 ki	42,243	53,359	53,325	53,395	42,204
3 ki	39,523	50,825	50,793	50,859	39,476
4 ki	36,370	47,826	47,797	47,856	36,317
5 ki	32,878	43,901	43,875	43,927	32,820
6 ki	29,372	40,059	40,037	40,080	29,312
7 ki	25,379	35,334	35,317	35,350	25,317
8 ki	21,722	31,784	31,771	31,795	21,664
9 ki	17,942	28,283	28,275	28,290	17,887
10 ki	5,922	10,536	10,532	10,538	5,873

Lanjutan tabel 5.42

1 ka	46,466	54,645	54,609	54,684	46,487
2 ka	47,757	56,996	56,962	57,034	47,792
3 ka	46,795	55,794	55,762	55,830	46,836
4 ka	44,892	53,442	53,413	53,474	44,938
5 ka	43,336	51,952	51,927	51,980	43,387
6 ka	40,447	48,913	48,891	48,936	40,499
7 ka	36,795	45,245	45,228	45,264	36,848
8 ka	31,522	39,336	39,324	39,349	31,570
9 ka	24,561	31,344	31,337	31,351	24,604
10 ka	11,544	14,706	14,704	14,709	11,573

Tabel 5.43 Momen tumpuan balok, struktur 16 portal 2 dinding geser

Balok	Momen Tumpuan (Tm)				
	Portal A	Portal F	Portal H	Portal L	Portal P
1 ki	41,616	45,979	50,513	17,813	41,592
2 ki	39,231	46,126	47,585	23,741	39,193
3 ki	36,817	46,750	45,723	27,302	36,773
4 ki	34,078	46,711	43,653	29,211	34,032
5 ki	30,987	45,442	40,668	29,817	30,938
6 ki	27,893	43,710	37,724	29,359	27,844
7 ki	24,284	41,079	33,825	28,397	24,237
8 ki	20,934	39,151	30,808	27,100	20,890
9 ki	17,398	36,857	27,646	26,149	17,358
10 ki	5,629	17,911	10,136	22,315	5,595
1 ka	43,052	40,945	48,306	32,082	43,072
2 ka	44,580	45,081	51,153	39,744	44,615
3 ka	43,913	45,504	50,666	40,851	43,952
4 ka	42,446	44,705	49,324	39,101	42,486
5 ka	41,384	44,396	48,879	38,218	41,426
6 ka	38,960	42,376	46,784	35,067	39,001
7 ka	35,753	39,776	43,985	31,571	35,793
8 ka	30,822	35,277	38,711	26,902	30,857
9 ka	24,137	28,575	31,128	21,682	24,168
10 ka	11,378	12,993	14,751	10,157	11,397

Tabel 5.44 Momen tumpuan balok, struktur 15 portal 3 dinding geser

Balok	Momen Tumpuan (Tm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1 ki	12,590	16,845	48,842	46,784	13,064
2 ki	17,103	22,375	45,910	44,277	17,834
3 ki	19,956	25,730	44,086	42,956	20,866
4 ki	21,611	27,568	42,083	41,480	22,670
5 ki	22,355	28,173	39,194	39,062	23,520
6 ki	22,258	27,788	36,407	36,689	23,469
7 ki	21,738	26,932	32,737	33,447	22,965
8 ki	20,874	25,762	29,955	30,987	22,073
9 ki	20,187	24,923	27,107	28,332	21,346
10 ki	17,355	21,225	9,928	10,922	18,406
1 ka	22,644	30,697	46,552	44,008	22,014
2 ka	28,750	37,813	49,419	47,051	27,746
3 ka	30,028	38,722	48,961	46,859	28,813
4 ka	29,208	36,963	47,681	45,891	27,847
5 ka	29,003	36,087	47,341	45,781	27,494
6 ka	26,941	33,085	45,380	44,063	25,408
7 ka	24,560	29,775	42,785	41,730	23,036
8 ka	21,131	25,361	37,789	37,046	19,724
9 ka	17,331	20,380	30,568	30,047	16,048
10 ka	8,650	9,327	14,525	14,327	7,812

Tabel 5.45 Momen tumpuan balok, struktur 16 portal 4 dinding geser

Balok	Momen Tumpuan (Tm)				
	Portal A	Portal F	Portal H	Portal L	Portal P
1 ki	12,869	16,979	46,839	44,587	13,353
2 ki	17,510	22,580	44,596	44,634	18,259
3 ki	20,441	25,985	43,619	45,265	21,372
4 ki	22,136	27,860	42,511	45,319	23,219
5 ki	22,899	28,491	40,352	44,185	24,091
6 ki	22,794	28,114	38,084	42,633	24,033
7 ki	22,250	27,252	34,793	40,202	23,504
8 ki	21,349	26,062	32,155	38,420	22,574
9 ki	20,622	25,196	29,068	36,272	21,806
10 ki	17,739	21,400	11,087	17,578	18,813

Lanjutan tabel 5.45

1 ka	23,045	30,870	44,085	39,519	22,400
2 ka	29,344	38,086	47,445	43,596	28,318
3 ka	30,709	39,049	47,644	44,039	29,466
4 ka	29,922	37,327	47,105	43,350	28,529
5 ka	29,748	36,486	47,294	43,201	28,205
6 ka	27,660	33,486	45,755	41,362	26,092
7 ka	25,233	30,159	43,454	38,955	23,676
8 ka	21,718	25,697	38,582	34,636	20,281
9 ka	17,830	20,657	31,116	28,107	16,520
10 ka	8,957	9,494	14,889	12,784	8,101

Tabel 5.46 Momen tumpuan balok, struktur 15 portal 5 dinding geser

| Balok	Momen Tumpuan (Tm)				
	Portal A	Portal H	Portal K	Portal M	Portal O
1 ki	11,870	14,678	14,958	42,688	12,365
2 ki	16,078	19,419	19,777	40,815	16,843
3 ki	18,768	22,458	22,824	40,338	19,719
4 ki	20,359	24,300	24,627	39,813	21,464
5 ki	21,077	25,045	25,315	38,270	22,292
6 ki	20,994	24,903	25,108	36,667	22,255
7 ki	20,474	24,282	24,430	34,325	21,745
8 ki	19,765	23,386	23,496	31,208	21,029
9 ki	19,208	22,684	22,774	27,455	20,463
10 ki	16,542	19,315	19,404	10,806	17,678
1 ka	21,557	27,495	27,882	39,268	20,897
2 ka	27,205	33,534	33,996	42,715	26,157
3 ka	28,286	34,175	34,602	43,106	27,017
4 ka	27,404	32,604	32,928	42,864	25,983
5 ka	27,113	31,904	32,126	43,360	25,539
6 ka	25,080	29,327	29,437	42,241	23,482
7 ka	22,497	26,175	26,182	40,211	20,927
8 ka	20,850	24,159	24,100	37,956	19,287
9 ka	19,465	22,243	22,160	34,206	17,875
10 ka	10,119	10,528	10,407	17,114	9,022
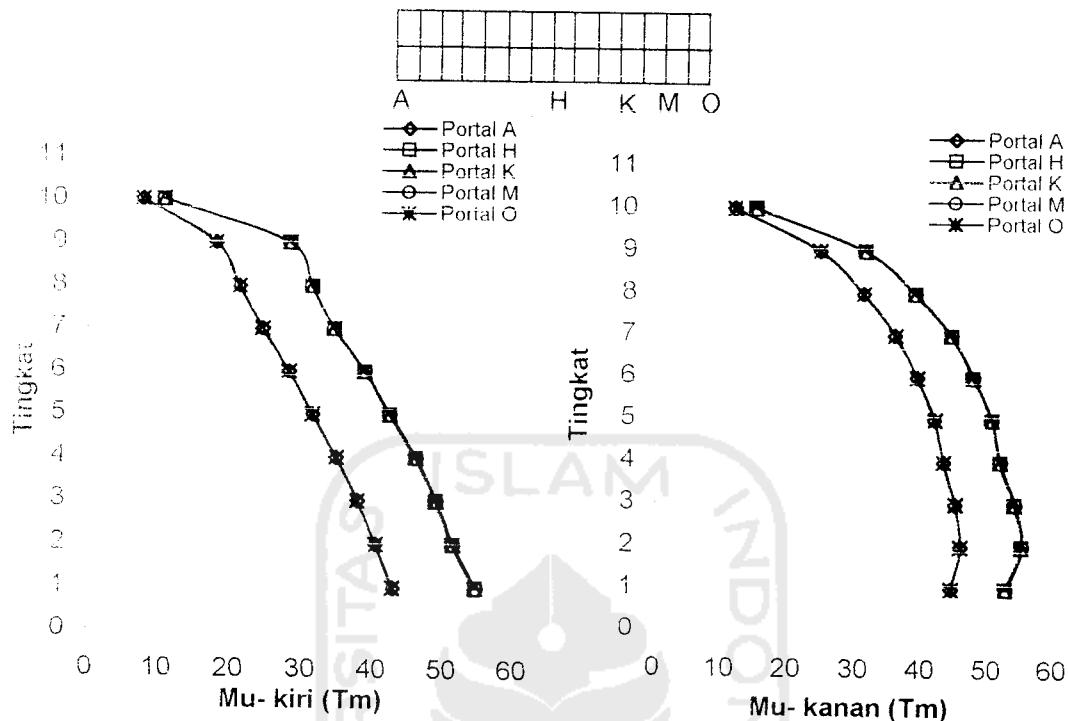
Gb. 5.23 Mu- balok kiri str.15 portal
tanpa dinding geser

Gb. 5.24 Mu- balok kanan str.15 portal
tanpa dinding geser
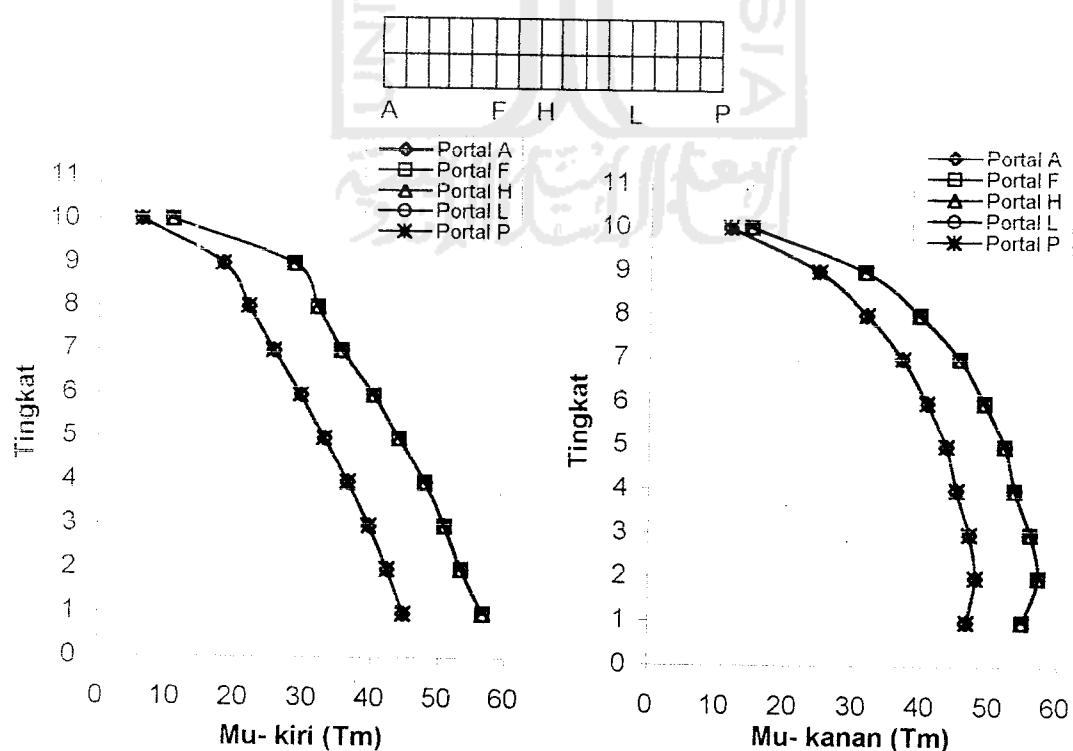
Gb. 5.25 Mu- balok kiri str.16 portal
tanpa dinding geser

Gb. 5.26 Mu- balok kanan str.16 portal
tanpa dinding geser
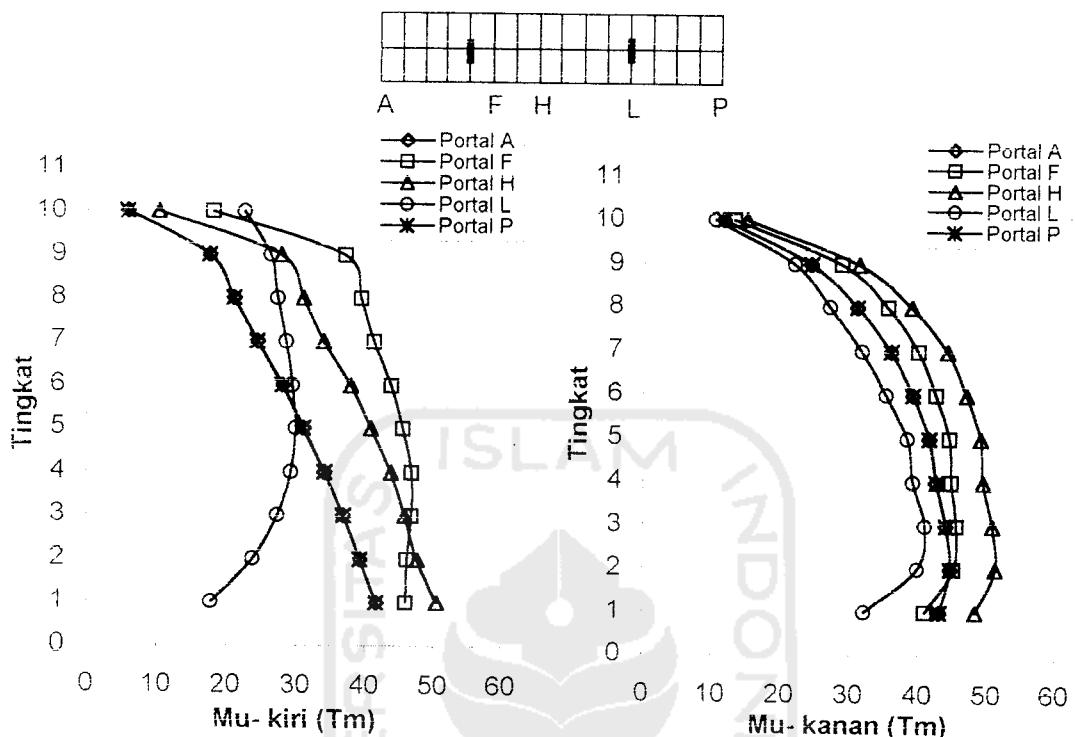
Gb. 5.27 Mu- balok kiri str.16 portal,
2 dinding geser

**Gb. 5.28** Mu- balok kanan str.16 portal,
2 dinding geser
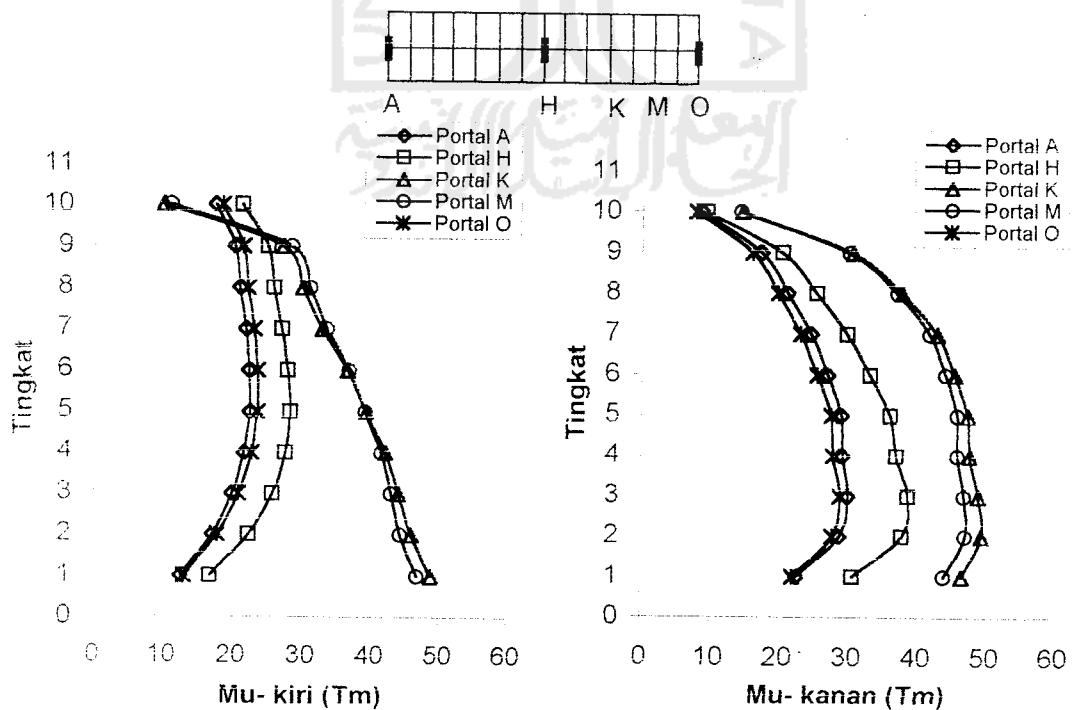
Gb. 5.29 Mu- balok kiri str.15 portal,
3 dinding geser

Gb. 5.30 Mu- balok kanan str.15 portal,
3 dinding geser
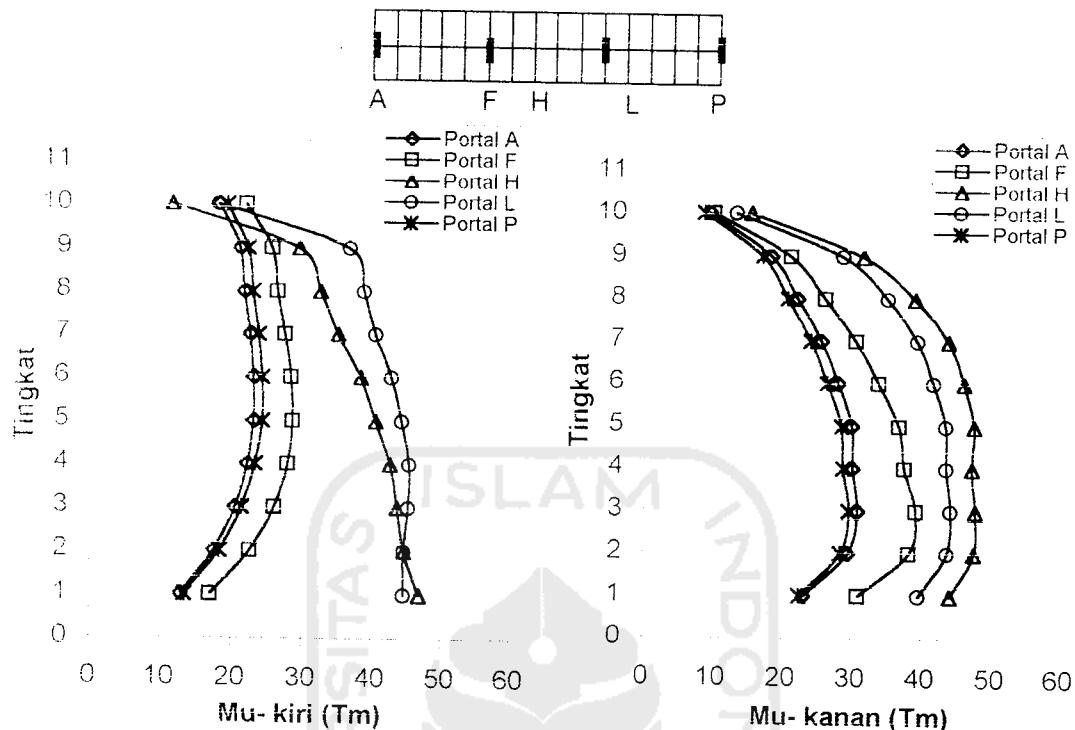
Gb. 5.31 Mu- balok kiri str. 6 portal, 4 dinding geser

Gb. 5.32 Mu- balok kanan str.16 portal, 4 dinding geser
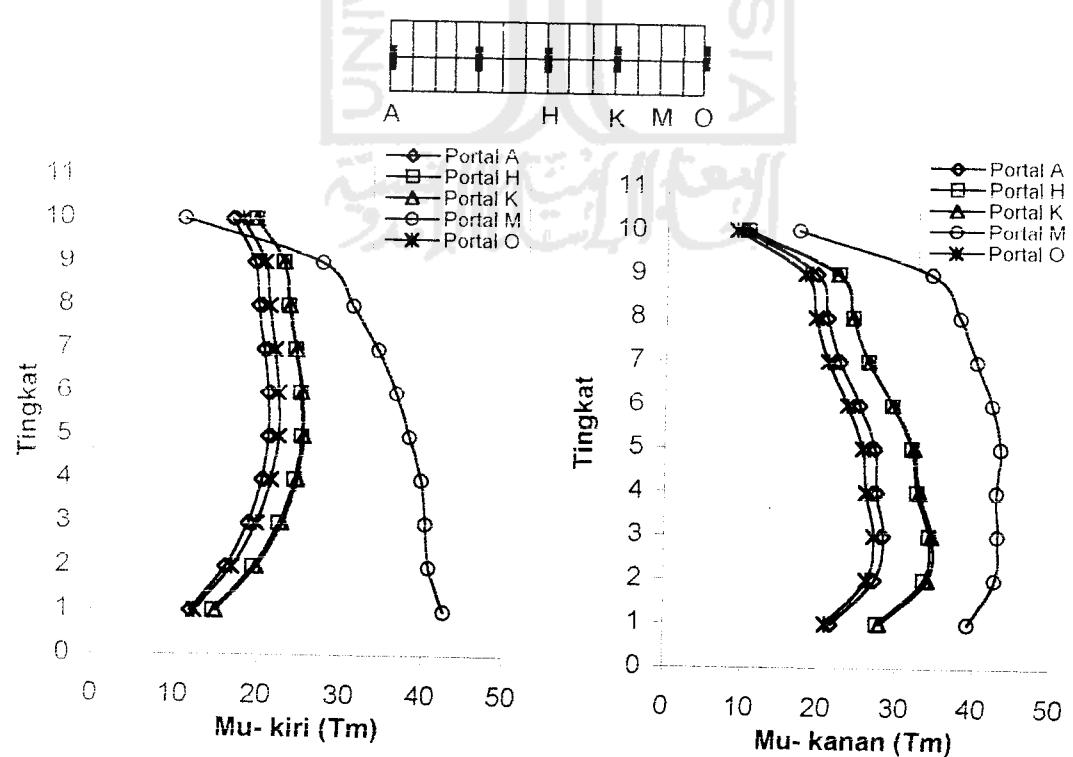
Gb. 5.33 Mu- balok kiri str.15 portal, 5 dinding geser

Gb. 5.34 Mu- balok kanan str.15 portal, 5 dinding geser

5.9.2 Momen Tumpuan Balok Searah Sumbu X

Tabel 5.47 Momen tumpuan as 1, struktur 15 portal tanpa dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	32,764277	18,75728	8,043095	2,491562	5,82656
BC	19,551041	17,169221	12,752764	7,824275	4,508722
CD	20,589204	15,758643	11,026578	6,19027	1,596737
DE	20,164218	15,397998	10,136344	4,946628	0,007147
EF	20,118458	15,238067	9,891873	4,649999	0,254
FG	20,079019	15,196329	9,856904	4,618412	0,228
GH	20,058171	15,174929	9,850002	4,613204	0,201
HI	20,03815	15,152484	9,836392	4,598434	0,195
IJ	20,019712	15,127875	9,815552	4,574994	0,202
JK	20,005321	15,103098	9,790822	4,546356	0,217
KL	19,994132	15,103622	9,807584	4,567508	0,192
LM	20,097911	15,235585	10,085315	4,89903	0,083532
MN	20,103202	16,052378	11,153064	5,904106	0,852146
NO	22,984188	16,94594	11,950007	6,759665	2,515313

Tabel 5.48 Momen tumpuan as 1, struktur 16 portal tanpa dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	33,131837	19,026877	8,439004	2,499221	5,900748
BC	19,778886	17,382747	13,028722	7,844722	4,485654
CD	20,825772	15,956941	11,290378	6,196733	1,568123
DE	20,395733	15,593957	10,387471	4,953259	0,027332
EF	20,347444	15,430893	10,133862	4,658649	0,285831
FG	20,305054	15,386272	10,090826	4,629464	0,257862
GH	20,281335	15,362103	10,076664	4,626185	0,228168
HI	20,258596	15,337573	10,057589	4,614191	0,218552
IJ	20,238465	15,312905	10,035481	4,597302	0,218573
JK	20,22037	15,287931	10,01028	4,575676	0,225833
KL	20,206545	15,263433	9,982903	4,549692	0,239948
LM	20,195769	15,26436	9,997844	4,57344	0,213497
MN	20,300288	15,396119	10,27356	4,905962	0,062089
NO	20,302352	16,212509	11,33347	5,903884	0,821257
OP	23,196374	17,081367	12,107214	6,723043	2,489371

Tabel 5.49 Momen tumpuan as 1, struktur 16 portal dengan 2 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	35,936326	21,100535	9,779049	2,765234	6,519736
BC	21,662194	19,31336	14,79046	9,218338	5,237227
CD	23,038575	18,496488	14,11628	8,788829	3,149221
DE	22,877857	18,511629	13,321276	7,377464	0,978215
EF	21,077384	14,115777	6,671446	0,171095	0,28889
FG	22,117097	16,860842	10,951905	5,033096	0,500741
GH	22,192951	17,085988	11,555905	5,787102	0,762623
HI	22,124759	17,008068	11,3926	5,537382	0,246425
IJ	22,187837	17,181005	11,710497	5,89398	0,448399
JK	22,398599	17,807824	12,792332	7,111971	1,34008
KL	22,675611	18,167707	12,900554	6,963262	0,805536
LM	20,915073	13,948016	6,538525	0,097135	0,009815
MN	22,113524	16,878428	11,151057	5,334958	0,880063
NO	22,190591	17,942507	12,790611	7,026881	1,810848
OP	25,139285	18,523244	13,027329	7,194544	2,850672

Tabel 5.50 Momen tumpuan as 1, struktur 15 portal dengan 3 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	37,039612	20,686478	7,98675	6,476986	7,842571
BC	22,283629	19,924695	15,044313	9,285106	5,880068
CD	23,56602	18,423452	13,284911	7,617036	2,522355
DE	23,043713	17,989913	12,192589	6,084382	0,388817
EF	23,089455	18,035963	12,31252	6,211726	0,40528
FG	23,273023	18,641241	13,377396	7,424436	1,330669
GH	23,528232	18,97643	13,470315	7,27225	0,810487
HI	21,788127	14,7935	7,160768	0,45788	0,31975
IJ	22,82361	17,507197	11,396768	5,2656	0,570279
JK	22,907988	17,723308	11,971666	5,97645	0,762431
KL	22,84259	17,651751	11,81398	5,73196	0,230619
LM	23,017541	17,929178	12,345635	6,343125	0,616796
MN	23,206514	19,396379	14,455585	8,472705	2,194461
NO	26,757753	20,850257	15,895911	9,937224	5,090713

Tabel 5.51 Momen tumpuan as 1, struktur 16 portal dengan 4 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	38,020787	21,363078	8,378727	6,585509	8,039057
BC	22,902646	20,507885	15,510372	9,595247	5,998199
CD	24,341362	19,276365	14,243565	8,508999	3,088683
DE	24,026397	19,457557	14,187587	8,130768	1,296868
EF	24,224507	19,562963	13,881517	7,49403	0,766829
FG	22,447373	15,322962	7,488505	0,59691	0,313615
GH	23,494373	18,101267	11,854415	5,563138	0,669809
HI	23,695432	18,61625	12,96731	6,899239	1,379911
IJ	23,845273	19,153747	13,846111	7,814178	1,689136
JK	24,06485	19,388696	13,74156	7,409559	0,841424
KL	22,315872	15,157402	7,341265	0,486811	0,227027
LM	23,370826	17,944964	11,706399	5,444677	0,630242
MN	23,694452	18,574378	13,042533	7,044746	1,530446
NO	23,82536	19,96932	14,960237	8,875752	2,531064
OP	27,388923	21,29102	16,157935	10,049863	5,178132

Tabel 5.52 Momen tumpuan as 1, struktur 15 portal dengan 5 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	38,931239	22,193878	9,071606	2,903418	8,789585
BC	23,545828	21,291274	16,308693	10,063965	6,171501
CD	25,131499	20,426051	15,685564	10,050053	4,075077
DE	24,868286	20,337892	14,681919	8,421764	1,562485
EF	23,252068	16,328289	8,630041	1,682613	0,645195
FG	24,444236	19,598541	13,866317	7,658807	2,067679
GH	24,812993	20,207112	14,628891	8,434	1,97909
HI	23,191347	16,327915	8,742838	1,868368	0,834663
IJ	24,378514	19,540358	13,851049	7,675327	2,142714
JK	24,726812	20,071024	14,462241	8,264624	1,864064
KL	22,998786	15,94683	8,13707	1,171259	0,406621
LM	24,19726	18,91374	12,889026	6,589541	1,363244
MN	24,481921	20,637388	15,585826	9,59404	3,3075
NO	28,03936	21,853968	16,580404	10,629594	5,700953

Tabel 5.53 Momen tumpuan as 2, struktur 15 portal tanpa dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	31,877856	17,008434	5,958756	1,075976	7,152394
BC	21,000699	18,01244	12,843234	7,645338	4,644956
CD	21,70776	16,443823	11,113173	5,790551	1,370153
DE	21,279563	16,01319	10,106399	4,444567	0,364271
EF	21,223806	15,840956	9,849871	4,123949	0,645747
FG	21,182882	15,79449	9,812461	4,088131	0,627495
GH	21,15972	15,768411	9,8027	4,078084	0,608334
HI	21,13788	15,74201	9,786892	4,059527	0,609414
IJ	21,117963	15,714053	9,764703	4,033263	0,622848
JK	21,101099	15,684131	9,735119	3,998066	0,648024
KL	21,086544	15,672488	9,733599	3,994117	0,65033
LM	21,182154	15,808119	9,994135	4,31555	0,398519
MN	21,275373	16,706536	11,359814	5,664896	0,703652
NO	24,093089	18,564511	13,431059	8,469304	3,916161

Tabel 5.54 Momen tumpuan as 2, struktur 16 portal tanpa dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	32,247224	17,27871	6,346629	6,186333	7,232576
BC	21,256131	18,247604	13,139183	7,6634	4,620177
CD	21,968672	16,663751	11,394709	5,798494	1,339944
DE	21,535282	16,229768	10,374242	4,452993	0,399357
EF	21,476668	16,054036	10,107814	4,1349	0,678070
FG	21,43257	16,004346	10,061695	4,101901	0,656771
GH	21,406291	15,975116	10,044024	4,094051	0,634636
HI	21,381458	15,946127	10,021926	4,078179	0,631979
IJ	21,359604	15,917788	9,997821	4,058477	0,63814
JK	21,340075	15,889589	9,971209	4,034591	0,651376
KL	21,323768	15,859974	9,938787	4,002342	0,675327
LM	21,309623	15,848747	9,935258	4,00116	0,676353
MN	21,40591	15,984261	10,193738	4,323861	0,423963
NO	21,49609	16,881745	11,551868	5,666555	0,670095
OP	24,323475	18,714499	13,598302	8,437235	5,761032

Tabel 5.55 Momen tumpuan as 2, struktur 16 portal dengan 2 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	34,84974	19,412276	7,378671	7,251921	8,686608
BC	23,627416	21,094754	16,077797	10,427446	6,55741
CD	25,830299	25,081092	23,390892	18,787228	11,794894
DE	37,174684	36,866016	36,410438	30,987581	23,563521
EF	34,986054	14,26748	23,77993	26,645533	23,130644
FG	21,878331	18,839216	13,433425	7,946744	8,45668
GH	24,027485	18,759814	13,374469	7,797455	3,783678
HI	23,325392	18,009619	11,570996	5,219203	0,207307
IJ	23,755384	18,698864	12,855372	6,759621	2,930409
JK	25,140975	24,242766	21,866166	16,926174	9,816215
KL	36,880512	36,42136	35,889044	30,465244	23,130644
LM	34,626661	14,446861	24,059123	27,009312	23,563521
MN	21,839545	18,825543	13,583098	8,222503	10,122929
NO	24,087895	19,716804	14,947741	9,449102	5,272467
OP	26,280034	20,573921	14,826402	9,279386	7,055804

Tabel 5.56 Momen tumpuan as 2, struktur 15 portal dengan 3 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	56,680934	18,935657	20,598166	26,420717	23,736244
BC	20,888912	21,30289	16,840062	11,697739	11,907204
CD	25,444902	20,055051	14,592085	8,885418	5,290177
DE	24,245456	19,18496	12,308006	5,622456	0,571537
EF	24,694645	19,811182	13,523972	7,099433	1,570637
FG	26,061857	25,388947	22,578119	17,306555	10,049964
GH	37,943444	37,656135	36,580645	30,767765	19,153662
HI	36,227748	9,920263	14,617289	19,479847	19,642995
IJ	22,572348	19,697514	13,928338	8,200851	8,482706
JK	24,795116	19,613293	13,813863	7,950129	3,609924
KL	24,115736	18,86468	12,003258	5,353745	0,097583
LM	24,67661	19,569961	13,370015	7,026187	3,201212
MN	25,882323	25,863705	23,263145	17,839049	10,120568
NO	42,873885	41,030335	40,689661	35,029046	20,178262

Tabel 5.57 Momen tumpuan as 2, struktur 16 portal dengan 4 dinding geser

Balok	Tingkat				
	1	3	6	8	10
AB	58,181474	20,006451	30,823287	34,601293	25,363178
BC	21,4068	21,858747	17,145885	10,193595	11,920035
CD	26,639785	21,718816	16,885907	11,414636	7,256873
DE	26,864275	26,500064	23,734511	18,42218	11,115452
EF	38,785947	38,399075	36,993002	30,946256	23,711296
FG	37,36594	10,845363	23,930903	26,808429	22,954279
GH	23,132093	20,30118	14,272051	8,389067	9,505021
HI	25,958148	21,320606	16,138302	10,503145	5,845643
IJ	26,702128	26,216708	23,450283	18,159152	10,72592
JK	38,629175	38,193366	36,850815	30,869095	22,954279
KL	37,207446	14,372258	23,892822	26,787255	23,711296
LM	23,058311	20,088842	14,051851	9,432219	10,192914
MN	26,021315	21,148185	16,045353	10,474526	6,403652
NO	26,567899	26,770833	24,2094	18,760725	11,033638
OP	43,660544	41,652728	40,987325	35,119746	25,363178

Tabel 5.58 Momen tumpuan as 2, struktur 15 portal dengan 5 dinding geser

| Balok	Tingkat				
	1	3	6	8	10
AB	59,462788	21,345408	21,15083	27,648688	25,543363
BC	22,424506	23,475783	19,316695	13,931644	15,395342
CD	28,59404	27,911481	26,120563	21,719953	15,639752
DE	39,543535	39,526779	37,989151	32,093576	20,621945
EF	39,124709	13,296574	17,124161	23,08477	24,611976
FG	25,648998	27,641014	25,574967	20,942843	18,894099
GH	40,100366	40,044649	39,592904	34,475522	23,868401
HI	38,994587	13,304372	17,154272	23,113195	24,831673
IJ	25,598636	27,564988	25,53758	20,910335	18,741589
JK	40,061714	39,912324	39,485087	34,39005	23,557463
KL	38,274449	11,846127	15,247913	20,754606	21,389398
LM	24,245035	21,784865	16,391332	10,580799	11,865991
MN	27,769113	28,107413	26,180197	21,467754	14,626413
NO	44,44996	42,71593	41,831405	36,092049	21,507898
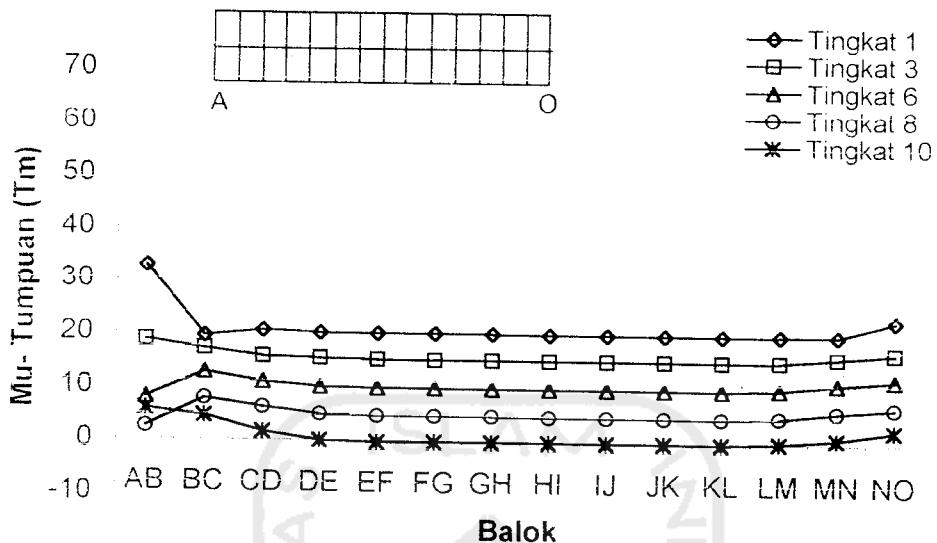
Gambar 5.35 Grafik Mu- balok tumpuan as1 struktur 15 portal
tanpa dinding geser
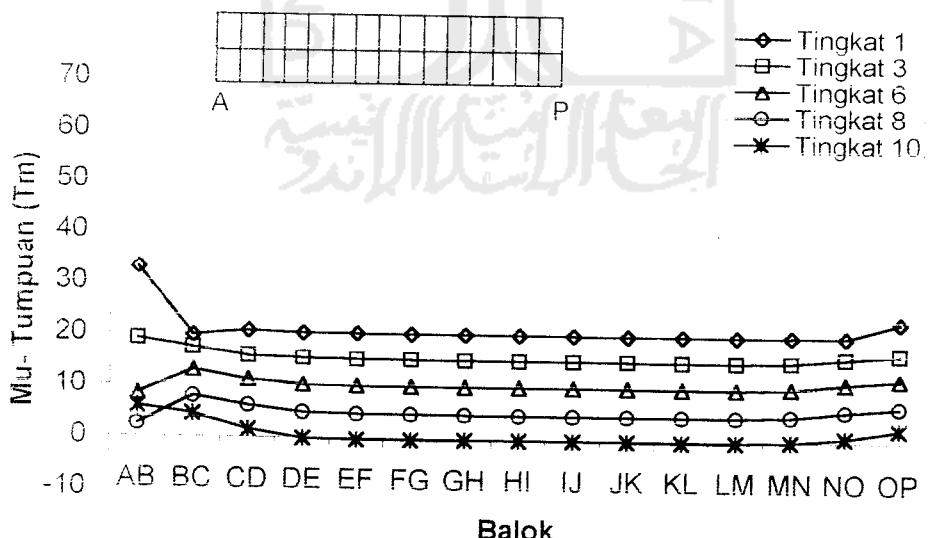
Gambar 5.36 Grafik Mu- balok tumpuan as1 struktur 16 portal
tanpa dinding geser
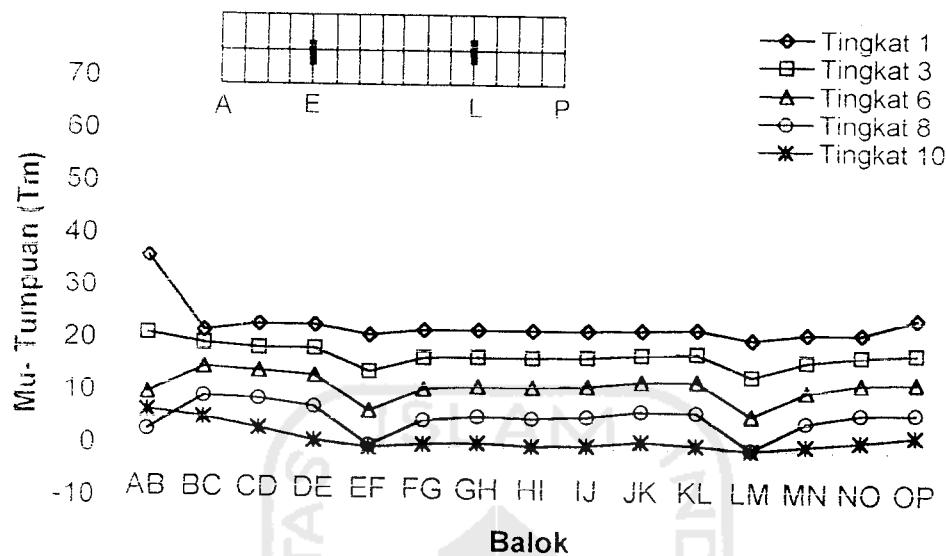
Gambar 5.37 Grafik Mu- balok tumpuan as1 struktur 16 portal
2 dinding geser
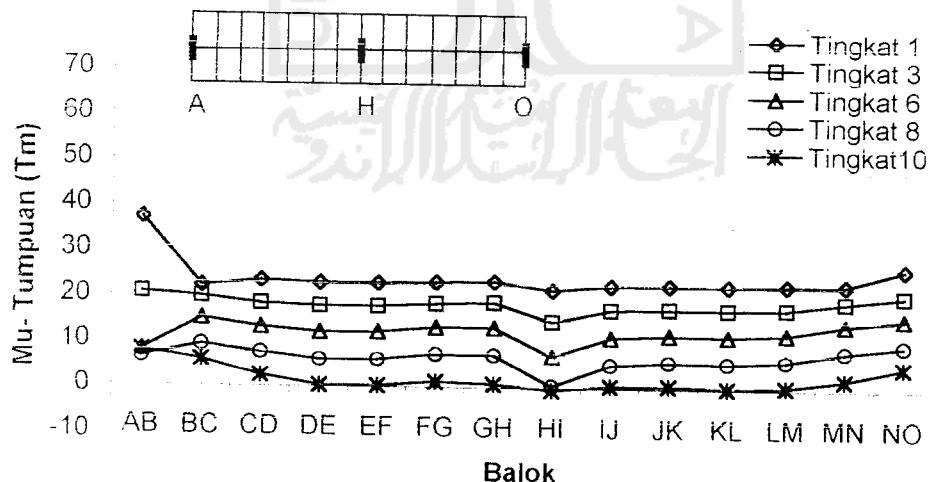
Gambar 5.38 Grafik Mu- balok tumpuan as1 struktur 15 portal
3 dinding geser
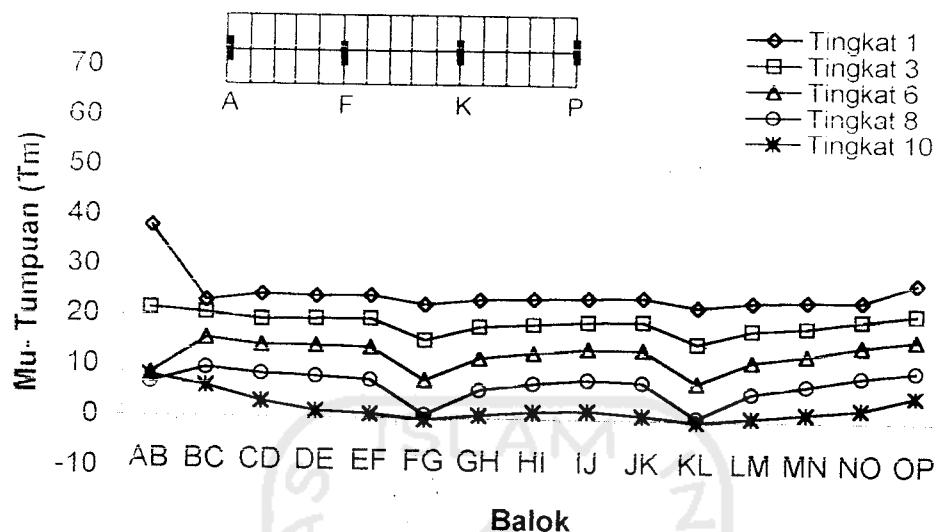
**Gambar 5.39** Grafik Mu- balok tumpuan as1 struktur 16 portal
4 dinding geser
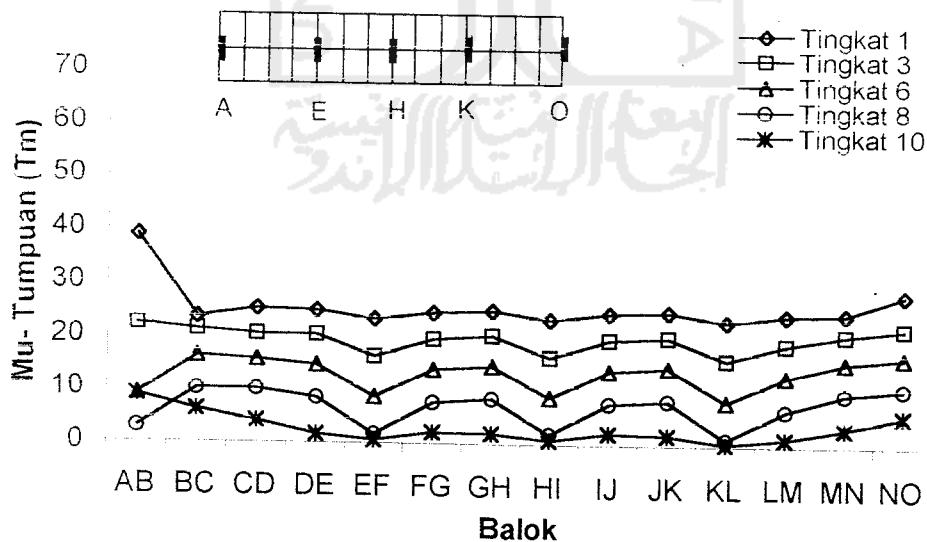
Gambar 5.40 Grafik Mu- balok tumpuan as1 struktur 15 portal
5 dinding geser
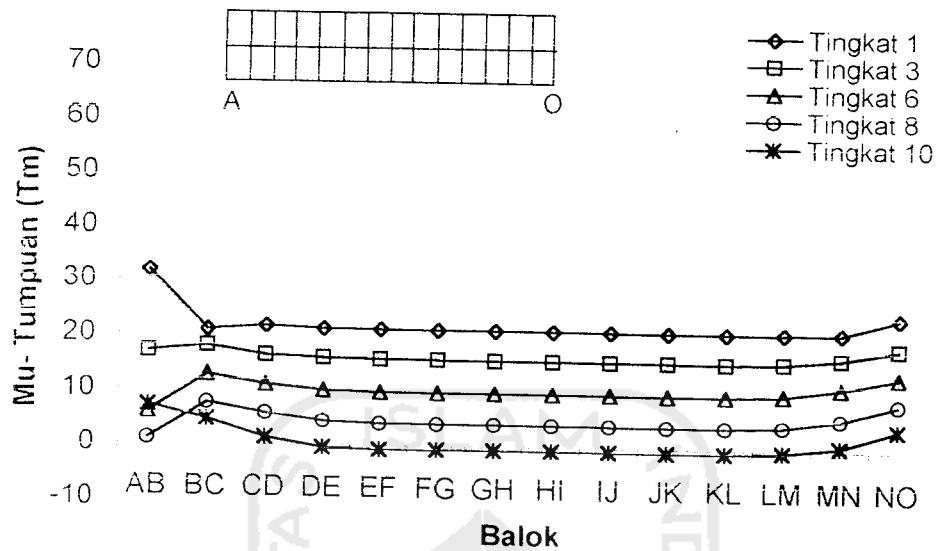
Gambar 5.41 Grafik Mu- balok tumpuan as 2 struktur 15 portal tanpa dinding geser
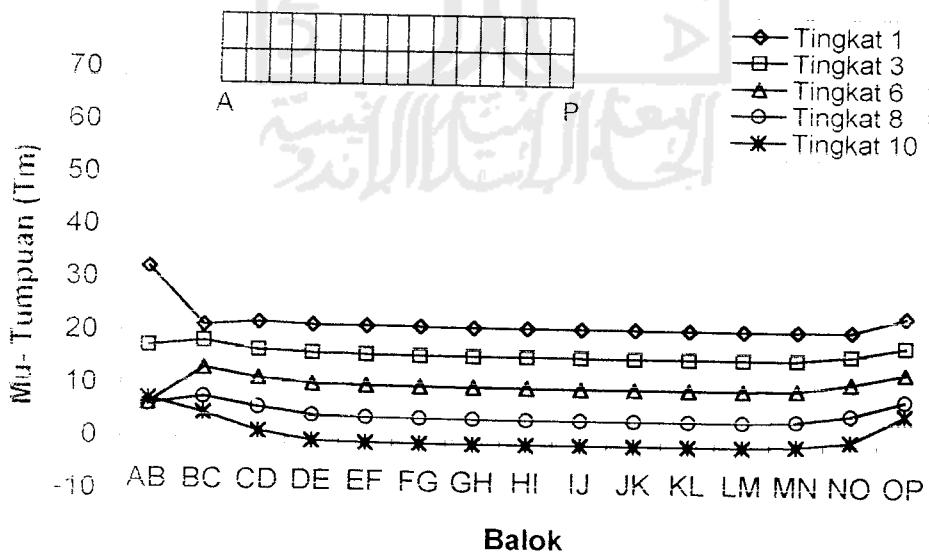

Gambar 5.42 Grafik Mu- balok tumpuan as 2 struktur 16 portal tanpa dinding geser
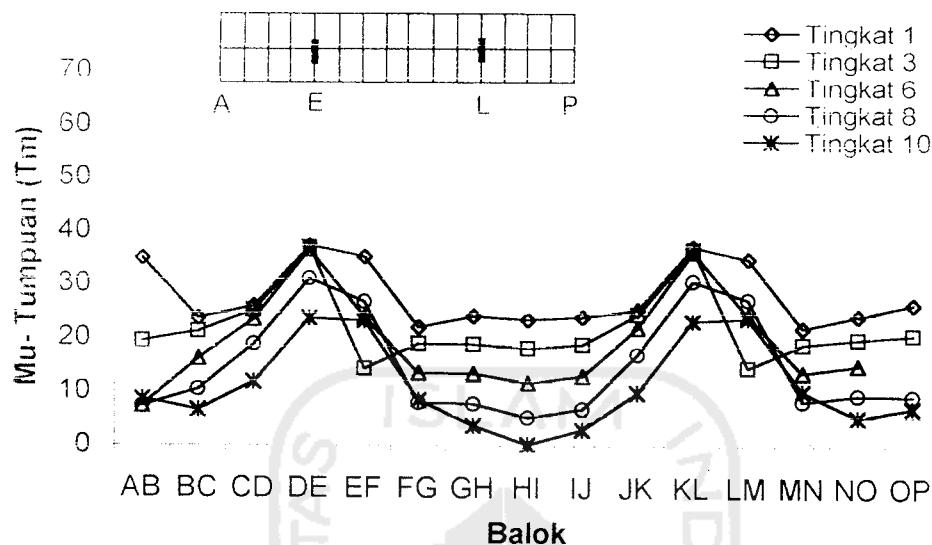
Gambar 5.43 Grafik Mu- balok tumpuan as 2 struktur 16 portal
2 dinding geser
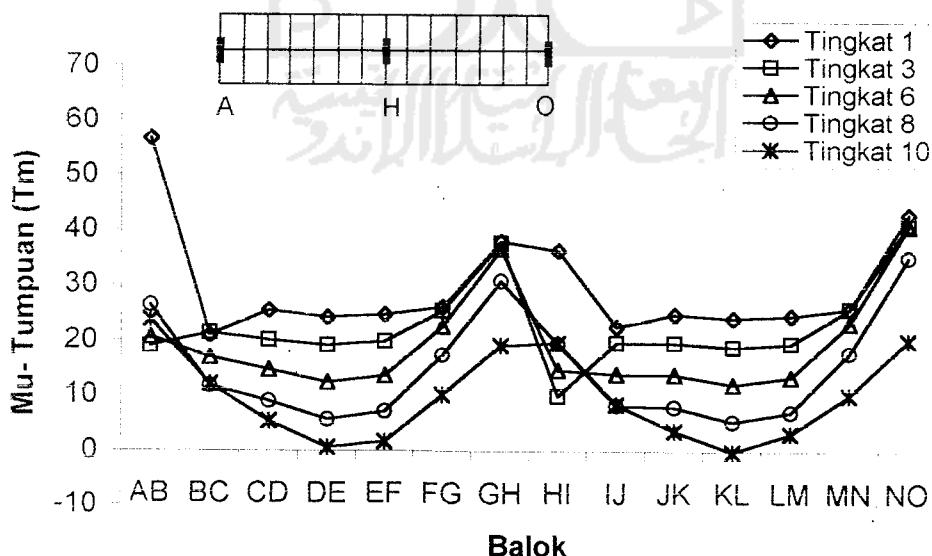
Gambar 5.44 Grafik Mu- balok tumpuan as 2 struktur 15 portal
3 dinding geser
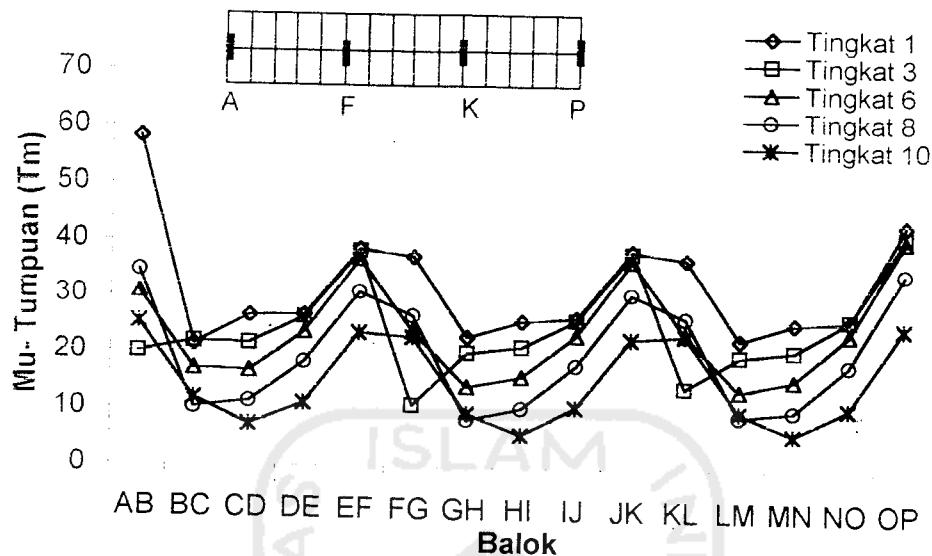
Gambar 5.45 Grafik Mu- balok tumpuan as 2 struktur 16 portal 4 dinding geser
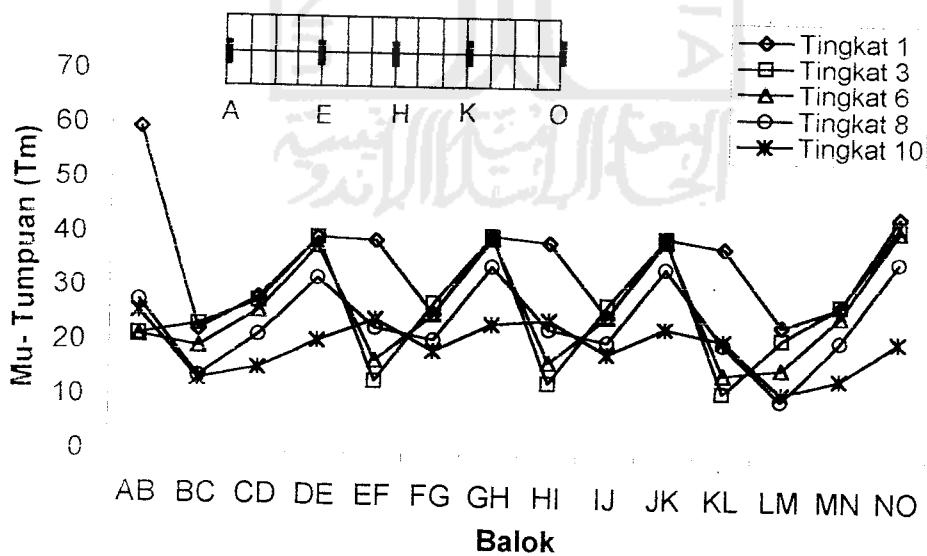
Gambar 5.46 Grafik Mu- balok tumpuan as 2 struktur 15 portal 5 dinding geser