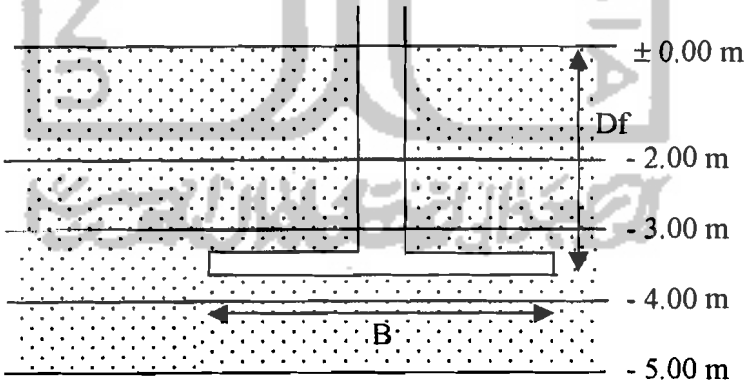
# BAB V

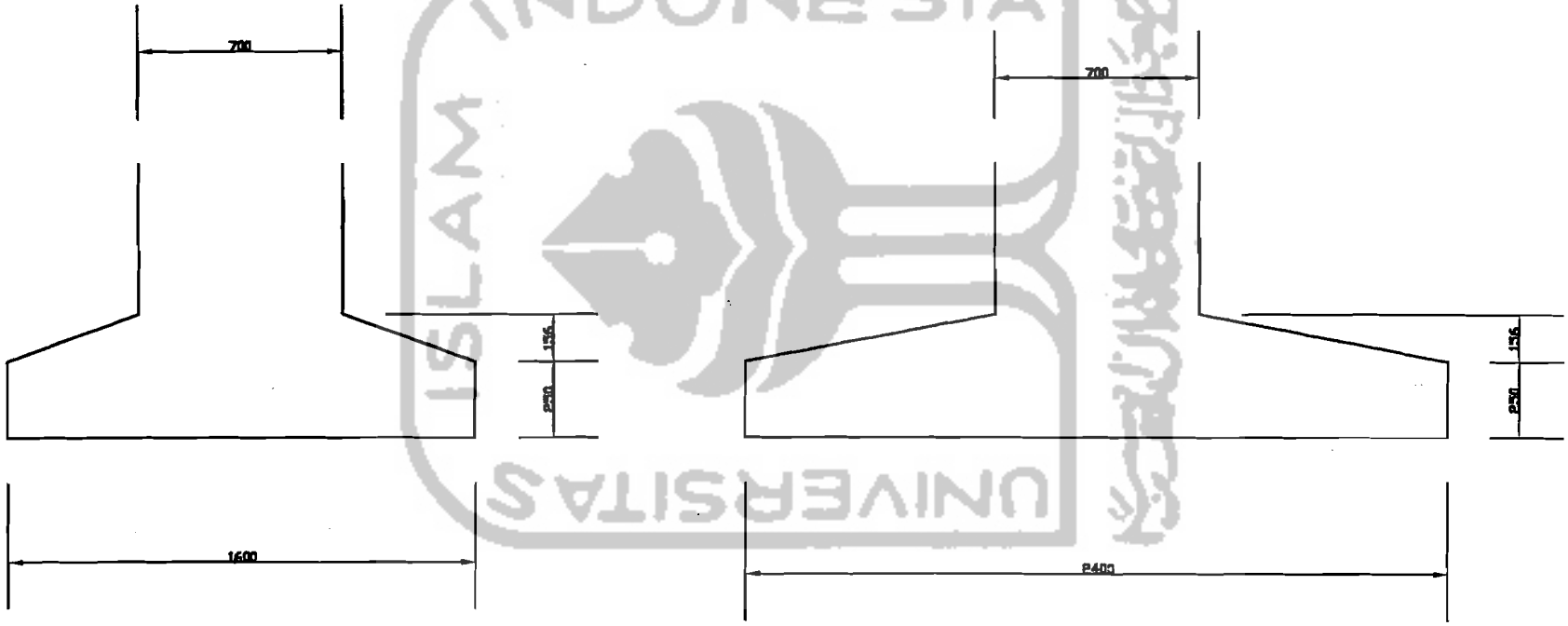
# ANALISIS HITUNGAN

## 5.1 Data Tanah

Data tanah diambil dari laporan hasil pengujian tanah yang dilakukan oleh Laboratorium Mekanika Tanah Fakultas Teknik Sipil dan Perencanaan Universitas Islam Indonesia Yogyakarta untuk proyek Pembangunan Gedung Registrasi UII Yogyakarta (terlampir). Dari data hasil pengujian di lapangan, hingga kedalaman 6,00 meter belum dijumpai muka air tanah. Keadaaan tanah tiap lapisan dapat dilihat berikut ini.




Gambar 5.1 Rencana Fondasi




Gambar 5.2 Tampak Samping Fondasi

(Satuan dalam mm)

Pengujian berupa pengujian lapangan dan pengujian laboratorium. Pengujian lapangan berupa SPT, CPT dan *Hand Boring*. Nilai c dan $\phi$ didapat dari pengujian *direct shear test*. Adapun data tanah tiap lapis seperti gambar di atas adalah sebagai berikut ini:

**Kedalaman –2.00 m**:

c = 0,026 kg/cm$^2$

$\phi_{peak}$= 24$^0$

$\gamma_b$= 1,768 gram/cm$^3$

$\gamma_k$= 1,638 gram/cm$^3$

w = 6,25 %

Gs = 2,726

**Kedalaman –3.00 m**:

c = 0,013 kg/cm$^2$

$\phi_{peak}$= 36$^0$

$\gamma_b$= 1,461 gram/cm$^3$

$\gamma_k$= 1,385 gram/cm$^3$

w = 5,49 %

Gs = 2,743

**Kedalaman –4.00 m**:

c = 0,061 kg/cm$^2$

$\phi_{peak}$= 40$^0$

$\phi_{cv}$= 29$^0$

$\gamma_b$ = 1,663 gram/cm$^3$

$\gamma_k$ = 1,524 gram/cm$^3$

w = 9,48 %

Gs = 2,720

N-SPT = 8

**Kedalaman –5.00 m**:

c = 0,008 kg/cm$^2$

$\phi_{peak}$ = 36$^0$

$\phi_{cv}$ = 25$^0$

$\gamma_b$ = 1,602 gram/cm$^3$

$\gamma_k$ = 1,390 gram/cm$^3$

w = 19,31 %

Gs = 2,718

N-SPT = 8

## 5.2 Analisis Daya Dukung Tanah

### 5.2.1 Metode Terzaghi

Persamaan daya dukung yang diberikan Terzaghi (1943) untuk tanah pasir adalah sebagai berikut:

$$q_{ult} = q'.N_q + \tfrac{1}{2}.\gamma'.B.N_\gamma \qquad (5.1)$$

Langkah yang digunakan untuk menghitung daya dukung *ultimate* fondasi dangkal dengan teori Terzaghi sebagai berikut:

1. Menentukan faktor daya dukung

$$N_q = \frac{\left[e^{(0,75.\pi - \phi/2).\tan\phi}\right]^2}{2.\cos^2(45+\phi/2)} \qquad (5.2)$$

$$N\gamma = \frac{\tan\phi}{2}.\left[\frac{Kp_\gamma}{\cos^2\phi} - 1\right] \qquad (5.3)$$

$$N_c = (N_q - 1).\cot\phi \qquad (5.4)$$

$$\phi' = a\tan[\tfrac{2}{3}\tan\phi] \qquad (5.5)$$

Untuk Df = 2m:

$\phi_{peak}$= $36^0$, maka $N_q$= 47,16

$\phi'_{peak}$=$26^0$, maka $N_q'$=14,21

Untuk Df = 3m:

$\phi_{peak}$= $34^0$, maka $N_q$=36,5

$\phi'_{peak}$=$24^0$, maka $N_q'$=11,40

Untuk Df = 4 m:

$\phi_{peak}$ = $40^0$, maka $N_q$=81,27

$N_\gamma$=37,12

$\phi'_{peak}$=$29^0$, maka $N_q'$=19,98

$N_\gamma'$=7,82

Untuk Df = 5m:

$\phi_{peak}$ =$36^0$, maka $N_q$ = 47,16

$N_\gamma$ =21,67

$\phi'_{peak}$=$26^0$, maka $N_q'$=14,21

$N_\gamma'$=5,86

2. Menentukan kedalaman fondasi (Df)

   Fondasi diletakkan pada kedalaman Df=3,25m.

3. Menentukan daya dukung ijin ($q_{all}$)

   A. Daya dukung untuk lebar fondasi 1600 mm

$$q_{ult} = q'.N_q' + 0,5.\gamma'.B.N_\gamma'$$

$$= \left[(2.0,768 + 1.0,461 + 0,25.0,663).81,3\right].9.80665$$

$$+ 0,5.(0,663.9,80665).1,6.37,12$$

$$= 1916,752\,\text{kpa}$$

Bila digunakan angka kemanan SF=3, maka:

$$q_{all} = \frac{q_{ult}}{SF} = \frac{1916,752}{3} = 638,9175\,\text{kpa}$$

B. Daya dukung untuk lebar fondasi 2400 mm

$$q_{ult} = q'.N_q' + 0,5.\gamma'.B.N_\gamma'$$

$$= \left[(2.0,768 + 1.0,461 + 0,25.0,663).9,80665\right]$$

$$+ 0,5.(0,663.9,80665).2,4.37,12$$

$$= 2013,279\,\text{kpa}$$

Bila digunakan angka keamanan SF=1,50, maka:

$$q_{all} = \frac{q_{ult}}{SF} = \frac{2013,279}{3} = 671,093\,\text{kpa}$$

Dengan cara yang sama, untuk daya dukung tanah menggunakan metode Terzaghi pada kedalaman telapak fondasi (Df) dan lebar telapak fondasi (B) yang berbeda, hasil perhitungan ditunjukkan pada Tabel 5.1 berikut ini

Tabel 5.1 Perhitungan daya dukung fondasi dengan metode Terzaghi

| Df (m) | B (m) | L (m) | $\phi_{peak}$ ($^o$) | $Kp_\gamma$ | q' (kpa) | $N_q'$ | $N_\gamma'$ | $q_{ult}$ (kpa) | $q_{all}$ (kpa) |
|---|---|---|---|---|---|---|---|---|---|
| 3.25 | 1.6 | 12 | 40 | 52.5 | 21.209 | 81.271 | 37.115 | 1916.752 | 638.917 |
| 3.25 | 2.4 | 12 | 40 | 52.5 | 21.209 | 81.271 | 37.115 | 2013.279 | 671.093 |
| 3.5 | 1.6 | 12 | 40 | 52.5 | 22.835 | 81.271 | 37.115 | 2048.854 | 682.951 |
| 3.5 | 2.4 | 12 | 40 | 52.5 | 22.835 | 81.271 | 37.115 | 2145.381 | 715.127 |
| 3.75 | 1.6 | 12 | 40 | 52.5 | 24.460 | 81.271 | 37.115 | 2180.956 | 726.985 |
| 3.75 | 2.4 | 12 | 40 | 52.5 | 24.460 | 81.271 | 37.115 | 2277.483 | 759.161 |
| 4.25 | 1.6 | 12 | 36 | 36.81 | 27.562 | 47.156 | 20.067 | 1394.471 | 464.824 |
| 4.25 | 2.4 | 12 | 36 | 36.81 | 27.562 | 47.156 | 20.067 | 1441.859 | 480.620 |
| 4.5 | 1.6 | 12 | 36 | 36.81 | 29.037 | 47.156 | 20.067 | 1464.068 | 488.023 |
| 4.5 | 2.4 | 12 | 36 | 36.81 | 29.037 | 47.156 | 20.067 | 1511.456 | 503.819 |
| 4.75 | 1.6 | 12 | 36 | 36.81 | 30.513 | 47.156 | 20.067 | 1533.666 | 511.222 |
| 4.75 | 2.4 | 12 | 36 | 36.81 | 30.513 | 47.156 | 20.067 | 1581.054 | 527.018 |

### 5.2.2 Metode pendekatan *relative density*

Rumus daya dukung tanah menggunakan metode pendekatan *relative density* dari Perkins & Madson (2000) sebagai berikut:

$$q_{ult} = q'.N_q' + 0{,}5.\gamma'.B.N_\gamma' \qquad (5.6)$$

$$q_{ult-prod} = q_{ult-peak} - I_{PF}.\left(q_{ult-peak} - q_{ult-cv}\right) \qquad (5.7)$$

Langkah-langkah yang digunakan untuk menyelesaikan persoalan daya dukung tanah pasir menggunakan pendekatan *relative density* sebagai berikut:

1. menetapkan nilai Dr, $\phi'_{cv}$ dan $\gamma'$

   a. nilai Dr

   $$\ln N = c_2 + 2{,}06.\ln Dr + c_3.\ln \sigma'_v$$

$$\ln 8 = 2{,}67 + 2{,}06.\ln Dr + 0{,}222.\ln(1{,}663.4.9{,}80665)$$

$$\ln Dr = \frac{\ln 8 - [2{,}67 + 0{,}222.\ln(1{,}663.4.9{,}80665)]}{2{,}06}$$

$$Dr = 0{,}481$$

b. nilai $\phi'_{cv}$

nilai $\phi_{cv}=29^0$, maka $\phi'_{cv}=20^0$.

c. nilai $\gamma'$

$\gamma_1=1{,}768$ gram/cm$^3$, maka $\gamma_1'=0{,}768$ gram/cm$^3$

$\gamma_2=1{,}461$ gram/cm$^3$, maka $\gamma_2'=0{,}461$ gram/cm$^3$

$\gamma_3=1{,}663$ gram/cm$^3$, maka $\gamma_3'=0{,}663$ gram/cm$^3$

2. menetapkan nilai B, L dan Df

digunakan Df=3,25 m → B=1600 mm; L=12000 mm

→ B=2400 mm; L=12000 mm

3. mengasumsikan nilai $P'$

$$p' = \frac{\sum \sigma}{n}$$

$$p' = \frac{(0{,}25 + 0{,}23594).9{,}80665}{2} = 2{,}3827 \text{ kpa}$$

4. menghitung nilai $\phi'_{peak}$

$$\phi'_{peak} = \phi'_{cv} + A.I_R$$

$$I_R = Dr(Q - \ln p') - R$$

$$= 0{,}481(10 - \ln 2{,}3827) - 1$$

$$= 3{,}39$$

A). $A = 1/3.(L/B + 8)$

$$= 1/3.\left(\frac{12000}{1600} + 8\right)$$

$$= 5{,}167 \approx 5$$

$$\phi'_{peak} = \phi'_{cv} + A.I_R$$

$$= 20 + 5.3{,}39$$

$$= 37{,}5^0$$

B). $A = 1/3.(L/B + 8)$

$$= 1/3.\left(\frac{12000}{2400} + 8\right)$$

$$= 4{,}3333 \approx 4$$

$$\phi'_{peak} = \phi'_{cv} + A.I_R$$

$$= 20 + 4.3{,}39$$

$$= 34{,}7^0$$

5. menghitung nilai $q_{ult\text{-}peak}$

$$q_{ult-peak} = q'.N_q' + 0{,}5.\gamma'.B.N_\gamma'$$

$$q' = \Sigma(Df.\gamma')$$

$$= [(0{,}768.2) + (0{,}461.1) + (0{,}663.0{,}25)]9{,}80665$$

$$= 21{,}21 \text{kpa}$$

A). $\xi = \pi/4 + {}^{\phi' peak}/_2$

$$= \pi/4 + {}^{37{,}5}/_2$$

$$= 0{,}340$$

$$N_\gamma = 1/4 \tan\xi\left[\tan\xi \exp\left(\frac{3\pi}{2}\tan\phi'_{peak}\right) - 1\right]$$

$$+ \frac{3.\sin\phi'_{peak}}{\left(1+8\sin^2\phi'_{peak}\right)}\left[\left(\tan\xi - \frac{\cot\phi'_{peak}}{3}\right)\exp\left(\frac{3\pi}{2}\tan\phi'_{peak}\right) + \tan\xi\frac{\cot\phi'_{peak}}{3} + 1\right]$$

$$= 1{,}583$$

$$N_q = \tan^2\xi.e(\pi.\tan\phi'_{peak})$$

$$= \tan^2 0{,}340.e(\pi.\tan 37{,}5)$$

$$= 15{,}72$$

$$q_{ult-peak} = q'.N_q' + 0{,}5.\gamma'.B.N_\gamma'$$

$$= 21{,}21.15{,}72 + 0{,}5.(0{,}663.9{,}80665).1{,}6.1{,}583$$

$$= 341{,}7309 \text{kpa}$$

B). $\xi = \pi/4 + \phi'_{peak}/2$

$= \pi/4 + 34{,}7/2$

$= 0{,}320$

$$N_\gamma = 1/4 \tan\xi\left[\tan\xi \exp\left(\frac{3\pi}{2}\tan\phi'_{peak}\right) - 1\right]$$

$$+ \frac{3.\sin\phi'_{peak}}{\left(1+8\sin^2\phi'_{peak}\right)}\left[\left(\tan\xi - \frac{\cot\phi'_{peak}}{3}\right)\exp\left(\frac{3\pi}{2}\tan\phi'_{peak}\right) + \tan\xi\frac{\cot\phi'_{peak}}{3} + 1\right]$$

$$= 1{,}096$$

$$N_q = \tan^2 \xi . \exp(\pi . \tan \phi'_{peak})$$

$$= \tan^2 0{,}320 . \exp(\pi . \tan 34{,}7)$$

$$= 8{,}32$$

$$q_{ult-peak} = q' . N_q + 0{,}5 . \gamma' . B . N_\gamma$$

$$= 21{,}21 . 9{,}8829 + 0{,}5 . (0{,}663 . 9{,}80665) . 2 , 4 . 1{,}096$$

$$= 184{,}9714 \text{ kpa}$$

6. menghitung rasio $p' / q_{ult-peak}$ hitungan

A). $\frac{p'}{q_{ult-peak}} = \frac{21{,}21}{341{,}7309} = 0{,}0070$

B). $\frac{p'}{q_{ult-peak}} = \frac{21{,}21}{184{,}9714} = 0{,}0129$

7. menghitung rasio $p' / q_{ult-peak}$ rumus

A). $\frac{p'}{q_{ult-peak}} = 1/6 \left[ 0{,}52 - 0{,}04 . L/B \right]$

$$= 1/6 \left[ 0{,}52 - 0{,}04 . \frac{12000}{1600} \right]$$

$$= 0{,}0367 \approx 0{,}04$$

B). $\frac{p'}{q_{ult-peak}} = 1/6 \left[ 0{,}52 - 0{,}04 L/B \right]$

$$= \frac{1}{6}\left[0{,}52 - 0{,}04.\frac{12000}{2400}\right]$$

$$= 0{,}0533 \approx 0{,}05$$

8. membandingkan nilai $p'/q_{ult-peak(hitungan)}$ dan $p'/q_{ult-peak(rumus)}$

Karena nilai $p'/q_{ult-peak(hitungan)}$ tidak sama dengan nilai $p'/q_{ult-peak(rumus)}$, maka dilakukan iterasi. Hasil dari proses iterasi ditunjukkan pada tabel 5.2 berikut:

Tabel 5.2 iterasi nilai $p'/q_{ult-peak(hitungan)}$ dengan $p'/q_{ult-peak(rumus)}$

| Df (m) | B (m) | $\phi'_{cv}$ | A | $I_R$ | $\phi'_{peak}$ ($^0$) | Nq' | Nγ' | $q_{ult-peak}$ (kpa) | $\frac{p'}{q_{ult-peak}}$ | $\frac{p'}{q_{ult-peak}}$ | Ket |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.25 | 1.6 | 20 | 2.831 | 2.604 | 27 | 69.906 | 8.906 | 1487.385 | 0.008 | 0.037 | trial |
| 3.25 | 1.6 | 20 | 2.831 | 1.887 | 25 | 48.928 | 6.975 | 1041.420 | 0.052 | 0.037 | trial |
| 3.25 | 1.6 | 20 | 2.831 | 2.058 | 26 | 53.226 | 7.382 | 1132.799 | 0.034 | 0.037 | trial |
| 3.25 | 1.6 | 20 | 2.831 | 2.018 | 26 | 52.176 | 7.283 | 1110.478 | 0.037 | 0.037 | **ok** |
| 3.25 | 2.4 | 20 | 2.913 | 2.729 | 28 | 77.528 | 9.577 | 1651.945 | 0.006 | 0.053 | trial |
| 3.25 | 2.4 | 20 | 2.913 | 1.656 | 25 | 44.758 | 6.572 | 954.511 | 0.092 | 0.053 | trial |
| 3.25 | 2.4 | 20 | 2.913 | 1.920 | 26 | 51.104 | 7.182 | 1089.598 | 0.047 | 0.053 | **ok** |

9. menghitung nilai $q_{ult-cv}$

$$\xi = \pi/4 + \phi'_{cv}/2$$

$$= \pi/4 + 20/2$$

$$= 0{,}188$$

$$N_q = \tan^2 \xi . e(\pi . \tan \phi'_{cv})$$

$$= \tan^2 \xi . e(\pi . \tan 20)$$

$$= 6{,}40$$

$$N_\gamma = \tfrac{1}{4} \tan \xi \left[ \tan \xi \exp\left( \frac{3\pi}{2} \tan \phi'_{cv} \right) - 1 \right]$$

$$+ \frac{3 . \sin \phi'_{cv}}{\left(1 + 8 \sin^2 \phi'_{cv}\right)} \left[ \left( \tan \xi - \frac{\cot \phi'_{cv}}{3} \right) \exp\left( \frac{3\pi}{2} \tan \phi'_{cv} \right) + \tan \xi \frac{\cot \phi'_{cv}}{3} + 1 \right]$$

$$= 1{,}76$$

A. $q_{ult-cv} = q'.N_q' + 0{,}5.\gamma'.B.N_\gamma'$

$$= 21{,}21.6{,}40 + 0{,}5.(0{,}663.9{,}80665).1{,}6.1{,}76$$

$$= 144{,}8776 \text{ kpa}$$

B. $q_{ult-cv} = q'.N_q' + 0{,}5.\gamma'.B.N_\gamma'$

$$= 21{,}21.6{,}40 + 0{,}5.(0{,}663.9{,}80665).2{,}4.1{,}76$$

$$= 149{,}4530 \text{ kpa}$$

10. menghitung $I_{PF}$

A. $I_{PF} = 0{,}044.I_R + 0{,}65$

$= 0{,}044.2{,}02 + 0{,}65$

$= 0{,}74$

B. $I_{PF} = 0{,}044.I_R + 0{,}65$

$= 0{,}044.1{,}92 + 0{,}65$

$= 0{,}73$

11. menghitung $q_{ult\text{-}pred}$

A. $q_{ult-pred} = q_{ult-peak} - I_{PF}.(q_{ult-peak} - q_{ult-cv})$

$= 1110{,}478 - 0{,}74(1110{,}478 - 144{,}8778)$

$= 404{,}8380$ kpa

B. $q_{ult-pred} = q_{ult-peak} - I_{PF}.(q_{ult-peak} - q_{ult-cv})$

$= 1089{,}598 - 0{,}73(1089{,}598 - 149{,}4530)$

$= 562{,}7618$ kpa

Dengan cara yang sama, untuk daya dukung tanah menggunakan metode pendekatan *relative density* dengan kedalaman telapak fondasi (Df) dan lebar telapak fondasi (B) yang berbeda, hitungan ditunjukkan pada tabel 5.3, 5.4 dan 5.5 berikut ini

Tabel 5.3 Perhitungan daya dukung fondasi metode pendekatan *relative density* (langkah 1-7)

| Df (m) | B (m) | L (m) | Dr (%) | $\phi'_{cv}$ (°) | p' (kpa) | $I_R$ | A | $\phi'_{peak}$ (°) | ξ | $N_q'$ | $N_\gamma'$ | q' (kpa) | $q_{ult\text{-}peak}$ (kpa) | $\frac{p'}{q_{ult-peak}}$ | $\frac{p'}{q_{ult-peak}}$ | ket |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.25 | 1.6 | 12 | 48.1% | 20 | 2.3827 | 3 | 5 | 38 | 0.341 | 15.7241 | 1.5827 | 21.2093 | 341.7309 | 0.0070 | 0.0367 | trial |
| 3.25 | 2.4 | 12 | 48.1% | 20 | 2.3827 | 3 | 4 | 35 | 0.317 | 8.3180 | 1.0961 | 21.2093 | 184.9714 | 0.0129 | 0.0533 | trial |
| 3.5 | 1.6 | 12 | 48.1% | 20 | 2.3827 | 3 | 5 | 38 | 0.341 | 15.7241 | 1.5827 | 22.8348 | 367.2897 | 0.0065 | 0.0367 | trial |
| 3.5 | 2.4 | 12 | 48.1% | 20 | 2.3827 | 3 | 4 | 35 | 0.317 | 8.3180 | 1.0961 | 22.8348 | 198.4919 | 0.0120 | 0.0533 | trial |
| 3.75 | 1.6 | 12 | 48.1% | 20 | 2.3827 | 3 | 5 | 38 | 0.341 | 15.7241 | 1.5827 | 24.4602 | 392.8486 | 0.0061 | 0.0367 | trial |
| 3.75 | 2.4 | 12 | 48.1% | 20 | 2.3827 | 3 | 4 | 35 | 0.317 | 8.3180 | 1.0961 | 24.4602 | 212.0124 | 0.0112 | 0.0533 | trial |
| 4.25 | 1.6 | 12 | 48.1% | 17 | 2.0828 | 3 | 5 | 35 | 0.318 | 8.6206 | 1.1176 | 27.5616 | 243.4093 | 0.0086 | 0.0367 | trial |
| 4.25 | 2.4 | 12 | 48.1% | 17 | 2.0828 | 3 | 4 | 32 | 0.293 | 4.5950 | 0.8102 | 27.5616 | 132.9668 | 0.0157 | 0.0533 | trial |
| 4.5 | 1.6 | 12 | 48.1% | 17 | 2.0828 | 3 | 5 | 35 | 0.318 | 8.6206 | 1.1176 | 29.0375 | 256.1323 | 0.0081 | 0.0367 | trial |
| 4.5 | 2.4 | 12 | 48.1% | 17 | 2.0828 | 3 | 4 | 32 | 0.293 | 4.5950 | 0.8102 | 29.0375 | 139.7485 | 0.0149 | 0.0533 | trial |
| 4.75 | 1.6 | 12 | 48.1% | 17 | 2.0828 | 3 | 5 | 35 | 0.318 | 8.6206 | 1.1176 | 30.5134 | 268.8554 | 0.0077 | 0.0367 | trial |
| 4.75 | 2.4 | 12 | 48.1% | 17 | 2.0828 | 3 | 4 | 32 | 0.293 | 4.5950 | 0.8102 | 30.5134 | 146.5303 | 0.0142 | 0.0533 | trial |

Tabel 5.4 Perhitungan daya dukung fondasi metode pendekatan *relative density* (langkah 8)

| Df (m) | B (m) | L (m) | Dr (%) | $\phi'_{cv}$ (°) | q' (kpa) | A | p' (kpa) | IR | $\phi'_{peak}$ (°) | ξ | $N_q'$ | $N_\gamma'$ | $q_{ult\text{-}peak}$ (kpa) | $\frac{p'}{q_{ult-peak}}$ | $\frac{p'}{q_{ult-peak}}$ | Ket |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.25 | 1.6 | 12 | 48.1% | 20 | 21.2093 | 3 | 12.5301 | 2.5940 | 27 | 1.024 | 69.5359 | 8.8728 | 1520.9602 | 0.0082 | 0.0367 | trial |
| 3.25 | 1.6 | 12 | 48.1% | 20 | 21.2093 | 3 | 55.7685 | 1.8758 | 25 | 1.006 | 48.6712 | 6.9502 | 1068.4344 | 0.0522 | 0.0367 | trial |
| 3.25 | 1.6 | 12 | 48.1% | 20 | 21.2093 | 3 | 39.1759 | 2.0457 | 26 | 1.010 | 52.9037 | 7.3519 | 1160.2928 | 0.0338 | 0.0367 | trial |
| 3.25 | 1.6 | 12 | 48.1% | 20 | 21.2093 | 3 | 42.5441 | 2.0060 | 26 | 1.009 | 51.8806 | 7.2555 | 1138.0918 | 0.0374 | 0.0367 | **ok** |
| 3.25 | 2.4 | 12 | 48.1% | 20 | 21.2093 | 3 | 9.8651 | 2.7090 | 28 | 1.029 | 76.7039 | 9.5048 | 1700.9965 | 0.0058 | 0.0533 | trial |
| 3.25 | 2.4 | 12 | 48.1% | 20 | 21.2093 | 3 | 90.7198 | 1.6418 | 25 | 1.002 | 44.4441 | 6.5418 | 993.6694 | 0.0913 | 0.0533 | trial |
| 3.25 | 2.4 | 12 | 48.1% | 20 | 21.2093 | 3 | 52.9957 | 1.9003 | 26 | 1.008 | 50.6072 | 7.1348 | 1129.0132 | 0.0469 | 0.0533 | **ok** |
| 3.5 | 1.6 | 12 | 48.1% | 20 | 22.8348 | 3 | 13.4673 | 2.5393 | 27 | 1.023 | 67.9661 | 8.7327 | 1597.4136 | 0.0084 | 0.0367 | trial |
| 3.5 | 1.6 | 12 | 48.1% | 20 | 22.8348 | 3 | 58.5718 | 1.8522 | 25 | 1.005 | 47.9331 | 6.8795 | 1130.3247 | 0.0518 | 0.0367 | trial |
| 3.5 | 1.6 | 12 | 48.1% | 20 | 22.8348 | 3 | 41.4452 | 2.0186 | 26 | 1.010 | 51.9886 | 7.2657 | 1224.9406 | 0.0338 | 0.0367 | **ok** |
| 3.5 | 2.4 | 12 | 48.1% | 20 | 22.8348 | 3 | 10.5862 | 2.6751 | 28 | 1.028 | 74.7197 | 9.3311 | 1779.0121 | 0.0060 | 0.0533 | trial |
| 3.5 | 2.4 | 12 | 48.1% | 20 | 22.8348 | 3 | 94.8806 | 1.6202 | 25 | 1.001 | 43.7540 | 6.4743 | 1049.6268 | 0.0904 | 0.0533 | trial |
| 3.5 | 2.4 | 12 | 48.1% | 20 | 22.8348 | 3 | 55.9801 | 1.8740 | 25 | 1.007 | 49.6545 | 7.0442 | 1188.8105 | 0.0471 | 0.0533 | **ok** |
| 3.75 | 1.6 | 12 | 48.1% | 20 | 24.4602 | 3 | 14.4044 | 2.5269 | 27 | 1.022 | 66.5685 | 8.6074 | 1673.0525 | 0.0086 | 0.0367 | trial |
| 3.75 | 1.6 | 12 | 48.1% | 20 | 24.4602 | 3 | 61.3453 | 1.8300 | 25 | 1.005 | 47.2655 | 6.8152 | 1191.5735 | 0.0515 | 0.0367 | trial |
| 3.75 | 1.6 | 12 | 48.1% | 20 | 24.4602 | 3 | 43.6910 | 1.9932 | 26 | 1.009 | 51.1664 | 7.1879 | 1288.9289 | 0.0339 | 0.0367 | **ok** |
| 3.75 | 2.4 | 12 | 48.1% | 20 | 24.4602 | 3 | 11.3073 | 2.6434 | 28 | 1.026 | 72.9719 | 9.1773 | 1856.5127 | 0.0061 | 0.0533 | trial |
| 3.75 | 2.4 | 12 | 48.1% | 20 | 24.4602 | 3 | 99.0140 | 1.5997 | 25 | 1.000 | 43.1312 | 6.4133 | 1105.0369 | 0.0896 | 0.0533 | trial |

Lanjutan Tabel 5.4

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.75 | 2.4 | 12 | 48.1% | 20 | 24.4602 | 3 | 58.9353 | 1.8492 | 25 | 1.006 | 48.8046 | 6.9630 | 1248.0979 | 0.0472 | 0.0533 | **ok** |
| 4.25 | 1.6 | 12 | 48.1% | 17 | 27.5616 | 3 | 8.9250 | 2.7572 | 25 | 1.001 | 43.8109 | 6.4799 | 1241.2025 | 0.0072 | 0.0367 | trial |
| 4.25 | 1.6 | 12 | 48.1% | 17 | 27.5616 | 3 | 45.5108 | 1.9736 | 23 | 0.982 | 30.2873 | 5.1060 | 861.3237 | 0.0528 | 0.0367 | trial |
| 4.25 | 1.6 | 12 | 48.1% | 17 | 27.5616 | 3 | 31.5819 | 2.1493 | 23 | 0.986 | 32.8707 | 5.3774 | 933.9382 | 0.0338 | 0.0367 | **ok** |
| 4.25 | 2.4 | 12 | 48.1% | 17 | 27.5616 | 3 | 7.0916 | 2.8678 | 25 | 1.005 | 47.6505 | 6.8523 | 1366.7863 | 0.0052 | 0.0533 | trial |
| 4.25 | 2.4 | 12 | 48.1% | 17 | 27.5616 | 3 | 72.8953 | 1.7470 | 22 | 0.977 | 27.7724 | 4.8366 | 803.1866 | 0.0908 | 0.0533 | trial |
| 4.25 | 2.4 | 12 | 48.1% | 17 | 27.5616 | 3 | 42.8366 | 2.0027 | 23 | 0.984 | 31.3493 | 5.2182 | 904.7493 | 0.0473 | 0.0533 | **ok** |
| 4.5 | 1.6 | 12 | 48.1% | 17 | 29.0375 | 3 | 9.3915 | 2.7327 | 25 | 1.000 | 43.1598 | 6.4161 | 1286.6237 | 0.0073 | 0.0367 | trial |
| 4.5 | 1.6 | 12 | 48.1% | 17 | 29.0375 | 3 | 47.1762 | 1.9563 | 22 | 0.981 | 29.9772 | 5.0731 | 896.8500 | 0.0526 | 0.0367 | trial |
| 4.5 | 1.6 | 12 | 48.1% | 17 | 29.0375 | 3 | 32.8845 | 2.1299 | 23 | 0.986 | 32.4928 | 5.3380 | 971.2735 | 0.0339 | 0.0367 | **ok** |
| 4.5 | 2.4 | 12 | 48.1% | 17 | 29.0375 | 3 | 7.4533 | 2.8438 | 25 | 1.004 | 46.8519 | 6.7754 | 1413.3254 | 0.0053 | 0.0533 | trial |
| 4.5 | 2.4 | 12 | 48.1% | 17 | 29.0375 | 3 | 75.3774 | 1.7309 | 22 | 0.977 | 27.4801 | 4.8050 | 835.4409 | 0.0902 | 0.0533 | trial |
| 4.5 | 2.4 | 12 | 48.1% | 17 | 29.0375 | 3 | 44.5568 | 1.9838 | 23 | 0.983 | 30.9609 | 5.1773 | 939.4200 | 0.0474 | 0.0533 | **ok** |
| 4.75 | 1.6 | 12 | 48.1% | 17 | 30.5134 | 3 | 9.8580 | 2.7093 | 25 | 0.999 | 42.5600 | 6.3571 | 1331.7166 | 0.0074 | 0.0367 | trial |
| 4.75 | 1.6 | 12 | 48.1% | 17 | 30.5134 | 3 | 48.8296 | 1.9397 | 22 | 0.981 | 29.6886 | 5.0424 | 932.1271 | 0.0524 | 0.0367 | trial |
| 4.75 | 1.6 | 12 | 48.1% | 17 | 30.5134 | 3 | 34.1780 | 2.1113 | 23 | 0.985 | 32.1425 | 5.3014 | 1008.3509 | 0.0339 | 0.0367 | **ok** |
| 4.75 | 2.4 | 12 | 48.1% | 17 | 30.5134 | 3 | 7.8149 | 2.8210 | 25 | 1.004 | 46.1219 | 6.7048 | 1459.6491 | 0.0054 | 0.0533 | trial |
| 4.75 | 2.4 | 12 | 48.1% | 17 | 30.5134 | 3 | 77.8480 | 1.7154 | 22 | 0.976 | 27.2086 | 4.7755 | 867.4848 | 0.0897 | 0.0533 | trial |
| 4.75 | 2.4 | 12 | 48.1% | 17 | 30.5134 | 3 | 46.2659 | 1.9657 | 23 | 0.9824 | 30.6027 | 5.1394 | 973.8911 | 0.0475 | 0.0533 | **ok** |

Tabel 5.5 Perhitungan daya dukung fondasi metode pendekatan *relative density* (langkah 9-11)

| Df (m) | B (m) | L (m) | $\phi'_{cv}$ (°) | $\xi$ | $N_q'$ | $N_\gamma'$ | q' (kpa) | $q_{ult-cv}$ (kpa) | $I_R$ | $I_{PF}$ | $q_{ult-pred}$ (kpa) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.25 | 1.6 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 21.2093 | 144.8776 | 2.0060 | 0.7383 | 404.8380 |
| 3.25 | 2.4 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 21.2093 | 149.4530 | 1.9003 | 0.7336 | 562.7618 |
| 3.5 | 1.6 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 22.8348 | 155.2795 | 2.0186 | 0.7388 | 374.2524 |
| 3.5 | 2.4 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 22.8348 | 159.8549 | 1.8740 | 0.7325 | 419.1484 |
| 3.75 | 1.6 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 24.4602 | 165.6815 | 1.9932 | 0.7377 | 541.2240 |
| 3.75 | 2.4 | 12 | 20 | 0.188 | 6.3994 | 1.7593 | 24.4602 | 170.2568 | 1.8492 | 0.7314 | 428.1635 |
| 4.25 | 1.6 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 27.5616 | 137.6877 | 2.1493 | 0.7446 | 415.4052 |
| 4.25 | 2.4 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 27.5616 | 140.7675 | 2.0027 | 0.7381 | 569.7934 |
| 4.5 | 1.6 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 29.0375 | 144.7309 | 2.1299 | 0.7437 | 376.6430 |
| 4.5 | 2.4 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 29.0375 | 147.8108 | 1.9838 | 0.7373 | 421.2968 |
| 4.75 | 1.6 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 30.5134 | 151.7741 | 2.1113 | 0.7429 | 542.8985 |
| 4.75 | 2.4 | 12 | 17 | 0.162 | 4.7721 | 1.1842 | 30.5134 | 154.8540 | 1.9657 | 0.7365 | 428.0413 |