Chapter 18

18.1 Eq. (18.6): $A_R(\%) = \dfrac{D_o^2 - D_i^2}{D_i^2}(100) = \dfrac{(3.5)^2 - (3.375)^2}{(3.375)^2} \times 100 = \mathbf{7.54\%}$

18.2 $A_R(\%) = \dfrac{D_o^2 - D_i^2}{D_i^2}(100) = \dfrac{(114)^2 - (111)^2}{(111)^2} \times 100 = \mathbf{5.48\%}$

18.3

Depth (m)	σ'_o (kN/m^2)	$C_N = 9.78\sqrt{\dfrac{1}{\sigma'_o}}$	N_{60}	$(N_1)_{60} = C_N N_{60}$
1.5	23.25	2.03	8	**≈16**
3.0	46.4	1.43	7	**≈10**
4.5	69.75	1.17	12	**≈14**
6.0	93.0	1.01	14	**≈14**
7.5	116.25	0.907	13	**≈12**

18.4 $\phi' = \tan^{-1}\left[\dfrac{N_{60}}{12.2 + 20.3\left(\dfrac{\sigma'_o}{p_a}\right)}\right]$; $p_a \approx 100$ kN/m^2

Depth (m)	σ'_o (kN/m^2)	p_o (kN/m^2)	N_{60}	ϕ' (deg) [Eq. (18.16)]
1.5	23.25	100	8	37.8
3.0	46.4	100	7	34.3
4.5	69.75	100	12	37.4
6.0	93.0	100	14	37.3
7.5	116.25	100	13	35.3

Average $\phi' \approx$ **36.5°**

18.5 Eq. (18.14): $$D_r\ (\%) = \left[\frac{N_{60}\left(0.23 + \frac{0.06}{D_{50}}\right)^{1.7}}{9}\left(\frac{98}{\sigma'_o}\right)\right]^{0.5} (100)$$

Given γ = 15.5 kN/m^3. The following table can now be prepared.

Depth z (m)	$\sigma'_o = \gamma z$ (kN/m^2)	D_{50} (mm)	N_{60}	D_r (%)
1.5	23.25	0.26	6	**86.8 ≈ 87**
3.0	46.5	0.26	12	**86.8 ≈ 87**
4.5	69.75	0.26	17	**84.3 ≈ 84**
6.0	93.0	0.26	21	**81.2 ≈ 81**
7.5	116.25	0.26	23	**76.0**

18.6 $$(N_1)_{60} = C_N N_{60} = \left(\frac{2}{1+\sigma'_o}\right) N_{60}$$

Depth z (m)	σ'_o (ton/ft^2)	N_{60}	C_N	$(N_1)_{60}$
5	$\frac{5\times115}{2000} = 0.2875$	6	1.55	**10.85 ≈ 11**
10	$\frac{10\times115}{2000} = 0.575$	7	1.27	**7.62 ≈ 8**
15	$\frac{15\times115}{2000} = 0.8625$	9	1.07	**9.63 ≈ 10**
20	$\left[\begin{matrix}(17.5\times115)\\ +2.5(118-62.4)\end{matrix}\right]\frac{1}{2000} = 1.076$	10	0.963	**9.63 ≈ 10**
25	$1.076 + \frac{5(118-62.4)}{2000} = 1.215$	12	0.903	**10.84 ≈ 11**
30	$1.215 + \frac{5(118-62.4)}{2000} = 1.354$	14	0.85	**11.9 ≈ 12**

18.7 a. The average value of N_{60} is about **11**.

b. $$F_d = 1 + 0.33\left(\frac{D_f}{B}\right) = 1 + (0.33)\left(\frac{1}{2}\right) = 1.165$$

$$q_{\text{net}} = \frac{N_{60}}{0.08}\left(\frac{B+0.3}{B}\right)^2 F_d\left(\frac{S_e}{25}\right) = \frac{11}{0.08}\left(\frac{2+0.3}{2}\right)^2 (1.165)\left(\frac{25}{25}\right) = \mathbf{211.8\ kN/m^2}$$

18.8 Eq. (18.30): $\dfrac{\left(\dfrac{q_c}{p_a}\right)}{N_{60}} = 7.64 D_{50}^{0.26}$. Use $p_a \approx 100$ kN/m^2.

Depth z (m)	N_{60}	D_{50} (mm)	q_c (kN/m^2)
1.5	6	0.26	**3,230**
3	12	0.26	**6,460**
4.5	17	0.26	**9,151**
6	21	0.26	**11,304**
7.5	23	0.26	**12,381**

18.9 Eq. (18.26): $c_u = \dfrac{q_c - \sigma_c}{N_k}$; $N_k \approx 18.3$

$$c_u = \frac{1400-(10)(18)}{18.3} = \mathbf{66.7\ kN/m^2}$$

18.10 From Eqs. (18.23) and (18.24):

E_s = 2 to 3q_c = 2 to 3(205) = **410 to 615 kN/m^2**

18.11 From Eq. (18.34):

$$\text{Recovery ratio, } R = \left(\frac{3}{4}\right)(100) = \mathbf{75\%}$$