Pg 126

#2.2 A soil profile is shown Fig P2.2 with standard penetration numbers in a clay layer. Use Eq 2.8 & 2.9 to determine the variation of C_u & OCR with depth. What is average C_u & OCR?

define C_u = undrained cohesion (undrained shear strength)

OCR = over consolidation ratio $\left(\frac{\text{Preconsolidation pressures, } \sigma_c'}{\text{effective over burden pressure, } \sigma_o'}\right)$

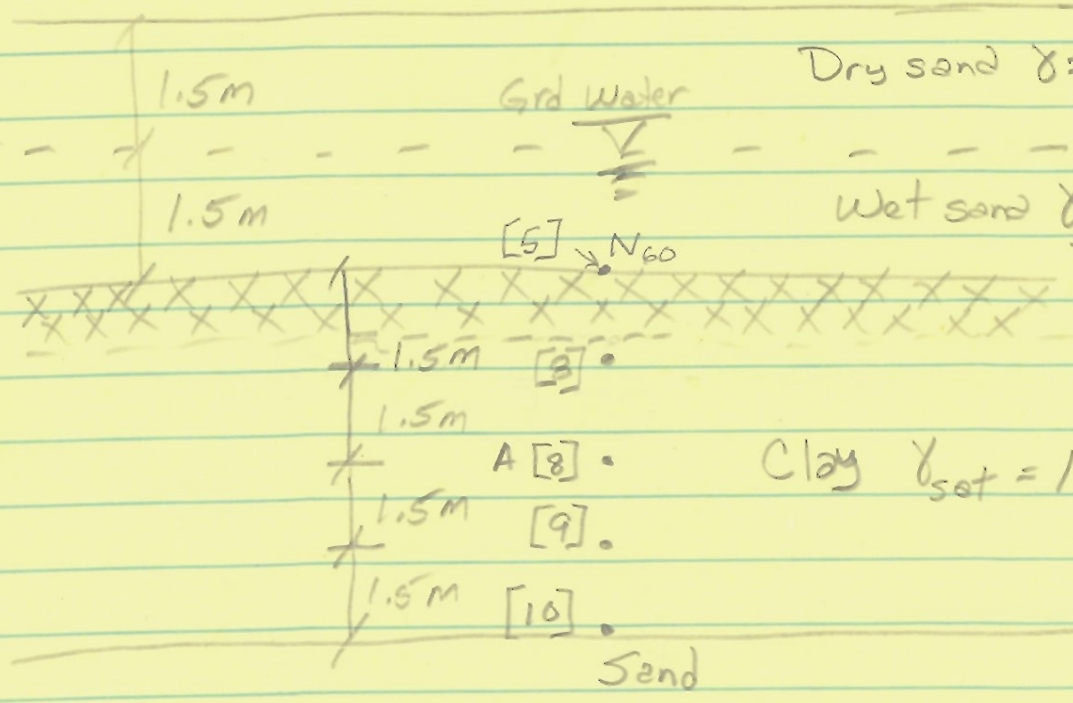
[2.8] $\frac{C_u}{P_a} = 0.29\, N_{60}^{0.72}$ P_a = atmospheric pressure $\approx 100\ kN/m^2 \approx 2{,}000\ \#/in^2$

$\therefore C_u = 0.29 P_a N_{60}^{0.72}$

[2.9] $OCR = 0.193 \left(\frac{N_{60}}{\sigma_o'}\right)^{0.689}$ σ_o' = effective vertical stress in MN/m^2 or $kN/m^2/1000$

$= h\gamma - h\gamma_{water}$

P2.2



#2.2 contin.

$C_u = 0.29 P_a N_{60}^{0.72}$ $\quad OCR = 0.193 \left(\frac{N_{60} \times 1000}{hY - hY_{water}} \right)^{0.689}$

3.0m $C_u = (0.29)(100 kN/m^2)(5)^{0.72} = \boxed{92.397}$

$OCR = 0.193 \left(\frac{5}{[(1.5m)(16.5 kN/m^3) + (1.5)(19)] - (1.5 m)(9.81 kN/m^3)/1000} \right)^{0.689}$

$OCR = 0.193 \left(\frac{5 \times 1000}{38.535} \right)^{0.689} = \boxed{5.514}$

4.5m $C_u = (0.29)(100 kN/m^2)(8)^{0.72} = \boxed{129.605}$

$OCR = (0.193) \left(\frac{8 \times 1000}{(1.5 \times 16.5) + (1.5 \times 19) + (1.5 \times 16.8) - (3.0)(9.81)} \right)^{0.689}$

$= 0.193 \left(\frac{8000}{49.02} \right)^{0.689} = \boxed{6.458}$

6.0m $C_u = 0.29(100 kN/m^2)(8)^{0.72} = \boxed{129.605}$

$OCR = 0.193 \left(\frac{8 \times 1000}{(1.5 \times 16.5) + (1.5 \times 19) + (3 \times 16.8) - (4.5 \times 9.81)} \right)^{0.689}$

$= 0.193 \left(\frac{8000}{59.5} \right)^{0.689} = \boxed{5.651}$

7.5m $C_u = 0.29(100 kN/m^2)(9)^{0.72} = \boxed{141.076}$

$OCR = 0.193 \left(\frac{9 \times 1000}{(1.5 \times 16.5) + (1.5 \times 19) + (4.5 \times 16.8) - (6.0 \times 9.81)} \right)^{0.689}$

$= 0.193 \left(\frac{9000}{69.99} \right)^{0.689} = \boxed{5.480}$

9m $C_u = 0.29(100 kN/m^2)(10)^{0.72} = \boxed{152.194}$

$OCR = 0.193 \left(\frac{10 \times 1000}{(1.5 \times 16.5) + (1.5 \times 19) + (6 \times 16.8) - (7.5 \times 9.81)} \right)^{0.689}$

$= 0.193 \left(\frac{10,000}{80.475} \right)^{0.689} = \boxed{5.353}$

	C_u (kN/m²)	OCR (m^3/mN)
3.0m	92.397	5.514
4.5m	129.605	6.458
6.0m	129.605	5.651
7.5m	141.076	5.480
9.0m	152.194	5.353
→ AVG	128.995	5.691

#2.6 The given table is the variation of the field standard penetration number (N_{60}) in a Sand deposit

Depth	γ (kN/m³)	σ_o' kN/m²/1000	P_a kN/m²	N_{60}	C_N	Pr%
1.5	18	27	100	6	1.575	50.55
3.0	18	54	100	8	1.30	51.67
4.5	18	81	100	9	1.105	49.70
6.0	18	108	100	8	0.962	43.17
7.9	20.2	127.741	100	13	0.878	52.23
9.0	20.2	139.17	100	14	0.836	52.70

[2.12] $C_N = \frac{2}{1+\left(\frac{\sigma_o'}{Pa}\right)}$

[2.20] $Dr = \left\{\frac{N_{60}}{\left[17+24\left(\frac{\sigma_o'}{Pa}\right)\right]}\right\}^{0.5}$

Depth	σ_o'
1.5	$1.5 \times 18 = 27$
3.0	$3.0 \times 18 = 54$
4.5	$4.5 \times 18 =$
6.0	$6.0 \times 18 =$
7.9	$(6 \times 18) + (1.9 \times 20.2) - (1.9 \times 9.81)$
9.0	$(6 \times 18) + (3.0 \times 20.2) - (3.0 \times 9.81)$

1.5m $C_N = \frac{2}{1+\left(\frac{27}{100}\right)} = 1.575$

$Dr = \left\{\frac{6}{\left[17+24\left(\frac{27}{100}\right)\right]}\right\}^{0.5} \times 100 = 50.55\%$

3.0m $C_N = \frac{2}{1+\left(\frac{54}{100}\right)} = 1.2987$

$Dr = \left\{\frac{8}{\left[17+24\left(\frac{54}{100}\right)\right]}\right\}^{0.5} \times 100 = 51.674$

4.5m $C_N = \frac{2}{1+\left(\frac{81}{100}\right)} = 1.105$

$Dr = \left\{\frac{9}{17+24\left(\frac{81}{100}\right)}\right\}^{0.5} \times 100 = 49.697$

#2.10 The following are details for a soil deposit in sand

Depth	Effective Overburden	Field Standard N_{60}
3.0m	55	9
4.5m	82	11
6.0m	98	12

$C_u = 2.8$ & $OCR = 2$

[2.19] $Dr\% = 12.2 + 0.75\left[222 N_{60} + 2311 - 711 \cdot OCR - 779\left(\frac{\sigma_0'}{p_a}\right) - 50 C_u^2\right]^{0.5}$

3.0m $Dr\% = 12.2 + 0.75\left[222(9) + 2311 - 711(2) - 779\left(\frac{55}{100}\right) - 50(2.8)^2\right]^{0.5}$

$= 46.294\%$

4.5m $Dr\% = 12.2 + 0.75\left[222(11) + 2311 - 711(2) - 779\left(\frac{82}{100}\right) - 50(2.8)^2\right]^{0.5}$

$= 48.170\%$

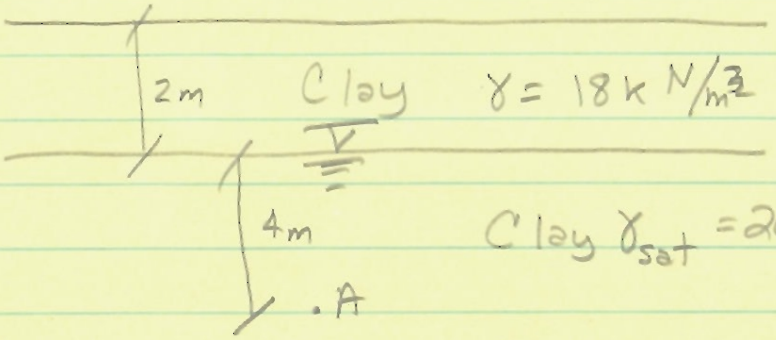
6.0m $Dr\% = 12.2 + 0.75\left[222(12) + 2311 - 711(2) - 779\left(\frac{98}{100}\right) - 50(2.8)^2\right]^{0.5}$

$= 48.924\%$

#2.17 The soil profile below, if the cone penetration resistance (q_c) @ A = 0.8 MN/m² (electric cone)

A. Estimate cohesion, C_u

B. Over consolidation ratio, OCR



$N_k = 15$ (electric cone)

$\sigma_o = (2 \times 18) + (4 \times 20)$

$= 116 \text{ kN/m}^2$

A. [2.51] $C_u = \dfrac{q_c - \sigma_o}{N_k} = \dfrac{0.8 \times 1000 - 116}{15} = \boxed{45.6 \text{ kN/m}^2}$

B. [2.55] $OCR = 0.37 \left(\dfrac{q_c - \sigma_o}{\sigma_o'} \right)^{1.01}$

$= 0.37 \left(\dfrac{(0.8 \times 1000) - 116}{116 \text{ kN/m}^2 - (4 \times 9.81)} \right)^{1.01}$

$OCR = 0.37 \left(\dfrac{684}{76.76} \right)^{1.01} = \boxed{3.370}$