Prince of Songkla University

Faculty of Engineering

Midterm Examination: Semester I
Date : 25 July 2009
Subject : 235–402 Geotecniques

Academic Year : 2009
Time : 9.00-12.00 A.M.
Room : A 400

Instructions

1. Do all questions of 7 pages and answer them in the given papers and do rear papers allowed.
2. Not allowed all books or notes and must reset a calculator programming capability.
3. Write your name in each answer page including graphs and returned all papers to controllers.
4. Total points are 115 or 30% of course.

"ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา สูงสุด ให้ออก"

No. Problem	Full Points	Assigned Points
1	20	
2	30	
3	30	
4	20	
5	15	
Total Points	**115**	

Name ..... Surname ..... ID .....

Bonne Chance et bon courage
Danupon Tonnayopas
21 July 2009

Name ..... Surname ..... ID .....

Calculation the following questions

1. A multistage triaxial test with a sawed jointed oriented 45° with the axis of the core yielded the following data. Determine cohesion and internal friction angle. (15 points)

Confining Pressure (MPa)	Maximum axial stress (MPa)
0.10	0.54
0.30	1.63
0.50	2.72
1.00	5.45

2. A diversion tunnel is to be driven through slightly weathered siltstone with a thick bed about 300 mm bedding plane dip of 50° against the direction of the drive. Index testing and logging of diamond drilled core give typical uniaxial compressive strength values of 120 MPa and average *RQD* values of 65%. The slightly rough and slightly weathered bedding plane with a separation of <1 mm,. Tunnelling conditions are anticipated to be wet. Determine self-supporting span, Stand-up time, and Modulus of deformability in RMR? (30 points)

3. Three specimens of rock were subjected to axial point load tests. The pressure gauge readings at rupture were 1.8, 5.0, and 12.5 MPa. If the ram area of point load test was 1335.48 mm^2, and the diameter and length of all core specimens tested was 54 mm, calculate I_{s50} and estimate for the unconfined compressive strength of each rock. (30 points)

4. From the grain size distribution of soil is shown in Table below
   (a) Plot the graph for percent finer versus grain size. (10 points)
   (b) Determine C_u and C_c of the soil (10 points)

Sieve No.	Mass retained (g)		
4	28		
10	42		
20	48		
40	128		
60	221		
100	86		
200	40		
Pan	24		

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5. Seismic investigation was carried out in a dam site can be recorded by seismic P-wave and S-wave are 16.2 km/sec and 8.1 km/sec, respectively. Then Schmidt hammer testing shows a reading of 48. Assuming the bulk density of the ground is 2560 MN/m^3. Calculate dynamic modulus of elasticity, Poisson' ratio and strength derived from Schmidt hardness? (15 points)

Equations and Tables for Midterm Examination

$$\upsilon_d = \frac{\left(V_p^2 - 2V_s^2\right)}{2\left(V_p^2 - V_s^2\right)} \; ; \quad CI = \frac{W_L - w}{I_p}$$

$$\rho_b = \frac{G_s + eSr}{1+e} \; ; \quad \rho_d = \frac{G_s \rho_w}{1 + wG_s}\left(1 - A_v\right);$$

$$I_p = W_L - W_p$$

$$T = \frac{\tau_v . \pi . d^2}{2}\left(h + \frac{d}{3}\right)$$

$$E_M = 2\text{RMR} - 100 \quad ; \quad K = \frac{E\upsilon}{(1+\upsilon)(1-2\upsilon)}$$

$$n = \frac{V_v}{V_t} \times 100 \; ; \; \lambda_d = \rho.\left(V_p^2 - 2V_s^2\right) \; ; \; I_L = \frac{w - W_p}{I_p}$$

$$\lambda = \frac{E\upsilon}{(1+\upsilon)(1-2\upsilon)} \quad ; \quad w = \frac{W_w}{W_s} \times 100$$

$$E_M = \rho . V_p^2 . (1+\upsilon)(1-2\upsilon)$$

$$I_D = \frac{e_{\max} - e}{e_{\max} - e_{\min}} \qquad G = \frac{E}{2(1+\upsilon)} \quad ; \quad \sigma_c = 10^{A_0} \quad ; \quad I_{s50} = F \times I_s$$

$$Y = \rho V_p^2 \quad ; \quad E = \frac{9KG}{3K+G} \quad ; \quad F = \left(\frac{D_e}{50}\right)^{0.45}$$

$$\sigma_t = \frac{2P}{\pi . t . d} \quad ; \quad E_d = \rho . V_s^2 . \frac{\left(3V_p^2 - 4V_s^2\right)}{\left(V_p^2 - V_s^2\right)}$$

$$A_0 = 1 + 0.0065\rho . SHV \; ; \; I_{s50} = \left(\frac{D_e}{50}\right)^{0.45} . I_s$$

$$E_M = 10^{(\text{RMR}-10)/40} \quad ; \quad G_d = \rho . V_s^2 \; ; \quad I_{s50} = \frac{P}{D_e^2}$$

$$K_d = \rho \frac{\left(3V_p^2 - 4V_s^2\right)}{3} \quad ; \quad I_d = \frac{(C-D)}{(A-D)} \times 100 \; ; \; D_e^2 = 4A/\pi \; ; \; A = WD$$

$$P = \frac{100 - RMR}{100} \gamma B \qquad C_u = d_{60}/d_{10}; \qquad C_z = d_{30}^2/d_{60}.d_{10}$$

$$\tau = c + \sigma_n . \tan\phi$$

$$S = \frac{V_w}{V_v} \times 100 \qquad e = \frac{V_v}{V_s}$$

Name ..... Surname ..... ID .....

A. CLASSIFICATION PARAMETERS AND THEIR RATINGS

Parameter			Range of values						
1	Strength of intact rock material	Point-load strength index	>10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial comp. strength	>250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5 - 25 MPa	1 - 5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core Quality RQD		90% - 100%	75% - 90%	50% - 75%	25% - 50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6 - 2 . m	200 - 600 mm	60 - 200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of discontinuities (See E)		Very rough surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered walls	Slightly rough surfaces Separation < 1 mm Highly weathered walls	Slickensided surfaces or Gouge < 5 mm thick or Separation 1-5 mm Continuous	Soft gouge >5 mm thick or Separation > 5 mm Continuous		
	Rating		30	25	20	10	0		
5	Groundwater	Inflow per 10 m tunnel length (l/m)	None	< 10	10 - 25	25 - 125	> 125		
		(Joint water press)/ (Major principal σ)	0	< 0.1	0.1, - 0.2	0.2 - 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

B. RATING ADJUSTMENT FOR DISCONTINUITY ORIENTATIONS (See F)

Strike and dip orientations		Very favourable	Favourable	Fair	Unfavourable	Very Unfavourable
Ratings	Tunnels & mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	

C. ROCK MASS CLASSES DETERMINED FROM TOTAL RATINGS

Rating	100 ← 81	80 ← 61	60 ← 41	40 ← 21	< 21
Class number	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

D. MEANING OF ROCK CLASSES

Class number	I	II	III	IV	V
Average stand-up time	20 yrs for 15 m span	1 year for 10 m span	1 week for 5 m span	10 hrs for 2.5 m span	30 min for 1 m span
Cohesion of rock mass (kPa)	> 400	300 - 400	200 - 300	100 - 200	< 100
Friction angle of rock mass (deg)	> 45	35 - 45	25 - 35	15 - 25	< 15

E. GUIDELINES FOR CLASSIFICATION OF DISCONTINUITY conditions

Discontinuity length (persistence) Rating	< 1 m 6	1 - 3 m 4	3 - 10 m 2	10 - 20 m 1	> 20 m 0
Separation (aperture) Rating	None 6	< 0.1 mm 5	0.1 - 1.0 mm 4	1 - 5 mm 1	> 5 mm 0
Roughness Rating	Very rough 6	Rough 5	Slightly rough 3	Smooth 1	Slickensided 0
Infilling (gouge) Rating	None 6	Hard filling < 5 mm 4	Hard filling > 5 mm 2	Soft filling < 5 mm 2	Soft filling > 5 mm 0
Weathering Ratings	Unweathered 6	Slightly weathered 5	Moderately weathered 3	Highly weathered 1	Decomposed 0

F. EFFECT OF DISCONTINUITY STRIKE AND DIP ORIENTATION IN TUNNELLING**

Strike perpendicular to tunnel axis		Strike parallel to tunnel axis	
Drive with dip - Dip 45 - 90°	Drive with dip - Dip 20 - 45°	Dip 45 - 90°	Dip 20 - 45°
Very favourable	Favourable	Very favourable	Fair
Drive against dip - Dip 45-90°	Drive against dip - Dip 20-45°	Dip 0-20 - Irrespective of strike°	
Fair	Unfavourable	Fair	

* Some conditions are mutually exclusive . For example, if infilling is present, the roughness of the surface will be overshadowed by the influence of the gouge. In such cases use A.4 directly.

** Modified after Wickham et al (1972).