Prince of Songkla University

Faculty of Engineering

Midterm Examination : Semester I
Date : 26 December 2009
Subject : 220–624 Rock Mechanics

Academic Year : 2009
Time : 13.30-16.30 p.m.
Room : Head of Robot

Instructions

1. Do all questions (5 pages) and answer them in the given papers and do rear papers allowed.
2. Allowed lecture notes and a calculator programming capability.
3. Write your name in answer page including graphs and returned all papers to controllers.
4. Total points are 60 or 25% of course.

"ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา สูงสุด ให้ออก"

No. Problem	Full Points	Assigned Points
1	60	
2	30	
Total Points	90	

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

Bonne Chance et bon courage
Danupon Tonnayopas
24 Dec 2009

1. The main rock types along the tunnel alignment of underground (drive South-North with plunging 15°) include phyllite, tectonic breccia and moderately weathered granodiorite. The tunnel line was below groundwater table so that it was occurred dripping along the wall.

   Phyllite is bluish-greenish gray in color, lens shaped, banded and moderately weathered. The uniaxial compressive strength (UCS) class of phyllite is medium with average strength of 30 MPa. The average RQD of phyllite is 26%. Joints are moderately spaced and range from 20 cm to 30 cm. Joints are highly persistent and their surfaces are planar and slightly rough. Apertures are 5 mm in width filled by silty sand. A very favorable discontinuity orientation is observed.

   The heavily broken phyllite is the most problematic rock unit along the tunnel alignment. This unit is in bluish-greenish gray color and it is moderately to highly weathered. This rock unit has very weak strength with the average UCS being 1.5 MPa. The average RQD for this rock unit is 10%. Joints are very closely spaced and in the range from 20 to 60 mm. They show high persistency and their surfaces are undulating smooth. Apertures are mostly bigger than 5 mm and are filled by silty clay.

   The tectonic breccia has weak strength with an average UCS of 15 MPa. It is highly weathered and the average RQD is 59%. Spacing of discontinuities ranges from 6 to 20 mm, which is classified as close spacing. Discontinuity surfaces are slickenslided with clay infilling and possess high persistence. Apertures range from 1 to 5 mm.

   The moderately weathered granodiorite is gray in color. Average RQD and UCS of this rock unit are 50% and 31 MPa, respectively. Joint spacing ranges from 20 to 30 cm and is classified as close spacing. Highly persistent joints are observed and 2 mm wide apertures are filled with silty sand.

   In total 149 discontinuities were measured in the field. The dip and dip directions of main discontinuities were determined as 37°/248°, 82°/149° and 87°/002°.

   Triaxial compressive strength tests were also conducted on core specimens to determine m and s Hoek–Brown constants of intact rock. Table 1 presents the results of the laboratory tests. (100 points)

Table 1 Physical and mechanical properties of the rock materials

Parameters, symbol, unit	Phyllite	Heavily broken phyllite	Tectonic breccia	Moderately weathered granodiorite
Uniaxial compressive strength, UCS, MPa	30	1.5	15	30.8
Unit weight, γ, t/m^3	2.85	1.96	2.08	2.68
m_i constant	7	7	19	26
s_i constant	1	1	1	1

Determine rock mass properties such as Hoek–Brown constants (m_b, s, a) in case of D = 0, deformation modulus of the rock masses and uniaxial compressive strength of the rock mass. The tunnel stability, the required support systems and excavation method by means of RMR and GSI rock mass classification systems. Also to assess portal slope (over inlet tunnel) is perpendicular to tunnel mining alignment (dip direction 180°) inclined 70° (dip angle) by means of stereographic projection. Internal friction angle of rock mass at portal slope is 20°.

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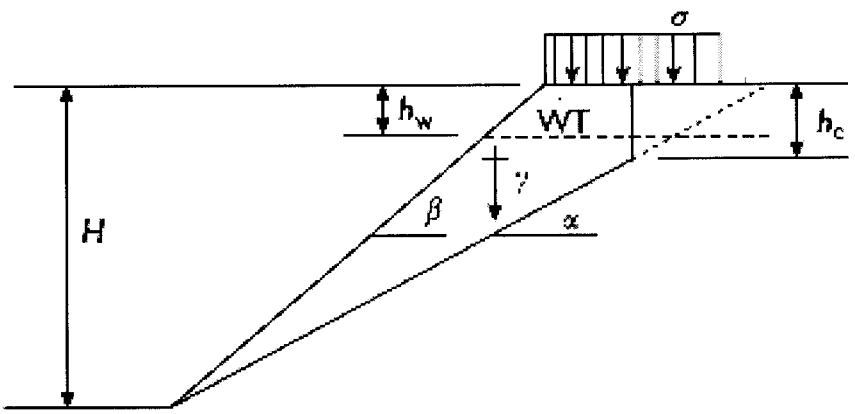
2. A generic diagram of a slope in a jointed rock mass that is threatened by a planar block slide is shown in the sketch. With any seismic load, find the slope height (pit depth) possible with a safety factor of 1.15, given that Mohr–Coulomb failure criteria apply, the joints constitute 86% of the potential shear failure surface and: (30 points)

   - slope height H = ? ft (m);
   - failure surface angle $\alpha = 37^{\circ}$;
   - slope angle $\beta = 48^{\circ}$;
   - friction angle (rock) $\varphi_r = 33^{\circ}$;
   - cohesion (rock) $c_r = 17.79$ MPa;
   - friction angle (joint) $\varphi_j = 33^{\circ}$;
   - cohesion (joint) $c_j = 0.0$ MPa;
   - specific weight $\gamma = 25.63$ kN/m^3;
   - tension crack depth $h_c = 0.0$ m;
   - water table depth $h_w = 0.0$ m;
   - seismic coefficient $a_o = 0.15$;
   - surcharge $\sigma = 0.0$ kPa.



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