National Exams

09-Mmp-B1, Applied Rock Mechanics

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1

The following results were obtained from a direct shear box test on a planar discontinuity in a sample of weathered granite.

Sample 1: The average normal pressure on the sample was 200 kPa.

Shear Stress (kPa)	Shear Displacement (mm)
138	0.05
186	1.21
238	3.52
234	4.32
223	8.78
206	9.48
205	11.56
199	12.64
168	17.54
168	22.11

{10} (1.1) Plot a graph of shear stress against shear displacement. Determine the peak and residual shear strengths of this rock surface.

{10} (1.2) Plot a graph of the peak and residual shear strength against the normal stress on the surface. Determine the peak and residual friction angles. Note any assumptions that you make.

Question 2

The following triaxial test results were obtained on intact rock granite specimens.

σ_1 (MPa)	σ_3 (MPa)
255	5
310	10
375	15
420	20
446	25

{10} (2.1) Determine the pertinent parameters and comment on the applicability of the Mohr-Coulomb criterion for these data.

{10} (2.2) Determine and comment on the applicability of the Hoek and Brown criterion for these data.

Question 3

A 25 m high rock slope has been excavated at a face angle of 55^0. The rock in which this cut has been made contains persistent bedding planes that dip at an angle of 30^0 into the excavation. A 6.8 m deep tension crack is visible 10 m behind the crest. The strength parameters of the perceived sliding surface are estimated as: cohesion (c) = 2.05 kPa and angle of friction, $\varphi = 35^0$. The unit weight of the rock is 27kN/m^3, and the unit weight of the water is 9.81kN/m^3.

{5} (3.1) Calculate the factor of safety of the slope.

{5} (3.2) Calculate the factor of safety if the tension crack was completely filled with water due to run-off on the crest of the slope.

{5} (3.3) Calculate the factor of safety if the slope is reinforced by installing tensioned rock bolts anchored into sound rock beyond the sliding plane. Assume the bolts are installed at right angles to the sliding plane and the total load on the anchors per linear meter of slope is 350 kN.

{5} (3.4) If the working load for each bolt is 200 kN, suggest a bolt layout to achieve a bolt load of 400 kN/m of slope length.

Question 4

A 3 m thick horizontal uranium bearing orebody is located at a depth of 1000 m. The unit weight of the overburden rock is 25 kN /m3. A preliminary mining layout is based on 6.0 m room spans and 5.0 m square pillars with the full orebody thickness of 3.0 m being mined.

The pillar strength is defined empirically by:

$S = 133.2h - 0.75\ wp^{0.5}$

where S is in MPa, and pillar height (h) and width (wp) are in m.

{8} (4.1) Determine the factor of safety against compressive failure of pillars in the planned layout.

{12} (4.2) If the factor of safety is inadequate, propose a mining layout which will achieve a maximum volume extraction ratio, for a selected factor of safety of 1.6. State and justify all assumptions.

Question 5

{10} (5.1) Provide a description of mechanical point anchors. Discuss any potential installation issues that may compromise the performance of rock bolts.

{10} (5.2) Provide a description for a type of friction bolt. Discuss any perceived advantages and limitations.

Question 6

{10} (6.1) Describe two surface support techniques for underground excavations in rock. Identify their advantages and disadvantages.

{10} (6.2) A circular excavation is located 750 m below the ground surface. The vertical stress (σ_v) is equal to depth stress and the horizontal stress σ_h is 0.35σv. The rock is adequately described by a cohesion of 25 MPa and $\varphi = 26^0$. The unit weight of the rock mass can be approximated to 2.5 kN/m^3. Predict the behavior of the excavation under these conditions.

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Marking Scheme

1.	20 marks total	a) 10 marks b) 10 marks
2.	20 marks total	a) 10 marks b) 10 marks
3.	20 marks total	a) 5 marks b) 5 marks c) 5 marks d) 5 marks
4.	20 marks total	a) 8 marks b) 12 marks
5.	20 marks total	a) 10 marks b) 10 marks
6.	20 marks total	a) 10 marks b) 10 marks