Aalto University
School of Engineering

ROCK MECHANICS
Exam 2016-10-24

Part 1. Questions without course material, only pen/pencil and eraser allowed

Max. points for each question is 6 p (5 x 6 =30 points).
For question 1 you may get bonus points (2p).

1) Explain typical failure which may take place in a rock slope:
   a) Plane failure
   b) wedge failure
   c) toppling failure
   d) circular failure.

How can these potential failure modes be presented/detected by stereographic projections? (Bonus 2p)

2) What components are shotcrete made on? (3p) Why are additives used in shotcrete? (3p)

3) Explain what is "In situ stress". What are the relevant components and how are they estimated or measured?

4) Explain, why timing of rock support installation, the yielding capacity and the load bearing capacity of the rock support are important aspects when considering the tunnel stability. Preferably explain this behaviour by using the ground reaction / support reaction curve.

5) Explain the rock conditions when "structurally controlled failure" may occur. How does the geometry of the underground opening affect the stability in such rock conditions?

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Part 2. Use of course material, your own notes, exercise papers etc., dictionary and calculator allowed.

Note 1. No phones, computers etc. are allowed in the exam!

Note 2. Loaning any material (including calculators) from other students during the exam is strictly forbidden!

6) A stope with rectangular cross-section, with vertical walls and horizontal roof is planned in 500 m depth. The stope width is 18 m, height 27 m and length 60 m. The rock is gabbro-type, coarse grained with density of 3300 kg/m^3. The in-situ horizontal/vertical stress ratio is 2 and the longitudinal axis of the stope is to the East (090). There are three joint sets (dip direction/dip):

085/20
170/60
300/50

Joint surfaces are closed, planar, rough and slightly altered. Joint spacing is about 0.5 m and joint length is 1 - 2 m. Only minor local groundwater inflow has been observed. The RQD is 92%. The UCS for intact rock samples is 105 MPa.

Estimate the stability of roof and sidewalls with Stability Graph -method. In this case, you can omit the short endwalls of the stope.

Design cablebolting for roof and sidewalls if needed.

(15 p)

7) Design reinforcement for 7 m wide and 5 m high drift at 600 m depth in same rock mass described in previous question. The drift is part of permanent underground workshop.

(5 p)