Department of Geology
University of Pretoria

ROCK MECHANICS GLY 364

SEMESTER TEST 2

28 October 2011

TIME: 1½ hours MARKS: 80

ANSWER ALL THE QUESTIONS

Question 1 [10]

List the most important parameters that are usually described during a line survey and explain the importance of each parameter in determining shear strength of a discontinuity.

Position – joint spacing
Type – indication roughness/continuity/spacing (geologic origin)
Orientation - possible slip direction
Continuity of planes – unbounded or blocked by solid rock bridges
Spacing – block size, length of discontinuity planes
Roughness – peak strength
Waviness – strength & movement direction
Strength of joint wall - effect of roughness on peak strength
Fill (Thickness, consistency and permeability) – shear strength & deformation
Seepage – shear strength

Question 2 [25]

Write short notes on:

2.1 Residual friction angle (3)

Friction angle after failure, roughness sheared off, lower than peak

2.2 JCS (3)

Joint wall compressive strength, determined with Schmidt hammer, same as intact rock when unweathered

2.3 GSI (4)

Geological Strength Index, degree of fracturing and block size, poor quality rock masses

2.4 Rock mass permeability (5)

low intact rock, movement through discontinuities, anisotropic, aperture/infill important, packer testing

2.5 Rock mass deformability (10)

Depends on intact rock & discontinuities, direct – in situ tests (flat jack, dilatometer) & geophysics (seismic), indirect – empirical equations – Mass Modulus (E_{mass}/E_{mat}); RMR and Q relations

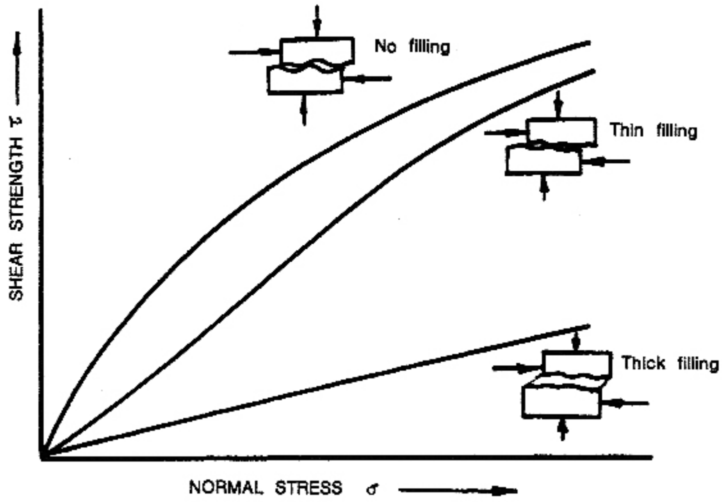
Question 3 [8]

Discuss the two most important parameters that influence rock mass strength and explain how these parameters are determined.

1. Strength intact rock – UCS, PLT, Schmidt hammer, tables
2. Strength discontinuities – single in lab, sets empirical failure criteria equations, line survey
Equations include intact strength, friction angle, cohesion & joint parameters (JCS & JRC)

Question 4 [9]

Discuss the three graphs shown in the diagram below.



No infill – high shear strength; 1st dilation then shearing so joint surface becomes smooth with reduction in shear strength at moderate normal stresses.
Thin infill – initially lower shear strength until normal stress increases to point where rock wall contact occurs
Thick infill – low shear strength due to discontinuity properties determined by c & phi of soil in joint

Question 5 [12]

Calculate whether failure will take place in the sidewalls of a circular tunnel with a diameter of 4m. The rock mass has the following properties:

Rock is quartzite with a UCS of 185 MPa.
Lab tests indicate a m_i value of 12,7
RQD of the rock mass is 75%.
Joint spacing is between 30 – 50 cm with a soft infill of 1 mm.
Joints are slightly rough and the rock mass is dry.

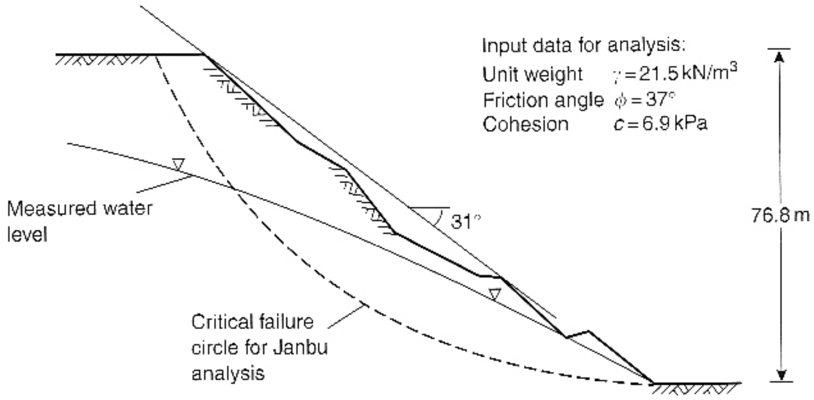
The rock mass is confined by a vertical stress of 62 MPa and horizontal stress of 31 MPa.
The induced stresses due to the excavation of the circular tunnel are $3 = \sigma_h/\sigma_v$

Use Hoek-Brown failure criterion
Good & blocky (or good & very blocky)
m_i – 12.7 (given)
Quartzite m_b/m_i = 0.29 (0.4); mb = 3.68 (5.08)
s = 0.021 (0.062)
a = 0.5

σ_1 = 31 + 185(3,68(31/185) + 0.021)^0.5 = 178,7 MPa (207MPa)
Sidewall failure implies horizontal stresses.
Existing horizontal stress = 31 MPa
Induced horizontal stress (due to tunnel excavation) σh = 3 x σv = 186
Total horizontal stress = 217 MPa > 178 MPa (maximum principal stress at failure)
Sidewalls will fail.

Question 6 [8]

Determine the factor of safety of a in heavily kaolinized granite slope with the following profile and characteristics.



Circular failure due to highly weathered rock mass without well defined discontinuities
Use Chart no 2 (or 3)
$c/\gamma H\tan\phi = 0.0056$
Value for $\tan\phi/FS = 0.76$ (0.5)
FOS = 1.01 (1.5)
Stability of slope inadequate

Question 7 [8]

Discuss the attached stereographic projection with regards to slope stability.

Two joint sets intersecting at point of intersection
Line of intersection dips in same direction as slope face at shallower angle the slope face angle.
Friction angle smaller than point of intersection = line of intersection dips steeper than friction angle.
Kinematically possible to form wedge failure.