DEPARTMENT OF CIVIL ENGINEERING
CVL712 : Slopes and Foundations
Major Test

1st September, 2020

1 a) A rock slope of vertical height 100 m is steeply inclined at 75° with the rock layers having thickness of 0.5 m. Compute values of P_u and P_d for buckling failure assuming $l_b/l=0.4$ and b=1. Take E=30000MPa and $\gamma=0.027$ MN/m^3 for rock layers, and interface friction $\phi=35°$ and cohesion as zero. Calculate factor of safety for buckling and comment. (6)

b) A 6 m high slope with an overhang face at an angle of 75° is shown in Fig. 1. A fault at the toe of the slope, and dipping at an angle of 15° out of the face is weathering and undercutting the face. A tension crack, wider at the top than at the bottom, has developed 1.8 m behind the crest of the slope (resulting in block of size 1.8 m x 6 m). The friction angle ϕ of fault is 20° and cohesion c is 25 kPa. The slope is dry. The unit weight of rock is 25 kN/m^3.
i) Calculate the factor of safety of the block against sliding.
ii) Is the block stable against toppling? If stable, how much more undercutting of the fault must occur before toppling failure takes place? (5)

c) A prismatic block between two parallel vertical joints J_1 and J_2 tends to slide on a joint plane J_3 dipping 50° as shown in Fig. 2. The stress normal to the joints J_1 and J_2 is σ_{nj}. Calculate the factor of safety for i) $\sigma_{nj}=0$ and ii) $\sigma_{nj}=0.5$ MPa. The properties are:
$\gamma=27$ kN/m^3, $\phi_1=\phi_2=\phi_3=35°$, $c_1=c_2=c_3=85$ kPa.
Calculate also the horizontal anchor force T required to have a factor of safety of 1.5 for i) $\sigma_{nj}=0$ and ii) $\sigma_{nj}=0.5$ MPa. (10)

d) Name the software used for wedge failure.
For a wedge failure $H=H_w=50$ m, $\gamma=0.027$ MN/m^3, $\gamma_w=0.01$ MN/m^3. The dips and dip directions of planes A and B, slope face and upper slope face are as follows:

	Dip	**Dip Direction**	**Properties**
Plane A	45°	100°	$c_A=0$, $\phi_A=35°$
Plane B	70°	230°	$c_B=0$, $\phi_B=30°$
Slope Face	60°	180°	
Upper Slope Face	10°	190°	

Calculate factor of safety for drained condition. (4)

2 a) A strip footing of width 3 m on rock is subjected to a vertical load of 1500 kN and clockwise moment of 300 kN-m. Calculate the eccentricity and contact pressures at the base of the footing. Sketch contact pressure distribution. (4)

b) For a pier subjected to total load of 15 MN and passing through soil and rock, the properties of rock and concrete are:
$E_r = 10$ GPa, $E_c = 20$ GPa, $\nu_r = \nu_c = 0.3$, allowable bearing pressure = 2 MPa, interface friction angle between rock and concrete $\delta = 45°$, allowable compressive stress in concrete = 9 MPa, and length of pier in soil $l_0 = 4$ m.
Design the pier assuming concrete is fully stressed. Compute side shear stress and settlement. (8)

c) For the dam section shown in Fig. 3, calculate FS against sliding, eccentricity e and contact pressures at the base. Assume drains are inoperative. Take γ_c = 24 kN/m^3, γ_w = 10 kN/m^3, α_h = 0.1 (no hydrodynamic force), and strength parameters for the interface between dam and rock: c_a = 500 kPa, δ = 40°, and partial factors of safety F_c = 3.6 and F_ϕ = 1.5. Compare the contact pressures with bearing capacity of rock foundation using Hoek-Brown strength criterion (m = 1, s = 0.0009, σ_c=60 MPa) and compute FS values. 10)

d) Prof. John Bray derived the equation for radial stress σ_r due to line load on jointed rock foundation.
   i. List the material properties used in the derivation of the equation. (1)
   ii. Is the radial stress σ_r of Bray a principal stress? Explain (1)
   iii. State the longitudinal stress σ_z. (1)

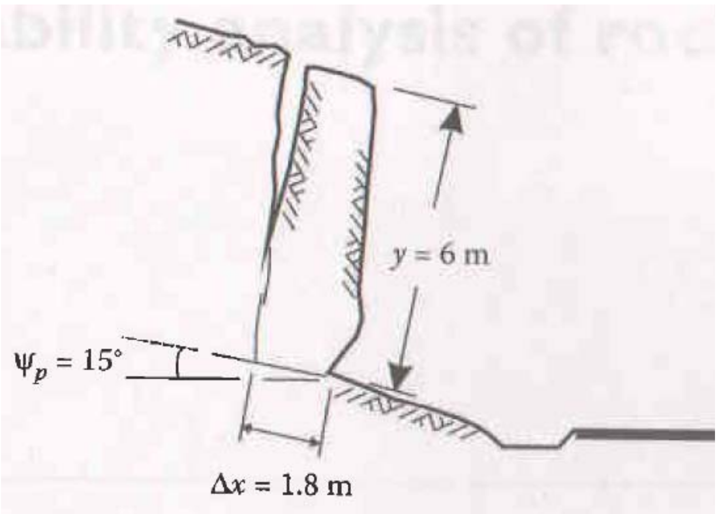

Figure 1

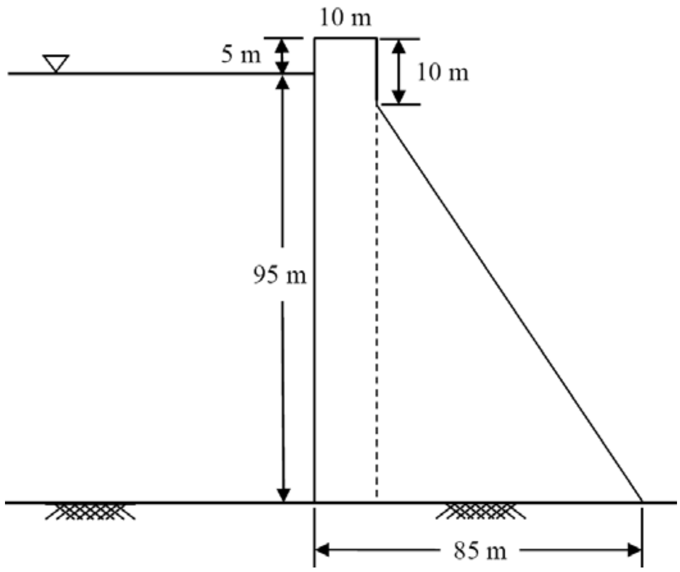

Figure 3

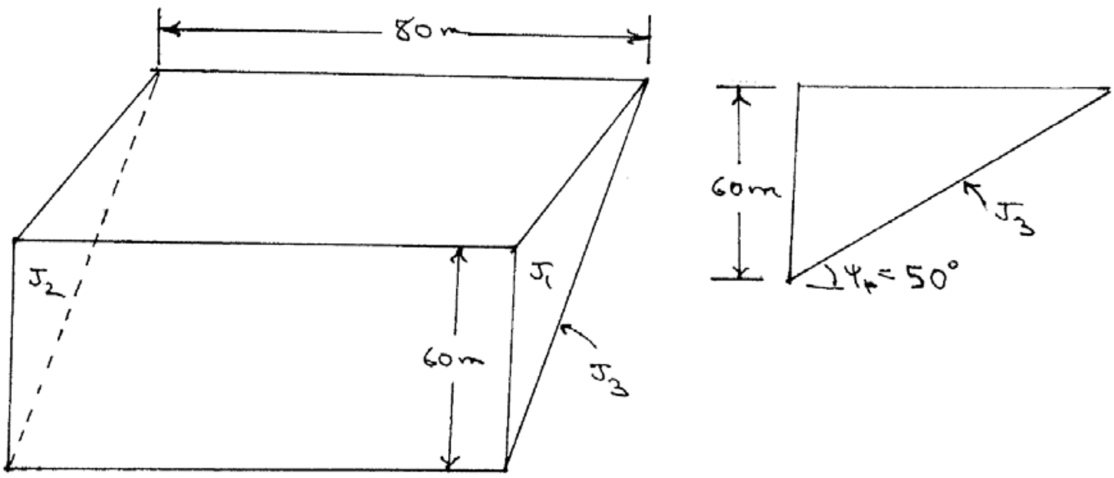

Figure 2