ORDRE DES INGÉNIEURS DU QUÉBEC

SESSION DE NOVEMBRE 2019

Toute documentation permise
Calculatrices : modèles autorisés seulement
Durée de l'examen : 3 heures
4 feuilles de papier calque.

14-MI-A6 APPLIED ROCK MECHANICS

Question 1 (20points)

An horizontal tunnel is to be excavated. A structural mapping of 200 joints allowed for the identification of 5 joint sets.

Set	Dip Direction	Dip
1	160	38
2	75	55
3	280	58
4	0	65
5	200	30

a) Identify all possible formed wegdes and their respective mode of failure.

NB: A stereonet projection an onion sheets are provided.

Question 2 (20points)

A geotechnical hole of 90m – oriented at $120^{o}/45^{o}$ (Trend/plunge) – was drilled through a rock mass. Four joint sets were intercepted.

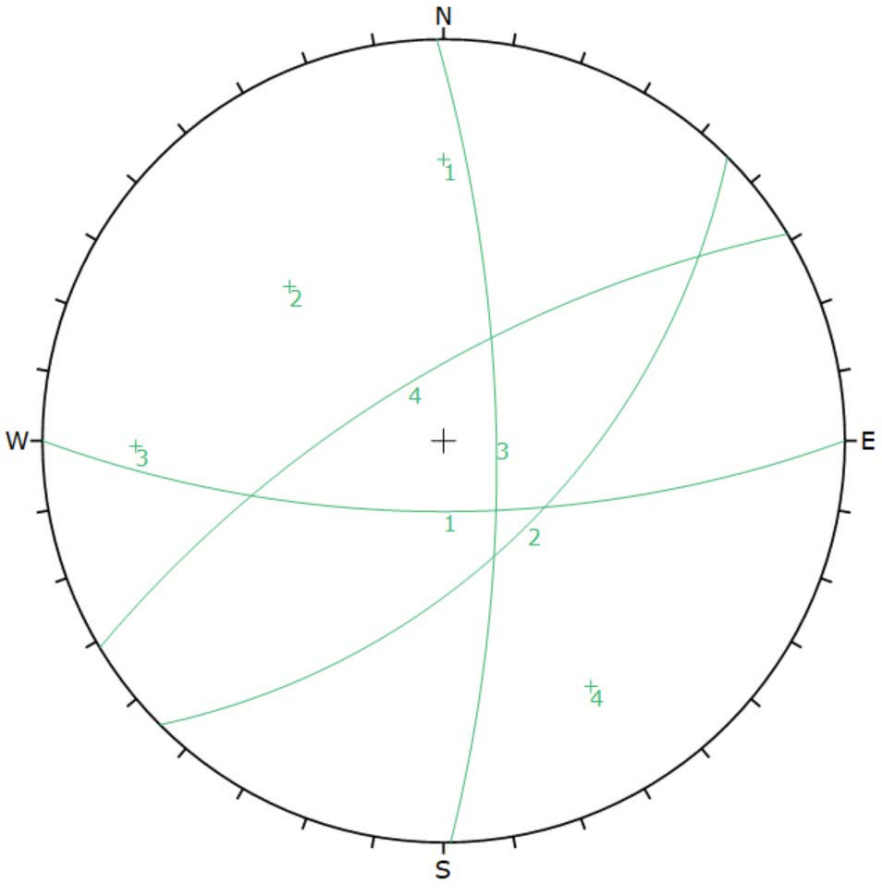
Set	Dip(^{o})	Dip Direction(^{o})	Number of joints
1	45	204	900
2	12	080	500
3	30	145	1000
4	88	330	4000

If a geotechnival hole of 150m would be drilled in the same rock mass at an orientation of $220^{o}/20^{o}$:

1. How many joints for every sets would have been intercepted?
2. What would be the normal spacing of those sets?
3. What would be the RQD along this hole?

Question 3 (20 points)

A field campaign allowed to quantify the orientation of 200 joints and 4 joint sets showed in the next figure. A rectangular pit is to be excavated. The planned global slope angles are to be excavated at a dip angle of 45 degrees. The benches are planned at a slope angle of 72 degrees. The estimated joint friction angle is 30 degrees.



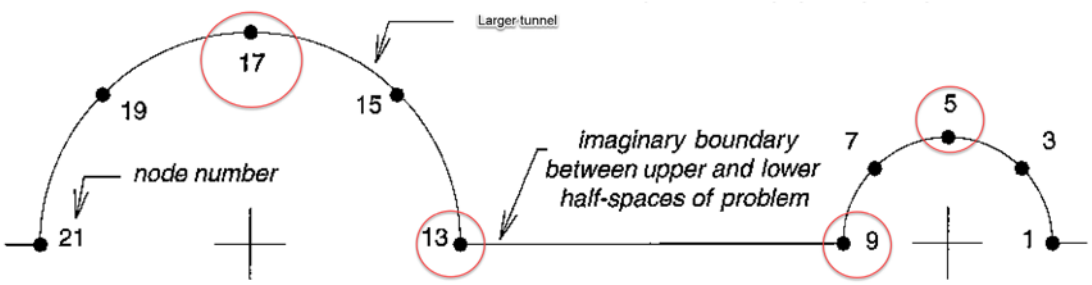
a) Identify all possible structural instabilities (toppling and planar) for mining benches.
b) Suggest an optimal angle for benches on the 4 walls minimizing structural failures and maximizing financial gain for the mine operators.

Question 4 (20 points)

At a depth of 450m, a 3m diameter tunnel is driven in rock having a unit weight of 26kN/m3 and a uniaxial compressive and tensile strengths of 50MPa and 2MPa respectively. Will the strength of the rock on the tunnel boundary be reached if

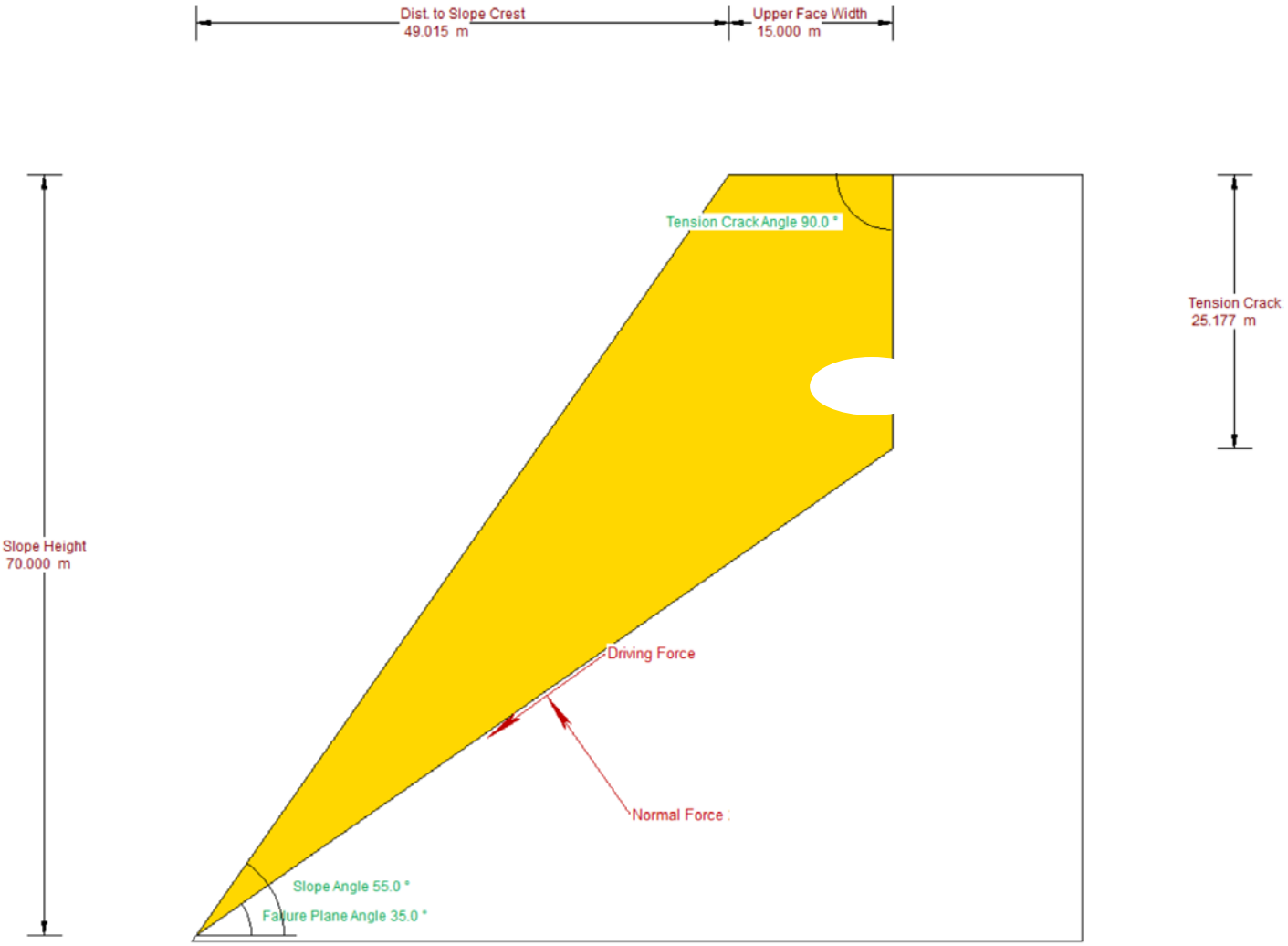
a) k0.3
b) k=2.5

A second tunnel of 6 m diameter is subsequently driven parallel to and at the same center line as the first, such that the center line spacing of the two tunnels is 10m. Comment on the stability of the two tunnels for the field stresses given in a) and b) at nodes 5,9,13,17 circled in red.



Question 5 (20 points)

a) Compute the factor of safety for the slope presented below.



b) Compute the factor of safety if the tension crack is filled with water.
c) Compute the factor of safety if the tension crack and the joint are filled with water.

The following results were obtained during a field campaign.

- RMR = 90 – 100
- γ_r = 27 kN/m^3.
- Shear tests on naturel jointsL: c = 0.20 MPa; φ = 30°
- Triaxial tests on intact rock samples: c = 50 MPa; φ = 55°

Informations possiblement utiles