UNISA university of south africa

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN ROCK MECHANICS PAPER 3.3 : MASSIVE UNDERGROUND MINING (HARD AND SOFT ROCK) **SUBJECT CODE:** COMRME **EXAMINATION DATE:** 19 MAY 2011 **TIME:** 14:30 – 17:30	**EXAMINER:** W C JOUGHIN **MODERATOR:** J V JAMES **TOTAL MARKS:** [100] **PASS MARK:** 60%

NUMBER OF PAGES: 10

SPECIAL REQUIREMENTS:

1. **Answer *ALL FOUR* questions**
2. References other than those provided are not permitted. (Refer No. 10)
3. Hand-held electronic calculators may be used.
4. Put your examination number on the outside cover of each book used and on any graph paper or other loose sheets handed in.

NB: your name must not appear on any answer book or loose sheets.

5. **Write in ink on the RIGHT HAND SIDE of the paper only (only the right hand pages will be marked).**
6. Show all calculations on which your answers are based.
7. Illustrate your answers by sketches of diagrams wherever possible.
8. In answering these questions, full advantage should be taken wherever necessary of your practical experience as well as of the data given.
9. Answers must be given to an accuracy that is typical of practical conditions.

MASSIVE UNDERGROUND MINING (HARD AND SOFT ROCK)

QUESTION 1

Describe the geology, rock mass characteristics and stress environment at your mine or any mine that you have investigated. Where the information is insufficient, provide preliminary information and indicate what further investigation is required. Use sketches as necessary.

a) Briefly describe the formation of the orebody, the geological sequences, major geological features and the characteristics of the mineralised zone. **[8]**

b) Describe each rock type, detailing the intact material properties and all the important geotechnical characteristics. **[12]**

c) Describe the stress environment and briefly indicate how it is likely to influence the stability of production excavations. **[5]**

[25 MARKS]

QUESTION 2

A large crusher chamber is being designed for an underground mine. The excavation is 20 m long, 15 m wide and 12 m high and the long axis is orientated 30° East of North. Geotechnical mapping has indicated that there are two major joint sets in the area. There orientations are as follows:

	Dip	Dip direction
J1	70°	120°
J2	45°	300°

The joint friction angle has been estimated as 21°. Cohesion can be considered negligible. The unit weight of the rock is 27kN/m^3. The excavation is to be supported with 250 kN grouted cable anchors to a safety factor of 1.5.

a) Draw a vertical cross-section showing the largest wedges that can be formed in the roof and sides of the excavation (approximately in proportion). Calculate the height and weight of each of the wedges and indicate these on the drawing. **[12]**

b) Calculate the number of cable anchors required to support the roof wedge. Suggest an appropriate pattern of cable anchors for the roof based on this calculation. **[5]**

c) Determine which of the two side wedges is more unfavourable and calculate the number of cable anchors required to prevent it from sliding. Suggest an appropriate pattern of cable anchors for the side based on this calculation. **[7]**

d) How could you improve the design in order to reduce the support requirements? **[1]**

[25 MARKS]

QUESTION 3

The footprint of a near vertical kimberlite orebody is approximately 80 m wide and 200 m long. The kimberlite has a Mining Rock Mass Rating (MRMR) of about 43 and is hosted within granite, which has a MRMR of 55. The upper part of the orebody has been extracted by surface mining to a depth of 300 m. It is planned to extract the orebody to a depth of 500 m below surface.

a) Determine the cave angle and the extent of the zone of failure on surface. Use this information to determine how far the shaft should be positioned from the orebody. Illustrate by means of a sketch. **[8]**

b) If the undercut is mined across the full width of the orebody, determine how far the undercut needs to advance before caving is induced using Laubscher's method (include and annotate the relevant graph with your script). **[8]**

c) Due to high stress and the relatively low strength of the kimberlite, damage to drawbells and production level can be anticipated. Describe, with the aid of sketches, two methods to prevent this damage using the undercut **[9]**

[25 MARKS]

QUESTION 4

A high grade massive sulphide orebody is hosted within metasediments. The orebody is typically 50 m wide, with a strike length of 1000 m and dips at 80° to the West. Mining is planned at depths of between 50 m and 300 m below surface and no surface subsidence can be tolerated. Geotechnical mapping indicates that the orebody and metasediments have Q' values of 13.5 and 14 respectively. The critical joint set is parallel to the hangingwall contact. The UCS of the orebody and host rock are both greater than 15°0 MPa.

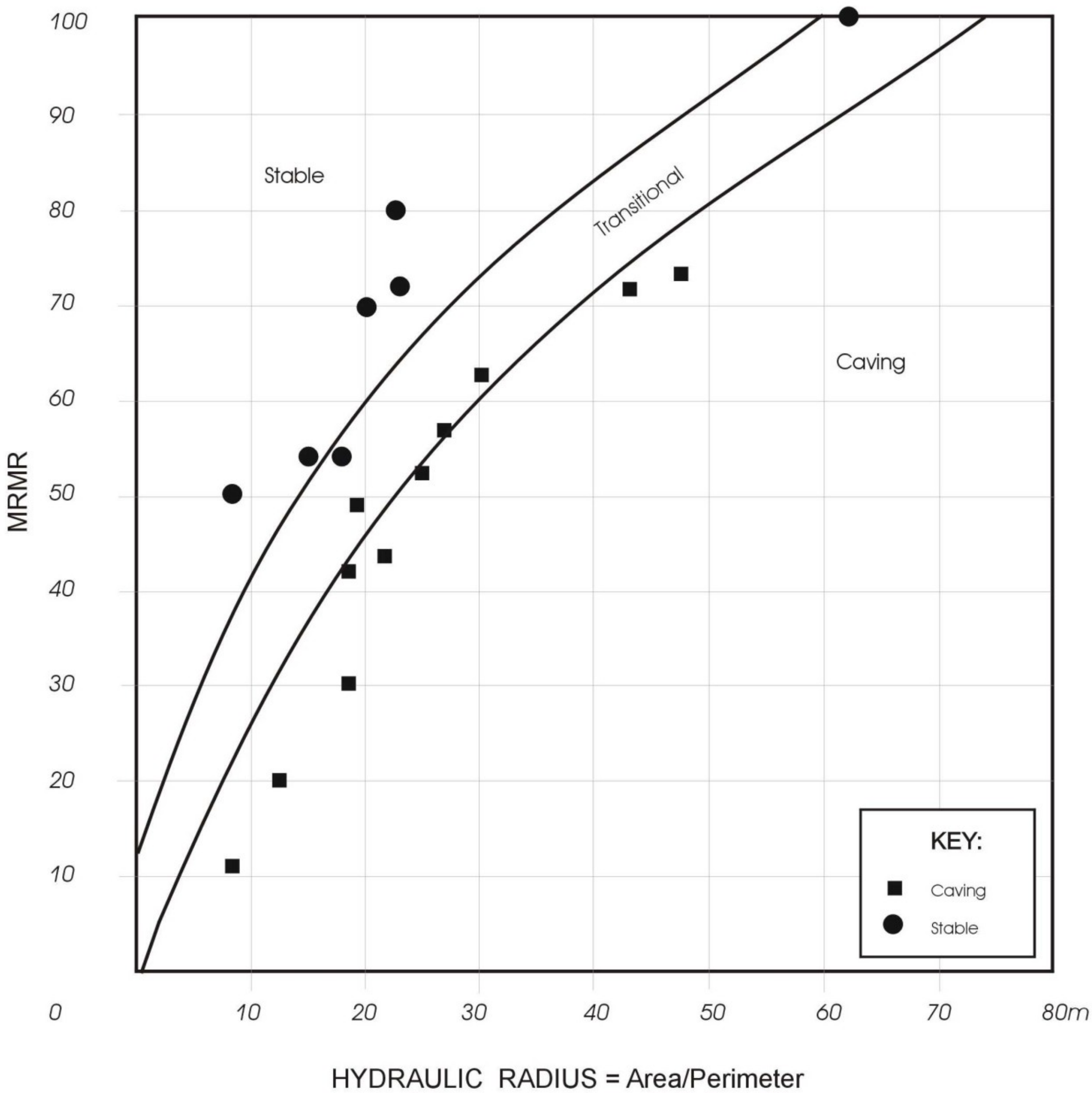
a) Determine the N' value for the stope hangingwall (geological) and back (crown). State your assumptions when determining values for each parameter. Calculate the maximum stable dimensions of the hangingwall and back using Potvin's stability method. **[12]**

b) Describe, with the aid of sketches, a suitable mining method for this project. **[8]**

c) Discuss the limitations of the Potvin stability method when stopes are surrounded by backfill. How can the risks be mitigated? **[5]**

[25 MARKS]

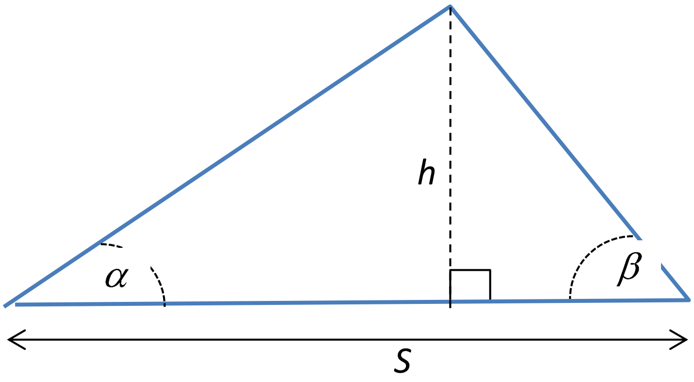
Information



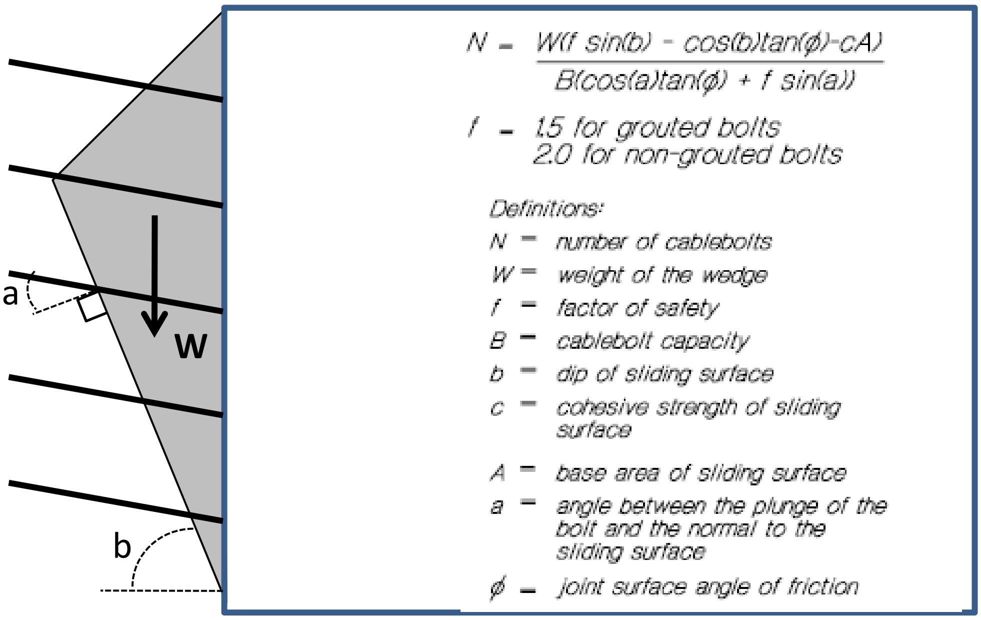
Laubcher's Stability graph

Cave angle and failure zone (Laubscher 1990)

	Condition	**Depth (m)**	**Adjusted *MRMR***				
			100-81	80-61	60-41	40-21	20-0
Cave angle	No lateral restraint	100	80	70	60	50	40
		500	70	60	50	40	30
	Lateral restraint from caved material	100	90	80	70	60	50
		500	80	70	60	50	40
Extent of failure zone	Surface	100	10 m	20 m	30 m	50 m	75 m
		500	10 m	20 m	30 m	50 m	75 m
	Underground	100	10 m	20 m	30 m	50 m	100 m
		500	20 m	30 m	50 m	100 m	200 m



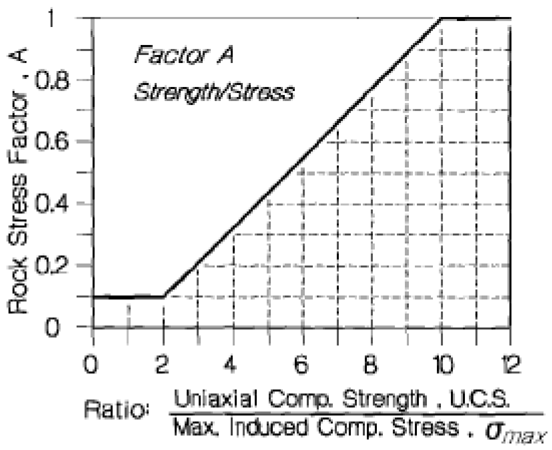
$$h = \frac{S \times \tan\alpha \times \tan\beta}{\tan\alpha + \tan\beta}$$

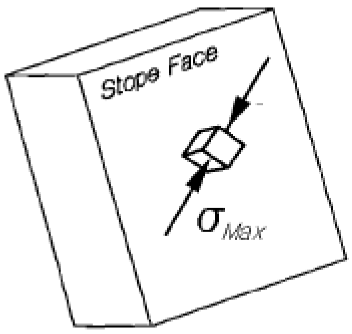


N’ = Q’ x A x B x C

Rock Stress Factor A

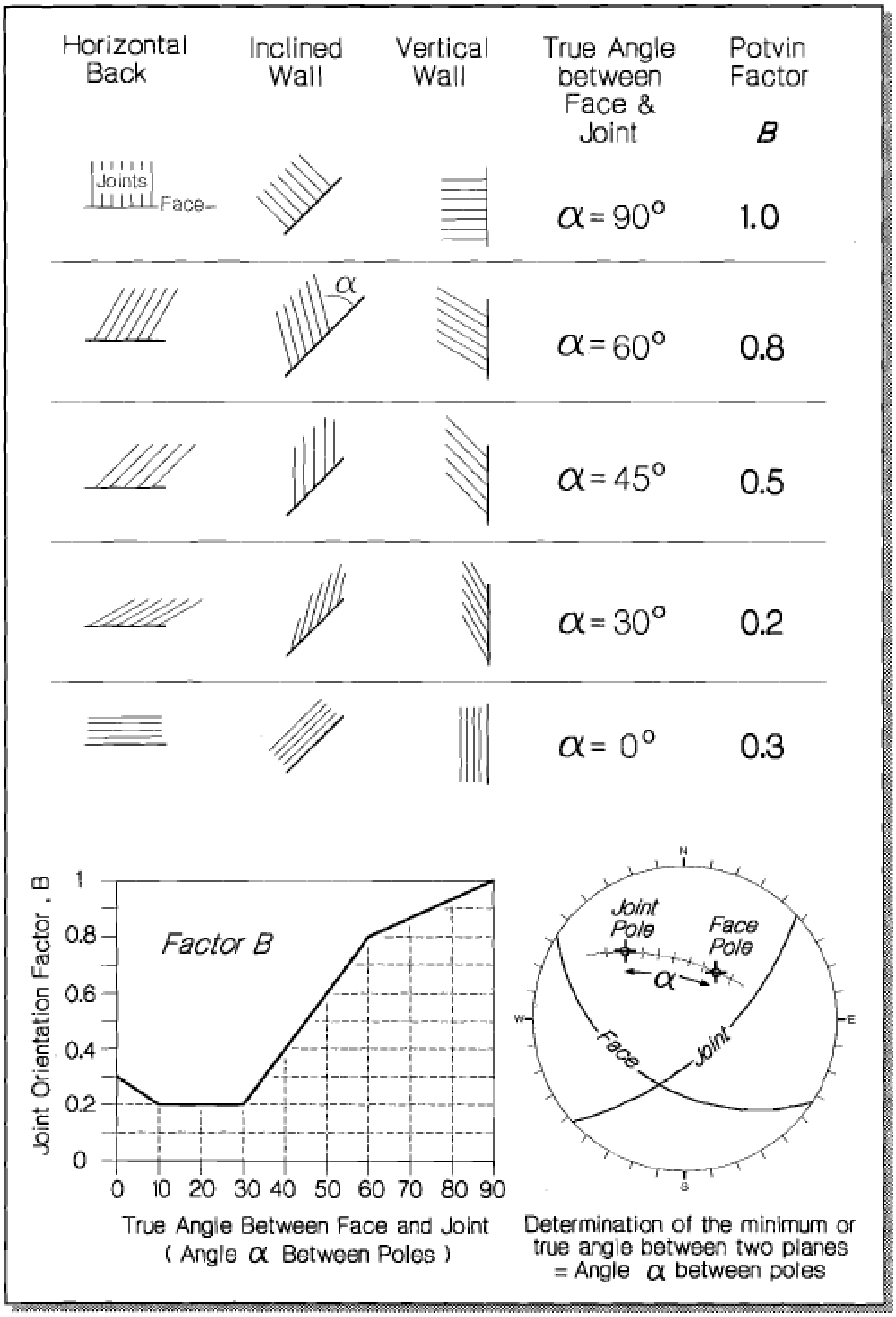
Determine maximum induced tangential stress (compressive) acting at the centre centre of the stope face being considered. Obtain uniaxial compressive strength strength for the intact rock. Evaluate Stress Factor, *A*, using the graph below:





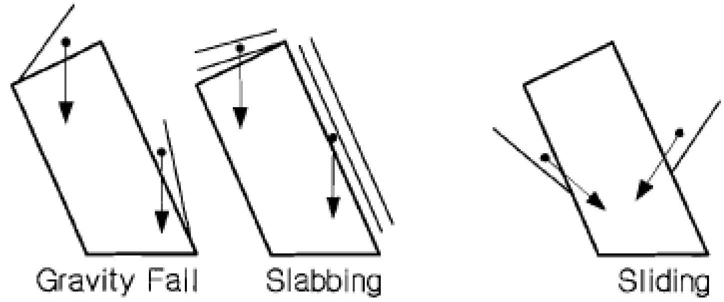
Obtain σ_{max} from 2D or (preferably) 3D numerical stress modelling.

Joint Orientation Factor, B

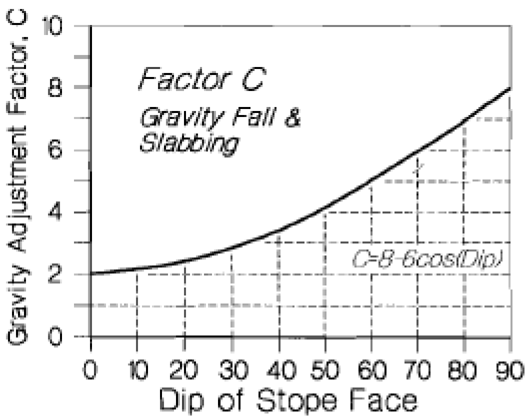


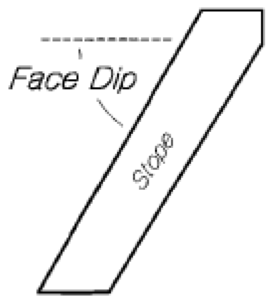
Gravity Adjustment Factor, C

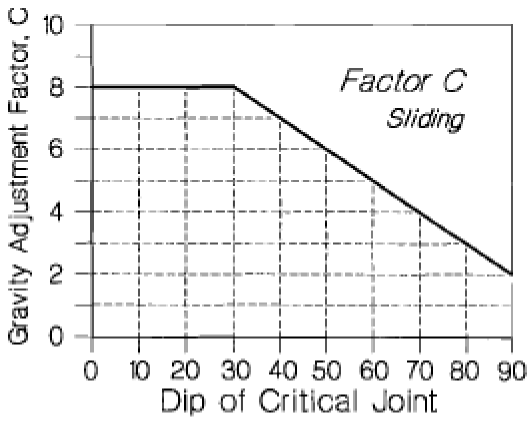
1) Determine the most likely mode of structural failure in case study using the figures below:

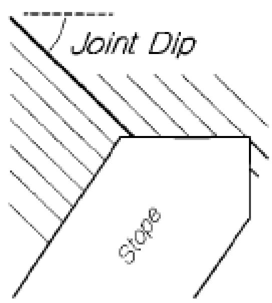


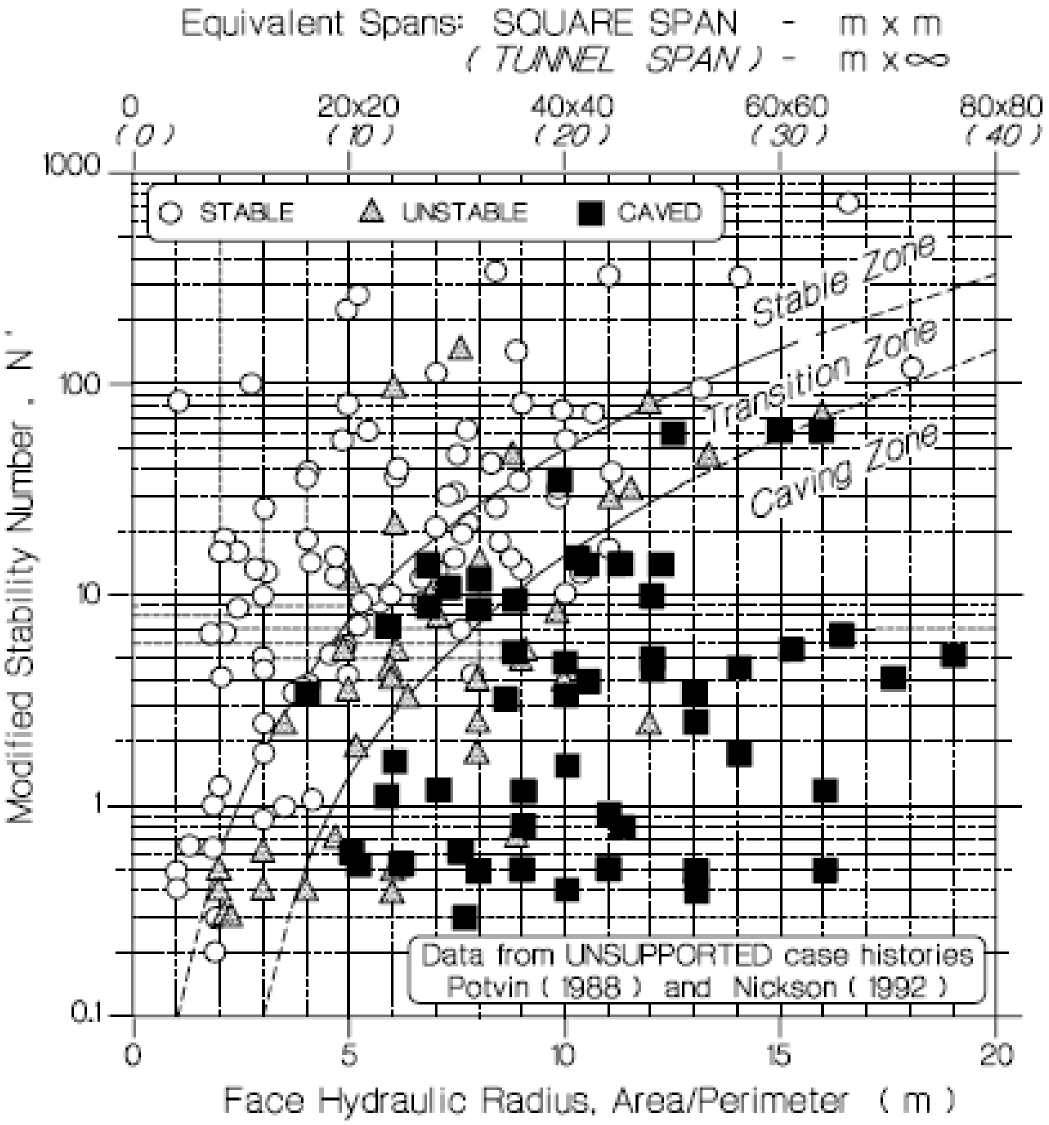
2) Next determine the gravity adjustment factor, C, based on the failure mode using the appropriate chart below.











Matthews/Potvin stability graph