

1. Use the Kirsch Equations and an Excel spreadsheet to predict stresses around a circular tunnel with 4 m radius. Assume the rock mass is elastic with the following parameters: $E = 10 \text{ GPa}$, $\mu = 0.25$, specific gravity = 2.3. The insitu stress can be estimated assuming a depth of 500 m below the ground surface and $k = 2.5$ ($k = \text{horizontal/vertical insitu stress}$).

(a) Plot the vertical and the horizontal stress versus depth along a vertical line passing through the centre of the tunnel over a range of 0 to 20 m from the tunnel axis.

(b) Plot the vertical and the horizontal stress versus distance along a horizontal line passing through centre of the tunnel over a range of 0 to 20 m from the tunnel axis.

(c) Repeat (a) and (b) by plotting the major and the minor principal stresses.

(d) Comment on what is happening with the principal stresses around the tunnel.

2. Assume the tunnel above was created by a tunnel-boring machine. The rock type is sandstone with a GSI value estimated to be 55. The intact rock has a ucs of 60 MPa and an m_i value of 19.

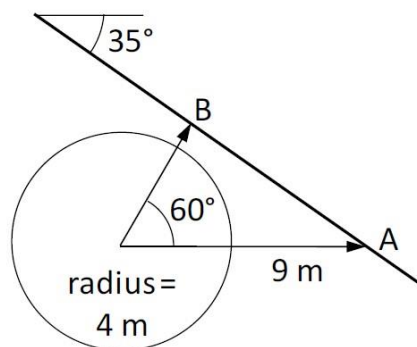
(a) Plot the rock mass strength versus distance along a horizontal line passing through centre of the tunnel over a range of 0 to 20 m from the tunnel axis.

(b) Plot the rock mass strength versus distance along a vertical line passing through centre of the tunnel over a range of 0 to 20 m from the tunnel axis.

(c) Compare the strength to the stress and comment on any expected stress-related problems that might occur as the tunnel is excavated.

(d) Using the empirical support selection method from Barton, suggest appropriate support for this tunnel assuming it will be used for a railway tunnel.

3. Calculate the normal and shear stress acting at points A and B on an inclined planar fault located near the tunnel. The fault dips 35° and strikes parallel to the tunnel axis. Indicate the sense of shear at both locations via a simple sketch.



4. Explain with words and sketches how the following support types are installed

(e) Resin-grouted rebar

(f) Split set bolt

(g) Swellex bolt

(h) Mechanical (end-anchored) rockbolt

5. What is the difference between dry-mix and wet-mix shotcrete and briefly list the relative advantages and disadvantages of both techniques?