



Chapter 6. Analysis of structurally controlled instability.

① Underground excavation in jointed rock mass

→ Wedge falling / sliding of rock blocks

② Required steps

- ① Determination of average dip and dip direction of significant discontinuity sets in the rock mass
- ② Identification of potential wedges which can slide or fall from the back or walls of the opening
- ③ Calculation of the factor of safety of these wedges, depending on the mode of failure.
- ④ Calculation of the amount of reinforcement required to bring the factor of safety of individual wedges up to an acceptable level.

1. Identification of potential wedges.

- (1) Size and shape of potential wedges
= f (size, shape, orientation of opening / discontinuity).
- (2) Can use "UNWEDGE"
- (3) Can solve by hand (stereographic projection).

2. Support to control wedge failure

- (1) Very little movement before failure
→ Movement along the surfaces must be minimized.
- (2) Rock bolting wedges
 - ① Support the full dead weight of the wedge.
+ allowance for errors & poor quality installation.
 - ② To prevent rotations, installation should be made to distribute the support elements uniformly about the wedge centroid.
 - ③ pattern bolting vs. spot bolting.



④ Rock bolting effects

- suspension - reduces sags and separations of rock blocks
- friction - clamping force induces frictional force
- keying - prevents or reduces movement along the planes of weakness.

(3) Shotcrete support for wedges.

① Large perimeter of a wedge

→ significant cross-sectional area

② Example.

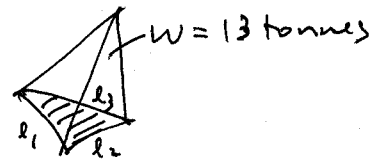
perimeter $l_1 + l_2 + l_3 = 16.4\text{m}$

shotcrete 50 mm thick.

X-sectional area 0.8m^2

shear strength of shotcrete 2 MPa (200 tonnes/m²)

$200\text{ tonnes/m}^2 \times 0.8\text{m}^2 = 160\text{ tonnes}$ (SF = 12.3)



③ A period of several days required before the full strength can be obtained

→ immediate support needed (rock bolts)

④ Shotcrete is efficient when the perimeter of wedge is covered.

Strong, large wedge → Rock bolt is better.

Closely jointed rock mass → Shotcrete better.

3. Consideration of excavation sequence.

