SLOPE STABILITY ANALYSIS IN ROCKS

PART 1 - PLANNER FAILURE

Created By: Shaloo Puri
Website: www.geotechnicaldesigns.com.au
Email id : geotechnicaldesigns@gmail.com
WhatsApp: +61452075310

E&M Expert: Mukesh Singh
Website : www.foxcons.com
Email id: Mukesh.singh@foxcons.com

SLOPE STABILITY ANALYSIS IN ROCKS

This Presentation on Slope stability analysis is divided into three parts. This presentation we will cover Planar Failure only.

1. Planar Failure
2. Wedge Failure
3. Failure in Rock mass

The direction and size of these failures depend upon the following parameters:

1. Joint sets
2. Joints dip and dip direction
3. Joints frictional properties (c and ϕ)
4. Dip and dip direction of slopes face

KINEMATIC ANALYSIS

Kinematic Analysis is very important method for determining the mode of failures. This method also determines which joint sets will have planar failure or wedge failure or toppling failure with a particular slope face dip direction.

We use Dips software (Rocscience) for determining the mode of failures.

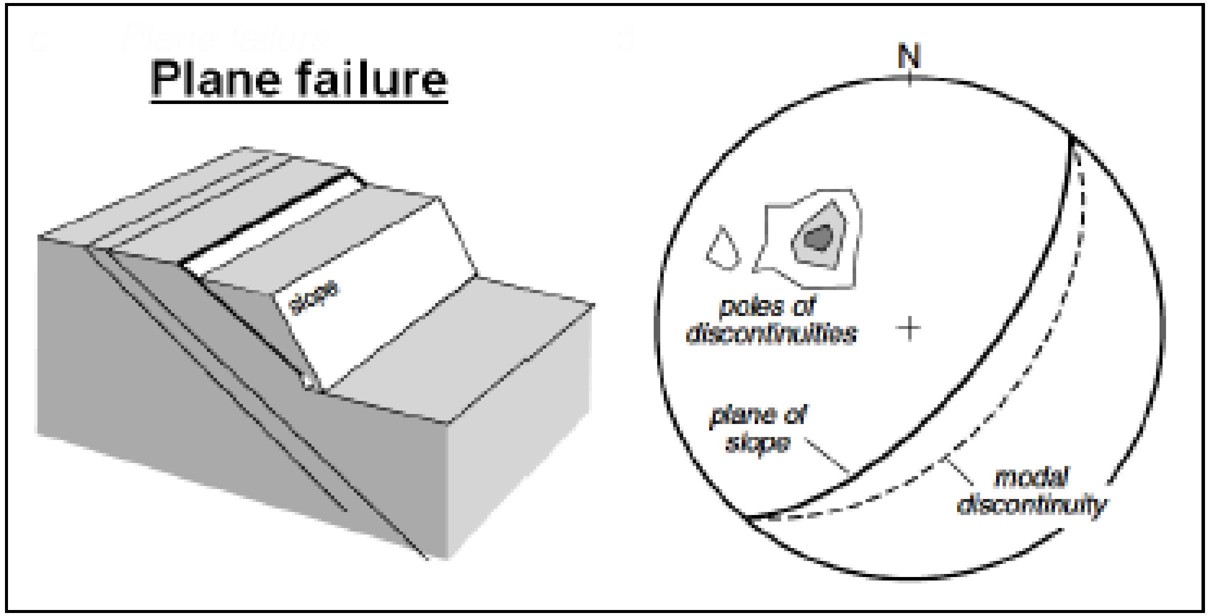
Input dip and dip direction of all joint, separate poles will develop for each joint sets.

KINEMATIC ANALYSIS – PLANAR FAILURE

Planar failure, would be favored in situation where:

a) The strike of a set of discontinuities run parallel to the slope.
b) The discontinuity dips towards the slope at a lower angle than the slope itself.
c) The angle of the dip must be steep enough to produce sliding (> friction angle of the rock material)
d) i.e. dip<angle of slope and Dip > friction angel

The stereogram shows, for a given rock slope, the orientation of discontinuities likely to lead to plane failure.

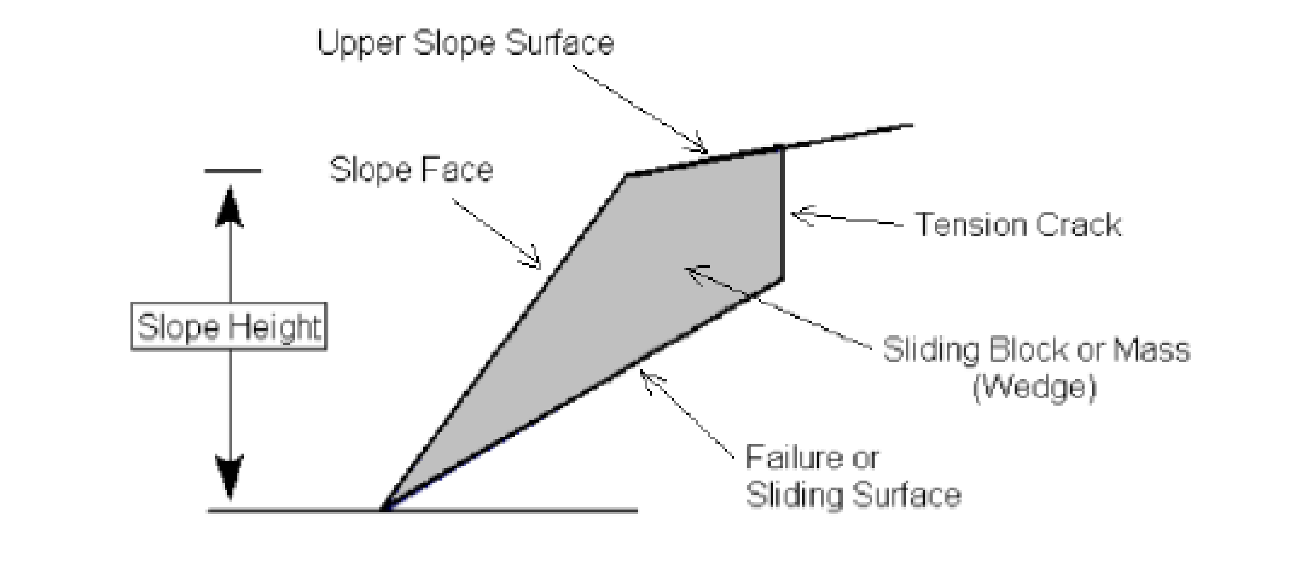


Plane failure is unlikely where joint sets have a strike which is oblique to the rock slope.

PLANAR FAILURE

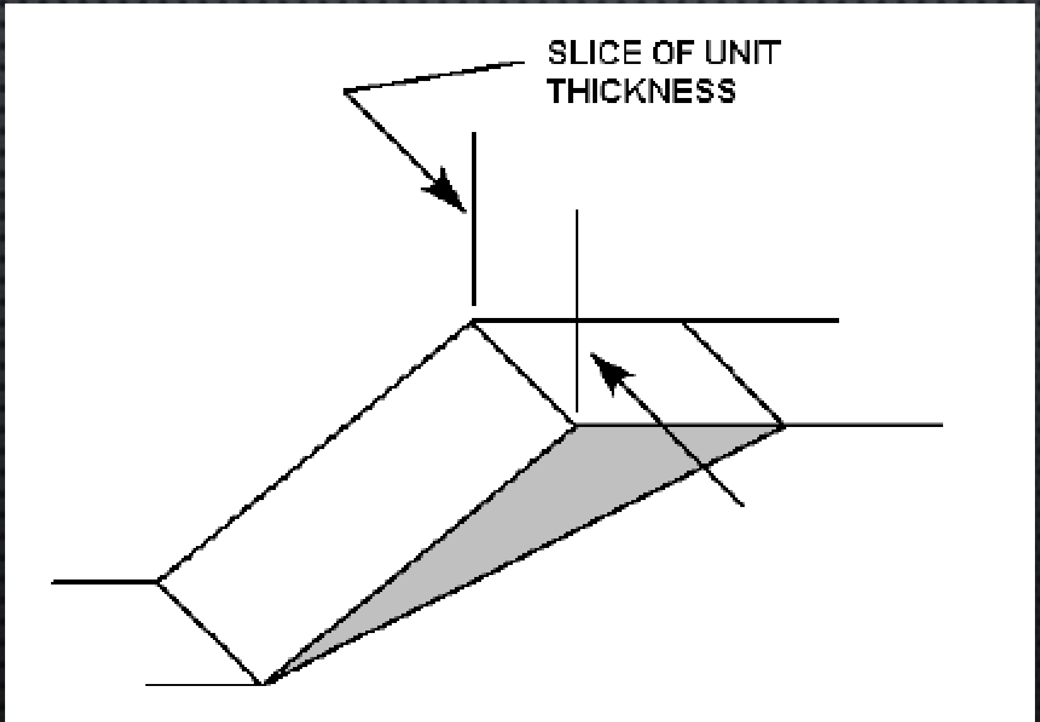
A planar wedge can be defined by:

1. Sliding Plane
2. Slope Face
3. Upper Ground Surface
4. An Optional Tension Crack



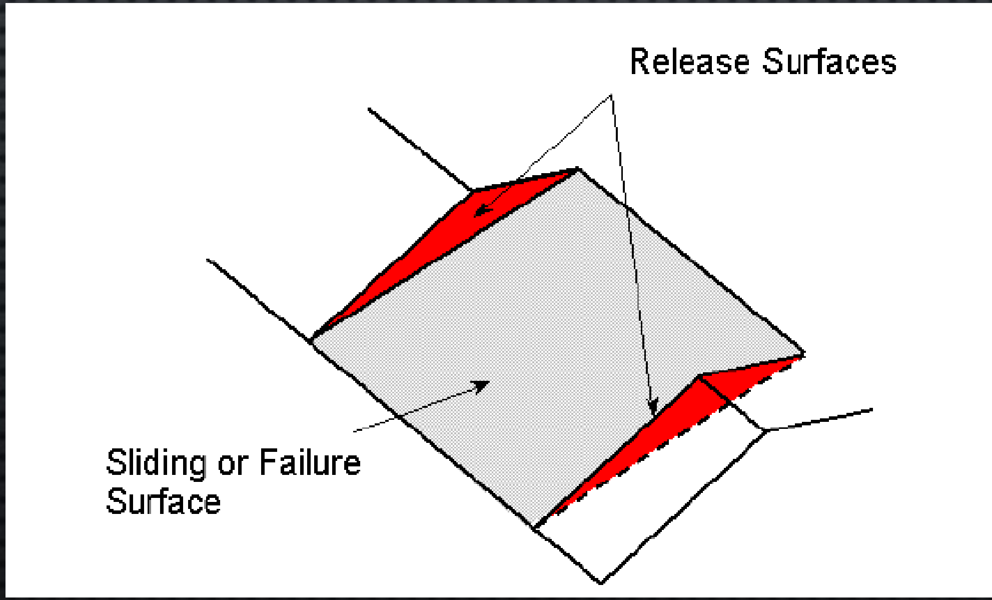
SOFTWARE - ROCPLANE

ROCPLANE is a quick, interactive and simple to use analysis tool for evaluating the possibility of planar sliding failure in rock slopes. Planar failures usually occur in good to very good rocks. This analysis is based on limit equilibrium method.



SOFTWARE - ROCPLANE

Release surfaces are present, parallel to the cross section of the analysis, which provide negligible resistance to sliding at the lateral boundaries of the failure. Alternatively, failure can occur on a failure plane passing through the convex “nose” of a slope.



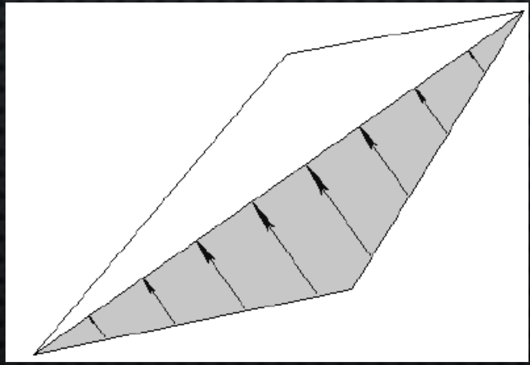
DECIDING FACTORS FOR SLOPE STABILITY

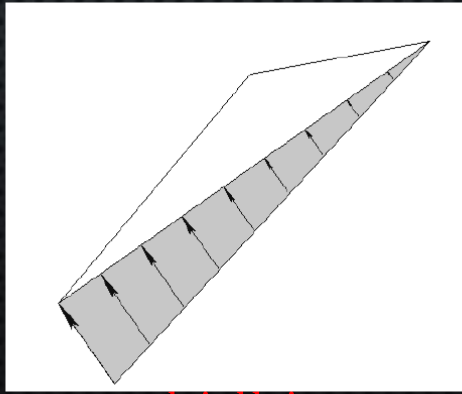
The factor which determines the stability of Palanr Failure are as follows:

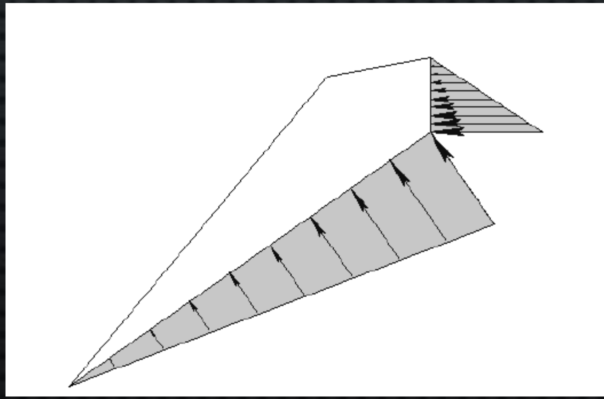
1. Water Pressure in joints.
2. Shear Parameters of Slip plane.

Water Pressure – Various Water Pressure Distribution Models can be assumed on the wedge failure plane and tension crack.

1. Peak Pressure at Mid Height
2. Peak Pressure at Toe
3. Peak Pressure at Tension Crack Base







DECIDING FACTORS FOR SLOPE STABILITY

Shear Strength - Planar slope stability analysis involves the shear strength of the sliding surface.
There is relationship between the shear strength of a sliding surface and the effective normal stress acting on the plane.

Mohr – Coulomb

$$\tau = c + \sigma_n \tan\phi$$

τ = Shear strength of the failure plane
σ_n = Normal Stress
c = cohesion of failure plane
ϕ = friction angle of failure plane
There are more strength criteria for analyzing slope stability. But here we are explaining the Mohr-Coulomb Criteria only for understanding.

ROCPLANE – EXAMPLE 1

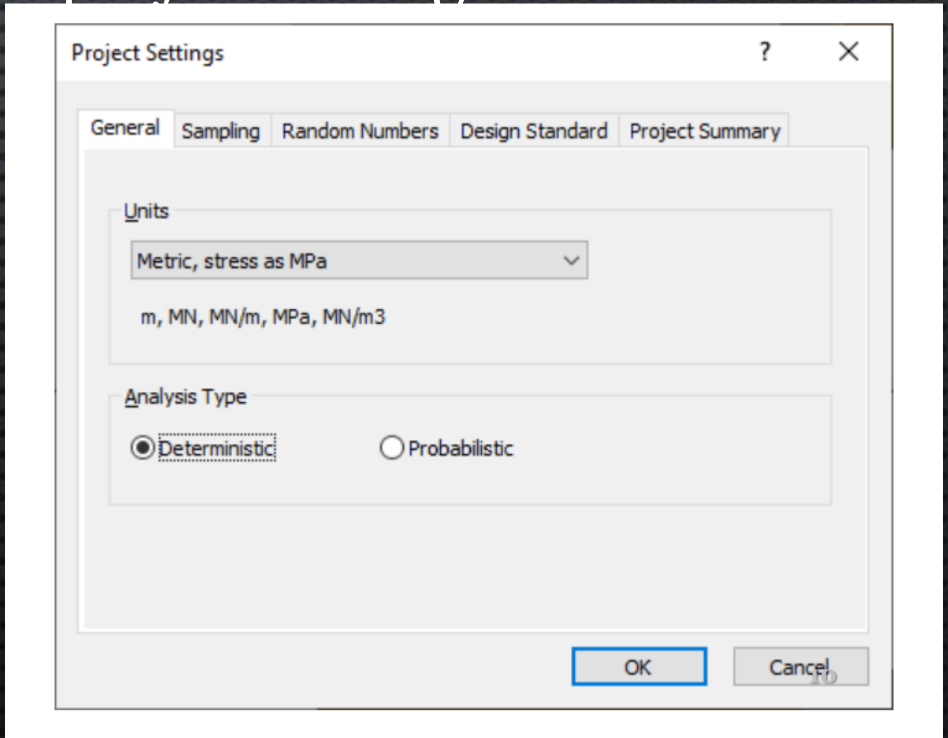
This example will show the basic modelling and data interpretation.

This software will provide the slope stability analysis and design for planar wedge stability in open pit mines and rock slopes.

Input Data – Input the know parameters in the project settings:

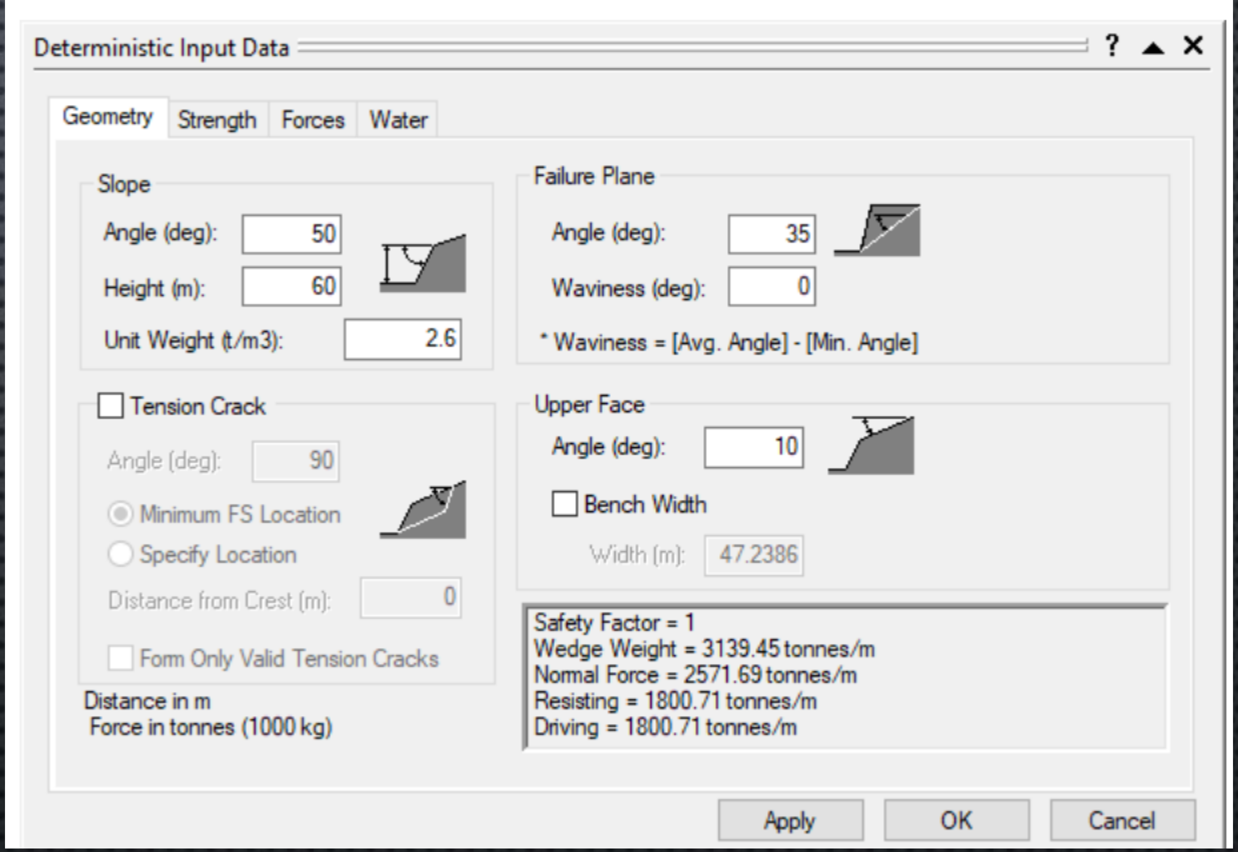
Input the Units in which you want to analyze the slopes.

Analysis Type is Deterministic where input parameters are known for eg. c and ϕ of failure plane and dip of joints.



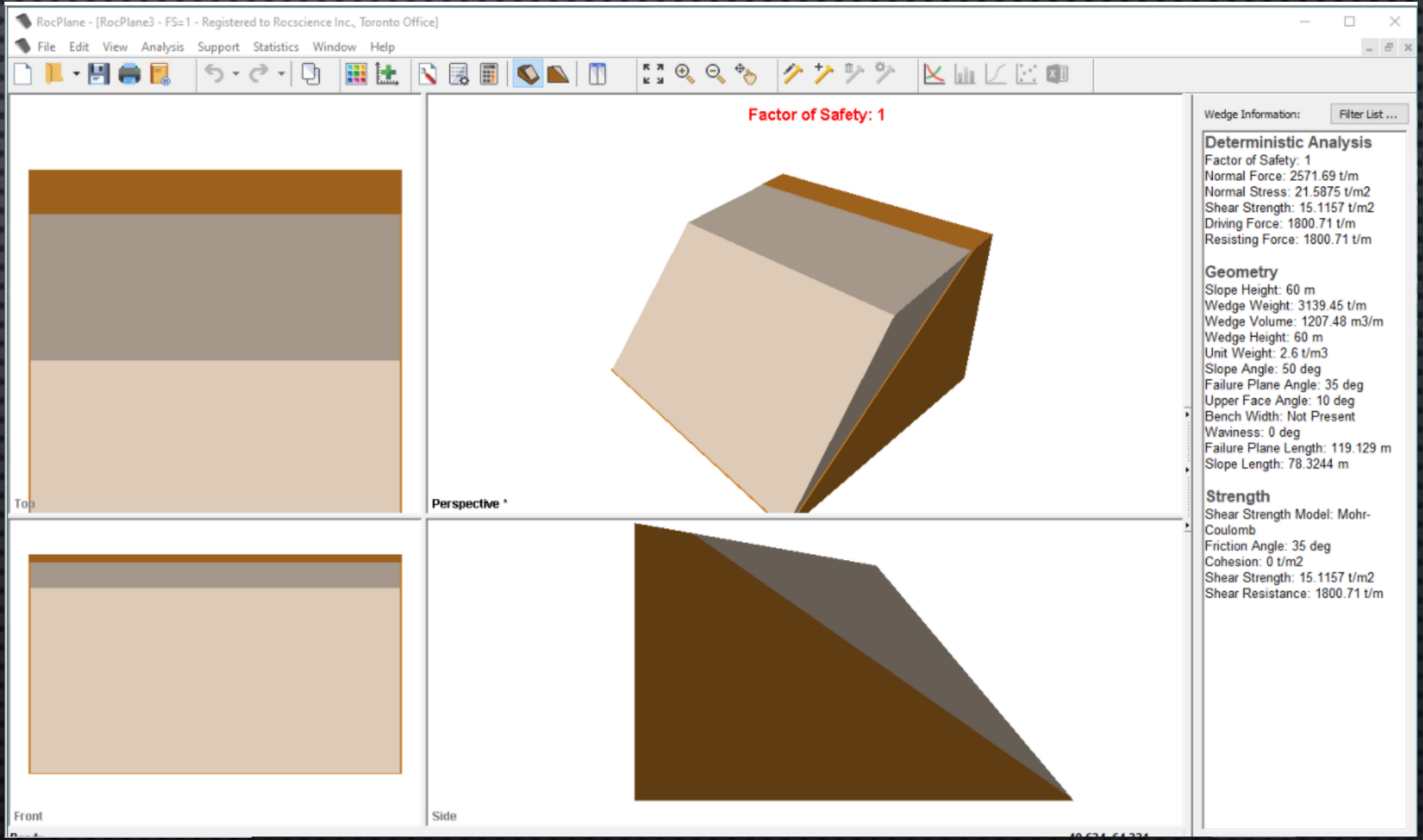
ROCPLANE – EXAMPLE 1

Analysis Type is Deterministic where input parameters are known for e.g. c and ϕ of failure plane from geotechnical investigation and dip of joints. From Kinematic Analysis we will determined that which joint is creating planar failure with the excavated slopes as explained in slide 4.



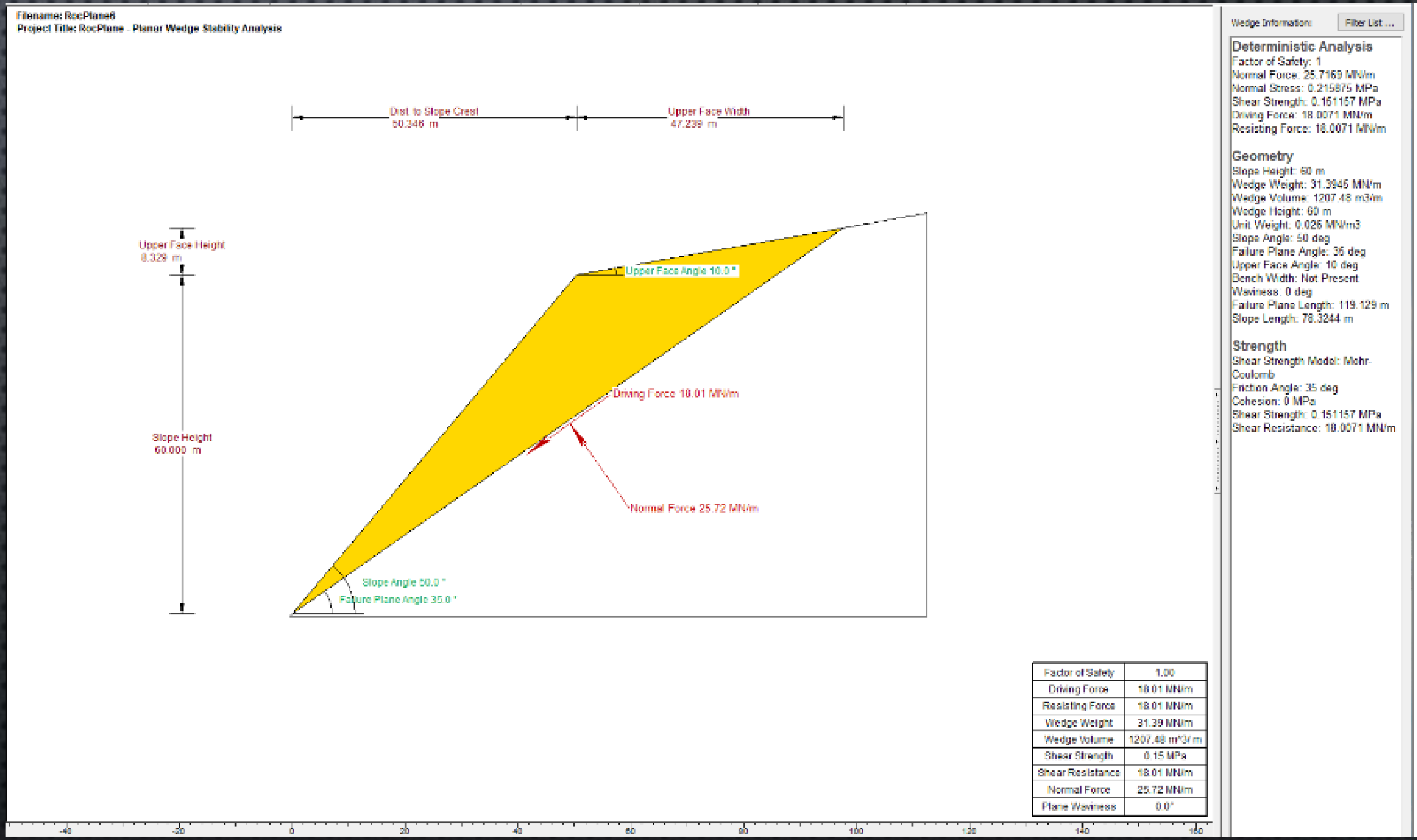
3D PERSPECTIVE VIEW

The view provides **a three-dimensional Perspective View**
of the RocPlane model as well as three orthogonal
views (Top / Front / Side) in a four-pane split screen format.



2D WEDGE VIEW

The 2D Wedge View in RocPlane allows you to display a two-dimensional view of your model. The view displays model lengths and angles, applied and resultant forces, and tables of analysis results and input data.

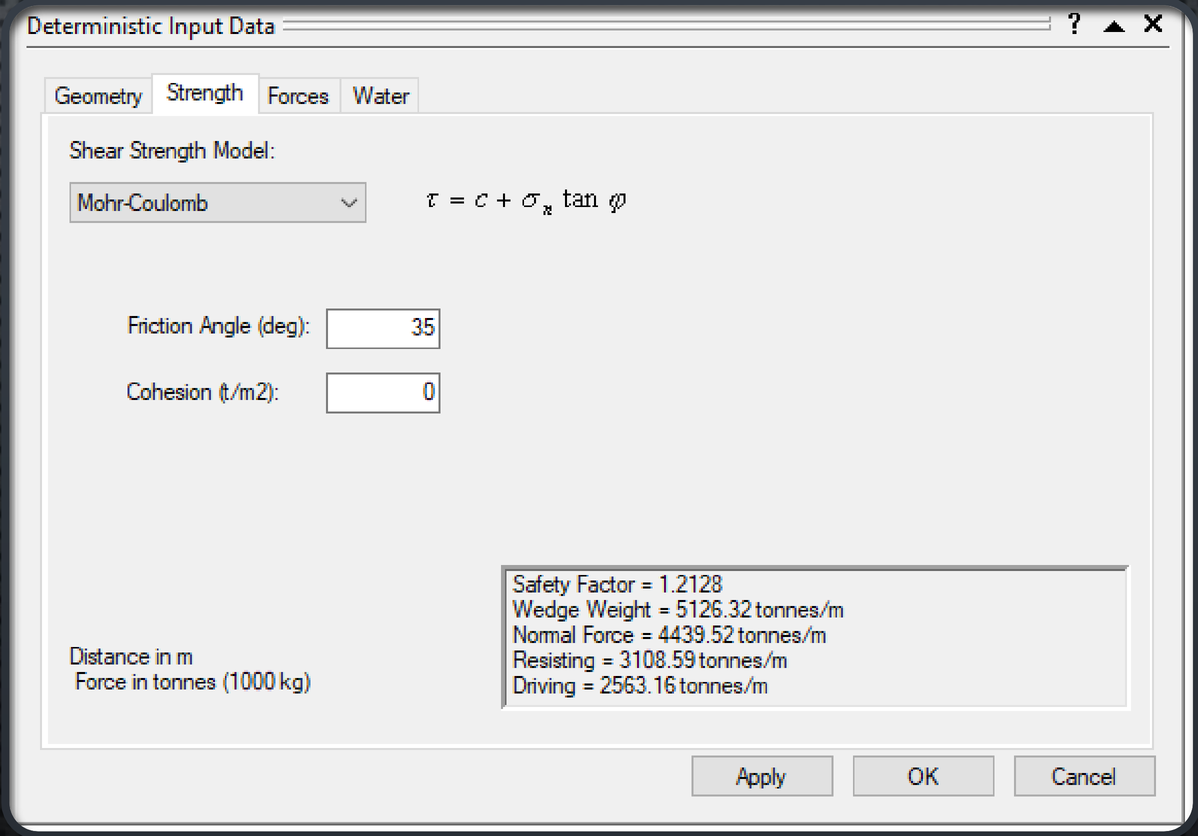


- Factor of safety = 1.00

  Just in equilibrium.
- In static case FOS shall be 1.5 or more and to achieve it, either we will change
  - Friction Parameter of Slip Plane or
  - Provide Supports

CHANGE IN FRICTION VALUES OF SLIP PLANE TO INCREASE FOS

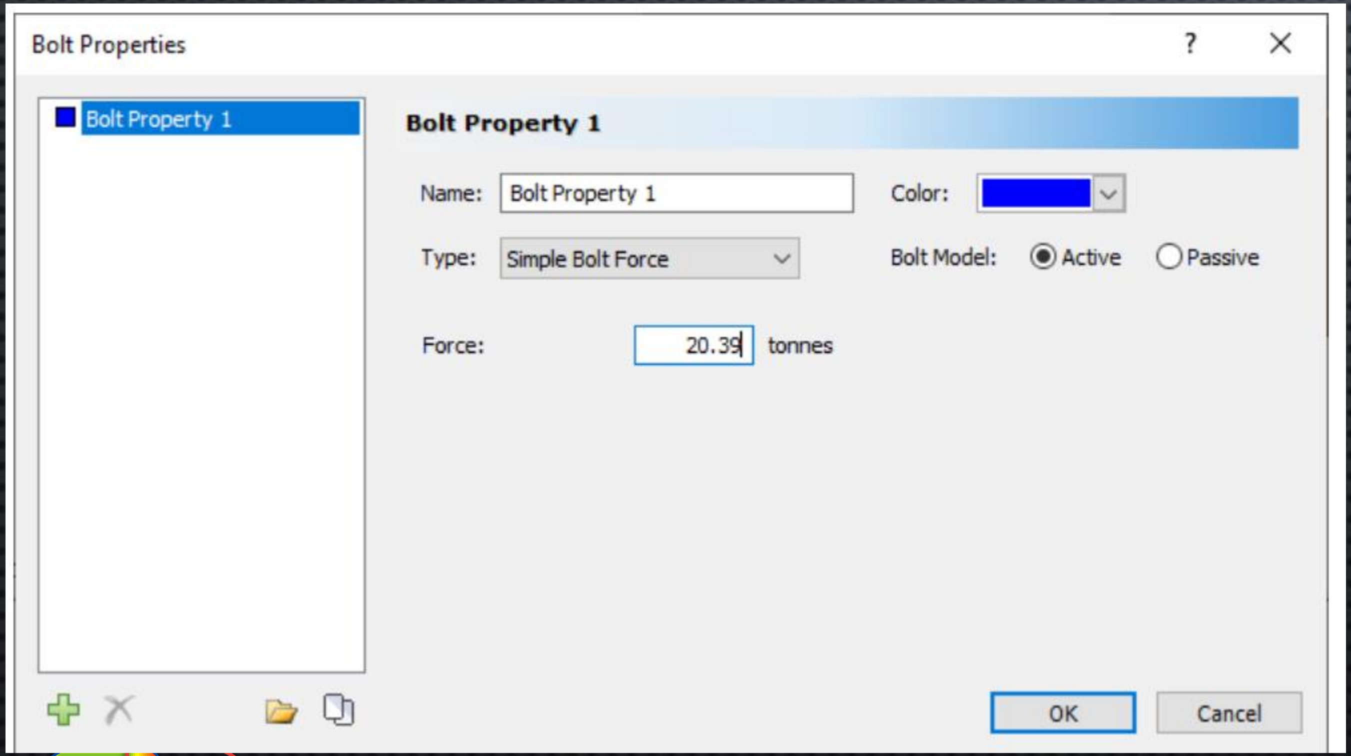
- ❖ If you look at the Slide 11 the Geometry of the slope has been given.
- ❖ Now we will put the actual strength parameters of the failure plane
- ❖ Change Cohesion to 10 t/m2
- ❖ FOS will change to 1.7

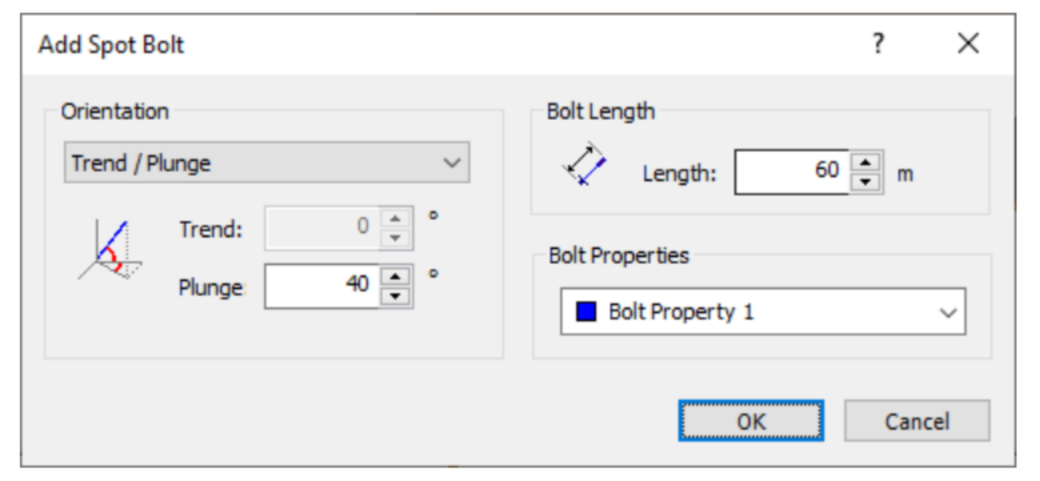


SUPPORT SYSTEM TO INCREASE FOS

To increase the FOS of the Plane wedge, we must provide ROCK BOLT.

Below figures are showing the Bolt Parameters we must provide in ROCPLAN software

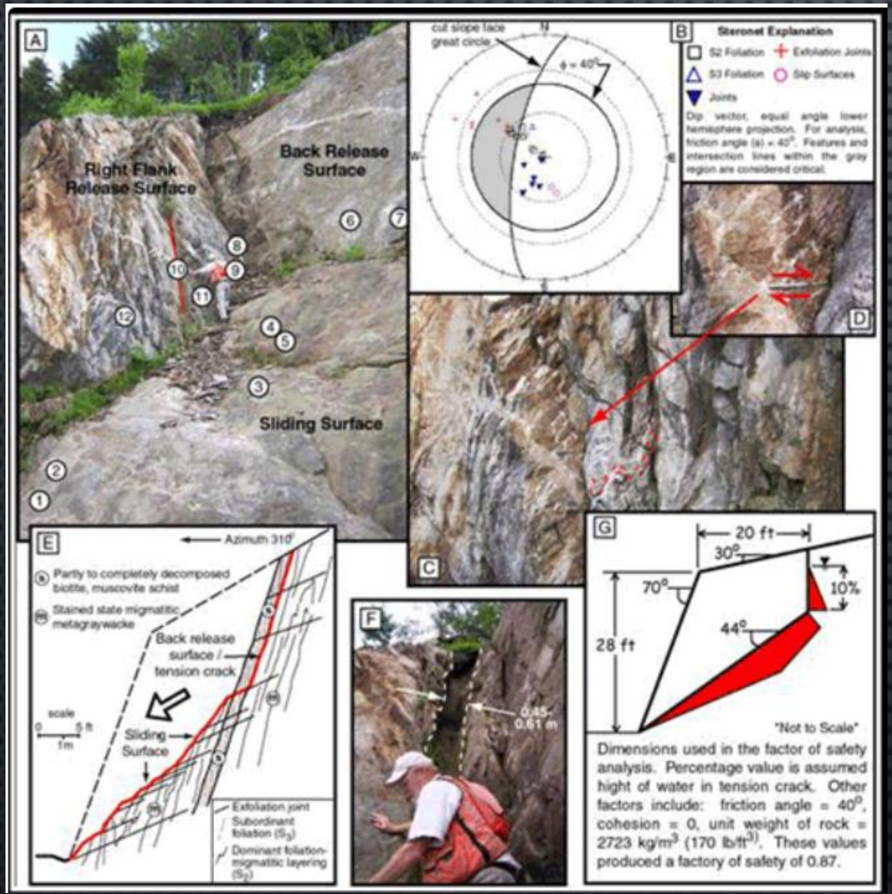




ROCK BOLT CAPACITY

- Since RocPlane is a 2D software, the bolt capacity entered in the Bolt Properties dialog (Force) is considered as a force per unit distance (tonnes per meter in this example).
- The capacity takes account of the spacing of the bolts in the out-of-plane direction. **For example, if the capacity of an individual bolt were 50 tonnes and the out-of-plane bolt spacing were 2 meters, you would enter a Force of 50 / 2 = 25 tonnes / meter.**
- Each bolt in RocPlane therefore actually represents a ROW of equally spaced bolts.
- After providing ROCK BOLTS the FOS will increase to 1.65.

FEW EXAMPLES OF PLANER FAILURES IN ROCK



FEW EXAMPLES OF PLANER FAILURES IN ROCK

THANKS FOR WATCHING MY PRESENTATION

Created By: Shaloo Puri
Website: www.geotechnicaldesigns.com.au
Email id : geotechnicaldesigns@gmail.com
WhatsApp: +61452075310