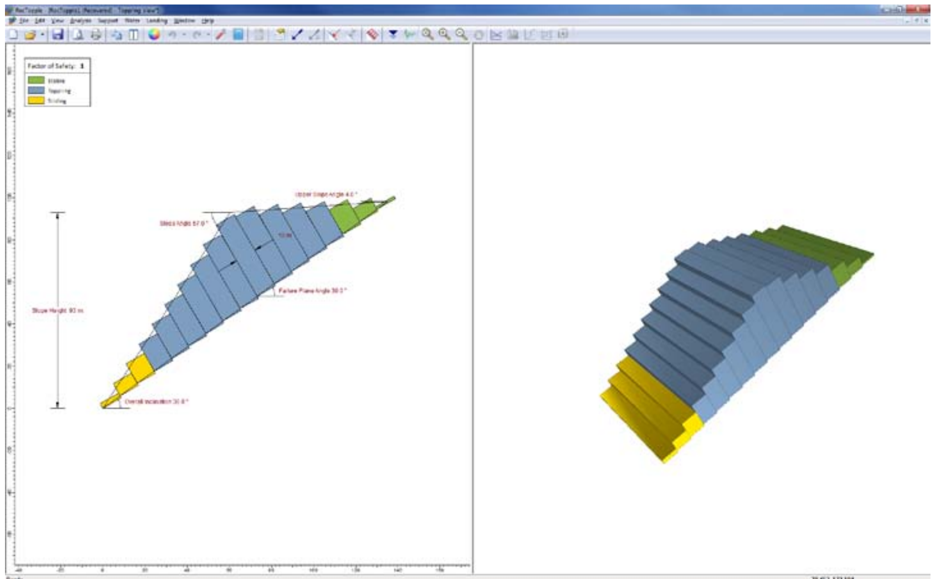
Quick Start Tutorial



RocTopple is an interactive and simple to use analysis tool for evaluating block toppling in rock slopes. This “quick start” tutorial will introduce you to the basic features of *RocTopple*, and demonstrate how easily a model can be created and analyzed with the software.

The finished product of this tutorial can be found in the **Tutorial 01 Quick Start.rtop** file. Tutorial files installed with *RocTopple* 1.0 can be accessed by selecting File > Recent Folders > Tutorials Folder from the *RocTopple* main menu.

Topics Covered in this Tutorial

- Project Settings
- Deterministic Analysis
- Input Data
- 3D View
- Viewing Options
- Analysis Results
- Info Viewer
- Water Pressure
- External Force
- Seismic Force
- Sensitivity Analysis

Introduction

RocTopple computes the factor of safety for **block toppling** using geometry generated from the Goodman and Bray method (1976). The slope is defined by:

- The slope face (A)
- The upper slope face (B)
- The overall base inclination (C)
- The toppling joints (D)

Typical problem geometry is illustrated below.

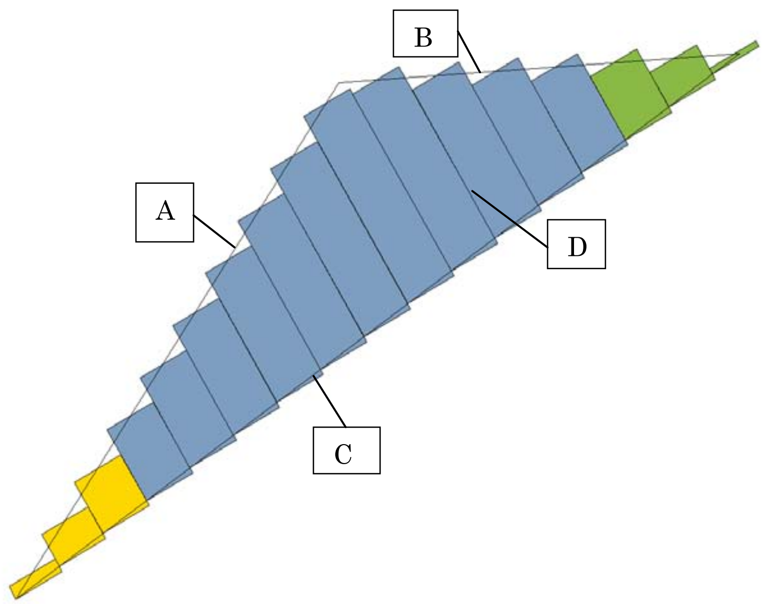


Figure 1: Classic Goodman and Bray geometry for *RocTopple* analysis.

The method assumes uniform spacing of the toppling joints, and that the basal failure plane for the blocks is perpendicular to the dip of the toppling joints.

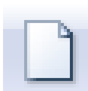
The heights of the blocks are generated such that they follow the slope and upper slope angle. The blocks intersect the slope plane (A) and upper slope plane (B) at the midpoints of the top of the blocks. This method results in the area of the blocks being equal to the area of the triangle formed by the slope (A), the upper slope (B) and the overall base plane (C).

Creating a New File

If you have not already done so, run the *RocTopple* program by double-clicking on the *RocTopple* icon in your installation folder. Or from the Start menu, select Programs → Rocscience → RocTopple 1.0 → RocTopple.

If the *RocTopple* application window is not already maximized, maximize it now, so that the full screen is available for viewing the model.

When the program is started, a default model is automatically created, allowing you to begin defining your model immediately. If you do NOT see a model on your screen:



Select: File → New

Whenever a new file is created, the default input data will form valid slope geometry, as shown in Figure 2.

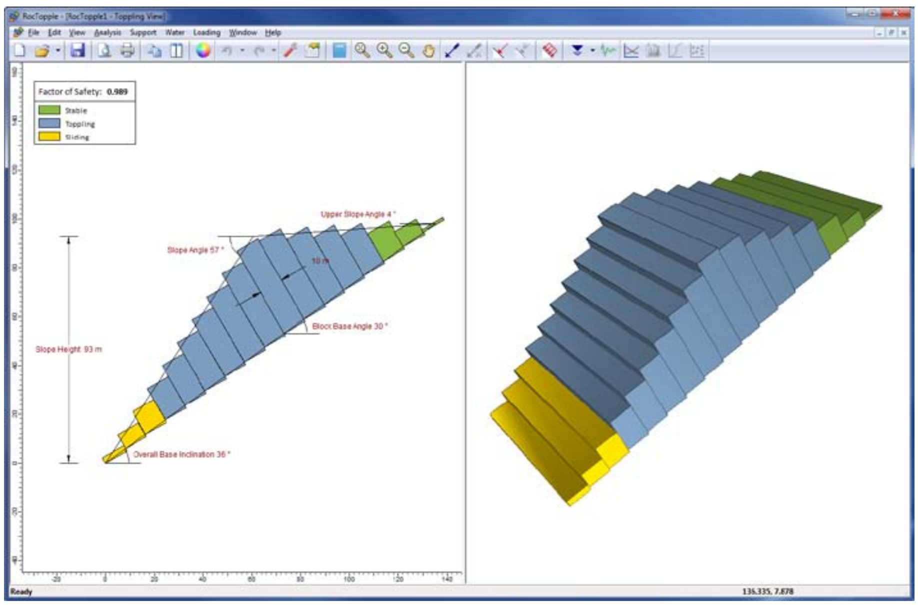
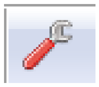


Figure 2: Default model.

Notice the split screen format of the display. The 2-D view shows the slope geometry and the factor of safety, while the 3-D view is interactive. Note that the computation is for 2-D geometry and assumes unit depth.

Project Settings



The **Project Settings** option allows you to configure the main analysis parameters for your model (i.e. Analysis Type, Units etc). Select Project Settings from the toolbar or the **Analysis** menu.

Select: Analysis → Project Settings

You will see the Project Settings dialog.

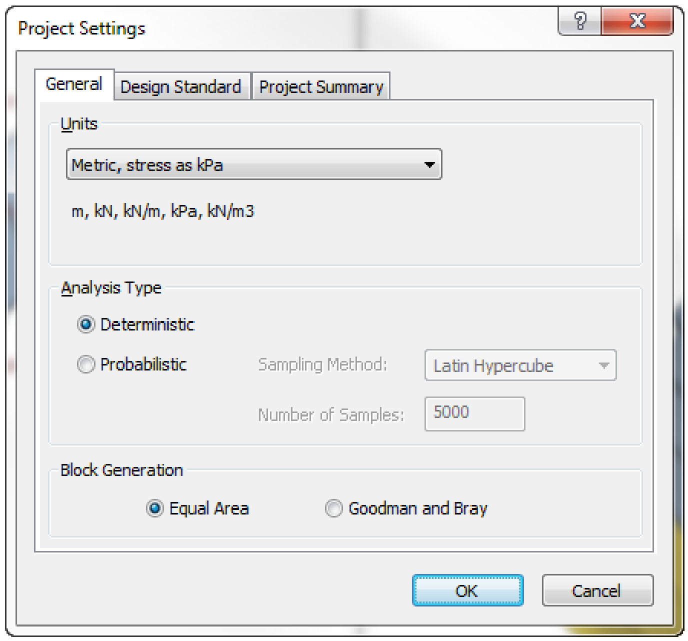


Figure 3: Project Settings dialog.

Analysis Type

There are two main Analysis Types in *RocTopple* – **Deterministic** or **Probabilistic**. By default, a Deterministic Analysis will be selected for a new file.

- A **Deterministic** analysis assumes that all input parameters are "exactly" known. *RocTopple* computes the factor of safety for a single set of input data. Deterministic analysis will be demonstrated in this tutorial.

- For a **Probabilistic** analysis, statistical input data can be entered to account for uncertainty in geometry and joint strength values. Statistics can also be applied to external loads. This results in a safety factor distribution, from which a probability of failure is calculated.

Units

For this tutorial we will be using the **Metric units, stress as kPa**. Select this option from the Units combo box.

NOTE: the most recently selected Units option automatically becomes the default for all new files, so you do not have to re-select the Units each time you start a project.

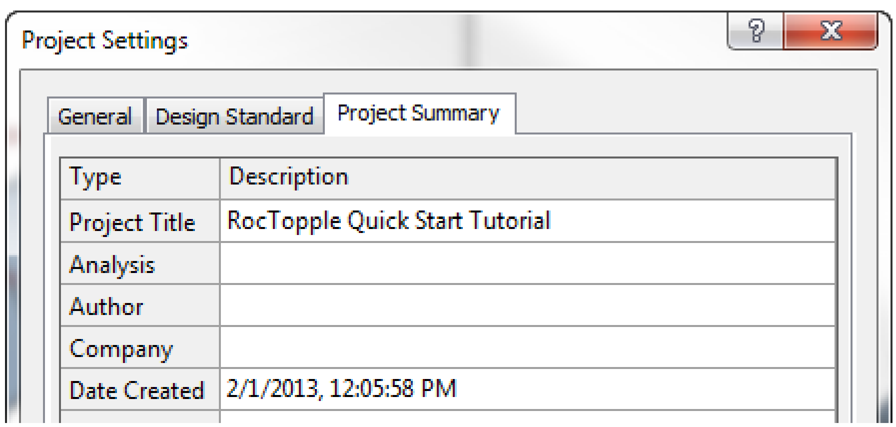
Sampling and Random Numbers

In *RocTopple*, all probabilistic analysis is done using pseudo-random sampling. This means all samples are generated using the same seed, and results can be reproduced.

Project Summary

Select the **Project Summary** tab in the Project Settings dialog.

Enter "RocTopple Quick Start Tutorial" as the Project Title.



NOTE:

- The Project Summary information can be displayed on printouts of analysis results, using the **Page Setup** option in the File menu and defining a Header and/or Footer.
- You can specify the **Author** and **Company** in the dialog so that this information always appears by default in the Project Summary for new files.

Select OK to close the Project Settings dialog. If you have changed the unit system, you will be warned that program specific defaults will be changed when you exit the Project Settings dialog.

Input Data

The **Input Data** option is the main input data dialog for *RocTopple*. It allows users to input slope geometry and rock strength parameters. Let's see what input data is used for the default *RocTopple* model.

Select: Analysis → Input Data

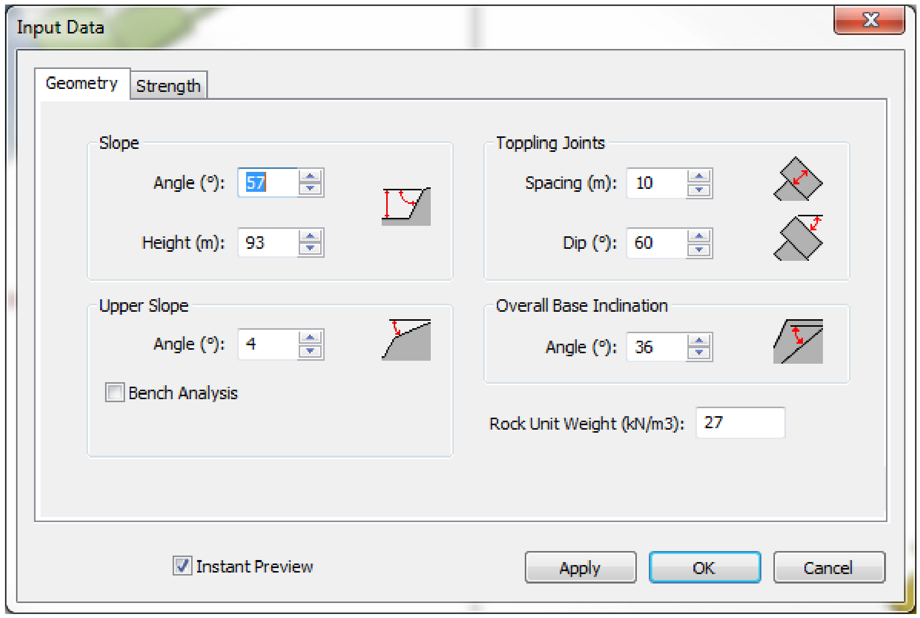


Figure 4: Input Data dialog (Deterministic) – slope geometry properties.

For a Deterministic analysis, the Input Data dialog is organized under two tabs – **Geometry** and **Strength**.

Examine the **Geometry** properties. All values are mandatory for input. Do not change any values just yet, we will be coming back to this shortly.

Select the **Strength** tab in the Input Data dialog. In this tab you define both the strength of the base joints (bottom of the blocks) and the strength of the toppling joints (between the blocks). There are two strength models available for defining the shear strength of joints – Mohr-Coulomb and Barton-Bandis. By default, the Mohr-Coulomb strength model is selected.

TIP: keeping "Instant Preview" checked will allow you to view changes in your model as you are changing the parameters in the input data dialog.

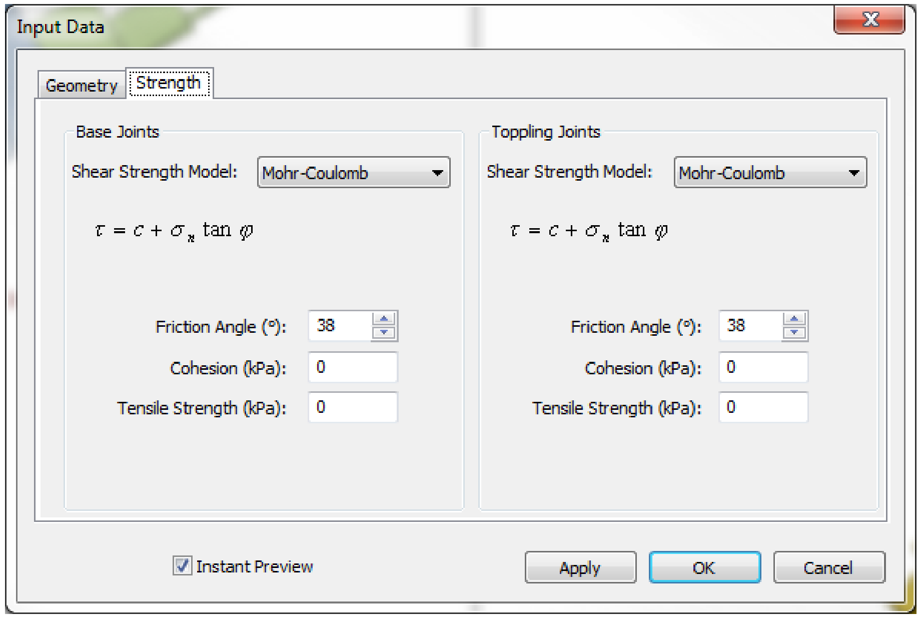


Figure 5: Input Data dialog (Deterministic) – rock properties.

External forces are applied through other dialogs. Users have the option to apply Water Pressure, Seismic Loads, Line Loads, Distributed Loads and Bolts. We will be demonstrating these options later in the tutorial.

NOTE: for detailed information about all *RocTopple* input data options, see the *RocTopple* help system. To access the Help system, you can select the question mark "**?**" icon in a dialog for context sensitive help. Or you can select **Help** > **Help Topics** from the menu.

Select Cancel to close the Input Data dialog.

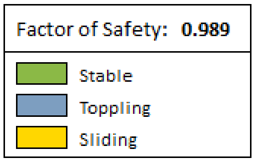
Analysis Results

The *RocTopple* analysis is automatically computed when:

- A file is opened, or
- Input data is entered or modified in a dialog (e.g. Input Data), and Apply or OK is selected in the dialog.

This ensures that the latest analysis results are always displayed.

The primary results from a *RocTopple* Deterministic analysis is displayed in the 2-D View legend.



Info Viewer

A comprehensive listing of input data and analysis results is presented in the *RocTopple* **Info Viewer**. To access the Info Viewer, select the **Info Viewer** option from the toolbar or the Analysis menu.

Select: Analysis → Info Viewer

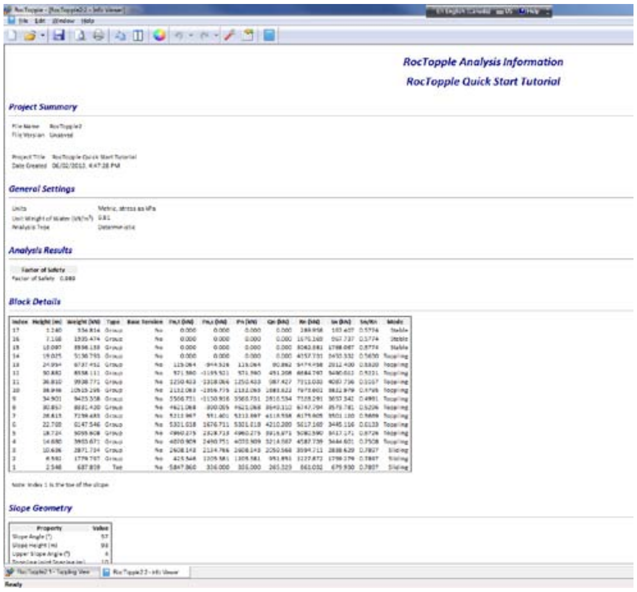


Figure 6: Info Viewer summary of analysis information.

Use the scroll bar or the mouse wheel to scroll down and view all of the data in the Info Viewer.

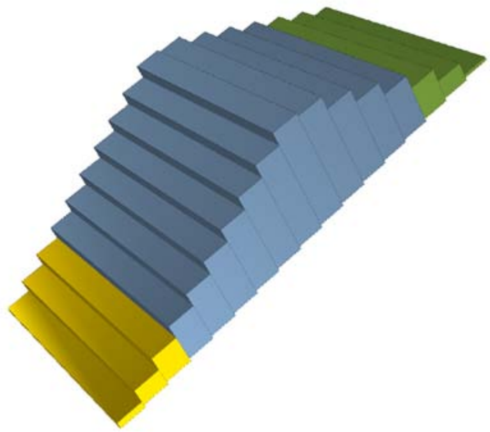
The Info Viewer data can be copied to the clipboard or saved to a file using the options in the right-click popup menu. This is left as an optional exercise.

Close the Info Viewer by selecting the X in the upper right corner of the view.

3-D View

The **3-D View** in *RocTopple* is interactive and shows the critical failure mode of blocks at the point of failure.

By default, the 3-D view is isometric.



Moving Blocks

Double-click on the 3-D view to maximize it.

To see how each block would fail, first hover the mouse over the slope. Notice that the cursor changes to a "two-way arrow" . Left-click and drag the mouse down to see the blocks move.

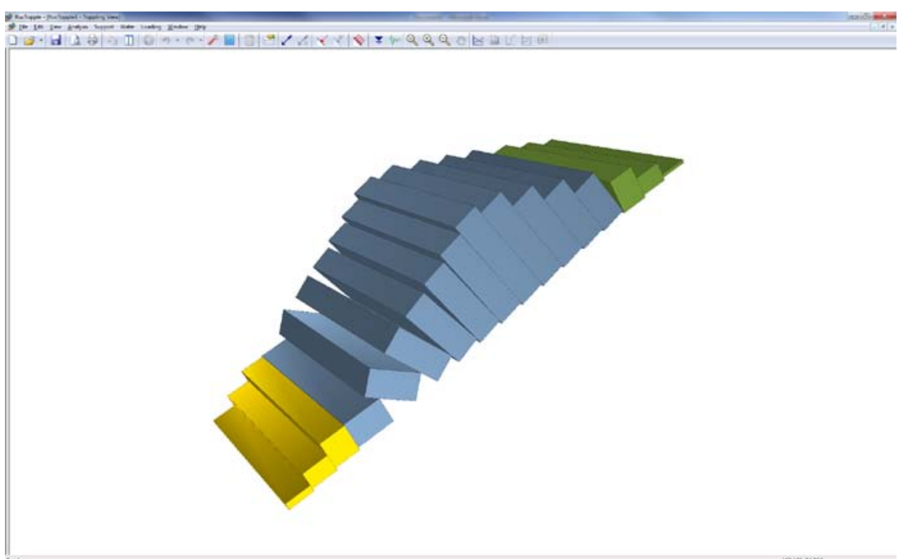


Figure 7: Displacement of blocks with left-click and drag of mouse

To reset the blocks to their original positions, either left-click and then drag the mouse up, or click "Reset Slope" in the right-click menu.

The blocks can also be moved by scrolling the mouse wheel.

View Options

The slope can be viewed from multiple perspectives. To rotate the slope, first left-click on the background (white space), and then drag the mouse. Notice the cursor changes to ↻.

For viewing the 3-D slope in other orientations:

Right click → Display Orientations

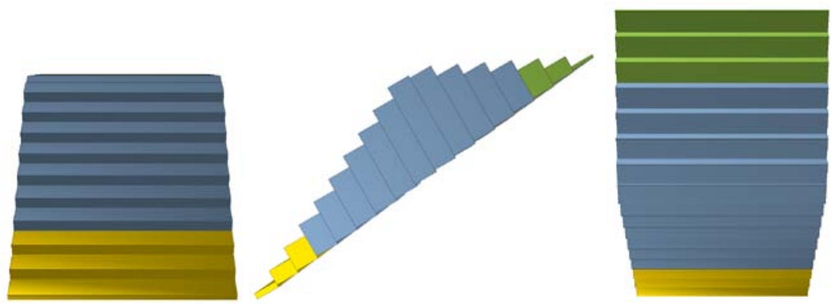


Figure 8: Examples of slope display orientations (front, right, top)

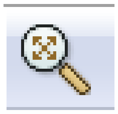
Re-sizing the Views

You can change the relative size of the 2-D or 3-D view. To maximize the size of any pane, *double-click the left mouse button* in the pane (e.g. double-click in the 2-D view to maximize the 2-Dview). Double-clicking again in the maximized view will restore the default display of 2 panes.

- You can also re-size the 2-view display by clicking and dragging on the vertical divider between the panes.

TIP: if you have re-sized the panes and you want to quickly restore the default display, double-click in any pane to maximize the view, and then double-click again to restore the default display.

Zoom and Pan



The following **Zoom** and **Pan** options are available for both the 2-D view and 3-D view:

- **Zoom Extents** – resets the model to its default size and location in the view
- **Zoom In** – zooms in to 90 % of the original area
- **Zoom Out** – zooms out to 111% of the original area
- **Pan** – translates the model left, right, up or down within the view

The zoom and pan options are available in the toolbar, the **View** menu, and through various keyboard and mouse shortcuts. Shortcuts include:

- Rotate the mouse wheel forward or backward to zoom in or out in the 2-D view.
- The function keys **F2**, **F4** and **F5** are shortcuts to Zoom Extents, Zoom Out and Zoom In, respectively.
- A shortcut to **Pan** is to click and hold the mouse wheel and drag to pan the model within the view.

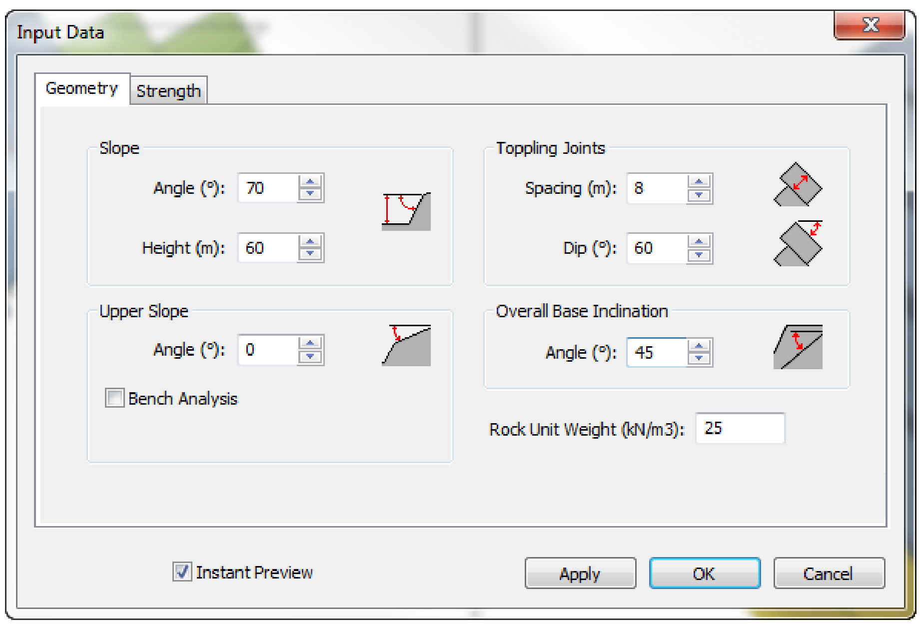
Changing Input Data

Now let's enter data for a different slope.

Select: Analysis → Input Data

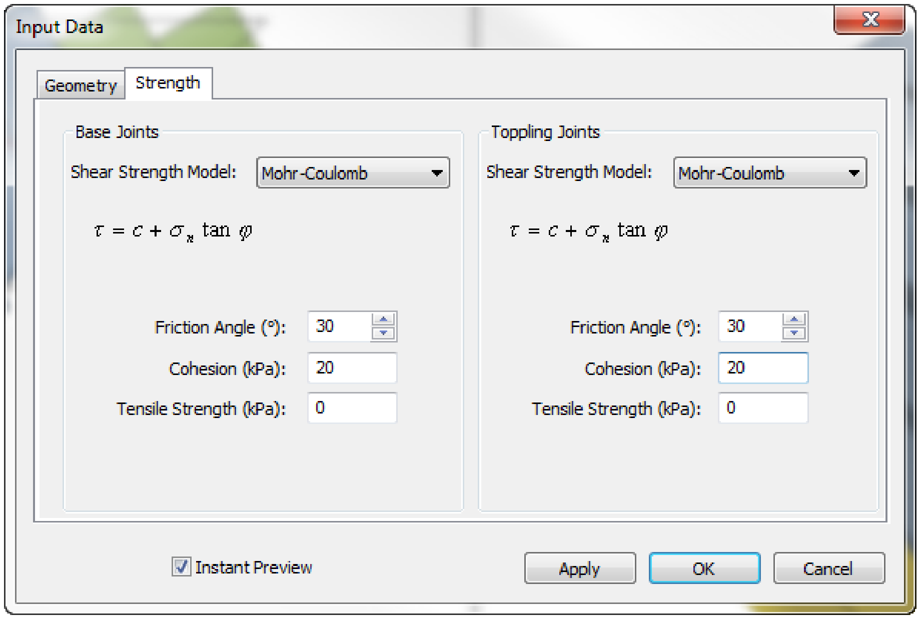
Select the **Geometry** tab in the **Input Data** dialog and enter the following data.

Slope Angle	70
Slope Height	60
Upper Slope Angle	0
Toppling Joint Spacing	8
Toppling Joint Dip	60
Overall Base Inclination	45
Rock Unit Weight	25



Select the **Strength** tab in the **Input Data** dialog and enter the following data for both the Base and Toppling Joints.

Shear Strength Model	**Mohr-Coulomb**
Joint Friction Angle	**30**
Joint Cohesion	**20**



Notice that with "Instant Preview" checked, RocTopple automatically updates the results in the 2-D and 3-D views. The factor of safety now should be 0.8.

Select OK to close the dialog.

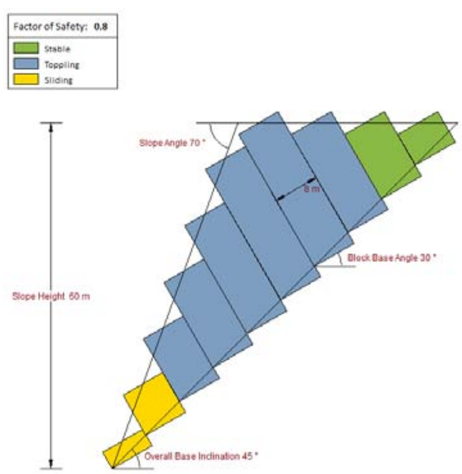


Figure 9: Slope formed from new input data.

Results indicate that at a shear strength reduction factor of 0.8, blocks 1 and 2 are sliding critical, blocks 3 – 8 are toppling critical, and blocks 9 and 10 are stable.

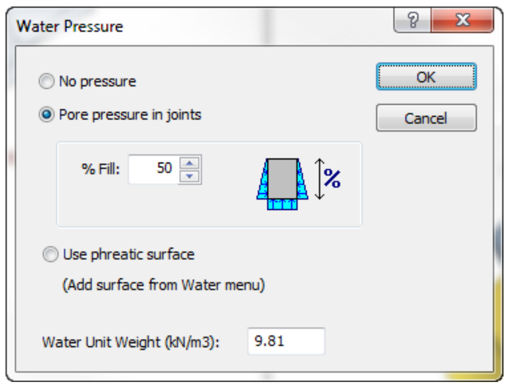
Water Pressure

By default, Water Pressure is NOT applied to a *RocTopple* model, and the analysis is therefore applicable to a DRY slope.

To include Water Pressure in a Deterministic analysis:

Select: Water → Water Pressure Options

In the dialog, select the **Pore pressure in joints** option. This allows you to specify a percent fill in the toppling joints. Enter 50%.



Select OK. The factor of safety is now 0.715.

Notice that blocks now have lighter colored areas to indicate the water level.

The 

symbol at the top right of the 2-D view shows that the joints are 50% filled in length with water. For easy access to the water dialog, you may right-click on this symbol and then *Modify Water Pressure*.

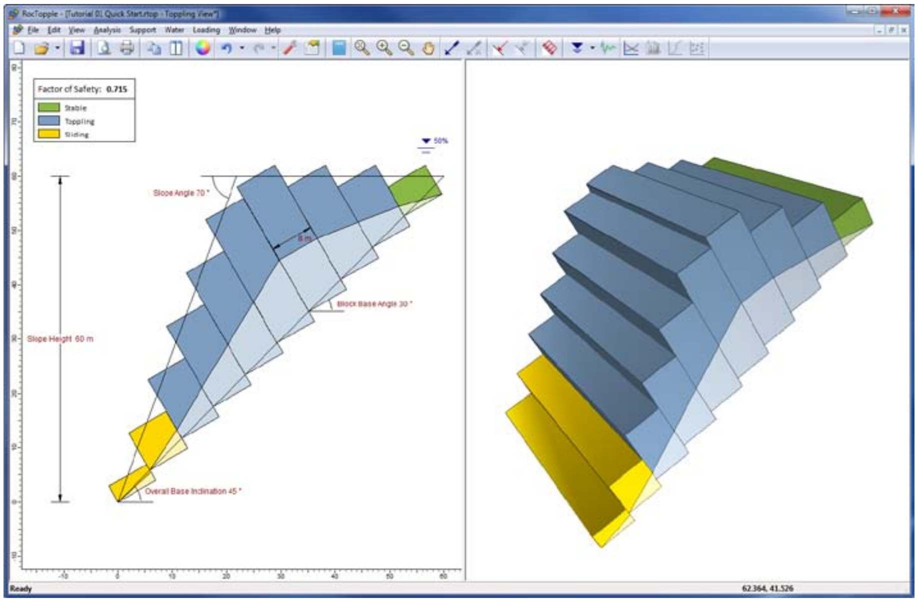
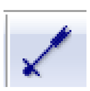


Figure 10: Model with water pressure.

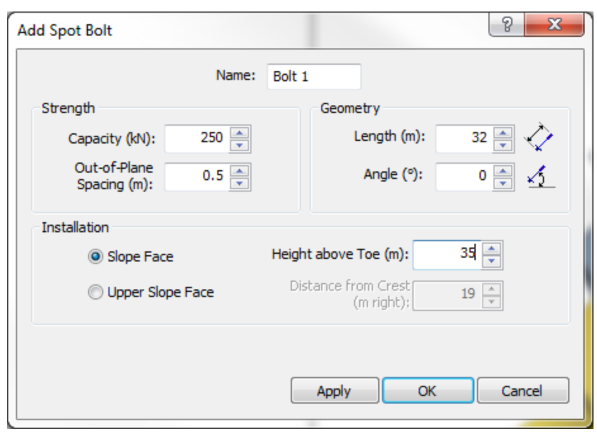
Bolt

Now let's add a single bolt that will add to the resisting force of the toe block.



1. Support→Add Bolt.

2. Enter Capacity = 250, Height above Toe=35, Angle = 0, Length=32 and Spacing = 0.5m.



The factor of safety (with Water Pressure still applied) increases to 0.75. Click Ok to close the water dialog.

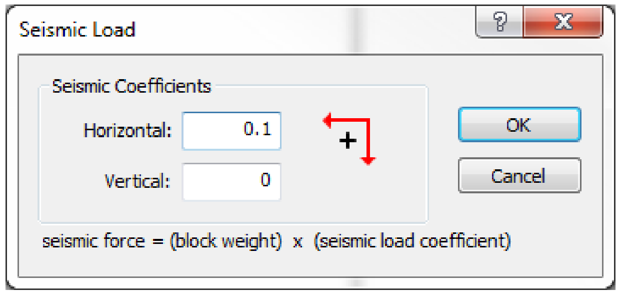
The bolt may be edited, moved or deleted simply by right-clicking on it.

Seismic Force

Now we will include Seismic Force in the analysis.

1. Loading→Seismic Load.

2. Enter a Horizontal Seismic Coefficient of 0.1.



3. Select OK. The factor of safety drops to 0.665.

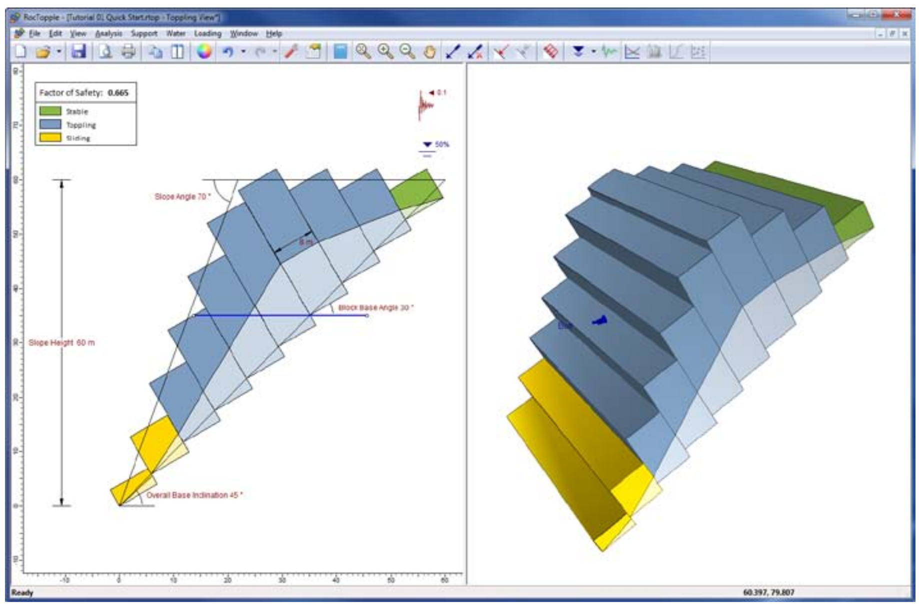
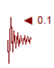


Figure 12: Slope with water pressure, seismic loading and bolt.

The  symbol at the top right of the 2-D view indicates that a horizontal seismic coefficient of 0.1 and to the left is applied on the slope. For easy access to the seismic dialog, you may right-click on the symbol and then *Modify Seismic Load.*

The Seismic Force (F) is applied to each block.

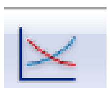
F = 0.1 * g * m, where 0.1 = horizontal seismic coefficient, g = acceleration due to gravity, and m = mass of the block.

Sensitivity Analysis

Before we conclude this tutorial, we will demonstrate the **Sensitivity Analysis** feature of *RocTopple*.

In a Sensitivity Analysis, individual variables can be varied between user defined minimum and maximum values, while all other input parameters remain constant. This allows you to determine the effect of individual variables on the safety factor.

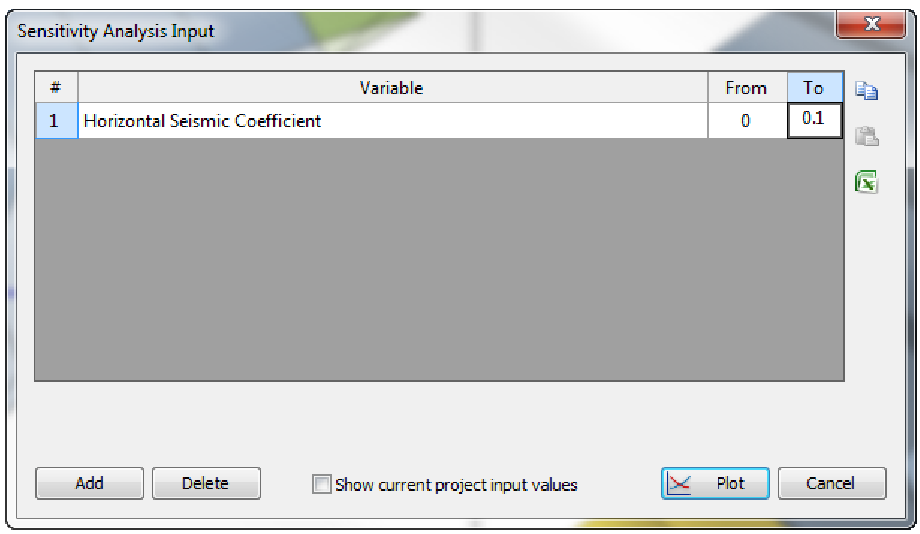
We will use Sensitivity Analysis to prove that increasing the seismic loading in the left horizontal direction will decrease the factor of safety. Leave the water pressure and bolt attributes as they are.



1. Select the **Sensitivity Analysis** option from the toolbar or the **Analysis** menu.

2. In the Sensitivity Analysis dialog, click "Add" to add a sensitivity variable.

3. Under the "Variable" column, select *Horizontal Seismic Coefficient*. Change the To value of the Range to plot a sensitivity graph from 0 to 0.1. Select Plot.



4. You should see the following sensitivity plot.

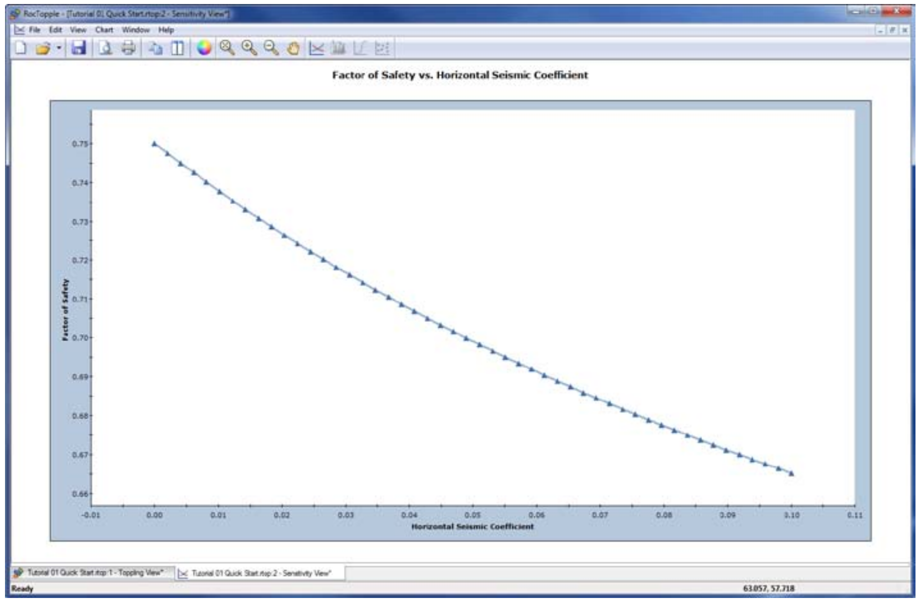


Figure 13: Sensitivity plot of seismic force versus safety factor.

You can clearly see from the graph that the factor of safety decreases with increase in the horizontal seismic coefficient.

By default, *RocTopple* calculates the factor of safety for 50 samples in the sensitivity analysis.

We conclude this quick start tutorial.