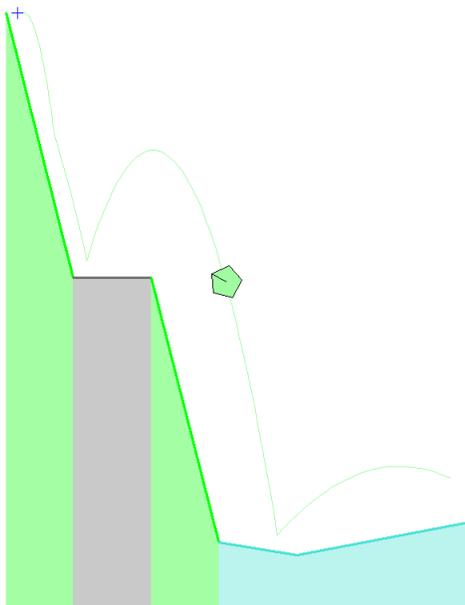# RocFall
version 6.0
Beta
is here!

Click here to become a RocFall v6 Beta Tester!

This article describes the new and improved features to be found in *RocFall* version 6.0, which is being released for beta testing in September 2016. New features include:

- **Polygonal rock shapes, custom polygons**
- **Barrier sensitivity analysis**
- **Forest damping for treed slopes**
- **Variable friction according to sliding distance**
- **Many other improvements (e.g. property tables)**

Polygonal Rock Shapes

In the previous version of *RocFall* (5.0) we introduced rigid body rock shapes, which were modeled by smooth rounded shapes (e.g. ovals, ellipses, etc). In *RocFall* 6.0 you can now also define polygonal rock shapes with sharp corners.
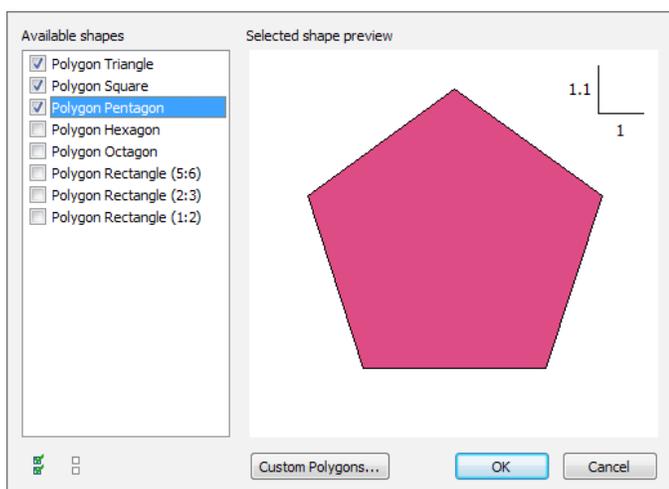
In the **Rock Type Library** dialog, smooth or polygonal shapes are selected in separate dialogs, but you may combine both smooth and/or polygonal rock shapes within the same analysis.

Rock fall path of 5-sided polygon
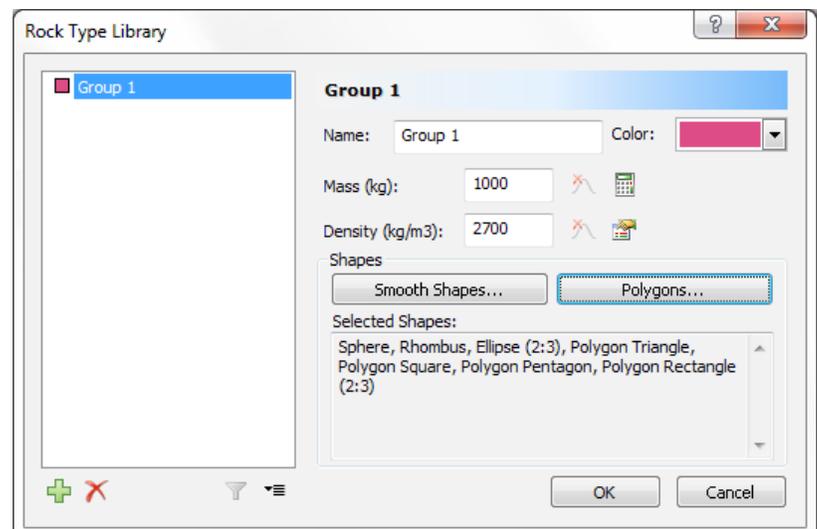
Rock Type Library dialog
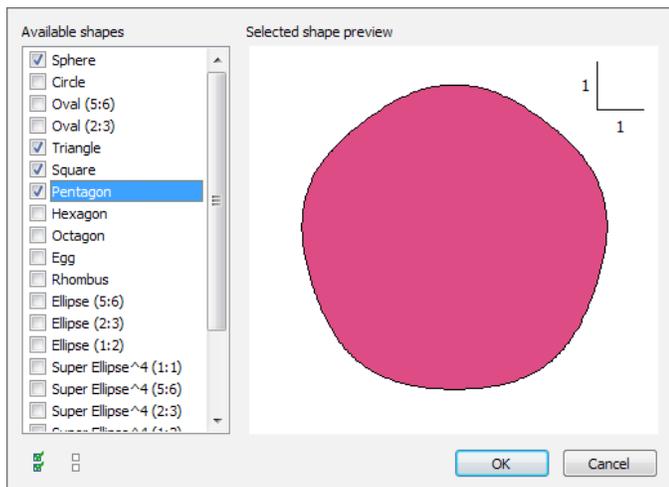
Dialog for choosing smooth rock shapes

Dialog for choosing polygonal rock shapes

In the polygonal rock shapes dialog you can choose from pre-defined regular polygons, ranging from triangles to octagons. You can also define custom polygons with any number of vertices in the **Custom Polygons** dialog. Rocks modeled as polygons can improve the rockfall simulation results, compared to smooth shapes, by more accurately modeling the impact and rolling behaviour of angular shaped rocks.
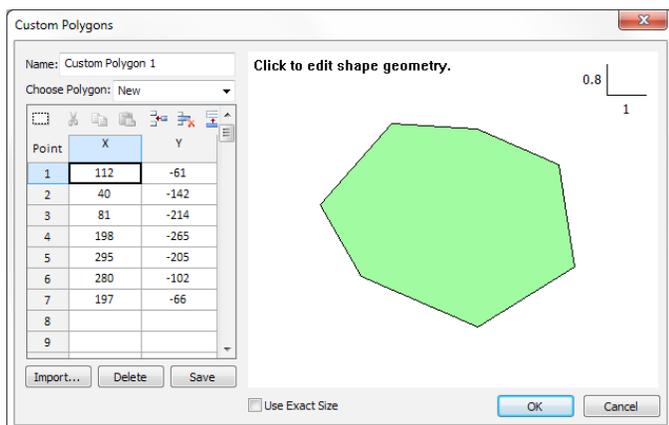

Dialog for defining custom polygon shapes

Rock shapes can be drawn graphically, entered in a coordinate table, or imported from a DXF or text file. Import from DXF file allows actual rock shapes obtained from laser scanning to be imported as a 2D profile. Custom rock shapes can be automatically scaled or defined as an exact size and mass by selecting the **Use Exact Size** checkbox.

Barrier Sensitivity Analysis

Barrier Sensitivity allows you to automatically vary the location, height, angle or capacity of rockfall barriers. Results are plotted as sensitivity plots, allowing you to determine the optimum location, height, angle or capacity of rockfall barriers without the need to edit and re-compute multiple files. Output variables include rock energy, number of rocks impacting or passing a barrier, impact height and velocity.
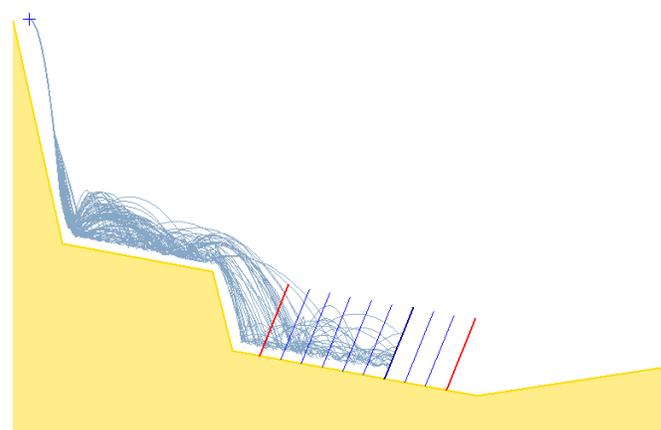

Sensitivity analysis of barrier location

To carry out a barrier sensitivity analysis, first define a barrier on the slope. Then select the **Barrier Sensitivity** option and define your input variable(s) and ranges.
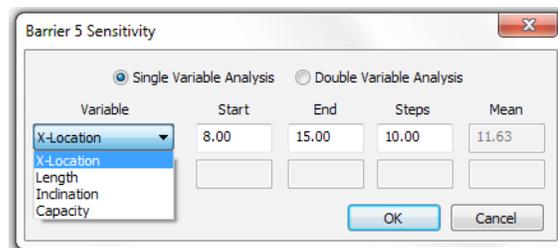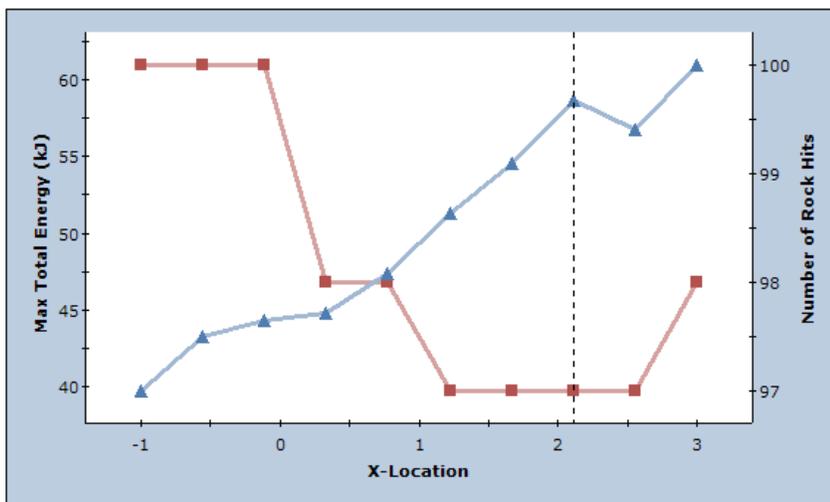

In this dialog, you can select **Single Variable** or **Double Variable** analysis. **Single Variable** analysis allows you to choose one input variable, and plot one or more output variables on a 2-dimensional plot as shown below.
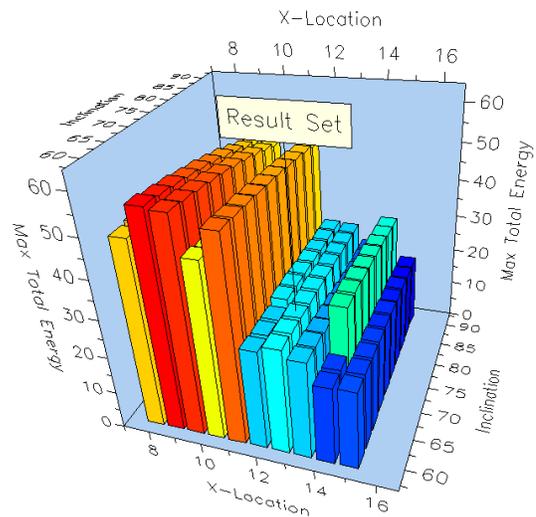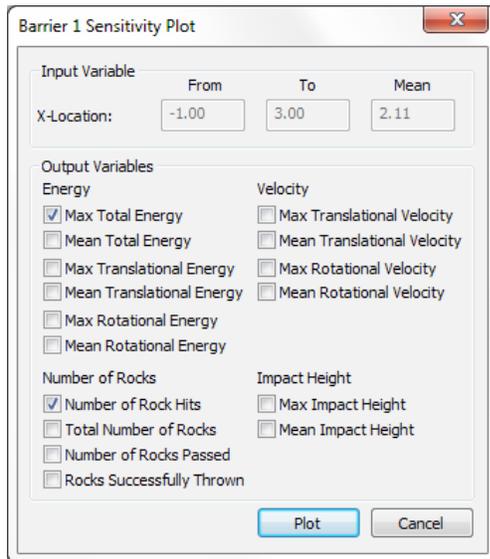
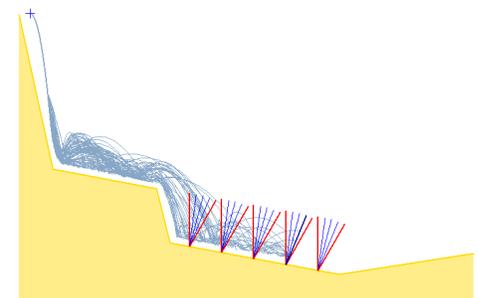*Results of two input variables and one output variable*

Max Total Energy (kJ) and Number of Rock Hits vs. X-Location

Barrier 1
Mean Properties: X-Location = 1.64, Length = 1.86, Inclination = 48.92, Capacity = infinite

Results of one input variable and two output variables

Double Variable analysis allows you to choose **two** input variables (e.g. location and height), and plot one output variable on a 3-dimensional plot as shown above.

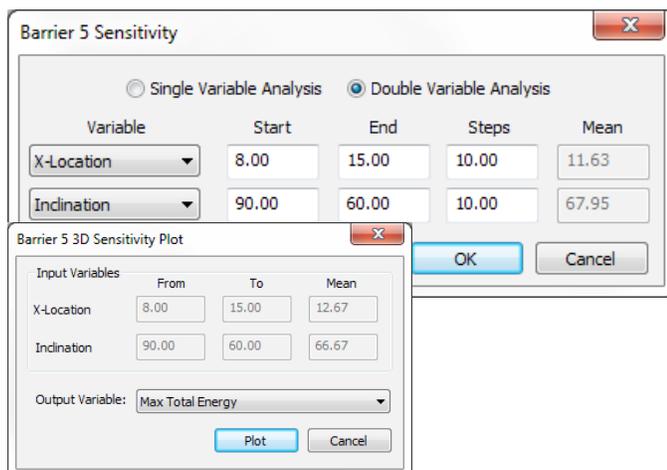*Input and output dialogs for double variable analysis*

Double Variable sensitivity analysis of barrier location and angle (constant length)

A barrier sensitivity analysis consists of a number of sequential runs, corresponding to your input variable range(s) and number of intervals. After you compute a barrier sensitivity analysis, you can access the results for any particular analysis run (i.e. any value of input variable), in one of two ways:

- Double-click the mouse on a sensitivity plot to display results corresponding to the value of the input variable(s) at that point. This works for both 2D and 3D plots.

- Double-click the mouse on an actual barrier on the slope (i.e. one of the barrier locations generated by the analysis).

When you do this, the rock paths which are displayed will correspond to the particular value of input variable (e.g. location and inclination). All other plotting features of *RocFall* (e.g. plotting rock endpoints or envelope graphs) will then plot the results for that particular value of input variable or combination of input variables.

In the following figure, the third barrier in the first group has been selected, as you can see from the rock paths and the rock endpoint location plot.


Analysis results correspond to the currently selected barrier

The barrier sensitivity analysis is a powerful new analysis option in *RocFall* which allows you to quickly see the effect of changing barrier parameters. Editing and plotting options are simple to use and allow you to test different barrier configurations based on various output criteria (e.g. mean or max rock energy, number of rocks past barrier, impact height etc).
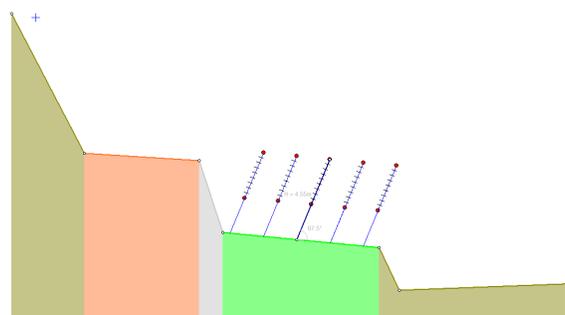
*Barrier length and location sensitivity (constant inclination)*
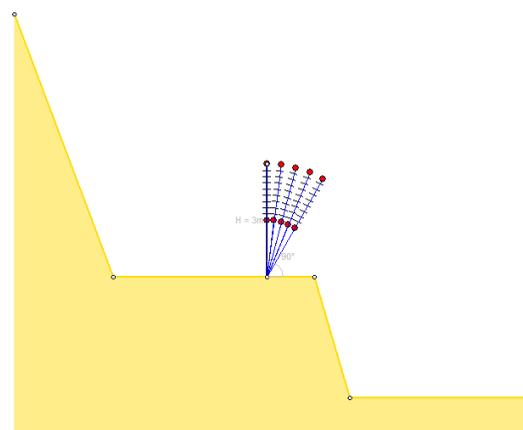
*Barrier length and inclination sensitivity (constant location)*

Forest Damping

An often requested feature is now available in *RocFall* 6.0 – forest (tree) damping. When rockfalls occur on a forested slope, impacts of rocks with trees or vegetation can reduce the speed and energy of rocks traveling down the slope.

Forest Damping is implemented as a slope material property (drag coefficient) as shown below. The Effective Height option allows you to specify the tree height over which the damping will take place. Any rock paths travelling through the shaded area will have damping applied. You can define and assign different coefficients to different segments of the slope, as required.
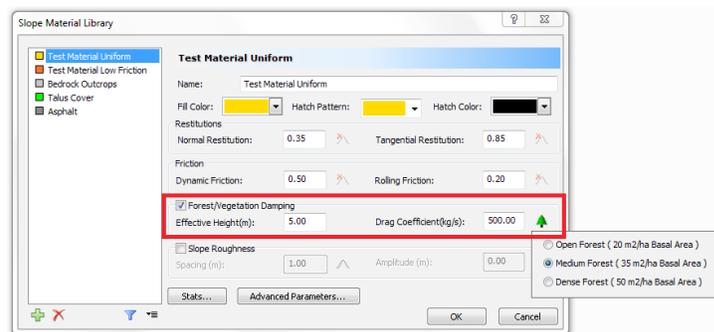
Slope material properties include tree damping coefficient
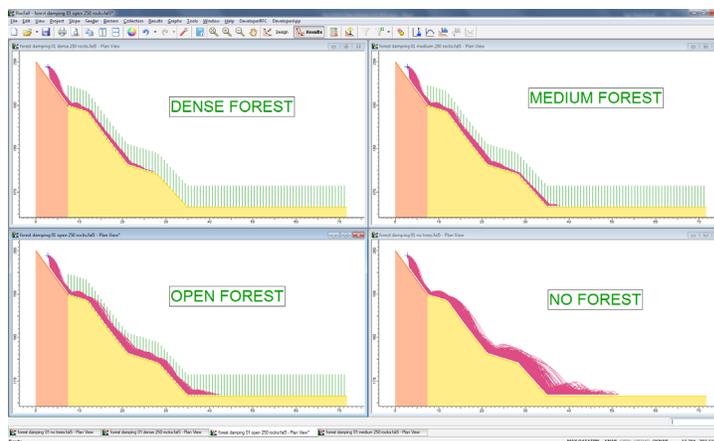

Comparison of slope with 3 different forest densities and with no forest

Advanced Friction Parameters

New friction options allow you to model the phenomenon of increase in friction with sliding distance, which may occur when a rock slides on soft ground and builds up

material in front of the rock as it slides. This creates a "scar" in the ground and effectively increases friction with distance, which may result in the rock coming to a stop, or flipping the rock back into the air.

This is an advanced modeling feature, and is implemented within the **Slope Material Library > Advanced Friction** dialog.
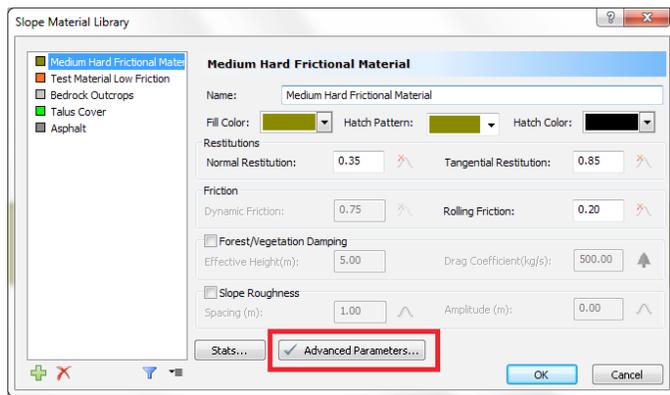

Advanced Friction parameters option

It is enabled by selecting the **Scarring Parameters** checkbox in the Advanced Friction dialog. You can choose from pre-set material types or enter custom parameters.
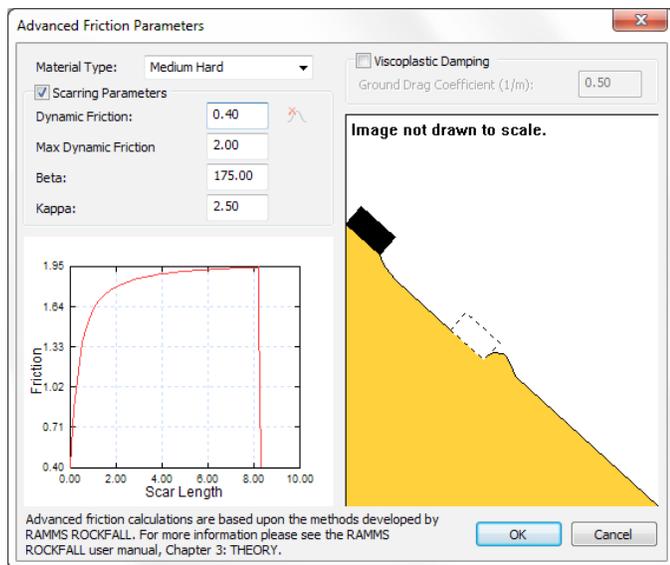
Advanced friction dialog

An additional option allows you to define a ground drag coefficient by selecting the **Viscoplastic Damping** checkbox in the Advanced Friction dialog.
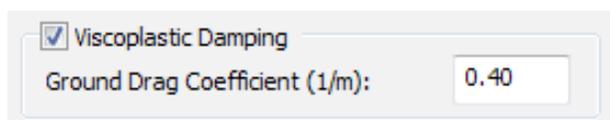

To illustrate the effect of these options, the simple model below shows a block on a horizontal plane which is given an initial horizontal velocity. The four cases shown below are:
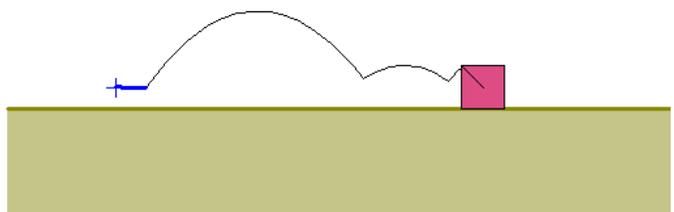
(i)   No scarring or viscous damping

(ii)   Scarring enabled

(iii)   Viscous damping enabled

(iv)   Scarring and viscous damping

This is an idealized model for purposes of illustration. NOTE: when scarring is enabled (cases (ii) and (iv)), the increased friction with sliding distance, in this case, causes the block to flip into the air after sliding a short distance, rotating about a vertex. When viscous damping is enabled (cases (iii) and (iv)), the block travels a shorter total distance compared to the corresponding undamped cases.
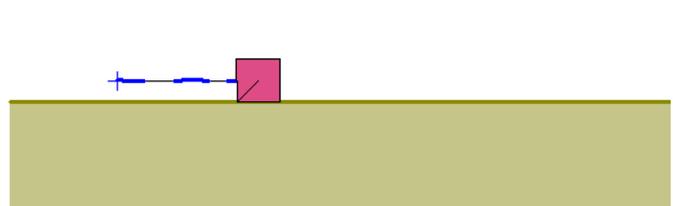
Scarring causes friction to increase with sliding distance, though it does not always cause blocks to become airborne; this only happens under certain conditions, such as the example below.
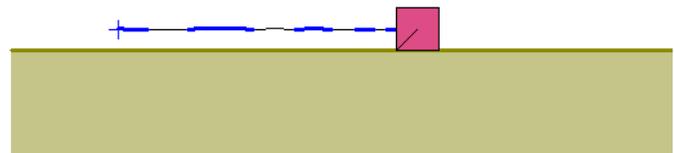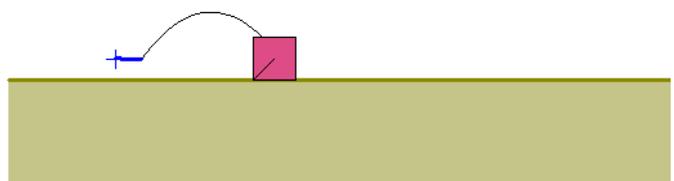

(i) Basic friction - scarring and damping turned off
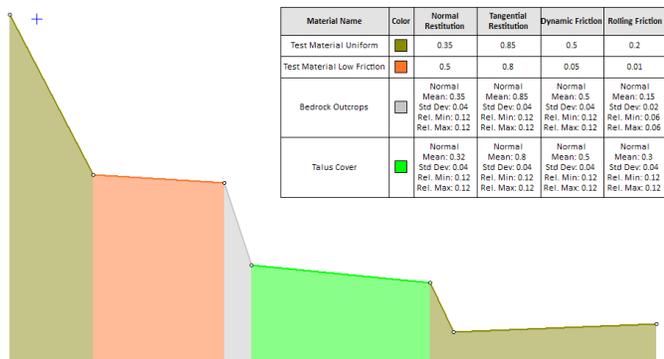

(ii) Scarring enabled

(iii) Viscous damping enabled

(iv) Scarring and viscous damping

Property Tables

You can now add **property tables** to the model view, as shown below. Options include slope material properties table, rock table, seeder table and barrier table. These are accessed through the **Tools** menu.
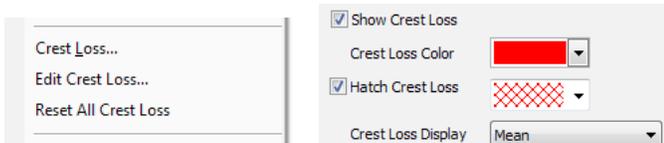

Material properties table added to model view

Rock, seeder and barrier property tables

Crest Loss

The **Crest Loss** option (introduced in *RocFall* version 5.0) has been improved in version 6.0, making it easier to edit and display the crest loss input in the slope model view.
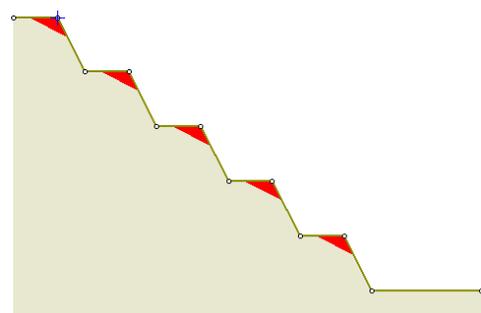
Crest loss (maximum) highlighted on slope in model view
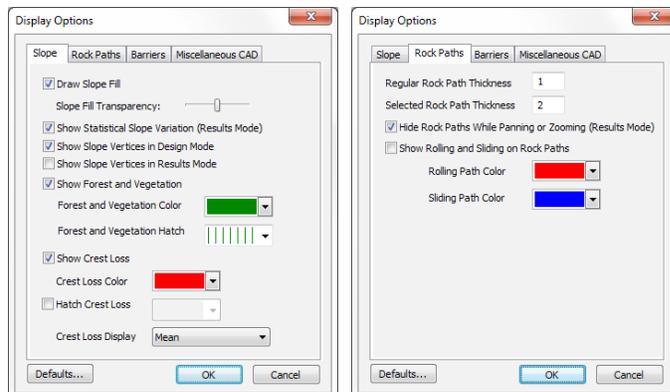

New crest loss editing and display options

Display Options

The **Display Options** dialog has been expanded to include more user-defined display options grouped into four tabs.
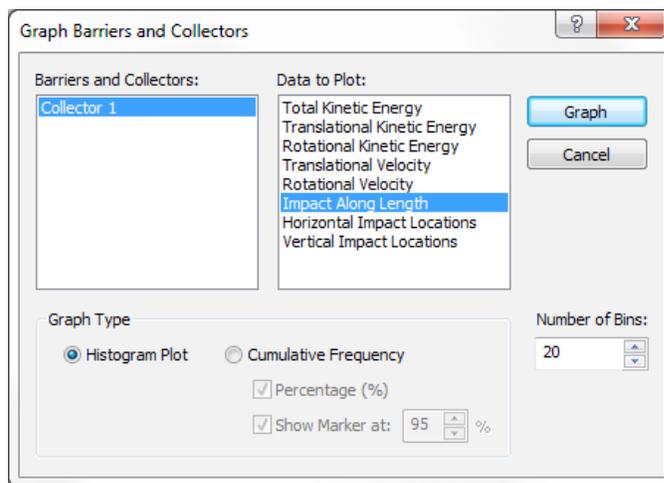
New options include the ability to highlight sliding and rolling modes on the rock path trajectories.

Display Options dialog - slope and rock path tabs

Other Improvements

When using Data Collectors, impact locations can now be plotted using relative coordinates using the **Impact Along Length** option.

Improvements have also been made to the main input dialogs, including:

- Slope Material Library
- Rock Type Library
- Barrier Properties

RocFall 6.0 Summary

Many useful new features and improvements have been made in *RocFall* 6.0. **Click here to become a Beta Tester!**