rocscience

Water Pressure Grid Tutorial

1. Introduction

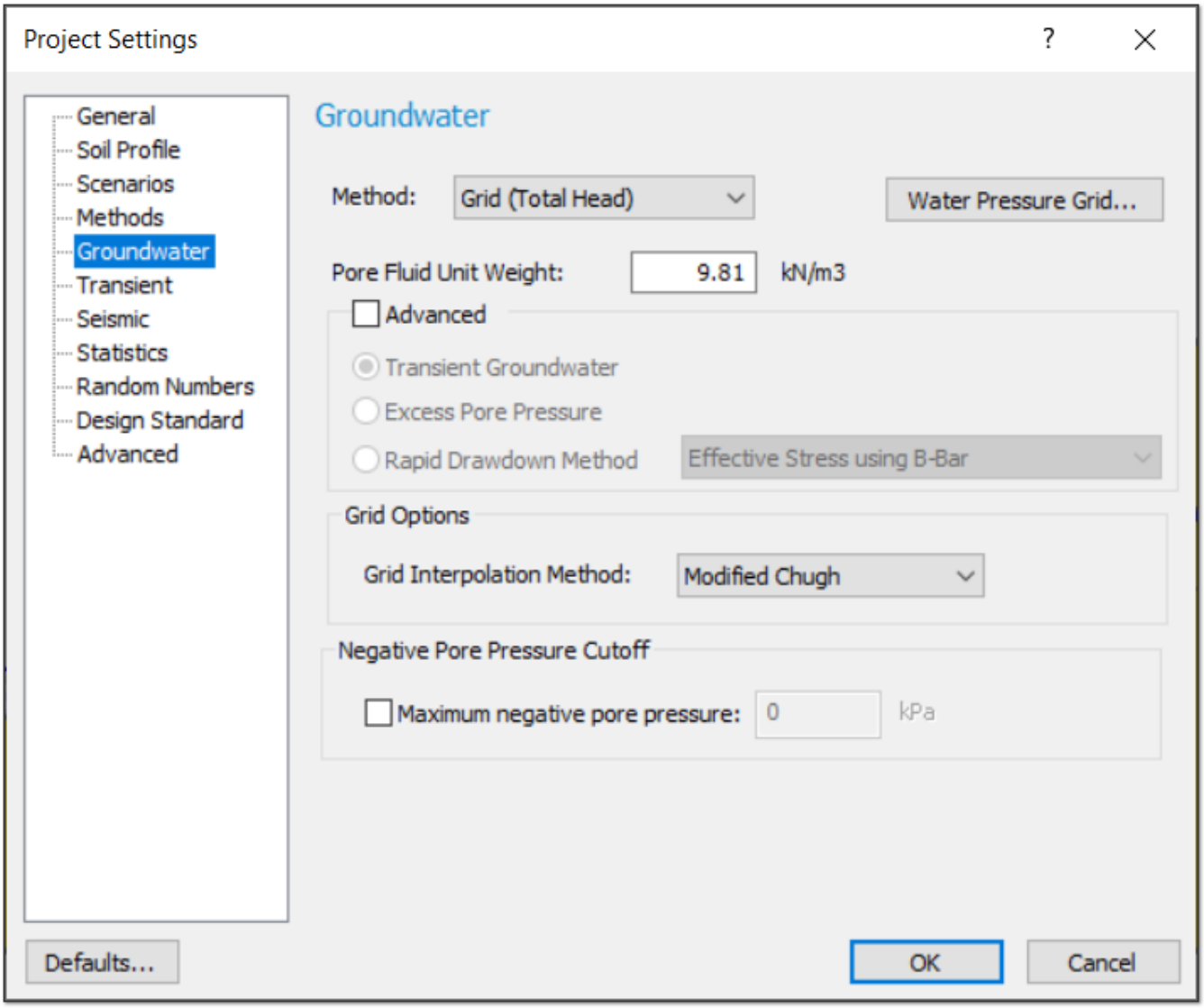
This tutorial will demonstrate how to use a water pressure grid to model pore water pressure in Slide2. The finished product of this tutorial can be found in the Tutorial 05 Water Pressure Grid.slim data file. All tutorial files installed with Slide2 can be accessed by selecting **File > Recent Folders > Tutorials Folder** from the Slide2 main menu.

This model is also presented in the Groundwater Tutorial (Tutorial 07 Groundwater Seepage.slim). A seepage analysis is carried out, and results are compared with the Water Pressure Grid tutorial.

2. Model Setup

In order to use a water pressure grid for pore pressure calculations, we must first set the Groundwater Method to one of the three available pore pressure grid options (Total Head, Pressure Head or Pore Pressure) in the Project Settings dialog. In this case, we will be using a grid of Total Head values (discrete).

 **Select:** Analysis > Project Settings



Select the Groundwater page, and set the Groundwater Method = Grid (Total Head).

Note

Slide2 can use one of several different methods for interpolating pressures at any point in the soil, from the grid values. We are using the default method (Modified Chugh). See the Slide2 Help system for a description of the interpolation methods available.

3. Boundaries

ADDING AN EXTERNAL BOUNDARY

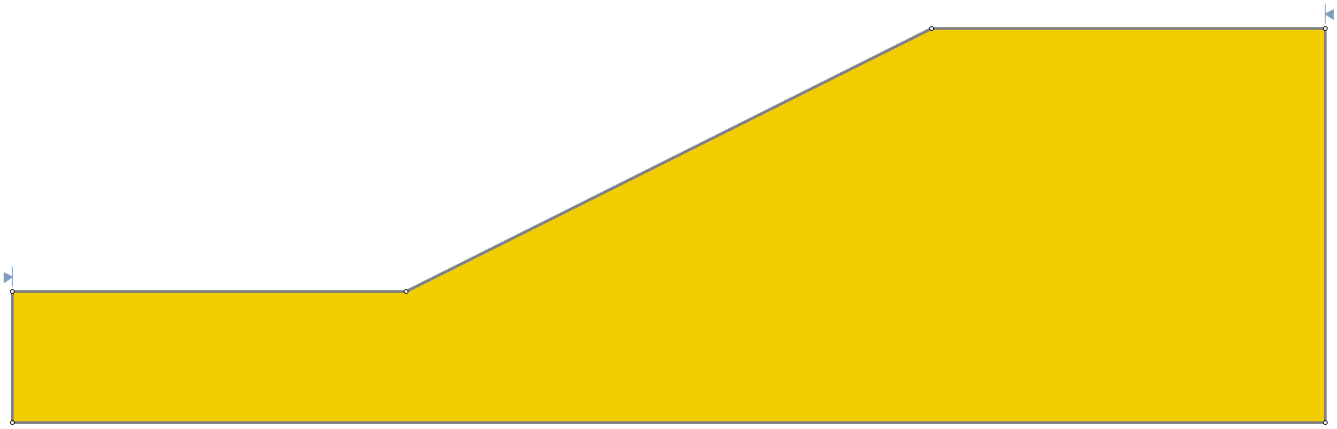
To add the External Boundary, select Add External Boundary from the toolbar or the Boundaries menu.

Select: Boundaries > Add External Boundary

Enter the following coordinates in the prompt line

(15, 20); (15, 25); (30, 25); (50, 35); (65, 35); (65, 20)

When you are done entering the coordinates enter "c" to close the boundary. The model should look like this:



ADDING A WATER PRESSURE GRID

Now let's add the water pressure grid to the model. To add a water pressure grid, select the Water Pressure Grid option from the Boundaries menu (or you can select Project Settings > Groundwater > Water Pressure Grid).

Select **Boundaries > Water Pressure Grid**

The points defining a water pressure grid can be entered in this dialog, by entering X and Y coordinates, and a value (in this case, Total Head), defining the pressure at each grid point.

Rather than entering the data manually, a water pressure grid file has been provided, which you can simply read in using the Import option in the Water Pressure Grid dialog.

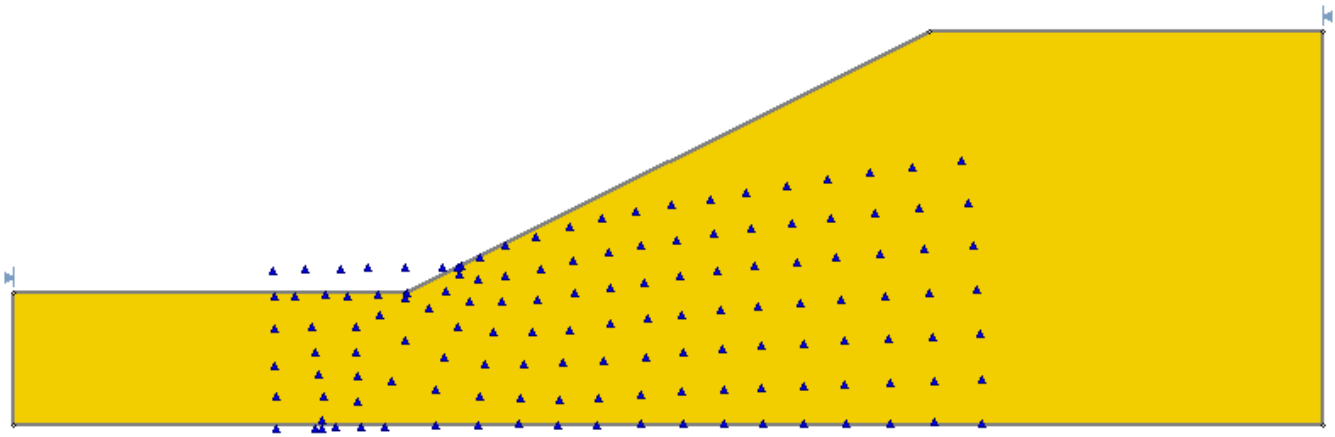
1. Select the drop-arrow at the right of the Import button. You will see a shortcut to the Tutorials folder appear.

2. Click on the Tutorials folder shortcut and you will see an Open file dialog. Water pressure grids can be imported from various file formats including .pwp files (these are simple text files where each line of the file contains X, Y and VALUE for one grid point) or .dxf format files (useful if a flownet has been digitized using AutoCAD, for example).

3. We will read in a *.pwp file. Open the file called Tutorial 05 Water Pressure Grid.pwp. The grid data appears in the Water Pressure Grid dialog.

4. Now select OK in the Water Pressure Grid dialog and the grid will be added to the model. Each blue triangular symbol represents one grid point.

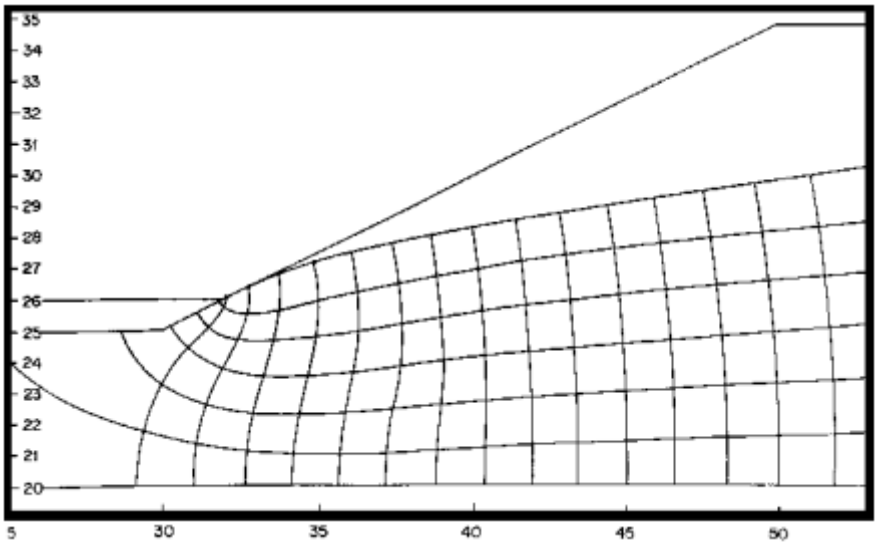
Your model should appear as follows:



Water pressure grid data such as this could come from a flow net, field measurements, or a numerical analysis such as the groundwater seepage analysis which is available in the Slide2 or RS2 programs.

In this case, the values at each grid point are Total Head values, which were originally obtained by digitizing the flownet shown below, using a digitizing tablet and AutoCAD. (The grid was originally saved as a *.dxf file, and then converted to a *.pwp file).

Remember that Slide2 also has the capability of using pressure head or pore pressure grids, as selected in the Project Settings dialog.



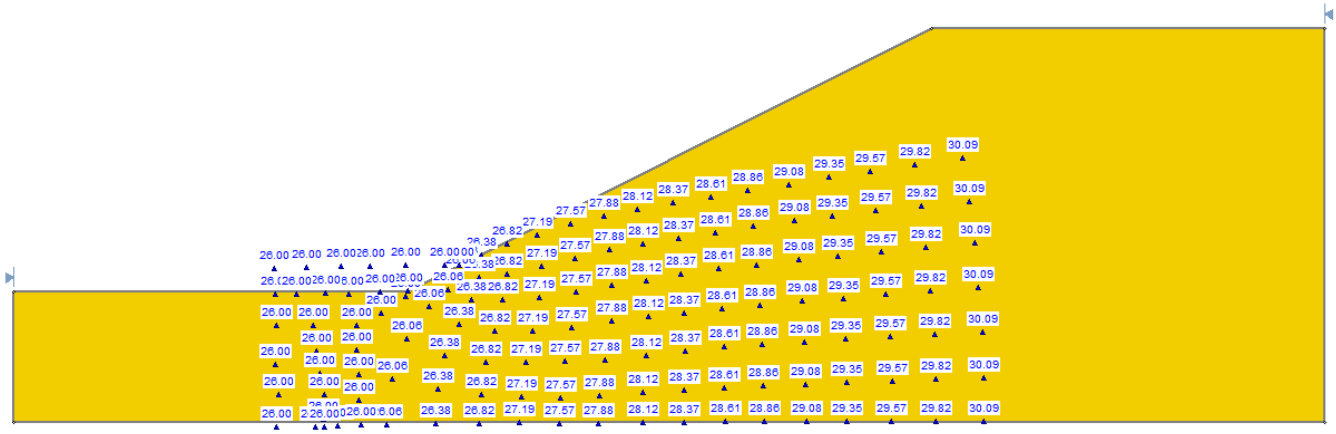
Flownet used to obtain total head measurements

The actual values at each grid point can be displayed on the model with the Display Options dialog or the sidebar. Let's take a quick look. Turn on the Pressure Grid Values checkbox in the Display Options in the sidebar:

The water pressure grid values will be displayed on the model.

If the values overlap, use one of the Zoom options (e.g. Zoom Window, Zoom Mouse or rotate the mouse wheel forward), to zoom in to approximately the center of the grid, so that the values are readable. The total head values were obtained at the intersections of each flowline and equipotential line of the flownet in the previous figure.

Now select Zoom All or press F2 to bring the whole model back into view.



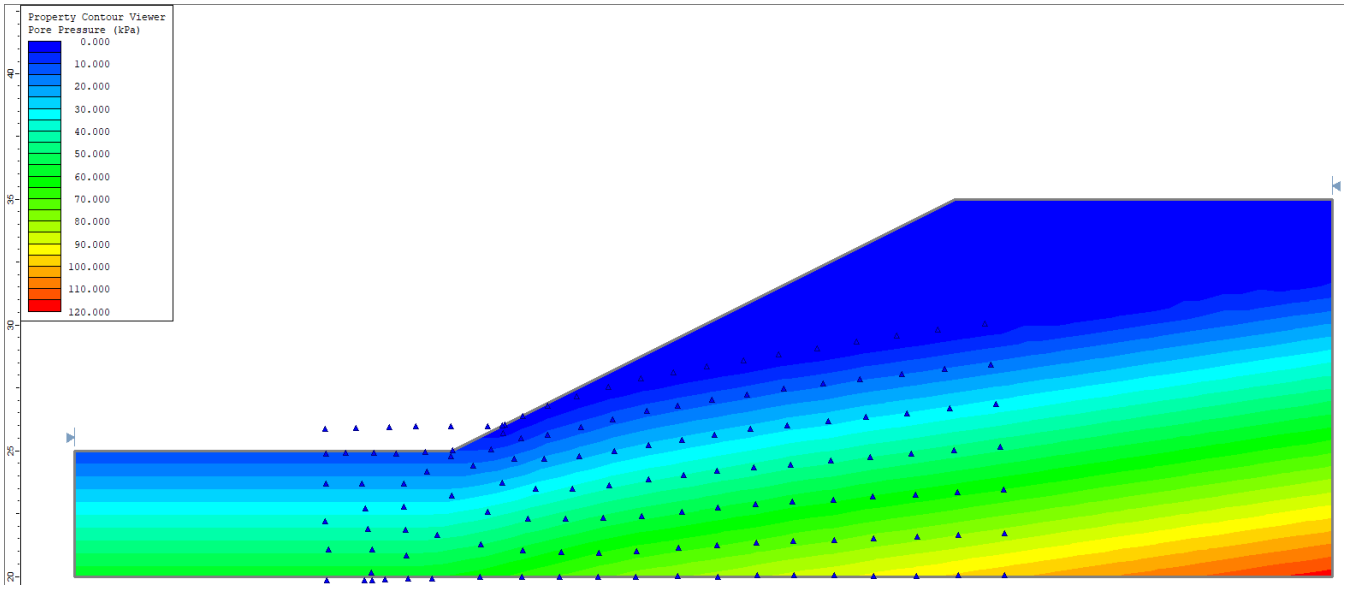
Water pressure grid values displayed on model

Now hide the grid values again. Clear the Pressure Grid Values checkbox in the sidebar.

The pore pressure can be previewed from the Property Viewer.

Select **Analysis > Property Viewer**

Ensure “Show Variable and Constant” is selected in the Property Viewer Options on the left side, and that the “Pore Pressure” property is selected. The pore pressure should look as follows:



The Property Viewer can also be used to view other spatially variable properties while running a spatial variability analysis. See Slide2 Help for more information.

Select the Close Property Viewer button to return to the model.

DEFINING PONDED WATER

You will notice that some of the water pressure grid points at the left of the model are above the ground surface. That is because this model will include ponded water at the foot of the slope, which we have not yet defined.

Ponded water in Slide2 can be created as follows:

If a Water Table is drawn above the External Boundary, Slide2 will automatically create a region of ponded water below the Water Table and above the External Boundary. This is the simplest method of defining ponded water.

A Water Pressure Grid CANNOT define ponded water. A Water Pressure Grid is only used to obtain values of pore pressure within the soil. The Grid does not simulate the weight and hydrostatic forces which act on the slope due to the ponded water.

ADD WATER TABLE

As demonstrated in previous tutorials, a Water Table can be used in Slide2 to define pore pressure conditions for a slope model. In this tutorial, the Water Table will NOT be used for pore pressure calculations, since the water pressure grid will be used for this purpose.

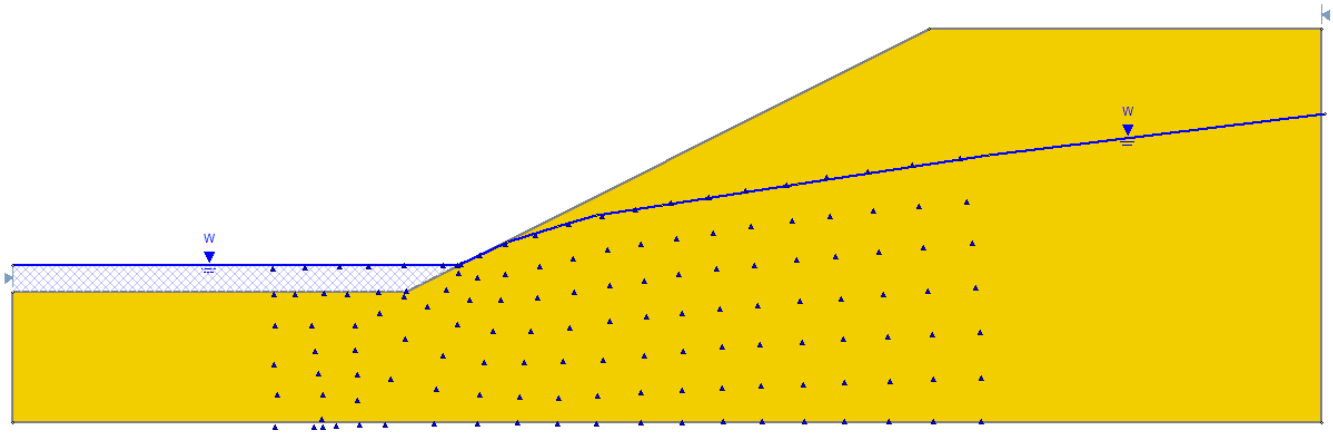
Regardless of the method of pore pressure definition (with the exception of the Finite Element Analysis method), a Water Table can always be used to define ponded water above a slope. Let's add a Water Table to see how this works.

Select **Boundary > Add Water Table**

Enter the following coordinates in the prompt line:

(15, 26); (32, 26); (33.9, 26.9); (35.8, 27.5); (37.3, 27.9); (39.8, 28.3); (45, 29.1); (52.3, 30.2); (65.1, 31.8)

Note that pressing Enter with nothing in the prompt line, after the last vertex has been entered, adds the Water Table to the model, and exits the Add Water Table option. Your model should now appear as follows:



Water table added to define ponded water

As you can see at the left of the model, the region above the ground surface and below the water table is filled with a hatched pattern. This region is automatically determined by Slide2 when the water table is drawn above the slope and indicates the existence of ponded water.

As we have already emphasized, pore pressures for this model will be calculated using the water pressure grid and NOT the Water Table, since we have configured the method of pore pressure calculation in the Project Settings dialog. However, we will point out one extra feature of using a Water Table in conjunction with a pore pressure grid:

All points ABOVE the Water Table will automatically be assigned a ZERO pore pressure, even if the water pressure grid interpolation procedure, determines a non-zero pore pressure for a point above the water table. This may be useful in some situations, for example, if a water pressure grid is defined by an insufficient number of points.

SLIP SURFACE SEARCH METHOD

For this tutorial, we will be performing a circular Auto Refine search, to attempt to locate the critical circular slip surface (i.e. the slip surface with the lowest safety factor). Since this is the default method, no action is required.

> **Note**
>
> See the Slide2 Help system for more information on this method.

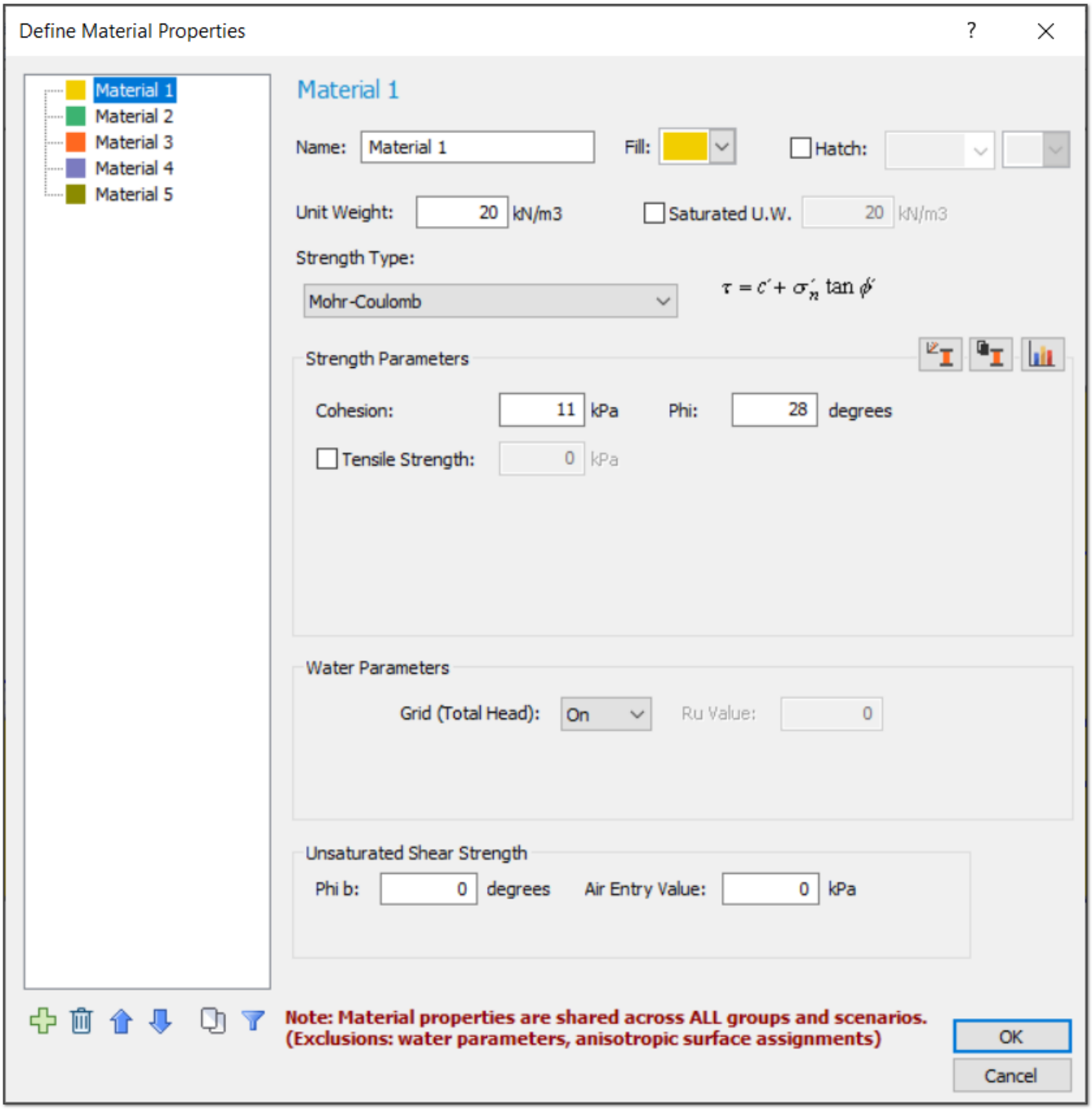
MATERIAL PROPERTIES

To complete our modelling, we still have to define our material properties, and we will then be ready to run the analysis.

Select: Properties > Define Materials

In the Define Material Properties dialog, enter the following parameters, with the first (default) material selected. Once you've filled out the parameters like the dialog below select OK.

- Name = "Material 1"
- Unit Weight = 20 (kN/m3)
- Strength Type = Mohr-Coulomb
- Cohesion = 11 (kPa)
- Phi = 28 (degrees)



In the Define Material Properties dialog, you will notice the Grid (Total Head) On / Off toggle, under Water Parameters. This allows you to toggle the effect of a Water Pressure Grid ON or OFF for any given soil. If the water pressure grid is turned OFF, then pore pressure will be ZERO for that soil. In this example, we are of course leaving the grid ON, since we want to see the results of using the water pressure grid.

Since we are dealing with a single material model, and since you entered properties with the first (default) material selected, you do not have to Assign these properties to the model. Slide2 automatically assigns the default properties (i.e. the properties of the first material in the Define Material Properties dialog) for you. For multiple material models, it is necessary for the user to assign properties with the Assign Properties option. This is discussed in Tutorial 2.

We are now finished with the modelling and can proceed to run the analysis and interpret the results.

6. Compute

Before you analyze your model, save it as a file called WPG.slmd.

Select **Analysis > Compute**

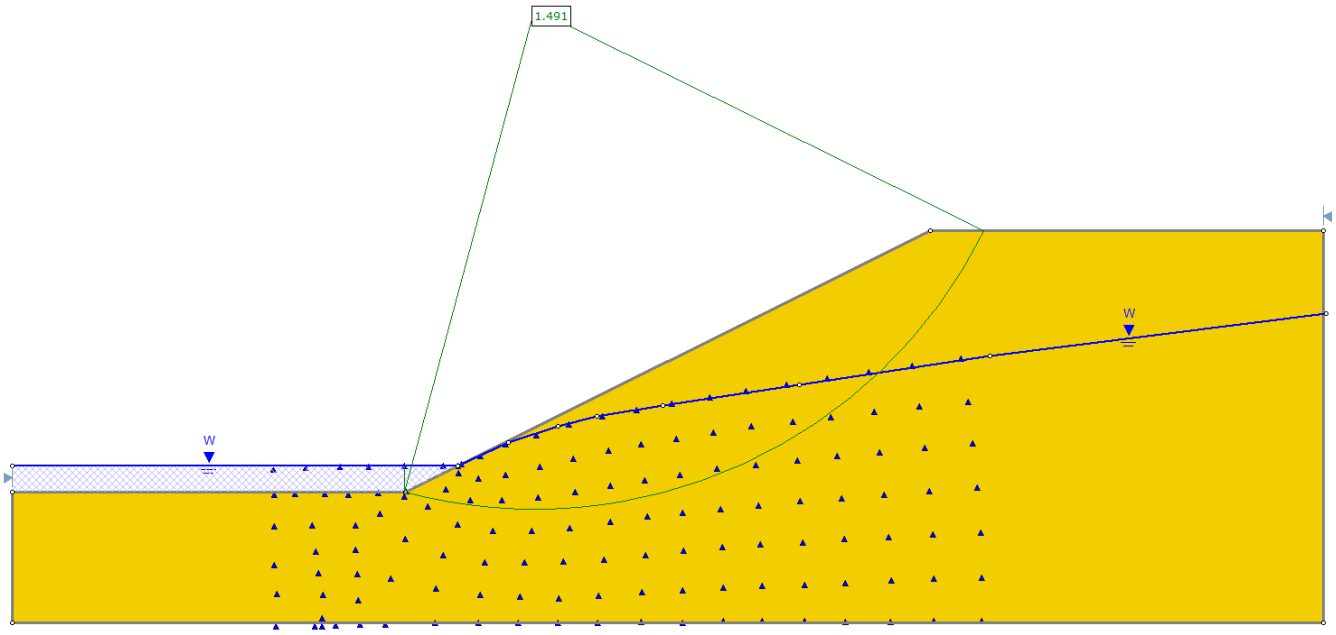
The Slide2 Compute engine will proceed in running the analysis. This should only take a few seconds. When completed, you are ready to view the results in Interpret.

7. Interpret

To view the results of the analysis:

Select **Analysis > Interpret**

This will start the Slide2 Interpret program. You should see the following figure.



By default, the Global Minimum surface for a Bishop analysis is initially displayed. The minimum safety factor = 1.491.

Let's view the results for another analysis method. Select Janbu Simplified from the drop-list in the toolbar.

For this model, the Janbu Global Minimum slip surface is different from the Bishop surface. Global Minimum surface information, for each analysis method, is always available in the Report Generator.

Select **Analysis > Report Generator**

Scroll down the Report Generator, to view the Global Minimum surface information. Note that each surface has different center coordinates, and radius. Close the Report Generator view, by selecting the X in the upper right corner of the view (make sure you select the view X and not the application X, so you don't close the INTERPRET program!)

ADD QUERY

Let's now add a query on the Global Minimum for the Bishop analysis, and plot pore pressure along the slip surface.

First, select the Bishop analysis method from the toolbar, if it is not already selected.

Queries can be added with the Add Query option in the Query menu. However, a shortcut for adding a query corresponding to a Global Minimum slip surface is to right-click anywhere on the slip surface, or on the radial lines joining the slip center to the slip surface endpoints, and select Add Query from the popup menu.

Do this now, for the Bishop analysis Global Minimum.

> **Note**
>
> The colour of the Global Minimum surface has changed to black, indicating that a query has been added. (Queries are displayed using black. The Global Minimum, before the query was added, was displayed in green).

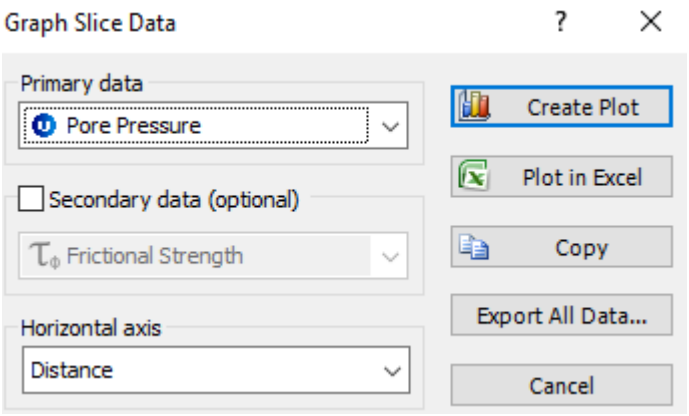
GRAPH PORE PRESSURE

After a query has been added, data can be graphed using the Graph Query option.

Select **Query > Graph Query**

Since only one Query exists (on the Global Minimum), it is automatically selected, and the Graph Slice Data dialog will appear.

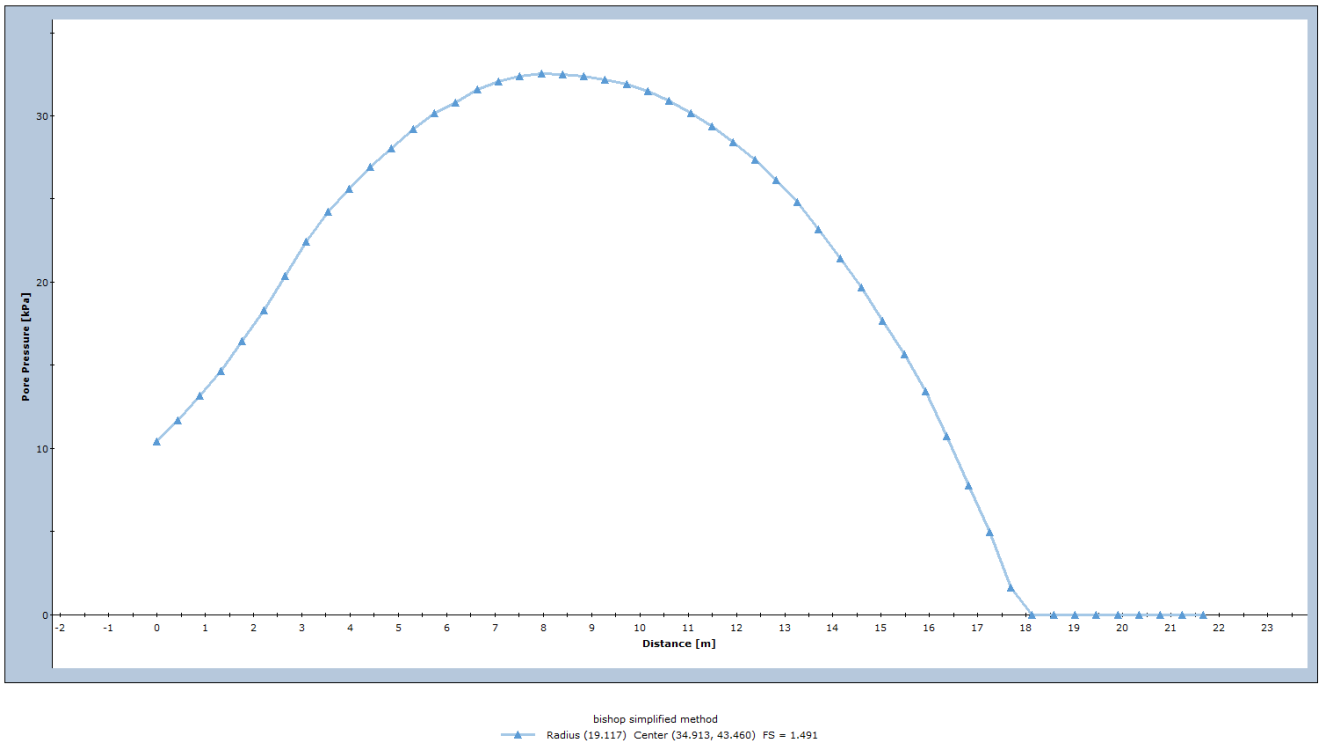
TIP: If you select Graph Query BEFORE you have added any queries, Slide2 will automatically create a Query for the Global Minimum, and display the Graph Slice Data dialog. This saves the user the step of using the Add Query option.



Let's graph pore pressure along the slip surface.

Select Pore Pressure from the Primary Data drop-list. Select Create Plot.

You should see the plot shown below.

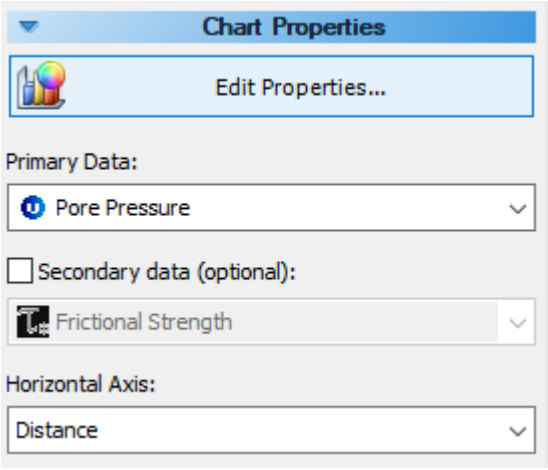


Pore pressure graphed along slip surface.

This graph shows the pore pressure calculated at the midpoint of the base of each slice, by interpolation from the water pressure grid values.

CHART PROPERTIES

After a Query graph is created, the Chart Properties options in the sidebar allow you to customize the graph appearance (Edit Properties button) or change the plot data.



These options are also available through the right-click menu, by right-clicking on a chart and selecting Chart Properties or Change Plot Data. This is left as an optional exercise. That concludes this tutorial.