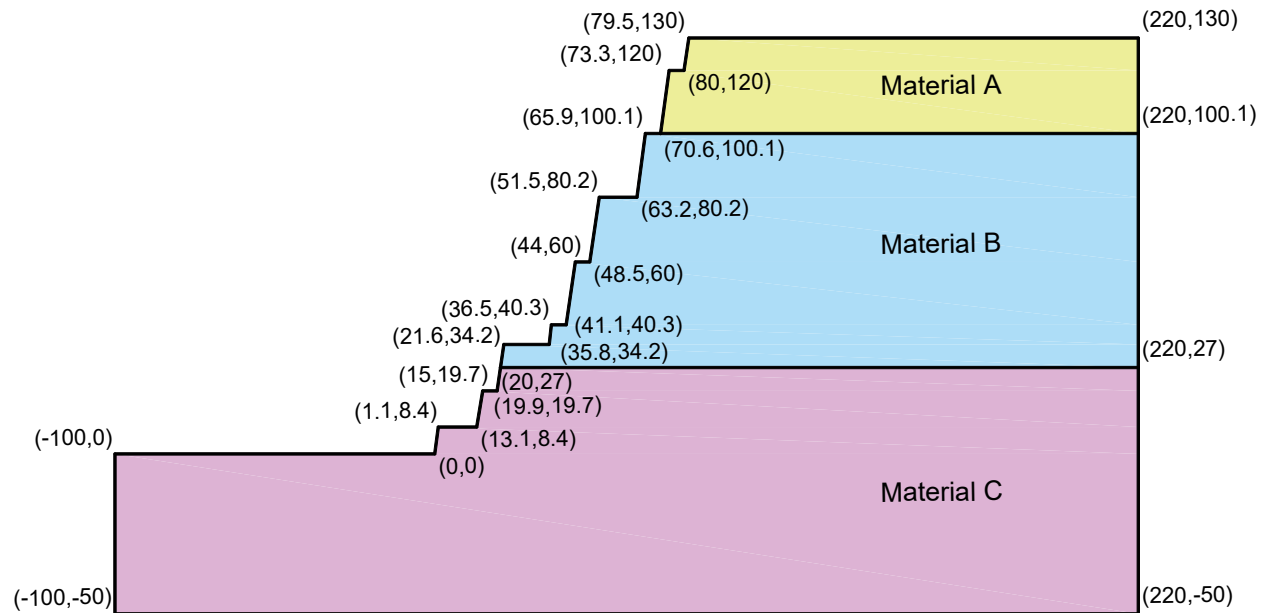


Slope Stability Evaluation Using the Generalized Hoek-Brown

Created By: [Roozbeh Geraili Mikola, PhD, PE](#)

Email: hyrcan4geo@outlook.com

Web Page: www.geowizard.org



This tutorial will demonstrate the evaluation of slope stability using the generalized Hoek-Brown criterion in **HYRCAN**.

Project Settings

Various important modeling and analysis options are set in the Project Settings dialog, including Failure Direction, Units of Measurement, Analysis Methods and Groundwater property. For this analysis make sure the failure direction is set to "Right to Left" then press Apply.

Select: *Analysis* →



Project Settings

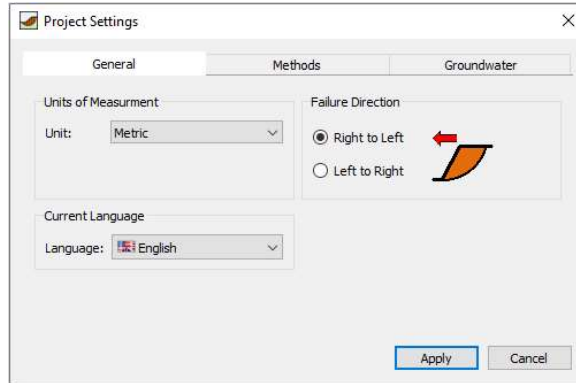
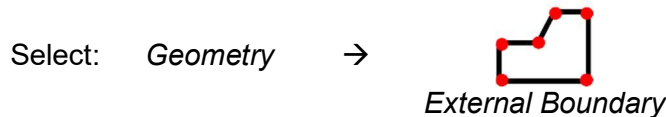


Figure 1- Project Settings dialog.

Create Geometry

- **External Boundaries**

The first boundary that must be defined for every model, is the External Boundary. To add the External Boundary, select External Boundary from the toolbar or the Boundaries menu.



Enter the following coordinates in the prompt line at the bottom right of the main window.

Enter vertex [esc=cancel]: -100 0	Enter vertex [c=close,esc=cancel]: 44 60
Enter vertex [esc=cancel]: -100 -50	Enter vertex [c=close,esc=cancel]: 41.1 40.3
Enter vertex [esc=cancel]: 220 -50	Enter vertex [c=close,esc=cancel]: 36.5 40.3
Enter vertex [c=close,esc=cancel]: 220 130	Enter vertex [c=close,esc=cancel]: 35.8 34.2
Enter vertex [c=close,esc=cancel]: 80 130	Enter vertex [c=close,esc=cancel]: 21.6 34.2
Enter vertex [c=close,esc=cancel]: 78 120	Enter vertex [c=close,esc=cancel]: 19.5 19.7
Enter vertex [c=close,esc=cancel]: 73.3 120	Enter vertex [c=close,esc=cancel]: 15 19.7
Enter vertex [c=close,esc=cancel]: 70.6 100.1	Enter vertex [c=close,esc=cancel]: 13.1 8.4
Enter vertex [c=close,esc=cancel]: 65.9 100.1	Enter vertex [c=close,esc=cancel]: 1.1 8.4
Enter vertex [c=close,esc=cancel]: 63.2 80.2	Enter vertex [c=close,esc=cancel]: 0 0
Enter vertex [c=close,esc=cancel]: 51.5 80.2	Enter vertex [c=close,esc=cancel]: c
Enter vertex [c=close,esc=cancel]: 48.5 60	

Note that entering **c** after the last vertex has been entered, automatically connects the first and last vertices (closes the boundary), and exits the External Boundary option. Your screen should now look as follows:

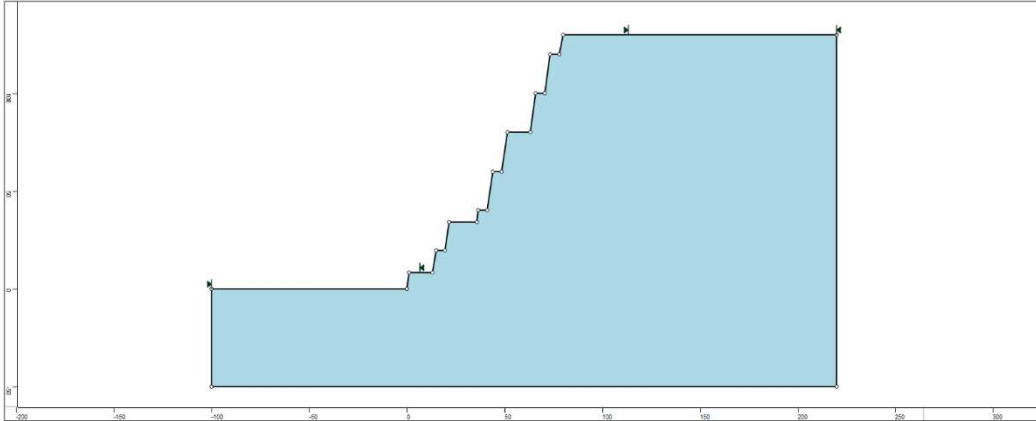
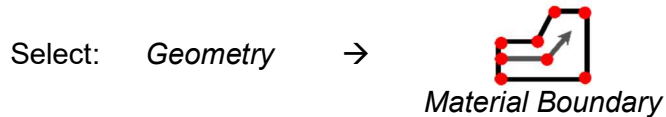


Figure 2- External boundary is created.

- **Material Boundaries**

Material boundaries are used in **HYRCAN** to define the boundaries between different material zones within the External Boundary. Let's add two material boundaries.



Enter the following coordinates in the prompt line at the bottom right of the main window.

Enter vertex [esc=cancel]: 70.6 100.1
 Enter vertex [d=done,esc=cancel]: 220 100.1
 Enter vertex [d=done,esc=cancel]: d

And repeat it for the following coordinates:

Enter vertex [esc=cancel]: 20 27
 Enter vertex [d=done,esc=cancel]: 220 27
 Enter vertex [d=done,esc=cancel]: d

Your screen should now look as follows:

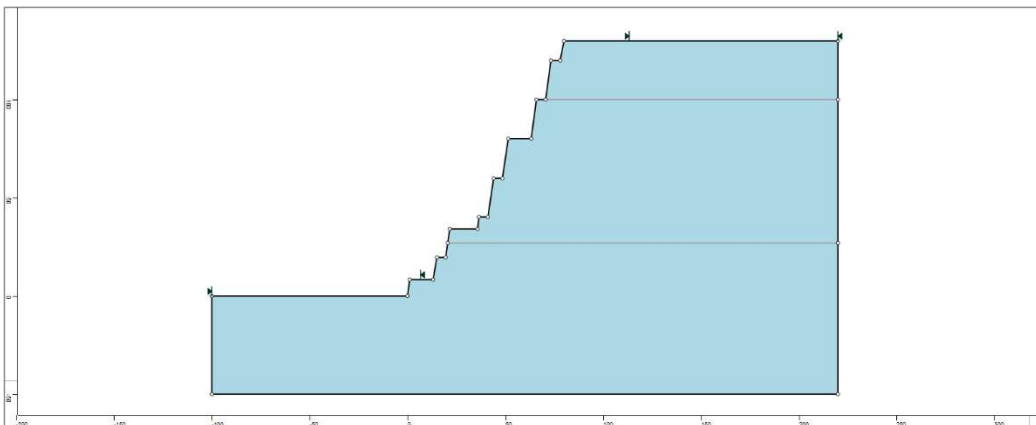
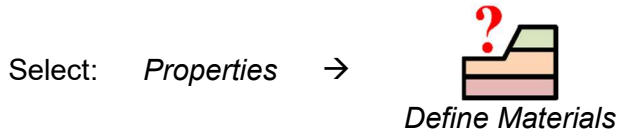


Figure 3- External and material boundaries added.

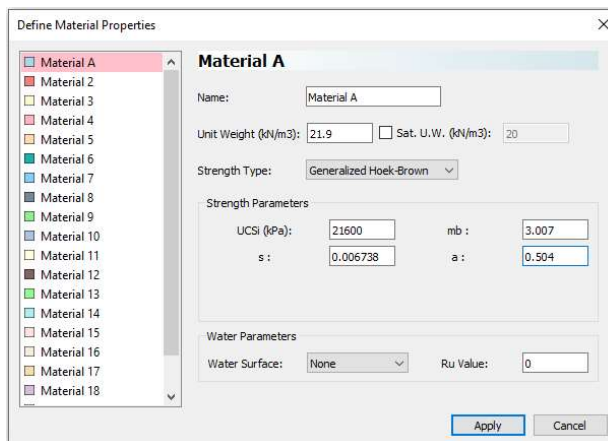
Define Properties

It's time to define our material properties. Select Define Materials from the toolbar or the Properties menu.



Material	Unit Weight (kN/m ³)	σ_c (MPa)	HB Parameter, <i>mb</i>	HB Parameter, <i>s</i>	HB Parameter, <i>a</i>
A	21.9	21.6	3.007	6.738×10^{-3}	0.5040
B	23.8	73.2	4.611	6.738×10^{-3}	0.5040
C	23.8	73.2	3.857	6.866×10^{-3}	0.5057

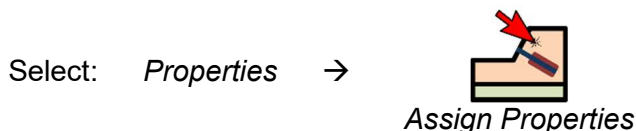
With the first (default) tab selected in the Define Materials dialog, select “Generalized Hoek-Brown” as strength type and enter the parameters shown above.



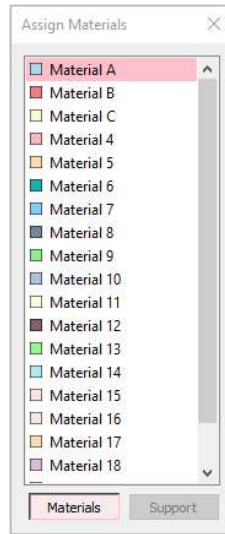
When all parameters are entered for the first material, select the second and third tabs, and enter the properties for the middle and lower layers and press Apply when finished.

Assigning Properties

Since we have defined multiple materials, it will be necessary to assign properties to the correct regions of the model, using the Assign Properties option. Select Assign Properties from the toolbar or the Properties menu.



You will see the Assign Materials dialog, shown below.



To assign properties to the soil layers:

1. Use the mouse to select the soil material, in the Assign Materials dialog (notice that the material names are the names you entered in the Define Material Properties dialog).
2. Now place the cursor anywhere in the soil region and click the left mouse button. Repeat the same sequence for other soil materials until all the materials are assigned.

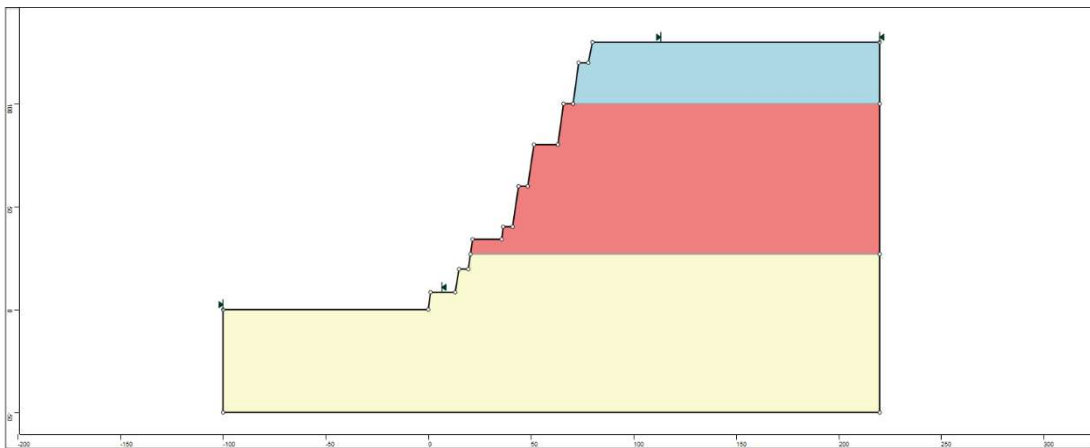



Figure 4- Geometry setup after assigning the properties.

Compute

The model is now ready to run.

Select: *Analysis* →  *Compute*

The engine will proceed in running the analysis. When completed, you are ready to view the results in Result Tab.

Results and Discussions

When calculation completed, you are ready to view the results in Result Tab. By default, when Result Tab opened, the Global Minimum slip surface, for the Bishop Simplified analysis method will be shown. This resulted in total of approximately 5000 trial slip surfaces. The result of the factor of safety calculation is shown in Figure 6. Table 1 summarize the comparisons of calculated factor of safety for the same model using different commercial programs.

Table 1- Comparison of Minimum Factor of Safety

Method	Slide2	HYRCAN
Bishop Simplified	3.762	3.744

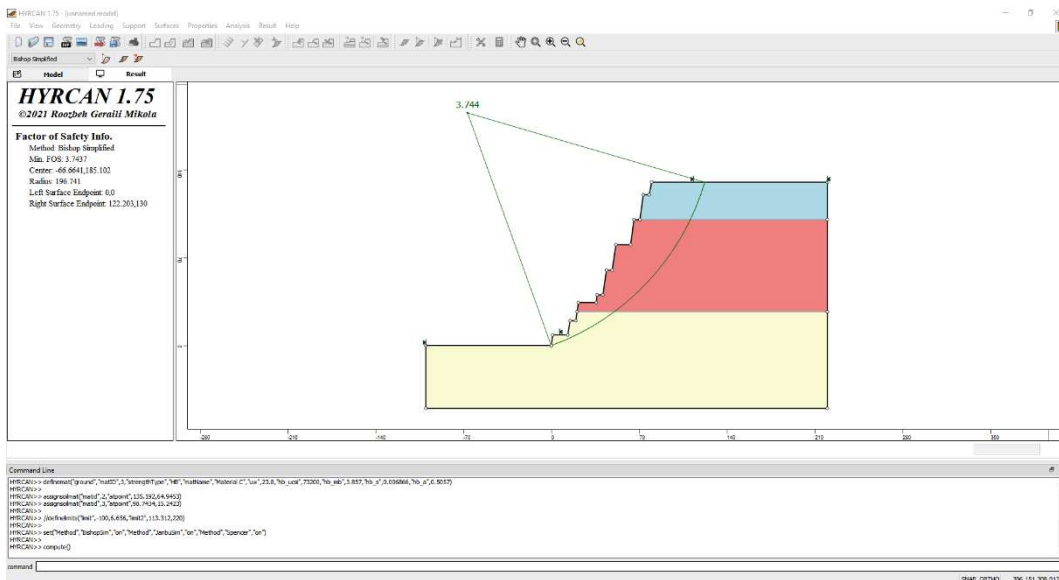


Figure 5- Result of automatic slope search.

To view ALL valid slip surfaces generated by the analysis, select the All Surfaces option from the toolbar or the Result menu.

Select: *Result* →



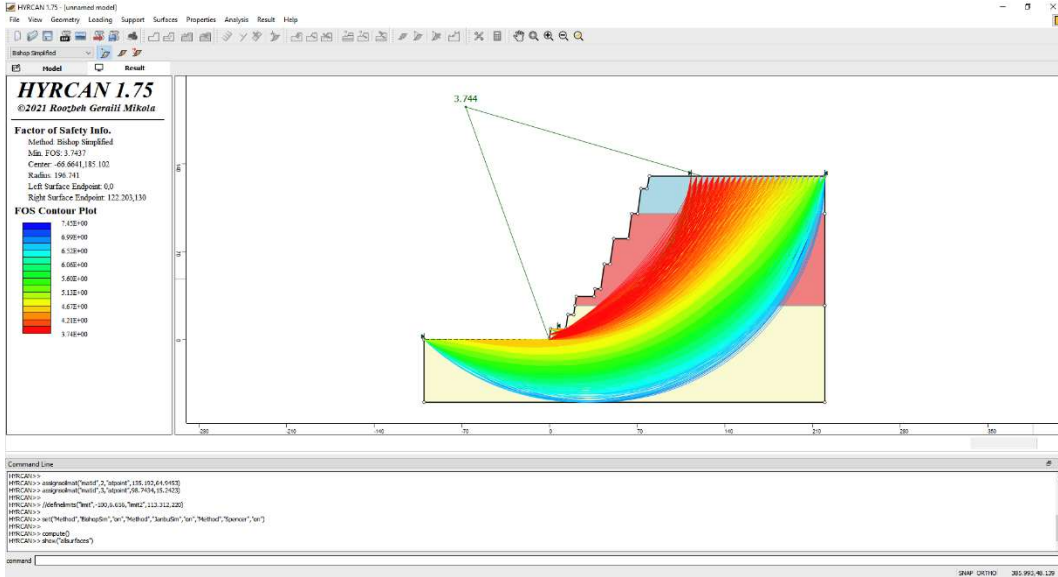



Figure 6- Circular surface search – All surfaces shown.

The Show Slices option can be used to display the actual slices used in the analysis.

Select: *Result* → 
 Show Slices

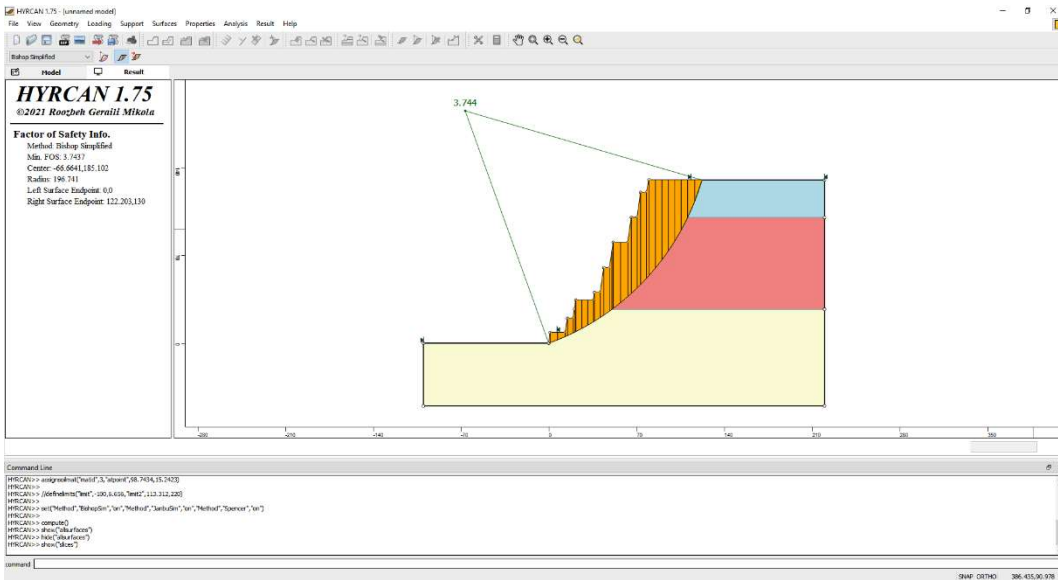


Figure 7- Slice displayed.

Script

After finishing the model, you will be able to save the generated script by **HYRCAN** in the text file.

Select:



The commands for this tutorial are listed below.

```
newmodel()

set("failureDir","r21")

extboundary(-100,0,-100,-50,220,-
50,220,130,80,130,78,120,73.3,120,70.6,100.1,65.9,100.1,63.2,80.2,51.5,80.2,48.5,60,44,60,41.1,40
.3,36.5,40.3,35.8,34.2,21.6,34.2,19.5,19.7,15,19.7,13.1,8.4,1.1,8.4,0,0,-100,0)

matboundary(70.6,100.1,220,100.1)

matboundary(20,27,220,27)

definemat("ground","matID",1,"strengthType","HB","matName","Material
A","uw",21.9,"hb_ucsi",21600,"hb_mb",3.007,"hb_s",0.006738,"hb_a",0.504)
definemat("ground","matID",2,"strengthType","HB","matName","Material
B","uw",23.8,"hb_ucsi",73200,"hb_mb",4.611,"hb_s",0.006738,"hb_a",0.504)
definemat("ground","matID",3,"strengthType","HB","matName","Material
C","uw",23.8,"hb_ucsi",73200,"hb_mb",3.857,"hb_s",0.006866,"hb_a",0.5057)

assignsoilmat("matid",2,"atpoint",135.192,64.9453)
assignsoilmat("matid",3,"atpoint",98.7434,15.2423)

compute()
```