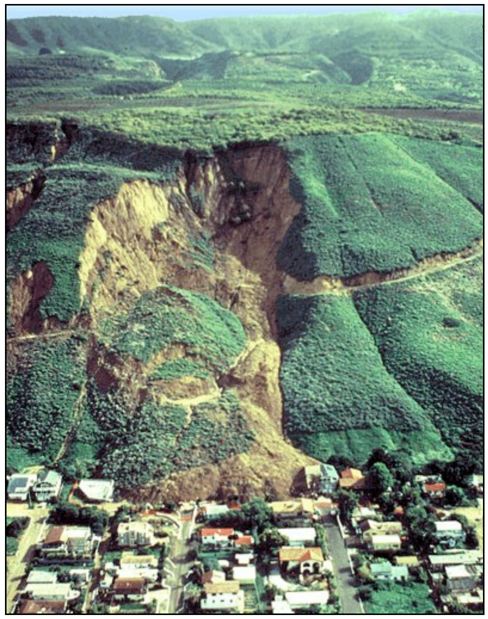
Your Name_________________________

Landslide Mechanics – the math behind the mess



Description:

Today's lab is designed to walk you through the application of a slope stability model. You will perform a sensitivity test to see how the model works, then you will try and figure out under what conditions the landslide we measured failed, as well as what conditions would be required to make the gully walls we looked at fail.

Specific skills and general knowledge:

By the end of the week, you should understand how a simple physical model can be used to understand better a complex natural system. Using sensitivity analysis, you will recognize which model parameters are most important for predicting slope stability.

Procedure:

This exercise should be done in groups of two. However, everyone needs to hand in their own lab sheets, especially the write-ups from part 3.

First, you will need to download the program "INFINITE_SLOPE.xls" from the class web site on the "lab handouts" page. You will be using this spreadsheet to perform several types of analysis.

http://www.uvm.edu/geomorph/2008/pages/lab_handouts.html

Exercise 1. Use the Infinite slope program to perform a sensitivity analysis of the infinite slope equation.

Do this by holding three parameters constant and varying the fourth parameter. Note carefully what happens to “F” the factor of safety. When it drops below 1, the slope will fail.

Set the following as default values:

phi angle at 30 degrees
dry density (rho) at 2000 kg/m2
h (slab thickness) at 1 m
alpha (failure plane) slopes at 15 degrees
g at 9.8 m s2
c=0 and h’=0 (this is dry granular material, no cohesion)

With ALL OTHER parameters at their default values, vary EACH of the parameters below over the following ranges. Pay careful attention to F, the factor of safety, as you vary other parameters.

dry density 800 to 3000 kg/m2
h 0.2 to 20 m
alpha 0 to 90 degrees

A. Graph your results both for **driving and resisting** force on the same plot for each sensitivity test. Each test should include at least five values. Make your graphs on the attached graph paper.

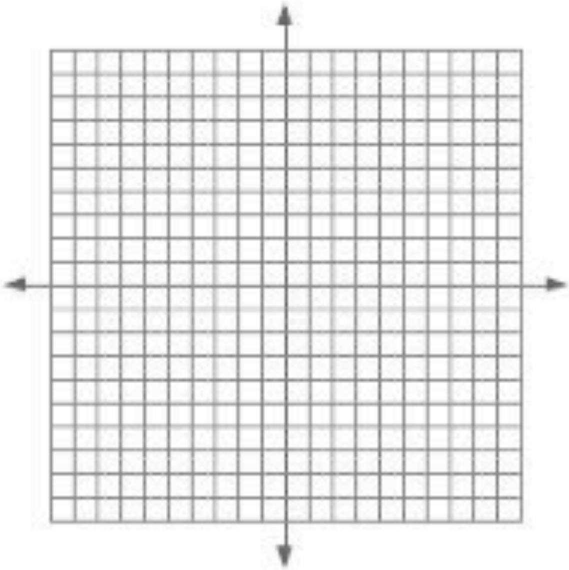
B. You should finish this part of the exercise with three graphs relating driving and resisting force to changing input parameters. Below, summarize in one sentence how changing a particular parameter affects the driving and resisting forces and *F*, the factor of safety.

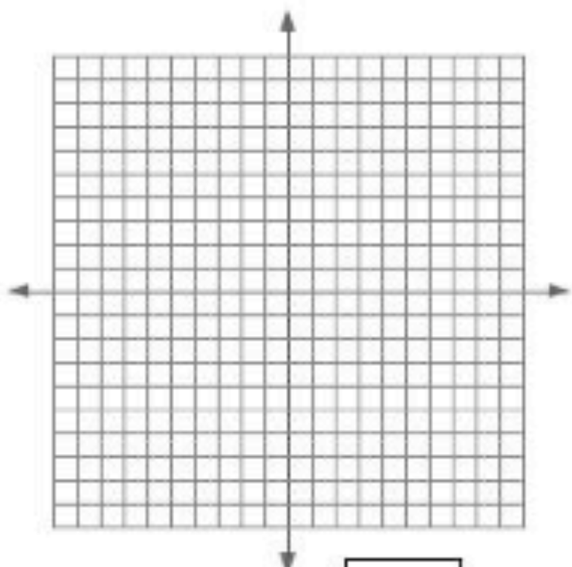
dry density

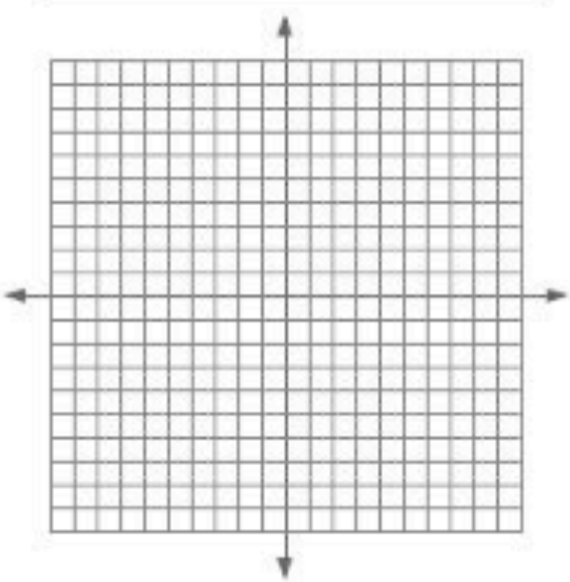
slab thickness (h)

Slope angle (α)

C. Based on the tests that you just did, describe what you believe to be the single most important parameter controlling slope stability? Explain why you picked this parameter?







Exercise 2: Using the data we collected behind Delehanty Hall, determine under what conditions the features we measured either failed, or would fail.

Part A: For the landslide that already failed:

Using the values listed below, as well as the data we collected in the field, perform a sensitivity analysis to determine under what conditions the slide we studied could have failed.

Dry density (rho) = 1600 kg/m^3
Wet density (rho) = 1900 kg/m^3
Gravity = 9.8 m s^2
Phi angle = 30 degrees

Slab thickness (h) ____________________________(m)

Failure Plane angle (alpha) ____________________________(degrees)

Cohesion ____________________________(pascals)
(be careful…need to convert your measurements to pascals)

Like you did earlier, perform a sensitivity analysis to figure out how this landslide occurred. Some questions to ask…1) was the ground dry or saturated when the failure occurred? 2) Could we have mis-measured the failure plane angle? 3) Could our cohesion measurements be too high because we pressed too hard on the shear vanes?

To Turn In:

1) A quick paragraph describing what approach you and your partner took in trying to unravel how this landslide failed. What variables did you test and over what ranges? What combination of values ultimately caused the slope to fail?
2) Any relevant plots showing the results of your analysis. You can either do these by hand or enter them into excel and then plot them. Either way you do it, make sure to label them well and describe what we are seeing in each plot you produce. I will post them all so you can see what other groups tried and found out.

Part B: For the gully that hasn't failed yet (at least where we measured):

Using the values listed below, as well as the data we collected in the field, perform a sensitivity analysis to determine what conditions would be required for the gully slopes to fail as a landslide

Dry density (rho) = 1200 kg/m^3
Wet density (rho) = 1700 kg/m^3
Gravity = 9.8 m s^2
Phi angle = 30 degrees

Slab thickness (h) ___________(m) (what to use…does it matter?)

Failure Plane angle (alpha) ___________(degrees)

Cohesion ___________(pascals)
(be careful…need to convert your measurements to pascals)

In this case, try and figure out what would need to happen to force the gully slopes to fail. Again, begin by asking yourself questions about what variables have the greatest effect. If you can't force the slopes to actually fail, think about why this may be. Is it due to the material the slopes are comprised of? Is it because maybe our measurements aren't representative? A combination of both?

To turn in:

1) A paragraph describing your approach. Remember, there isn't necessarily one correct answer. If, despite your best efforts, you can't seem to make the gully walls slide, why do you think this is?
2) Turn in any relevant plots you produce during your analysis. Remember to label your axes and include titles, and describe what is happening in each plot.

There is some graph paper attached. If you need more, you can download it from the "lab handout" website, and print it out.