GEO-SLOPE | Direct Contact

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Sensitivity Analysis with SLOPE/W

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### Sensitivity Analysis with SLOPE/W

When conducting a slope stability analysis, common questions are: "How sensitive is the factor of safety to the phi value I've defined for one of my soils?" or: "What would happen to the factor of safety if the wa`ter table were to rise or lower?" The purpose of this article is to highlight how a simple sensitivity analysis can be used to help obtain a better understanding of the influence of particular parameters in a slope stability analysis.

In SLOPE/W 2004, a sensitivity analysis is somewhat analogous to a probabilistic analysis. However, instead of randomly selecting the variable parameters and statistically concentrating them around the defined mean, the parameters are selected in an ordered fashion between a defined minimum and maximum range using a Uniform Probability Distribution function. The characteristic of a uniform distribution is that all values have an equal probability of occurrence. This is also apparent from the shape of the sampling function, which becomes a straight line as shown in Figure 1.

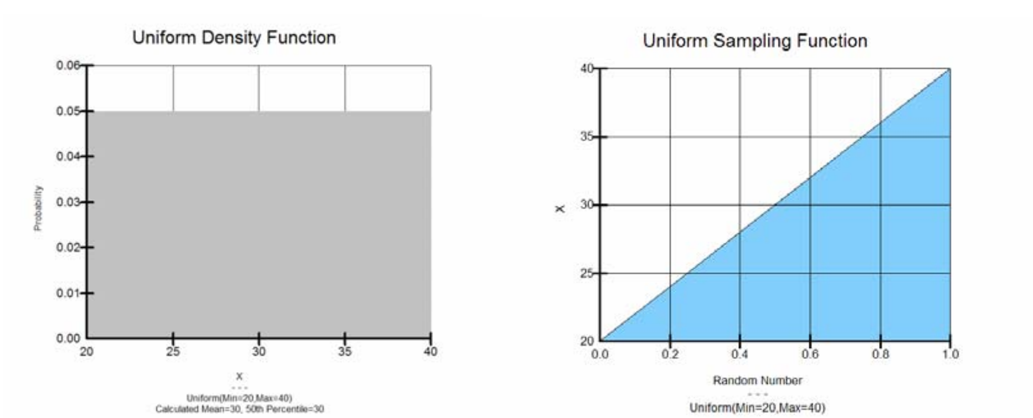


***Figure 1*** **– Uniform probability density function and generated sampling function**

Consider the simple slope shown in Figure 2. Two materials are defined where there is some question about the actual value of cohesion for the lower soil layer, and the exact location of the water table.

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Initially SLOPE/W determines the factor of safety and the critical slip surface using the defined mean value of cohesion (c = 5) and the drawn phreatic surface. Once the critical slip surface has been found, SLOPE/W will use this slip surface and hold the water table constant, recalculating factors of safety for cohesion values that range from c = 0 to c = 10. Next, the cohesion is once again set equal to the mean value of c = 5, and new factors of safety are computed while the location of the phreatic surface is varied by +/- 0.5 m.

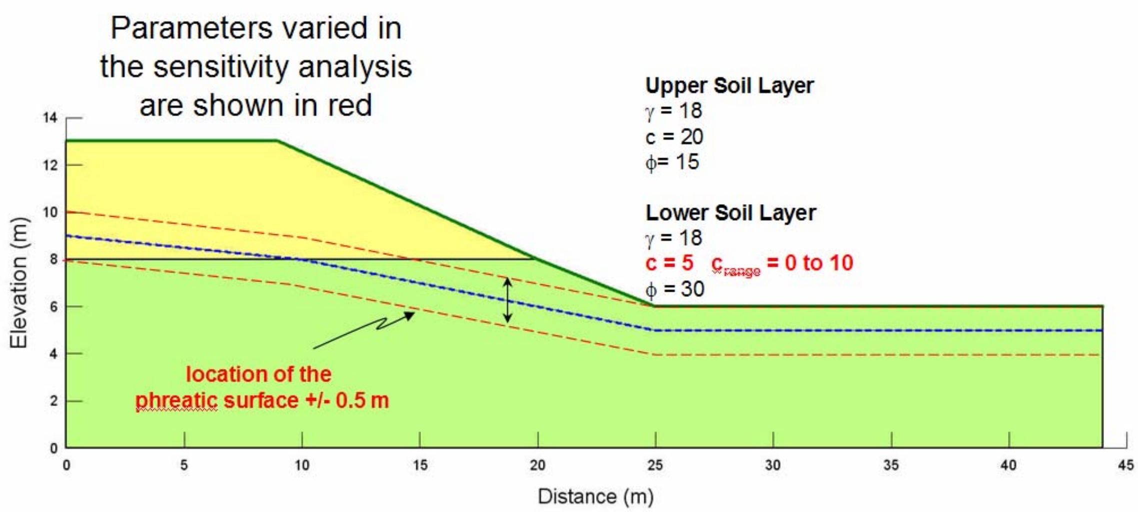


***Figure 2 – Profile and parameter range used in the sensitivity analysis***

The results of the sensitivity analysis are then displayed on a single graph where the computed factors of safety are plotted versus a normalized sensitivity range. A normalized value of 0.0 means the lowest specified parameter value was used and 1.0 means the highest specified value of each parameter was used. By normalizing the sensitivity range, all parameters selected for the analysis can be plotted onto a single graph for comparison purposes.

Figure 3 shows the results for the above analysis. Comparing the slope of both lines shows that for this analysis, the solution is more sensitive to variations in cohesion for material #2 than it is to a fluctuating water table.

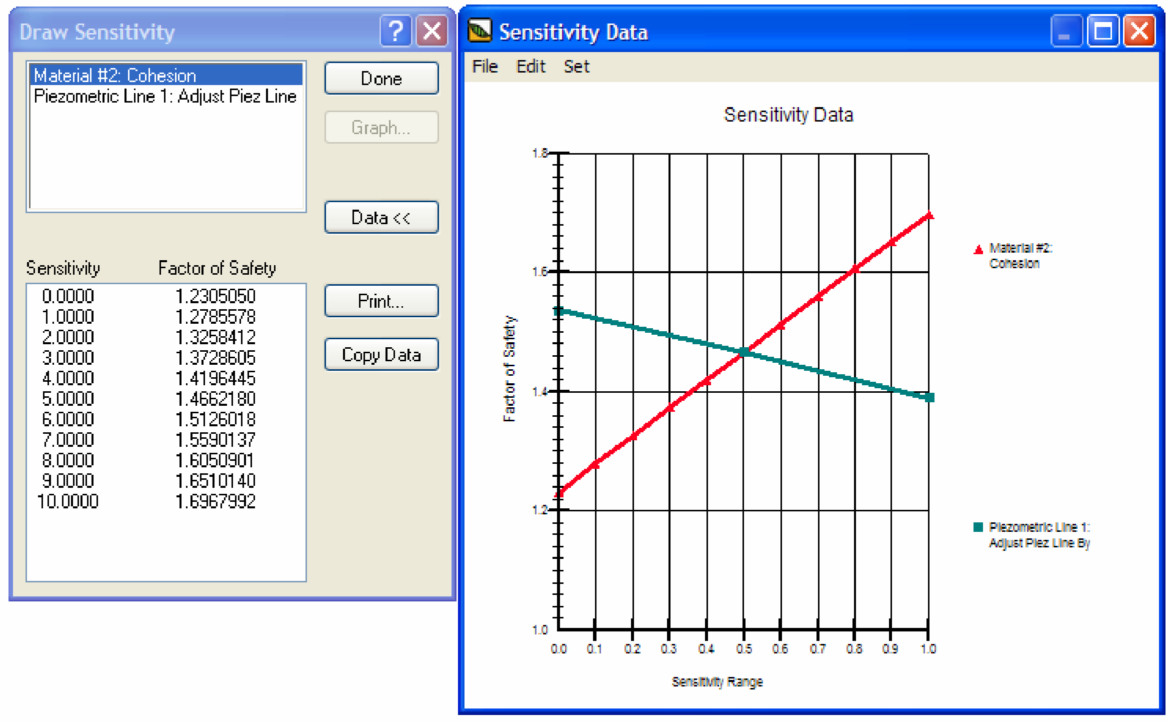


***Figure 3 – Graph Data and Sensitivity Plot***

While a sensitivity analysis can be a very helpful tool, especially for those that have limited experience with slope stability analyses, ultimately it is prudent to rerun individual analyses if you want to investigate the effect of parameter variability beyond simply comparing factors of safety. For example, a sensitivity analysis may identify that your solution is especially sensitive to variations in cohesion of a particular soil layer. Only by running multiple analyses, varying the cohesion of a particular layer, will you be able to understand the effect of this parameter on the computed shear mobilized along the slip surface, or on the location of the critical slip surface, which may change as the parameter is varied.

To learn more about probabilistic analyses or sensitivity analyses, please refer to the Engineering Methodology book Stability Modeling With SLOPE/W.

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