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# GeoStudio Example File
# Basic Sensitivity Stability Analysis

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# Introduction

It is often useful to determine how sensitive the stability of a structure is to variation in a certain parameter. If the stability is very sensitive to that parameter, then a greater effort is required to define the parameter through further study and testing. SLOPE/W makes it possible to conduct a sensitivity analysis on material properties, pore-water pressure conditions, external loads, seismic loads, and reinforcement parameters. This basic example demonstrates how to set-up and interpret a sensitivity analysis on Mohr-Coulomb strength properties.

# Numerical Simulation

The model domain is shown in Figure 1. The objective is to determine the effect of variability in the friction angle on the factor of safety. The range of $\phi'$ values to be considered is specified in the Set Sensitivity Parameters dialog box (Figure 2). This range is specified as an offset. The range will be 1° (delta) in 5 steps in both directions for the foundation friction angle. This results in a range from 21 to 31°.

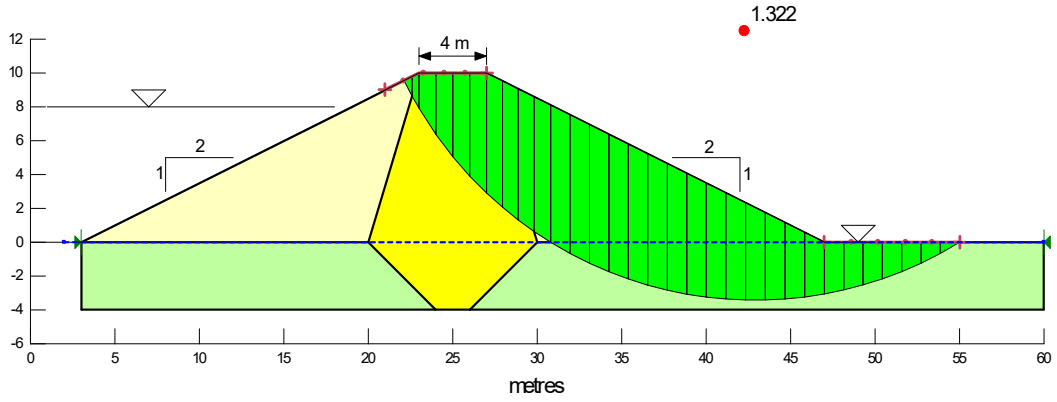


**Figure 1. Example problem configuration.**

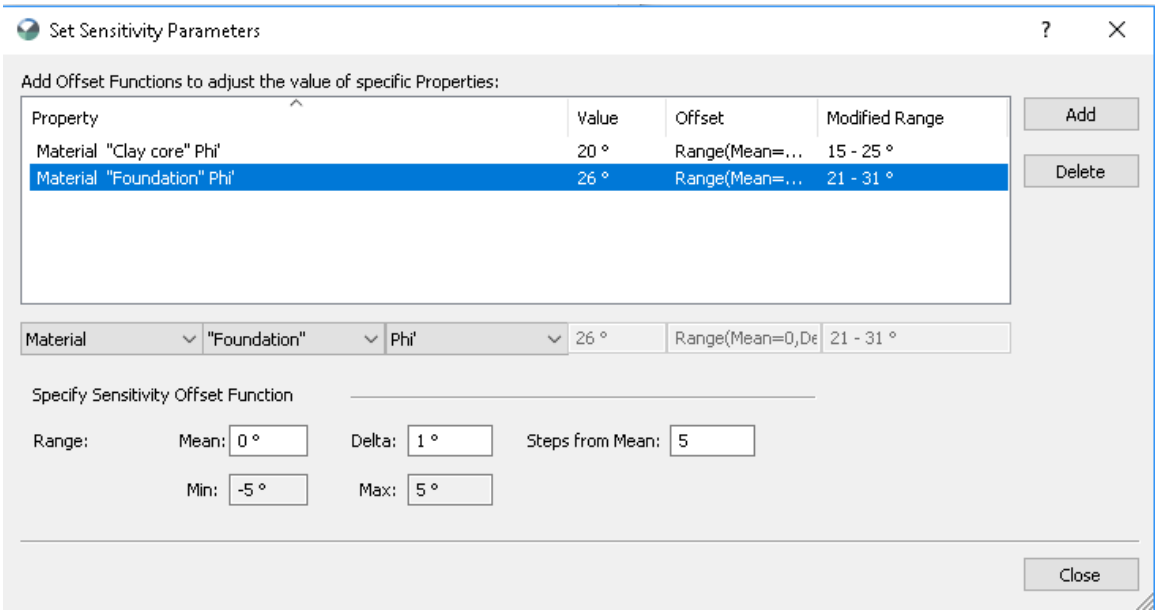


**Figure 2. Set Sensitivity Parameters dialog box.**

The advantage of using an offset is that the base value can be changed without altering the offset parameters. For example, the range will automatically shift to between 25 and 35° if $\phi'$ is set to 30° in the Define Materials dialog box.

In this example, the four (4) most critical slip surfaces are saved to file for a deterministic Parent analysis. The sensitivity analysis is then done on these four slip surfaces for two different Child analyses. The first analysis considers only variability in the foundation, while the second analysis considers both the clay core and foundation.

# Results and Discussion

Figure 3 presents the variability in the factor of safety for changing friction angles in the foundation. This graph is for the most critical slip surface. Similar graphs are available for the other three slip surfaces. The sensitivity range is normalized (-1 to +1) so that more than one parameter can be plotted on the same graph.

The sensitivity graph shows that the factor of safety ranges from 1.125 when $\phi'$ is 21° to 1.534 when $\phi'$ is 31°. This is a significant range in the margin of safety against failure. Therefore, it might be concluded that the stability is sensitive to a variation in the foundation strength parameter $\phi'$.

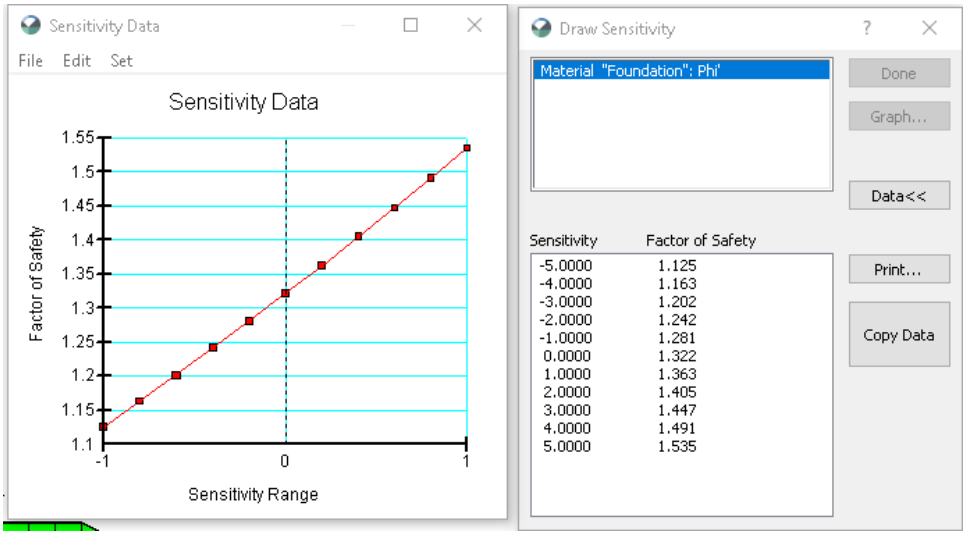


**Figure 3. Sensitivity plot for vvariations in the foundation friction angle.**

Figure 4 presents the results when the friction angle of both the foundation and clay core is varied. The specified value and range for the core is 20 ± 5°. Changing the core material $\phi'$ from 15 to 25° has less effect on the stability than changing the foundation material $\phi'$ from 21 to 31°, despite the range being 10° in both cases. The inclinations of the curves provide an indication of the relative sensitivity of the two parameters. It should be noted that the graph for the foundation friction angle is the same as shown in Figure 3. This occurs because all sensitivity inputs are varied independently; that is, only one sensitivity parameter is changed at a time.

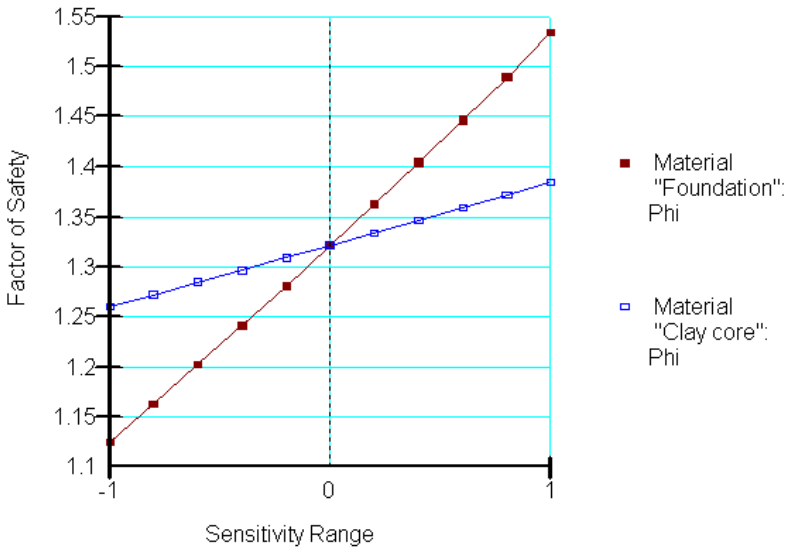


**Figure 4. Sensitivity plot for variations in the foundation and the clay core materials.**

# Summary and Conclusions

Sensitivity analyses can be insightful provided that the parameters are chosen selectively. The results are the most meaningful when varying one parameter at a time. Considering multiple variables at the same time is reasonable, provided that the parameter is of the same type as shown in Figure 4. The interpretation of the sensitivity graph becomes difficult if it includes parameters of a different type. For example, mixing unit weight, cohesion and $\phi'$ makes interpretation difficult because the values can be significantly different.

It is also very important to recognize that only one value gets changed at a time. If the desire is to change multiple parameters of various types at the same time, it is better to conduct a probabilistic analysis.