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GeoStudio Example File
Analyzing Gravity Retaining Walls

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Seequent, The Bentley Subsurface Company

Introduction

This example demonstrates how to analyze two potential modes of failure for gravity retaining walls using SLOPE/W: deep-seated rotational failure and translation. In most cases, the strength of the wall is very high. It is therefore necessary to filter out any slip surfaces that pass through this material. This is accomplished in SLOPE/W by assigning the wall a special material type called High Strength.

Numerical Simulation

The example involves a 10-m high concrete retaining wall (Figure 1). Slip surfaces cannot pass through the concrete, so the strength of the concrete is irrelevant. The weight, however, is important. The weight affects the normal stress on a possible slip surface under the wall, which, in turn, affects the shear resistance.

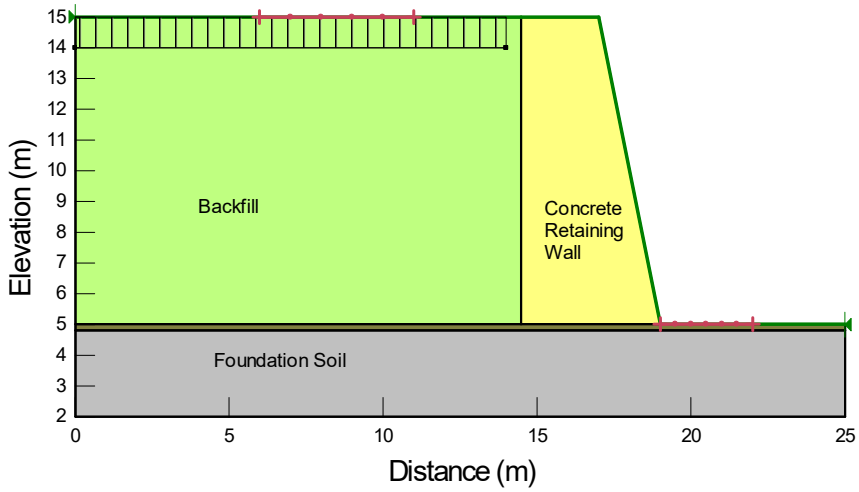

Figure 1. Example configuration.

The concrete is assigned a High Strength Material model as shown in Figure 2. The friction between the concrete and the underlying soil is considered to be something less than the Phi (ϕ) of the soil. This can be modeled with a thin layer as shown in Figure 1. The ϕ for this material is set to 25°.

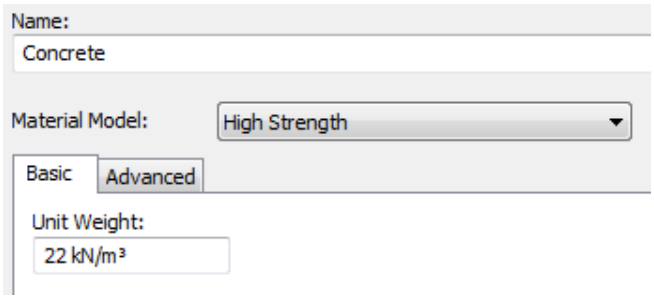

Figure 2. Property of concrete.

Results and Discussion

Translational Mode using Enter-Exit

Translational failure can be investigated using the Entry-Exit trial slip definition as shown in Figure 3. The foundation soil was modeled using the impenetrable (bedrock) material model,

causing the slip surfaces to be horizontal beneath the wall. There are eleven slip surface that have a factor of safety between the critical value and 1.9.

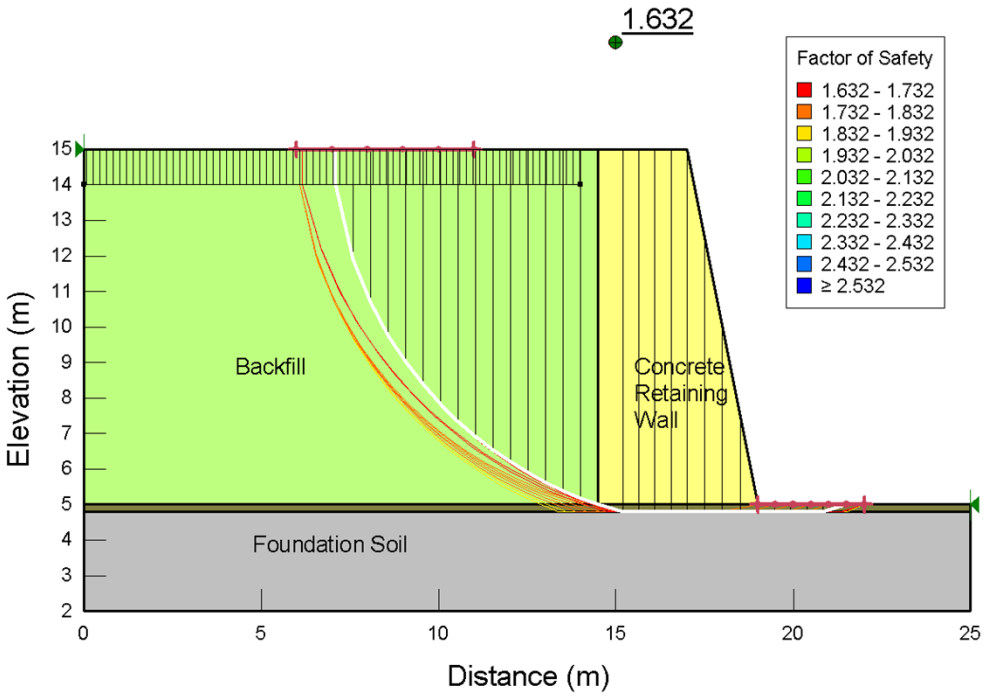

Figure 3. Stability with Enter-Exit trial slips.

Notice that any trial slip surface that passes through the concrete is ignored (Figure 4). The downside of this approach is that very few slips meet the geometric requirements and are therefore filtered.

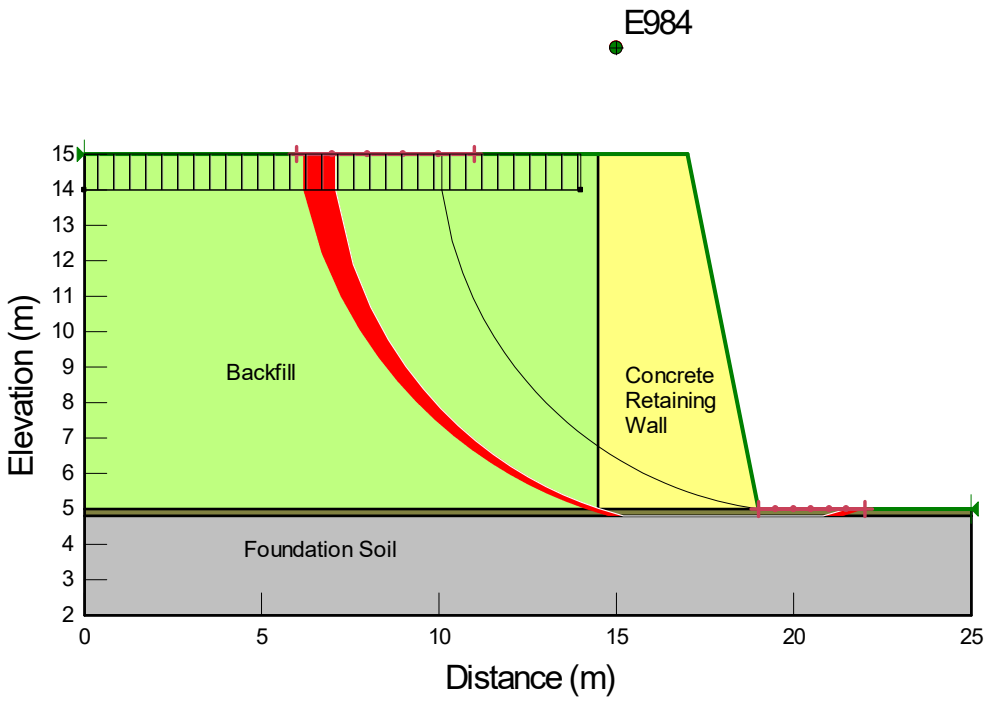

Figure 4. Trial slip surfaces passing through the concrete are ignored.

Translational Mode using Block-Specified

The block-specified search technique can also be used to analyze the translational mode of failure. Both the left and right blocks can be specified as a point with a range of projection angles at each point. This yielded the result shown in Figure 5, which has a similar factor of safety compared to the entry-exit slip surface presented above.

The downside of the Block-Specified approach is that converged solutions can only be obtained if the slip surfaces are not too steep in the back fill. If the slip becomes too steep, it is not possible to obtain a converged solution primarily due to the sharp corners along the slip surfaces. As is evident in Figure 6, the moment and force factor of safety curves tend to be parallel making it impossible to find a cross-over point. Extending the lambda range does not help. At higher lambda values it is not be possible to compute a factor of safety for either the moment FofS or the force FofS.

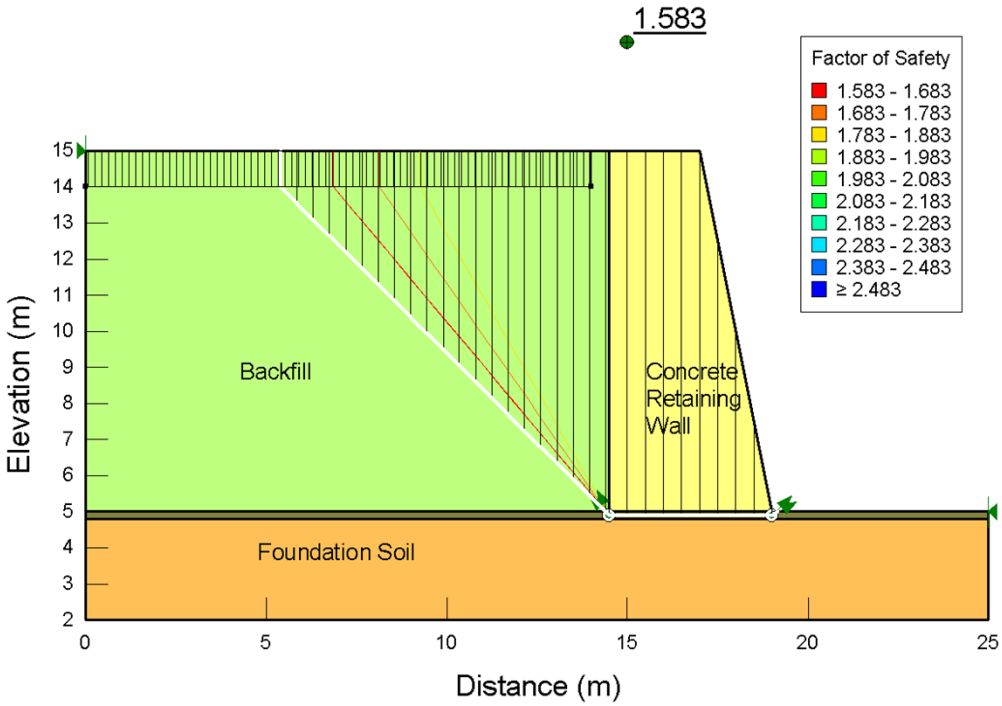

Figure 5 Stability with Block-Specified trial slips

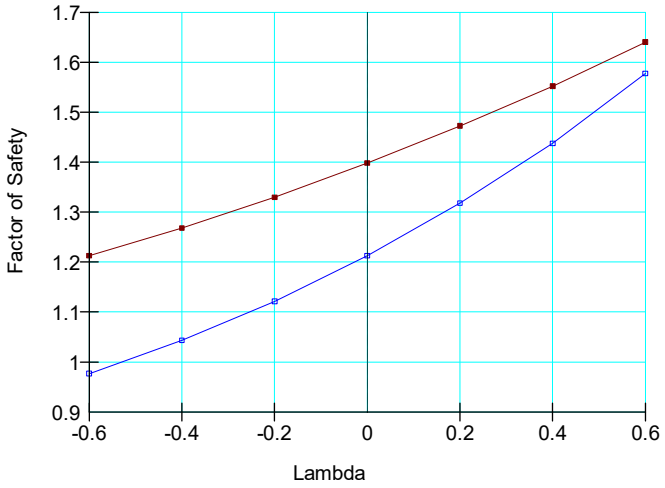

Figure 6 Factor of Safety versus lambda plot for a non-converged trial slip

Rotational Mode of Failure

The possibility of a rotational base stability can be investigated by simply assigning the foundation soil Mohr-Coulomb properties. The result is shown in Figure 7. For this illustrative example, the margins of safety against a sliding and a base rotational failure are about the same.

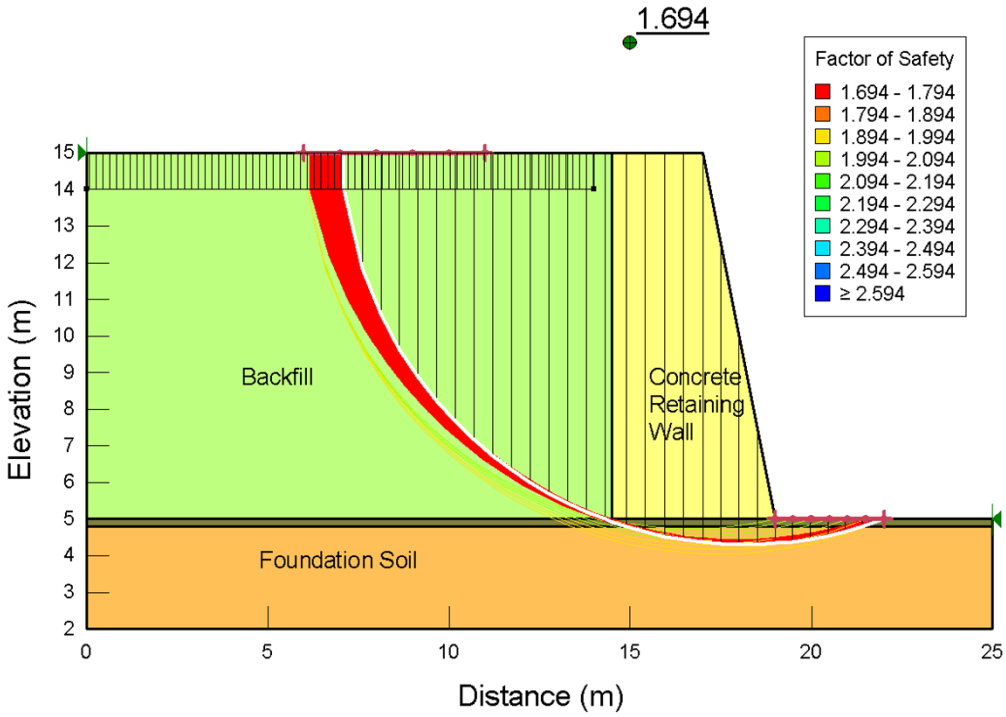

Figure 7. Rotational base stability.

Summary and Conclusions

Gravity retaining walls can be analyzed by SLOPE/W for both rotational and translational modes of failure. Translational failure can be analyzed using a combination of entry-exit slip surface definition and the bedrock material model. The bedrock material model forces the slip surfaces to pass laterally beneath the wall. Conversely, the block-specified technique can be used to control the location of the slip surface search. It is recommended that the high-strength material model be used for the gravity wall to filter inadmissible slip surfaces.