GeoStudio Example File
Embankment on Geosynthetic

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Introduction

This example demonstrates how a geosynthetic can be included as reinforcement in the staged construction of an embankment on soft ground. The amount of load transferred into the geosynthetic is evaluated along with the deformation pattern caused by construction.

Numerical Simulation

The problem configuration is shown in Figure 1. The foundation is treated as a soft soil while the embankment is defined as a sandy material. The embankment is constructed in five 1 m lifts, which are each simulated via individual child analysis (Figure 2). Once the embankment has been constructed, a SLOPE/W Finite Element stress stability analysis is conducted to calculate the Safety Factor.

Figure 1. Problem configuration.

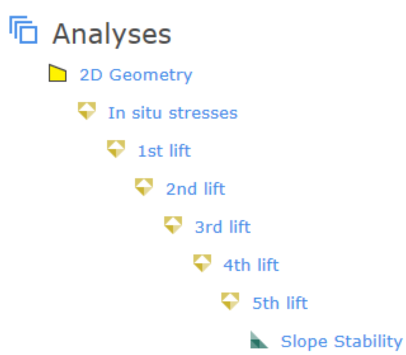

Figure 2. Sequential analysis steps and stages.

Both soils are defined using an isotropic linear elastic material model. The geosynthetic is modeled as a structural beam with no flexural stiffness; that is, the moment of inertia (*I*) is specified as zero. The geosynthetic has stiffness (*E*) and a cross-sectional area. This being a 2D analysis, the thickness into the page is unity (1 m). The structural beam is defined to only allow tension.

For the slope stability analysis, the embankment is defined using a Mohr-Coulomb model with a friction angle of 30° and a cohesion of 0 kPa. The soft soil is defined using an Undrained material model with cohesion of 20 kPa.

Results and Discussion

Figure 3 shows the load transferred into the geosynthetic as each embankment lift is placed. The maximum tension is toward the embankment toe area for Lifts 1 and 2. Ultimately, the maximum tension is under the centre of the embankment due to the deformation pattern, which is predominantly downward. The toe area goes into compression as indicated by the 0 kPa axial force.

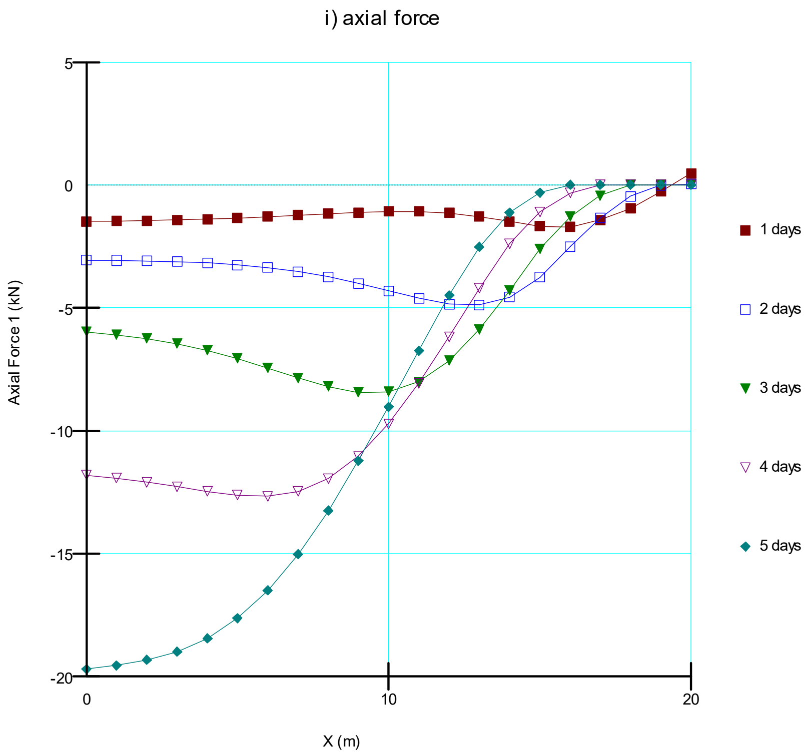

Figure 3. Tension in the geosynthetic.

The resulting embankment and foundation stresses are used in SLOPE/W to do a stability analysis (Figure 5). However, there are several issues that need to be recognized and appreciated. The tension in the geosynthetic itself does not enter into the safety factor calculations. The geosynthetic alters the stresses, which in turn are used in the stability analysis, but the geosynthetic itself does not enter into the calculations. The geosynthetic forces come into play in a conventional Limit Equilibrium analysis, but not when the SIGMA/W computed stresses are used in the stability calculations.

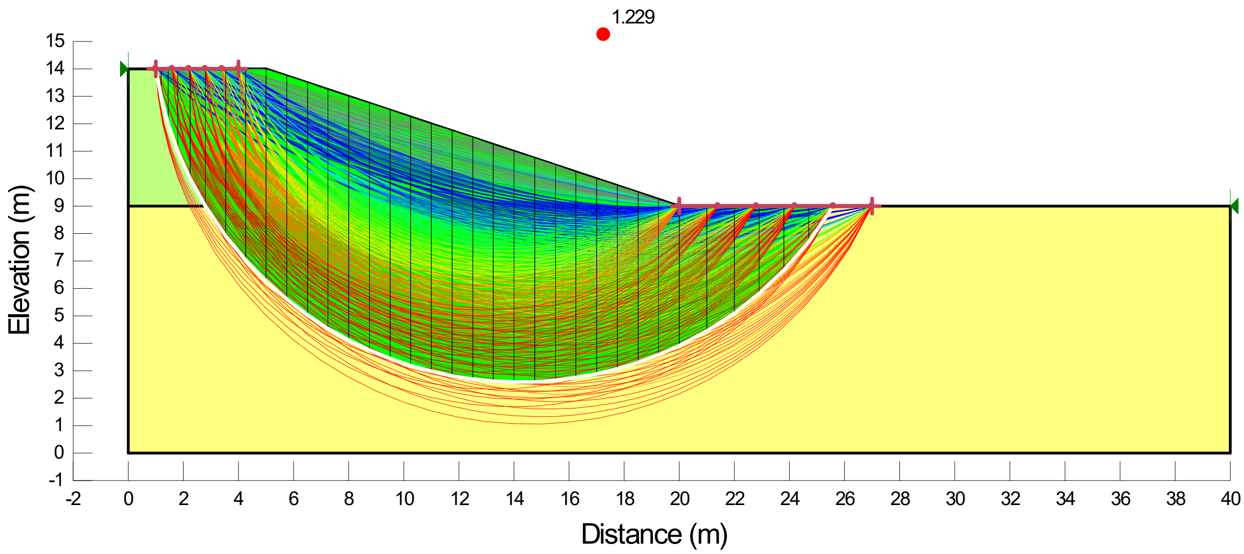

Figure 5. Stability analysis of reinforced embankment.

Summary and Conclusions

This example demonstrates how a structural beam element can be used to model the effects of geosynthetic reinforcement. Stability is just one issue in the analysis, design and construction of reinforced embankments on soft ground. Other issues, like long term settlement, for example, are beyond this illustrative example, but may be equally important.

The advantage of including the geosynthetic in a SIGMA/W analysis is that it is possible to study the tension in the reinforcement and to consider deformations. If the analyst is only interested in changes in factor of safety, then doing a SLOPE/W limit equilibrium type of analysis is likely a better alternative.