Slope Stability

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Exercise 4b - Solution

LEM software application

EXERCISE AND TUTORIAL OF GEOSTUDIO SLOPE/W

Introduction

Similarly to Exercise 4a, the goal of this exercise is to perform slope stability analyses by using the commercial software GeoStudio 2018 (student version). Let $F(s_i)$ the safety factor computed for a specific surface s_i. By considering that the actual failure surface is unknown, a certain number of potential failure surfaces s_i needs to be considered. The actual safety factor is defined as $F = min_i \{F(s_i)\}$.

1.1 Exercise description

In this exercise the stability of a cut and fill is analyzed. The geometry and soil properties are recalled in Figure 1 and in Table 1. The soil is considered dry. In the following tutorial, coordinates to define the slope geometry will be also given.

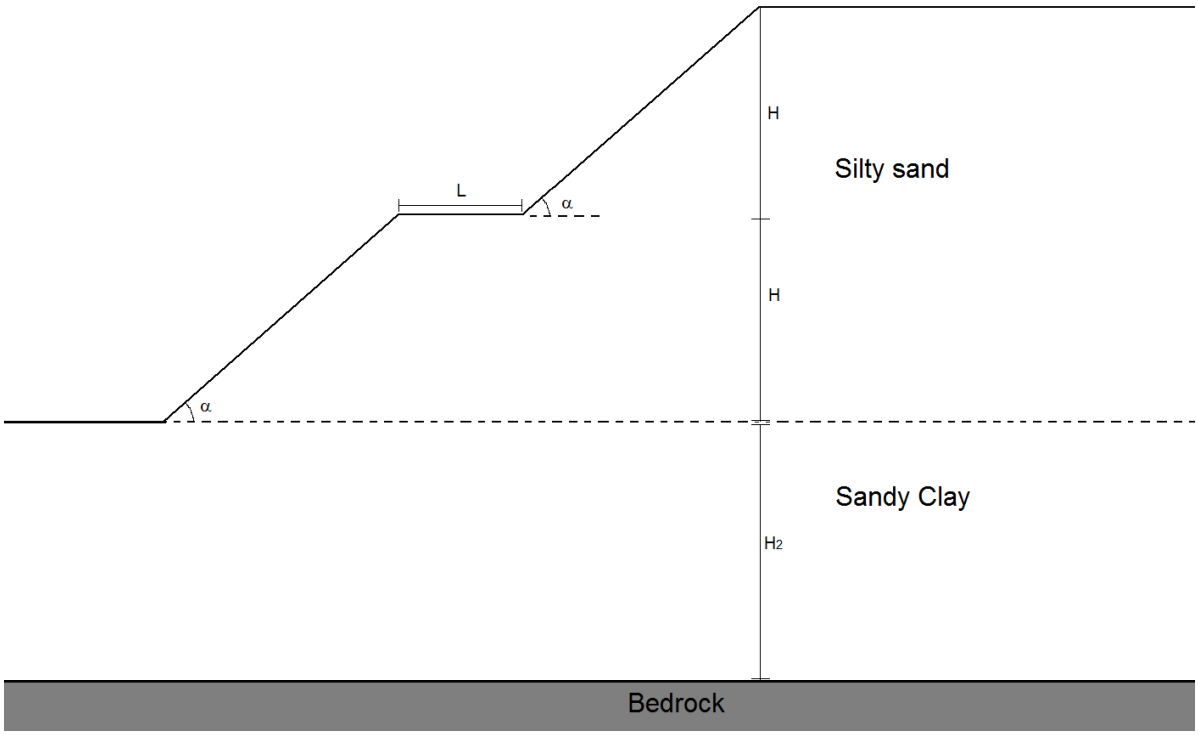

Figure 1: “Cut and fill” slope geometry.

Table 1: geometry and soil properties of the slope reported in Figure 1.

Material	γ_d (kN/m^3)	φ' (°)	c' (kPa)
Silty sand	18	32	6
Sandy clay	16	18	10

Slope geometry	α (°)	$H(m)$	$H_2(m)$	$L(m)$
	41.3	10	16	6

For the proposed slope configuration, evaluate the factor of safety $F = min_i \{ F(s_i) \}$ by adopting GeoStudio™ SLOPE/W. Subdivide the slope in a number of slices equal to 40 and perform the stability analyses by using the simplified Bishop's method and the Morgenstern-Price method. For identifying the circular slip surfaces it is suggested to use the *Grid and Radius* method.

Write in Table 2, for the dry and submerged conditions and for each applied method, the results of the analyses in terms of:

- safety factor F;
- characteristics of the failure surface (coordinate of the center C and radius r).

Make final comments on the obtained results. Can the slope be considered stable? Consider satisfactory a safety factor $F \geq 1.3$ in order to keep into account uncertainties due, for example, to the estimation of the geotechnical parameters. In discussing the results, distinguish between superficial and deep failure mechanisms.

Table 2: summary of results obtained by using GeoStudio SLOPE/W.

	BISHOP simplified	*MORGENSTERN-PRICE*
"Cut and fill"	F = (x_C ; y_C) = r =	F = (x_C ; y_C) = r =

Solution

The results of the performed slope stability analyses are summarized in Table 3.

Table 3: summary of results obtained by using GeoStudio SLOPE/W.

	BISHOP simplified	*MORGENSTERN-PRICE*
Cut and fill Absolut minimum Superficial mechanism	F = 1.214 (x_C ; y_C) = (-7.38 m; 23.58 m) r = 24.69 m	F = 1.211 (x_C ; y_C) = (-4,52 m; 19.90 m) r = 20.40 m
Cut and fill Local minimum Superficial mechanism	F = 1.221 (x_C ; y_C) = (14.81 m; 25.99 m) r = 16.15 m	F = 1.216 (x_C ; y_C) = (14.81 m; 25.99 m) r = 15.075 m
Cut and fill Local minimum Deep mechanism	F = 1.280 (x_C ; y_C) = (4.06 m; 26.09 m) r = 30.49 m	F = 1.232 (x_C ; y_C) = (4.057 m; 26.83 m) r = 28.48 m

The contour maps and the identified critical failure surfaces for the analyzed cases are given from Figure 2 to Figure 7.

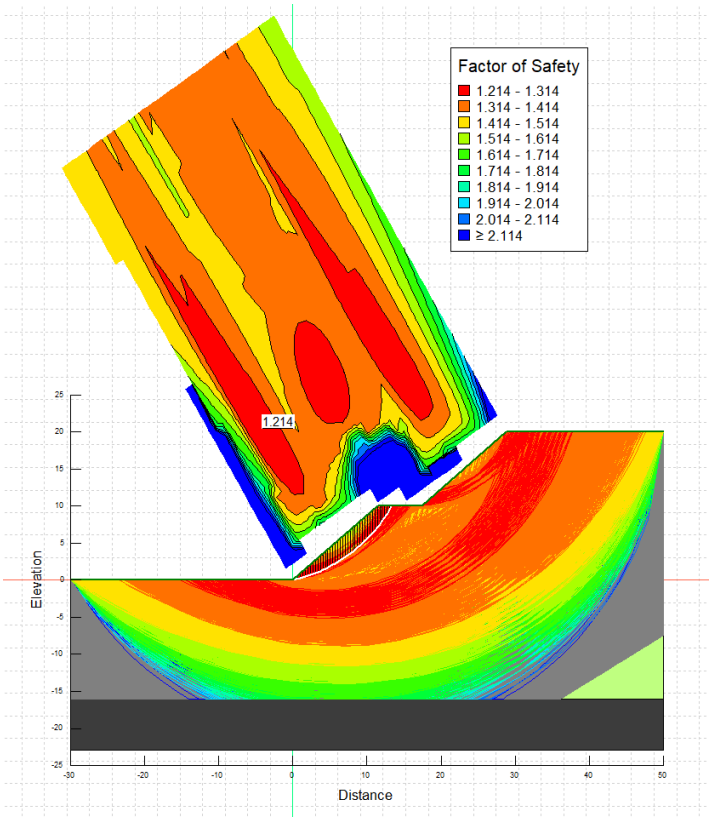

Figure 2: Results according to Bishop simplified method F=1.214.

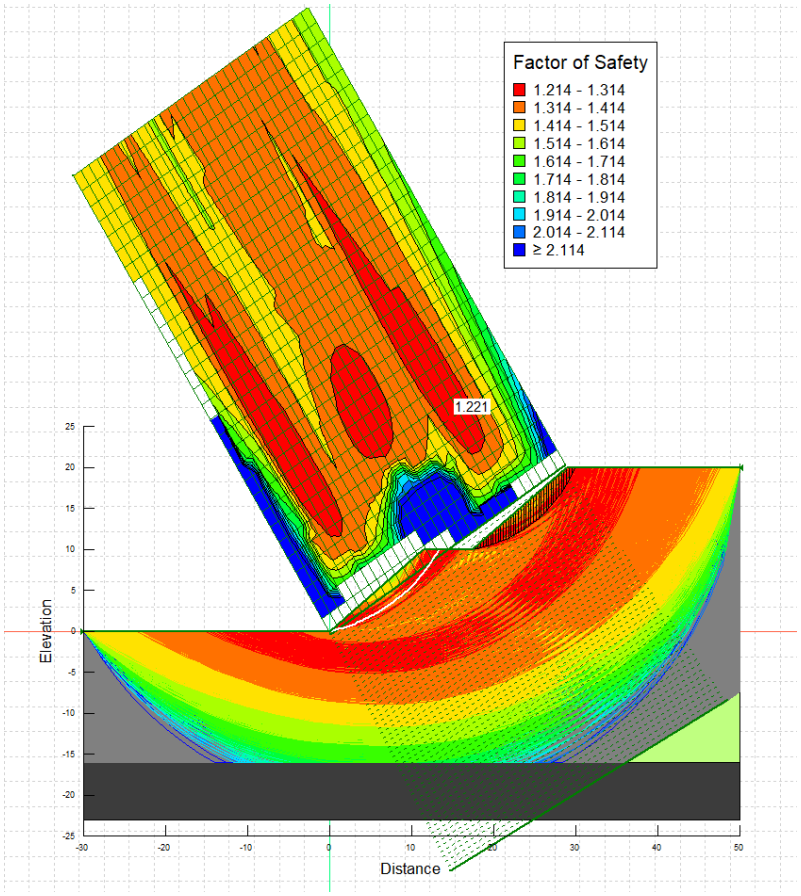

Figure 3: Local minimum for superficial mechanism according to Bishop simplified method, F=1.221

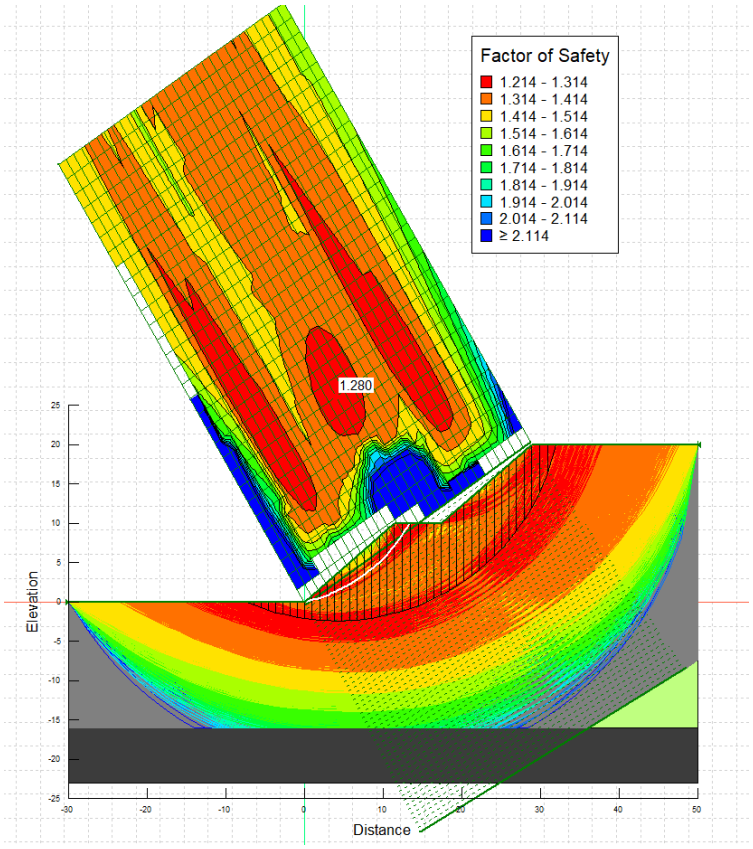

Figure 4: Local minimum for deep mechanism according to Bishop simplified method, F=1.280

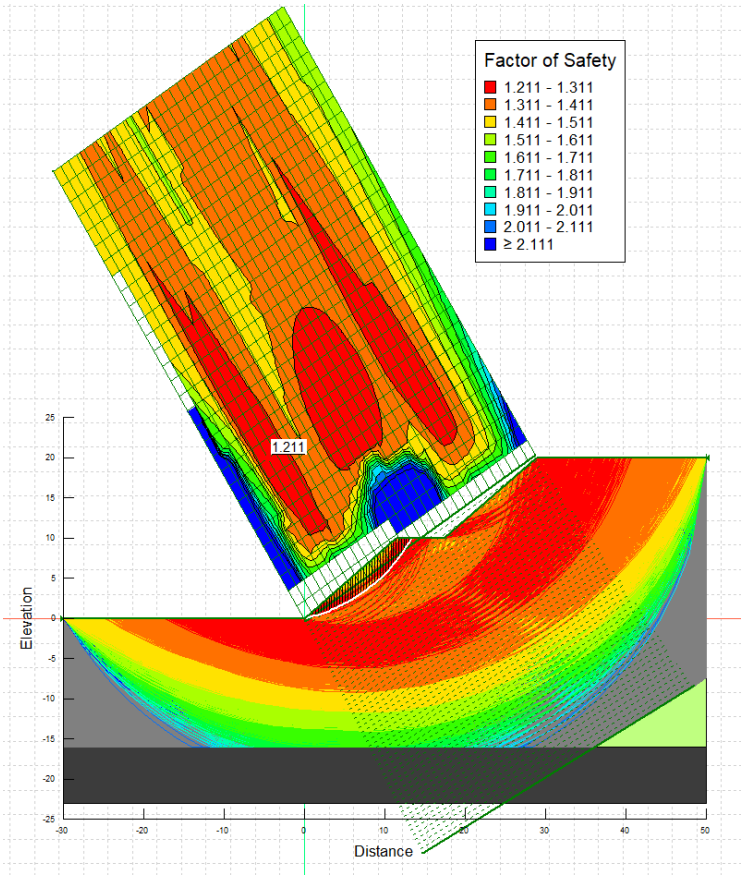

Figure 5: Results according to Morgenstern-Price complete method F=1.211.

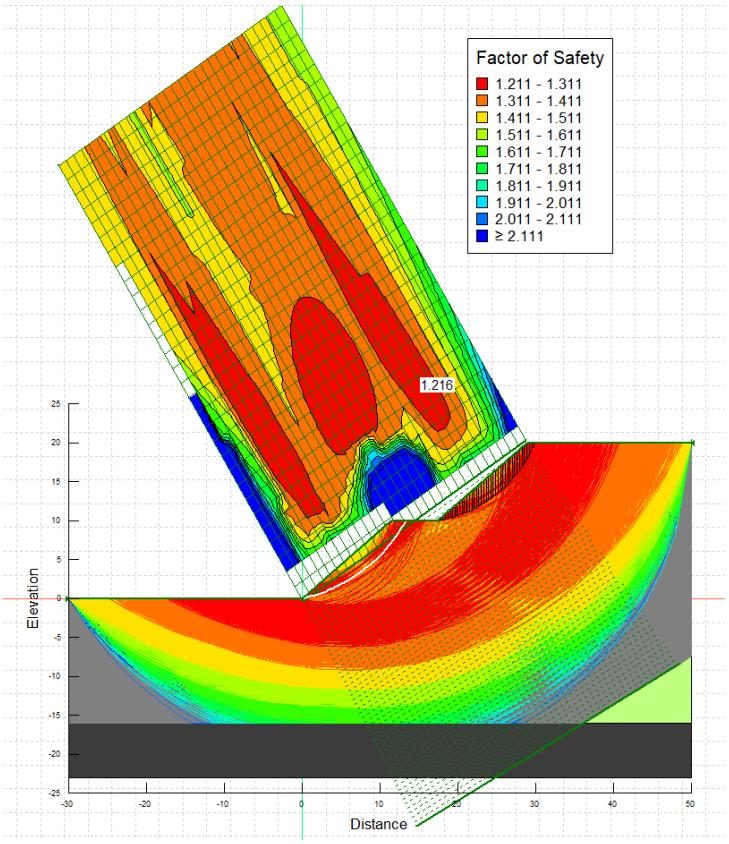

Figure 6: Local minimum for superficial mechanism according to Morgenstern-Price, F=1.216

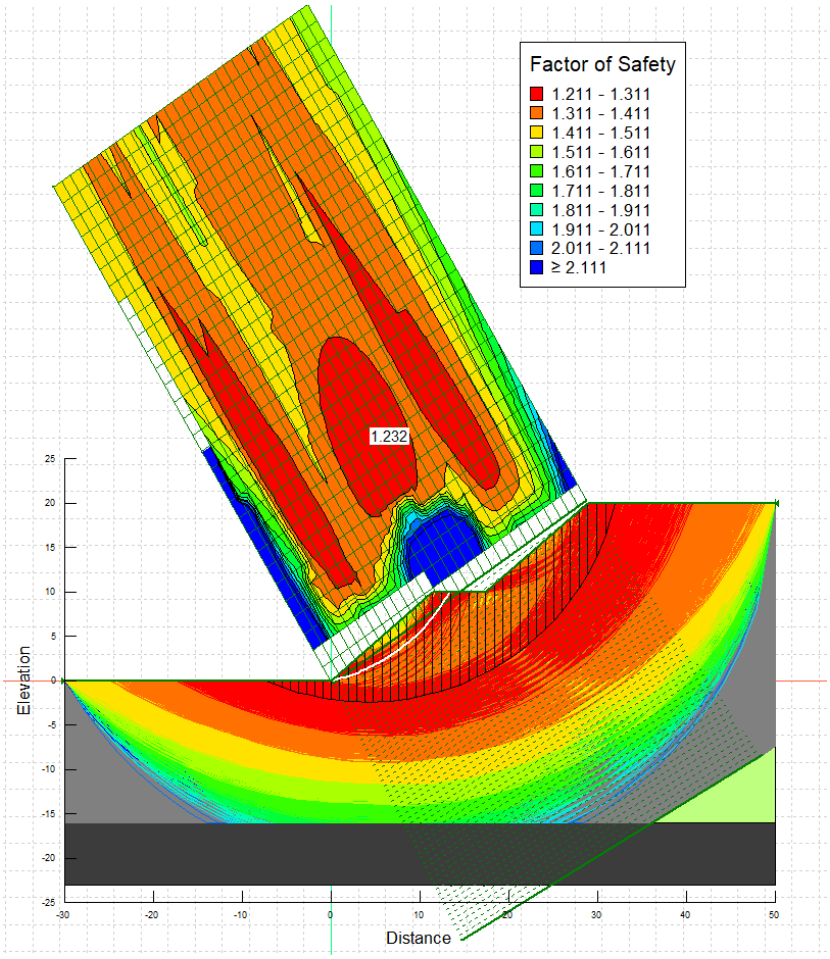

Figure 7: Local minimum for deep mechanism according to Morgenstern-Price, F=1.232

References:

1. Krahn, John. Stability Modeling with SLOPE/W - An Engineering Methodology. 2004.

2. Stability Modeling with GeoStudio (http://downloads.geoslope.com/geostudioresources/books/9/0/SLOPE%20Modeling-20180124.pdf