Slope Stability

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Exercise 4a - Solution

LEM software application

EXERCISE AND TUTORIAL OF GEOSTUDIO SLOPE/W

Introduction

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 with reference to 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 $F = min_i \{F(s_i)\}$.

GeoStudio 2018 can be downloaded at the following website: https://www.geoslope.com/learning/downloads/alternate-downloads. A tutorial is presented in section 1.2 in order to guide the student through the basic steps of GeoStudio. The tutorial refers to the GeoStudio 2018 version (if you would like to download a newer version there might be some small differences compared to this tutorial but it should be quite easy to understand them).

1.1 Description of the exercise

In Exercise 3 the slope given in Figure 1 was analyzed by applying the simplified Bishop's method. The slope stability analyses were performed by referring to a given failure surface. The geometry and soil properties are recalled in Table 1.

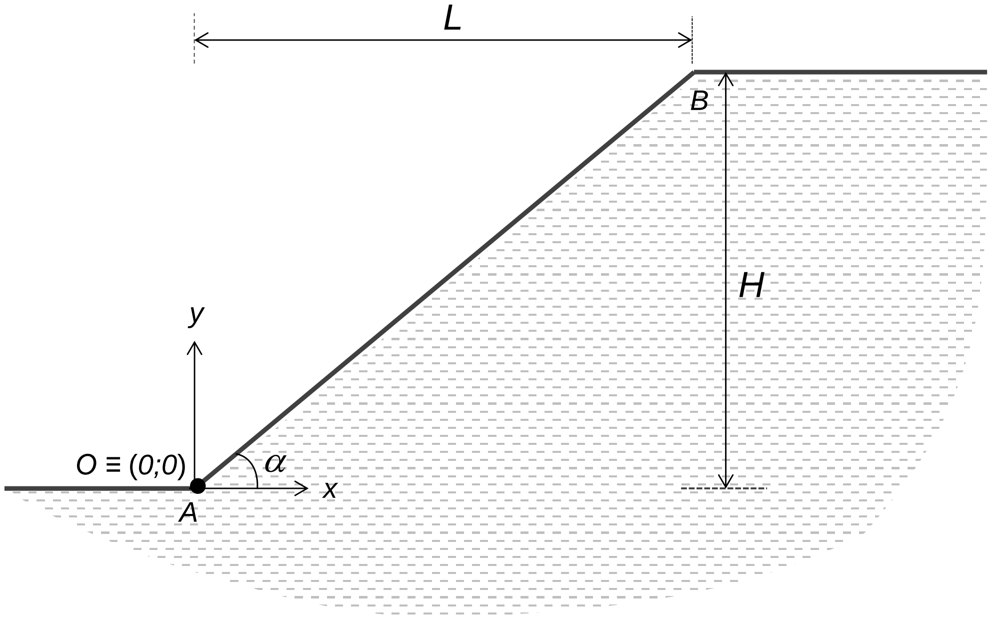


Figure 1: slope geometry.

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

γ_{sat} (kN/m^3)	γ_d (kN/m^3)	α (°)	H (m)	L (m)	φ' (°)	c' (kPa)
21.0	18.0	30.0	8.0	13.9	22.0	5.0

Subdivide the slope in a number of slices equal to 20 and perform the stability analyses by using the simplified Bishop's method and the Morgenstern-Price method.

Part a

By referring to the simplified Bishop's method, evaluate the safety factor of the failure surface given in Exercise 3 (i.e. check the consistency between the results obtained by using the software and the results obtained by using the Excel file for the provided failure surface).

Part b

Evaluate the actual safety factor $F = min_i \{F(s_i)\}$ of the given slope, in the dry and submerged conditions; evaluate if the failure surface provided in Exercise 3 coincides with the actual one (i.e. the one providing the minimum safety value).

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 for each condition? 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.

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

	BISHOP simplified	*MORGENSTERN-PRICE*
dry slope	F = (x_C ; y_C) = r =	F = (x_C ; y_C) = r =
submerged slope	F = (x_C ; y_C) = r =	F = (x_C ; y_C) = r =

<u>Solution</u>

Part a

The slip surface provided in Exercise 3 does not coincide with the critical slip surface. For the slip surface provided in Exercise 3, a value of the safety factor approximately equal to the one obtained by using the Excel file is obtained.

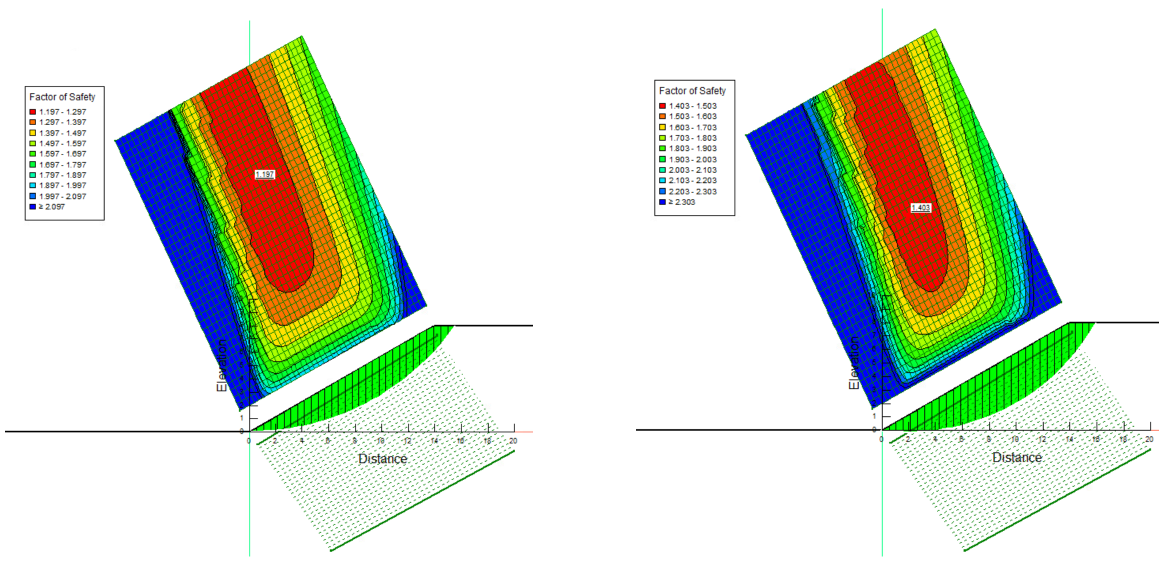
Part b

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

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

	BISHOP simplified	*MORGENSTERN-PRICE*
dry slope	F = 1.197 (x_C ; y_C) = (0.24 m; 18.75 m) r = 18.71 m	F = 1.194 (x_C ; y_C) = (0.24 m; 18.75 m) r = 18.71 m
submerged slope	F = 1.403 (x_C ; y_C) = (2.00 m; 15.90 m) r = 16.03	F = 1.400 (x_C ; y_C) = (2.00 m; 15.9 m) r = 16.03

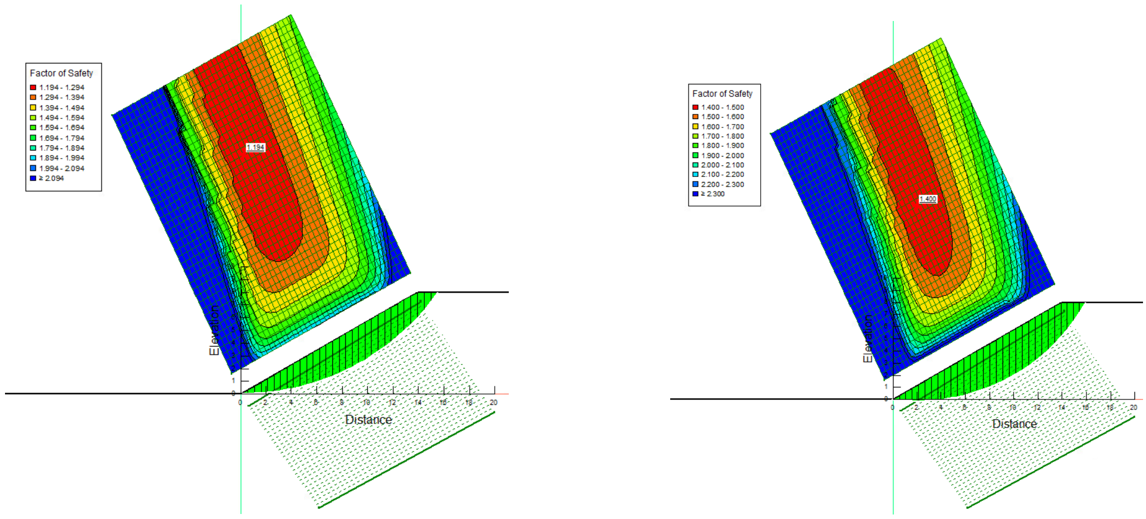
The safety requirement $F \geq 1.3$ is satisfied only for the submerged condition. Figure 2 and Figure 3 show the contour maps and the identified critical failure surfaces for the analyzed cases.



(a): dry conditions: 1.197

(b): submerged conditions:1.403

Figure 2: results according to the Bishop's method.



(a): dry conditions: 1.194

(b): submerged conditions:1.400

Figure 3: results according to the Morgenstern-Price method.