Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2912-1309
Vol. 2 Issue 2, February - 2016

Slope Stability Analysis Using Finite Element Method

Meftah Ali
Civil Engineering, Sidi Bel Abbés University, Algeria
genietech2013@yahoo.fr

Abstract— **This study aims to analyze the static stability and pseudo-static slope by using the finite element method. The analyses were carried out using SAS-FEM (stability analysis of slopes using finite element method), modeling in two dimensions to calculate the safety factor values, under various loads such as earthquake effect, the water level, and road mobile charges, to evaluate the state of the slope. The results of the static study show that the slope is stable against by the results of the study indicate that the pseudo-static makes the slope unstable.**

Keywords—Slope stability; finite element method; pseudo-static; safety factor.

I. Introduction

Traditional tools used to address the problem of slope stability based on simple static approaches (equilibrium calculation limits the method of slices), although these approaches practice, are not stringent since they do not take into account the seismic action on structures [1]. In this area Duncan [2] has a much more detailed study of equilibrium and finite element analysis methods, this study is included as an example of the ordinary method of slices, the balance of power method, Spencer method, the method of prices, widespread Janbu method, and the method of Morgenstern. These methods generally require the soil mass to be divided into slices. There after Zaki. [3] Provides a real advantage for the use of finite element more than the limit boundary equilibrium method. Lane et al. [4] present an assessment of slope stability under drawdown of the water level by using the finite element method has produced a chart. Kim et al. [5] analyzed several slopes with different soils, with an irregular geometry.

The development of methods numerical computer calculation, (method of finite differences and finite element method), allowed to look much more realistic and general solutions, based on a number of theological models and algorithms for solving the various aspects of soil behavior, these models based an nonlinear elastic approaches, or on elastic-plastic approaches for describing quite properly the behavior of soils. When the resolution algorithms, reliability and performance depend essentially on the method of calculation used, and define the convergence criteria. In general, there are two approaches to the analysis of slope stability of finite element method, the first is to increase the gravity load, and the second approach is to reduce soil shear parameters.

This research presents a static analysis and pseudo static of a slope located near the RN 90, in the town of Mazouna (wilaya of Relizane - Algeria) [6].

Using the finite element method provides a crucial advantage, especially in cases where the slope has a complex geometry or when the slope is prone to various types of loads such as static or pseudo static. The SAS-FEM software performed the analyses. [7] It can analyze slope stability of finite element method, and calculate the mass of any safety factor is sloping soils of one or more layers, with or without the presence of the layer of water, under monotonic stress or pseudo static; he uses the technique of reducing the shear strength to calculate the safety factor.

II. Modeling of the Slope by Finite Element Method

TABLE I. Material Properties

The layers	γ_h (KN/M3)	Cu (KPA)	φ
The backfill layer	19	20	15 °
The altered marl layer	18	13	17 °
The own marl layer	21	146	14 °
Stop (gabion)	21	10	35 °

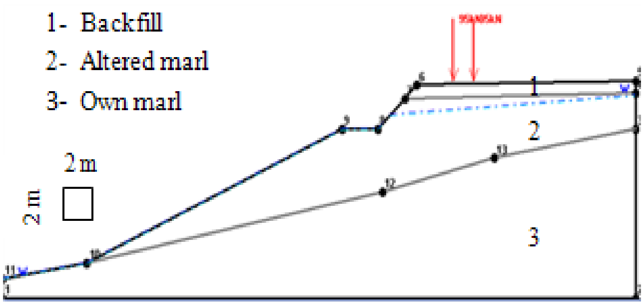


Fig. 1. *Modeling of the slope with SAS-FEM*

Fig .1 *shows the modeling Mazouna slope by the SAS-FEM software with the presence of water level, and road load*

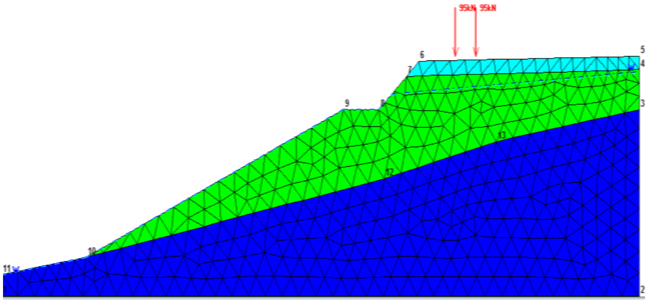


Fig. 2. *Mesh* slope

Fig .2 *presents the profile of the geometric model with a non-deformed mesh thereof.*

III. RESULTS OF CALCULATIONS OF STATIC STABILITY (SAS- FEM)

The results of static calculations and their designated graphic presentations in the figures below, Figure 3 shows the slope of deformed mesh (Fig. 3), the fracture surface (Fig. 4) and the displacement vector (Fig. 5).

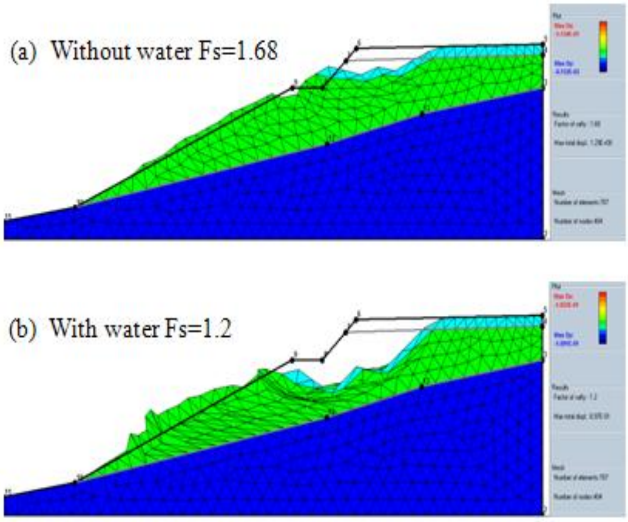


Fig. 3. *Deformed mesh slope*

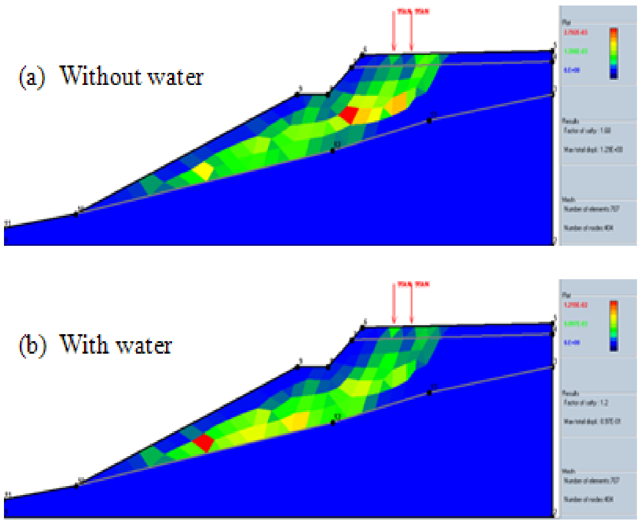


Fig. 4. *Failure Surface*

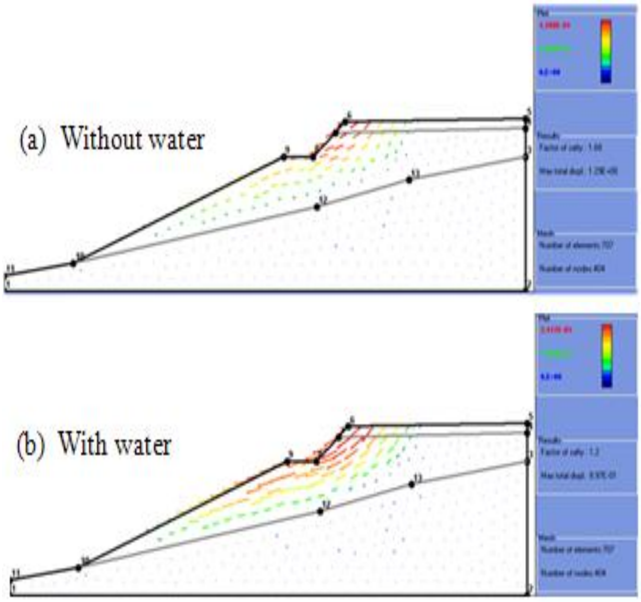


Fig. 5. *Displacement vector*

- DISCUSSION

Arguably, the results of stability calculations from SAS-FEM show that the slope is stable under static conditions.

IV. RESULTS OF CALCULATIONS OF THE PSEUDO-STATIC STABILITY (SAS- FEM)

Fig. 6 *shows the result of calculation of the pseudo static stability of finite element method SAS-MEF without the effect of the water. Calculation results are presented in Table II.*

TABLE II. RESULTS OF THE PSEUDO-STATIC CALCULATION WITHOUT WATER (SAS-FEM)

Kh	0.10	0.20	0.30	0.40	0.50	0.60
Fs	1.68	1.34	1.08	0.90	0.82	0.72

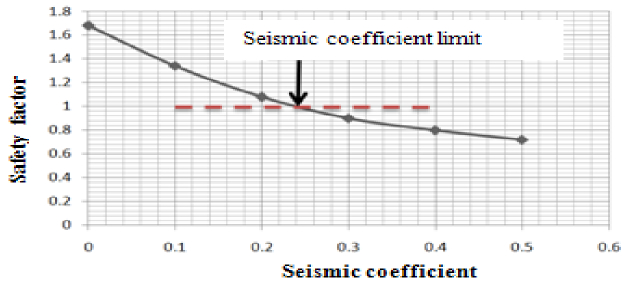


Fig. 6. *Results of calculations of the pseudostatic stability SAS-FEM without water*

- DISCUSSION

Analyses of the pseudo-static stability by finite element method without water (SAS-FEM), the seismic coefficient Kh limit is 0.24, higher than this seismic coefficients have a lower coefficient of safety 1 (Fig. 6).

Fig. 7 shows the results of calculations of the pseudo static stability of finite element method with

SAS-FEM the effect of water, the results of calculations are presented in Table III.

TABLE III. RESULTS OF THE PSEUDO-STATIC CALCULATION WITH WATER (SAS-FEM)

Kh	0	0.10	0.13	0.20	0.30	0.40	0.50
Fs	1.20	0.94	0.86	0.76	0.66	0.60	0.56

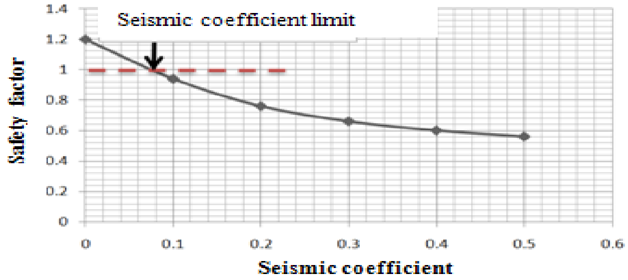


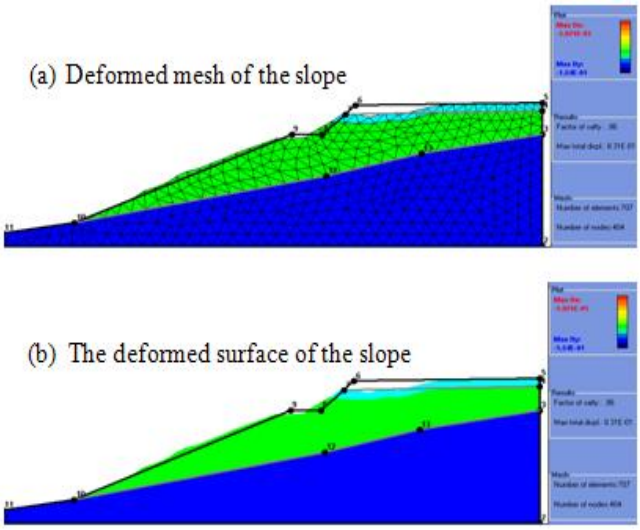
Fig. 7. *Results of calculations of the pseudo-static stability SAS-FEM with the effect of the water*

- DISCUSSION

From analysis of the pseudo static stability by finite element method (SAS-FEM), and under the effect of the water, the seismic coefficient is limited 0.08, higher than this value have a coefficient safety of less than 1 (Fig. 7).

V. ALGERİAN EARTHQUAKE REGULATİONS RPA99 VERSİON 2003:

For horizontal seismic coefficient Kh = 0.13, and under the effect of traffic loads and the effect of the water, the SAS-FEM software gives us a safety factor Fs = 0.86, so theoretically the slope is unstable, Fig. 8 graphically shows the operation of this result [8].



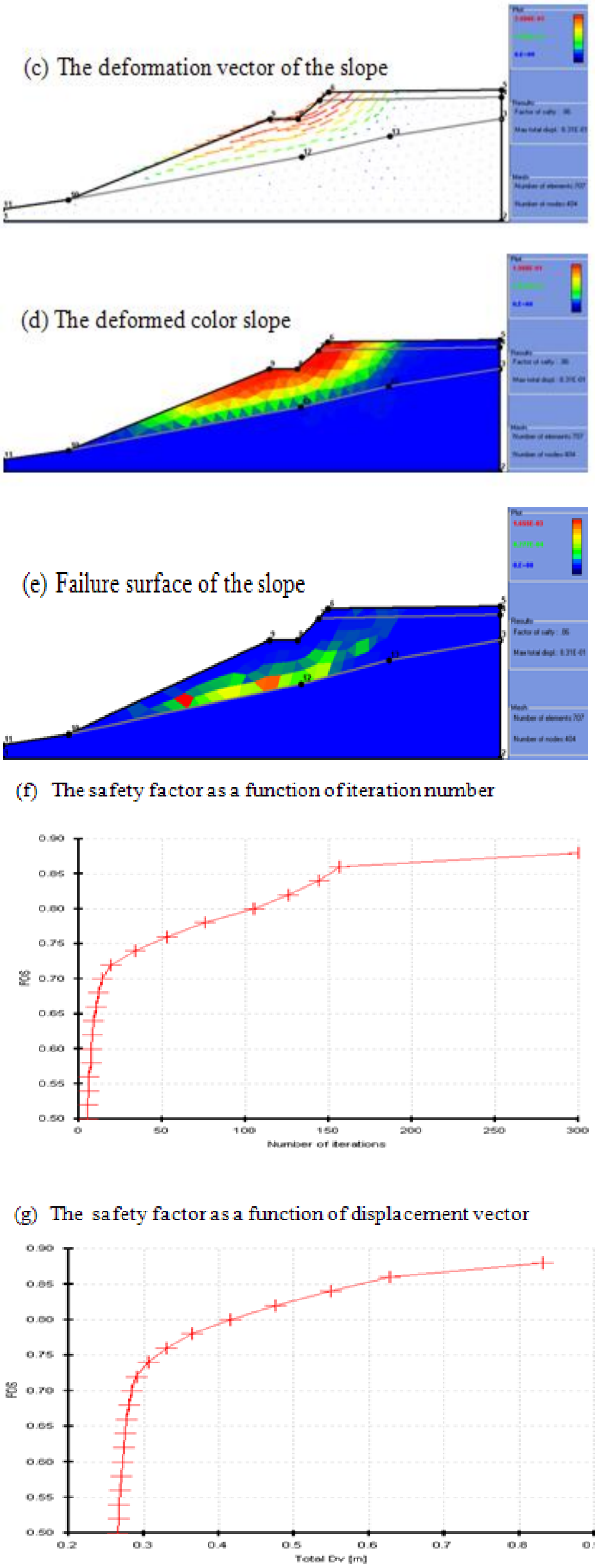


Fig. 8. Graphical exploitation of results

VI. CONCLUSIONS:

This study, presented the analysis of the stability of the slope Mazouna by the finite element method. Static analysis results indicate that the slope is stable theoretically, for against the static analysis results nickname, gives us a limited seismic coefficient is around 0.24, RPA 99 amended 2003 also shows the seismic instability this slope.

The study analyzed a real case, and conclude probable causes rupture of a slope, as the resistance of soil, full, the effect of pore pressures, excessive loading effect upstream slope and the effect of unloading, if any, down the cons slope in the presence of a possible earthquake.

The rupture often comes either from increased stress associated with changes in the hydraulic characteristics, or a reduction of soil strength characteristics, or their combination.

REFERENCES

[1] A. Meftah, 2015. "Static analysis and pseudo static slope stability", International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, waste, Vol: 9, No: 6, 2015, pp. 658 - 661.

[2] J. Duncan, 1996. State of the art: limit equilibrium and finite element analysis of slopes. J Geotech Geoenviron Eng ASCE 122(7):578–584.

[3] A. Zaki, 1999. Slope stability analysis overview. University of Toronto

[4] P. Lane, D. Griffiths, 2000, Assessment of stability of slopes underdrawdown conditions. J Geotech Geoenviron Eng ASCE 126(5): 443–450.

[5] J. Kim, Salgado, J. R. Lee, 2002. Stability analysis of complex soil slopes using limit analysis. J Geotech Geoenviron Eng ASCE 128(7):546–557

[6] A. Meftah, 2013. "L'utilisation de la méthode des éléments finis et les méthodes classiques pour l'analyse statique et pseudo statique de la stabilité des talus" mémoire de Magister, Université de Saida, Algérie, 2013, 127 p.

[7] k. Belakhdar, 2008. SAS-FEM, ce logiciel a été développé par lui.

[8] RPA. 1999 (Version 2003). "Règles Parasismiques Algérienne ", 89 p.