Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Second Engineering Scientific Conference
College of Engineering –University of Diyala
16-17 December. 2015, pp. 13-19

SLOPE STABILITY EVALUATIONS BY FINITE ELEMENT METHODS IN DIFFERENT SOIL PROPERTIES

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ABSTRACT: - This paper deals with slope stability assessment carried out by regularly used finite element (FE) methods. The study utilizes based software (PLAXIS). The main objective obtain from this study is to simulation and analysis of slope in case of different soil properties. Due to complexity for modelling different soil condition in previous studies, this study aims to solve this problem in this kind of condition. It was conclude that, the sandy soils observed high displacement compared other soils. The deep sand and deep clay resisted more than the normal soils like sandy soil and clayey soil.
Keywords: slope stability, factor of safety, 2D FEM, failure criteria, total displacement

1- INTRODUCTION

Instability related problems in the construction field as well as natural slopes are communal challenges to equally researchers and specialists. In construction areas, instability possibly result due to rainfall, rise in groundwater table and modification in stress conditions. Similarly, natural slopes that have been stable for several years could be rapidly fail due to changes in geometry, external forces and loss of shear strength (Abramson et al. 2002).

According to (Abbas, 2014 and 2015), a many of investigation had been exist meanwhile the paper of the original method of analysis by (Huang et al., 2013) that were whichever related to slope stability or complicated slope stability analysis problems. Among the current methods of analysis are the limit equilibrium methods of slices, boundary element methods (Jiang, 1990), finite element methods (Matsui and San, 1992), and neural network methods (Jaritngam et al, 2001). There are several additional investigates for the problem of slope issue using different method and especially FEM (Leong and Rahardjo, 2012; Li et al., 2009; Ji et al., 2012; Jinchun et al., 2013)

In view of that, the slope stability problems need further and additional studies. Commonly, various investigators endorse to use finite element method for many reasons. This suitable and easy method can help the researchers and professionals to assess wholly probable problems can be established throughout studying the problems of slope stability. Hence, this study includes 2D finite element simulation and analysis of slope stability problems.

Details of Case Study

Figure 1 shows plan and profile views of idealized prototype of side slope with totally of B and height of highest point represented by H1 while the lowest point is represented by H2. This project takes into account two types of soil, sandy and clayey soil. It has been assumed that the characteristics of these soils are constant during the study. In addition, the depth H1 is constant. While the study take various values of H2.

METHODOLOGY

The soil profile includes one layer soil condition with different soil specification. In addition three layers soil profile with and without inclination. This evaluation provided by adopting 15-node triangular elements for finite element simulation with Mohr-Columb elasto-plastic model to represent the surrounded soil. This study was also representing the soil in drained condition. The baseline soil parameters used for the analysis of slope stability are illustrated in Table 1.

The investigation was achieved with PLAXIS 2D program, Two-dimensional (2D), plane strain FE modeling has been used to simulate the whole geotechnical system as illustrated in in next sections. All dimensions are in meters as usual cases. The bottom boundary condition is fixed of the slope system, which means no deformation occurred in boundary. In addition only vertical deformation can be occurred on both sides of this case study. There are no any external load applied in this case, that means the assessment is depend only on the gravity force of the soil. As a result of FEM, the whole system is divided into a number of triangular elements; all elements include number of nodes with certain degree of freedom. In the analysis of slope stability problems it is important to consider the final stability. It is interesting to evaluate the global safety factor in the case. A more appropriate definition of the factor of safety is therefore: safety factor is equal to S (maximum available) to S (need for equilibrium), where S represent the shear strength. The finite element mesh for this case was illustrated in Figure 2.

RESULTS AND DISCUSSIONS

This part the assessment of slope stability using the data of 16 soil types. The soil used in this study is homogenous and included only one layer. The comparison has been done for all these types of soil to provide good assessment for most types of soils and slope angle.

Single layer and different soil conditions

The case is included the affect for type of soil on the behavior of slope. The soil profile was involved only one layer. In this situation, the soil take into consideration as one types and this represented the deep layer system. Depend on this, the sandy soils show high displacement when compare with other soils. This is probably as a result of high soil resistance for the case of clayey soils. It can be observed that for deep sand and deep clay resisted more than the normal soils such as sandy soil and clayey soil, respectively and it can be shown in Figure (3). Overall, the slope angle below 12 degree take a smaller amount of displacement compared with angles above these values. This is perhaps due to effect of slope angle which can conduct the small angle is usually represent high stability.

Furthermore, the Extreme Total Principle Stress verses slope angle is shown in Figure 4. It can be concluded that the influence of soil type on the performance of slope is really represented by this figure. This figure can be used in any related study to assess the performance of slopes in any type of soils. In the other hand, the extreme total strain versus slope angle is illustrated in Figure (5). As well as the extreme active PWP is illustrated in Figure (6). All these figures is generally included most expected issues for soil in case of slope stability problems.

Prediction of Safety Factor

The prediction of factor of safety results from finite element simulation was discussed in this part. Figure 7 shows the FOS versus slope angle.

CONCLUSIONS

The sandy soils observed high displacement compared with clayey soils. The deep sand and deep clay resisted more than the normal soils like sandy soil and clayey soil. The total stresses are similar for all soil types until reached to 12 degree. The total strain is slightly increased from lower values to maximum magnitude in two case (i.e. deep sand and deep clay). The deep sand obtained high FOS compared with other types of soils.

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Table 1 soil specifications

	γuns KN/m2	γsat KN/m2	E kN/m2	ν -	c kN/m2	ϕ -
sandy soil (S1)	17	20	1300	0.3	1	31
Sandy soil (S2)	17	20	41000	0.3	1	32
sandy soil (S3)	17	20	20000	0.3	1	25
sandy soil (S4)	17	20	30000	0.3	1	34
sandy soil (S5)	16	20	3000	0.3	1	30
Sandy soil (S6)	16.5	20	80000	0.3	1	31
clayey soil (S7)	16	18	10000	0.35	5	25
clayey soil (S8)	16	18	2000	0.35	2	24
calyey soil (S9)	15	18	1000	0.33	2	24
Calyey soil (S10)	15	18	1000	0.33	5.5	24
peat soil (S11)	8	11.5	500	0.35	7	20
Fill (S12)	16	20	8000	0.3	1	30
Loam (S13)	17	19	20000	0.33	8	29
Peat soil (S14)	8	11	350	0.35	5	20
deep clay (S15)	16	18	100000	0.33	4	25
deep sand (S16)	17	21	120000	0.3	1	33

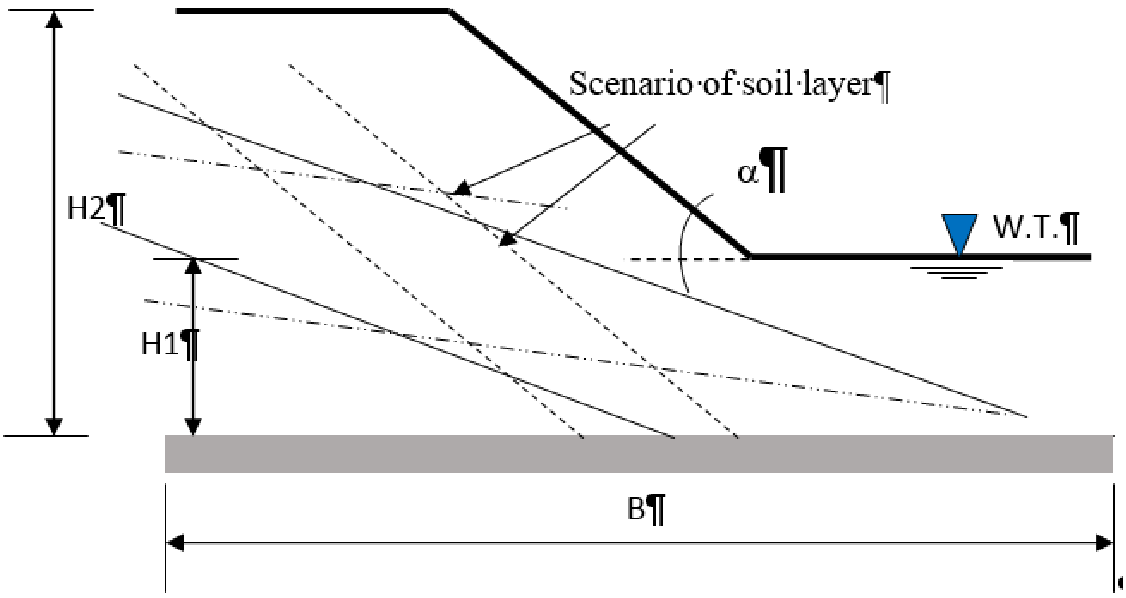

Figure 1. Model for the slope

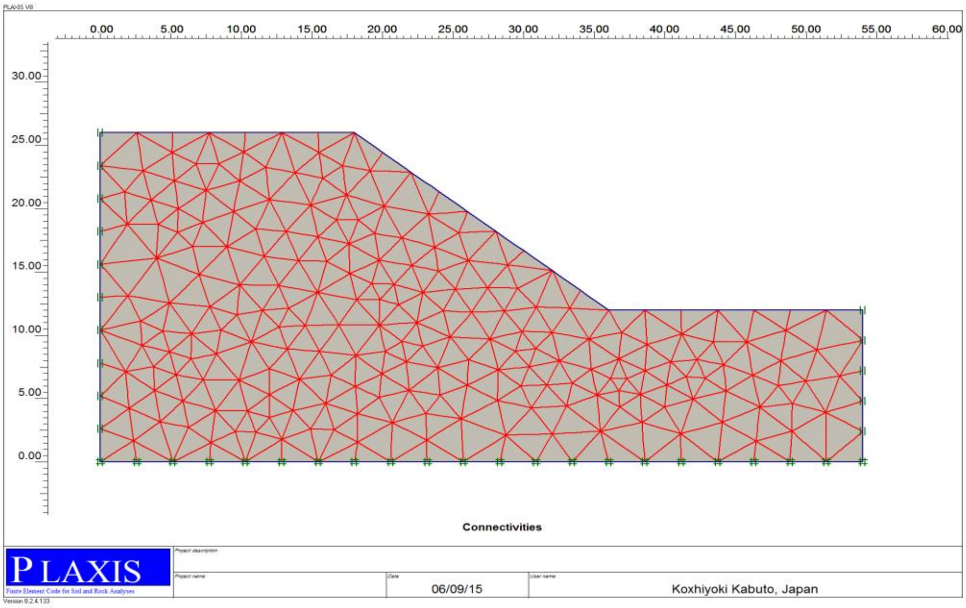

Figure 2. Two Dimensional Finite Element mesh

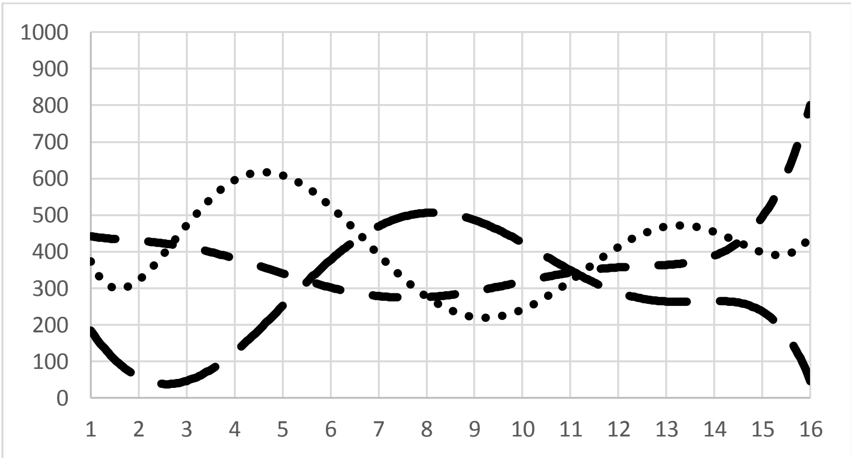

Figure 3. Total Displacement (mm)

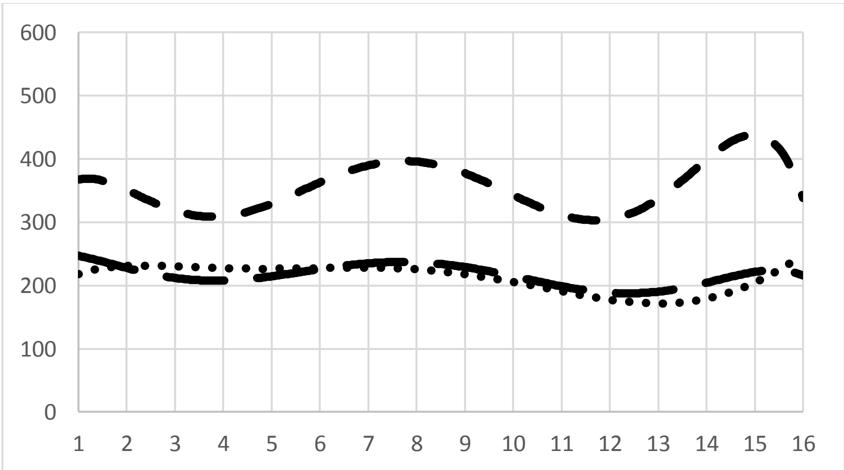

Figure 4. Extreme Total Principle Stress kN/m3

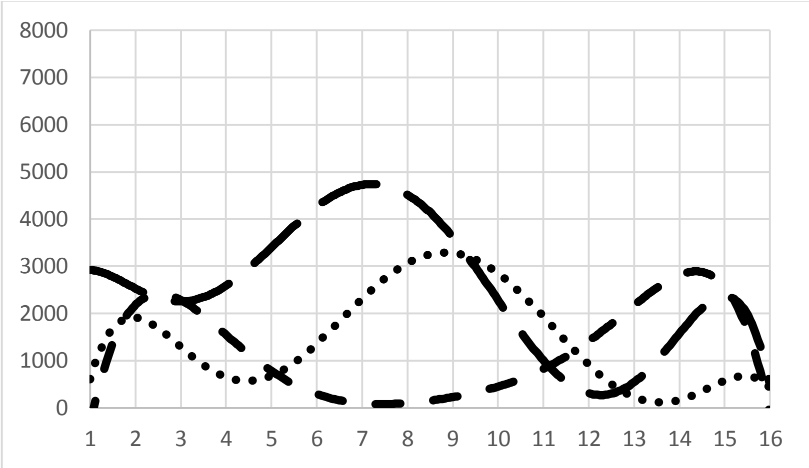

Figure 5. Extreme Total Principle Strain %

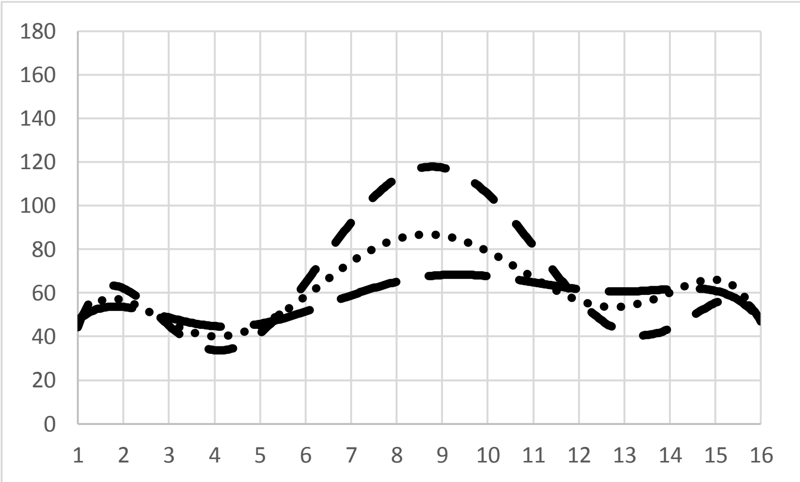

Figure 6. Extreme Active PWP kN/m2

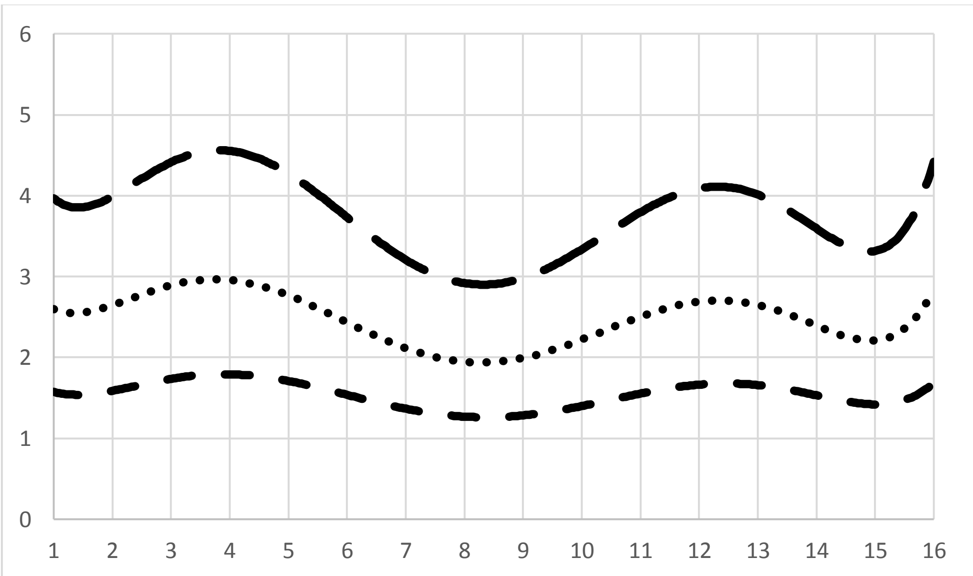

Figure 7. Factor of Safety FOS

الخلاصة:

تقوم هذه الدراسة بتقييم الميل بواسطة الطريقة التقليدية وهي طريقة العناصر المحددة. وتم استخدام برنامج (بلاكسز) المختص. ان الهدف الأساسي من هذه الدراسة هو تمثيل وتحليل الميل في حال تغيير خواص التربة. بسبب صعوبة تمثيل التربة في مختلف الظروف في الدراسات السابقة فان هذه الدراسة يمكن ان تأخذ بنظر الاعتبار هذه الحالات. يمكن الاستنتاج ان الترب الرملية تعطي هطول اعلى من الترب الأخرى. و ان الترب الرملية العميقة و الترب الطينية العميقة بالتأكيد تعطي مقاومة اعلى مقارنة بباقي أنواع الترب.