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Application of Genetic Algorithm for the Length Design of Reinforcement in Reinforced Soil Slopes

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ABSTRACT

Two effective parameters in determining the length of reinforcements in the reinforced soil slopes are, the one, the length of reinforcement located in the active zone till to the location of failure surface and the second, the length of reinforcement located after the failure surface. Generally, the first one is calculated based on the angle of failure wedge by Rankin method. In this method the effect of reinforcement on the location of failure surface is ignored, while the presence of reinforcement is effective.In order to assess the location of the failure suface, the horizontal slice method based on Spencer assumption is used. In this method, slippery mass with the presence of reinforces is divided into a number of horizontal slices parallel to reinforcement direction. Inter-slice forces are computed by using Spencer basic rules. Earthquake load is affected on the center of each slice by horizontal and vertical pseudo-static coefficients. In the presented method, unlike the other existing methods, all of the critical slip surfaces are examined and are reinforced. In this paper, Genetic Algorithm (GA) optimization method is used to optimize the objective function for the produced non-circular slip surface of each horizontal for the safety factor of one. By comparing the results of Genetic Algorithm optimization approach introduced in this research with the results of the other investigators for the same geometry, material properties and loadings of the slopes it is indicated that the introduced and utilized method is more critical for the estimation of the length of reinforcements and the design of reinforcements with the proposed method is more reliable.

KEYWORDS:

Reinforced Slope, Optimization, Genetic Algorithm, None Circular Failure Surface

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1- Introduction

One of the problems with the evaluation of the reinforced soil slopes is the assumption of the circular and smooth shape of failure surface. Or flat and continued shape of the slide surface based on Rankin assumption. While, with the presence of the reinforcement, the shape of failure surface is not a simple circle or continued and flat slide surface.

In this research, according to the horizontal slice method introduced by Ling [1] and based on Spencer assumptions [2] for the slop stability analysis, which a reinforced soil slope is divided into a number of horizontal slices or segments parallel to the reinforcement.

Taking into account the equilibrium equations including all applied forces and their induced moment on each slices, their summation of all forces and their moment should be also considered to zero for the factor of safety of one.

By application of Genetic Algorithm method [3] the summation equation is considered as an objective function for factor of safety of one.

Through the optimization process, the most probable and critical sliding surface of each slices is investigated and detected. At the same time the length of the reinforcement located in the passive zone of each slices should we estimated by considering the constrain of bearing capacity satisfaction and resistance of the reinforcement against to the applied pulling out force reinforcement located in each slices.

2- Methodology Of The Research

In order to do the research, first of all the most critical slip surface of each slices should be detected .For the production of the sliding surface, the approach introduce by Cheng [4,5] and Nouri et al [6] is used. In this research, the pore pressure is not considered and the base of the reinforced soil slope is assumed rigid and very dense.

To optimize the resultant of all applied forces and also their moment applied an each slice around each point of interest should be zero. Thus, the objective function for optimization would be introduced by equation (1).

$$|\sum M| + |\sum (Q_i \cos\theta_i)| = 0 \quad (1)$$

Qi: The inter slice resultant force, the slice number i

After of optimization in accordance with the provisions of none-tearing and none-pulling out of the reinforcement strip, the length of each slice is calculated.

The results of length calculation are introduced by the dimensionless parameter of Lc/H for different internal friction angles and for different slope angles.

3- The Evaluation Of The Results And Disscusion

In order to evaluate the results of this study, the obtained results were compared with the results of three other researchers including Ling [1], Michalowski [7] and Nouri et al [6].

The geometry and geotechnical characteristics of the slopes studied in this research are presented in Table 1 in accordance with three other researchers.

Table 1. Geometry and geotechnical characteristics of reinforced soil slopes

5m	Height of slope (H)
45°-90°	Slope angle to horizon (β)
18 kN/m^3	Soil density (γ)
0	Cohesion (c)
20-45°	Internal friction angle (φ)
0.2	Horizontal acceleration coefficient (α_h)
0	Vertical acceleration coefficient (α_v)
1	Factor of safety (F.S)

5The results for the dimensionless parameters Lc/H for horizontal earth quake acceleration coefficient 0.2, slope angle of 450 and internal friction angle between 200- 450 are displayed in Figure 1.

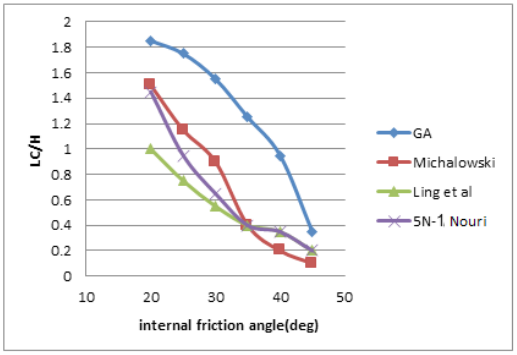

Figure 1. Lc/H vs internal friction angle (deg) for (α_h=0.2, β=45°) for all four methods of analysis

As the results indicated, the length of reinforcements estimated by GA approached is increased in comparing with the results of three other

researchers.

The Lc/H estimated by GA method for slope of 450 shows an increase in comparing with Michalowski [7] results with an average 28 percent and Ling [1] and Nouri et al [6] results with an average 95 percent.

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4- Conclusion

The horizontal slice method introduce by Ling[1] this simple and useful for analyzing of the reinforced soil slopes.

The ratio of estimated by GA approach shows a distinguishable increase in comparing with other three methods introduced in this research. By increasing the slope angle, this ratio is also increased.

The broken slip surface of the reinforced soil slope which is detected and investigated by optimization of the objective function of each slice is most likely failure surface of the slope. In other words, this broken surface of the reinforced soil slope detected by GA approach can represent the real failure surface of the reinforced soil slope.

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