



Reliability analysis for static stability of reinforced soil

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ABSTRACT: In this study the stability of the flexible walls and the type of reinforced soil walls are evaluated to examine the stability and design the retaining walls with reliability method which gives more realistic results than other design methods. In this paper, using related softwares the effect of various parameters such as internal friction angle, soil specific gravity, reinforcement resistance, friction angle between the soil and the retaining wall, load, assuming uncertainty in the parameters and also the investigation the correlation of parameters will be investigated on the stability of reinforced soil walls after analyzing and determining the effective parameters among these parameters, we will analysis the sensitivity of these parameters to see which of these parameters has more influence on the stability of reinforced soil walls. Two types of stability are considered in reinforced soil walls which include external stability and internal stability.

1- INTRODUCTION

Retaining walls are walls that maintain the pressure caused by the existing state of the difference in levels caused by embankment, excavation or natural factors. A retaining wall is a structure that holds or retains soil behind it. There are many types of materials that can be used to create retaining walls like concrete blocks, poured concrete, treated timbers, rocks or boulders. Some are easy to use, others have a shorter life span, but all can retain soil [1]. Seismic designs of geotechnical earth structures, such as slopes, retaining walls, embankments and dams, are conducted routinely using a pseudo-static approach [2, 3].

Reinforced soil retaining walls can be broadly categorized into following two types; Cantilever retaining walls and Geosynthetic reinforced soil retaining walls. Cantilever earth-retaining walls are made of cast-in-place and steel-reinforced concrete. Also, cantilever retaining walls is able to retain soil behind it according to internal strength characteristics and rigidity. Geosynthetic reinforced-soil retaining walls consist of several horizontal layers of geosynthetic or steel reinforcements extended into a soil backfill and are generally pinned to a hard facing [4].

2- METHODOLOGY

Reinforced soil wall is a special material that is formed by the combination of the soil and the reinforcement member. Basically the soil is weak in stretching and cutting and the idea

of reinforced soil wall is in fact the solution to this problem. There are many uncertainties in civil engineering and in particular in the geotechnical discussions the discussion of the uncertainty of the parameters is much more evident because the anonymity of the soil behavior. The traditional methods of evaluated the stability of reinforced soil walls which are usually based on empirical judgments such as the concept of a coefficient. Efforts to quantify uncertainties causing genesis of probabilistic methods. Probabilistic analysis in comparison with definite analysis the uncertainties in the calculations and instead of using the confidence coefficient in the project safety level it usually uses the probability of failure or the reliability index. In these methods, the large values of the reliability index represent safety [5].

The sustainability of the reinforced soil walls includes the control of external stability and internal sustainability. In this research, referred to the FHWA guidelines [6].

The FHWA guidelines recommended that the safety factor of reliability for slip and overturning stability control be 1.5 and 2, and that the minimum safety coefficient for controlling the load bearing capacity recommended to be between 2 and 2.5. To control the rupture and pulling out of the arming, 1.5 is also proposed. In this study, soil bearing capacity is considered as a Vesic approach, reinforce material are geotextile and soil is coarse grains [7 and 8].

3- DISCUSSION AND RESULT

External stability includes three modes of failure and

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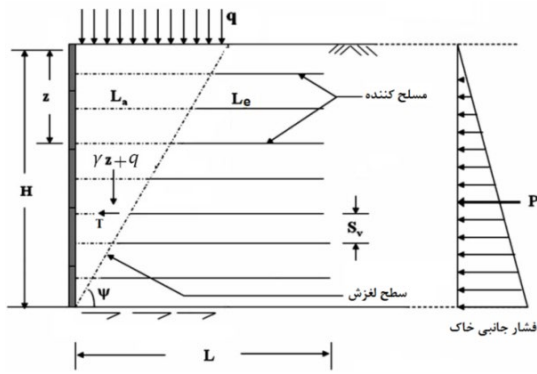


Fig. 1. Controlling the stability of the reinforced soil wall

Table 1. Reliability and probability index without regard to correlation

	Slip		Overturning		Load bearing	
	β	P_f	β	P_f	β	P_f
FORM	2.29	0.0108	6.96	1.69×10^{-12}	2.39	0.0083
MCS	2.27	0.0115	6.95	1.71×10^{-12}	2.38	0.0085

Table 2. Reliability and Failure Index with respect to Correlation

	Slip		Overturning		Load bearing	
	β	P_f	β	P_f	β	P_f
FORM	2.21	0.013	6.16	3.45×10^{-10}	2.34	0.0094
MCS	2.19	0.014	6.17	3.32×10^{-10}	2.34	0.0095

internal stability including two types of failure modes Overturning, Sliding, Bearing Capacity, Rupture and pulling out are considered as failures. The purpose of this study was first-order reliability analysis of the reinforced soil walls and validation was performed using the Monte Carlo simulation method then we will find that the reliability index in each mode of failure and the angle of internal friction is the most effective variable among variables because with the little change the reliability index dramatically changes.

In geotechnical engineering, the correlation between random variables is inevitable. Discarding the correlation between random variables can affect the answer. Correlation coefficient is one of the important parameters in reliability calculations.

Reliability calculations for extreme conditional functions

are done by writing the program in MATLAB and RT software. The program is performed in two “solidarity” and “no correlation” between variables whose results are presented in Table 1 and Table 2. These results indicate that the dependence of the specific gravity and the internal friction angle is very tangible and therefore, in this section, their dependence was investigated. The results of the FORM and Monte Carlo simulation show that the difference between them is less than one percent, and in fact, the FORM method can well determine the reliability index.

4- CONCLUSION

In this paper, the reliability analysis of the internal and external stability of the reinforced soil wall was performed in static conditions using the first order method. Validation of the data was done by Monte Carlo simulation method. These results are the result of studying the specific geometry of physical and mechanical properties of materials. The most important results of this research can be summarized as follows:

- The dominant failure mode is slip in external stability, while in internal stability it is a geosynthetic failure.
- The effect of correlation coefficient between different random variables can be very important for changing the reliability index.
- The sensitivity analysis showed that the first and second variables affecting the slip are, respectively, the angle of friction and the friction of the base of the wall. It also for wall overturning are internal friction angle and loading.
- The average variation of random variables showed that with increasing overhead, the reliability index decreases.
- The results of this study show that the type of probability distribution function can affect the reliability index. The type of distribution function has the greatest effect on the overturning of the wall.
- Considering the changes in the height of the wall and the geosynthetic length, it is observed that the reliability index decreases with the constant of the arming length with increasing wall height. Reversibly increasing the height of the wall with the increase of the arming length increases the reliability index.

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