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PSEUDO-STATIC RELIABILITY STABILITY ANALYSIS OF INFINITE SLOPE WITH TRIANGLE WEDGE FAILURE

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By increasing in demands for appropriate infrastructures, design of slopes in urban and industrial areas is currently required more than ever, given the fast-growing world population and developing countries. The occurrence of failures in such situations is not uncommon, and collapses may bring irreparable consequences to both life and property. This subject becomes crucial when accounting for the earthquake conditions due to the fact that Iran is located on the active seismic belt.

The simplified pseudo-static method of analysis is one of the most practical ones for seismic stability analysis of geotechnical structures (Kontoe et al., 2013). The pseudo-static approach is still the most common procedure employed for standard, seismic slope stability evaluation. This approach is a generalization of common Limiting Equilibrium (LE) slope stability analysis in which earthquake effects are represented by an equivalent static force, the magnitude of which is a product of a seismic coefficient k and the weight of the potential sliding mass.

Recent studies show the insufficiency of traditional deterministic assessment of stability problems in which stability is evaluated only base on the factor of safety (FS) (Cai and Ugai, 2000). Due to the inherent variability of soil properties, a reliability-based approach needs as a complementary measure to the FS to aid geotechnical experts to make acceptable designs (Duncan, 2000).

To address these issues, this paper provides a probabilistic framework with limit equilibrium by the coded program in MATLAB to evaluate the reliability indices of seismic stability of slope with consideration of inherent uncertainty of soil properties. The Monte Carlo simulation was used for probabilistic analysis and reliability assessment of the stability of infinite slopes with triangle wedge failure. The selected stochastic parameters were internal friction angle, cohesion, and unit weight which are modeled using a truncated normal probability distribution function (Johari and Javadi, 2012). Dimensionless horizontal and vertical pseudo-static coefficients are modeled using an exponential probability distribution function (Johari and Khodaparast, 2015).

Table 1. Stochastic parameters.

c (kPa)		φ (Deg.)		γ (kN/m^3)		k_h		k_v	
mean	**Std**	**mean**	**Std**	**mean**	**Std**	**min**	**max**	**min**	**max**
16.0	0.80	20.0	0.80	19.0	0.80	0.10	0.15	0.01	0.10

The parameters related to geometry, height, angle between failure line and horizontal ground surface (Beta), angle between slope surface and horizontal ground surface (Theta) and length of the failure plane were regarded as constant parameters.

On the other hand, the factor of safety formula is:

$$FS = \frac{c(lab) + [(w - Fv)\cos\beta - Fh(\sin\beta)]\tan\varphi}{(w - Fv)\sin\beta + Fh(\cos\beta)} \tag{1}$$

The final probability density function curve for seismic stability of infinite slope is determined using 5,000,000 generation points. The result of the pseudo-static and static methods were compared to each other and shown in Figure 2.

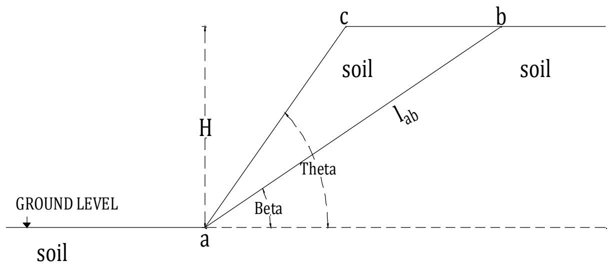


Figure 1. Parameters of the infinite slopes with triangle wedge failure.

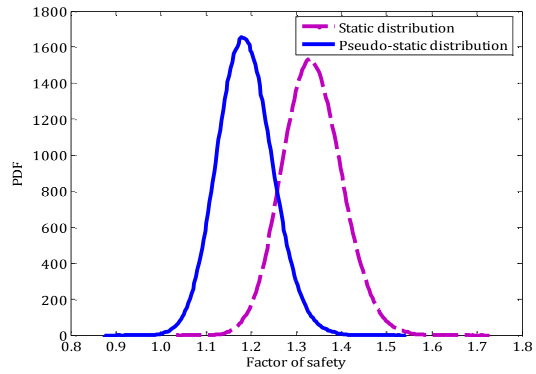
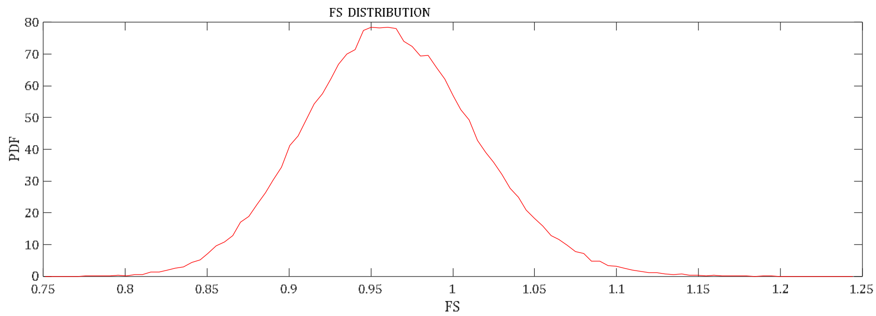


Figure 2. Comparing the pseudo-static and static distribution.



The result showed that without the implementation of seismic horizontal and vertical coefficients, the probability distribution of the factor of safety shifts rightwards indicating that a slope has a greater factor of safety. Furthermore, the reliability index of pseudo-static slope stability analysis was lower than the reliability index of static slope stability analysis. The results showed that the horizontal and vertical pseudo-static coefficients are the most effective parameter in factor of safety of infinite slopes.

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