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ANALYSIS OF SOIL-NAILED WALLS USING A PSEUDO-DYNAMIC APPROACH, CONSIDERING THE EFFECT OF NAILS

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ABSTRACT

One of the soil stabilization techniques is the Nailing System that is very popular for its flexibility. The common analytical method for evaluation of overall stability of soil-nailed walls in earthquake conditions, is the pseudo-static method. Saran et al. (2009) conducted the evaluation of overall stability of soil-nailed walls, using moment equilibrium and the pseudo-static approach. The pseudo-static approach considers the earthquake loads in a very approximate way and independent of time. Besides, the effect of parameters such as loading frequency and velocity of shear and pressure waves is not noticed in this approach. In order to overcome these shortcomings, the pseudo-dynamic approach is used for evaluation of seismic forces and the active pressure coefficient of the nailed soil. Choudhury and Nimbalkar (2007) used the pseudo-dynamic method for determination of passive and active soil pressure coefficients. Sarangi and Ghosh (2016) studied the effect of different parameters of soil and nail, using a pseudo-dynamic approach. However, they did not consider the effect of tensile of nails on the active seismic soil pressure coefficient formulation. In the present study, the active seismic soil pressure coefficient formulation and the safety factor of seismic stability are presented using a pseudo-dynamic approach considering the effect of nails on the active seismic soil pressure. Moreover, the effect of soil damping ratio on the safety factor of stability is investigated.

METHODOLOGY

According to Figure 1, a vertical wall with the height of H is considered in which the nails are installed at an angle of α and with the uniform length of L. The pseudo-dynamic approach is used for analysis of inertial earthquake forces acting upon the failure wedge of soil-nailed walls. By conducting the pseudo-dynamic analytical method, the active seismic soil pressure coefficient and the safety factor of seismic stability is obtained by the following equations:

$$k_{ae(\mathrm{modified})} = \frac{Q_V \sin(\theta-\varphi) - Q_h \cos(\theta-\varphi) - w\sin(\theta-\varphi)}{\left[\left(-\frac{1}{2}\gamma H^2 \sin\delta + (\gamma H) S_H S_V \sin\alpha \sum_{i=1}^{n}\mu_i\right)\sin(\theta-\varphi) - \left(\frac{1}{2}\gamma H^2 \cos\delta + (\gamma H) S_H S_V \cos\alpha \sum_{i=1}^{n}\mu_i\right)\cos(\theta-\varphi)\right]} \quad (1)$$

$$FOS = \frac{F_R}{F_d} = \frac{\left[(w-Q_v)\cos\theta - Q_h \sin\theta + T_{eq}\sin(\theta+\alpha)\right]\tan\varphi}{(w-Q_v)\sin\theta + Q_h\cos\theta - T_{eq}\cos(\theta+\alpha)} \quad (2)$$

where S_h and S_v are the horizontal and vertical spacing of the nail respectively, and μ is the empirical depth factor, Q_h, Q_v and T_{eq} are horizontal, vertical inertial forces and the tensile pullout resistance of the wall respectively.

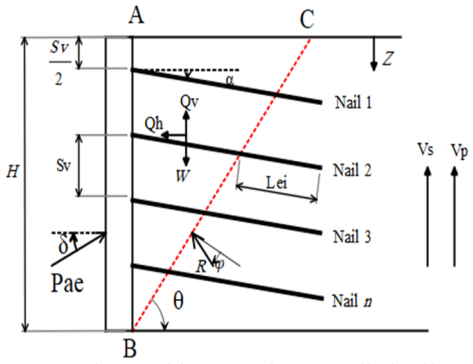

Figure 1. Scheme of forces acting on nailed soil wedge.

RESULTS

The main result of this study is development of pseudo dynamo formulations 1 - 2 for soil nailing wall considering the effect of tensile force on the seismic active earth pressure. To verify the presented solution, a comparison with result of shaking table is shown in Figure 2. As can be observed, the presented formulation is more accurate than other available solutions.

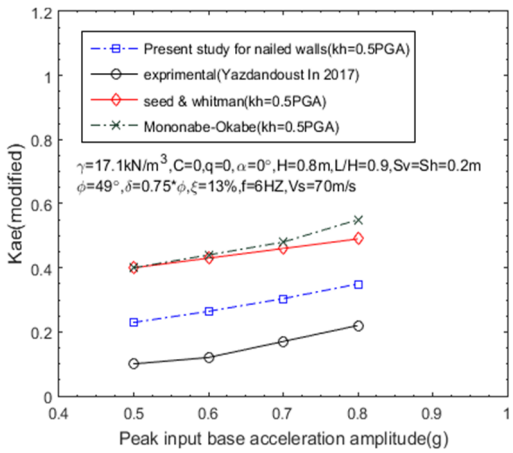

Figure 2. Verification of the presented analytical pseudo dynamic method.

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