AN ANALYTICAL EVALUATION OF PILE-SOIL INTERACTION IN TWO-PHASE APPROACH

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Keywords: Two-phase model, Analytical method, Interaction, Reinforced soil, Elastic form

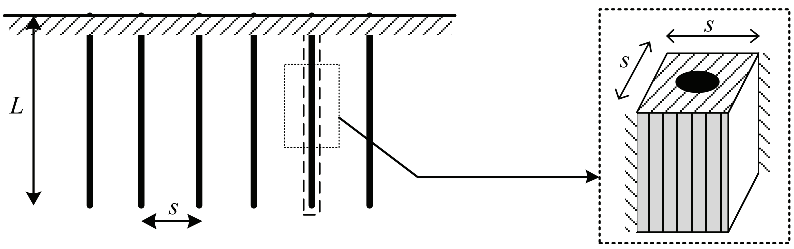
'Two-phase approach' as an extension of the homogenization method has been proposed recently (Sudret, 1999). This is a very powerful method that has been used in the analysis of many reinforced soil structures such as reinforced soil retaining walls (Seyedi Hosseininia & Ashjaee, 2018; Seyedi Hosseininia & Farzaneh, 2010; Seyedi Hosseininia & Farzaneh, 2011), tunnels (de Buhan et al., 2008) and piled embankments (Hassen et al., 2009). At first, this method is used whereas perfect compatibility of displacement at the reinforcement-soil interface has been assumed. Later on, researchers have focused on the interaction between the reinforcement and the surrounding soil. It has been shown in many studies (Bourgeois et al., 2012 and 2013) that the interaction has an important role on results. In order to extend such scientific endeavours, this contribution is devoted to the extension of the analytical evaluation of the soil-reinforcement interaction.

Referring to the two-phase description, each point of the system in macroscopic scale that is composed of two mutually continues media, 'matrix' and 'reinforced' phases, have two different kinematics fields. These two phases have mechanical interaction ($\underline{I}$) that is introduced as follows:

$$\underline{I} = C^{I}.\Delta\underline{\xi} \tag{1}$$

where C^I is an interaction stiffness and $\Delta\xi$ is the relative displacement between the two phases. C^I is a constant factor that can be determined from analytical or numerical methods; both approaches are based on an investigation of the representative elementary volume (REV) of reinforcement region (Hill, 1963). For a bar reinforcement, REV is mentioned in Figure 1.

In the present configuration, the values of the interaction parameters are calculated analytically on the basis of the best fitting function to deformation of single inclusion in REV, which is obtained from the elastic solution of a representative



(a) schematic view of a reinforced soil (b) laterally constrained representative volume

Figure 1. Representative volume of reinforced soil by bars.

volume. For a linear deformation function, interaction stiffness coefficient is obtained as:

$$C^{I} = \frac{3\pi G_s \sqrt{\eta}}{s^2} \tag{2}$$

It is clear that C^I depends on the soil shear modulus (G_s), the pile spacing (s) and reinforcement fraction (η). The following estimate of the interaction stiffness coefficient is determined based on the logarithmic deformation function:

$$C^{I} = \frac{2\pi E^{m}}{s^{2}\left(1+\nu^{m}\right)\left(\dfrac{\ln\eta}{\eta-1}-1\right)} \tag{3}$$

This idealization approach is a good approximation of the deformation patterns as compared with those obtained from rigorous analysis such as the finite element method (Miguel et al., 2006).

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