NUMERICAL INVESTIGATIONS ON LOAD-SETTLEMENT BEHAVIOUR OF GEOSYNTHETIC ENCASED STONE COLUMN

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Abstract

Ground improvement is a prerequisite for construction in problematic soils such as soft clay, due to its high compressibility and low bearing capacity. Among the various ground improvement methods in practice, the installation of stone columns is an effective method that can improve the strength and settlement characteristics of soft clay. Encasing the stone column with a geosynthetic material can further improve the load carrying capacity of the stone column due to increased confinement. The present paper discusses the numerical investigations conducted on the behaviour of geosynthetic encased stone column (GESC) installed in soft clay, using the finite element program PLAXIS 2D. Parametric investigations are carried out to determine the influence of different factors such as friction angle of column material, stiffness of geosynthetic material, length of encasement and shear strength of the soft soil on the load-settlement behaviour of the geosynthetic encased stone column (GESC).

The geosynthetic encased stone column (GESC) is modelled as an axisymmetric problem in PLAXIS 2D. A column of diameter 100mm and length to diameter ratio of 5 is considered for the numerical analyses. Mohr-Coulomb model is used to model the stone column and the surrounding soft clay. The geotextile encasement is modelled using the 'geogrid element' with its axial stiffness (E_A) as the input parameter. The input parameters used in modelling are given in table 1. 6 noded triangular elements are used in the finite element analyses. The model with deformation due to loading is shown in fig.1.

Table 1 Input parameters for the model

Material	Clay	Stone	Geotextile
Young's modulus (E kN/m^2)	600	40000	-
Poisson's ratio	0.47	0.3	-
Cohesion (kPa)	15	0	-
Dilatancy angle	0	0	-
Friction angle (^{0})	0	46	-
Dry unit weight (kN/m^3)	16.8	16	-
Saturated unit weight (kN/m^3)	19	19	-
Axial stiffness (kN/m)	-	-	35

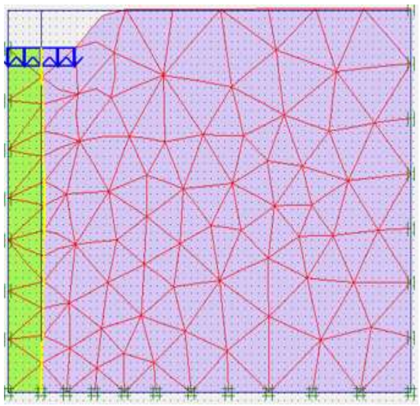

Fig. 1. Deformed mesh of the model

The results of the parametric investigations are shown in fig. 2-5. Fig. 2 shows the influence of angle of internal friction (φ) of the column material on the bearing capacity of the GESC. It is evident that, the bearing capacity increases with increase in angle of internal friction (φ) of the

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column material. Fig . 3 compares the behavior of GESC by varying the axial stiffness of the geotextile encasement. The bearing capacity of stone column is found to increase with increasing axial stiffness of geotextile. From fig. 4 the influence of length of encasement on the bearing capacity of stone column can be observed. When compared with the ordinary stone column (OSC) which is not encased, GESC have higher load carrying capacity and it increases with increasing the length of encasement. Fig. 5 shows the effect of shear strength or cohesion of the surrounding soft soil on the load-settlement behavior of GESC.It can be seen that with increasing shear strength of soil, the lateral confining pressure also increases, which results in improved bearing capacity of GESC.

From the numerical investigations, it can be concluded that the load bearing capacity of the geosynthetic encased stone column can be improved by increasing the angle of internal friction(φ) of the column material, length and stiffness of the encasement and the shear strength of surrounding soil. Compared to an ordinary stone column (OSC), a geosynthetic encased stone column (GESC) with its half length encased shows an improvement in load carrying capacity by 115% and it further improves to around 138% when the entire length of the column is encased.

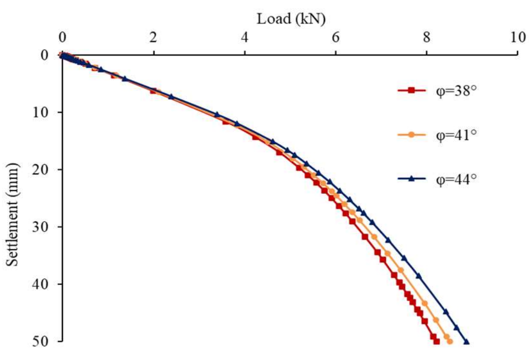

Fig. 2. Load-settlement behaviour of GESC showing the influence of angle of internal friction(φ) of the column material

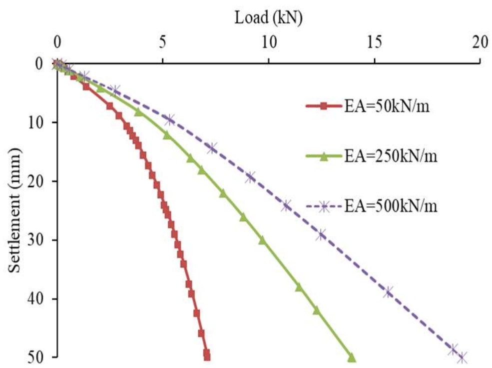

Fig. 3. Load-settlement behaviour of GESC showing the influence of stiffness(E_A) of the geotextile encasement

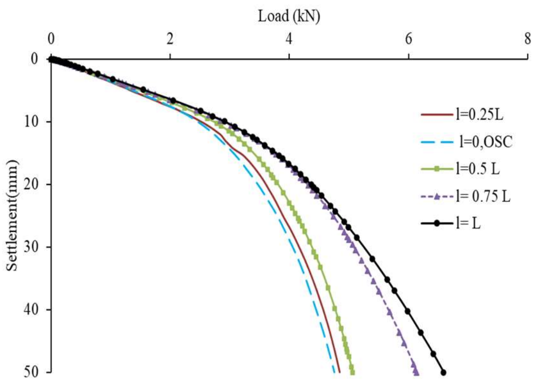

Fig.4. Load-settlement behavior showing the influence of encasement length (L- length of the column, l= encasement length)

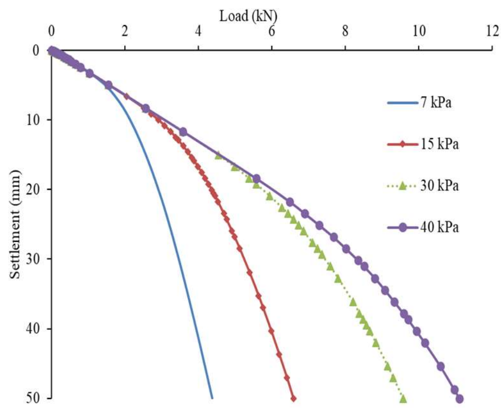

Fig.5. Load-settlement behavior of GESC showing the influence of shear strength of clay

Keywords: Geosynthetic encased stone column (GESC), load-settlement behaviour, PLAXIS 2D, parametric investigations

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