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Numerical simulations of model tests on geotextile reinforced soil wall with and without improved intermediate soil wall for rear end anchorage.

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1. GENERAL

Economy, environment and construction period are the major constraints in finding out a very good fill material with high friction and cohesion for the construction of embankments or soil wall. Because of these reasons, the surplus soil in other construction sites which does not necessarily have good engineering properties, is required to be used in the construction of embankments as fill material. Conventional practice of plain laying is not much effective in the case of aforementioned surplus soils possessing poor engineering properties, demands special ways to improve its deformation and failure characteristics. The economical method of improving the efficiency of reinforcements might be the anchoring of the rear end of geotextile by introducing an intermediate soil wall with remarkably good engineering properties. The same surplus soil can be specially treated used to make such improved intermediate soil wall. Such anchorage of the reinforcements on the front as well as on the rear ends has improved the axial force development, and deformation and failure characteristics of the wall. In this paper, such a method is experimented and numerical simulations of the method are checked via linear elastic finite element method.

2. OUTLINE OF THE MODEL TESTS

Full scale geotextile reinforced soil models of 4m high with block facing were constructed in series, first without any aforementioned type improved intermediate soil wall and second with such intermediate soil wall (for details, refer. Ochiai et al., 1998). Cross section of the improved soil wall case is shown in Fig. 1. There are 8 layers of geotextile with 0.5 m vertical spacing and each 3 m long. The geotextiles are anchored on the back of the concrete block by roll and pin joint as explained by Nakajima et al. (1996). The rear end was free in the first model, and vertical pins were used to anchor the geotextile end with improved soil mass. The effective width of the improved soil wall was about 75cm, and effective lap length was assumed to 25 cm for finite element simulations. The wall was externally under 3 different load or deformation modes: a. gravity load (self weight) b. foundation settlement (differential settlement) and c. footing load on the top of the wall. In this paper, the first and second type of deformation mode under Phase 2 type foundation settlement will be discussed because of space limitations. The foundation settlement in the Phase 2 is shown in Figure 2. Lateral deformation of the wall face, lateral earth pressure distribution on the back of the facing are shown in Fig. 3~4.

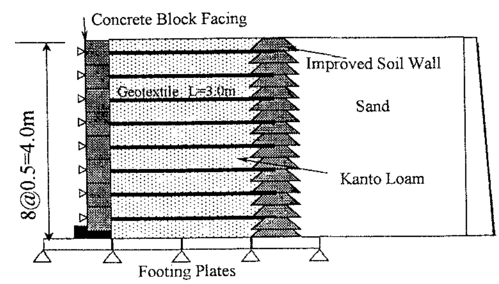
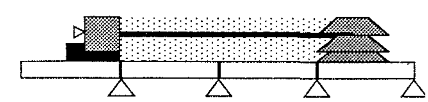
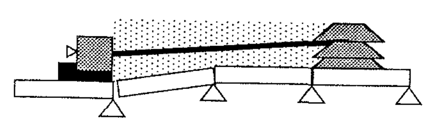


Fig. 1 Schematic view of the improved soil wall model



Phase 1(without footing plate settlements)



Phase 1(20 mm settlement of footing plate under facing)

Fig. 2 Schematic details of the footing plate settlements

3. OUTLINE OF FE SIMULATIONS

In this paper, the finite element simulations of the model tests are explained for a linear elastic condition. Linear elastic modulus for fill soil (Kanto loam) was taken from Triaxial Tests (UU) where E50= 600 tf/m2 and Poisson's ratio, ν=0.3. Engineering properties of the facing blocks, geotextile material, and improved soil mass can be found in Ochiai et al.(1998). Four node isoparametric elements were used for both soil and for facing concrete blocks as proposed by Nakajima et al. (1996). As the exact compaction force and the characteristics at the toe of the facing were not known, it is very difficult to predict the lateral deformation and axial force in the reinforcements at the end of construction. There seems to be an initial lateral movement of the facing toe which caused high tensile force in the reinforcement very close to the facing. This part of the axial force is not predictable unless the toe movement is exactly known before computation or back analysis is carried out. In order to avoid this problem, authors have decided to make only qualitative comparisons (regarding the bar force and lateral deformation of the wall face). Because of the lack of the data, the stiffness of the improved soil was varied from $E_{improved} = E_{loam}$, $2.5E_{loam}$, $5E_{loam}$, $10E_{loam}$, $20E_{loam}$.

4. RESULTS AND DISCUSSIONS

The earth pressure distribution on the wall along the wall height is shown in Fig. 3b and the observed values are in Fig. 3a. The computed earth pressure distribution pattern is similar with the observed pattern. The increase in the stiffness of the improved soil wall caused decrease in the earth pressure close to the wall toe and increase on the upper part. The

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improved soil wall model has more earth pressure compared to unimproved case in upper part which can be attributed to the increase in confinement due to decreased lateral movement (Fig. 4). The deviation in lateral movement and earth pressure with FE results might come from modeling of the wall as continuous wall while the block in real model were just resting over one another. The axial force distributions (Fig.5) shows that as the stiffness of the intermediate improved soil wall increases, the axial force on the upper geotextile close to the intermediate wall is remarkably increased and the decrease in lateral movement of the wall face can be attributed to this behavior. The displacement vectors (Fig. 6) for homogeneous loam case and with intermediate improved soil wall case, clearly indicate the differences. The displacement vectors are almost horizontal in and around the improved wall and thus, the intermediate soil wall not only anchors the reinforcement ends, but, also supports the vertical stresses, ultimately the earth pressure close to the facing wall toe is reduced. It may be another hidden advantage of the intermediate soil wall.

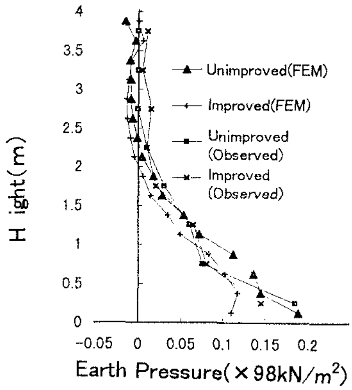
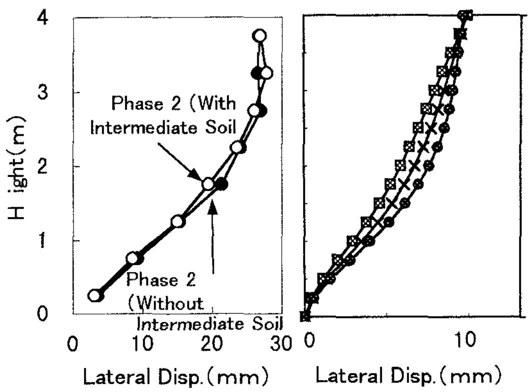


Fig. 3 Earth pressure distribution



a. Observed results b. FE results

Fig. 4 Lateral Movement of wall face

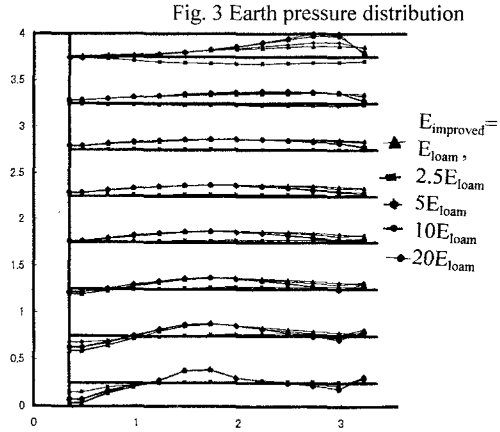
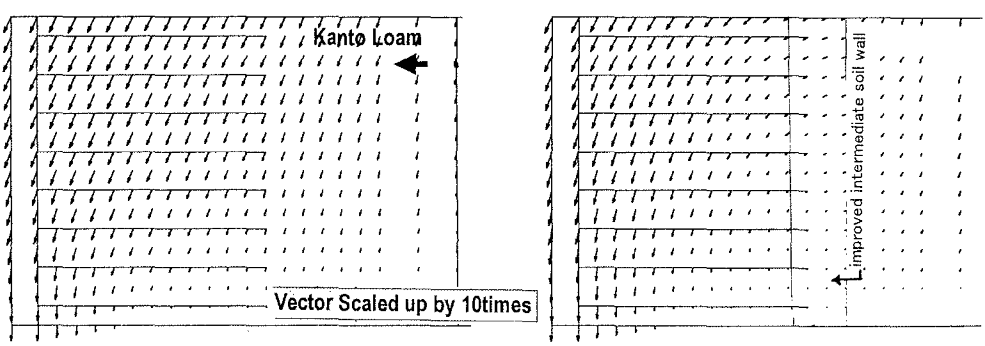


Fig. 5 Axial force on reinforcements



a. Unimproved case b. FE results($E_{improved}$= $20E_{loam}$)

Fig. 6 Displacement Field/ Vectors

5. CONCLUSIONS AND RECOMMENDATIONS

The intermediate improved soil is very effective in reducing the lateral movement of the facing wall, increases the efficiency of the reinforcements, and decreases vertical settlement. The earth pressure around the wall toe is also significantly reduced. The effect of width and stiffness of the intermediate wall can be further investigated and compared with multiple intermediate walls of smaller thickness. FE analysis seems best suited to do parametric study. The proposed intermediate wall will prove effective in the perspective of the cost and the environmental impact.

REFERENCES

Nakajima et al. (1996), FEM Comp. Ana.… pp. 433-438, IS Kyushu '96, Balkema Publishers.

Ochiai et al.(1998) Full scale failure experiment of geotextile reinforced soil wall using construction surplus soil, Proceedings of the Annual Conference of Japanese Geotechnical Society, 1998(in press).