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EFFECTS OF CHANGES IN GEOMETRY ON LATERAL DEFORMATION BEHAVIOR OF EMBANKMENTS

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Introduction

The lateral deformation of an embankment is an important index for the satisfactory performance of the structure. The importance has further arisen from the observations of the detrimental effect of lateral deformations on the behavior of adjacent structures. For safe performance of the structures, therefore, it is essential to make more accurate predictions. The widely used finite element approximation based on infinitesimal strain assumption is found to overpredict the lateral deformations beside its satisfactory settlement predictions (Tavenas et al., 1979). In the present paper, lateral deformation behavior has been investigated by finite element method based on the finite deformation theory. Firstly, linear elastic constitutive law is used to examine the pure effects of geometry change on lateral deformation and subsequently elasto-plastic analysis is done employing the subloading surface (Ref. 1) Cam-clay model.

Pure Effects of Changes in Geometry

Two embankment geometries; named A and B, having base widths 45m and 27m respectively are used in the analysis. The soil parameters used are shown in Table 1. The embankments were replaced with gradual application of equivalent nodal loads ignoring the interaction of embankment on the foundation. The lateral deformation behavior at the vertical section through the embankment toe during load application and consolidation under constant load for embankment B is shown in Figs. 1a and 1b. Infinitesimal deformation (ID) predictions are shown in broken lines. Throughout the deformation process, finite deformation theory (FD) predicts lesser magnitudes than the infinitesimal deformation theory. The complete lateral deformation behavior with time by FD theory for two applied load magnitudes of both the embankments are shown in Figs. 2a and 2b. As shown in Fig. 2b, at the applied load of 450kN/m^2, embankment B having smaller width moves towards the embankment centerline during the constant load consolidation phase at a faster rate than embankment A. This behavior is attributed to the load concentration effect, in which the increased load intensity due to shortened loaded width causing increased settlement at the embankment center.

Previous studies on lateral deformation behavior (Ref. 3), which were solely based on the infinitesimal approach reveal that ID theory always tend to make over predictions. In addition, various reasons have been put forward for such overpredictions excluding the effect of geometry change. Through the result shown here, it is evident that the effect of geometry change also can be a major contributor for the lower lateral deformation magnitudes over the ID predictions.

Fig. 3 shows the Asaoka's method applied to lateral deformations. The convexity of the plot indicates that a faster rate by FD theory over the ID theory in reaching the final deformed state.

Elasto-plastic Deformation Behavior

Employing the subloading surface Cam-clay model with the soil parameters shown in Table 2, an elasto-plastic deformation analysis has been carried out. The complete deformation behavior of embankment B by FD and ID theory is illustrated in Fig. 4. As shown, the lateral deformation behavior is affected by the geometry change from the early stages of deformation process. This result further shows that the embankment has already reached the failure state (Ref. 2) during load application, when the geometry change is not accounted in the analysis (ID theory).

Conclusions

1. Geometry change affects the lateral deformation behavior resulting lesser magnitudes.
2. Rate of consolidation becomes faster towards the end of deformation process.

References

1. Hashiguchi, K. (1989): Subloading surface model in unconventional plasticity, Int. J. of Solids and Structures, Vol. 25, pp. 917-945.
2. Matsuo, M. and Kawamura, K. (1977): Diagram for construction control of embankment on soft ground, Soils and Foundations, Vol. 17, No. 3, pp. 37-52.
3. Tavenas, F., Mieussens, C. and Bourges, F. (1979): Lateral displacements in clay foundations under embankments, Can. Geotech. J., Vol. 16, pp. 532-550.

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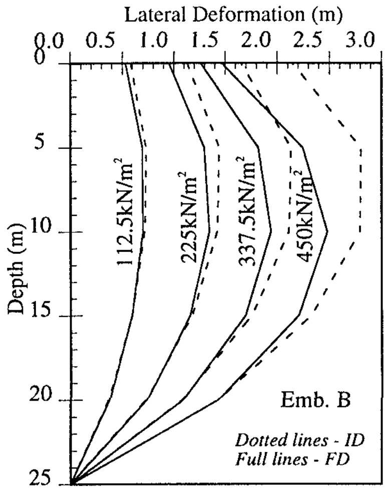

Fig. 1a Lateral Deformation during Loading

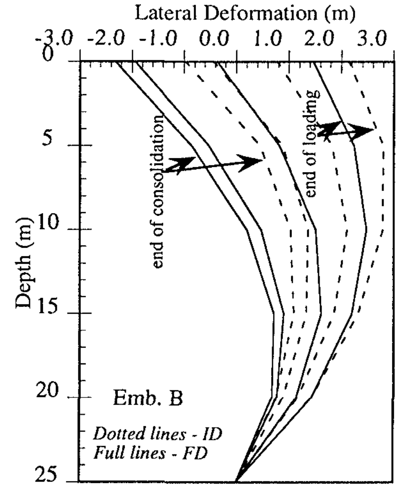

Fig. 1b Lateral Deformation during Constant Load Consolidation

E	1000 kN/m^2
ν	0.30
k	1x10^{-7} cm/s
γ_{sat}	18.5 kN/m^3

Table. 1

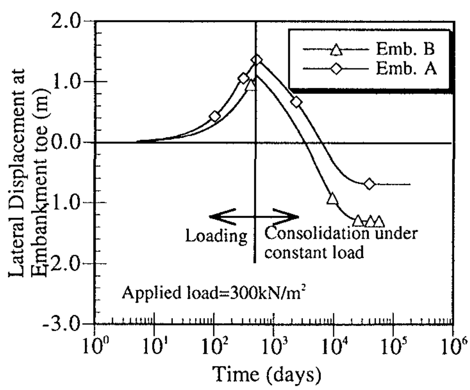

Fig. 2a Lateral Deformation Variation with Time (FD)

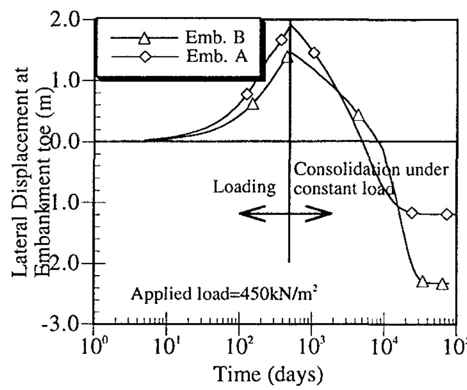

Fig. 2b Lateral Deformation Variation with Time (FD)

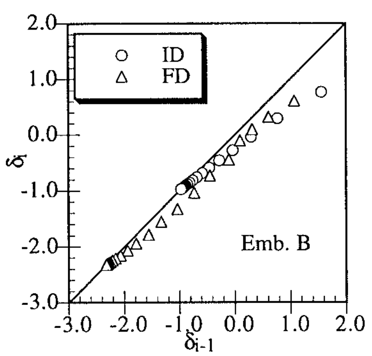

Fig. 3 Asaoka's Method for Lateral Deformation at Embankment Toe

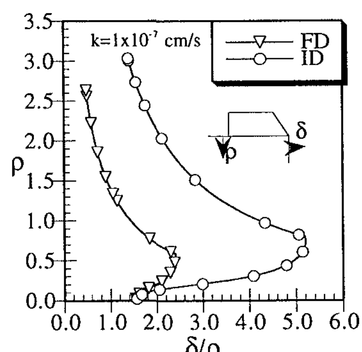

Fig. 4 Lateral Deformation Behavior at Embankment Toe (Ref. 2)

λ	0.2
κ	0.04
M	1.53
k	1x10^{-7} cm/s
v_0	3.0
ν	0.30
OCR	2
v_2 (Subloading model constant)	10
γ_{sat}	18.5 kN/m^3
γ_w	9.81 kN/m^3
K_0	0.70

Table 2