Parametric Study of Stage Excavation Using the Finite Element Method

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Abstract: The selection of the boundaries for an excavation analysis using the finite element method is important. In this a parametric study of a relatively deep excavation was studied using the three dimensional finite element analysis. Effect of soil properties and the boundary conditions are also investigated.

1 Introduction

Building projects often require undertaking excavation in the vicinity of the existing structures. The new construction may include excavation from depths of 3 ft to more than 60 ft. below existing ground surface for placing any type of foundation from a spread footing to a mat, or for allowing one or more subbasements. Reliable predictions of ground movements around deep excavations are needed in order to assess their potential damage to adjacent structures. Preliminary estimates of the surface settlements can be determined from the published empirical database (Clough et al, 1990). But site specific predictions of ground movements can only be achieved through relatively complex numerical analysis (Whittle et al, 1994). In this study a parametric analysis of an embankment was performed to study the effect of the geometry of the finite element and the boundary conditions. Effect of soil properties, boundary condition for a stage excavation was studied by using PLAXIS.

2 Objective

The objective of this study was to perform a parametric analysis of on the bottom of the excavation heave using the finite element method.

3 Finite Element Analyses

The behavior of excavation was modeled using the 15 node wedge elements (6-node triangular faces and 8-node quadrilateral faces) using the PLAXIS. Linear elastic model was used for the soil layers. Figure 1 shows the model used for this study. The influence of the extent of the boundaries on the vertical deformation of the bottom of the excavation was investigated with three different stiffness parameters.

4 Discussions

Figure 2 shows the variation of vertical deformation at the center of the excavation for different excavation depth by using non-dimensional parameters. As the stiffness of the soil was increased the heave in the center of the excavation decreased. Figure 3 shows the effect of lateral extent of the boundary (X and Z direction) on the vertical deformation of the excavation. When the excavation depth is less the lateral boundary has less influence on the deformation. As the excavation depth increased the vertical deformation (Uy/Y) decreased with the increase in the B/Z and L/X ratio. Hence the boundaries of the finite element mesh are more important for the prediction of deformation.

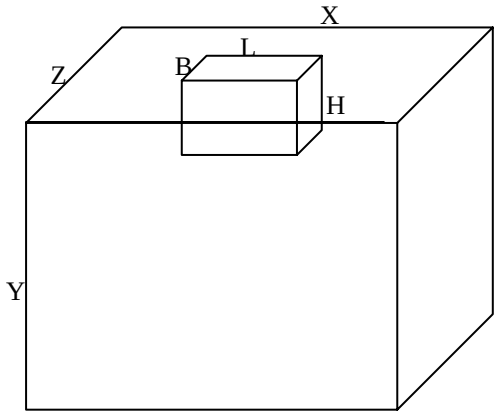

Fig. 1 Excavation Model

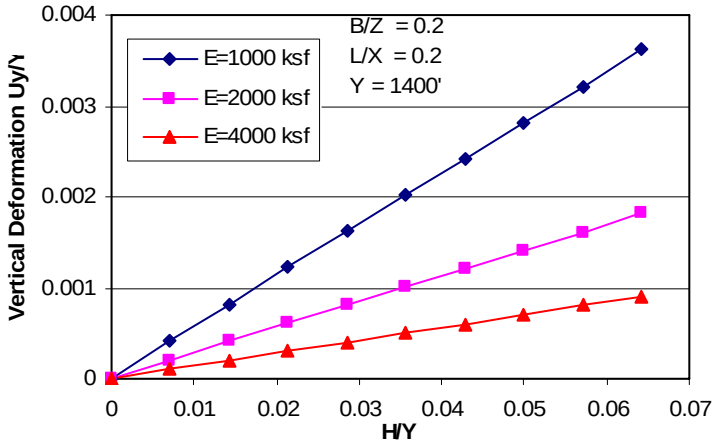

Fig. 2 Effect of the Modulus of Soil

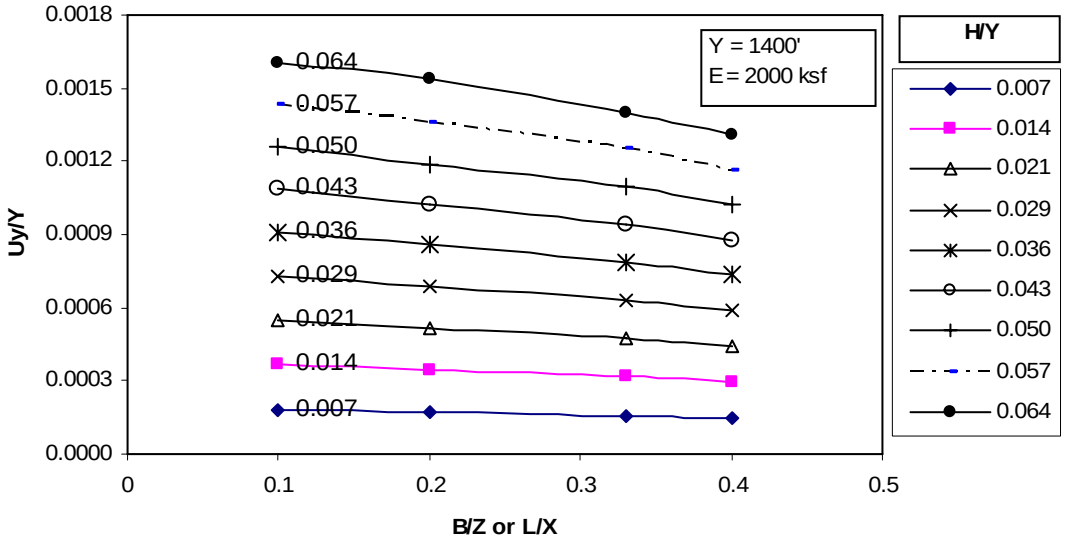

Fig. 3 Effect of the Lateral Extent of the Boundary

6 Conclusions

Based on the parametric study, it has been found that the vertical deformation increased with the decrease in B/Z and L/X ratios. Vertical deformation was also depended on the excavation depth (H) to boundary depth(Y) ratio and increased with the increase in the ratio.

7 Acknowledgement

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8 References

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