REDUCTION OF LATERAL EARTH PRESSURE ON RIGID RETAINING WALLS USING EPS GEOFOAM INCLUSIONS

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Sub Theme: Numerical and physical modeling

ABSTRACT

Earth retaining structures are used either as free standing units e.g. gravity or cantilever type walls, or as components of more complex infrastructure construction e.g. bridge abutments, basement walls and tunnel walls.In geotechnical field the application of expanded polystyrene (EPS) geofoam has widespread popularity because of itslow density, high young's modulus (E) and high compressibility.In the present study, the effectiveness of EPS geofoam compressible inclusion in reducing the static earth pressure on non-yieldingcantilever retaining wall of height (h) 7 mwas studied using finite element code, PlAXIS 2D.In the present study, magnitude and distribution of earth pressure on retaining wall with and without geofoam subjected to surcharge loadings were evaluated.Geofoam densities 10kg/m3 and compressible inclusion thickness (t)of 0.07h were used. Isolation efficiency and pressure distribution along the height of wall was evaluated and validated with the available literature. The results from study shownon-linear earthpressure distribution on the wall, which could be attributed to arching effect.The earth pressure reduction observed with the geofoam inclusion.

Keywords: Expanded polystyrene (EPS) geofoam, Rigid retaining wall, PLAXIS 2D

I. INTRODUCTION

Retaining structures are an important component of various civil engineering works. These structures may be of a number of types (e.g. reinforced concrete retaining wall, Gravity wall, cantilever wall, bridge abutments and basement walls). The design of the retaining structure requires the determination of the magnitude and point of application of the lateral earth pressure. The magnitude of the earth pressure depends upon a number of factors, such as the mode of movement of the wall, the flexibility of the wall, the properties of the soil and the drainage conditions. For the design of earth retaining structures, it is essential to have proper knowledge on the magnitude and distribution of lateral earth pressure on the retaining wall due to retained material and surcharge pressure due to loads from foundations of the adjacent buildings on their backfills, and manmade or natural dynamic events. In earthquake prone areas earth retaining structure should be designed in such a way that it can resist seismic earth pressure also in addition to the static earth pressure. In the case higher magnitude earthquake and higher shaking intensity the combined (i.e. both static and dynamic) earth pressures may be more than two times higher, compared to the static pressures. Poor design in such cases may lead into serious damage or even collapse of the retaining structure, with catastrophic consequences to important infrastructure works.

II. NUMERICAL MODELING

For the analysis a 15-node elements mesh was taken and the texture of the mesh was set to fine so as to reduce the distance between two consecutive elements and thus the accuracy of analyzing the effect of surcharge loading. Fine texture of a mesh gives highly accurate results and the results are reliable. Plane-strain analysis was selected. Spacing value and number of snapping intervals can be chosen in Plaxis to create required geometry model. By using lines, plates and interfaces the outlines of the model are made and the different magnitude of surcharge load is applied in the present study in the form of uniformly distributed load (UDL). The uniformly distributed load was applied at a distance 1.5 m away from the face of the wall to the end of backfill. The option of standard Fixities is chosen for the boundaries which renders a fixed boundary situation for the entire geometry model. A common value of interface coefficient R=0.70 used for all cases between sand and geofoams.

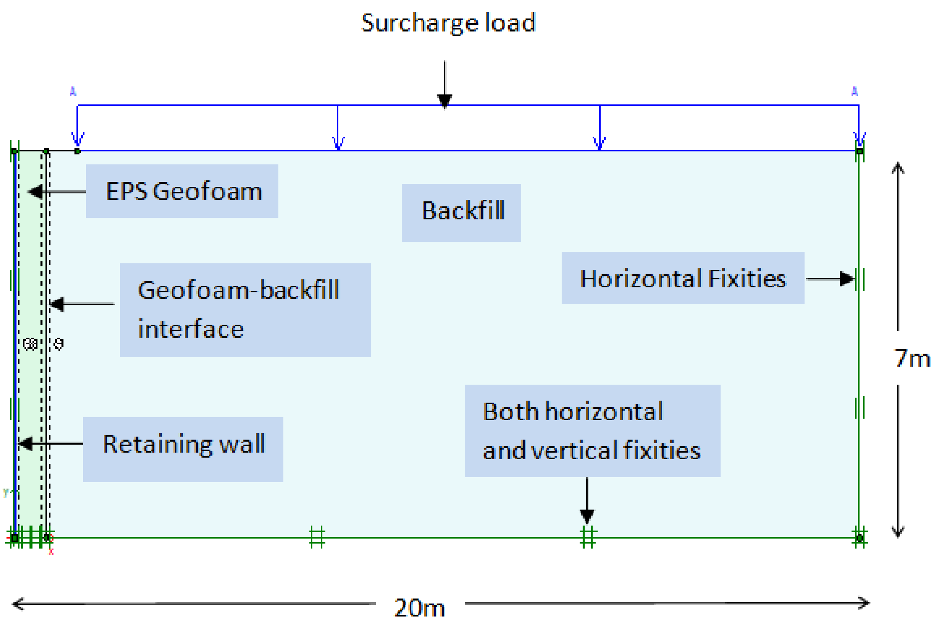

Fig 1Plaxis model for surcharge load with EPS geofoam (PLAXIS 2D)

Table 1 Material properties of sand (Ertugrul et al. 2011)

Material model	Unit weight (kN/m^3)	Young's modulus (kPa)	Poisson's ratio (ν)	Cohesion (kPa)	Friction angle (^{o})	Dilatancy angle (^{o})
Mohr-Coulomb	16.5	5200	0.33	0	43.5	22.5

Table 2 Material properties of plate modeled as retaining wall

Properties	Density (kg/m^3)	Elastic modulus (GPa)	Axial rigidity (kN/m)	Flexural rigidity ($kN\text{-}m^2$)	Poisson's ratio (ν)	Weight (kN/m^2)
Plate	7850	180	72000000	38400	0	6.16

Table 3 Material properties of EPS geofoam (Ertugrul et al. 2011)

Material model	Density (kg/m^3)	Unit weight (kN/m^3)	Young's modulus (kPa)	Cohesion (kPa)	Friction angle (^{o})	Dilatancy angle (^{o})	Poisson's ratio (ν)
Linear-elastic	15	0.15	1500	---	---	---	0.01

Table 4 Material properties of EPS geofoam (Trudeep Dave data 2012)

Material model	Density (kg/m^3)	Unit weight (kN/m^3)	Young's modulus (kPa)	Poisson's ratio (ν)
Linear-elastic	10	0.0981	1325	0.0584

III. VALIDATION AND RESULTS

A wall of 0.7m high and 2m backfill width was modeled in Plaxis 2D with and without geofoam. The results of numerical parametric studies on evaluation and distribution of earth pressure on retaining wall for the case of wall with and without geofoam are validated with results presented by Ertugrul et al. (2011).

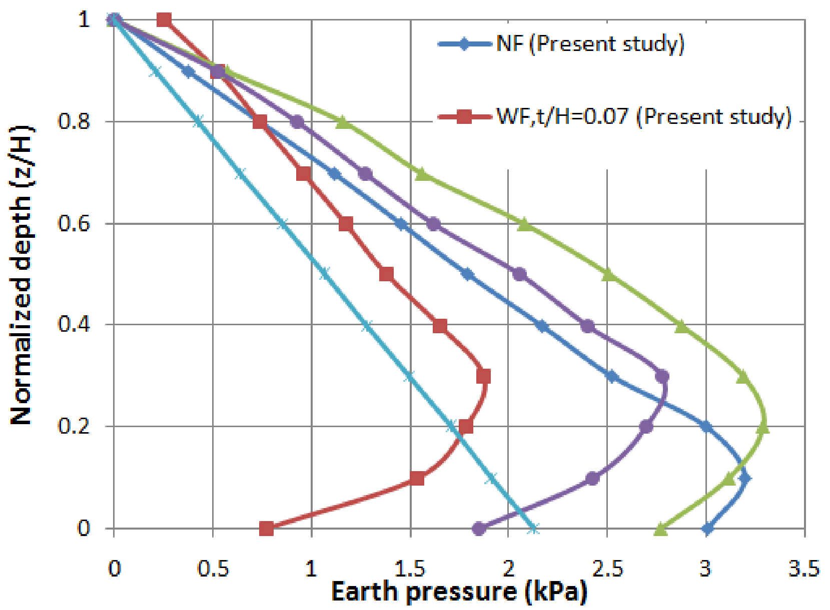

Fig 4 Earth pressure distributions for a 0.7m wall with buffer thickness t_r =7%

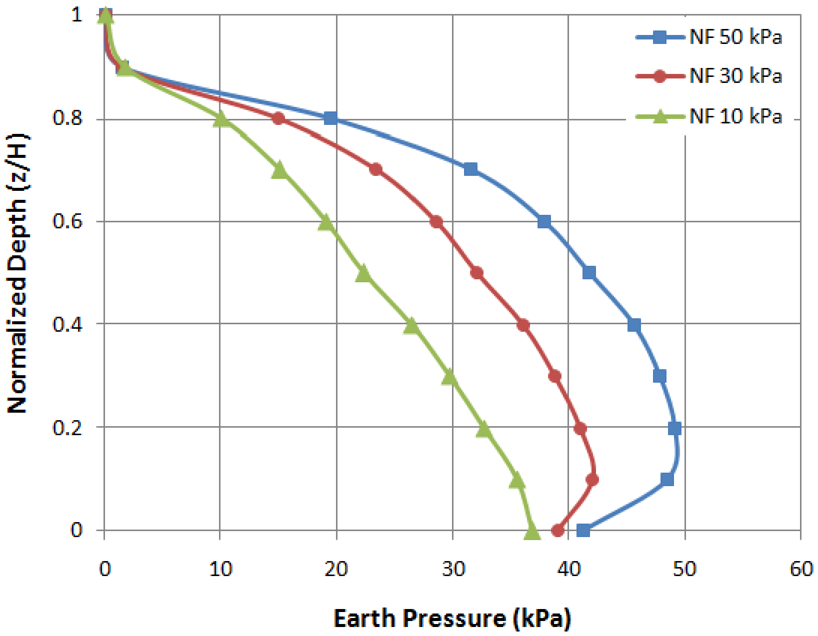

Fig 5 Earth pressure distribution with surcharge for no foam case

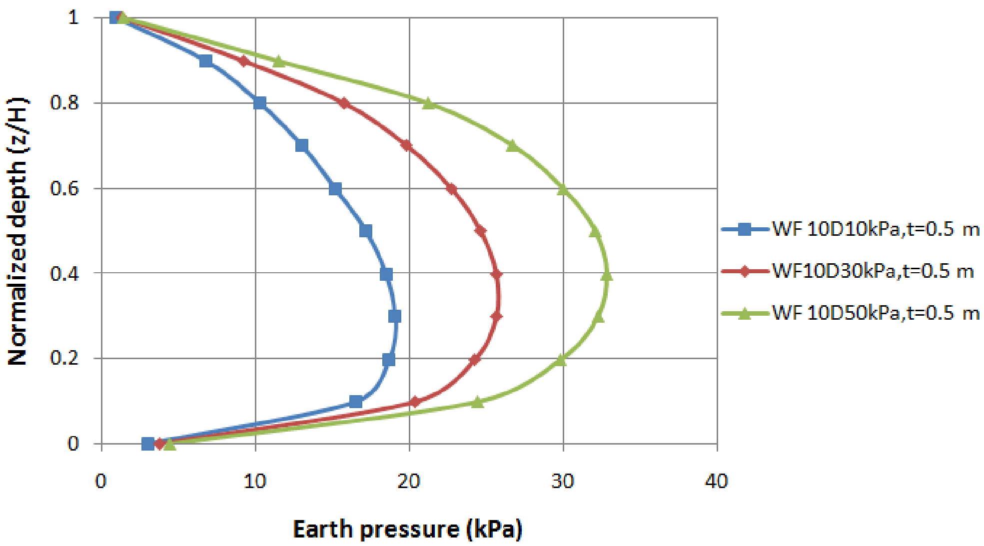

Fig 6 Earth Pressure Distribution with geofoam thickness 0.5m (10D10 -10D30 -10D50)

IV. CONCLUSION

Use of EPS geofoam to reduce lateral earth pressure behind the rigid retaining wall was investigated using numerical simulation approach. The results shows that placement of EPS geofoam panel behind the retaining wall could reduce the magnitudes of lateral earth pressure and total wall thrust behind the retaining wall approximately 50%.As the surcharge load increases, the efficiency is decreasing, though there is not much difference in the % of reduction

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