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Analysis of Retaining Wall in static condition and Qualitative Study of inclusion of Geofoam in Retaining Structures

[1] Vallabh A Deshpande, [2] Jay Chitroda, [3] Indraja Bandewar, [4] Priyadarshani Rudramoorty
[5] Pankaj A Yadav
[1, 2, 3, 4] Student, MIT School of Engineering MIT-ADT University,
[5] Lecturer, Shri Datta Meghe Polytechinc., Nagpur.

Abstract: **-- The expanded polystyrene (EPS) Geofoam in the geotechnical field is popularly used by engineers because of its low density, high Young's modulus (E) and high compressibility. In the present study, the use of EPS geofoam is in reducing the static earth pressure on the non-yielding retaining wall of height 6 meters, the test was conducted using finite element method in PlAXIS 2D. In this present study, magnitude and distribution of earth pressure on retaining wall with and without geofoam are evaluated. Geofoam densities 0.15 kN/m3 and compressible inclusion thickness (t) were used. With the use of Geofoam, a considerable reduction in pressure was recorded.**

Index terms**: - Low Density, High compressibility, PLAXIS 2D.**

I. INTRODUCTION

Retaining walls are generally constructed to support earthen soil mass. The soil at higher elevation would tend to move down if without any structural support & exerts pressure on the structure. This exerted pressure on structure is called lateral earth pressure. The design of the retaining structure requires the determination of the magnitude and point of application of the lateral earth pressure. Poor design in such cases may lead to serious damage due to collapse of retaining structure. Geofoam is lightweight elastic material which can be used in the back face of retaining wall to dissipate lateral thrust. The uniformity and compressibility of geofoam plays important role in the active and passive state of retaining wall. The total lateral earth pressure on retaining wall would decrease because some amount of pressure will dissipated to compress the geofoam

II. OBJECTIVE

To reduce the static pressure that a retaining wall has to resist.
To reduce the self-weight of the structure.
To do qualitative study of the inclusion of geofoam in retaining walls.
To carry out tests in PLAXIS 2D, with and without inclusion of Geofoam.
To analyze the test results derived from PLAXIS 2D.

III. LITERATURE REVIEW

The initial paper regarding geofoam as a compressible inclusion appears to be by Patros & Kazaniwsky. This involved a below grade parking garage where in the opposing walls were braced against one another in a manner so as to generate at-rest earth pressure, where it would be realized that there is a 35% reduction.

Subsequently, Hovarth has shown that geofoam can actually reduce lateral earth pressure to even less than active pressure conditions. Note that at- rest pressure is uniformly higher that the active earth pressure and that both are linearly increasing with depth .The passive earth pressure is the highest of all, but it is not particularly in the walls to be discised. Hovarth indicated that a compressible inclusion allows for arching in the backfill soil and that the subsequent earth pressure is curved, with a peak value near mid-height of the structure. Depending on the geofoam's thickness, the values are generally less than active earth pressure, and as depth increases the difference becomes

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substantial. The behavior is quantified based on a FEM procedure that was developed by Hovarth.The trend is clearly evident & furthermore, the thicker geofoam reduces the wall pressure to almost a negligible amount.

PLAXIS:

Plaxis is Finite Element Software which was developed at the Technical University of Delft for Dutch Government. Initially it was intended to analyze the soft soil river embankments of the lowlands of Holland. Soon after, the company Plaxis BV was formed, and the program was expanded to cover a broader range of geotechnical issues. The value of active earth pressure plays a major role in design criteria and it depends on soil parameters. In the present study, active earth pressure was calculated for sand using the software PLAXIS. By using lines, plates and interfaces the outlines of the model are made. The option of standard fixtures 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 is used for all cases between sand and geofoams. The backfill material type that is taken in this study is cohesionless soil (sand). The material properties of sand is taken from result of bender element test and the properties of concrete is assigned to plate which has been modelled as retaining wall is taken as M25 grade of concrete according to IS code .

IV. NUMERICAL MODELING

Table 1. Properties of backfill material (sand)

Properties	Unit	Value
Unit weight	kN/m^3	16.5
Young's modulus	kN/m^2	40000
Poisson's ratio	---	0.3
Cohesion	kN/m^2	1
Friction angle	Degrees	36
Dilatancy angle	Degrees	6

Table 2. Properties of plate as retaining wall

Properties	Unit	Value
Weight	kN/m^3/m	8.6
Axial rigidity	kN/m^2	2.5E10
Flexural rigidity	kN/m^2	1.5E9
Poisson's ratio (□)	---	0.15
Density	kN/m^3	24

The height (H) of retaining wall is 6m.

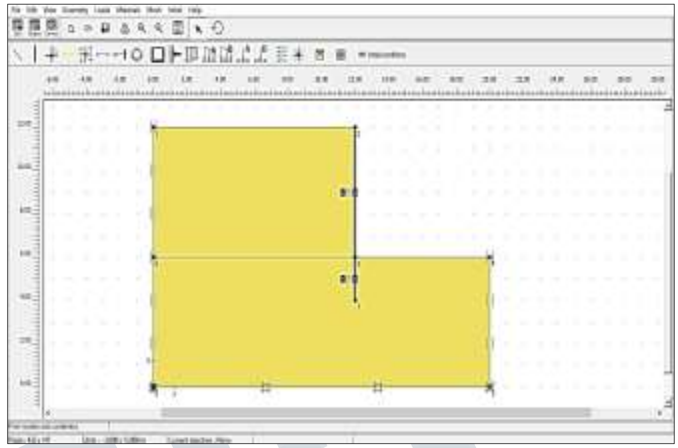

Figure 1. Modelling of retaining wall and backfill without geofoam in Plaxis 2D

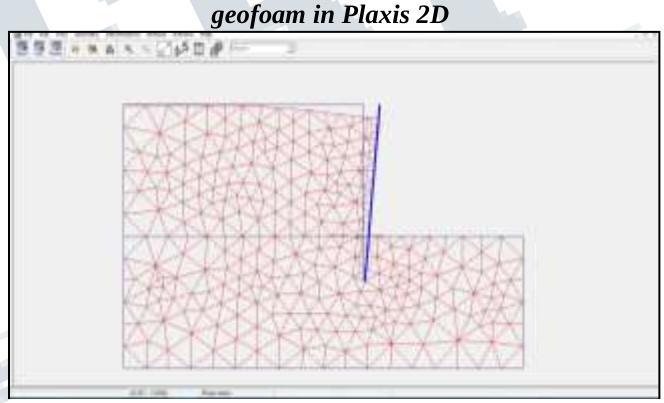

Figure 2. Deformed mesh at final stage of calculation to evaluate maximum lateral pressure on retaining wall

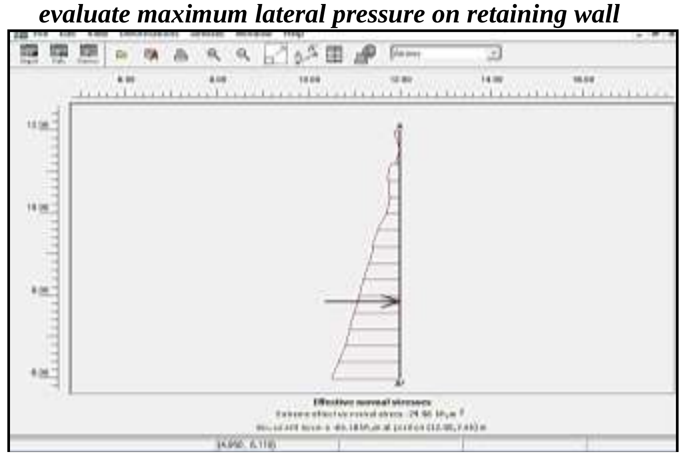

Figure 3. Pressure distribution and Maximum Pressure on retaining wall without geofoam

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Table 3. Properties of EPS Geofoam

Properties	Unit	Value
Unit weight	kN/m^3	0.15
Young's modulus	kN/m^2	1500
Poisson's ratio	---	0.05
Cohesion	kN/m^2	29
Friction angle	Degrees	6
Dilatancy angle	Degrees	---

Thickness of geofoam is H/10 = 0.6m

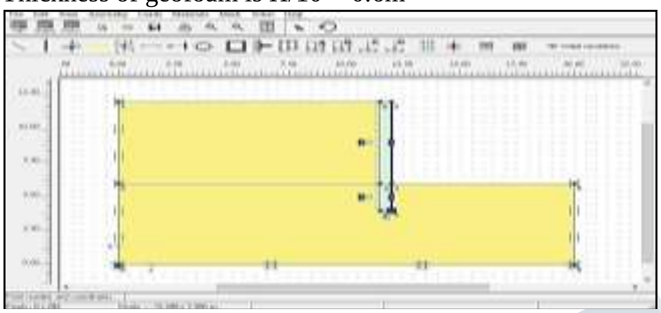

Figure 4. Modelling of retaining wall and backfill with geofoam in between interface of retaining wall and backfill material

Figure 5. Pressure distribution and Maximum Pressure on retaining wall with geofoam

V. RESULT AND DISCUSSION

Table 5. Lateral Earth Pressure on Retaining wall

1	Pressure at Rest (analytical)	40.8 kPa
2	Active earth pressure (analytical)	27.98 kPa
3	Pressure without geofoam (software, Plaxis 2D)	26.48 kPa
4	Pressure with geofoam (software, Plaxis 2D)	10.58 kPa

VI. CONCLUSION

At the conclusion of such intensive modelling of the retaining wall and backfill with geofoam inclusion at interphase of backfill and retaining wall, many observations can be made and many questions have been clarified and raised as a result. The EPS geofoam reduces the lateral earth pressure because of its compressibility and uniformity. As the thickness of geofoam increases the reduction in lateral pressure on retaining wall increases and becomes negligible.

VII. FUTURE SCOPE

Due to the development of construction industry in India and a demand for environmental friendly and economical construction material there is a great demand for application of geofoam in various construction activities such as road stabilization ,abutment ,backfilling ,gardening, decorative purpose, road construction over poor soil, road widening, culverts, pipeline and buried structures, compensating foundation, rail embankment, landscaping and vegetative green roofs, retaining and buried wall backfill, slope stabilization, stadium and theater seating, airport ways, taxi ways,

VIII. ACKNOWLEDGMENT

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