iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: XII Month of publication: December 2020

DOI: https://doi.org/10.22214/ijraset.2020.32580

Comparative Behaviour of Retaining Walls using Plaxis v8.6

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Abstract: Nowadays, Geosynthetics have been used as routine reinforcement in earth structures such as reinforced soil retaining walls. Over the last few years new technology which is combination of reinforced concrete lofts and cantilever retaining wall has been used for construction of retaining wall also called as Graviloft. This Paper presents the study carried out to analyse the behavior of retaining wall and backfill soil for various approaches. Analysis is performed on cantilever retaining wall, Reinforced soil retaining wall and Graviloft wall and the comparison of behavior is based on parameters ,displacements (vertical and horizontal displacement), Stresses (shear stresses and normal stresses) using PLAXIS V8.6.The comparison shows that displacements and stresses occurred in reinforced wall and graviloft wall are much less as compared to conventional cantilever retaining wall, thereby reducing lateral thrust and improving stability.
Keywords: Retaining wall, Plaxis, FEM, Graviloft, Geosynthetics.

I. INTRODUCTION

Retaining walls are civil engineering structures required to support earth, loose stone and backfill and in the construction of bridges, abutments, cross drainage works etc. The retaining walls may be categorized as Gravity wall, cantilever retaining walls, Counter fort walls, Buttress wall, etc. The introduction to the new technology of including lofts in the conventional retaining wall is also included in the project work viz. The properties of the structure and the superiority of it over the conventional cantilever retaining wall and the cantilever retaining wall with geosynthetic. Over the last few years, environmental and economic issues have stimulated in the development of alternate approaches to fulfill the specifications. The recent technique in which the reinforced concrete lofts are provided perpendicular to the height of the wall also known as graviloft wall, which is combination of gravity retaining wall and RCC wall concepts affected by provision of relief shelves or reinforced concrete loft, is now a days used for construction of retaining walls. This technique is believed to be most economical and efficient in reducing the displacement in the wall, normal and shear stresses, ultimately making the wall more stable against the lateral pressure.

II. LITERATURE REVIEW

A. Hadi Abioghli(2016)

In this research behavior of geosynthetic reinforced soil wall is studied by numerical method (FEM) with Plaxis 2d software. The numerical model simulates the panel with beam elements, the reinforced layers with geogrid elements and the soil structure contact area with interface elements.

Furthermore Mohr-Coulomb's plastic model is used for soil. The wall construction is modelled with staged construction. Then numerical models are calibrated by using instrumental model results or experimental model and ability of Plaxis in wall displacement, facing deformation and tension of reinforced layer is assessed. According to results of numerical analysis, increasing the length of reinforcement, the effect of small on maximum deformation of facing has total height of wall, when the length of reinforcement has reduced or increased.

B. Hadi Khabbaz, Binod Shreshtha and Behad Fatahi (2013)

In this study, the behavior of reinforced soil retaining walls with combined horizontal and vertical reinforcements are investigated experimentally as well as numerically. The results, indicating the effects of vertical reinforcement inclusion, are compared to conventional reinforcing types under static and dynamic loads. In this paper, Plaxis, well known geotechnical software, is used for conducting a series of parametric studies on behavior of reinforced soil walls under construction and subject to earthquake loading, incorporating the vertical reinforcement. The performance of the wall is presented for the facing deformation and crest surface settlement, lateral earth pressure, tensile force in the reinforcement layers and acceleration amplification. The results show that these variables are considerably reduced when incorporating the vertical reinforcement in the system.

C. A.L. Shinde, J. N. Mandal(2007)

In this study, several experiment were carried out to understand the deformation behavior of reinforced soil retaining wall with limited fill zones under vertical surcharge strip loading. Test set-up along with all the instrumentations were developed to carry out the experiments. Panel displacements and strain distribution along geogrid layers were observed. Effectiveness of the reinforced soil wall are also evaluated using a geogrid material. Finite element analysis were carried out using commercial software Plaxis version 8 for the above problem without and with anchoring of reinforced soil retaining wall in the limited fill zone. The results are compared and reported in this present paper.

D. Yash Chaliawala, Gunvant Solanki, Anuj. K. Chandiwala(2015)

In this paper the study of the behavior and optimal design of two types of reinforced concrete walls of varying heights namely cantilever retaining wall, counter fort retaining wall. Cost against each optimal design of wall for particular height is calculated by using the volume of concrete and the amount of steel. Amidst the cost estimates of all the two optimal designs for particular height, a comparative study is carried out and the alternative with the least cost estimate is chosen as the best design solution.

E. R.J. Balwan, Ajinkyakumar Kumbhar(2011)

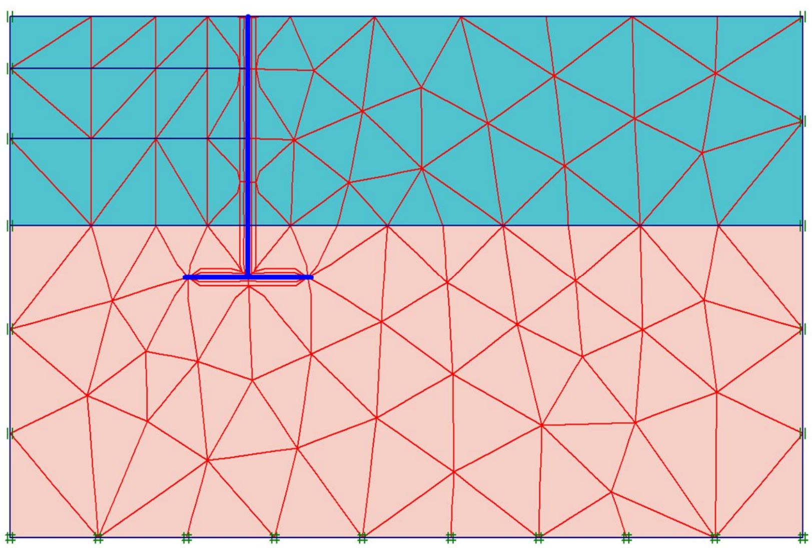
The site under consideration is Mahindra Vehicle Manufacturers Ltd, Chakan industrial area, Pune. In this study wall of 6.0m height is considered for cost comparison. The aim was to, evolve retaining walls suitable for Indian conditions such that these walls are cost-effective, easy to construct, could serve as load bearing members, would use conventional material, and would not require higher technical skill, with ease of construction and saving in time. Conclusion of this study shows that use of Graviloft Technology is cost saving solution to retain earthwork. The stability requirements of these walls are same as for gravity walls and the loft design is as per engineering norms, but the provision of loft reduced the section of the wall thereby achieving economy of construction over the walls mentioned earlier.

III. METHODOLOGY

The finite element program Plaxis v8.6 was used to developed a numerical model of a reference problem to study on retaining walls. Finite element models created in Plaxis v8.6 for the analysis of the three retaining wall types viz. conventional cantilever retaining wall (without reinforcement in the backfill), reinforced soil retaining wall and the latest geotechnical concept of the retaining wall with the lofts at particular height throughout the height of the wall called as Graviloft retaining wall. The beam element or the plate element need to be defined for partricular analysis in terms of its Flexural rigidity (EI) and normal stiffness(EA). The results on the basis of various parameters like displacement and mean stresses generated due to retaining action of the structure.

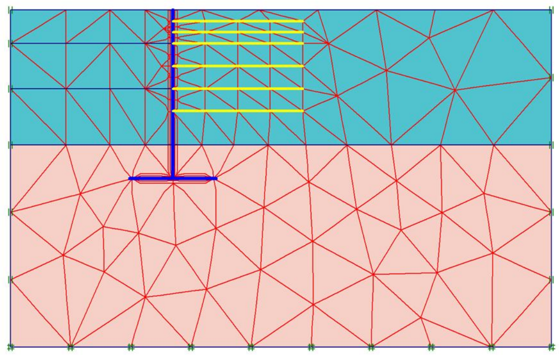
A. Model 1: Conventional cantilever Retaining Wall.

The retaining wall of conventional cantilever type is analyzed using Plaxis v8.6. The finite element model is created, retaining wall modeled is about 7.5m height and have the base width of 4m.The surcharge is about 3 KN/m^2 over the length of 4 m.The modeling is done without reinforcement in the backfill soil. The modeling is done without reinforcement in the backfill soil as given below.



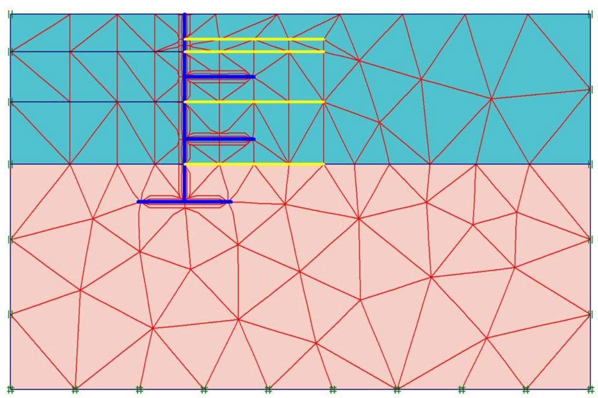
B. Model 2: Reinforced soil Cantilever Retaining wall using Geogrid as Reinforcement.

The Plaxis model is created for the reinforced soil retaining wall having height 7.5m and the base with of 4m. The surcharge pressure on the backfill is about 3 KN/m^2 acting over length of 4m. The additional input given in this case is by using the Geogrid as reinforcing material. The geogrid used is SR2/UX1800 by Tansar Pvt. ltd. having stiffness about 74.1 KN/m. The geogrids are placed with the spacing of 0.5m between the first three and spacing of 1 m between the rest 4. The finite element model mesh is generated as follows;



C. Model 3: Graviloft Retaining Wall.

The Graviloft is the newly developed type of retaining wall in which the wall is provided with the reinforced concrete Lofts into height of the wall with equal distance between them. The finite element model is prepared for the Graviloft retaining wall having the wall height 7.5m and base width 4m and the two lofts of the length 3m and 0.3m thickness are constructed across the height at the spacing of 2.5m between them. The surcharge intensity acting on backfill is 3 KN/m^2 over the length of 4m. The finite element mesh generated for the structure is as follows;



IV. CONCLUSION

A. Inclusion of Geosynthetic material i.e. Geogrid, reduces the displacements in the conventional cantilever retaining wall in horizontal and vertical direction.

B. With the change in geometry of the reinforced soil retaining wall the horizontal and vertical displacements reduces significantly in Graviloft as compared with the conventional and reinforced soil cantilever retaining wall.

C. The total normal and shear stress are greatly reduced in case of Graviloft retaining wall as the displacement caused due to the earth pressure of the soil backfill and the surcharge pressure acting over the backfill is reduced.

D. Due to the lofts provided in the structure which minimizes the design load as the stability of the wall is governed by its self-weight, retention on the loft and the friction developed at interface of the loft and distributes the pressure on the wall equally throughout the height of the wall.

E. Shear stress and Normal stress along with total mean stress on the wall decreased with change in geometry of the wall from conventional cantilever to graviloft wall which increases the shear strength of soil, which helps increase the stability of the structure and the reduces failure possibilities to a greater extent which ultimately improve the life of the structure.

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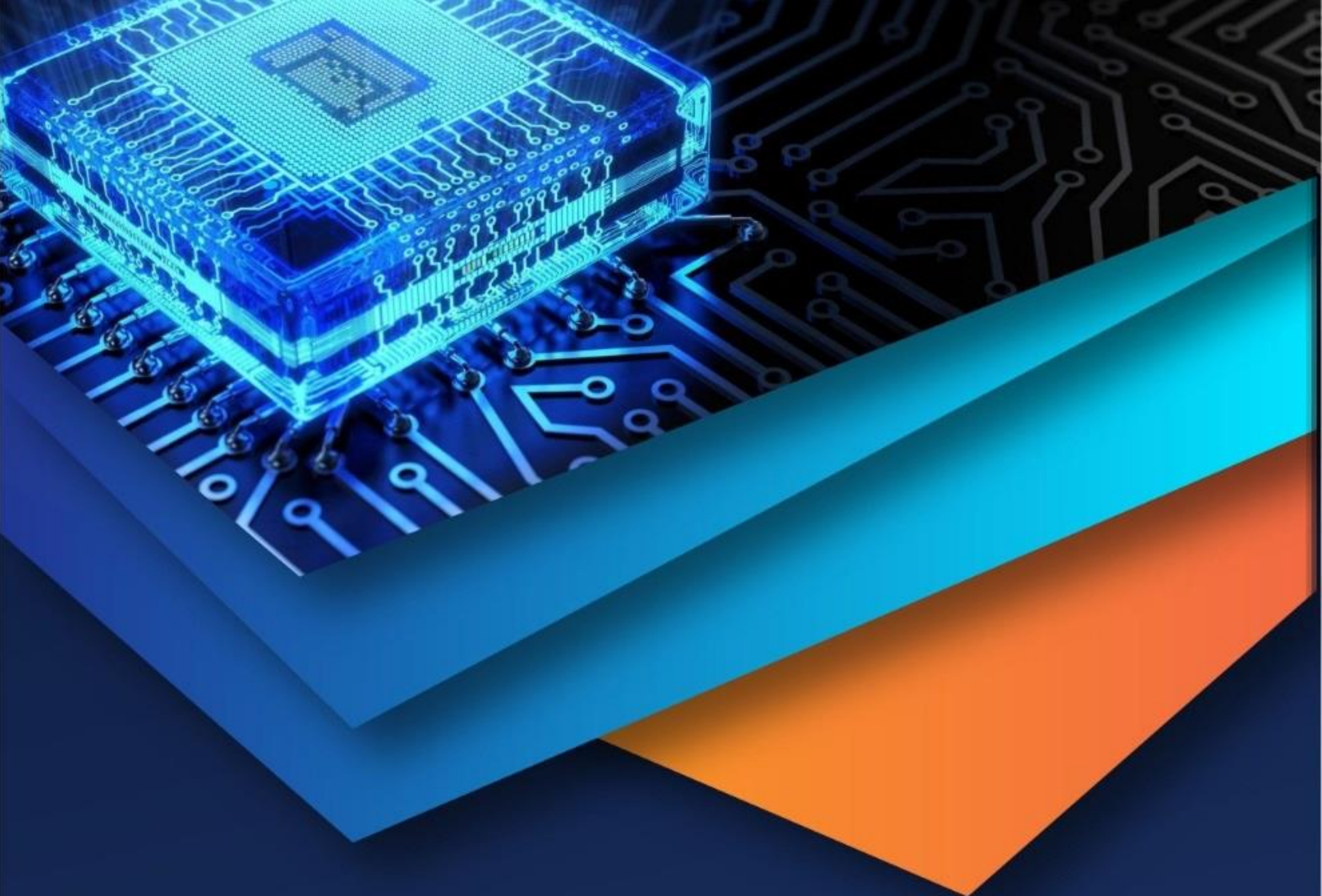

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