PARAMETRIC STUDY ON GEOGRID REINFORCED RETAINING WALL SYSTEM

Ms. Radhika Borkar
P. G. Student, Department of Civil Engineering
Government Engineering College,
Aurangabad, Maharashtra, India

Dr. Mrs. Shubhada S. Koranne
Associate Professor, Department of Civil Engineering
Government Engineering College,
Aurangabad, Maharashtra, India

Abstract— Reinforced earth retaining is a type of retaining wall which can bear the lateral earth pressure which is made up of backfill, stressed geosynthetic and facing system. “Zornberg J.G, (2001) in their work emphasis that- Traditional soil reinforcing techniques involve the use of continuous geosynthetic inclusions such as geogrids and geotextiles”. The acceptance of geosynthetics in reinforced soil construction has been triggered by a number of factors, including aesthetics, reliability, simple construction techniques, good seismic performance, and the ability to tolerate large deformations without structural distress. Examples include advances in reinforced soil design for conventional loading (e.g. validation of analysis tools), advances in design for unconventional loading (e.g., reinforced bridge abutments), and advances in reinforcement materials (e.g., polymeric fiber reinforcements).”R.D. Haltzs (2001) in their work emphasize -Geosynthetics as soil reinforcement used for embankments on soft foundations, steep slopes, and for the backfills of retaining walls and abutments”. Emphasis is on the materials properties of the geosynthetics required for design and construction. Reinforced soil retaining walls (RSW) are widely used in geotechnical engineering practice throughout the world. Reinforced soil walls have been constructed using steel strip reinforcement geogrids, geosynthetics, and geocomposite. Geosynthetics manufactured from advanced polymer materials became popular as an alternative to steel strip reinforcement in reinforced soil walls.

Keywords – Geotextiles, Geogrids, Geosynthetic, Reinforcement materials, Retaining wall

I. INTRODUCTION

Retaining wall

A retaining wall is a structure designed and constructed to resist the lateral pressure of soil, when there is a desired change in ground elevation that exceeds the angle of response of the soil. Retaining wall is a cantilever type wall, which is a freestanding structure without lateral support at its top. These are cantilevered from a footing and rise above the grade on one side to retain a higher level grade on the opposite side.
Fig. 3 Geogrid’s rib formation in machine and cross machine directions of manufacturing process
Based on direction of stretching during manufacture
Uniaxial geogrids
Biaxial Geogrids
Uniaxial Geogrids
These geogrids are formed by the stretching of ribs in the longitudinal direction. So, in this case, the material possesses high tensile strength in the longitudinal direction than on the transverse direction.
Biaxial Geogrids
Here during the punching of polymer sheets, the stretching is done in both directions. Hence the function of tensile strength is equally given to both transverse and longitudinal direction.

Fig 3. Uniaxial and Biaxial Geogrids manufactured by the method of extrusion

II. HEADINGS
Objectives of Study:
1. To evaluate the influence of system properties, such as soil, geogrid and interface stress-strain parameters and loading conditions on the overall wall response as indicated by performance parameters such as the maximum settlement of the wall and maximum tension in the geogrid.
2. To account for scale effects that would occur when predicting the response of large-scale reinforced systems based on small-scale test data.
3. To evaluate the effect of different types of geogrid reinforcement and/or backfill soils.
4. To explore appropriate means of analytically modeling creep and geogrid degradation effects.
5. To evaluate and verify the long-term performance of MSE walls through experiments, supplemented with analysis methods.
6. To incorporate the above findings in the current design guidelines and to develop a computer program for designing and analyzing MSE walls under creep conditions.

EXPERIMENTAL WORK-
1 Materials-Soil
For the model tests cohesion less, dry and clean standard sand is used as the foundation material. The particle size of sand used for the test was passing through 600 micron sieve.

Geogrid
The glass fiber geogrid is chosen as research material because the strength of glass fiber geogrid is lower than other model grids; it meets the need of scaled model test.

TGSG 1515
Aperture Size = 1.8mm X 1.8mm
Color - white

Steel Box
The test setup consists of a strong mild steel (MS) box having 720 mm in length, 220mm in breadth and 600mm in height (internally). Four handle are provided on top side for holding purpose.

Polythene
The front walls were coated with a thin layer of white petroleum grease and polythene sheet strips of 60 mm width were placed to reduce boundary friction effects.

Footing-
Size
- Upper plate- 140 mm– rectangular size
  Height – 100mm
- Lower plate – 20 mm square size
  Material – steel

Wall facing-
The facing of reinforced wall is done with the gravel gabion wall along with wrap around facing. Gravel gabion wall is made at 90 degree to the surface. The spacing of grids is maintained using the gravel gabion of two different sizes. For spacing 5cm- gabion height 5cm
  Spacing 7.5 cm – gabion height 7.5cm

III. INDENTATIONS AND EQUATIONS

Height of Mould, \( H =15.24 \) cm
Diameter of Mould, \( D =15.24 \)
Volume of Mould = \( \frac{\pi}{4} \times D^2 \times H \)
\[ = 2780.006 \text{ cm}^3 \]
Density of Soil = \( \frac{3700}{2780.006} \approx 1.331 \text{ gm/cc} \)
For maximum density-
Wt. of soil = 10250-5920
= 4330 gm
Density = 4300/27000 = 1.558 gm/cc
Density at Field condition, \( \bar{\rho}_{\text{df}} = 1.5 \) gm/cc
Relative Density = \( \left[ \frac{1.558(1.5-1.333)}{1.5(1.558-1.333)} \right] \times 100 \)
= 77.09%
% of compaction = \( \frac{\bar{\rho}_{\text{df}}}{\bar{\rho}_{\text{max}}} \times 100 \)
= (1.5/1.558)\times100
= 96.28%

IV. FIGURES AND TABLES

Summary of test results:

| Soil Property | Loose Sand | Dense Sand |
|---------------|------------|------------|
| 1. Unit weight| 15         | 17         |
| 2. \( \phi \) in Plane Strain Condition | 39         | 45         |

| Soil Property | First Sample | Second Sample | Third Sample | Fourth Sample |
|---------------|--------------|---------------|--------------|---------------|
| Normal Stress (KN/m²) | 27           | 54            | 82           | 112           |

Graph -1

Graph -2
| LOAD | UNREINFORCED | TYPE A | TYPE B |
|------|--------------|--------|--------|
| 0    | 0            | 0      | 0      |
| 0.5  | 1.9          | 0.88   | 0.62   |
| 1    | 3.8          | 1.74   | 1.23   |
| 1.5  | 5.7          | 2.67   | 1.85   |
| 2    | 6.8          | 3.58   | 2.56   |
| 2.5  | 7.6          | 4.43   | 3.13   |
| 3    | 8.6          | 6.22   | 3.71   |

| Load | Unreinforced | Type A | Type B |
|------|--------------|--------|--------|
| 0    | 0            | 0      | 0      |
| 0.5  | 1.9          | 1.635  | 1.535  |
| 1    | 3.8          | 3.31   | 3.1    |
| 1.5  | 5.7          | 5      | 4.61   |
| 2    | 6.8          | 6.54   | 6.23   |
| 2.5  | 7.6          | 8.25   | 7.75   |
| 3    | 10.4         | 9.81   | 9.21   |
studied. As the spacing is decreased strength of structure is increased. Thus spacing and strength of structure are inversely proportional to each other.

3. It is observed through the study that overturning may be the most critical mode of failure with short reinforcement length of .3H to .4H, while sliding governs the wall with reinforcement length of .6H to .7H.

4. It is analysed that the geogrids of larger aperture size has ideal results of durability and displacement values until the rupture point.

VI. ACKNOWLEDGEMENTS

I express my heartfelt gratitude and deepest sense of regards to Dr. Mrs. Shubhada S. Koranne, Associate Professor, Department of Civil Engineering, Government Engineering College, Aurangabad (M.H.), and India under her able guidance and kind supervision the present piece of investigation could be completed. I am grateful to Dr. R. M. Damgir Head, Dept. of Civil Engineering, Government Engineering College, Aurangabad, (M.H.) for providing facilities for my research work. I express my sincere thanks to Dr. P.B. Murnal, Principal, Government Engineer College, Aurangabad, (M.H.) for valuable help and co-operation. My thanks are to my research colleagues Mr. Mahesh S. Hudekar, Mr. Manoj S. Sadafale for their kind co-operation.

VII. REFERENCE

1) Curtis.R.L, Chouery V.L et al.(1988) ,” Geogrid Reinforced Soil Retaining Wall On Compressible Soils” , International Conference On Case Histories In Geotechnical Engineering .

2) Karpurapu R, BATHURST RJ (1995), “BEHAVIOUR OF GEOSYNTHETIC REINFORCED SOIL RETAINING WALLS USING THE FINITE ELEMENT METHOD” Computers And Geotechnics 17.

3) Randeniya. R, Valsangkar.AJ, et al (1994), “PERFORMANCE OF A GEOGRID REINFORCED W ALLSTONE Retaining W ALL SYSTEM”, Calgary, Canada.

4) Ochiai H., Otani J. et al. (1996), “The Pull – Out Resistance Of Geogrids In Reinforced Soil” , Geotextiles And Geomembrane .

5) Allen T.M, Bathurst RJ (2014), “Performance Of An 11 M High Block-Faced Geogrid Wall Designed Using The K-Stiffness Method” Can. Geotech. J. Vol. 51.

6) Holz.R.D (2001), “Geosynthetics for Soil Reinforcement”, 9th Spencer J. Buchanan Lecture, November.

7) Bathurs.R.J, Miyata.Y et al.(2008), “Refinement Of K-Stiffness Method For Geosynthetic Reinforced Soil Walls”, Geosynthetics International.
8) Bathurst R.J, Allen T. (2009), “Reinforcement Loads in Geosynthetic Walls and the Case for a New Working Stress Design Method”.

9) Hatami K., Bathurst R.J, et al. (2001) “Static Response of Reinforced Soil Retaining Walls with Nonuniform Reinforcement”, The International Journal of Geomechanic.

10) Allen, T.M., Bathurst R.J, et al. (2013) “Comparison of Working Stress and Limit Equilibrium Behavior of Reinforced Soil Walls”, Geotechnical Special Publication.

11) Graeme D.S, Rowe R.K, et al. (2005) “Design and Behavior of a Geosynthetic Reinforced Retaining Wall and Bridge Abutment on a Yielding Foundation”, Geotextiles and Geomembranes 23.

12) Bathurst R.J, Miyata.Y. et al. (2010). “Facing Displacements In Geosynthetic Reinforced Soil Walls ”, Earth Retention Conference 3.

13) Kibria G., Hossain S. et al (2014) “Influence of Soil Reinforcement on Horizontal Displacement of MSE Wall”, American Society of Civil Engineers.

14) Kawarmura T. And T.Hirai, (2007), “Confining Effect In Geogrid Reinforced Soil Related To Soil Dilatancy.”

15) Scotland, N. D & Horgan M.G, (2012) “Serviceability Limit State Design in Geogrid Reinforced Walls and Slopes, International Geosynthetics Society."