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Parametric Analysis of Reinforced Soil Wall

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Abstract - The use of geosynthetic material for earth reinforcement purpose allows us to replace the massive concrete retaining walls by reinforced earth structures with some distinctive advantages. Beside the static equilibrium, these methods consider the influence of reinforcement stiffness on overall RSW stiffness, axial forces and strain induced in reinforcement. The seismic stability check governs the stability of RSW under seismic events and subsequent catastrophic failure. The RSW wall design will be done considering the existing ground conditions at reference site khed-sinner highway NH-50. The static analysis and seismic analysis of RSW will be done conducting numerical analysis with standard design procedure AASTHO LRFD and . The present study also includes authenticated computer software TechGrid Pro Designer for each case of stability check for further analysis of RSW. Using design codes and related literature the numerical analysis has be done by use of software. The analysis will focus on effect of variation of friction angle and reinforcement parameters on RSW design .Parametric analysis of reinforced soil wall by using TechGrid Designer Pro is been done for analyzing factors of safety external, internal and seismic.

Keywords -- Reinforced soil wall, AASTHO, TechGrid designer pro.

I. INTRODUCTION

Reinforced soil Walls are in use for more than 40 years world over and for the last 25 years in India and are increasingly being adopted in highway and bridge construction. These applications call for use of relatively new technology and materials. The developments in the theory, design methods and experience of the behaviour of RSW gained in laboratories, full scale tests and field applications in India and abroad have brought knowledge from developmental stage to widespread applications in hands of practicing engineers. To bring uniformity in partial load factors and partial material safety factors fulfilling a long standing need in the field of Highways and Bridges Engineering.

TechGrid Designer Pro is accurate, versatile, advanced, fully automated and integrated software for the design of reinforced soil walls in which TechGrid geogrids (world-class geogrids manufactured by TechFab India Industries Ltd) are used to reinforce the soil. The program helps engineers to design reliable and economic solutions and efficiently generates all the information required by the engineer to complete the project - design reports, construction drawing sand material quantity estimates

A) Global Status

Innovative engineered systems to build reinforced soil structures compared to traditional ones Geogrids are considered to work as primary reinforcements since they guarantee the overall and compound internal stability of the structure. Whereas the wire mesh units are considered a secondary reinforcement providing the local stability at the facing, ensuring that no local mechanism of direct sliding, pull-out or rotational failure occurs. Results on existing structures indicate that, as structures achieve relevant heights, there is a large potential for cost effectiveness in using wire mesh and grids combined. By using AASTHO method and FHWA method stability checks are been calculated of RSW.

B) Development in India

Parametric study is carried out to investigate the applicability of limit equilibrium method for analyzing reinforced embankment on soft soil with the use of *GEO5* software in this paper. The effect of vertical spacing of geotextile layers, slope inclination, and tensile strength of *PET* (Polyester) and *PP* (Polypropylene) geotextile on the behaviour of reinforced. Results divulge that use of full length of geotextile covering whole width of embankment can increase factor of safety at stiffer slope inclination**.** The methods adopted in india as per IRC: SP:102-2014 RSW for stability checks in been consider.

C) Types of Reinforced Soil Wall

Different types of wall as below:-

1. Precast concrete discrete panels.
2. Precast concrete segmental concrete blocks.
3. Gabions.
4. Wrap-around using welded wire mesh cages.

5. Wrap around using soil filled bags.

These paper analyze only Precast concrete segmental concrete blocks reinforced soil wall it been used mostly world-wide.

II. MATERIAL AND METHOD

Material is been taken from highway project currently under construction named as khed-sinner NH-50 .Retained soil sample and Reinforced soil sample both are taken from site and been experiments had been carried-out on them. Soil and Input parameters of RSW are been consider of these project. Method used for analysis are AASTHO LRFD by using TechGrid Designer Pro software and analytical calculation is been done by FHWA method. Software used in these research is first fully Indian develop software for design of RSW.

A. Soil properties of REW

Different type of soil are been taken for different levels in RSW. For reinforced and leveling pad GW- well graded gravels, gravel sand little or no fines is been used. And for Retained soil and foundation soil is CL Inorganic clays, low to medium plasticity, gravelly sand is present at referred site.

B. Reinforcements

Reinforcements used are manufactured by Techfab india pvt ltd there engineering properties and types of reinforcements are as follow TUG-40, TUG-60, TUG-80, TUG-100, TUG-120, TUG-150, TUG-200, TUG-250.these all reinforcements are polymer coated reinforcements.

III. METHODOLOGY

The design methodology is focused on stability analyses by AASTHO and FHWA LRFD related to four general classification of failure. Each is explained in detail below.

1. External stability
2. Internal stability
3. Global stability
4. Seismic stability

Internal and external stability is considered for different potential failure mechanisms. In addition to normal principles of design on the basis of which earth retaining structures are Designed, consideration has to be given to soil/reinforcement interaction while designing Reinforced soil structures. Analysis is done in two distinct parts External Stability and Internal Stability. External stability deals with stability of the reinforced block as a unit, while internal stability deals with mechanisms of transfer of lateral pressures to reinforcement and related mechanisms involved.

Once the design loads (serviceability load , or working load) are carried by the metallic reinforcement such as bars, plates etc. at an axial strain less than the strain in the soil, the Reinforcement is classified as "inextensible" reinforcement. Polymeric reinforcements which are characterised by temperature and time dependent strains (creep) are normally classified as extensible reinforcements. However, Polymeric and other reinforcements which show less strain as compared to soil strain may be also classified as inextensible reinforcement

A. External Stability

External stability of the reinforced soil mass/block is checked for three different conditions:-

A. Bearing and tilt failure.
B. Sliding and Overturning
C. Global stability.

B. Internal stability

It cover internal mechanism (tension and pull out failure) such as shear within the structure , arrangement and behaviour of the reinforcement and backfill. It checks the stability for each reinforcement layers and stability of wedges within the reinforced fill.

- Geogrid over tension
- Pullout failure
- Internal sliding

C. Wedge stability

The reinforcement structure will assume to fail internally in the form of wedge. It is not known at which level the wedge is originated. Therefore the wedge originates from different level to be checked. Checked for stability considering all the forces acting on it. Wedges are assumed to behave as rigid bodies and may be any size and shape. Stability of any wedge is maintained when friction forces acting on the potential failure plane in connection with the tensile resistance/ bond of the group of reinforcing elements in the fill beyond the plane are able to resist the applied loads tending to cause movement

D. Seismic stability

As per FHWA LRFD these stability is been calculated .

E. *Factor of Safety*

Factor of safety for different checks are taken below:-

Base Sliding	1.00
Internal Sliding	1.00
Connection Strength	1.00
Bearing Capacity	1.00
Pullout	1.00
Facing Shear	1.00
Crest Toppling	1.00
Pullout Barrier Impact	1.00
Overturning	1.00
Tensile Barrier Impact	1.00

F) Input Parameter

Soil Zone	Soil type	Friction angle	Density KN/M^2	Friction factor
Infill (i)	GW	28	18.50	---
Retained	CL	28	18.50	---
foundation	CL	30	18.00	0.55
Base	GW	28	18.50	0.70
drainage	SW	28	18.50	0.65

Table no.1 Input Parameter

IV. RESULT AND DISCUSSION

The RSW is been design by AASHTO LRFD method by using TechGrid Designer Pro .By giving referred input parameters and by keeping height constant with various in reinforcement , spacing ,length of reinforcement effect on factor of safety on all stability is been analysis below in been analysis graphs are been shown below.

A. Various reinforcement quatity w.r.t overall geometry of wall.

Below comparison of quantity is been made of various reinforcement which directly affects the economy of the RSW .If high strength reinforcement is been used than the quantity of reinforcement required gets reduced.TUG-40 558.48 m^3 And TUG-200 168.39 m^3 Reinforcement is required.

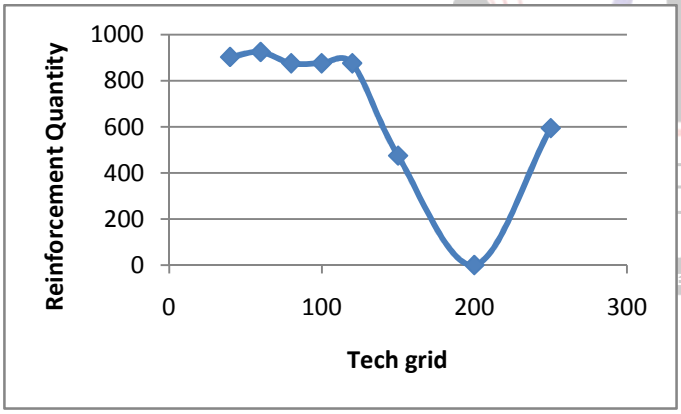

Fig. 1 various reinforcement quantity with respect to geometry of wall.

B. External static graph

Below graph analyze the external static stability for bearing capacity, overturning and base sliding. In these height of wall is been kept 6.90m constant with variation in length, spacing and type of reinforcement. Effect on factor of safety is been analyzed.

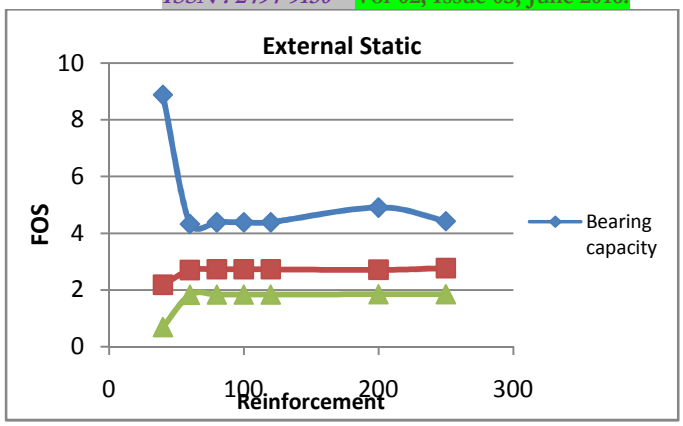

Fig. 2 External static

C. External Seismic graph

Below graph analyze the external seismic stability for bearing capacity, overturning and base sliding. In these height of wall is been kept 6.90m constant with variation in length, spacing and type of reinforcement. Effect on factor of safety is been analyzed.

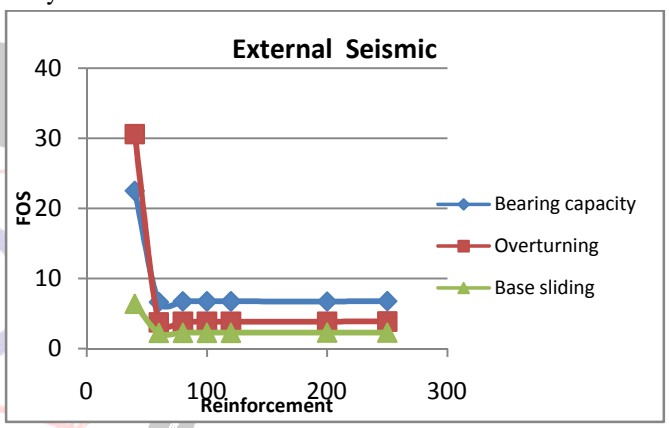

Fig. 3 External Seismic

D. Internal static graph

Below graph analyze the internal static stability for bearing capacity, overturning and base sliding. In these height of wall is been kept 6.90m constant with variation in length, spacing and type of reinforcement. Effect on factor of safety is been analyzed.

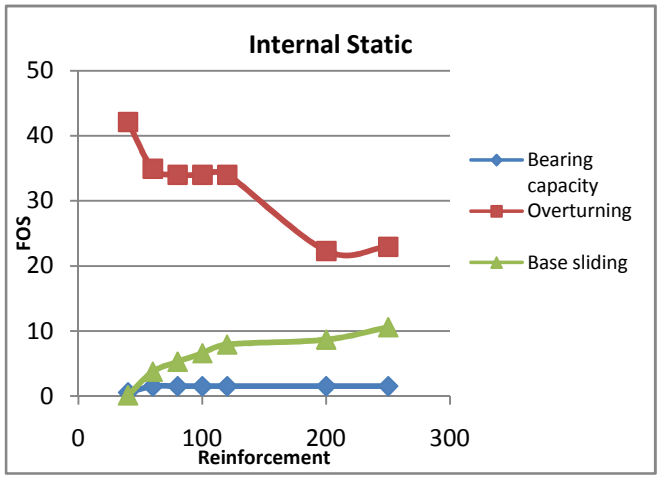

Fig. 4 Internal static

V. CONCLUSION

With variation in reinforcement length and spacing factor of safety for external static stability reduces at constant height. Thus combination of reinforcement must be used for RSW.

Overturning stability increases as the strength of reinforcement is been increased. Base sliding factor is also increased with change in length of reinforcement. Most economical reinforcement for 6.90 heights is TUG 200. Internal static stability changes with tensile overstress it gets increased with horizontal layer uniform spacing.

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