Improvement of Soft Subgrade Using Geogrid Reinforcement

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***Abstract*— Long term performance of pavement structure depends on stability of underlying soils. It is crucial to develop subgrade with CBR value at least 10. If CBR value is less than 10, the sub base material get deflected under traffic loading and deterioration of pavement takes place. Improving the soil with geogrid increase the stiffness and load carrying capacity of the soil by fractional interaction between the soil and geogrid material. Application of geogrid helps to reduce cost of bringing in earth materials from a borrow pit. It performs two functions such as separation and reinforcements. This project is an attempt to investigate the effect of geogrid mesh on the improvement of soft subgrade layer. The effect on strength after the inclusion of geogrid mesh at varying depth is also studied while placing it at varying depths in single and multiple layers. The effect in strength at soaked and unsoaked condition is also studied.**

Keywords*— CBR, geogrid, subgrade, Soaked

I. INTRODUCTION

Durability of pavement depends on the stability of the underlying soils. The existing soil at a particular location may not be suitable for the construction due to poor bearing capacity and higher compressibility or even sometimes excessive swelling. The properties of a soil may be altered in many ways among which a few are chemical, thermal, mechanical and other means. Stabilization is being used for a variety of engineering works such as construction of all-weather roads and air-field pavements including helipads, where the main aim is to increase the strength or stability of soil by making best use of the locally available materials. Engineers are responsible for selecting or specifying the correct stabilizing method, technique, and quantity of material required.

Soil reinforcement is a well-known procedure for improving the properties of problematic soil. Geogrids provide interlocking of aggregate at the subgrade interface, provided that the aggregate locks into the grid structure that are of sufficient rigidity and geometry. The interlocking of the base aggregate and geogrid is a function of the gradation and angularity of the aggregate and the geometry of the geo-grid. Geogrids are made from high molecular weight, high tenacity polyester multifilament yarns. The yarns are woven on tension in machine direction and finished with a polymeric coating, geogrids are polymeric in nature with tensile strength varying from 100 to 220KN, they are either biaxial or uniaxial in strength i.e. they are biaxial when they have major strength in both X, Y directions and uniaxial when they have major strength along the Y-direction and minor strength along the X-direction. Technique of improving the soil with geo-grid increase the stiffness and load carrying capacity of the soil through fractional interaction between the soil and geo-grid material improving the soil. Geogrids used within a pavement system perform two functions which are separation and reinforcements. The primary function of geo-grids is used as pavements reinforcement, in which the geo-grid mechanically improves the engineering properties of the pavement system. Also it helps reduce cost of bringing in earth materials from a borrow pit.

II. MATERIALS AND METHODOLOGY

Materials used: Soil collected from English India Limited company, Veli, Trivandrum and jute geogrid of aperture size 2mm X 2mm purchased from Kolkata.

The initial properties of the soil are given in the Table I.

TABLE I INITIAL PROPERTIES OF SOIL

PROPERTIES	VALUES
Liquid limit (%)	34.9
Plastic limit (%)	23.4
Plasticity index (%)	11.5
Specific gravity	2.59
Maximum dry density (g/cc)	1.54
Optimum moisture content (%)	24
Is classification	CL
Unconfined compressive strength (kN/m^2)	71
Particle size distribution	
• Percentage of sand (%)	5
• Percentage of silt (%)	40
• Percentage of clay (%)	55

The physical property of natural geogrid mesh is shown in Table II.

TABLE II PHYSICAL PROPERTIES OF NATURAL GEOGRID MESH

CHARACTERISTICS	VALUES
Specific gravity	1.29
Density (kN/m^3)	13
Tenacity (MN/m^2)	525
Elongation (%)	1.1
Cellulose/lignin content (%)	61/12
Micro-fibril angle (degree)	8.1

Properties of the collected soil sample and natural geogrid were determined as per IS specification. Natural geogrid was treated using sodium hydroxide at 0.1M concentration. CBR test (IS:2720 Part 16 - 1987) was carried out on the soil with geogrid reinforcement at various layers. Single layer and multiple layer placement were studied by placing the geogrid at first, second, third, first & second, second & third and first & third layers from the top of the specimen correspondingly. Effect of treated and untreated geogrid reinforcement was determined. Also untreated and treated geogrid reinforcement at soaked and unsoaked conditions were compared.

III RESULTS AND DISCUSSIONS

CBR test was conducted on geogrid reinforced soil (single and multiple layer placement) and load penetration curve for unsoaked specimens was plotted as shown in figure 1 and figure 2. After the soaking period of four days specimen was tested and load penetration curve was obtained as shown in figure 3 and figure 4. Effect of geogrid treatment on bearing strength for single layer placement was studied at unsoaked condition and soaked condition as in figure 5 and figure 6. CBR value at unsoaked and soaked conditions for untreated and treated geogrid reinforcement is studied as in table IV and table V.

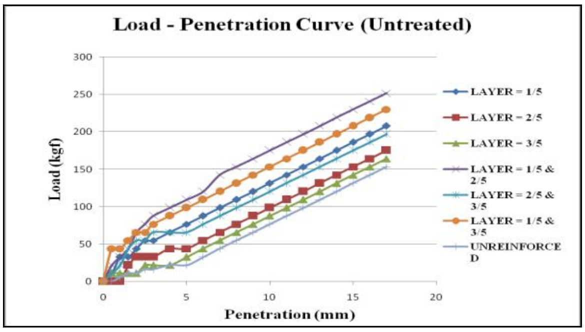

Fig 1: Load Penetration Curve for untreated geogrid reinforced soil in unsoaked condition

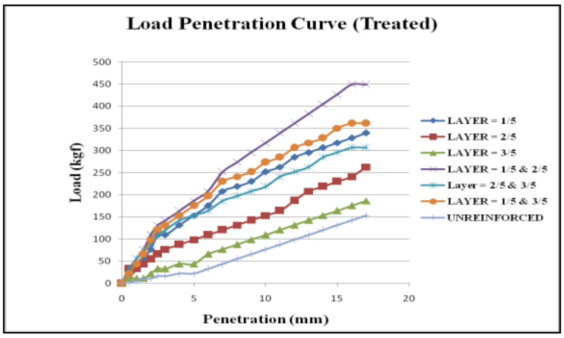

Fig 2: Load Penetration Curve for treated geogrid reinforced soil in unsoaked condition

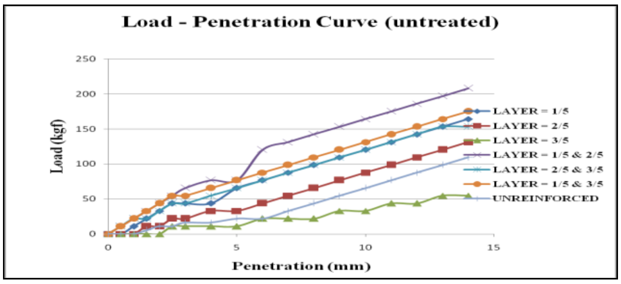

Fig 3: Load Penetration Curve for untreated geogrid reinforced soil in soaked condition

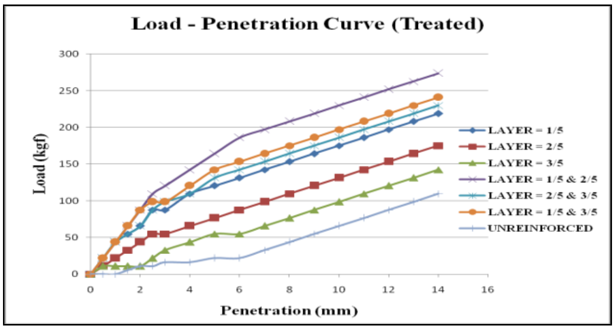

Fig 4: Load Penetration Curve for treated geogrid reinforced soil in soaked condition

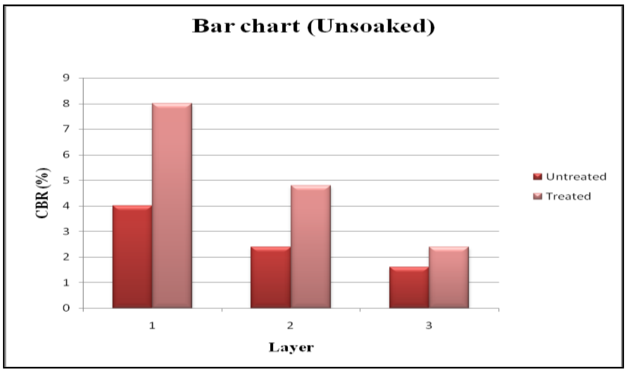

Fig 5: Bar chart for treated and untreated geogrid reinforced soil in unsoaked condition

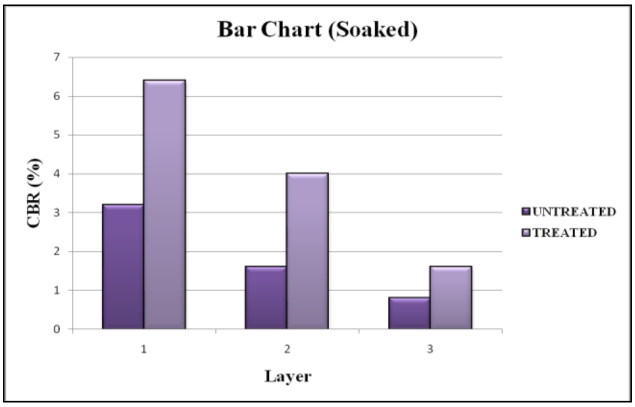

Fig 6: Bar chart for treated and untreated geogrid reinforced soil in soaked condition

TABLE IV: CBR VALUE FOR UNTREATED GEOGRID REINFORCEMENT AT UNSOAKED AND SOAKED CONDITION

LAYER	CBR (%)	
	UNSOAKED	SOAKED
0.2 H FROM TOP	3.99	3.19
0.4 H FROM TOP	2.39	1.59
0.6 H FROM TOP	1.59	0.79
0.2H & 0.4H FROM TOP	5.59	3.99
0.4H & 0.6H FROM TOP	3.99	3.19
0.2H & 0.6H FROM TOP	4.79	3.79

TABLE V: CBR VALUE FOR TREATED GEOGRID REINFORCEMENT AT UNSOAKED AND SOAKED CONDITION

LAYER	CBR (%)	
	UNSOAKED	SOAKED
0.2 H FROM TOP	7.99	6.39
0.4 H FROM TOP	4.79	3.99
0.6 H FROM TOP	2.39	1.59
0.2H & 0.4H FROM TOP	9.59	7.99
0.4H & 0.6H FROM TOP	7.99	7.19
0.2H & 0.6H FROM TOP	8.79	6.39

Load penetration curve improves with different layer placement and shows similar trend for treated and untreated geogrid placement. CBR value improved for treated geogrid than untreated geogrid when placed in 1/5H in single layer placement (83.32% for treated and 66.61% for untreated). Multiple layer placement achieved more strength than single layer placement. CBR value decreases in soaked condition than unsoaked condition. Optimum strength is obtained for treated geogrid placement at multiple layer (1/5 & 2/5) [15].

IV CONCLUSIONS

The following conclusions were drawn from conducting the study:

- Load penetration curve showed similar trend for untreated and treated geogrid.
- CBR value improved by 50.06 % for treated geogrid reinforcement than untreated geogrid, when the geogrid is placed at 0.2 H from the top of the specimen in unsoaked condition.
- Multiple layer reinforcement achieve greater strength than single layer.
- Optimum value is obtained when geogrid is placed in multiple layers at 0.2H and 0.4H from top of the specimen by providing the benefit of better load distribution.
- Thus treated geogrid at multiple layer should be used for reinforcement to achieve maximum strength with long term durability.
- CBR value decreases at soaked condition for both treated and untreated geogrid placement.
- At soaked condition, CBR value increased for treated geogrid by 50.07% than untreated geogrid when placed at 0.2 H from top of the specimen.

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