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EXPERIMENTAL STUDY ON STRENGTH IMPROVEMENT OF BASE COURSE OF FLEXIBLE PAVEMENT USING GEOGRID

Pavithra S[1], Goutham K[2], Jai Ganesh D S[3]

[1]Assistant Professor, Dept. of Civil Engineering, S.A. Engineering College, Tamil Nadu, India
[2,3]UG Student, Dept. of Civil Engineering, S.A. Engineering College, Tamil Nadu, India

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Abstract - *This project presents the result of lab studies on strength improvement of base course of flexible pavement using geo grid reinforcement [1]. The relative advantages of placing reinforcing material like geo grid in the soil base course are studied in terms of increase in CBR value. The optimum number of geo grid layers and its optimum location is found such that the maximum benefits of placing geo grid within the soil sub grade and at the interface of sub grade &base course is derived. Tests are also carried out by placing coarse aggregate beneath the geo grid layer, so that the interfacial friction developed between the aggregate & reinforcement can more effectively contribute to improvement in CBR value [2]. By placing the geo grid along with coarse aggregate, CBR value increases considerably thereby decreasing thickness of pavement.*

Keywords: Geo grid, CBR value, Coarse aggregate

1. INTRODUCTION

The unpaved low volume roads are used extensively for either temporary or permanent transportation purposes, such as haul roads, access roads, rural roads and parking loads. These roads will be subjected to problems like excessive rutting and mud pumping when constructed on weaker sub grade soil, making the road unusable for the traffic [3]. Geo Grids are being widely used for reinforcing unpaved and paved roads constructed on weaker soils as they provide support to the loads through membrane action and also to separate different layers of the road, besides being cost-effective compared to traditional ground improvement methods.

Most of the studies are largely concentrated on unpaved roads and have been able to identify benefits in terms of reduced plastic deformation. By referring the works carried out by previous researchers, a clear idea is obtained about the geo grid's function as reinforcement. In [2]it is observed that CBR increases when coarse aggregate is added in the soil sub grade or when the soil is mixed with coarse aggregate. The present study identifies the relative advantages of reinforcement materials placed at the base course layer & at the interface of sub grade and base course by carrying out CBR test.

1.1 GEO SYNTHETICS

Geo synthetics are man-made materials used to improve soil conditions. The word is derived from: Geo = earth or soil + Synthetics = man-made. Geo synthetics are typically made from petrochemical-based polymers ("plastics") that are biologically inert and will not decompose from bacterial or fungal action. Geo synthetic materials placed in soil can serve the following functions.

- Drainage
- Filtration
- Separation
- Reinforcement

Types of Geo Synthetics

- Geo grids
- Geo Nets
- Geo Membrane
- Geo Foam
- Geo Pipe

1.2GEO GRIDS

Geo grids are polymeric products formed by joining intersecting ribs. They have large open spaces also known as "apertures". The directions of the ribs are referred to as machine direction (md), orientated in the direction of the manufacturing process are cross machine direction (cmd) perpendicular to the machine direction ribs. Geo grid are mainly made from polymeric materials, typically polypropylene (PP), high density polyethylene (HDPE) and polyester (PET)[3] . Based on stretching direction geo grid are classified into

- Uniaxial geo grids &
- Biaxial geo grids.

UNIAXIAL GEO GRIDS

These geo grids 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 GEO GRIDS

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.

2. METHODOLOGY

The study aims to improve the strength of base course in flexible pavement. The soil was tested to find its basic properties and hence to classify it according to IS classification system.The soil was classified as CI. CBR test was performed by keeping geo grid in various positions as mentioned below:

i. Top layer.
ii. Top,middle and bottom layer.

Since the improvement in the CBR value did not meet MORTH specifications, 20mm coarse aggregate layer was added along with the geogrid reinforcement. This resulted in a higher CBR value.

The design of flexible pavement was carried out for 2 conditions

1. For soil without reinforcement
2. For soil with reinforcement along with coarse aggregate.

The difference in thickness of pavement was found to be 312mm.

3. TEST ON GEO GRID & SOIL

The following are the tests carried out on Geo grid and soil in .

The tests in Geo grid are
1. Aperture size
2. Percent open area
3. Thickness
4. Mass per unit area

The tests in soil are
1. Specific gravity.
2. Sieve analysis.
3. Standard proctor compaction test.
4. Liquid limit & plastic limit.
5. Unconfined compressive strength.
6. California bearing ratio.

3.1 TEST IN GEO GRID

TABLE -1: TEST IN GEO GRID

S.NO	TEST NAME	RESULT
1.	Aperture size	2.5cm x 2cm
2.	Percent open area	71.13%
3.	Thickness	Ribs = 1mm
		Joints = 1.5mm
4.	Mass per unit area	0.01536 g/cm^2

3.2 TEST IN SOIL

TABLE -2: TEST IN SOIL

S.NO	TEST NAME	RESULT
1.	Specific gravity	2.68
2.	Unconfined compressive strength	90 kN/m^2
3.	Liquid limit	47.53 %
4.	Plastic limit	21.15%
5.	Plasticity Index	26.38%

According to the Plasticity chart, the soil is classified as as CI (clay of intermediate plasticity) .

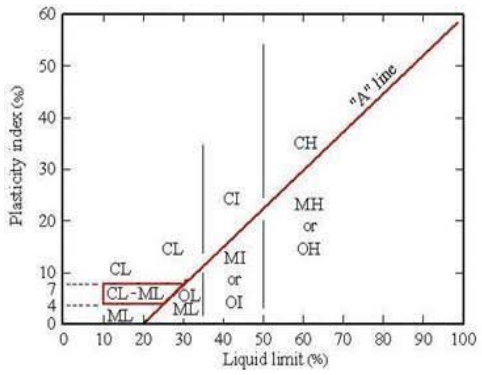

FIG -1: Plasticity Chart

CALIFORNIA BEARING RATIO

S. no	Reinforcement Details	CBR VALUE			
		Unsoaked (%)		Soaked (%)	
		2.5mm	5mm	2.5mm	5mm
1.	Soil without Geogrid	4.74	4.31	3.16	2.89
2.	Soil + Geo Grid(Top Layer)	6.08	5.27	4.51	4.13
3.	Soil + Geo Grid(top+middle +bottom Layer)	7.92	7.59	6.43	6.27
4.	Soil+coarse aggregate	12.87	11.2	9.72	9.12
5.	Soil + Geo Grid+coarse aggregate	14.08	13.79	11.87	11.13

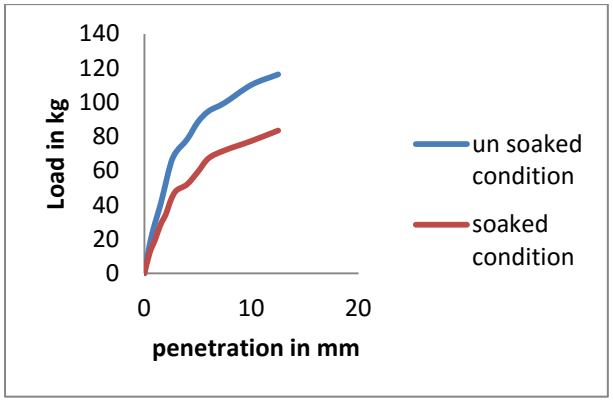

Chart-1: load vs penetration curve for soil

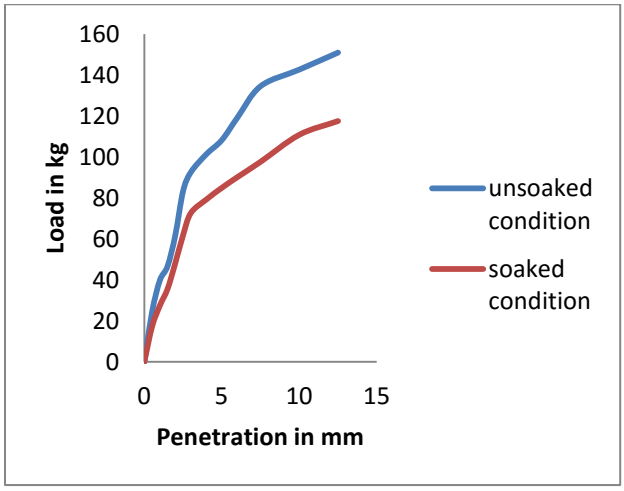

Chart-2: load vs penetration curve for soil and geo grid in top layer

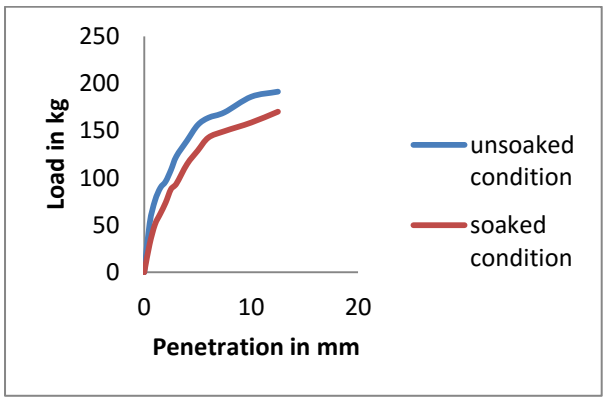

Chart-3: load vs penetration curve for soil and geo Grid in top, middle and bottom layers

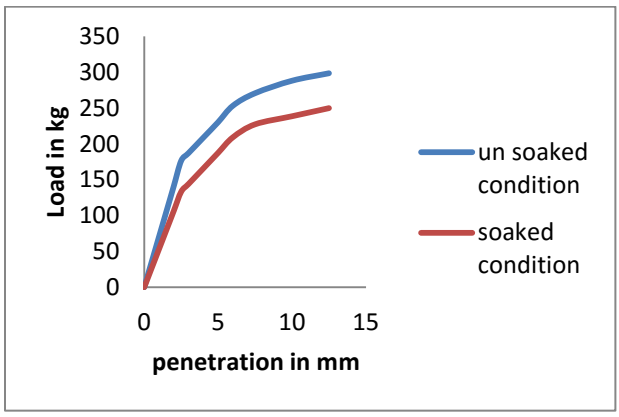

Chart-4: Load vs penetration curve for soil and coarse aggregate

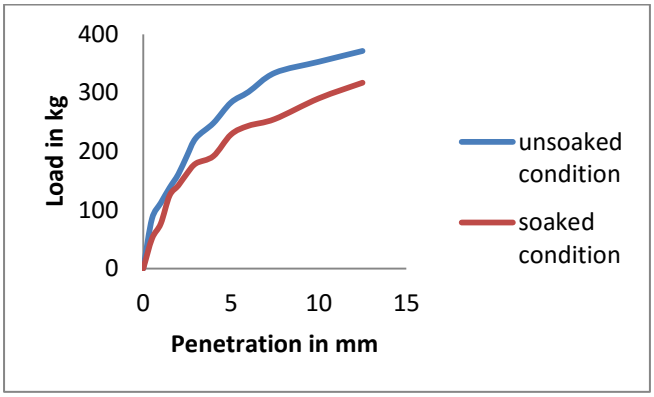

Chart-5: Load vs penetration curve for soil, coarse aggregate and geo grid

4. CONCLUSIONS

This work aims to find the contribution of geogrid reinforcement to improve the CBR value of base course of pavement.

It is concluded that:

i. Geo grid resists settlement and improves the stability of soil which is confirmed from the CBR test on soil for various.
ii. It is found that the thickness of the pavement gets reduced when CBR value of the soil increases due to introduction of geogrid and coarse aggregate as reinforcing layer.
iii. The following are the results obtained from CBR test for both soaked and unsoaked condition

a. For un soaked condition

- CBR value in the soil is 4.74 for 2.5mm penetration and 4.31 for 5 mm penetration.
- When Geo grid is placed in top layer CBR value increases to 6.08 for 2.5mm penetration and 5.27 for 5 mm penetration.
- When it is placed in top, middle and bottom layer CBR value increases to 7.92 for 2.5mm penetration and 7.59 for 5 mm penetration.
- When it is soil with coarse aggregate CBR value increases to 12.87 in 2.5mm penetration and 11.20 in 5 mm penetration.
- When geo grid is placed along with soil and coarse aggregate CBR value increases to 14.08 for 2.5mm penetration and 13.79 for 5 mm penetration.

b. For soaked condition

- CBR value in the soil is 3.16 for 2.5mm penetration and 2.89 for 5 mm penetration.
- When Geo grid is placed in top layer CBR value increases to 4.51 for 2.5mm penetration and4.13 for 5 mm penetration.
- When it is placed in top, middle and bottom layer CBR value increases to 6.43 for 2.5mm penetration and 6.27 for 5 mm penetration.
- When it is soil with coarse aggregate CBR value increases to 9.72 for 2.5mm penetration and9.12 for 5 mm penetration.
- When geo grid is placed along with soil with coarse aggregate CBR value increases to 11.87 for 2.5mm penetration and 11.13 for 5 mm penetration.
- It is therefore concluded that, the CBR value is maximum in the case where geo grid is placed along with coarse aggregate.

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