Investigation on Deformation Behaviour of Flexible Pavement with Different Composition of Material

N.V.Varun, P.D.Arumairaj, S.Janakiraman

ABSTRACT--- Damages in flexible pavements are mostly due to weak soil subgrade. In this work, reinforced earth technique is used to improve the sub grade soil. It helps to improve the compaction characteristics of soil besides reduction in the permeability and compressibility. It also helps to increase its shear strength and the bearing capacity. Unsoaked CBR test are conducted on locally available soil reinforced with geotextile. Addition of geotextile results in reduction in the design thickness of flexible pavement. Then use of solid waste material of concrete recycled aggregates and natural aggregates at different combination as well as at different layers of flexile pavement. The software PLAXIS-2D are used to evaluate the performance of unreinforced and geotextile reinforced pavement. Traffic Benefit Ratio (TBR) arrived at indicates that addition of geotextile improves the service life of pavement.

Index Terms - Unsoaked CBR, soaked CBR, Geotextile, Recycled aggregate, PLAXIS-2D.

I. INTRODUCTION

Improvement of subgrade soil is done either by mechanical method or by adding additives to the subgrade soil. In subgrade soil, fibers are added by randomly or reinforced in layers. Randomly distributed fiber-reinforced technique is mostly used in geotechnical engineering. Improvement of strength is due to surface friction between the fiber and soil. Use of geotextile in soil as reinforcement gives improvement of soil properties. Geotextile has synthetic Some examples of Geotextile are Polyester, polypropylene, polyethylene, nylon, rayon, glass, steel, spandex, acrylic and kevlar. Soil which is used in this project is collected from Perur road, Coimbatore.

As per Indian Roads Congress (IRC: 37-2001) California Bearing Ratio (CBR) value of subgrade soil must have minimum two per cent. If CBR of the subgrade soil is less 2%, a capping layer of 150mm thickness of material should be provided. Soil which is collected from Perur road has CBR value of 3%. Improvement of soil has to be done to avoid capping layer.

Geotechnical properties of clay such as particle size distribution, Atterberg's limits, specific gravity, Differential free swell, Optimum Moisture Content (OMC), Maximum dry density (MDD), unconfined compressive strength (UCS) and CBR values are determined. Based on the results, the clay is classified as clay of high compressibility (CH) as per BIS.

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In this study, the CBR test carried out on nonwoven needle-punched geotextile combines with the granular soils with different grading, the geotextile reinforcement placed between three different sub grade layers and the comparison between bearing capacity of soil with and without geotextile reinforcement under axisymmetric loading condition was investigated.

The design of pavement with and without artificial fiber reinforcement is done to compare the reduction in thickness of pavement. In addition to this, Software analysis of Pavement is done by using PLAXIS. The performance of polyester fiber, polypropylene fiber, glass fiber, nylon fiber and steel fiber reinforced pavements is evaluated using the softwares. Maximum vertical compressive strain is determined from PLAXIS.

II. MATERIALS AND TEST METHODS

A. Soil used

Soil sample is collected from perur raod,

Coimbatore. The sample is collected at a depth of 0.3m below the ground surface. The soil used for analysis is identified as clay.

B. Soil properties

The properties of clay as obtained from soil analysis are shown in table I.

TABLE I
PROPERTIES OF CLAYEY SOIL

S.NO	Properties	Results
1	Natural Moisture Content	27.23%
2	Specific Gravity	2.44
3	Percentage Gravel	4.20%
4	Percentage sand	30.11%
5	Percentage silt & Clay	64.30%
6	Liquid limit	26%
7	Plastic limit	15%
8	Shrinkage limit	11.4%
9	Differential Free Swell	29%
10	Soil Classification	CH
11	OMC	20%
12	MDD	1.80g/cc
13	UCS (q_u)	80 KN/m^2
14	Unsoaked CBR	3.2%
15	Soaked CBR	2.5%

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TABLE II
PROPERTIES OF Natural Aggregates

S.NO	Properties	20 mm	40mm
1	Specific Gravity	2.77	2.56
2	Density (kg/m^3)	1.47	1.60
3	Los Angeles Abrasion	26 %	28%
4	Flakiness Index	7.2 %	8 %
5	Elongation Index	12 %	13 %

PROPERTIES OF Recycled Aggregates

S.NO	Properties	20 mm	40mm
1	Specific Gravity	2.52	2.39
2	Density (kg/m^3)	1.47	1.50
3	Los Angeles Abrasion	38 %	44.64 %
4	Flakiness Index	8.7 %	10%
5	Elongation Index	13 %	15%

TABLE III
PROPERTIES OF Geotextile

Property	Geotextile
Length(mm)	30
Puncture (N)	2000N
Elongation (%)	45-50%
Tensile strength	13 kn.m
Density(g/cc)	1.4
Thickness	0.90mm

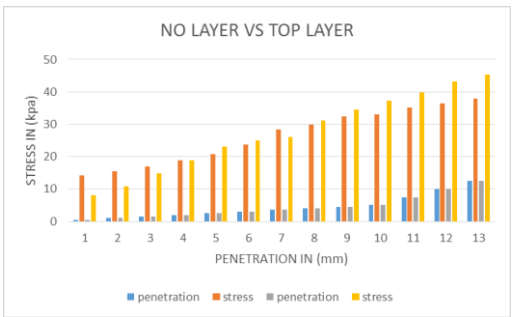
D. Methodology

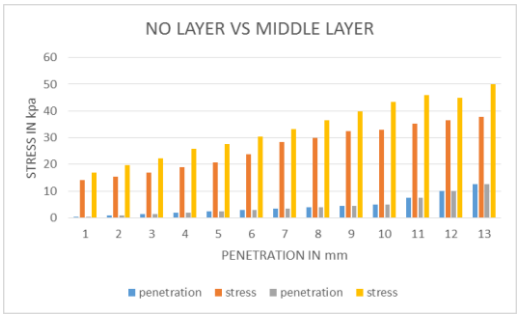
Laboratory tests such as Standard Proctor compaction. CBR tests are conducted on the subgrade soil with various layers, One layer of geotextile at top, middle and bottom, Two layered 1/3rd from top and 1/3rd from bottom and three layered combined tests were conducted.

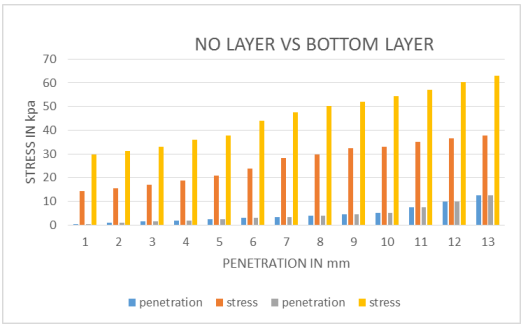
III. RESULTS AND DISCUSSION

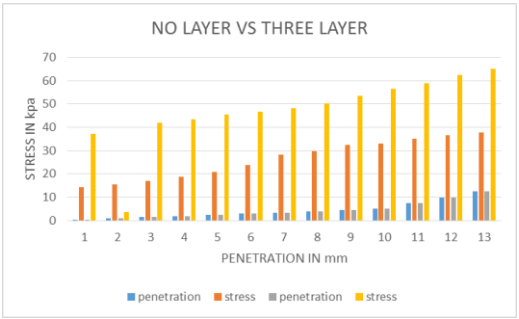
A California Bearing Ratio

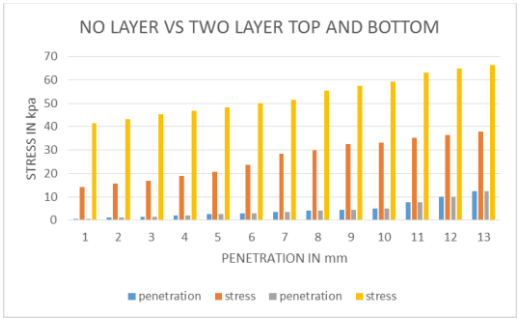
The variation in Unsoaked CBR values with addition of geotextile at various layers under is carried out.











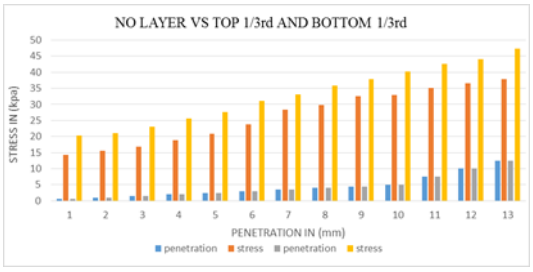


Fig.1-6 Unsoaked CBR Graphs with geotextiles.

Unsoaked CBR value of the sub grade soil increases from 3 % to 3.30 % which is laid top of the soil layer.

When the geotextile material is laid at the middle layer the unsoaked CBR value is increased as 3.3 % to 3.9 %.

When the geotextile layer is laid at the bottom of the subgrade soil the unsoaked CBR value is increased as 3.9 % to 5.2 %.

Then two layered geotextile had placed at the 1/3rd from the top and 1/3rd from bottom of the CBR subgrade soil then the unsoaked CBR value has increased as 4 % with compared to no layer CBR value.

Then three layered geotextile unsoaked CBR test had been conducted, then value is increased as 4% to 5.3 %.

Two layered geotextile had placed at the top of the subgrade and bottom of the subgrade then unsoaked CBR test had been performed, which is increased as 5.3 % to 5.65 %.

IV. CONCLUSION

Based on the experimental studies, pavement design and the following conclusions were drawn.

1. The selected soil sample is found to have low strength with Soaked CBR value of 3%. It indicates that subgrade has to be improved.
2. Geotextile reinforced subgrade improves the strength properties of soil which makes the subgrade suitable for pavement.
3. The Unsoaked CBR value of the sub grade soil is increased to 3.3% for top layer geotextile
4. The Unsoaked CBR value of the sub grade soil is increased to 3.9% for middle layer geotextile.
5. The Unsoaked CBR value of the subgrade soil is increased to 5.2 % at the bottom layer.
6. The Unsoaked CBR value has decreased 3.8 % by laying geotextile at the Two layer 1/3rd from top and 1/3rd from bottom.
7. The Unsoaked value has increased 5.3 % by laying geotextile at three layers of the subgrade.

The CBR value had been increased as 5.65% by laying geotextile at two layers from top of the subgrade and bottom of the subgrade.

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