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STUDY ON PERFORMANCE EVALUATION OF SOIL STABILISED PAVEMENT BY USING GEOTEXTILES

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ABSTRACT

Throughout the world, the demand for new and improved roads and structures is constantly increasing, while the funds available for their construction and maintenance are decreasing at an alarming rate. The modern engineer is therefore to construct or built more economical and low maintenance type roads or structures. The lucrative demand for raw materials in road infrastructure development projects in India can be minimised by use of innovative techniques based on new developments in Geo-synthetics. In this paper presented the behaviour of Geo-synthetic Reinforced Soil (GRS), with a series of laboratory experiments were conducted on GRS samples made up of soft soil and the placement of a geo-textile at different depths. California Bearing Ratio (CBR) tests of the GRS mass with and without Geo-textiles were studied to evaluate the performance of the GRS samples. The focus of the tests was to determine the effects of the vertical spacing of the reinforcement and the relative compaction of the soft soil on the performance of the GRS mass.

Keywords*: Geo-synthetics, reinforced soil, geo-textiles, California Bearing Ratio, vertical spacing, compaction.*

I. INTRODUCTION

A. General description

Geotechnical properties of problematic soils such as soft fine-grained and expansive soils are improved by various methods. The problematic soil is removed and replaced by a good quality material or treated using mechanical and or chemical stabilisation.

Different methods can be used to improve and treat the geo-technical properties of the problematic soils (such as strength and stiffness) by treating it in-situ. These methods include densifying treatments (such as compaction or pre-loading), Pore water pressure reduction techniques (such as dewatering or electro osmosis), the bonding of soils particles (by ground freezing, grouting, and chemical stabilisation) and use of reinforcing elements (such as geo-textiles and columns)

The chemical stabilisation of problematic soils (soft fine-grained and expansive soils) is very important for many of the geo-technical engineering applications such as pavement structures, roadways, building foundations, channel and reservoir linings, irrigation systems, water lines, and sewer lines to avoid the damage due to the settlement of the soft soil or to the swelling action (heave) of the expansive soils.

The engineers are often faced with the problem of constructing road beds on or with soils (especially soft clayey and expansive soils). These problematic soils do not possess enough strength to the wheel loads upon them either in construction or during the service life of the pavement. These soils must be, therefore, treated to provide a stable sub-grade or a working platform for the construction of the pavement. One of the strategies to achieve this is “soil stabilisation”.

The pavement structure consists of a relatively thin wearing surface constructed over a base course and sub-base course, which rests upon an in-situ sub-grade. The wearing surface is primarily asphalt/concrete. The properties of all of the pavement structure layers are considered in the design of the flexible pavement system. The flexible pavement structure should have economical and long lasting requires sub-grade materials with good engineering

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properties. These desirable properties include strength, drainage, ease and permanency of compaction, and permanency of strength.

The quality of the sub-grade soil used in pavement application is classified into five types (very poor, poor to fair, fair, good and excellent) depending on the California Bearing Ratio (CBR) values. The quality of the sub-grade soil used in pavement applications is classified into five types (soft, medium, stiff, very stiff and hard sub-grade) depending on unconfined compressive strength values.

The sub-grades having CBR values of (0-3%) are very poor and poor to fair (3-7%). Sub-grades having Unconfined Compressive Strength (UCS) values (25 – 100 KN/m2) are soft and medium. These types are considered as unstable sub-grades and need to be stabilised especially in terms of pavement applications.

B. Geo-textiles

The enhanced performance and economics of Geo-synthetics to reinforce flexible pavements over weak sub-grade is a key ingredient in the efforts to improve the Indian transportation infrastructure, faced by limited resources, problematic soils and the need for durable all- weather roads.

Geo-textiles are one of the most versatile and cost-effective ground modification materials to stabilize the soft sub-grade soils. The ASTM (1994) defines Geo-textiles are permeable textile materials used in contact with soil, rock, earth or any other Geo-technical related material as an integral part of Civil Engineering project, structure, or system. Based on their structure and the manufacturing technique, Geo-textiles may be broadly classified into woven and non-woven Geo-textiles. Woven Geo-textiles are manufactured by the interlacement of warp and weft yarns, which may be of spun multi-filament or of slit film.

Non- woven Geo-textiles are manufactured through a process of mechanical interlocking or thermal bonding of fibers/filaments. Mechanical interlocking of the fibers/filaments is achieved through a process called needle punching. Needle punched non-woven Geo-textiles are best suited for a wide variety of Civil Engineering applications and are the most widely used type of Geo-textile in the world.

The role of geo-textiles is more extensive in permanent road constructions and also in the stabilisation of weak sub-grade soil.

C. Functions of Geo-textiles

- Separation
- Reinforcement
- Filtration
- Drainage

Separation: the introduction of a flexible synthetic barrier placed between dissimilar materials such that the integrity and functioning of both materials can remain intact or be improved.

Reinforcement: the synergistic effect on system strength created by the introduction of a Geo-textile (good in tension) into a soil (poor in tension but good in compression) or other disjointed and separated material.

Filtration: the equilibrium fabric-to-soil system which allows for free water flow (but not soil loss) across the plane of the fabric over an indefinitely long time period.

Drainage: the equilibrium fabric-to-soil system which allows for free water flow (but not soil loss) in the plane of the fabric over an indefinitely long time period.

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II. METHODOLOGY

Performance of Geo-textiles (Monofilament sheet from Tencate Pvt.Ltd) as a soil interaction to improve the strength of sub-grade was studied by using California Bearing Ratio (CBR) test in the laboratory by two cases.

Case1: Strength performance of soil without using Geo-textiles.
Case-2: Strength performance of soil with using Geo-textiles at varying depths.

III. TEST RESULTS & GRAPHS

A. California Bearing Ratio (CBR) test results without using Geo-textile.

Table I .Unsoaked Soil Without Using Einforcement

Penetration (mm)	Load (kg)
0	0
0.5	30.5
1	60.92
1.5	91.46
2	164.6
2.5	213.0
3	238.0
4	274.9
5	292.68
7.5	335.3
10	365.8
12.5	384.1

CBR @ 2.5 mm penetration = 15.5%
CBR @ 5 mm penetration = 14.24%

Table II Soaked soil without using einforcement

Penetration (mm)	Load (kg)
0	0
0.5	24.39
1	30.48
1.5	36.58
2	36.58
2.5	42.6
3	42.6
4	48.78
5	54.8
7.5	54.8
10	60.9
12.5	67.07

CBR @ 2.5 mm penetration = 3.1%
CBR @ 5 mm penetration =2.66%

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Table III. Unsoaked soil with reinforcement at 2.5cm

Penetration (mm)	Load (kg)
0	0
0.5	67.0
1	146.3
1.5	189.02
2	231.7
2.5	262.19
3	286.5
4	335.36
5	378.04
7.5	457.3
10	518.5
12.5	561.7

CBR @ 2.5 mm penetration = 19.5%
CBR @ 5 mm penetration = 18.1%

Table IV .Soaked soil with reinforcement at 2.5 cm

Penetration (mm)	Load (kg)
0	0
0.5	24.3
1	36.5
1.5	48.7
2	54.8
2.5	60.9
3	67.07
4	67.07
5	73.17
7.5	79.26
10	85.36
12.5	97.56

CBR @ 2.5 mm penetration =4.45%
CBR @ 5 mm penetration = 3.56%

Table V .Unsoaked soil with reinforcement at 5 cm

Penetration (mm)	Load (kg)
0	0
0.5	42.6
1	109.7
1.5	164.6
2	219.5
2.5	250.0
3	274.3
4	317.07
5	341.46

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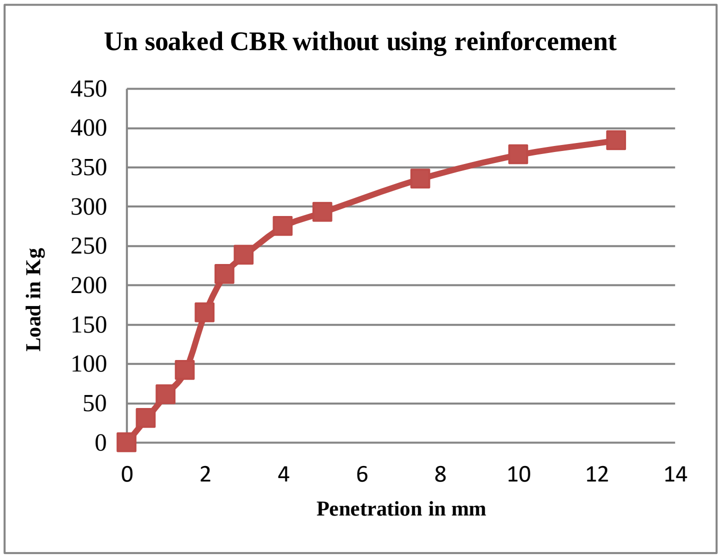
7.5	390.2
10	420.73
12.5	445.12

CBR @ 2.5 mm penetration = 18.2%
CBR @ 5 mm penetration = 16.66%

Table VI .Soaked soil with reinforcement at.5 cm

Penetration (mm)	Load (kg)
0	0
0.5	24.39
1	30.48
1.5	36.58
2	36.58
2.5	48.78
3	48.78
4	54.8
5	60.9
7.5	60.9
10	67.07
12.5	73.17

CBR @ 2.5 mm penetration = 3.6%
CBR @ 5 mm penetration = 2.96%



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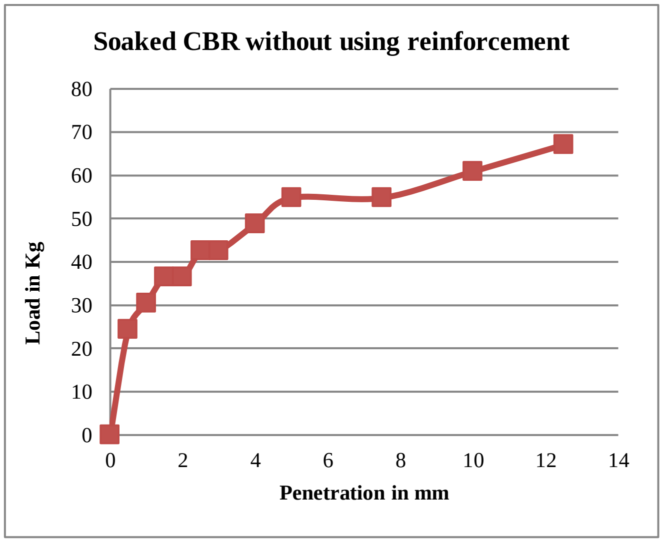

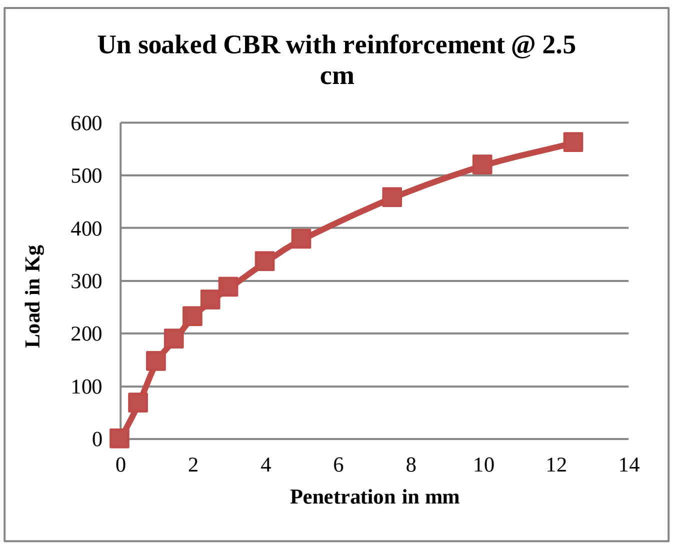

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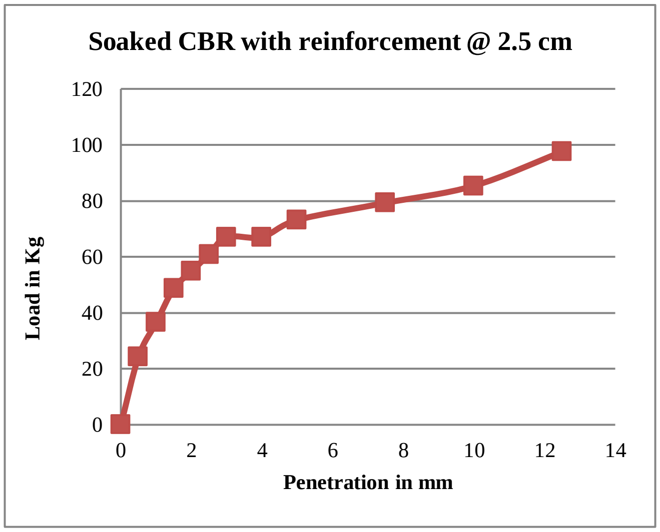

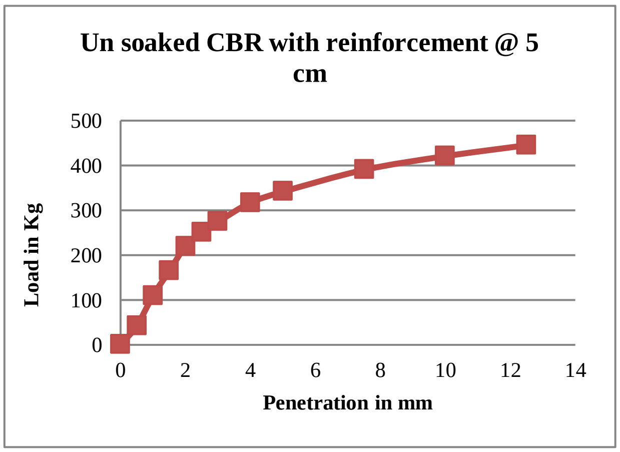

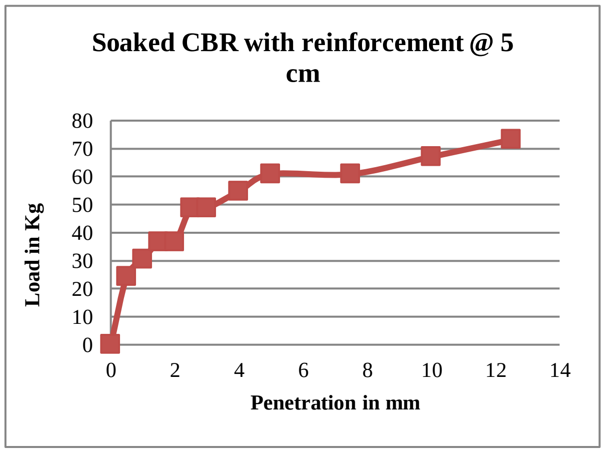

IV. DISCUSSION OF RESULTS AND CONCLUSIONS

California Bearing Ratio (CBR) is used as an index of soil strength and bearing capacity. This value is broadly used and applied in design of the sub-grade, sub-base and base material for pavement. The present study is a geotechnical laboratory program to estimate how the use of Geo-textiles could improve the California Bearing Ratio (CBR) of soft sub-grade soil.

In this study soil samples are tested for un-soaked and soaked for four days by using with and without Geo-textile as an interface to evaluate the California Bearing Ratio values. In the un-soaked condition without using Geo-textile the CBR values are 15.5%, with the provision of Geo-textile at a depth of 2.5cm the CBR value is 19.5% , this shows that addition of Geo-textile improves the bearing capacity of the soil tested. Similarly the same trend was observed in the soaked sample without the addition of Geo-textile the CBR value is 3.1% and with provision of Geo-textile at 2.5 cm depth the CBR value is 4.45%.

In un-soaked and soaked conditions of CBR tests, the addition of Geo-textile increases the CBR values.

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