North Asian International Research Journal of Sciences, Engineering & I.T.

IRJIF. I.F. : 3.821

ISSN: 2454-7514 Vol. 8, Issue-7 July-2022

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

NAIRJC A Peer Reviewed Refereed Journal

DOI: 10.5949/NAIRJC_joe_00007.85

A STUDY ON THE ADVANCED APPLICATION OF GEOTEXTILES IN PAVEMENT DESIGN

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ABSTRACT

The various geosynthetic products have the broadest range of properties that will strengthen the pavement design by adhering to the strict nomenclature associated with geotextile materials. Considerable increase in length of roads in India has increased the necessity of rapid, economic and sustainable construction methodologies. Thus, at various construction stages of pavement the use of additives has gained significance over the period of time. Geotextiles are an important product for increasing the strength of the soil subgrade. The use of geotextiles in soil subgrade pavements has resulted in a massive increase in the value of geotextile products. This improves not only the strength but also the drainage characteristics of the soil subgrade. Keeping the use of geotextile in pavement application in mind, it can be divided into several parameters such as separation, filtration, drainage, reinforcement, and mitigation. Geotextile also functions as a permeable synthetic textile material.

This Study involves a stretch of village road in Ganderbal district. CBR tests were conducted on the virgin soil and soils with geotextiles to see the improvement in the CBR values. The geotextiles were placed at the depth of 1.5 cm, 3 cm, 4.5 cm 7 cm and 8.5 cm. The values of CBR improved from 3.15 % to 5.61% for 4.5 cm depth of geotextile.

On the test section of the road geotextile was introduced between subgrade and sub-base and field test, DCP was performed to evaluate the penetration of geotextile road and compare it with non-geotextile road. The average values obtained for test road section with and without geotextiles are 5.44mm/blow and 6.05mm/blow respectively.

***KEY WORD**: Advanced , Application, Geotextiles, Pavement, Design*

1. INTRODUCTION

When handling difficult construction sites with inside the past, the traditional exercise was to either replace the unsuitable soils or bypass them with high priced deep foundations. Besides that, this same age-old concern of land availability and the need to reestablish crumbling infrastructure in urban areas, heightened awareness of seismic activity, and provisions mandated for environmental deterioration have reignited the progression of a variety of ground improvement throughout the last 25 years. New surface treatments methods are increasingly widely used to address the specific soil-related issues, and are generally viewed as perhaps the most cost-effective option to improve an undesirable site state.

Geosynthetics have demonstrated to be the maximum flexible and cost-efficient base change substances. Their use has increased unexpectedly into almost all regions of prime engineering fields. Geotextiles is currently one of the maximum essential practices in pavement layout and construction. It was already proven to be useful in nearly all conditions, apart from a few. Pavement with various site volumes faces troubles which includes melancholy at the surface, cracks, volatile sub base, drainage and seepage, and so on, relying on a selection of things which includes soil properties, sub base properties, and other things.

The following are the vital components of geotextiles that are relevant to this project:

A. Physical Properties: - Specific gravity, density, thickness, stiffness, and so on are examples of physical properties.

B. Mechanical properties: - Its Tensile strength, flexibility, compatibility, tear strength, burst strength, puncture strength, and other features

C. Durability Properties: - Reclining, wearing resistance, choking span, and flow, among other things.

1.1 Geotextiles

Geotextile was first used as a landslide protection device as an alternative to traditional granular filling. Preliminary geotextile selection criteria in the filter program were permeability, soil retention, strength and modulus. Mostly in late 1960s, French researchers started employing fibers for separation and reinforcing applications. They used needle-punched textiles to avoid mixing of various substances and contaminating of granular layers on dirt tracks, railway substructure, and soil berms. They also recognized textiles' potential to disperse excess pore pressures by allowing for within-plane water movement.

1.1.1 Types of Geotextiles

Geotextiles are made up of polymers such as polyester or polypropylene. They have been categorized into three types on the idea of the manner they're prepared, woven material geotextile, non-woven geotextile and knitted geotextile.

Woven Fabric Geotextiles: - Geotextiles are generally observed to be woven and are produced the usage of strategies just like the ones used to weave conventional garb textiles. It is distinguished by the appearance of two parallel sets of threads or yarns. The yarn that runs alongside the span is referred to as warp, and the yarn that runs perpendicular to it is referred to as weft.

Non-Woven Geotextiles: -Nonwoven geotextiles are made of continuous filament yarn or short staple fiber. Fiber bonding is accomplished through the use of thermal, chemical, or mechanical techniques, alias composition these methods. Geo-fibers obtained through the manual bonding or reaction or gradual heat bonding have a thickness of 0.5-1 mm, whereas chemically bonded non-woven are typically 3 mm thick.

Knitted Geotextiles: -Knitted geotextiles are made by interlocking a series of yarn loops together. All knit geosynthetics are created by combining knitting techniques with another geosynthetic manufacturing process, such as: B. Weaving. In addition to these three geotextiles, other geosynthetics are also used include geonets, geogrids, geocells, geomembranes and geocomposites, each with its own characteristics and uses.

1.1.2 Applications

Segregation -Where geosynthetics are placed between two different geotechnical materials to prevent mixing;

Filtration - Geotextile allows the passage of liquids from the soil while preventing the uncontrolled passage of soil particles.

Drainage -Where geosynthetics can collect and transport liquids on their own plane;

Reinforcement - in which, a geosynthetic defends stresses and consists deformations in geotechnical structures by the tensile characteristics.

2. OBJECTIVES

Those primary goals of our study are as follows:

1. Investigating the effects of soil properties, aggregate properties, and geotextile properties on the use of

geosynthetics in pavement.

2. Creating a laboratory test plan that can directly evaluate the usefulness of geotextile separators for various pavement structures.

3. Measurement of shear strength and resistance to penetration of soil, aggregate and asphalt layers using a portable tester called Dynamic Cone Penetration (DCP).

3. MATERIAL & METHODOLOGY

The selected project was implemented to develop roads in a small village of our area.

Fig 1: soil

3.1 GEOTEXTILES

Geotextiles are permeable fabrics It can be separated, filtered, fortified, protected or drained in combination with soil. They are typically constructed of polypropylene or polyester. Non-woven geotextile from Crewel Fabric Lal chowk was used.

Fig 2: Geotextile

3.2 EXPLORATORY APPROACH

STAGE 1: This stage involved the collection of soil samples from the study area as well as collection of geotextiles from the vendor.

STAGE 2: The soil samples were taken to the lab and a number of experiments like sieve analysis, liquid limit, plastic limit, Standard proctor test and CBR tests were carried out to determine the properties of soil.

STAGE 3: In this stage the geotextiles are added to the samples at the depth of 1.5 cm, 3cm, 4.5 cm,7 cm and 8.5 cm.

STAGE 4: The CBR values for soil samples were calculated for different percentages of geotextiles.

STAGE 5: We compared the values of CBR of soil with addition of geotextiles with that of virgin soil.

STAGE 6: We added the geotextile to the test section of the road.

STAGE 7: Field test like Dynamic cone penetrometer was carried out on pavement for both the stretches with and without Geotextile.

STAGE 8: The values of penetration were compared and a conclusion was drawn.

Table 1: Properties of the soft soils

Soil characteristics	Details
Liquid limit	59.14
Plastic limit	46.23
Plasticity index	12.91
Optimum moisture content	17.1
Maximum dry density	1.97
CBR value (soaked)	3.15
Specific gravity	2.45

4. RESULTS AND DISCUSSION

4.1 Liquid Limit

The values in the below table show the values of liquid limit for virgin soil.

Table 2: Values of liquid limit for virgin soil

Samples	Liquid limit (%)
1	55.55
2	63.63
3	58.30
AVG	59.14

The lowest limit of water content at which soil begins to flow like water. It exists between plastic state and liquid state. The liquid limits were found using the Casagrande's apparatus.

4.2 Plastic Limit

The values in the below table show the values of liquid limit for virgin soil.

Table 3: Values of Plastic limit for virgin soil

Samples	Plastic limit (%)
1	43.75
2	53.33
3	42.85
AVG	46.23

The lowest limit of water at which a thread of soil which is one- eighth in diameter begins to crumble.

4.3 Compaction properties

Maximum dry density (MDD) and optimum moisture content (OMC) of all trial mixtures were determined in the laboratory in accordance with IS: 2720 (Part 8) - 1983. A standard proctor test was performed to determine the correlation between dry density and moisture content.

Table 3: MDD and OMC

Samples	OMC (%)	MDD(g/cc)
1	17.1	1.97
2	19	1.90
3	16.2	1.95

The above table shows the values for OMC and MDD for virgin soil.

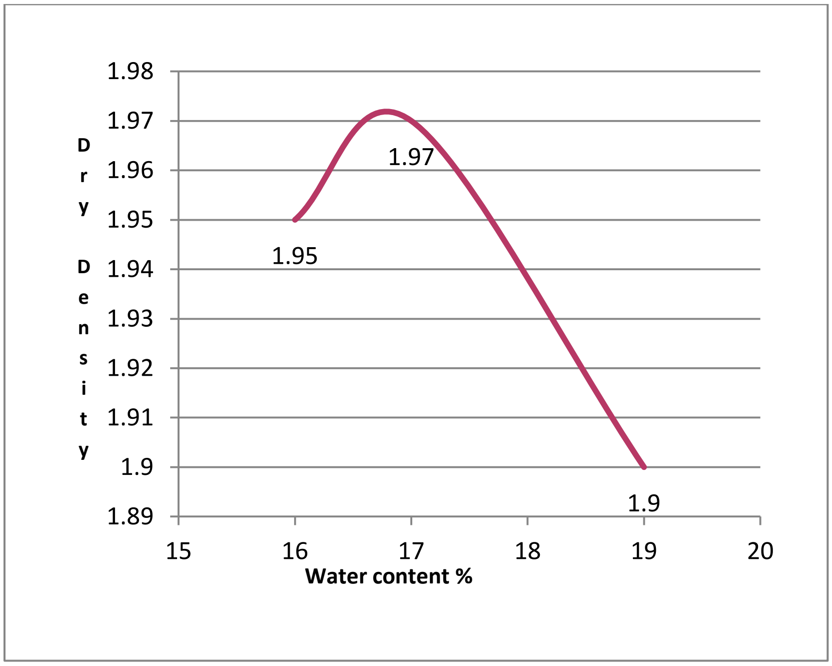

Fig 3: Dry density and Water content graph

4.4 Effect on CBR

The specimens have been compacted at their OMC and MDD from the Proctor test, and the test was run until 12.5mm of penetration was achieved. The test was performed on soaked samples.

Table 4: CBR values for Soil Mixed with Varying Geotextile at varying depths for 2.5 mm

S no	Geotextile depth	CBR (%)
1	0	3.15
2	1.5	3.88
3	3	4.04
4	4.5	5.61
5	7	4.11
6	8.5	5.59

Table 5: CBR values for Soil Mixed with Varying Geotextile at varying depths for 5 mm

S no	Geotextile depth	CBR (%)
1	0	1.83
2	1.5	3.49
3	3	3.97
4	4.5	3.87
5	7	3.92
6	8.5	3.44

The Values of CBR increases as the depth of geotextile is increased and increases till 4.5 cm of depth and beyond which when the depth is increased the CBR value decreases. Thus, the optimum depth at which the maximum value of CBR is obtained is 4.5 cm.

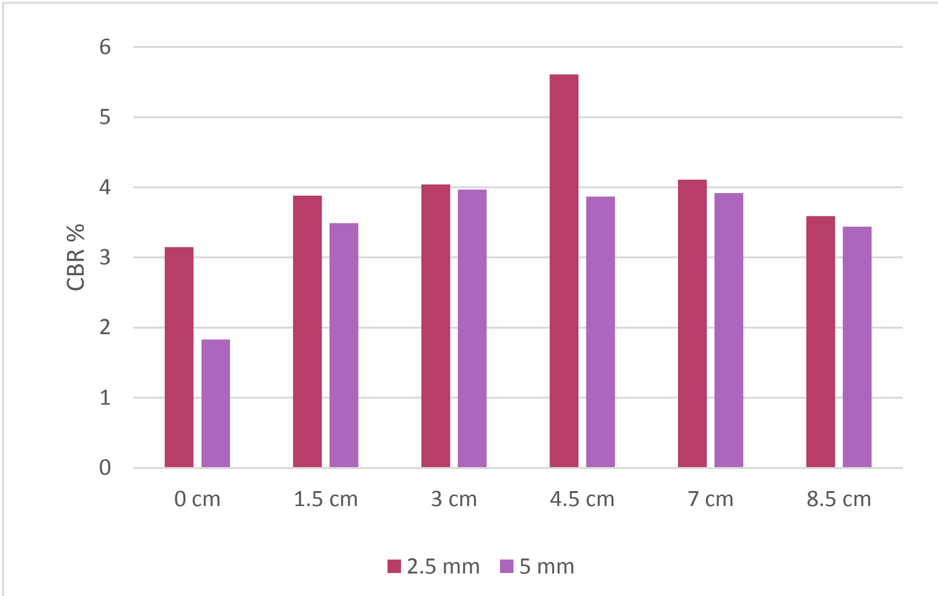

Fig 4: CBR percentages for 2.5 and 5 mm for various depth of geotextiles

4.5 Dynamic Cone Penetration Test

DCP test is conducted on the pavement and the depth of penetration is taken as 300 mm and the penetration value obtained is plotted with the number of blows in graphs. The initial/reference reading was found to be 20mm.

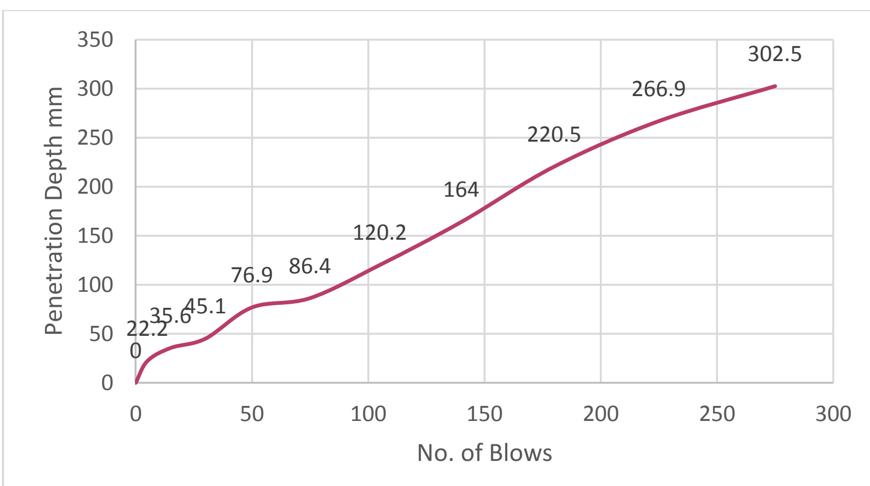

Fig 5: Penetration vs no of blows for road without geotextile

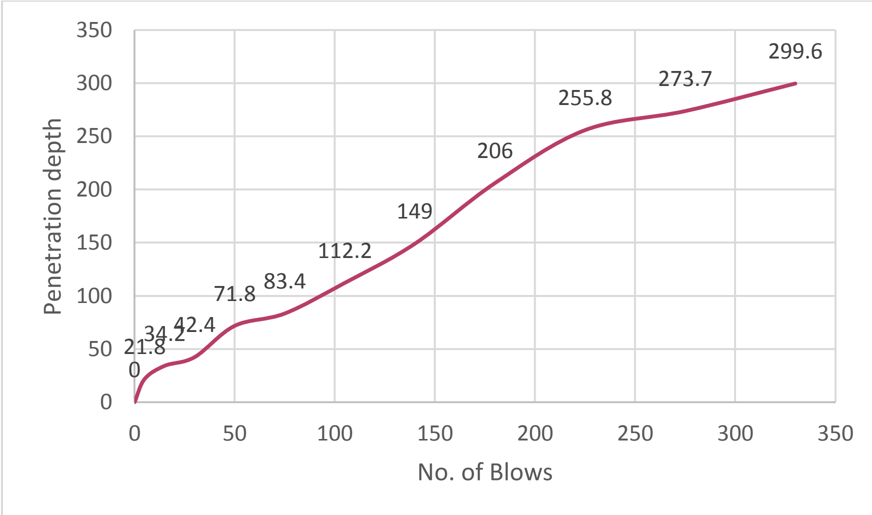

Fig 6: Penetration vs no of blows for road with geotextile

Means obtained in the geotextile-free and geotextile-enhanced test sections are 6.05 mm / beat and 5.44 mm / beat, respectively.

5. CONCLUSION

The effects of increase of geotextile percentage on soil are as such: -

1. The addition of geotextiles to soil caused an increase in the CBR values from 3.15% to 5.61 % for a depth of 2.5 mm when geotextiles were placed at a depth of 4.5 cm.
2. The addition of geotextiles to soil caused an increase in the CBR values from 1.83% to 3.87 % for a depth of 5 mm when geotextiles were placed at a depth of 4.5 cm.
3. The average values obtained for without geotextile test and with geotextile-reinforced test sections are 6.05 mm/blow 5.44 mm/blow respectively.
4. It can be seen that all geotextile reinforced sections required higher number of blows for penetrating of 300 mm depth of subgrade than that of unreinforced section. Therefore, it can be concluded that there is an increase in the strength of pavement in the geotextile reinforced section.

REFERENCES

[1] Olukayode Olawalw Alao, Ifedapu Oduyemi, September, 2011,"The Use of Geosynthetics in Road construction (Case Study – Geotextile."Bachelor of Engineering in Civil EngineeringAdvisor: Engineer(Mrs) A.B Oluyemi.

[2] Cazzuffi, D. (1987), "The use of geomembranes in Italian dams. "Water Power and Dam Construction.."Pages: 17-21

[3] Bhavesh Joshi, Dr. R.P Arora, Nov 2015, "Pavement Design By Using Geotextile."International Journal of Civil Engineering and Technology (IJCIET) Volume 6, Issue 11, Nov 2015, pp. 39-44,

[4] Al-Qadi, I. L., T. L. Brandon, R. J. Valentine, and T. E. Smith. 1994"Laboratory Evaluation of Geosynthetic Reinforced Pavement Sections", In Transportation Research Record: Journal of the Transportation Research Board, No. 1439, TRB,

National Research Council, Washington, DC, 1994, pp. 25-31.

[5] Al-Qadi, I., T. I. Brandon, and S. A. Bhutta. Geosynthetic Stabilized Flexible Pavements. Proceedings of Geosynthetics '97, Long Beach, CA, Mar 10-13, 1997, pp. 647-661.

[6] Ravindra Kumar , Utsav Singh , Priyanshu Saini , Varun Sharma, Matloob Ali, 2020, International Journal of Engineering research and technology, Volume 09, Issue 06 (June 2020).

[7] Aniket, S.Raut, Akshay, A. Dahiwade, Kamalshil R. Jangale3 Pratik O. Lawhale4 Sujesh D. Ghodmare, 2016,"Performance and Evaluation of Pavement Design with and without using Geotextiles",IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 03.

[8] A.A. Bhosale, Swapnil K Sutar, Manjunath S Dhage, Rahul M Hattalage, Nadeem Maner, Amit B Jadhav, April, 2017,"Application Of Geotextile Used In Road Pavement Construction",International Journal of Engineering Technology, Management and Applied Sciences, April 2017, Volume 5 Issue 4, ISSN 2349-4476.

[9] P.Rajendra Kumar, "Laboratory Study of Black Cotton Soil Blended With Copper Slag and Fly-Ash", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 2, February 2017

[10] Bharath Goud "Stabilization of Black Cotton Soil with Copper Slag and Rice Husk Ash – An Environmental Approach", International Journal of Science and Research, Volume 7 Issue 5, May 2018.

[11] Jaber Shahiri, "Utilization of Soil Stabilization with Cement and Copper Slag as Subgrade Materials in Road Embankment Construction", International Journal of Transportation Engineering, Vol.5/ No.1 summer 2017.