Usage of Woven Geo-Textiles in the Construction Subgrade in Flexible Pavements

Muntazir Ahmad Bhat [1], Dr. Rakesh Gupta [2]
[1]Dept of Civil Engineering
[2]Professor, Dept of Civil Engineering
[1, 2,]SRMIET, Bhurewala, Ambala, Haryana, India

Abstract*- The best connectivity to any part of the country is first to develop infrastructure of the country. The use of geo-textiles in flexible pavements has been a well-accepted practice over the past thirty years. In most recent years, the base course of flexible pavement is reinforced by geo-textiles to improve performance and to reduce the thickness of base course. There are two major types of pavements: flexible and rigid. In this we are discussing about the flexible pavements. The performance of some flexible pavements in some climatic condition has been proved disappointing because a transverse crack has been developed within a few years of construction. Other forms of flexible pavements distress include alligator or map cracks, ruts and reflective cracking. The additional benefit in the construction of flexible pavement by using geo-textile is that they are very stiff.*

Review of the most papers concluded by using Geo-textiles in the flexible pavement can rise the service life of the pavement than the previous pavements. Geo-textiles of both natural and synthetic are helpful in improving the geo-technical properties of soil. These fabrics are used for erosion control, filtration, for vegetation support etc. Geo-textile is eco-friendly and can be used in road works cost effectively.

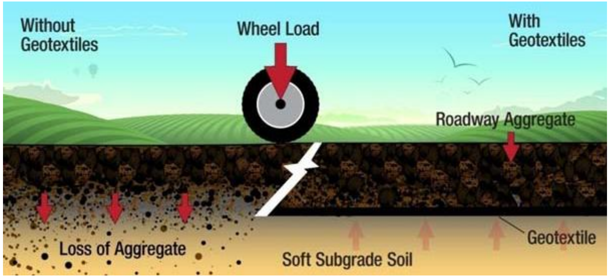
Keywords- Geosynthetics, Geotextiles, pavements, service life, life cycle, cost analysis, erosion control, filtration,

I. INTRODUCTION

Woven Geotextiles are some of the strongest fabrics available for erosion control, stabilization, and layer of aggregate separation. Offering an increased grab tensile strength, woven geotextile fabrics offer a robust design that allows them to successfully implement in almost any location, including the Pavement, Roads, Railroads Structures, and Rip Rap. Woven Geotextile Fabric is manufactured by blending and weaving fibers. The result is a product that is not only strong, but also remarkably well equipped to handle drainage and erosion problems.

In the past 20 years the geo-textiles growth in the market has risen. In Geo-textiles, Geo means Earth and textile means fabric. Polypropylene, polyethylene, polyester are the petroleum products which are used in the production of Geo-textiles. Geo-textiles are mainly constituents of polypropylenes, polyesters, polyethylene, and polyimides, which do not decompose under any biological and chemical processes. This will help in construction and maintenance of roads. The flexibility of geotextile is most useful for the filtration purpose and soil, rock and waste material can be reinforced by the geo-textiles. These textiles consist of synthetic fibres such as cotton, wool or silk. Flexibility and porous nature can be obtained by the usage of standard weaving machinery. Subsurface drainage and erosion control applications as well as for road stabilization for wet moisture sensitive soils are given by Non-woven geotextiles. Woven geotextile are made from weaving monofilament, multifilament, or silt film yarns. Silt film yarns further subdivided into flat tapes and fibrillated yarns. There are two steps for making woven geotextiles. First manufacturing of filaments or slitting the thin film to create yarns.

There are different types of geo-synthetics namely geo-membranes, geo-nets, geo-composites, geo-mat, geo-cell, bio-mat and bio-net. Some of the natural forms of geotextiles are jute, flax or coir, coconut matting, cotton, hemp, straw. The different types of composite/synthetic materials of geotextiles are kevlar, polyester, polypropylene, jute composite.



. Fig. 1.1 Arrangement of geo-textiles in subgrade

1.1 Characteristics of Geo-textiles

Moisture Barrier

Both woven and non-woven geo-textiles can reduce the moisture when in bituminous, rubber bitumen, and polymeric mixtures. The moisture barrier is the main function plays in the use of geo-textiles in paving overlays. It reduces the surface water entering in the base and sub-grade. Ultimately improves the performance of the pavement system.

Erosion Control

In this geo-textile safeguards soil surfaces from the tractive forces of wind and rainfall. Geo-textiles also one of the alternative protection against erosion on newly laid slopes. The erosion control function can be act as special case such as combination of the filtration and separation functions.

Sediment Control

Geo-textile can serve as sediment control. A silt fence which is composed of a geotextile acts as a vertical barrier. The silt fence reduces the velocity of water allowing the sediment out of suspension.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

In experimentation the following tests be conducted:

a) Sieve analysis
b) Casagrande's apparatus for Liquid limit
c) Determination of Plastic limit
d) Standard proctor test

. The above sited tested were conducted with and without the usage of woven geotextiles in the subgrade of flexible pavement section.

3.1 Materials Required for this Work

3.1.1 Geo-Textile

Geo-textiles are main largest group of geo-synthetics. A geotextile is any permeable textile material used with foundation, soil, rock earth, etc. that is an integral part of project, structure or system. It may be made of synthetic or natural fibers. Geotextiles are also known as filter fabrics, road rugs and geosynthetics. They are generally associated with high standard all season roads, but can be used in low standard logging roads. These fabrics have the ability to separate, filter, reinforce, protect, or drain and is designed to increase soil. These synthetic fibres are usually built into flexible, permeable fabrics. Geo-textiles are first used in the days of second intermediate period (1802-1550 BC) of Egypt. Even though they were strive for unsteady soils. They finally found that fibres will upgrade the road condition especially for unstable type soils. Modern geo-textiles are mainly constituents of polypropylenes (85%), polyesters (12%), polyethylene (2%), and polyimides (1%) which do not decompose under any biological and chemical processes. These geotextiles are high in strength to allow for maximum slope support, stabilization and erosion control Mostly geotextiles are placed at the tension surface to strengthen the soil. The different properties of geo-textiles are shown in Table 1.1. The sample is collected from Ambala City as show in fig. 1.2 where 4-laning highway project is going on from Ambala City to Kaithal Haryana.

Fig. 3.1 Woven geo-textiles

Table 1.1 Properties of woven geo-textile

Property	Test Method	Units	300 Gsm
Tensile strength	IS 1969	KN/M	60
Trapezoidal strength	ASTM D 4533	N	1500
Puncture strength	ASTM D 4833	N	800
Discharge	ASTM D 4491	$L/M^2/S$	18
Apparent opening size	ASTM D 4751	MICRONS	250
Roll width		M	4

III. WRITE DOWN YOUR STUDIES AND FINDINGS

3.3 Laboratory Investigations for this Work

The laboratory tests are performed as per Indian Standard codes of practice. Descriptions of the different types of tests are mentioned.

3.3.1 Sieve Analysis

This test is to determine the percentages of grain sizes contained in a soil sample. It is required in soil classification also. The test method is followed as per standard test method for particle size analysis of soil (ASTM D 422).To determine the size distribution of particles, the sieve analysis test procedure is an effective method that prevailed from the past. In sieve analysis, the particle size distribution is defined using the mass or volume. Sieve analysis is laboratory test procedure in which particles will move vertically or horizontally through sieve mesh. Depending on the needs and particle material different sieving methods are available for the application. They are manual sieving method, mechanical sieving method, dry sieving method and wet sieving method.

1kg oven dried soil sample is taken. Prepared a stack of sieves which are thoroughly cleaned and assembled them in ascending order of sieve numbers. The stack of sieves are generally used are no's 4, 10, 20, 40, 60, 140 & 200. We can also place different sieves. At last, pan is provided and top sieve is closed with a cap. The soil is poured in the stack of sieves and is shaken for about a 10-15 minutes. The weight of soil in each sieve along with weight of soil in pan is measured with using weighing balance. The sieve for different classification of soil are shown in Fig. 1.3

Fig. 3.2 Stack of sieves

Table 4.2 Table for sieve analysis

Sieve No	Sieve Size (MM)	Mass of soil Retained on each sieve (Wn)	Percent of Mass Retained on each sieve (Rn)	Cumulative percent retained (∑Rn)	Percent Finer 100-(∑Rn)
4	4.75	60	6	6	94
8	2036	67	6.7	12.7	87.3
102	2	32	3. 2	18.9	84.1
18	1	77	7.7	23.6	76.4
30	0.6	45	4.5	28.1	7
40	0.425	49	4.9	33	67
50	0.3	1	0.1	33.1	66.9
70	0.212	473	47.3	80.4	19.6
80	0.18	19	1.9	82.3	17.7
100	0.15	53	5.3	87.6	12.4
170	0.09	77	7.7	95.3	4.5
200	0.075	2	0.2	95.5	4.5
Pan	……	35	3.5	99	1

$\sum$ 990=w_n

Therefore, the value of mass of soil retained of each sieve W_n = 990

Mathematically calculation of mass loss during sieve analysis:-

$$\text{Mass loss during sieve analysis} = \frac{(W_t - W_n)}{W_t} \times 100\%$$

= **(**1000–990) × 0.1
= 1 % (Ok if less than 2 %)

Where

- w_T = total mass
- W_n = mass of soil rerained on each sieve

A log graph is plotted between the percentage finer and particle size in the analysis part. From the curve, grain sizes D_{10}, D_{30}& D_0 are obtained.

The formulae for coefficient of curvature (C_c) and coefficient of uniformity (Cu) is given

$$(C_c) = \frac{(D30)^2}{D50} \text{ X } D10$$

$$(C_u) = \frac{D50}{D10}$$

where,

C_c = coefficient of curvature
D = effective grain size
C_u = coefficient of uniformity

3.3.2 Plastic limit

The experimental procedure is done according to IS: 2720 (part-5):1985.

Take 50 grams of soil sample passing 425µm sieve from the prepared sample in the evaporating dish and add distill water to the soil sample and mixed it so that the soil mass is plastic enough and easily moulded, prepare a ball weighing about 8 grams out of this soil mass, place the ball on glass plate and roll it with the figures so that a thread of uniform diameter is formed, the rate of rolling should be between 80-90 strokes per min. continue rolling till the thread reaches a diameter of 3mm by taking reference of metallic rod. Neat the soil of this thread into a ball and roll it again into a thread repeat the process of rolling until thread starts crumbling just retained a diameter of 3mm, now collect the pieces of crumbled sample thread in container of non-weight and determine the moisture content as per standard procedure.

Fig. 3.4 Sample of Plastic limit

Table 4.3 Table for determination of liquid limit

Weight of Container	Weight of Container + Wet Soil	Weight of Container + Dry Soil	Weight of oven – Dry soil	Moisture content
26.10	32.29	31.20	5.10	21.37
21.86	34.74	32.51	10.65	20.94
23.91	30.15	29.06	5.15	21.17

Mathematically, calculation of moisture content

$$\text{Moisture Content} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \text{ X } 100$$

IV. CONCLUSION

On the basis of data gathered and analysis, the conclusion is as follows:-

The bearing capacity of the soil increases and the thickness of the pavement decreases and eventually the cost of constructing the project decreases. The CBR value gets varied with the introducing of woven geo-textile at different depths of soil. A geo textile layer at 6cms introduced in the mould shows better performance than any other layer in different depths.

To protect the aggregate layer from shrinking into the soil, geotextiles are being used in the form of separator between the aggregate layer and subsoil. From the above studies it is clear that, it is a time to take a big step towards the use of geotextiles in Indian road construction. Geotextiles are an emphatic and economic method of fixing the most geotechnical problems in roads. The designer engineer should be well aware of the problems arising while construction of roads and should use comparatively new techniques for solving the problem. Engineer should be well cognizant of the properties and capabilities of geotextile material. Despite having huddles, the profits for implementing geotextiles are well known. If all the industries would collaborate we would definitely gain the practical specifications so the potential of geotextiles can be obtained.

REFERENCES

[1] Christopher B.R. and Holtz R.D., (1985) "Geotextile Engineering Manual, Report No, FHWA-TS-86/203", Federal Highway Administration, Washington, D.C., Mar 1985, 1044p.
[2] Hicks et al., (1986) "Base Course Contamination Limits, Presented at 65th
Annual Meeting of Transportation Research Board", Washington, D.C.
[3] Bonaparte et al., (1987) "Soil reinforcement Design by using Geotextile and Geogrids" American, Society for testing and Material, ASTM, Vol. 952.
[4] Holtz R.D. and Sivakugan., (1987) "Design Charts for Roads with Geotextiles", Geotextiles and Geomembranes, Vol. 5, No, 3, pp. 191-199.

[5] Bonaparte Holtz and Giroud., (1987) “Soil Reinforcement Design Using Geotextiles and Geogrids”, American Society for testing and Materials, ASTM, Vol. 952.
[6] Anderson P. and Killeavy M., (1989) "Geotextiles and Geogrids: Cost Effective Alternative Materials for Pavement Design and Construction”, Geosvnthetics '89 Conference. pp 353-364, San Diego, CA.
813, pp. 44–48, 2013.