APPLICATION OF GEOFARICS IN PAVEMENT SUB-GRADE CONSTRUCTION

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ABSTRACT

The purpose of this project is to enhance the sub grade strength by using geofibres. India has one of the largest road networks in the world, aggregating to about 33 lakh km at present. However many of the existing roads are becoming structurally inadequate because of the rapid growth in traffic volume and axle loading. At locations with adequate sub-grade bearing capacity/CBR value, a layer of suitable granular material can improve the bearing capacity to carry the expected traffic load. But at sites with CBR less than 2% problems of shear failure and excessive rutting are often encountered. The ground improvement alternatives such as excavation and replacement of unsuitable material, deep compaction, chemical stabilization, pre loading and polymeric geosynthetics etc are often used at such sites. The cost of these processes as well as virgin material involved is usually high and as such they are yet to be commonly used in developing nations like India.

In this context natural fiber products hold promise for rural road construction over soft clay. India is the first largest country, producing coir fiber from the husk of coconut fruit.. The fibers are now a day's being needle punched or adhesive bonded to obtain non woven products or blankets. Geofibre are proving to be cost effective alternative to traditional road construction method. But these synthetic products are biodegradable and cause environment problems, whereas natural geofibre like coir is biodegradable.

KEYWORDS: *CBR, Geofibre, Geosynthetic Reinforcement, Sub-grade, Biodegradable.*

1.0 INTRODUCTION

The geo fabrics industry has expanded rapidly in recent years, and the number and types of geo fabrics manufactured with a specific focus in roadway design has increased dramatically. This increase has resulted in many new performance-enhancing and cost-saving design alternatives for roadways. Traditionally, the use of geo fabrics in pavement applications has addressed five main functions: separation, filtration, drainage, reinforcement, and mitigation of crack propagation.

Depending on the type of geo fabrics and its location within the pavement system, geo fabrics can perform one or more of these various functions simultaneously as part of an overarching application. The challenges facing engineers who will potentially use geo fabrics in roadway design are to select the appropriate application, to determine relevant properties and criteria for selection of an adequate product, and practice proper installation and construction technique in order to ensure the integrity of the placed geo fabrics.

1.1TYPES OF GEOFABRICS

Geo fabrics can be produced by fibres such as carbon fibre, glass fibre, aramid fibre, Steel, copper and so on. The current production of geo fabrics is the main raw material used in natural cotton and hemp fibres and chemical fibre polyester, Polypropylene, nylon, polyvinyl alcohol and so on. Geo fabrics is any permeable textile material used with foundation, soil, rock, earth, or any other geotechnical engineering related material as an integral part of a man-made product, structure, or system.

1.1.1 Knitted Geofabrics

1.1.2 Nonwoven Geofabrics

a) Heat Bonded Non-woven

b) Needle Punched Non-woven

1.1.3 Woven Geo fabrics

a) Plain weave

b) Twill weave

c) Satin weave

1.1.4 Braid fabric

1.1.1 KNITTED GEOFABRICS:

Knitted geofabrics by a string of one or more yarns circle from each other, rarely[3] used geofabrics. But with Directional Fabric Structure (DSF) geofabrics advent, people gradually changed his views. DSF fabric comprises uniaxial fabric (vertical warp, weft link), biaxial fabric (warp and weft vertical, linked by a join line) and multi-axial fabrics. The knitting process consists of interconnecting loops of yarn on powered automated machines. [2]The machines are equipped with rows of small, hooked needles to draw formed yarn loops through previously formed loops. The fabric is designed to take force in two directions (0° and 90°). For this can be used roving of glass, high tenacity polyester, aramid or carbon as pillar threads and weft threads. These fabrics are used for reinforced composites.

1.1.2 NONWOVEN GEOFABRICS

Nonwoven geofabrics are mainly spun bonded, needle-punched, hot-melt[1] and adhesive type[12] geofabrics, it has lower strength and initial modulus, but good elongation at break. Nonwoven geofabrics has good elasticity, good frictional properties, porosity and uniform, high filtration efficiency Non-woven geofabrics features simple production process, high labour efficiency, low cost, multi-process changes.

HEAT BONDED NON-WOVENGEOFABRICS

This is done by fibre having same polymer type but different melting point in the mat, known as incorporating fibres or by using hetro filaments, that is fibre composed of one type will be inside and fibre having low melting point will be covered all around[3].

NEEDLE PUNCHED NON-WOVENGEOFABRICS

Carded and needle punched nonwovens offer very high loft (low density) at a very low cost.It is the process of pushing many needles into the one or more layers of the fibre normal to the geo- textiles plane. The process causes mechanical effect and results in geo-fabrics has an appearance of felt mat.

1.1.3 WOVEN GEOFABRICS

Woven geofabrics is composed of two groups of filaments or flat woven into the fabric wear, a variety of[1] single-layer woven geofabrics (also known as anti-geofabrics cloth), double layer geofabrics (also known as geofabrics mould cloth bags) and woven fabric impermeable. Large numbers of geosynthetics are of woven type, which can be sub-divided into several categories based upon their method of manufacture. These were the first to be developed from the synthetic fibers.

The majority of low to medium strength woven geosynthetics are manufactured from polypropylene which can be in the form of extruded tape, silt film, monofilament or multifilament. Often a combination of yarn types is used in the warp and weft directions to optimize the performance/cost. Higher permeability is obtained with monofilament and multifilament than with flat construction only.

- **PLAIN WEAVE:** Most simple and most common type of construction Inexpensive to produce, durable, Flat, tight surface is conducive to printing and other finishes. The simplest of all patterns is the plain weave. Each weft yarn goes alternately over and under one warp yarn. Each warp yarn goes alternately over and under each weft yarn.

- **TWILL WEAVE:** Creates a diagonal, chevron, hounds tooth, corkscrew, or other design. The design is enhanced with colored yarn is strong and may develop a shine. Twill weave is characterized by diagonal ridges formed by the yarns, which are exposed on the surface. These may vary in angle from a low slope to a very steep slope
- **SATIN WEAVE:** A satin fabric tends to have a high luster due to the high number of floats on the fabric. Fabrics created from satin weaves are more flexible, Smooth, soft luster, with better draping characteristics than plain weaves, allowing them to be formed around compound curves, which is useful in carbon-fiber composites manufacturing.

1.1.4 BRAID FABRIC.

Braiding is a simple form of narrow fabric construction. A braid is a rope like thing, which is made by interweaving three or more stands, strips, or lengths in a diagonally overlapping pattern. They are used for various Industrial applications. They have good elongation characteristics and are very pliable, curving around edges nicely. Braid is stretchy and easily shaped.

1.2 VARIETIES OF COIR GEOFIBRES

The specifications of H2M8 and H2M9varieties of coir are shown in Table 1.1 as per ASTM-D1777 (2001).

TABLE NO 1.1 SPECIFICATIONS OF H2M8 AND H2M9VARIETIES OF FIBRE

S.NO	CHARACTERISTICS	H2M8	H2M9
1.	**Material**	100% Natural Fibre	
2.	**Maximum Length (M)**	50	50
3.	**Width (Cm)**	120 to 300	
4.	**Thickness (Mm)**	8.52	10.9
5.	**Minimum Breaking Load (Kn/M)(Dry) Machine Direction (Warp Way) & Cross Direction (Weft Way)**	28.25 & 1.59	39.52 &2.63
6.	**Maximum Elongation At Break (%) Machine Direction (Warp Way) & Cross Direction (Weft Way)**	32&30	38 &35
7.	**Maximum Breaking Load (Kn/M)(Dry) Machine Direction Cross Direction**	56 &46	70 &75

1.3Objectives of the Present Investigation

1) To improve the sub grade strength by using geo fabrics
2) To determine the selected soil characteristics by conducting laboratory tests such as LL, PL, PI, OMC, DD,CBR TRETED
3) To compare the various changes occurred in the strength of soil with the geo fabrics I.e.., before adding , after adding

2. LITERATURE REVIEW

RESL AND WERNER (1986) carried out the laboratory tests under an axisymmetric loading condition using nonwoven, needle-punched geotextiles. The results showed that the geotextile layer placed between sub base and sub grade can significantly increase the bearing capacity of soft sub grades.
VENKATAPPA AND DUTTA (2005) performed monotonic and cyclic load tests on Kaolinite sand bed. According to him the coir geotextile retained 20 % of their original tensile strength after one year in incubator test with high fertile soil.
YAMAN ET AL (2005) AND KORKUT ET AL (2006**)** concluded that the geotextiles can trap the biofilms effectively and augment biodegradation more efficiently. Such an application becomes a necessity in the situation when the septic tank effluent poses a serious threat to the drinking water quality in a region. Due to rapid urbanization, the size of the plots available for construction of residential units turned very small and as a result strict adherence to these norms became difficult.
DR MARIAMMA JOSEPH AND DR.SHEELA (2015) conducted a case study on Coir Geotextiles in pavements having soft soil subgrade" The main objective of the project is to reduce maintenance cost and increase pavement longevity of roads in rural roads using Coir Geotextiles.

3. METHODOLOGY

The draft construction specifications for base separation were developed by combining the construction guidelines from AASHTO specification for geofabrics. At First, general description followed by the corresponding material requirements, and finally the specific construction method, which addresses the following aspects:

3.1 TRENCH PREPARATION:

Prepare the trench on which the geofabrics is to be placed so that no damage occurs to the geofabrics. The bottom and the sides of the trench receiving the geofabrics shall be smooth and free of stones, sticks, and other debris or irregularities that might puncture or damage the geofabrics during the placement of geofabrics. Dispose of material with defects, rips, holes, flaws, deterioration, or other damage..

3.2 GEOFABRICS PLACEMENT:

The graded surface of the bottom shall be smooth and free of debris. When placing the geofabrics, it shall be unrolled in line with the placement of the new aggregate and the geofabrics shall be placed free of tension, stress, or wrinkles, and with no void spaces between the geofabrics and the ground surface. The geofabrics shall be protected at all times during construction, and the geofabrics should be repaired immediately whenever any damage is founded. Place a sufficient width of geofabrics to entirely cover the perimeter of the trench and allow for the required overlap.).

3.3 OVERLAPPING:

In trenches equal to or greater than 12 inch in width, after placing the drainage aggregate the[5] geofabrics shall be folded over the top of the backfill material in a manner to produce a minimum overlap of 12 inch. In trenches less than 12 inch, but greater than 4 inch wide, the overlap shall be equal to the width of the trench. Where the trench is less than 4 inch the geofabrics overlap shall be sewn or otherwise bonded. All seams shall be subject to the approval of the engineer.

3.4 DAMAGE REPAIRS:

If the geofabrics is damaged during installation[2] or drainage aggregate placement, a geofabrics patch[2] shall be placed over the damaged area extending beyond the damaged area a distance of 3 feet. Draining saturated soils can increase their strength and stability. Unfortunately, soils will only drain if there is an adjacent soil layer or zone of higher permeability into which the water can escape. The lower the permeability of the subgrade soils, the closer together the drainage layers/zones must be to provide effective dewatering.

3.5 AGGREGATE BACKFILL:

Placement of drainage aggregate should[2] proceed immediately following placement of the geofabrics. The geofabrics should be covered with a minimum of 12 inch of loosely placed aggregate prior to compaction. If a perforated collector pipe is to be installed in the trench, a bedding layer of drainage aggregate should be placed below the pipe, with the remainder of the aggregate placed to the minimum required construction depth.

3.6 COMPACTION:

The aggregate should be compacted with vibratory equipment to a minimum of 95% Standard AASHTO density unless the trench is required for structural support. [1]If higher compactive effort is required, a Class 1 geofabrics should be used. For the Under drain application, the objective was to lower the water table and differences between under drain and trench drain are the location and the dimensions of the trench.

4. RESULTS AND DISCUSSION

4.1 INVESTIGATION ON SUB GRADE

The Soil was taken from **MEDAK STREET& SHAMSHABAD DISTRICT** was used.
In chapter 5, experimental program was conducted on virgin soil to identify the Atterberg's limits, OMC, MDD; CBR .This soil was then stabilized with geofibre to improve the sub grade strength. This chapter provides the soil properties and strength properties sub grade soils. The main focus is on conducting CBR test for sub grade with reinforced geo fiber of two grades and out to determine the various properties of soil . The factorials of experiments were listed in Table 5.3.
Tests were carried out to determine the various properties of soil and results are tabulated below in table no 5.1 & 5.2

TABLE 4.1 INVESTIGATIONS ON SUB GRADE FOR MEDAK

Sl. No	Laboratory Test	Result	Relevant IS codes
1	Grain size distribution (%)		IS 2720 Part IV
	Gravel	8.5	
	Sand	20.3	
	Clay	71.22	
2	Liquid limit(%)	59.15	IS 2720 Part V
3	Plastic limit(%)	28.74	IS 2720 Part V
4	Plasticity index	30.41	IS 2720 Part V
5	Optimum moisture content (%)	20.06	IS 2720 Part VIII
6	Maximum dry density(g/cc)	1.59	IS 2720 Part VIII

The basic properties of soil sample collected were found in the laboratory are as given in the table 5.1, the tests was carried out as per codes shown in the table.
From the above tests, the Soil is classified as-

- The given soil is classified as fine grained i.e more than 50 % of soil is passing through 75 µ IS sieve
- Grain size distribution 75µfraction>50fine so it is inorganic in nature.
- The soil classified as CH clay(C) .the liquid limit value is >50.

- Therefore liquid limit is greater than 50 %, it is highly compressible clay, and hence the soil is very poor. **WOVEN GEO FIBRE IS ADOPTED.**

TABLE 4.2 INVESTIGATIONS ON SUB GRADE FOR SHAMSHABAD

Sl. No	Laboratory Test	Result	Standard value	Relevant IS codes
1	Grain size distribution (%)		>50	IS 2720 Part IV
	Gravel	5		
	Sand	25		
	Clay	70		
2	Liquid limit (%)	62.9	>50	IS 2720 Part V
3	Plastic limit (%)	31.8		IS 2720 Part V
4	Plasticity index	31.1		IS 2720 Part V
5	Optimum moisture content (%)	16.31		IS 2720 Part VIII
6	Maximum dry density(g/cc)	1.77		IS 2720 Part VIII

The basic properties of soil sample collected were found in the laboratory are as given in the table 5.2, the tests was carried out as per codes shown in the table.
From the above tests, the Soil is classified as-

- The given soil is classified as fine grained i.e more than 50 % of soil is passing through 75 µ IS sieve
- Grain size distribution 75µfraction>50fine so it is inorganic in nature.
- The soil classified as CH clay(C) .the liquid limit value is >50.
- Therefore liquid limit is greater than 50 %, it is highly compressible clay, hence the soil is very poor **.HENCE WOVEN GEOFIBRE IS ADOPTED.**

TABLE NO 4.3: PARAMETERS CONSIDERED FOR STRENGTH PROPERTIES

PARAMETERS	NO OF VARIABLES
COIR TYPES	**2** fibre type 1 : Medak (H2M8) fibre type 2: Shamshabad (H2M9)
CBR SPECIMENS	**2** (Untreated ,Treated)
SOAKING PERIODS	**4** (1,2,3,4 days)

4.2 INVESTIGATION ON GEOFIBRE

This study was conducted to bring out the effect of soaked California Bearing Ratio values of soils reinforced with treated coir geofibre and with untreated coir geofibre. CBR tests were done for two different grades of coir geofibre by placing the coir geofibre at a depth of 0.2H where H is the height of the specimen (12.5cm) as shown in figure

5.4 OBSERVATIONS

TABLE 4.4 CBR VALUES FOR SPECIMENS WITH UNTREATED GEOFIBRE

Soaking time	**position**	**CBR (%)**	
		Medak	**Shamshabad**
Day 1	**0.2H**	1.49	1.52
Day 2		1.19	1.21
Day 3		1.03	1.06
Day 4		0.6	0.83

From the above Table 5.4, shows that there is a decrease in the CBR value with increasing soaking time from 1 to 4 days without placing H2M8, H2M9 fibers.subgrade strength is very low.

CBR values obtained for specimens with treated geofibers i.e., (H2M8, H2M9) after 1,2,3,4 days of soaking were presented in Table 5.5.

TABLE 4.5 CBR VALUES FOR SPECIMENS WITH TREATED GEO FIBER.

Soaking time	**position**	**CBR (%)**	
		H2M8	**H2M9**
Day 1	**0.2H**	1.56	1.81
Day 2		1.27	1.43
Day 3		1.13	1.21
Day 4		0.6	0.98

From the above Table 5.5, it was observed that soil treated with geo fiber of grade H2M8 shows maximum 0.07% increased and for H2M9 grade shows maximum value 0.29 % but there is a decrease in the CBR value with increasing soaking time from 1 to 4 days for both grade fibre

4.3 SUMMARY

It can be computed that the treated geofibre shows more CBR value than unreinforced geo fibre.

Hence geo fibre is adopted.

4.4 DISCUSSIONS

Figure 4.1 shows the CBR values of MEDAK unreinforced section after soaking periods of 1, 462, 3, and 4 days.

CBR value of MEDAK & SHAMSHABAD Untreated soil

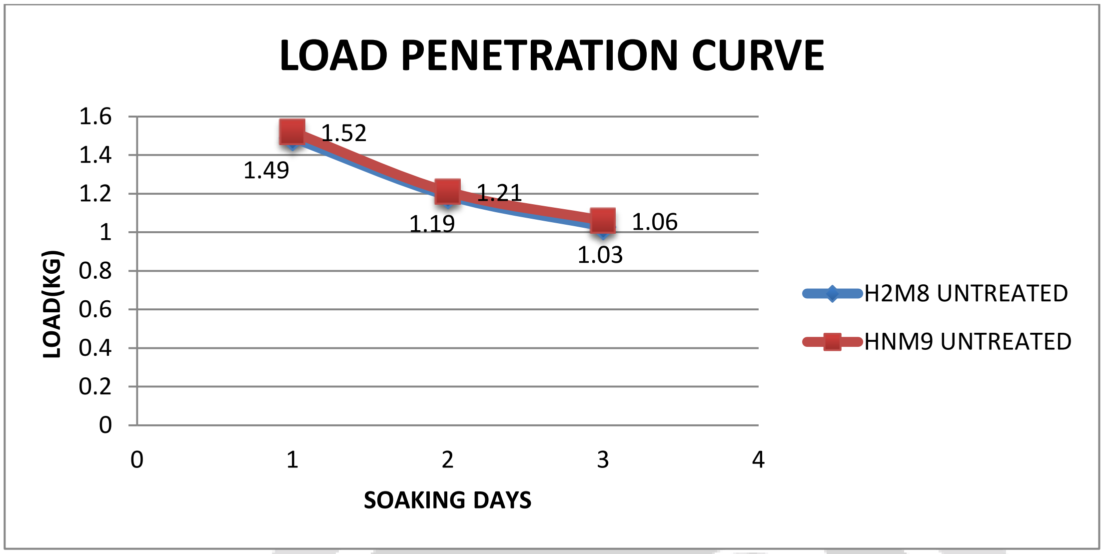

FIG. 4.1 UNTREATED H2M8 & H2M9 GRADE OF COIR GEOFIBRE

From the figure 5.8, it shows that the maximum CBR value of 1.49% is obtained for H2M8 grade of coir geo fiber on first day. The maximum value of H2M9 grade of coir geo fiber is 1.52% on first day, but there is a gradual decrease in the two grades of coir geo fiber with increasing the soaking time from 1 to 4 days

Figure 5.8 shows the CBR values of treated coir geo fiber of MEDAK (H2M8) and SHAMSHABAD (H2M9) for different soaking periods

CBR value of MEDAK & SHAMSHABAD Treated soil

From the above figure 4.2, it shows that the maximum CBR value of 1.56% is obtained for H2M8 grade of coir geo fiber. The maximum value of H2M9 grade of coir geo fiber is 1.81%, but there is a gradual decrease in the two grades of coir geofibre with increasing the soaking time from 1 to 4 days

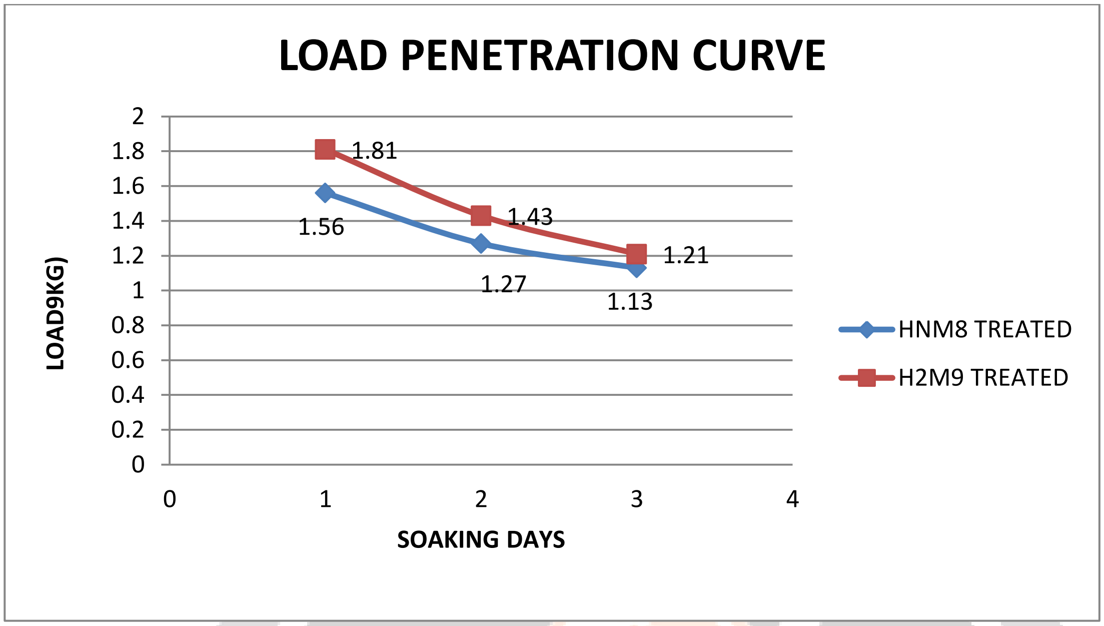

FIG. 4.2 TREATED H2M8 & H2M9 GRADE OF COIR GEO FIBER

4.5CONCLUSIONS

- The following conclusions were drawn from the present investigation:
- The maximum CBR improvement ratio is obtained for H2M8 is from 1.49% to 1.56%.
- The maximum CBR improvement ratio is obtained for H2M9 is from 1.52% to 1.81%.
- The soil is reacting better results when treated with geo fiber.
- The soils treated with H2M9 geo fiber gives more strength when compared to H2M8 geo fiber
- The sub grade strength is decreasing with increasing soaking periods due to the swelling property of collected soils. This kind of trend is observed for unreinforced, untreated and treated cases.
- The soil sample treated H2M8 gives more value compare to unreinforced sample.
- The soil sample treated H2M9 gives more value compare to unreinforced sample.

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