Strengthening and Drainage of Flexible Pavement Using Coir Geotextile

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Abstract: ***Coir, being a biodegradable and eco-friendly material, can practically replaceable by any of the modern polymer substitutes. With the diversification of products and the evolution of new technologies for the fiber production, the export of coir products has been enormously increased. The demand for coir geotextiles increased. India's total coir export comprises only less than 3% of it. The strong involvement of the local population governments, with the support of public research institutions and private companies is necessary to innovation, manufacturing and marketing of coir. More roads have to be built on expensive soils due To to the scarcity of land in India. Usually black cotton soil has an expensive nature and one or more problems, namely, low shear strength, high compressibility, low hydraulics conductivity, swelling and shrinkage. Coconut fillets give a positive effect on road embankment. The present study shows the type of coir geotextile (CGT), properties of coconut fiber, function of CGT, application of CGT and application of CGT in road construction. As well discussed a case study from South India in which construction of rural roads using coir nets and their performance.***

Keywords: Coir Geotextile (CGT), Coir Net, black cotton ground (CB)

1.Introduction

The development of conveyance infrastructure is the key to overall development of a country. For countries like India, where resources are constrained, the consequentiality of roads is to be highly accentuated. The subgrade, which is the bottom most layer of the pavement, is composed of compacted soil and so additionally for the highway embankments. The road alignment is decided predicated on many factors of which one is the availability of good soil along the proposed alignment. In early days, areas having impotent soil deposits were evaded while fine-tuning up the alignment. But with scarcity of land and other resources, there is no cull of land and hence roads and embankments have to be built on them (Chauhan et al 2008). These problematic soils may have one or more of the short comings viz., low shear vigor, high compressibility, low hydraulic conductivity, swelling and shrinkage, susceptibility to frost action etc., and hence are associated with quandaries such as lowbearing capacity, high settlement, high seepage loss, liquefaction during earthquake and instability of substratum excavation. In such cases, it is often infeasible to build a stable base course over soft subgrade, without losing extravagant base material which perforates into the soft sub grade soil and hence a ground amelioration method has to be resorted to. Ground amendment is a general term utilized for the modification of soil to enhance the vigor and other engineering properties. There are many methods of ground amendment such as utilizing additives (like cement, lime etc.), compaction (both static and dynamic), soil stabilization etc. Geotextiles form one of the most immensely colossal groups of geosynthetics. Now a days one of the most famous utilization of Geotextiles is in field of construction in pavements and embankments on soft soil. They are indeed textiles in the traditional sense, consisting mainly of synthetic fibers, though natural fibers are withal utilized for manufacturing. They can be Woven or Non-woven type. There are brobdingnagian concrete application areas for geotextiles. Generally the fabric performs at least one of the four discrete functions viz., disunion, reinforcement, filtration, drainage (IRC: SP: 59-2002). In many ground-engineering quandaries, geosynthetics are mainly required to perform its function in full capacity, only for a constrained duration: for example, within ad interim haul roads, basal reinforcements for incipient embankments, vertical drainage to increment shear vigor, etc. In most of the cases, the geosynthetic capacity is surplus to the requisites during the later periods of the working life of such systems. In such situations, the deliberate and designed utilization of a geosynthetic system, which has a prognosticable abbreviation of capacity with time, is a good engineering practice. In such cases, utilization of natural geotextile could be a better option. In additament to the low cost of natural fibers, the growing concern over the impact of the utilization and disposal of synthetic materials has recently led to a renowned interest in the possible advantages of natural geotextiles. Natural geotextiles composed of coconut fiber, jute fibre, sisal, etc. can be utilized as an alternative to polymeric geosynthetic materials. It is even possible to have tailor made composites of natural fibers to engender a material with required vigor -time profile. Coir geotextiles with Indianised connotation "Coir Bhoovastra", a generic member of the geosynthetic family, is made from coconut fiber extracted from the husks of coconut fruit. The utilization of biodegradable natural materials is gaining popularity in rehabilitation of areas damaged either by natural or industrial causes, especially in the light of growing cognizance of sustainable development throughout the world.

Type of Coir Geotextile

Coir geotextiles with its Indianised connotation "Coir Bhoovastra", a generic member of the geosynthetic family, are made from the coconut fiber extracted from the husk of the coconut fruit as expounded in the following section. Like their polymeric counter components, coir geotextiles can be synthesised for categorical applications in geotechnical engineering practice. Coir geotextiles is not a consumer product, but a technology predicated product. A range of different mesh matting is available, meeting varying requisites. Coir fibers can be converted into fabric both by woven and non-woven process. Coir geotextile of different sieve sizes is the most recognized coir geotextiles. Mesh matting having different specifications is available under quality code numbers H2M1 to H2M1O. These qualities represent coir geotextiles of different mesh sizes ranging from 3.175mm to 25.4mm. Several types of non-woven geotextiles also exist. Mostly non-woven mats are manufactured from unconfined fibers, which are locked together by needling or rubberizing. Non-woven geotextiles are available in several dimensions and have a minimum thickness of 2mm.

1.1 Properties of Coir Fiber

Coir fibers are extracted from the husks surrounding the coconut. There are two distinct varieties of coir fiber based on the extraction process viz., white coir and brown coir. The average fiber yield depends on geographical area and the variety of coconut tree. In southern states of India and in Sri Lanka, where the best quality fibers are produced, the average yield is 80 to 90 grams per husk. Husks are composed of 70% of pith and 30% of fiber on a dry weight basis. The maximum total world production of coir fiber is estimated to be between 5 and 6 million tons per year.

The coir has following chemical composition.

Cellulose: Cellulose is made up of a series of sugar molecules linked together in a long chain.

Hemicellulose: Hemicellulose is composed of chains of sugars. They comprise a group of polysaccharides (omitting pectin) bonded together in relatively short, branching chains and remains associated with the cellulose after lignin has been abstracted.

Lignin: Lignin is a class of complex organic polymers that forms key structural materials in the support tissues of most plants. Natural fibers could not produce rigidity without lignin.

Pectin: Pectin is the rudimental structural component of all plant fibers. The outer cell wall is porous and consists withal of pectin and other non-structural carbohydrates.

The pores of the outer skin are the prime diffusion paths of dihydrogen monoxide through the material. The approximately, chemical composition of coir fiber as reported by Ravi Shankar et al. 2012, at % given 0

Chemical composition of coir fiber

Content	Percentage
Lignin	45.84
Cellulose	43.44
Hemi cellulose	0.25
Pectinand related compounds	3.00
Water soluble	5.25

Engineering Properties of Coir Geotextile

Property	Value
Length(mm)	15-280
Density(g/cc)	1.15-1.4
Breaking elongation(%)	29.04
Diameter(mm)	0.1-1.5
Rigidity modulus(dynes/cml)	1.8924
Swelling in water(%)	5.0
Moisture at 65% RH (%)	10.5
Specific gravity	1.15
Young's modulus (GN/m2)	4.5
Tenacity (g/tex)	10.0
Specific heat	0.27

1.2 Reinforcement Mechanisms

Three fundamental reinforcement mechanisms have been identified involving the utilization of geotextiles in unpaved road applications. These are: a) disunion, b) lateral restraint, and c) tensioned membrane effect. In general geosynthetics perform at least one or more of functions viz., disseverment, reinforcement and filtration/drainage in ameliorating the road performance. The benefit of utilizing geotextiles in flexible pavement depends largely on the quality and thickness of the granular base and location of the geotextiles within the pavement structure.

1. Separation

One of reasons for distress or failure of roads is migration or mixing of fines from the subgrade to overlaying granular layer. High wheel load stresses acting on the road surface coalesced with impuissant/saturated subgrade, typically cause a base and subgrade mixture. This mixing causes a truncation in the efficacious base thickness by truncating the authentic modulus of granular base as well as its physical thickness.

2. Lateral restraint

It truncates the horizontal deformation of the base course and the subgrade, when these are in contact with the geosynthetic. It has been reported that geosynthetics hold the base material and the subgrade together by developing friction forces between it and the other two material. This action of the geosynthetic and the basic material is applied to as base bridle and that between the geosynthetic and subgrade as subgrade bridle.

3. Tensioned membrane effect

The expression “membrane effect” refers to the ability of a geosynthetic sheet to be deformed, thereby absorbing forces initially perpendicular to its surface through tension. The tension in a highly distorted membrane at the base of an overlaying granular layer provides a reaction with a vertical component contributes to fortify the wheel load at the surface and confines the soft subgrade below.

1.3 Application of Coir Geotextiles

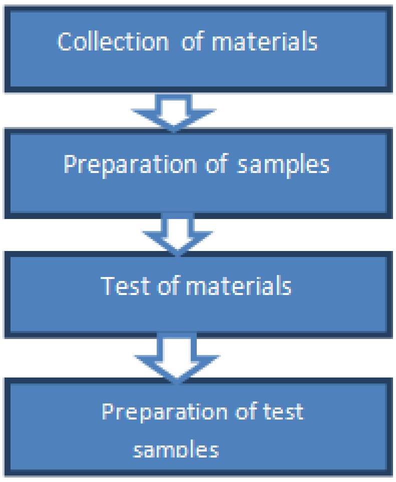
Coir geotextiles find application in a number of situations in geotechnical engineering practice. Coir geotextiles can be utilized as an overlay or interlay, the former forfending the surface from runoff and the latter performing the functions of disseverment, reinforcement, filtration and drainage. Soil bio –engineering with coir geotextiles finds efficacious application in the following field situations.

1. Disseverment application in unpaved roads, railways, parking and storage areas.
2. Shore line stabilization.
3. Storm water channels.
4. Water course protection
5. Mud wall reinforcement
6. Providing sub base layer in road pavement.
7. Soil stabilization.

2.Need for Present Study

The subgrade soil and other materials, which are utilized for the construction of roads and embankments, play major roles in deciding the method of design and construction. It is always recommended to utilize the locally available materials if their vigor and hydraulic characteristics sanction. Yellowish clay soil have low bearing capacity, high settlement, low seepage loss, In such cases, it is often infeasible to build a stable base course over soft subgrade, without losing sumptuous base material which perforates into the soft sub grade soil and hence a ground amendment method has to be resorted to. Utilization of geotextiles for amelioration of engineering properties of soil is a proven method, which sanctions the utilization of local materials to a certain extent, albeit the available materials are not so competent in view of design considerations. This can be achieved only at some supplemental cost and the cognation between price and performance is paramount in the cull of the material. A geotextile can perform one or several functions to ameliorate the mechanical and or hydraulic demeanor of the structure in which it is incorporated. The polymeric geotextiles is a multifarious material with alluring characteristics and advantages, and as a result, this material is now being used abundantly all over the world. At the same time these materials have disadvantages as well that it is non-biodegradable, petroleum predicated and is expensive. The utility of coir geotextiles for performing different functions to ameliorate the engineering deportment of soil and the structure as such need to be studied. Other methods of stabilization like lime stabilization, cement stabilization, fly ash stabilization etc. are not congruous because the additives (Calcareous, argillaceous and silicate) do not congruous mix with soil. Coir net is readymade material, cheap, easy laying in field and biodegradable. The coir-geotextile reinforcement is a superior solution for the construction of roads on weak subgrade soils. Coir nettings have minimum life of 5 years. The use of natural geotextiles has not gained popularity though India produces large quantities of coir geotextile and their use for geotechnical and highway engineering applications is possible.

3.Methodology



4.Experimental Material and Methods

- Soil sample
- Yellowish clay Soil
- Determine the CBR value of soil sample at Optimum moisture content to find out the maximum dry density of soil.
- Determine the permeability of the soil sample at same OMC.
- Coir Geotextile
- First of all, Add the Coir geotextile at H/2 the at H/3 of the surface then note down the CBR value and Permeability at H/2 AND H/3.

5.Data Collections & Result analysis

Soil Parameters-

Test	Value	Unit
OMC	18	%
MOD	1.69	%

IS 2720 PART-7

Test	Value	Unit
Sieve analysis(Gravel)	9.5	%
Sand	22.26	%
Silt and clay	68.24	%
Specific gravity	2.71	%
Liquid Limit	42.00	%
Plastic Limit	25.00	%

As per IS: 2720- PART 17-1986

Test	Result	Unit
Soil permeability	1.22x10^-2	m/sec
Soil permeability H/2	1.42x10^-2	m/sec
Soil permeability H/3	1.588x10^-2	m/sec

CBR Value in Soil

CBR	Value	Unit
2.5mm	1.71	%
5.0mm	1.73	%

CBR value in H/2 Coir Geotextile

CBR	Value	Unit
2.5mm	1.33	%
5.0mm	1.58	%

CBR value in H/3 Coir Geotextile

CBR	Value	Unit
2.5mm	2.52	%
5.0mm	2.72	%

6.Conclusion

CBR value at H/3 increased when coir geotextile was put in soil sample & drainage also got improved gradually at H/2 and H/3. So we can conclude that, In poor soils the soil sub-grade vigor and other desirable properties can be achieved by sundry betokens. The conventional method such as lime, cement, fly ash stabilization can be utilized as per their availability/practicality. The geosynthentic offers wide variety of products to solve may geotechnical quandaries being non-biodegrable and costly. Their utilization should be restricted the natural materials as if coir geotextile can be an option to ameliorate the indigent subgrade soil. The laboratory and field studies have been done on the application of coir geotextile in road construction in poor marine place. So successful application of it, at places where Black Cotton soil or yellowish clay soil which viz. expensive in nature, low shear strength, high compressibility, swelling and shrinkage, on embankment of road.

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