ASSESSMENT OF LATERITIC SOIL STABILIZED WITH SAND AND COIR MAT GEOTEXTILE AS PAVEMENT SUBBASE MATERIAL

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Abstract: Lateriticsoils are used as fillmaterials for various construction Works. Thesesoils are weatheredunder conditions of high temperatures and humidity. So the properties of thissoilseasily changes over dry and wetseasonsresulting in poor engineering propertiessuch as high plasticity and lowstrength, The effective use of thesesoilsisthereforeoftenhindered and canonlybeutilizedafter modification/stabilization. The application of Geotextiles in stabilizing the soils is goes on increasing nowadays because of the appreciable advantages both in versatility and cost. In this study, the locally available lateritic soil is stabilized with coir mat to improve its Bearing Capacity. Plasticity index of this soil is found to be higher due to the presence of silt and clay in large percentage. As per Indian Roads Congress recommendation, liquid limit should be less than 25% and plasticity index less than 6%, for any soil which could be used as sub base. In this investigation, the lateritic soil is blended with suitable percentage of sand to achieve the required specifications. The tests were carried out to determine the consistency limits and CBR of blended soil. Plate load test are conducted to know the improvement in strength when coir mat is used as stabilizer.
Keywords: coir mat, Geotextiles, lateritic soil, soil stabilization.

Introduction: Transportation plays vital role for economic, industrial and social development of the country. Road transport is the only mode which could give maximum services through its maximum flexibility. As with any structure, the underlying soil must ultimately carry the load that is placed on it. It is the pavement's function to distribute the traffic loading stresses to the soil (sub-grade) at a magnitude that will not shear or distort it. The pavement is usually consists of several layers. The lower layer is called the sub-grade, which is the soil itself. The next layer is the sub-base, which usually consists of crushed aggregates mixed with murrum or any other coarser material. The next layer is the base course. This layer can be made of WBM or WMM. The base layer can be considered as the primary layer that distributes the traffic loads to the sub-base and the sub-grade.

The sub grade is the most important layer in the road pavement which must have minimum strength to construct the pavement. But all the subgrade soils will not be having minimum strength. So, it should be stabilized with some soil stabilizers to gain the strength. *The soil must be stabilized otherwise it may not satisfy the requirement as pavement material.* Therefore engineering properties of these soils are modified by means of a process, known as stabilization. This is not only economic solution, but offers a potential use of industrial / domestic waste materials.

The Applications of Soil Stabilization Are to:

- Increase the shear strength
- Increase the load bearing capacity
- Reduce the compressibility.
- Improve the natural soil for the highway and airfields.
- Avoid changes in soil characteristics due to increase or decrease in moisture content.
- Reduce the permeability
- Alter the chemical properties
- Increase resistance softening action of water.

Lateritic soil that is rich in iron oxide. It forms in tropical and subtropical regions where the climate is humid.Lateritic soils that present such problems during construction processes are termed problematic laterites [10,11].Geotextiles are used in wide range of areas in the treated-untreated, blended-nonblended, natural and synthetic. They may be woven-nonwoven, knitted-netted, corded, composite and sandwiched etc. But application of Geotextiles is location specific, so in addition to the characteristics of Geotextiles, identification and application depends on soil type, soil composition, moisture content, liquid limits, plasticity index, bulk density, soil pH, iron/calcium content, clay/silt and sand composition, land sloping & hydraulic action etc. Moreover climatic condition of the application site is also to be considered.

A fibre material would be suitable for geotextile production when it has reasonably good mechanical properties and resistant to microbial attack. Coir fibres are of different types and are classified according to varying degree of colour, length and thickness. The decomposition of coir fibre is generally known to be much less than that of jute due to high lignin content.

Review of Literature: The application of fly ash and coir mat Geotextiles to stabilize the black cotton soil in the region of Menonpara in Vadakarapathy Panchayat, Palakkad, where the pavement distress was found to be very high, was done in (2011) [6]. Singh, R.R,Er. Shelly Mittal find out the OMC of soil-coir mix increases with increasing the percentage of coir fiber and concluded the Coir fiber is a waste material which could be utilized in a sub base for flexible and rigid pavements. The OMC of soil-coir mix increases with increasing the percentage of coir fiber (2014) [9].

Objective of Study: The main objective of this research is to improve the properties of locally available lateritic soil.

1. To be blended with sand to improve its engineering properties (LL≤25%, PI≤ 6%).
2. The soil is to be strengthened further with coir mat geotextile.
3. Load settlement behavior is to be analyzed by conducting PLT.

Materials Used:

Coir Fiber: Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre is Coir, Cocos nucifera and Arecaceae (Palm), respectively. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker. Coconut fibres are commercial available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. *In engineering, brown fibres are mostly used* [12],

Fig1: coir mat

The two principal mechanism of the coir mat is to confine and restrain movement of the granular, structural layer and the so called membrane effect where by a fabric that develops high tensile strength under load can induce a vertical stress upward. This aids the granular layer to support vehicular loading while reducing the magnitude of stress imposed upon sub grade. Coir mat will ensure that no intermixing takes place at this level and the effective depth of the pavement to remains intact.

Installation of coir mat: The three basic steps involved in installation of the coir mat are-

1. Sub-grade preparation
2. Geo-textile placement
3. Aggregate application and compaction

The area over which the coir mat is to be placed must be cleared sharp objects, tree stumps or large stones that could puncture the coir mat. The area should be excavated, stripping away soft soil or unsuitable base materials, then compacted to design grade. The coir mat is unrolled on to the prepared sub-grade in the direction that aggregate will be placed. The coir mat sections must be overlapped side-to-side and end-to-end around 0.5 m. The edges of coir mat should slope towards drainage ditches or other drain systems that parallel the roadway. Granular material can now be back dumped on to the coir mat, beginning on firm ground just in front of the coir mat edge. The aggregate is then spread to a thickness sufficient to allow subsequent compaction. Initial compaction can be accomplished and then fully compacted. Ruts must not be graded down; rather, they should be filled with additional aggregate and compacted. (See fig:1).

Soil: The properties of the lateritic soil used in this investigation are given below:

Specific gravity – 2.65

Grain size distribution (%)

Gravel – 25.0
Sand – 46.0
Silt – 26.5
Clay – 2.50

Consistency limits:

Liquid limit – 53.7%
Plastic limit – 27.4%
Plasticity index – 26.3%

IS soil classification – CH (silts and clays, Liquid Limit greater than 50%. Inorganic clays of high Plasticity, fat clays)

Composition of Coir Fibre:

Lignin : 45.84%
Cellulose : 43.44%
Hemi-Cellulose: 0.25%
Water soluble components: 7.74%
Components soluble in boiling water: 3.00%

Coir netting placed between the weak subgrade soil and the aggregate fill, the coir Geotextiles:

- ✓ Provide a physical barrier to the intermixing of the aggregate and sub grade soil
- ✓ Provide local reinforcement
- ✓ Act as a support membrane

Experiments Done:

Blending Of Soil: The tests were conducted on unblended lateritic soil, soil blended with several percentages of sand until the liquid limit value is less than 25% and plasticity index value is less than 6-7%.

Standard Proctor, Compaction and CBR Test: The degree of compaction of a soil is measured in terms of its dry density. The degree of compaction mainly depends upon its moisture content, compaction energy and type of soil. For a given compaction energy every soil attains the maximum dry density at a particular water content which is known as optimum moisture content. Compaction and CBR tests were conducted on original and blended soil as per relevant IS codes. (See table 1a&1b)

Plate Load Test:In this study, laboratory plate load test set up is used to determine the load-deformation behavior of original soil, soil blended with sand and soil treated with coir mat geotextile. In this investigation, the plate load test is conducted for original soil; blended soil (sand) and placing one layer of coir mat at a depth 1B (B=Dia of Plate).

Results are shown in (fig: 2,3 and 4)

Results And Discussions:

Table: 1a

Soil	Standard Proctor compaction			
	MDD (gm/cm^3)	OMC (%)	CBR (%) unsoaked	CBR (%) soaked
Original soil	1.87	16.2	11	3
50%soil+ 50% sand	2.02	11.7	14	4

Liquid Limit and Plastic Limit has less influence on CBR values. But CBR value varies with Plasticity Index, as like if PI increases CBR also increases.

MDD of original soil is increases when blended with 50%sand. So CBR value also increased both unsoaked and soaked condition.

Table: 1b

Soil	IS modified coKPaction			
	MDD (gm/cm^3)	OMC (%)	CBR (%) unsoaked	CBR (%) soaked
Original soil	2.06	11.6	23	9
50%soil + 50% sand	2.34	7.40	32	11

OMC of original soil decreases, but CBR value increases, for the same blended mixture (see table 1a&1b)

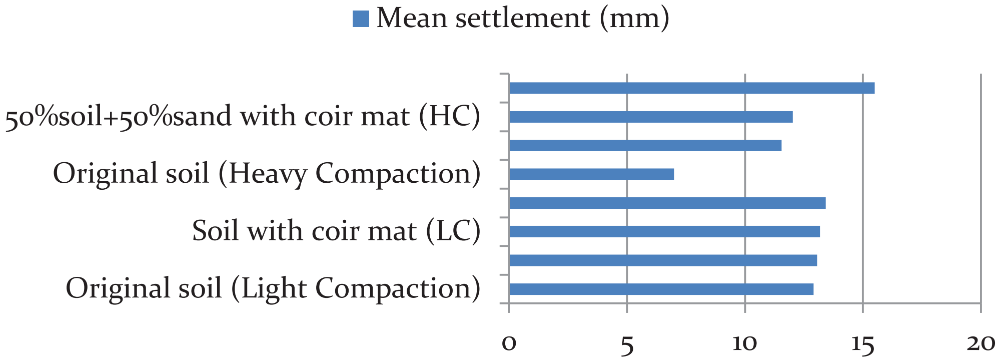

Fig:2 From graph (fig: 2) it is observed that soil blended with 50%sand and coir mat shows lower settlement value.

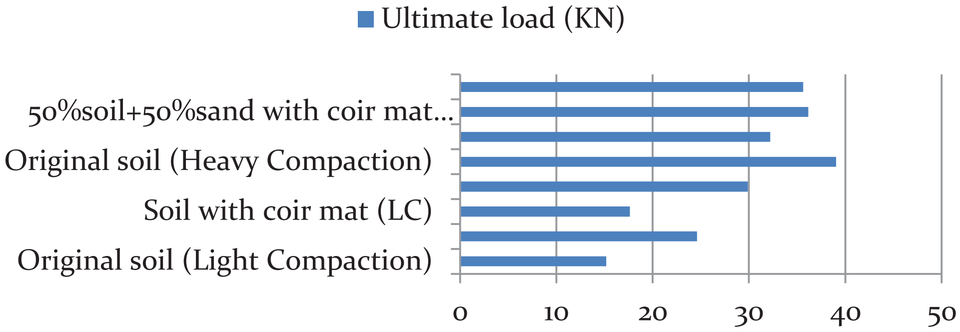

Fig: 3 From graph (fig: 3) it is observed that soil blended with 50%sand and coir mat have high ultimate bearing capacity.

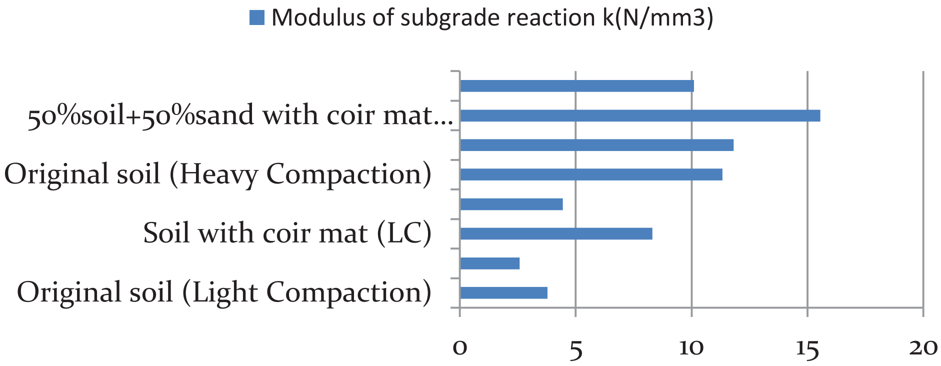

Fig:4 From graph (fig: 4) it is observed that soil blended with 50%sand and coir mat is having high modulus of sub grade reaction.

Conclusion: From the results it is clear that some changes in the properties of lateritic soil takes place.

1. When sand is mixed with the original soil, liquid limit and plasticity index decreases. It can be concluded that the soil blended with 50% sand and reinforced with coir mat geotextile can be a substitute for the GSB.
2. The soil blended with 50% sand satisfies the sub-base requirement.

Acronyms:

CBR=California Bearing Ratio
WBM= Water Bound Mecadam
WMM= Water Mixed Mecadam
OMC= Optimum Moisture Content
LL=Liquid Limit
PI=Plasticity Index
PLT=Plate Load Test
MDD=Maximum Dry Density
GSB=Granular Sub Bas

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