Subgrade Strength Improvement Using Rubber-Coir Composite

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***Abstract*— Many types of soil reinforcements are used and it's a reliable method for improving the soil strength. Geocomposites are used for this purpose. Various types of geosynthetics are there geogrids, geotextiles etc. A composite of rubber and coir fiber are used in this present study. Use of fiber and rubber for stabilizing the soil is economical because they are cost effective, commonly available and eco-friendly. Soil sample was reinforced with the composite. CBR tests were conducted on soil specimen with composite at various depth to determine the optimum depth. The composite placed at 20%, 40%, 60%and 80% of the total depth from top of the sample and optimum position of composite was determined.CBR test conducted corresponding to its optimum moisture content in the CBR mould with and without composite. Soaked tests are conducted in the laboratory. Strength of the soil was improved by adding rubber –coir composite .The highest increase in the CBR value was obtained when composite placed at 20% depth from the top of the specimen.The thickness of the subgrade can be reduced by incooparating the composite at the optimum position**

Keywords*— rubber coir composite, California bearing ratio, optimum position, subgrade

I. Introduction

The overall strength and performance of a pavement is dependent not only upon its design but also on the load bearing capacity of the subgrade soil. Thus anything that can be done to increase the load bearing capacity of the subgrade soil will most likely improve the pavement load bearing capacity and thus pavement strength and performance. Geosynthetics are used to improve the strength of soil. Various types of geosynthetics have different functions. In pavement sections geosynthetics have a major role in load carrying capacity. It takes more load repetitions. But the durability of such material is the reason to decrease the use of natural geosynthetics. Also the increased cost of geosynthetics make construction more costly. So, the use of natural composite made with rubber and coir is considered and its optimum position in a subgrade was obtained by conducting CBR test.

Chandrakaran et al (2008) has presented an experimental study to investigate the use of woven coir geotextiles as a reinforcing material in a two-layer pavement section. Through a rigid circular plate monotonic and repeated loads were applied on reinforced and unreinforced laboratory pavement sections. Using two base course thicknesses and two types of woven coir geotextiles the effects of placement position and stiffness of geotextile on the performance of reinforced sections were found. The test results indicate that the inclusion of coir geotextiles enhanced the bearing capacity of thin sections. The load carrying capacity significantly at large deformations increased when geotextile placed at the interface of the subgrade and base course. **Elsa Eka Putri et al (2012)** has as presented the paper that deals with the tests California Bearing Ratio (CBR) tests and FEM analysis to evaluate the modulus of elasticity (E) and the modulus of subgrade reaction value. By using Cosmos works .FEM model where the soil, the load plunger, and the steel mould of CBR are represented the pressure-displacement response of the soil in the CBR mould is simulated. Based on the elastic properties of the soil sample the correlation of Modulus of Elasticity (E) with California Bearing Ratio (CBR) is developed. Using modulus of subgrade reaction the E values, can be calculated and vice versa as well. **Abhijith et al (2015)** has gone through series of experiments to study effect of natural coir fibers on unpaved roads. In subgrade soil Coir fibers provide a reinforcement action. Coir fiber is a natural material obtained from coconut husk which is commonly available in India. Use of coir fibres strengthen the subgrade soil. Coir fibers of varying percentage from 2 to 8 of total weight of soil and length from 0.5 to 3cm were added with the soil and CBR test was conducted. From the test results, it was concluded that the CBR strength using coir fibre was improved and optimum fibre length obtained was1.5cm and optimum fibre content was 5% of total weight of soil. **Pradhipa et al (2015)** conduct study on expansive soil which undergoes swelling and shrinking that with respect to the changes in water content. High compressibility, low bearing capacity and low shearing strength are the engineering properties of such soils. In this study, the expansive clay is treated with rubber latex modified coir in different percentages. To determine the bearing capacity and shear strength of treated soil, natural fibers are used and hence it will not create environmental problems as they are biodegradable. Natural extract- rubber latex was used to increase the durability of coir added to soil .The results concludes, the coir treated with rubber latex gives increase in strength up to 2% inclusion to the soil. **Imran Akond et al (2015)** evaluates the performance of geosynthetic-reinforced unpaved road sections over soft subgrade using plate load test. The parameters the location and tensile modulus of geosynthetics, and the number of geosynthetic layers are investigated. Stress distribution on top of the subgrade layer and strain distribution along the geosynthetic reinforcements were also identified. The test results includes increase of bearing capacity and geosynthetic reinforcement in appreciable reduction of surface deformation. The results also indicated the effects of geogrid location on the performance of unpaved test sections, with double reinforcement location best improvement yielded.

A. Objectives

- To evaluate the performance of composite reinforced subgrade
- To identify the benefit of incorporating composite in the subgrade section
- To obtain the optimum position for placing the composite in the soil
- To evaluate the reduction in pavement thickness by incorporating the composite

II.METHODOLOGY

Coir fiber and latex were used to develop the composite. Coir and latex were collected from Rubco Coir Mattress Factory, Kottayam. Soil sample was collected from Alappuzha district at a depth of 5M below the surface.CBR test was conducted on the soil sample by placing this composite at 20%, 40%, 60 % & 80% of total depth from the top of the sample. Optimum position for placing the composite was determined. Composite of 150 mm diameter and 8 mm thickness was used to conduct the CBR test

A. Sample collection

Coir fiber and treated latex were obtained from Rubco coir mattress factory, Kottayam. In order to conduct CBR test composite is developed with 150mm diameter and 8mm thickness. Soil sample was collected from Edathua, Alappuzha district.

Table 1: Properties of soil

Property of soil	Laboratory value
Initial moisture content	69.4%
Specific gravity	2.6
Liquid limit	105%
Plastic limit	38%
Plasticity index	67%
Optimum moisture content	29%
Dry density	1.235 g/cc
Percentage of gravel	1%
Percentage of sand	9.9%
Percentage of silt	43.1%
Percentage of clay	46%
Soil classification	MH
UCC	3.869 KN/M^2

B. Development Of Composite

A trial test specimen was developed with 600g of fiber (100mm) and tested. Fibers of length 100 mm was spread uniformly in a bed into which chemically treated latex was sprayed manually to obtain a mat shaped composite. Later, it was kept for oven dried. The oven dried composite was compressed in a mechanical compressor to attain minimum strength and thickness. Chemical treatment of coir fiber was found to be ineffective due to improper bonding of latex to treated coir fiber, hence the treatment was avoided. Coir fibers and treated latex was collected from Rubco Coir Mattress Factory, kottayam. Fig 1 to 7 shows the processes included in the development of composite.

Fig 1: coir fiber is collected

Fig 2: 500g of latex is spreaded

Fig 3: Hydraulic compression

Fig 4: Composite before Compression

Fig 5: Composite after Compression

C. Experimental Programme

Geocomposites are used to improve the strength of Soil. But strength varies with the position of installation of geocomposites .The geocomposites placed at different height show different strength. The depth at which geocomposites shows maximum strength is called optimum depth. The optimum depth is therefore very necessary to obtain maximum strength.

To determine the optimum depth various CBR tests are conducted by placing geocomposites at different height of the sample. The depths are 0.2H, 0.4H, 0.6H and 0.8H where H is the height of the sample from the top. The CBR test can be carried out at optimum moisture content for reinforced soil at 20%, 40%, 60%&80% of the total depth.

III RESULTS

The CBR value is defined as the resistance offered by the soil sample against the penetration of 50 mm diameter plunger penetrating at the rate of 1.25mm/min. CBR of soil sample reinforced at various positions are shown below.

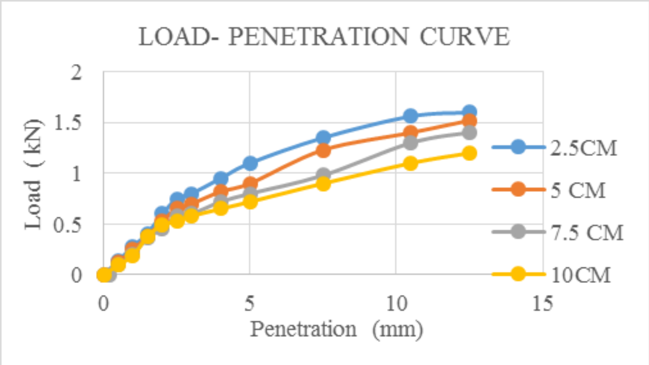

Fig 7: Load –penetration curve for CBR corresponding to composite at various position

CBR values corresponding to each position is shown below (Table 2).

Table 2: CBR values

Position from top	CBR values
With out composite	3.02
At .2H	5.73
At .4H	5.28
At .6H	4.46
At .8H	3.94

By IRC 37:2001 CHART 2 recommends the subbase thickness corrusponging to CBR of unreinfocred and reinfoeced soil with composite at 0.2H depth are shown below.

Table 3: Sub base thickness for unreinforced and reinforced at .2H depth

Sub base thickness	Unreinforced soil	Reinforced at 20% of depth
	300 mm	260 mm

CONCLUSION

In this study position of placing composite is an important factor along with other relevant. By addition of composite strength can be improved and also pavement section can be construct economically due to the reduced thickness

- Inclusion of composite increases CBR of the soil
- Increase in CBR value indicates increase in bearing capacity of soils
- The highest increase in the CBR value obtained when composite placed at 20% depth from the top of the specimen.
- It is possible to reduce the sub base thickness by incooparating the composite at the optimum depth.

REFERENCES

[1] Maliakal teresa and Thiyyakkandi Sudheesh, "Influence of randomly distributed coir fibres on shear strength of clay " Springer ,2013, pp. 425-433

[2] Nehla and Madgi M Zumrawi, "Evaluation Of Geogrids Used For Stabilizing Soft Subgrades"International Journal Of Civil Environmental, Structural, Construction And Architectural Engineering ,2016, volume 10(3).

[3] Biplabkesharimal and Binayakbidyasagar,"Application of Geotextiles in Pavement" International Journal Of Engineering Sciences And Research Technology ,2015,volume 6 (11)

[4] Pardeep Singh and Gill K S, "CBR Improvement Of Clayey Soil With Geogrid Reinforcement"International Journal Of Engineering Technology And Advanced Engineering,2012,volume 2(6)

[5] Murad Y,Abu farsakh and Qiming Che, "Ealuation of geogrid base reinforcement in flexible pavement using cycling plate load testing" International journal of pavement engineering,2011,volume 12 (3).pp.275-288

[6] Perkins, S. W and M. Ismeik. 1997. " Synthesis and Evaluation of Geosynthetic Reinforced Base Layers in Flexible Pavements" Geosynthetics International,1997, 4(6).pp.549–604.

[7] Chaple Parag M and Dhatrak A I,"Performance of Coir fiber Reinforced Clayey Soil" International Journal of Engineering and Science,2010,volume 2 (4).pp.54-64.

[8] Mittal Shelly and Singh R. R."Improvement of local subgrade soil for road construction by the use of coconut coir fiber" International Journal of Research in Engineering and Technology, 2014,volume 3 (5).

[9] Abu-Farsakh, M and Tao, M.,"Laboratory evaluation of geogrid base reinforcement and corresponding instrumentation program" Geotechnical Testing Journal,2009,volume32(6).pp.516–525.

[10] Kim, T. and Tutumluer, E. "Unbound aggregate rutting models for stress rotations and effects of moving wheel loads" Transportation Research Record: Journal of Transportation Research Board,2005, No. 1913, 41–49.

[11] Qi an, Y., Han, J., Pokharel, S. K., and Parsons, R. L., "Stress Analysis on Triangular-Aperture Geogrid-Reinforced Bases over Weak Subgrade under Cyclic Loading," Transp. Res. Rec., 2011,Vol. 2204,pp. 83–91.

[12] Werkmeister, S., Dawson, A. R., and Wellner, F.,"Permanent Deformation Behaviour of Granular Materials," Road Mater. Pavement Des, 2005, Vol. 6, No. 1,pp. 31–51.

[13] Giroud, J. and Han, J., "Design Method for Geogrid-Reinforced Unpaved Roads. I. Development of Design Method," J. Geotech. Geoenviron. Eng., 2004, Vol. 130, No. 8, pp. 775–786.

[14] Talukdar, D. K., "A Study of Correlation Between California Bearing Ratio (CBR) Value with Other Properties of Soil," Int. J. Emerg.Technol. Adv. Eng., 2014, Vol. 4, No. 1, pp. 559–562.

[15] Perkins, S. W., Schulz, J. L., and Lapeyre, J. A., "Local Versus Global Strain Measurement of a Polymeric Geogrid.Journal of Testing and Evaluation, 1997, Vol. 25,No. 6, pp. 576–583.

[16] Meyerhof, G. G., "Ultimate Bearing Capacity of Footings on Sand Layer Overlying Clay," Can. Geotech. J, 1974, Vol. 11, No. 2, pp. 223–229.

[17] Perkins, S. W., Schulz, J. L., and Lapeyre, J. A., "Local Versus Global Strain Measurement of a Polymeric Geogrid. Journal of Testing and Evaluation," J. Test. Eval., 1997,Vol. 25, No. 6, pp. 576–583.

[18] Ashmawy, A. and Bourdeau, P., "Geosynthetic-Reinforced Soils Under Repeated Loading: A Review and Comparative Design Study," Geosynth. Int., 1995,Vol. 2, No. 4,pp. 643–668.