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A Review on Stabilization of Soil Using Coconut Coir Fibre, Lime and PSC

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***Abstract*: Soil is very important in civil engineering constructions. The poor engineering properties of the local soils may present many difficulties for construction and therefore need to improve their engineering properties. Stabilization techniques can be used to improve the properties of soil. Soil stabilization improves various engineering properties e.g., bearing capacity, compressibility, strength, and various other properties of soil. In this research we study the impact of coconut coir fiber to improve the strength of soil. This is aimed at assessing the effects of coconut coir fiber on the stabilization of poor strength soil using 0, 0.5, 1, 2 and 3% of coconut coir fiber by mass of soil sample. In order to achieve our research goal, the following laboratory soil tests must have to carry out on the stabilized soil samples: California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), and Safe Bearing Capacity (SBC).**

***Keywords*: Stabilization of soil.**

1. Introduction

Soil Stabilization is the process of improving the Engineering properties of the soil and thus making it more stable. However, the term Stabilization is generally restricted to processes which alter the Soil material itself for improvement of its properties. Several materials have been used as stabilizers which include lime, coconut husk ash, rice husk, bagasse fibers, chemical additives, coir fibers, and etc. soil stabilization increase the bearing capacity of soil. It helps the black cotton soil to stay stable.

In India, black cotton soil causes issues related to the durability of engineering structures. Hence, to improve its bearing capacity it is need to use the other material which perform method on black cotton soil. Thus, the use of agricultural waste materials such as Coir Fiber will considerably reduce the cost of construction and as well reducing the environmental hazards they cause.

In this study we are studying the nature and behavior of soil with addition of coconut coir fiber. Coconut coir fiber is obtained from the husk of coconut and belongs to the group of hard structural fibers. The fibrous husks are soaked in pits or in nets in a slow-moving body of water to swell and soften the fibers. The coir is purchased from market. It is the fibrous portion of the coconut extracted Mainly from the green nut.

Coir extracted consists of rotting the husk in water and removing the organic material binding the fiber. Diameter is 0.5mm. The coir is cut into pieces of 3cm to 5cm, as those percentage remains 0, 0.5, 1, 2, 3%. Laboratory soil tests must have to carry out on the stabilized soil samples like; California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), and Safe Bearing Capacity (SBC).

2. Literature Review

D. A. Priya, Gopalakrishnan, R., & Jawahar, M. (2017) Stabilization of Black Cotton Soil Using Coir Pith. International Research Journal of Engineering Technology

California bearing ratio tests are conducted on soil samples and on soil Samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith. The tests were carried out on samples prepared under light compaction. The test was carried on samples under unsoaked condition. The CBR Values corresponding to various percentages of coir pith were elaborated in experimental study.

Shukla Devdatt, Rajan Shikha, Saxena A.K., Jha A.K. (2015) Mentioned in his paper that the addition of Coconut coir Fiber into the Expensive soil has changed the compaction parameters. The OMC of the Expensive soil has decreased and the maximum dry density (MDD) increased with the addition of Coconut coir Fiber. The soaked CBR values have also increased significantly with the addition of Coconut coir Fiber content. The addition of 1% Coconut coir Fibre into the Expensive soil, increase the CBR values from 3.9 % to 8.6 %. Length of fibers has an insignificant effect on this soil characteristic, whereas Fiber contents proved more influential and effective. Addition of Fiber resulted in decrease in plasticity and increase in hydraulic conductivity.

T. Subramani, D. Udayakumar (2016), in paper Experimental Study on Stabilization of Clay Soil Using Coir Fiber, conclude that the coir fiber is a waste material which could be utilized in a stabilization of clay soil. The strength of soil-coir mix increases with increasing the percentage of coir Fiber. CBR and UCS values of soil-coir Fiber mix increases with increasing percentage of Fiber. Maximum improvement in U.C.S. and C.B.R. values are observed when 0.5% of coir is mixed with the soil. It is concluded that proportion of 0.5% coir

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Fiber in a soil is optimum percentage of materials having maximum soaked CBR value. Hence, this proportion may be economically used in stabilization of clay soil.

Priyanka, Vishal Kumar and Ved Parkash (2017), mentioned in their research paper Soil Stabilization of Clayey Soil Using Coir Fibre and Lime that the increase in coir fiber percentage the dry density increases up to 0.25% and after the MDD value it starts falling. Though, an increase in OMC has been observed with increase in percentage of coir fiber

Singh and Mittal (2014) conducted an experimental study on clayey soil mixed with varying percentage of coir fiber. Soil samples for unconfined compression strength (UCS) and California bearing ratio (CBR) tests are prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould without and with coir fiber. The percentage of coir fiber by dry weight of soil is taken as 0.25%, 0.50%, 0.75% and 1% and corresponding to each coir fiber content un-soaked and soaked CBR and UCS tests are conducted in the laboratory. Tests result indicates that both un-soaked and soaked CBR value of soil increases with the increase in fiber content. Soaked CBR value increases from 4.75% to 9.22% and un-soaked CBR value increases from 8.72% to 13.55% of soil mixed with 1% coir fiber. UCS of the soil increases from 2.75 kg/cm² to 6.33 kg/cm² upon addition of 1% randomly distributed coconut fiber. Adding of coconut coir fiber results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of natural fiber changes the brittle behavior of the soil to ductile behavior.

Tiwari and Mahiyar (2014) have tested individual behavior of Fly Ash Crushed Glass & Coconut Coir Fiber with soil, which shows that for adding 10%, 15%, 20%, 25% & 30% FA with soil produces highest CBR of value 4 at max 25%, after that curve height decreases gradually. Similarly on adding 3%, 5% & 7% they obtained highest CBR of value 3 .1 at 7% CG after curves falls down enormously. Also, for adding 0.25%, 0.5%, 0.75%, 1% & 1.25%. of CCR we obtained max curve height at CBR value of 3.6 after that curve should successive depletion.

G. Narendra Goud et al (2018) Expansive soil stabilization with coir waste and lime for flexible pavement in it they find Increase in coir pith content cause the reduction in densityand increase in optimum water content

Babu S G L, Vasudevan AK (2008), Use of coir fibre for engineering properties of expansive soil After modification with coir subgrade value They have tested it after modifying it coir subgrade and conduct the California Bearing Ratio Test on it in the laboratory and their research finding arise with coir subgrade value improved with CBR of 8%.

Johnson s,and gopinath B 2016 A study on swell behavior of expansive clays reinforced with saw dust, marble dust and coir pith. While mixing the marble dust and saw dust the typical potential volume change for soil is observed.

Banu R, Lohith H G, Ali D, and Ramya H. N. (2015) Stabilization of Black Cotton Soil Using Coir Pith. Many natural wastes being sent out to environment, Coir Pith is one such waste. Being a natural waste the cost towards the application is very less. After the experiment study made it was found that the Coir Pith can be used as natural stabilizer in improving the properties of Black Cotton soil. However, the application is bounded to minor projects. The study can further be extending by conducting the test in combination with Coir Pith. That is Coir Pith and Lime, Coir Pith and Fly ash etc

D. A. Priya, Gopalakrishnan, R., & Jawahar, M. (2017) Stabilization of Black Cotton Soil Using Coir Pith They observed Increase in percentage of treated coir pith also contributed the increase in CBR value. But increase in the percentage of CBR value by adding untreated coir pith is greater than that of treated coir pith. The proctor compaction and CBR values increased for 2%, 2.5%, 3% and 3.5% of coir pith and the optimum moisture content and maximum dry density of the untreated soil were 12% and 17.46KN/m3. Addition of 2%, 2.5%, 3% and 3.5% of treated coir pith increased the CBR value respectively 4.29, 5.3, 6.57 and7.28%. When compared to the CBR value of untreated coir pith which is about 3.82

Stuti Maurya, A. K. Sharma, P. K. Jain and Rakesh Kumar (2015) Coir fiber is a useful biodegradable waste that improves strength and stiffness of all types of soil coir used in different proportion and different lengths affect the soil properties. Further work can be done on degradation of coir waste

A. K. Raji R. Karthika, G. R. Amruthalekshmi, Anju K. Peter, and M. Mohamed Sajeer (2011) The strength characteristics of the selected subgrade soil in terms of CBR and rut depth were studied in detail through various experiments. Measures were adopted to improve the strength by the introduction of marginal materials. The following conclusions were arrived at from the experiments: i. Wheel Tracking Apparatus can be effectively used for studying the rut failure of pavements simulating the field conditions. ii. The results of rut analysis found to correlate with the CBR values obtained. iii. Stabilisation of black cotton soil with flyash and cement increases its CBR by 300 per cent and decreases the rut depth by 30 per cent. iv. Reinforcing the soil with geotextile can improve the strength characteristics of the soil. It can increase the CBR by 140 per cent and decrease the rut depth by 17 per cent. v. The highest performing subgrade was obtained with the application of flyash, cement and coir geotextile. vi. Equations for mechanistic design approach have been formulated by which the design life of pavement can be estimated

Ankita, P.P., Bahera, D., Bastia, T.K., and Rath, P., (2013) In this work, we have investigated the effect of both untreated and treated jute fiber & coir pith on the mechanical and thermal performance, corrosion and water ingress properties of hybrid BisGMA composites. The fabricated composites exhibited better mechanical properties than BisGMA. HEA treatment of jute fiber and the alkali treatment of coir pith led to improved mechanical and thermal performance of composites including corrosion and water ingress properties. All the properties get enhanced with increasing filler content but only upto 15 wt% beyond which the values decrease. The BTJTCPC15 exhibited optimum improvement in all the above-mentioned properties and can thus be recommended for use in structural purposes specifically for housing projects and members in marine

application in saline environment.

G. Narendra Goud et al (2018) Expansive soil stabilization with coir waste and lime for flexible pavement subgrade

The following conclusions are drawn Increase in coir pith content causes the reduction in density and increase in optimum water content , Addition of lime to expansive soil reduces the swell index and makes the soil to be eligible for use in subgrade, Unconfined compressive strength of the modified soil (expansive soil + lime + coir pith) is in the range of 300 kPa to 380 kPa after 3 days curing, and after 7 days curing it is in the range of 470 kPa to 570 kPa , Combined effect of lime and coir pith inclusion in to the soil causes significant increase in CBR from 1.04% to 9%. , It is a potential technique that can improve the quality of soil from very poor and unsuitable condition to fair and suitable for use in subgrade and reduce the disposal problem of coir pith , After modification with lime and coir pith the soil can be utilised as subgrade for highways with improved CBR of 8% and above.

3. Methodology

The methodology comprises with the following tests are carried out on the soil sample by adding suitable percentages of coir fiber such as 0.5, 1, 2 & 3%, and the following laboratory and field tests are carried out as per IS code recommendation:

1) Particle size distribution
2) Liquid limit test
3) Plastic limit test
4) Shrinkage limit test
5) Plasticity Index
6) Standard proctor test for optimum moisture & maximum dry density
7) Unconfined compression strength test
8) California bearing ratio

4. Material Properties

A. Properties of Coir Fibre

From the literatures, the different fibre extraction processes yield different but also varying qualities of fibres generally 56-65 per cent long fibres of over150 mm (up to 350 mm staple length) and 5-8 per cent short fibres of under 50 mm. The fibre fineness varies between 50 and 300 µm. The fibres are composed of individual fibre cells of about 1 mm length and 5-8 µm diameter. The tensile strength of coir is relatively low when compared to sisal or abaca fibres, but it is less impaired by immersion in water. Coir fibre has the advantage of stretching beyond its elastic limit without rupturing, as well as having the power to take up a permanent stretch. Its resistance to microbial degradation and salt water is unique.

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Table 1
Physical properties of coir fibre

Length in inches	6-8
Density (g/cc)	1.40
Tenacity(g/Tex)	10.0
Breaking Elongation%	30%
Diameter in mm	0.1 to 0.5
Rigidity of Modulus	1.8924dyne/cm^2

Table 2
Chemical properties of coir fibre

Lignin	45.84%
Cellulose	43.44%
Hemi –Cellulose	0.25%
Pectin's and related Compound	3.0%
Water soluble	5.25%
Ash	2.22%

5. Conclusion

Coir fiber is a useful biodegradable waste that improves engineering properties of black cotton soil. Further work can be done on degradation of coir waste. The Engineering properties of soil vary with the addition of coir waste but further studies need to be conducted before its implementation in the field. Processing of coir waste in usable form is an employment generation activity in coir fibre manufacturing units and the effective use of coir waste can uplift rural economy and leads to beneficial effects in engineering construction.

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