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A Study On Soil Stabilization with Jute and Coir in Highway Sub-Grade

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***Abstract*: Many soils in natural state at the construction site are very weak as per structural design load. For improvement soil stabilization methods are applied. Soil stabilization is method of addition of material for enhancing the properties of weak soil. Methods available for the stabilization of soils with materials like cement, lime as additive, chemical stabilization are available. Duty of an engineer is to utilize the waste materials as additives so that waste disposal can be achieved effectively in addition to improvements in soil properties. In this study we used Jute and Coir Husk Ash as stabilized material for soil as these two materials were easily available, cheap and were available in abundance. Highway sub grade plays an important role in distribution of load from upper layers to lower layers safely so its strength and load bearing capacity must to enough to hold the stresses and load. So by using these above mentioned material an effort was made to improve the properties of sub grade soil. Tests like Liquid limit, plastic limit, specific gravity test, standard proctor test, CBR test and unconfined compressive strength tests were conducted. It was seen that OMC and MDD was achieved with 1% replacement with Jute and in case of Coir husk ash it was also with 1% replacement. Compressive strength increase with increase in replacement of Jute and Coir at 1% for both. Same was the case for CBR value.**

***Keywords*: pavements, soil, strength, jute, coir husk ash, percentage.**

1. Introduction

The good connectivity to any part of the country in all seasons is the first step to develop the infrastructure of the nation. The structure of road consists of the formation or sub-grade and the pavement. The structural element of the pavement is the foundation (soiling or bottoming) also called the sub-base of the base. The base may be surfaced either with a concrete or a bituminous surfacing. Sub-grade is an integral part of road pavement structure as it provides support to the pavement as the foundation. The main function of the sub-grade is to give adequate support to the pavement and for this the sub-grade should possess sufficient stability under adverse climate and loading conditions. The formation of waves, corrugations, rutting and shoving in black top pavements are generally attributed to poor sub- grade conditions. These are the main reasons why Improvement in sub-grade has always been an area of concern to highway and geotechnical engineers. In case of a highway, a weak sub-grade results in greater thickness of pavement layer which increases the cost of pavement construction. So in order to keep the thickness of pavement under control and cost effective it is better to make the base that is sub- grade (soil) strong enough to bear the load of above layers and traffic. Soil is a major component of the earth's surface which sustains life. It is made up by the disintegration of rocks due to various environmental processes like changing weather, volcanic action, erosion of rocks by water etc. Some of the various types of soil that are found in our country are alluvial soil, laterite soil, black cotton soil or expansive soil etc. The type and availability of these soils are based upon the climatic and geographical location of a particular area. Apart from helping the plants grow, soil also helps the humans to carry out all the basic activities on it like travelling, construction, agriculture etc. A developing country like India demands rapid growth in its infrastructure i.e., a proper network of roads and buildings for development. All the constructions related to civil engineering, like a simple house or a multi-storey building, a road or a highway, everything is built on the soil. It is very important to check all the engineering properties of the soil like the cohesion, capillarity, permeability etc before starting any constructional work on it because all the soils are not suitable for construction always. Before starting the construction of any project, site selection is the foremost objective of engineering department. One of the main purposes of site selection or investigation is to determine stable and good quality soil where the construction is to be done. It also helps in collecting all the relevant information about soil and its properties. Afterwards, soil with the best quality is selected for construction so that it would result in better structure. Foundation is the main part of any construction and it largely depends upon the type of soil. Foundation soil is the one that carries all the loads of structure and good foundation gives more stability to the structure.

2. Literature Review

Lot of research work has been done related to the research

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work I have opted. I explored various research papers which were related to use of various waste materials in sub grade soil. Before the commencement of methodology and various credentials of my research work, following are some researches that were closely related to my work.

Vidhana, et al., (1997) [1] incorporated coir dust for improving the properties of soil because they are locally available in every state and in most countries, biodegradable and ecofriendly. The tests that were conducted included simply to check the moisture retention capacity of coir in soil and checking enhancement in pore size distribution. Its main research was on sandy soils. The test result indicated the moisture retention of sandy soil progressively increased up to the incorporation ratio of 6.3 % coir dust or 15:1 sand/coir dust (vol/vol) equivalent to 21,000 kg coir dust/ha into sandy soils and there after remained constant upto the incorporation ratio of 20% coir dust (62,000 kg coir dust/ha incorporation into about 10 cm depth) beyond which it increased.

Sivakumar Babu, et al., (2008) [2] used natural fibre (coir) for improving properties of soil because it is easily available, cheap and ecofriendly. The tests that were conducted included Standard Triaxial test, Consolidation, Shear strength test and Swell test. Test result indicated that deviator stress increased up to 2.5% fibre beyond that it became difficult. Swelling got decreased maximum between 1 to 1.5%. Compressibility got decreased maximum at 1.5% fibre.

Praveen Aggarwal, et al., (2010) [3] applied natural fibre (jute) and bitumen for improving properties of soil because jute is easily available and by coating it with bitumen would make it non-biodegradable. The test that were conducted included Procter compaction test and CBR test. Test result from proctor test indicated the diameter change did not show any effect so it was eliminated. It was found at 1% jute fibre MDD was 1.88gm/cc and OMC was 15.5% which was maximum than previous readings. Also at 0.8% jute fibre CBR value increased 3 times as that of soil sample i.e. 5.53%. So overall CBR value of sub- grade soil increased up to 250% with the inclusion of bitumen coated jute fibre.

H. P. Singh, et al., (2013) [4] applied natural fibre (jute) for improving properties of soil because they are cheap, locally available, biodegradable and eco-friendly. In this study the soil samples were prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould with and without reinforcement. Tests result indicates that CBR value of soil increases with the increase in fibre content. It was also observed that increasing the length and diameter of fibre further increases the CBR value of reinforced soil and this increase is substantial at fibre content of 1 % for 90 mm fibre length having diameter 2 mm. Thus there is significant increase in CBR value of soil reinforced with Jute fibre and this increase in CBR value will substantially reduce the thickness of pavement sub-grade.

R. R. Singh, et al., (2014) [5] made use of coir fibre for improving the properties of soil because they are cheap, locally available, biodegradable and eco-friendly. The test that were conducted included CBR test and UCS test. Test results indicated that both soaked and unsoaked CBR value of soil increases with increase in fibre content. Soaked CBR value increased from 4.75% to 9.22% and unsoaked value increased from 8.72% to13.55% of soil mixed with 1% coir fibre.UCS of soil increased from 2.75kg/cm to 6.33kg/cm upto addition of randomly distributed coir fibre. Adding of coconut fibre results in less thickness of fibre as CBR value has increased.

Jadhav, and Kulkarni, (2014) [6] premeditated the feasibility study of Improving Properties of Black Cotton Soil Using Industrial Wastes. The studies revealed that stabilization using industrial wastes from 0% to 60% saves the natural materials. The pavement thickness for stabilized road is reduced by 280 mm and cost saving is 21.91% with respect to flexible pavement of 1km road length. It is economical to construction as well as maintenance of road.

Akhtar Hossain, et al., (2015) [7] made use of natural fibre (jute) and bitumen for improving properties of soil because jute is easily available and by coating it with bitumen would make it non-biodegradable. The test that were conducted included Procter Compaction test and CBR test. Test result indicated that inclusion of jute fibre reduces the maximum dry density and increases the optimum moisture content for each length and diameter of jute fibre. Test results for CBR test indicated that CBR value of soil increases with the increase in length of jute fibre. It was also observed that increasing the diameter of jute fibre further increases the CBR value of reinforced soil, and this increase is substantial at fibre content of 1.2% for aspect ratio of 3.75 (length = 30 mm, diameter = 8 mm).

Kunal R. Pokale et al., (2015) [8] carried out an experimental investigation for Stabilization of Black Cotton soil by using waste material-Brick Dust. On the basis of experimental test results, it is observed that the moisture content (MC) reduces after 7 days and 28 days results respectively. MC of 30% BD is reduces to 26.46%. Hence replacement of brick dust is more effective.

Subramani, et al., (2016) [9] incorporated natural fibre (coir) for improving properties of soil because they are easily available, cheap and ecofriendly. The tests that were conducted included Consolidation test, Permeability test, Direct Shear test and Unconfined Compression test. Test result indicated that CBR and UCS values of soil-coir Fibre mix increases with increasing percentage of Fibre and maximum improvement in U.C.S. and C.B.R. values are observed when 0.5% of coir is mixed with the soil. Also the strength of soil-coir mix increases with increasing the percentage of coir Fibre.

Bipin Prajapati et al., (2016) [10] carried out the stabilization on silty sands using marble dust and used foundry sand as stabilizing agents. The mix involved utilization of foundry and marble dust separately with the soil starting from 5% up to 30% with a difference of 5. The testing procedure involved tests like the California Bearing Ratio test, Standard Proctor Test, Hydrometer analysis, Particle Size Distribution, Liquid Limit and Plastic Limit. For the CBR testing results it was observed that the foundry sand helped in increasing the CBR value of the soil while with the addition of marble dust the CBR value decreased. The maximum CBR value i.e. 6.8%, of the soil was achieved with addition of 30% foundry sand by weight of soil as against 4.82% of the normal soil. While the CBR value

decreased to 4.3% from 5% with the addition of marble dust. At 30% addition of marble dust the CBR value was found to be least. Thus it is very clear that foundry sand proved to be a better stabilizing agent for the soil as compared to the marble dust.

Shwetha Prasanna, et al., (2017) [11] incorporated natural fibre (coconut shell ash) for improving the properties of soil as it is an agricultural waste, cheap and s readily available. The test that were conducted included Atterbergs limit test and Compaction test. Test result were of two different samples out of which from Sample 1 maximum plasticity index, liquid limit (approx.) was achieved at 2% and also maximum plastic limit was obtained at 10% coconut shell ash reinforcement. For sample 2, it was observed that maximum plasticity index, liquid limit and also plastic limit were obtained at 5% coconut shell ash as reinforcement. Then regarding compaction for sample 1, by comparing results from all the graphs, it was found that, at 0.8% ash achieved maximum improvement of MDD and OMC. For sample 2, it was observed from the results of graph that, 0.4% to 0.6% of coconut shell powder reached max improvement of MDD and OMC.

Bharatidevi, et al., (2019) [12] had added natural fibre (jute and coir) for improving the properties of soil because both are agricultural waste, cheap and easily available. The tests that were conducted included Atterbergs limit test, Proctor Compaction test, Shear test and UCS test. Test result indicated for Jute maximum OMC and minimum MDD was obtained at 1% of fibre but for Coir it was at 1.5%. For UCS test maximum value for both the fibres was found at 1%. Similar thing happened in case of Shear strength in which maximum value was found at 1% for both the fibres.

Tanu Kumari and Er. Neeraj Kumar (2019) [13] performed on three different types of soils that are generally available in Haryana. These are ML type (silts of low plasticity collected from Shahbad), CL type (clays of low plasticity collected from Ambala) and SM type (silty sands collected from Kala aamb (Ambala)). The laboratory investigations are carried out with a view to improve CBR value of the soils. The admixtures used with the soils include slaked lime (available in powder form) and fly-ash (source thermal power plant Jagadhari). The results of the study are applicable for the given types of soils and given admixture as used in study. The methodology and procedure used for conducting the study however, being general in nature can be applied to any other soil and admixture having similar properties. Investigations include evaluation of properties like specific gravity, gradation, Atterberg's limits, and wet sieve analysis, maximum dry density (MDD), optimum moisture content (OMC) and California Bearing Ratio (CBR) value of the selected soils. The lime and fly ash are mixed separately with the each of the soils at 4%, 7%, and 10% by the weight of dry soil.

Shwetha Prasanna, et al., (2020) [14] had applied jute fibre for enhancing the properties of soil because they are locally available, biodegradable and ecofriendly. The tests that were conducted included CBR test, modified Compaction test and Atterbergs test. Test result included that, at 0.5% to 1% of jute fibre, increment of MDD and OMC was achieved. but overall, it was concluded that inclusion of jute fibre reduces the MDD and OMC. By comparing the results of direct shear tests it was concluded that angle of internal friction and cohesion is achieved at the range of 1% to 2% of jute fibre. In direct shear strength, cohesion, increase with increasing fibre content until reaching a fibre content of 1%, after which slight decrease in cohesion could be observed because fibre content tends to reduce fibre-reinforcing effects due to the replacement of soil particles by too many fibres by comparing the results of CBR it was observed that maximum improvement in California Bearing Ratio values is observed between 1% to 2% of jute fibre as reinforcement.

All above mentioned research work were used for this research.

3. Methodology

A. Selection of Materials

To increase the strength of subgrade soil material selection is very vital and crucial part. Materials choose were based on availability and cost. Samples were prepared from the mixture of Soil, Jute and Coir Husk Ash.

The various materials used for carrying out the project work with their particular type used and the source from which they were obtained are given in the following table as under:

Table 1
Materials used

S. No.	Material	Type
1	Soil	Obtained from local area
2	Jute	Obtained from local vendor
3	Coir Husk Ash	Obtained from local vendor

The properties of the additives in this research work are as under:

Table 2
Properties of the additives

Properties	Results
Color	Brown
Specific gravity	0.72
Diameter(mm)	0.18-0.27

Table 3
Properties of jute

Properties	Results
Color	Yellowish brown
Specific Gravity	1.12
Diameter (mm)	2-9
Hemicellulose(%)	83-88
Lignin (%)	11-14
Wax (%)	0.4 to 0.81
Ash (%)	0.5 to 1.05
Nitrogen (%)	0.4

B. Test Results

The test results that were conducted for the research work showed the following results:

Specific Gravity:

Specific gravity of natural soil is 2.64

Liquid Limit (LL):

Liquid limit of natural soil is 35.86%.

Plastic Limit (PL):
Plastic limit of natural soil is 15.58%

Plasticity Index (Pi):
Plasticity Index of natural soil = (Liquid Limit- Plastic Limit)
= (35.86 % - 15.58 %)
= 20.28%

Proctor Compaction Test:

Table 4
Water Content and Dry Density for natural soil

S. No.	Sample	Dry density	Optimum moisture content
1	Nature of soil	1.89	15.30
2	**1% addition of jute**	**1.81**	**16.20**
3	2% addition of jute	1.76	17.10
4	3% addition of jute	1.68	18.50
5	4% addition of jute	1.51	19.90
6	**1% addition of coir**	**1.74**	**16.10**
7	2% addition of coir	1.68	16.80
8	3% addition of coir	1.59	17.50
9	4% addition of coir	1.42	18.10

California Bearing Ratio:

CBR Value for soil sample on addition of various percentages of Jute and Coir (Unsoaked condition).

Table 5
CBR Value for soil sample on addition of various percentages of Jute and Coir (Unsoaked condition)

S. No.	Sample	CBR value(%)
1	Natural soil	4.32
2	**1% addition of jute**	**9.78**
3	2% addition of jute	7.52
4	3% addition of jute	5.84
5	4% addition of jute	3.32
6	**1% addition of coir**	**10.58**
7	2% addition of coir	9.65
8	3% addition of coir	7.51
9	4% addition of coir	5.63

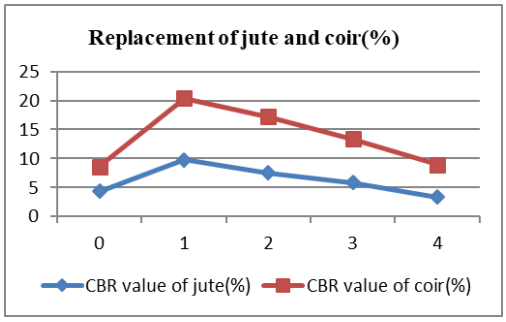

Fig. 1. Replacement of jute and coir

Table 6
CBR Value for soil sample on addition of various percentages of Jute and Coir (Soaked condition)

S. No.	Sample	CBR Value %
1	Natural soil	1.89
2	1% addition of jute	5.67
3	2% addition of jute	4.25
4	3% addition of jute	2.36
5	4% addition of jute	1.23
6	1% addition of coir	7.25
7	2% addition of coir	6.58
8	3% addition of coir	5.34
9	4% addition of coir	3.26

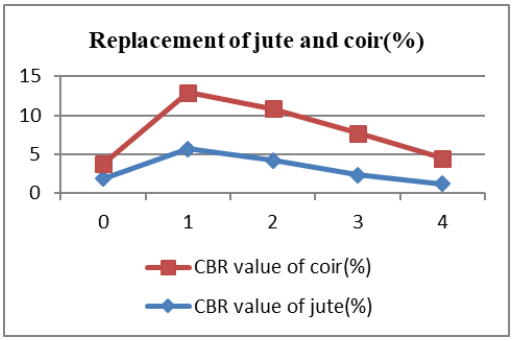

Fig. 2. Replacement of jute and coir

Table 7
Unconfined compressive strength with different percentage

S. No.	Sample	Unconfined compressive strength (kpa)
1	Natural soil	178.69
2	**1% addition of jute**	**290.23**
3	2% addition of jute	270.65
4	3% addition of jute	241.36
5	4% addition of jute	190.41
6	**1% addition of coir**	**284.69**
7	2% addition of coir	261.36
8	3% addition of coir	220.78
9	4% addition of coir	180.91

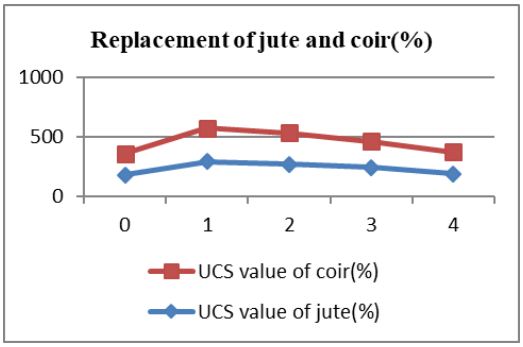

Fig. 3. Replacement of jute and coir

4. Conclusions and Scope of Work

Following conclusion made from outcomes:

- The MDD came maximum at 1% replacement in both conditions while OMC increased with the increase in percentage of both jute as well as coir.
- Maximum CBR value achieved on addition of 1% of jute as well as coir.
- The optimum value of UCS test obtained as 290.23 kPa and 284.69 kPa on 1% addition of jute and coir.

Use of waste materials make this study ecofriendly and also reduced the load of waste material on environment.

Scope of Work:

We have studied the effect of Jute and Coir Husk Ash on Clayey soil and the results have been encouraging. Only Compaction characteristics, CBR and unconfined compressive strength of the treated soil were studied. In future all the aspects can be studied in great detail and that would prove to be a success in the context of utilization of waste material.

Studies that can be undertaken,

- To study the compressibility characteristics of treated soil when Jute and Coir are added.
- To make use of new waste material for improvement.

References

[1] L. P. Vidahana and L. L. Somarsiri, "Use of coir dust on the productivity of coconut on sandy soils", 1997.

[2] Shivkumar Babu, Vasudevan and Sayida, "Use of Coir Fibres for improving the Engineering Properties of Expansive soils", Journal of Natural Fibres, vol. 5(1), 2008.

[3] Praveen Aggarwal and Bajinder Sharma, "Application of Jute Fibre in the Improvement of Sub-Grade Characteristics", Amsterdam Centre for European Ethnology, 2010.

[4] H. P. Singh and M. Bagra, "Improvement in CBR Value of Soil Reinforced with Jute Fibre", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, August 2013.

[5] Kumar A., Kumar R. and Singh B., "Effect of Waste Materials on Strength Characteristics of Local Clay", International Journal of Civil Engineering Research, 2014.

[6] Jadhav S. T. and Kulkarni S. S., "Feasibility Study of Improving Properties of Black Cotton Soil Using Industrial Wastes", Current Trends in Technology and Science, Volume 3, Issue 4, 2014.

[7] Akhtar Hossain, Shakhawat Hossain and Kamrul Hassan, "Application of jute fibre for the Improvement of sub-grade characteristics", American Journal of Civil Engineering, Vol. 3, February 2015.

[8] Pokale K. R., Borkar Y. and Jichkar R. R., "Experimental Investigation for stabilization of black cotton soil by using waste Material-Brick dust", International Research Journal of Engineering and Technology, vol. 2, 2015.

[9] T. Subramani and D. Udayakumar, "Experimental Study On Stabilization of Clay Soil Using Coir Fibre", International Journal of Application or Innovation in Engineering & Management, Vol. 4, May 2016.

[10] Prajapati B, A. K., Tiwari R. P. and Singh N. K., "Comparative Study of used foundry sand and marble dust on geotechnical properties of Silty Soil", International Research Journal of Engineering and Technology, May 2016.