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SOIL STABILIZATION USING JUTE AND HUMAN HAIR FIBER

ANJANADEVI K.A[1], AZHAR RAHMAN A.R[2], MERINE GEORGE[3], SOUMYA MARKOSE[4], SRUTHI M.G[5]

[1,2,3,4]B.TECH Student, Department of Civil Engineering , ILM College of Engineering and Technology, Kerala, India
[5]M.TECH, Assistant Professor, ILM College of Engineering and Technology, Kerala, India

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Abstract – *Generally clayey soil exhibits undesirable engineering properties like poor bearing capacity and higher compressibility. Thus the improvement of soil at a site is indispensable. There are many stabilizers to improve the strength of soil like jute, gypsum, fly ash, Rice-husk ash, Cement, lime, used rubber tyres etc. In the present study, we added jute and human hair as stabilizer to improve the properties of clayey soil. Marine clay available in the coastal area of Ernakulam district is used in this study. The objective of this study is to improve the strength of the clayey soil by making soil-jute and hair mixture. The soil sample are prepared by adding 0%, 0.5%, 1%, 1.5% of jute with length of 2cm and hair in varying percentages such as 0.5%, 1%, 1.5%, 2%. Standard proctor test, unconfined compressive strength test, Atterberg's limit test, California bearing ratio test are conducted to analyze the Optimum moisture content (OMC), Maximum dry density (MDD), compressive strength of soil mixture, index properties and also subgrade strength. By the addition of jute and hair maximum dry density, unconfined compressive strength, California bearing ratio values increases and optimum moisture content, liquid limit values decreases.*

***Key Words*: Jute, Human hair fiber (HHF), UCC test, Proctor compaction test, CBR test, Atterberg's test, Clayey soil.**

1. INTRODUCTION

A developing country like India which has a large geographical area and population, demands vast infrastructure i.e. network of roads and buildings etc. Everywhere land is being utilized for various structures from ordinary house to sky scrapers, bridges to airports and from rural roads to expressways. Almost all the civil engineering structures are located on various soil strata. Soil can be defined as a material consisting of rock particles, sand, silt, and clay. Transportation of soil materials by wind, water and ice forms different soil formations such as those found in river deltas, sand dunes and glacial deposits. In India, soils are classified into six groups namely alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, desert soil and boulder deposits. Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives. The different types of methods used for soil stabilization are: Soil stabilization using cement, Soil stabilization using lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of stabilization that is stabilization of soil by using Geo textiles and Geo synthetic fibers.

Primary and secondary binders form cementitious composite material when they come in contact with the water or in the presence of pozzolanic material reacts with water. The commonly used binders are Cement, Lime, Gypsum, Jute, Hair, Flyash etc. The above materials can be used alone or in combination. This Thesis makes the use of Jute and hair with clayey soil.

2. MATERIALS USED

In this project the material used as stabilizer is jute and Hair fiber. The test were conducted by adding jute and hair in varying percentages to the parent soil. Also it is experimentally proved that the soil changes its property by adding jute and hair as soil stabilizer.

2.1 Jute

Jute is collected from coir factory in Alapuzha district. Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. Jute is one of the most affordable natural fibers and is second only to cotton in amount produced and variety of uses of vegetable fibers. The jute is treated chemically, the chemical surface treatments provide mechanical interlocking between the fiber and polymer by increasing the surface roughness of jute fibers. In addition, the surface modification also provide numbers of chemical bonds formed in the interface by increasing the number of functional groups on fiber surface.

2.2 Human Hair

The human hair is collected from both saloons and hair stylist shop. It is a non-biodegradable material, while it is directly disposed into soil the soil get polluted. The HHF is a best stabilizing agent to use as a soil stabilizer. In this study we are going to use this material as a strong reinforced material which is used to enhance the subgrade strength for clayey soil which is quite soft in nature.

2.3 Soil

Nearly 200 kg of marine clay was collected from Kuzhipilly beach and it is thoroughly hand sorted to eliminate the all vegetative matters, boulders and pebbles. Then the clayey soil was sieved through 4.75mm sieve so as to remove the

gravel fraction. Then the soil was oven dried for 24 hours before execution of various geotechnical tests.

Table-1: Properties of soil

Properties	Values
Specific gravity	2.40
Plastic limit	33.33%
Liquid limit	45.5%
Plasticity index	12.17%
MDD	1.250g/cc
OMC	25%
CBR	5.0%
UCC	0.286
Soil classification	SC

3. METHODOLOGY

In this project, we are adopted jute and hair as soil stabilizer. Beside using as a stabilizer jute have many uses such as clothing, bags etc. Also hair is a waste product which is locally available in our surrounding areas. Jute is added in varying percentages such as 0%, 0.5%, 1%, 1.5% and hair in 0.5%, 1%, 1.5%, 2%. Clayey soil is mixed with different proportions of jute and hair, then we have performed various tests like proctor compaction, Atterberg's limit, Unconfined compression, California bearing ratio tests.

Step 1- Collection of raw materials

Step 2- Test on soil

Specific gravity, Grain size analysis, Sieve analysis, Hydrometer analysis, Atterberg's limit, California bearing ratio test, Proctor compaction, Unconfined compression test.

Step 3- Experimental programme

a. Proctor compaction

b. Atterberg's limit

c. Unconfined compression

d. California Bearing ratio

4. TEST RESULT

4.1 Proctor Compaction Test

Proctor compaction test was done based on IS 2720 part VII, varying percentage of jute and hair fiber were added to the parent soil and mixed thoroughly. These test result shows the maximum dry density and optimum moisture content of the soil.

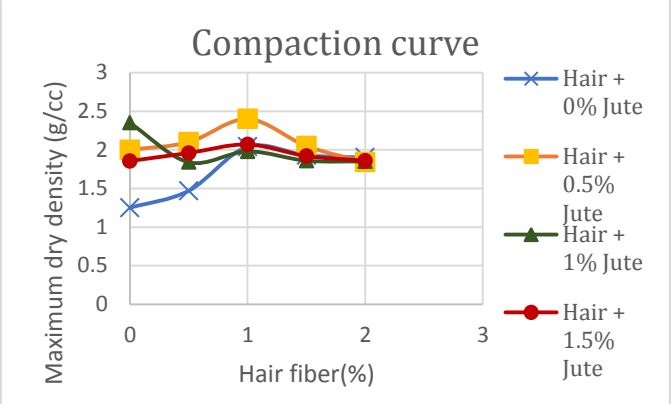

Fig-4.1: Graph Showing Maximum Dry Density Relationship with Different Percentage of Hair Fibers and Jute Mixed with Parent Soil

Table-4.1: Maximum dry density of marine clay with different percentage of hair fiber and jute.

Jute / Hair	0%	0.5%	1%	1.5%
0%	1.250	2	2.35	1.856
0.5%	1.47	2.1	1.84	1.96
1%	2.04	2.4	1.98	2.07
1.5%	1.93	2.05	1.86	1.92
2%	1.9	1.84	1.85	1.86

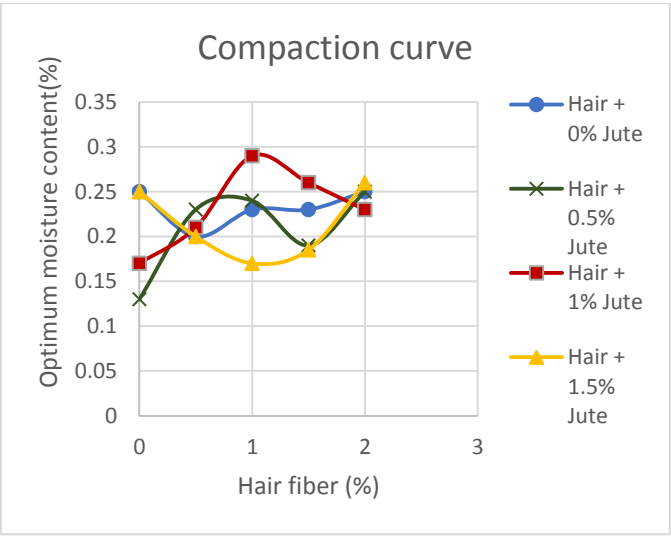

Fig-4.2: Graph Showing Optimum Moisture Content Relationship with Different Percentage of Hair Fibers and Jute Mixed with Parent Soil

Table-4.2: Optimum moisture content of marine clay with different percentage of hair fiber and jute.

Jute / Hair	0%	0.5%	1%	1.5%
0%	0.25	0.13	0.17	0.25
0.5%	0.2	0.23	0.21	0.2
1%	0.23	0.24	0.29	0.17
1.5%	0.23	0.19	0.26	0.185
2%	0.25	0.25	0.23	0.26

It was found that on increasing the percentage of jute and hair, the dry density of marine clay increases and moisture content decreases. The maximum dry density was 2.4g/cc and is obtained at range of 1% hair and 0.5% jute. And the corresponding moisture content is 24%.

4.2 Atterberg's Limit Test

The Atterberg's limits are a basic measure of the critical water contents of a fine grained soil, the test was conducted according to IS 2720 Part V. The soil sample mixed with different percentage of jute and hair fiber are used for the testing.

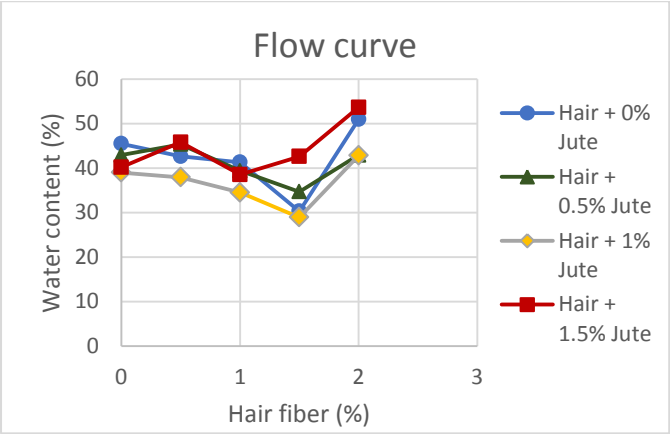

Fig-4.3: Graph showing Liquid limit of marine clay with different percentage of hair and jute fiber mixed with it.

Table-4.3: Liquid limit values for marine clay with different percentage of hair and jute fiber

Jute / Hair	0%	0.5%	1%	1.5%
0%	45.5	42.93	39.02	40.2
0.5%	42.63	45.336	37.93	45.83
1%	41.32	39.402	34.521	38.54
1.5%	30.322	34.693	28.93	42.62
2%	50.94	42.93	42.83	53.64

The result shows that, the water content decreases with inclusion of fiber content. The lowest value obtained is 28.932% achieves at ratio of 1% jute and 1.5% hair and it is lower than 45.5% with 0% of fiber content.

4.3 Unconfined Compression Test

The unconfined compression test was conducted according to IS 2720 part X. It is used to determine the compression strength of the soil. Also we analyze the change in properties of soil with addition of jute and hair in the soil sample in different proportions.

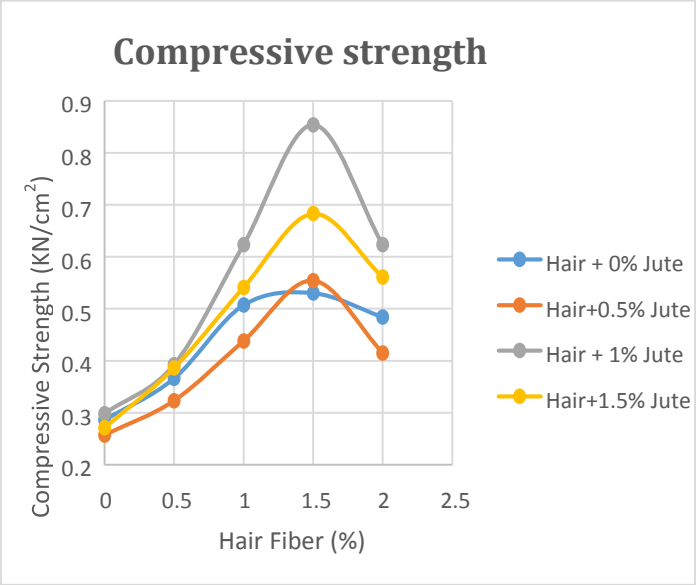

Fig-4.4: Graph showing the unconfined compressive strength of marine clay with different percentage of hair and jute fiber mixed with it.

Table-4.4: Unconfined compressive strength of marine clay with different percentage of hair and jute

Jute / Hair	0%	0.5%	1%	1.5%
0%	0.286	0.257	0.298	0.271
0.5%	0.366	0.323	0.392	0.386
1%	0.507	0.438	0.623	0.541
1.5%	0.53	0.554	0.854	0.683
2%	0.484	0.415	0.623	0.561

The unconfined compressive strength of parent soil was 0.286 and by the addition of jute and hair the unconfined compressive strength of soil increases to 0.854 and it is obtained at 1.5% hair with 1% jute.

4.4 California Bearing Ratio Test

The California bearing ratio test was conducted according to IS 2720 Part XVI. The test was conducted to determine the subgrade strength, CBR is a penetration test. The sample with varying percentage of jute and hair fiber is used for testing.

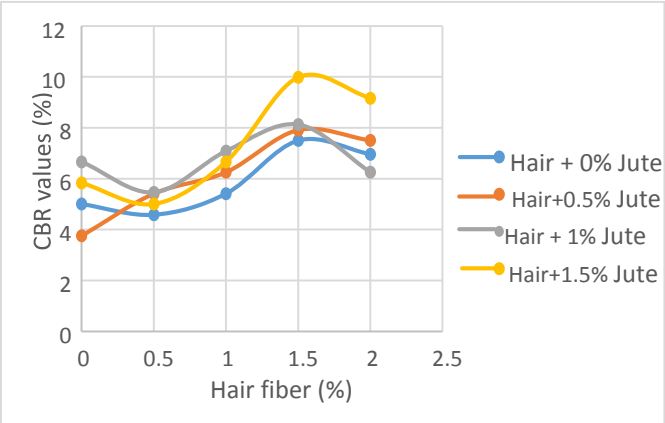

Fig-4.5: CBR curve at 2.5mm penetration for different percentage of hair and jute fiber.

Table-4.5: CBR values at 2.5mm penetration for different percentage of hair and jute fiber.

Jute / Hair	0%	0.5%	1%	1.5%
0%	5%	3.88%	6.91%	5.94%
0.5%	4.58%	5.41%	5.46%	5%
1%	5.41%	6.25%	7.08%	6.66%
1.5%	7.5%	7.91%	8.12%	9.98%
2%	6.96%	7.5%	6.25%	9.16%

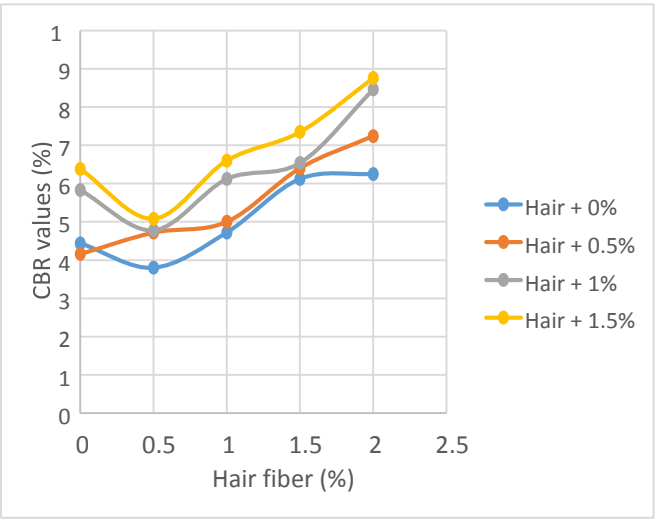

Fig-4.6: CBR curve at 5 mm penetration for different percentage of hair and jute fiber.

Table-4.6: CBR values at 5 mm penetration for different percentage of hair and jute fiber.

Jute / Hair	0%	0.5%	1%	1.5%
0%	4.44%	4.28%	5.92%	6.39%
0.5%	3.8%	4.72%	4.78%	5.12%
1%	4.72%	5%	6.12%	6.6%
1.5%	6.12%	6.4%	6.54%	7.54%
2%	6.25%	7.24%	8.76%	8.76%

Initially the CBR value of marine clay at 2.5mm penetration was 5%. When jute and hair is added to marine clay, the California bearing ratio value increases to 9.98%, it is obtained at the range of 1.5% Hair with 1.5% Jute. Hence it will provide subgrade strength.

5. CONCLUSIONS

It is inferred from the study that in regions where marine clay is encountered, the construction of buildings and roads are highly risky on geotechnical grounds as the soil is highly compressible, possessing low shear strength and is susceptible for volumetric instability. The jute fiber has the potential of being used to serve as a filter fabric as well as a fabric reinforcement to stabilize and protect weak subgrades. The engineering properties of jute are suitable for separation, reinforcement, drainage and filtration function and can be suitably used in overcoming geotechnical problems of weak soil. Based on test results and investigation conducted on soil sample the following conclusion were given, it may be concluded that human hair and jute fiber can be used as a natural reinforcement agent for stabilization of marine clay. Human hair has good strength properties, low cost, high toughness to biodegradability.

- The maximum dry density of marine clay is found to be increased by adding jute and hair fibre. The Maximum dry density of parent soil is 1.250g/cc. Maximum dry density of combined jute and hair fiber mixed soil was 2.40g/cc. It is obtained at the range of 0.5% jute and 1% hair. The percentage increased by 92%.The corresponding moisture content was 24%, it shows that optimum moisture content of soil decreases.
- The liquid limit of marine clay is 45.5% which is not suitable for construction purpose. By the addition of 1.5% hair and 1% jute, the liquid limit was decreased upto 28.932%.
- The unconfined compressive strength of parent soil is 0.30KN/cm^2.From the result, it shows the

unconfined compressive strength of marine clay increased to 0.854 KN/cm^2.

- It is concluded that CBR value of soil increases with the inclusion of jute and hair fibre. When the content of fibres is increased, the CBR value of soil further increases and this increase is remarkable at fibre content of 1.5% hair and 1.5% jute. The increment of CBR value is from 5% to 9.98%. Thus it will provide subgrade strength.

- Adding jute and hair in between layers of soil strengthens its interlocking ability among soil particles, thus, providing a strong bond to it.

REFERENCES

1. Atul Krishna Takur, Haris Sheikh, (2018), "Soil Stabilization Using Human Hair Fibre", *International journal for emerging research and development,* Vol.1, Issue 2, pp.89-94.

2. Maari Srinivas Reddy, Kodela Rishi Kumar, (2018), "Pavement Evaluation and Application of Geo Textiles in Pavement", *International journal of research,* Vol.7, Issue 8, pp.417- 421.

3. Shahid Mohammed Khan, Shivakumar R.H, (2017), "Role of Geo Grid in Enhancing the Bearing Capacity of Soil", *IJESC*, Vol.7, Issue 5, pp.11295-11298.

4. S Sugandhini, Dr. M. Madhuri, (2017), "Stabilization of Soils Using Geosynthetics", *IJARIIE*, Vol.3, Issue 6, pp.1118-1131.

5. Ujwal Mishra, (2017), "Human Hair Fibre: A Discrete fibre to improve soil subgrade strength: A Review", *International journal of innovative Research and advanced studies*, Vol.4, Issue 3, pp.339-343.

6. Aamir Farooq, Prof.Dr.Rajesh Goyal, (2017), "Stabilization of Soil By Use of Geo-Jute as Soil Stabilizer", *IRJET*, Vol.4, Issue 8, pp.1654-1665.

7. Anzar Hamid, Huda Shafiq, (2017), "Subgrade Soil Stabilization Using Jute Fibre as a Reinforcing Material", *IJEDR*, Vol.5, Issue 1, pp.74-80.

8. Harshita Bairaghi, R.K Yadav, (2017), "Effect of Jute Fibre on Engineering Characteristics of Black Cotton Soil", *International journal of research*, Vol.1, Issue 3, pp.1-7.

9. Swapan Kumar Ghosh, Murari Mohan, (2017), "Potential Application of Open Weave Jute Geotextiles in Meeting Geotechnical Difficulties", *3rd International conference on natural fibres (ILSEVIER),* pp.200-205.

10. K Shankar Narayanan, S Mary, (2017), "Stabilization of Clay with Human Hair Fiber", *International journal of civil engineering and technology*, Vol.8, Issue 4, pp.662-667.

11. Yagya Sharma, Dr.Sunil Sharma, (2017), "Improvement of Soil Properties by Using Jute Fibre as Soil Stabilizer", *American Journal of Engineering Research (AJER),* Vol.6, Issue10, pp.123-129.

12. Rishi Srivastava, Shalinee Shukla, (2016), "Effect of Woven Polyster Geotextile on the Strength of Black Cotton Soil", *IJIRSET*, Vol.5, Issue 7, pp.12402-1240.

13. Amit Kumar Singh, R.K Yadav, (2016), "Improvement in CBR of Expansive Soil with Jute Fiber Reinforcement", *International Research Journal of Engineering and Technology*, Vol.3, Issue 11, pp.767-771.

14. R.Thirumalai, Dr. S. Suresh Babu, (2016), "Influence of Geosynthetics on Different Types of Soils", *IJCIET*, Vol.7, Issue 6, pp.149-155.

15. Prakash Patil, Harini H. N, (2016), "An Innovative Method of Improving Subgrade Strength of Soft Soil Using Human Hair Fibers as Reinforcement", *IJSRSET*, Vol.2, Issue 4, pp.551-554.

16. Leema Peter, K Balan, (2016), "Laboratory Investigation in the Improvement of Subgrade Characteristics of Expansive Soil Stabilised with Coir Waste", *ELSEVIER*, pp.558- 566.

17. Treasa Maliakal and Sudheesh Thiyyakkandi, (2012), "Influence of randomly Distributed Coir Fibers on Shear strength of Clay", *Journal of Geotechnical and Geological Engineering,* pp.425 - 433.

18. Abd el Megeed Kabasy Mohamed, (2012), "Improvement of Swelling Clay Properties Using Hay Fibers", *Journal of Engineering Sciences*, Vol.40, Issue 5, pp.1337-1349.

19. Omidazadegan, E Akbari, (2012), "Influence of palm fiberin soil stabilization", *International conference on Applied Science on Engineering*, Vol.8, Issue 4, pp.2027-2035.

20. A.R Estabragh, A.T Bordhbar and A.A Javadi (2011), "Stabilization of soil using nylon fiber" *International Journal of Research,* Vol 3, issue 2, pp.330-34