

Soil Stabilization of Clayey Soil Using Jute Fibre and Gypsum

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ABSTRACT: Generally clay has undesirable engineering properties like low bearing capacity and high compressibility. Thus the improvement of soil at a site is necessary. 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 as stabilizer and gypsum as additive to improve the properties of Expansive soil. Locally available expansive soil is used in this study. The objectives of this study are to improve the strength of the expansive soil by making soil- jute and soil-jute-gypsum mixture. Twelve specimens are prepared to investigate the properties of soil out of which four specimens are prepared by adding 0.5%, 1%, 1.5% and 2% of jute with length of approximately 2cm and the remaining specimens are prepared by adding 5% and 10% gypsum in each of the above sample with approximate length of 2cm of jute. Standard proctor test and unconfined compressive strength test are conducted to analyze the optimum moisture content (OMC), Maximum dry density (MDD) and compressive strength of soil mixture.

KEYWORDS: OMC, MDD, Compaction, Fibre, UCS, Gypsum.

I. INTRODUCTION

Many part around the globe such as India, U.S.A. Egypt etc. are facing problems in construction work due to clayey soil. Damage to the light structures and road pavement has been reported. Replacement of soil with suitable one and disposal of the former is costly process and this is critical in developing country like ours where construction cost is quite high.

Moreover pavement on clayey soil requires a greater thickness of base and sub-base course which results increases the expenditure of project. To set right this problem it becomes mandatory to increase the strength of the soil which in-turn will help in lessening the thickness of the pavement layers and thus project cost.

Two common additives which are widely used in stabilizing the soil are cement and lime. Lime is preferred over cement stabilization because lime is cheaper than cement and Carbon-Di-Oxide (CO₂), which causing detrimental to the environment, is emitted during the production of cement. Lime stabilization is requires adequate clay content and a relatively high curing temperature and hence it is more suitable for tropical and sub-tropical countries like India. Cement is generally used where clay content in soil is comparatively less and the temperature is relatively less. Researches are going on for alternative by-products to cement and lime which not only satisfy the engineering requirements and cause no pollution but also be cost effective.

Present thesis makes the use of both Jute and Gypsum with soil and finds the changes in the soil properties.

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II. OBJECTIVE OF THE STUDY

The study is focused on

1. Improvement of locally available soil using some eco-friendly and cheap waste materials.
2. Evaluation of strength characteristics of virgin as well as blended soil using different percentage of jute and gypsum.
3. Determination of appropriate jute and gypsum content ratio to achieve the maximum gain in strength of soil.

III. MATERIAL COLLECTION

SOIL

Nearly 50 Kg of locally available clayey soil was collected from Kurukshetra and thoroughly hand sorted to eliminate the vegetative matters and pebbles. Then the soil was sieved through 4.75mm sieve to remove the gravel fraction. Soil was oven dried for 24 hours before execution of geotechnical tests.

Table 1. Physical Properties of Soil

S. No.	Parameters	Result
1.	Light Compaction Test	
	I. MDD (gm/cc)	1.62
	II. OMC (%)	24.4
2.	Liquid Limit (%)	49.67
3.	Plastic Limit (%)	20.69
4.	Plasticity Index (%)	28.98
5.	Specific Gravity	2.67
6.	Indian Soil Classification	CI

JUTE

Jute Fibres have been purchased from the market of Kurukshetra. The Fibres are cut into pieces of approximately 20mm lengths and are mixed in percentage of 0.5%, 1%, 1.5% and 2% by dry weight of soil.

Table 2. Properties of Experimental Fibre

Property	Range/Value
Fibre length, mm	20 mm
Fibre Diameter, mm	0.3 – 0.45
Specific Gravity	1.3
Bulk Density, Kg/m ³	1300
Ultimate tensile strength, N/mm ²	3400
Modulus of Elasticity, N/mm ²	72
Elongation at Break, (%)	2 - 3

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GYPSUM

Gypsum has been purchased from the market of Kurukshetra. The properties of Gypsum is given in Table 3

Table 3. Physical Properties of Gypsum

Chemical Classification	Sulphate
Color	Clear, Colorless, White, Gray, Yellow, Red, And Brown.
Cleavage	Perfect
Mohs Hardness	2
Specific Gravity	2.3
Chemical Composition	Hydrous Calcium Sulphate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
Crystal System	Monoclinic
Uses	Use to Manufacture dry wall, Plaster, Joint Compound, An agriculture soil treatment.

IV.METHODOLOGY

Compaction Test

This Phase of Study involved a detailed investigation of the compaction characteristics of the parent soil and blended sample containing different length of jute and gypsum contents, in order to obtain the optimum moisture contents and maximum dry densities. The optimum moisture contents thus obtained is used in preparing samples for Unconfined Compressive Strength Test. This test confirms to IS: 2720 (Part 7)1980.

Unconfined Compressive Strength

After the compaction test the compressive strength of the sample is measured. Cylindrical specimen is compacted by static compaction in 3.8 cm diameter and 7.6 cm high mould. The inner surface of the mould is lubricated with mobile oil so as to extrude the sample from mould with minimum disturbance. The sample is placed inside the specimen mould in seven layers using spoon, leveled and gently compacted. Pressure pad will be inserted into the mould and the whole assembly will be statically compacted in loading frame to the desired density. The sample is to be kept under static load for not less than 10 minutes in order to account for any subsequent increase in height of sample due to swelling. The sample will then be removed from the mould with the help of sample extruder. Initial dimensions are measured.

V. TEST RESULTS AND DISCUSSIONS

The Compaction and UCS values of soil and soil reinforced with different combinations of Jute fiber and Gypsum determined in the laboratory. The interpretation of tests result have been discussed in the following sections with Graphical Results:

A. Effect of Fibre content and Gypsum on MDD and OMC

From the proctor test, it has been observed that the maximum dry density (MDD) increases by the addition of jute in parent soil upto a certain percentage, after that it gradually decreases and the optimum moisture content varies at each percentage. Initially the OMC & MDD of the parent soil were 24.4% & 1.62 gm/cc respectively according to the proctor test conducted. But after the addition of jute with gradual increase in jute percentage with constant length of jute 2cm, it is observed that the maximum dry density increases with addition of 0.5 and 1 percent of jute fibre but with further increase in jute percentage MDD starts to decrease. It is also been observed that the optimum moisture content varies with addition of jute. Further with the addition of gypsum with the above jute mixture, it shows increment in the optimum moisture content of the respective jute mixture.

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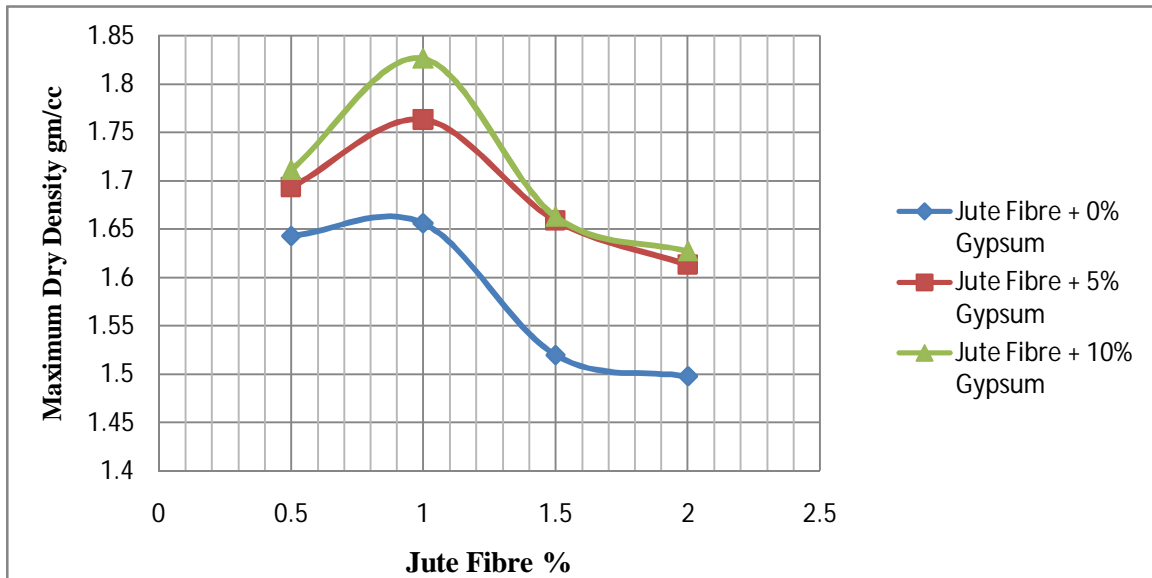


Fig 1. Graph Showing Maximum Dry Density Relationship with Different Percentage of Jute Fibres and Gypsum Mixed with Parent Soil

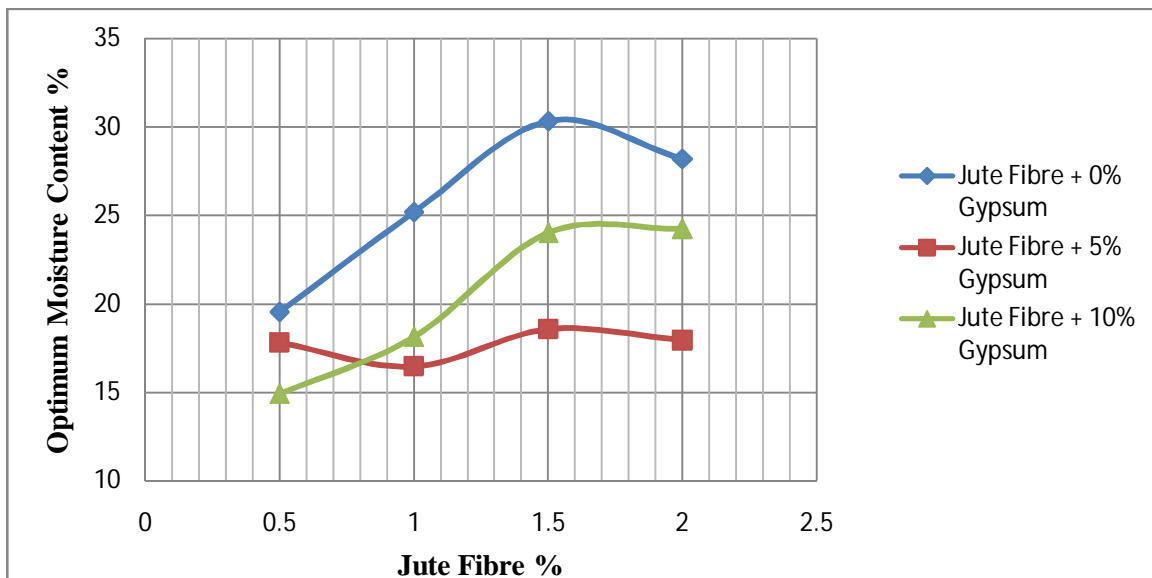


Fig 2. Graph Showing Optimum Moisture Content Relationship with Different Percentage of Jute Fibres and Gypsum Mixed with Parent Soil

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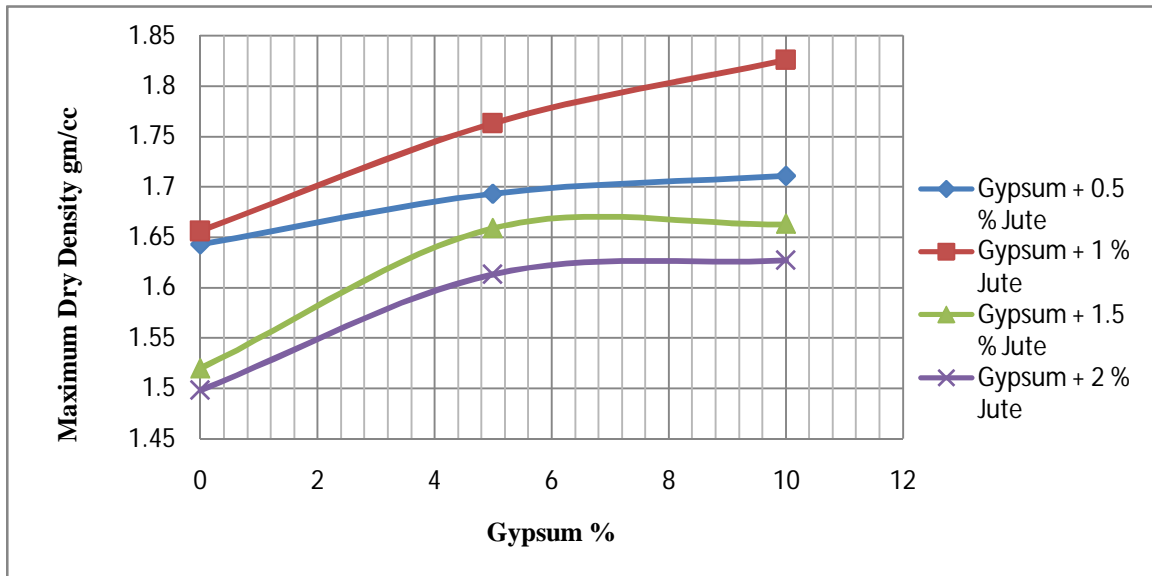


Fig 3. Graph Showing Maximum Dry Density Relationship with Different Percentage of Gypsum and Jute Fibre Mixed with Parent Soil

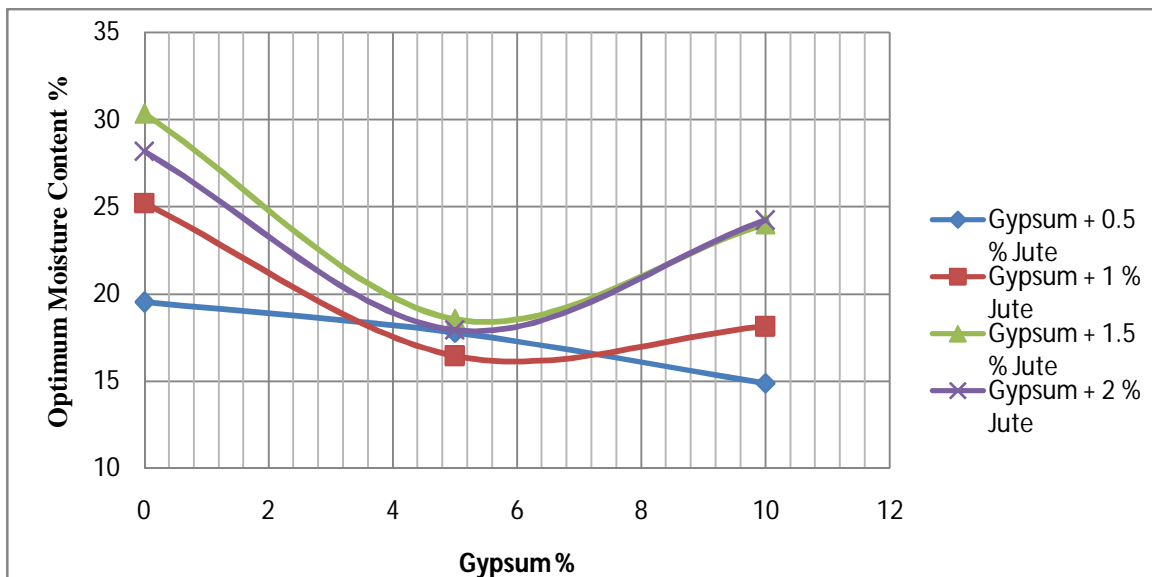


Fig 4. Graph Showing Optimum Moisture Content Relationship with Different Percentage of Gypsum and Jute Fibre Mixed with Parent Soil

B. Effect of Fibre and Gypsum on UCS

From UCS test conducted for the same sample as described in proctor test, the strength of samples shows increasing tendency for some samples with the increment of jute percentage in the soil i.e.; for parent soil strength obtained 1.18

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kg/cm². For the jute-soil mixture and jute-gypsum mixture shows incremental results in the compressive strength as compared to the parent soil.

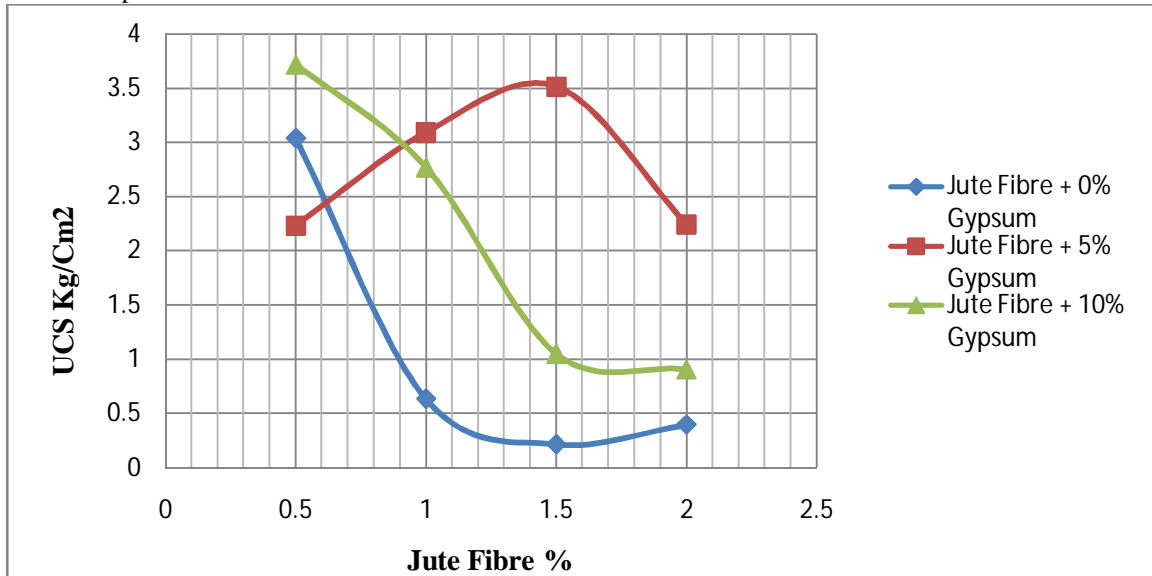


Fig 5. Graph Showing Unconfined Compressive Strength Relationship with Different Percentage of Jute Fibres and Gypsum Mixed with Parent Soil

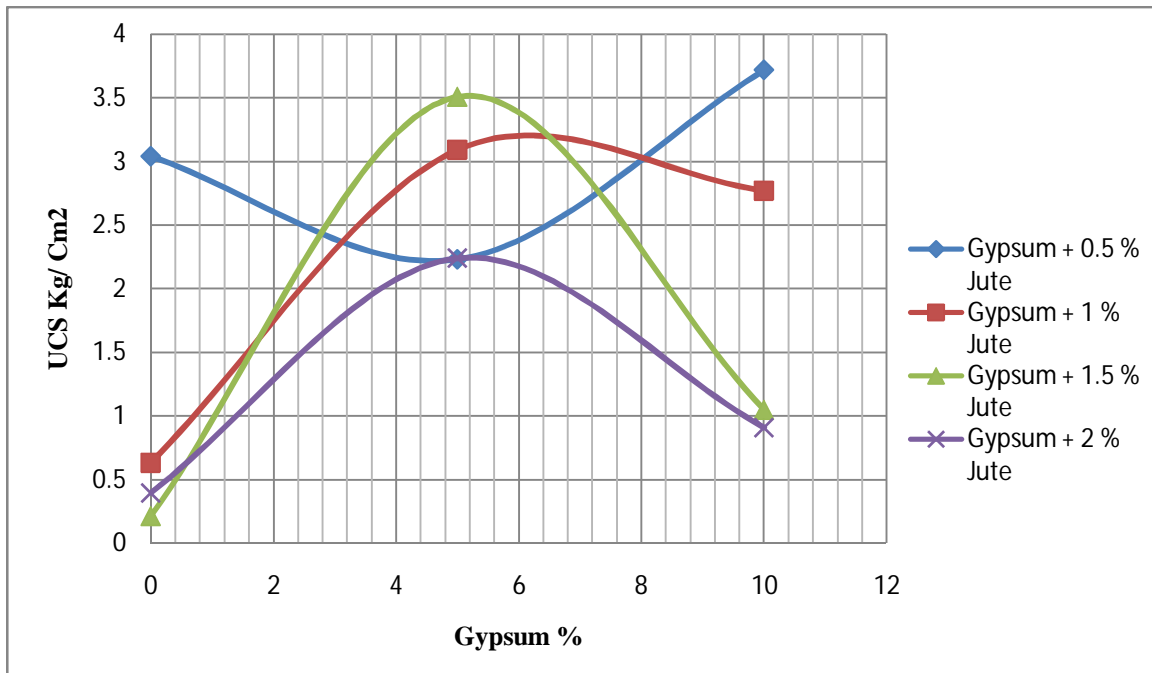


Fig 6. Graph Showing Maximum Dry Density Relationship with Different Percentage of Gypsum and Jute Fibre Mixed with Parent Soil

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VI. CONCLUSION

In This thesis, strength characteristics of soil-jute-gypsum have been studied. The following conclusion can be made based on the test result obtained from jute-gypsum stabilized clayey soil:-

1. With the addition of jute percentage in the soil the maximum dry density increases up to 1% and the optimum moisture content decreases. But with further addition of jute percentage in the soil the maximum dry density starts to decrease with an increase in optimum moisture content.
2. Further with addition of gypsum in soil-jute mixture the maximum dry density increases and the optimum moisture content decreases.
3. In UCS, the strength of soil-jute mixture increase at 0.5% of jute fibre addition and beyond that it decreases. Further with the addition of gypsum in the mixture the compressive strength increases suddenly.
4. Gypsum not only acts as a activator in this case but also reduces the plasticity of the soil.
5. Soil-jute and soil-jute-gypsum specimen fails by formation of vertical cracks.

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