Performing Studies On Soil Stabilized With Natural Materials " Jute and Gypsum "

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Abstract:

Soil stabilization is a crucial aspect of construction and civil engineering projects, aimed at improving the engineering properties of soils. This paper presents a comprehensive review of the utilization of jute and gypsum for soil stabilization. Jute, a natural fiber, and gypsum, a mineral, have shown promising results in enhancing the mechanical and geotechnical properties of various types of soils. The objective of this study is to evaluate the effectiveness of jute and gypsum as soil stabilizers, examining their impact on soil strength, durability, and sustainability. This paper also highlights the mechanisms and interactions involved in the soil stabilization process using jute and gypsum and discusses potential challenges and future research directions.There are many stabilizers like jute, gypsum, rice-husk ash, cement lime, HHF, shredded rubber tyres etc. are used to strengthen the properties of soil. In this study, we added jute and gypsum as stabilizing material to increase the engineering properties of clayey soil. The purpose of this study is to improve the strength of the clayey soil by making soil-jute and soil-jute-gvpsum mixture. Several specimens are prepared to examine the properties of soil. Some specimens are prepared by adding varying length of l cm, 1.5 cm and 2cm jute and the parent soil. Some specimens are prepared by adding 1.5% of jute and 0.5% of gypsum with parent soil, with varying length of 1 cm, 1.5 cm and 2cm of jute as used earlier. The Standard proctor test is performed to determine Optimum Moisture Content (OMC) and Maximum dry density (MDD) of the soil. The Unconfined compressive strength test is conducted to investigate compressive strength of soil mixture.

Key Words: Soil, Jute, Gypsum, Soil Stabilization, Waste Products, Economical , Environmental Benefit

INTRODUCTION

Soil stabilization is a fundamental aspect of construction and civil engineering that involves improving the mechanical and geotechnical properties of soils [1],[2],[3]. The stability and strength of the soil are critical factors for the successful execution of various infrastructure projects, including buildings, roads, embankments, dams, airports, and railways [4]. The natural properties of soil can vary significantly, leading to variations in its engineering characteristics. Some soils may possess inadequate strength, high compressibility, poor drainage, or susceptibility to erosion, which can pose significant challenges during construction. Unstable soils can result in foundation failures, slope instability, excessive settlement, pavement [6],[7] .

Jute and gypsum are two materials that have shown potential as soil stabilizers, offering distinct properties and mechanisms for improving soil strength and stability [9]. Here is an overview of jute and gypsum as potential soil stabilizers:

- Jute:

Jute is a natural fiber derived from the stems of the jute plant. It is biodegradable, renewable, and abundantly available in many regions. Jute fibers possess high tensile strength and excellent resistance to degradation from moisture, making them suitable for reinforcing weak soils [10]. The use of jute in soil stabilization involves incorporating jute fibers or jute-based geotextiles into the soil mass. Jute reinforcement enhances soil cohesion, reduces soil erosion, improves compaction characteristics, and increases the load-bearing capacity of soils [11].

Jute geotextiles act as a mechanical stabilizer, distributing loads and reducing differential settlement. Jute also aids in controlling soil erosion and sediment transport, making it useful in slope stabilization and erosion control applications.

- Gypsum:

Gypsum is a mineral composed of calcium sulfate dihydrate. It is widely available and commonly used in construction, agriculture, and industrial applications. Gypsum has unique chemical properties that contribute to soil stabilization. When gypsum is mixed with soil, it

undergoes a chemical reaction, leading to soil improvement [12]. Gypsum modifies the soil structure by promoting flocculation, which aggregates fine particles into larger clusters, reducing soil plasticity and improving drainage [13],[14]. The presence of gypsum reduces the soil's swelling and shrinkage potential, preventing excessive volume changes due to changes in moisture content. Gypsum can enhance the load-bearing capacity of clay soils by increasing their bearing strength and reducing compressibility. It also improves soil permeability, allowing for better water infiltration and drainage, thereby reducing the risk of water-induced instability. Both jute and gypsum offer unique advantages as soil stabilizers. Jute provides mechanical reinforcement and erosion control, while gypsum primarily acts through chemical modification [14]. The combined use of jute and gypsum in soil stabilization has the potential to exhibit synergistic effects, further improving soil properties such as strength, stability, and durability [16] .

It is important to note that the effectiveness of jute and gypsum as soil stabilizers may vary depending on soil types, environmental conditions, and the specific application. Thorough site-specific evaluations, laboratory testing, and field trials are necessary to determine the optimal dosage and application methods for achieving desired soil stabilization

Objective of the study

The focused of study is on

1. In present study we are going to use environment friendly waste products to improve the properties of soil.
2. Evaluation of strength characteristics of blended soil using different percentage of gypsum and jute by varying length of jute.
3. Determination of appropriate Jute and Gypsum content at which we get maximum strength of soil.

LITERATURE REVIEW

Soil stabilization is an essential technique in civil engineering to improve the properties of soil, including strength, stability, and durability, for construction purposes. In recent years, researchers have explored various materials to stabilize soil, including jute and gypsum.

- Jute is a natural fiber obtained from the stem of the jute plant. It is a biodegradable and eco-friendly material that has been used in various industries. Jute fibers have

been shown to improve the mechanical properties of soil, including tensile strength, shear strength, and bearing capacity. A study by Islam et al. (2015) investigated the use of jute fiber as a reinforcement material in soil stabilization. The results showed that the inclusion of jute fibers in soil improved its compressive strength, modulus of elasticity, and shear strength. Another study by Biswas et al. (2016) showed that the addition of jute fiber to soil reduced its compressibility and improved its tensile strength.

- Gypsum is a naturally occurring mineral that has been used in the construction industry for various purposes, including soil stabilization. Gypsum reacts with soil particles and forms stable compounds, which improve the soil's mechanical properties. A study by Basha and Hashim (2009) investigated the use of gypsum as a soil stabilizer. The results showed that the addition of gypsum to soil improved its strength and reduced its compressibility. The researchers also found that gypsum improved the soil's water retention properties.

- Several studies have also investigated the combined use of jute and gypsum in soil stabilization. A study by Karthikeyan et al. (2014) showed that the combination of jute fibers and gypsum significantly improved the soil's mechanical properties, including its compressive and tensile strength, as well as its water retention properties. Another study by Khatibimoghadam et al. (2019) investigated the effect of different ratios of jute fibers and gypsum on soil stabilization. The results showed that the combination of jute and gypsum improved the soil's strength and reduced its permeability.

In summary, jute and gypsum are promising materials for soil stabilization. Jute fibers improve the soil's mechanical properties, including its strength and stability, while gypsum improves its water retention and binding properties. The combined use of jute and gypsum has shown significant improvements in soil properties. However, further research is needed to investigate the long-term effects of these materials on soil stability and durability.

- PROPERTIES OF SOIL

Table 1 Physical properties of soil

S.No.	Parameters	Results
1.	Light compaction test MDD(gm/cc) OMC(%)	 1.60 20.00
2.	Liquid limit (%)	51.10
3.	Plastic limit (%)	22.38
4.	Plasticity index (%)	27.72
5.	Specific gravity	2.51
6.	Indian soil classification	CH

- JUTE

The Jute which was used in this experimental work was of length 1cm,2cm & 3cm with 2% by the dry weight of soil , And the jute was purchased from the rajpura town which was used in this experimental work

- GYPSUM

The Gypsum Was also purchased from the Rajpura town

Table No 2. PHYSICAL PROPERTIES OF GYPSUM

	Information	Reference(s)
	Gypsum(13397-24- 5)	
Physical state	White crystalline powder or lumps	IPCS (2004a)

Odor	Odourless	NIOSH (undated-c)
Melting Point (°C)	100	Registry(2005)
Density (g/cm3)	2.4	IPCS(2004a);Registry (2005)
Specific Gravity	2.32	NIOSH (undated-d)
Water Solubility	0.24g/100 mL @ 25 (°C)	IPCS(2004a)

Table 2: Properties of jute

Parameters	Results
Maximum Dry Density(MDD)	1.65 gm/cc
Optimum Moisture Content(OMC)	20%
Liquid Limit	46.50%
Plastic Limit	25.40%
Plasticity Index	21.10%
Specific gravity	2.62
USCS classification	CI

Preparation of samples

Soil is collected and percentage of sample is taken. after sampling is done the tests to be conducted on them. Different samples are prepared with varying length of jute 1cm, 1.5cm, 2cm keeping content of jute 1.5% and gypsum 0.5% with parent soil. Thesis has been made to find optimum value of moisture content for the mixed samples by conducting a no of tests.

- **Laboratory tests**

Compaction Test

In compaction test we determine the compactness of the soil by making mixture of soil and different lengths of jute keeping content of jute 1.5% and gypsum 0.5% in order to obtain the optimum moisture contents and maximum dry densities of various specimens or samples

Unconfined Compression Test

It is performed to obtain the unconfined compressive strength of soil. samples are prepared same as in compaction test.

RESULTS AND DISCUSSIONS

Compaction Test

From the proctor test, it has been experimental that the optimum moisture content (OMC) decreases by the adding up of jute in parent soil and maximum dry density (MDD) increases. Initially OMC & MDD of the parent soil were 20. & 1.65 gm/cc respectively as the proctor test conducted on parent soil. But after the accumulation of jute with gradual increase in the length of jute, it is observed that the maximum water content increases and maximum dry density decreases noticeably. In addition varying the length of the jute in the parent soil with the constant amount (1.5%) of jute. it has been observed that the OMC of the mixture shows a declining tendency with increase in the jute length i.e; for lcm length of jute optimum moisture content is 27.06, 25.45 for 1.5cm jute length and 22.05 for 2cm jute length. Also the MDD for the above jute varies as 1.53gm/cc, 1.54gm/cc and 1.64gm/cc for 1cm, 1.5cm and 2cm respectively. The maximum dry density shows the increasing fashion with the increase of the jute length in the soil mix. From results it is clear that as optimum water content decreases and maximum dry density increases as per the opposite relationship between MDD and OMC.

Again by addition of 0.5% gypsum with the above jute mixture, it shows small increase in optimum moisture content of the respective jute mixture as

- For 1cm jute length mixture, the optimum moisture content is 27.06. for the jute mixture and 24.38. after the addition of 0.5% gypsum.
- For 1.5cm jute length mixture, the optimum moisture content is 25.45 for the jute mixture and 25.69 after the addition of 0.5% gypsum.
- For 2cm jute length mixture, the optimum moisture content is 22.05 and 25.58 after the addition of 0.5% gypsum.

Table 3 Standard Proctor test on parent soil

SI no	2	4	5	6
Wt of empty mould+ compacted soil (gm)	6175	6395	6405	6403
Wt of empty	4393	4393	4393	4393

mould (gm)				
Wt of sample (gm)	1868	1991	1999	2005
Density of sample (gm/cc)	1.844	1.998	2.01	2.006
Container no.	81	309	11	48
Wt of empty container (gm)	9.156	10.309	10.0	10.33
Wt of empty container + wet soil(gm)	35.4	32.37	45.86	47.51
Wt of container+ dry soil (gm)	31.21	26.87	35.59	33.17
Wt of water in the sample (gm)	3.60	3.12	5.54	3.84

Wt of dry soil(gm)	20.228	16.55	28.00	22.81
Water content, in percentage	13.250	20..0446	21.3211	30.438
Dry density (gm/cc)	1.608	1.5519	1.5455	1.576

Table 4: Standard proctor test on parent soil with 2%,1cm jute

SI no	1	2	3	4
Wt of empty mould+ compacted soil (gm)	6125	6186	6397	6398
Wt of empty mould (gm)	4397	4397	4397	4397

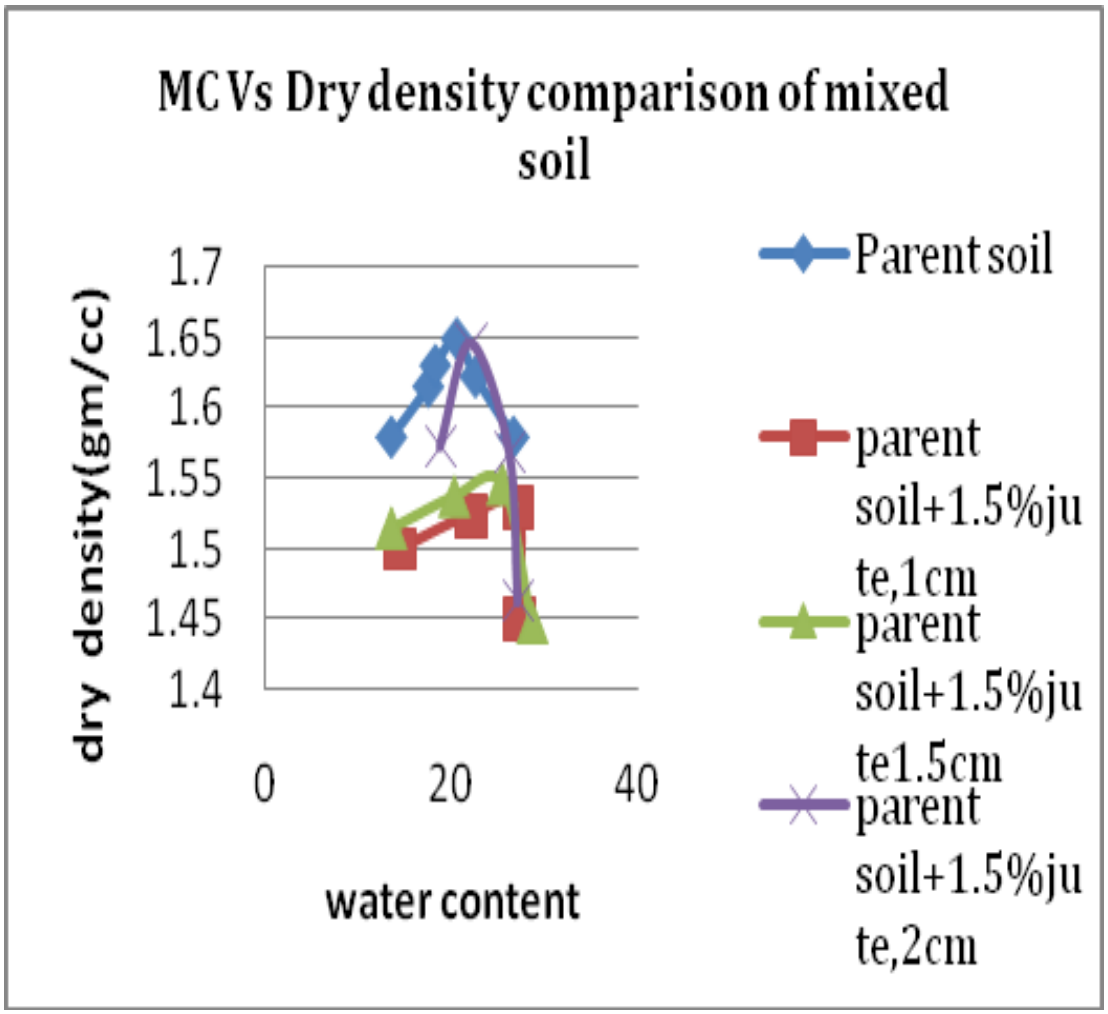
Wt of sample (gm)	1721	1761	1956	1765
Density of sample (gm/cc)	1.73	1.88	1.95	1.80
Container no.	13	82	325	328
Wt of empty container (gm)	10.413	10.00	22.32	26.57
Wt of empty container + wet soil(gm)	34.8	36.45	71.23	62.01

Wt of container+ dry soil (gm)	31.51	33.11	63.8	60.91
Wt of water in the sample (gm)	2.29	3.34	7.43	7.1
Wt of dry soil(gm)	21.021	22.96	39.48	30.34
Water content, in percentage	13.2913	22.70611	29.16009	26.6073
Dry density (gm/cc)	1.533676	1.557502	1.449989	1.43326

- Unconfined Compressive Strength Test

From the UCS test conducted for the same samples as described earlier in the proctor test, the strength of sample shows increasing tendency with the addition of varying length of jute keeping content as constant 1.5%, for parent soil strength obtained 1.75kg/cm2 amount .i.e. But for the jute mixture the strength obtained 2.1kg/cm2 2.3 kg/cm2 and 2.9 kg/cm2 for 1cm length 1.5cm and 2cm respectively. And again by addition of gypsum in the three jute mixture sample, The strength shows a extreme increase as 1cm jute mixture shows an increase of strength from 2.1 kg/cm2- 3.4kg/cm2 after the addition of 0.5%gynsum. 1.5cm jute length mixture shows an increase of strength from 2.3 kg/cm2- 5.1 kg/cm2 after the addition of 0.5%gypsum. 2cm jute length mixture shows an increase of strength from 2.9 kg/cm2 to 5.2 kg/cm2 after the addition of 0.5%gypsum.

Fig. 2: graph showing MC Vs DD curves of mixed sample of jute



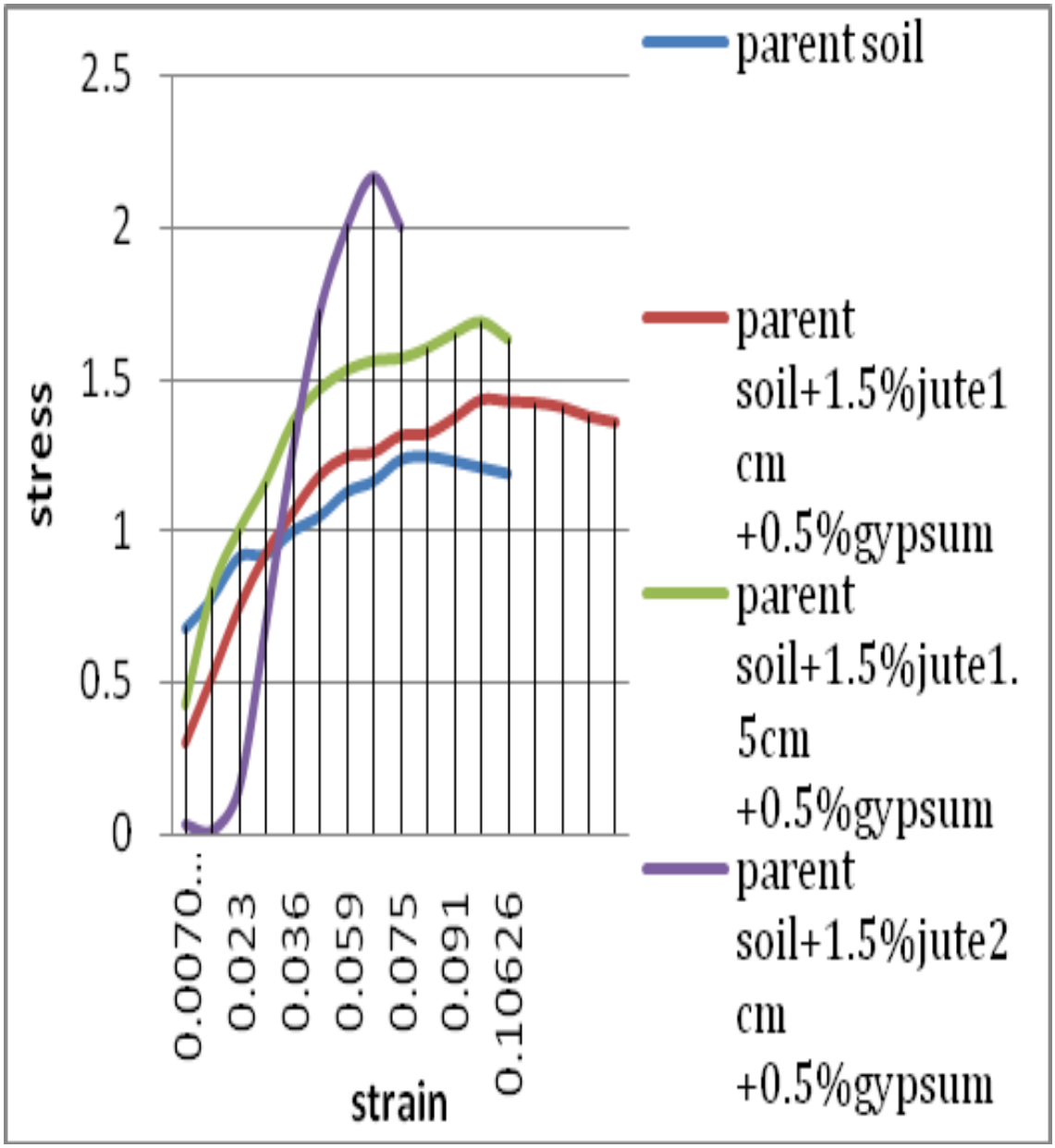


Fig.4 Showing Sress Vs Strain curves of mixed soils of jute

CONCLUSIONS

In this Reseach we conduct several no of tests to improve the engineering properties of soil. After tests we observed as, jute and gypsum are suitable materials for soil stabilization. Jute fibers improve the soil's tensile strength, while gypsum improves its compressive strength.

1. The combined use of jute and gypsum significantly improves the soil's mechanical properties and reduces its permeability.
2. The use of these materials in soil stabilization is an eco-friendly and cost-effective solution that has great potential in the field of civil engineering.
3. When the length of jute (1cm, 1.5cm, 2cm) is increases with constant addition of jute (1.5%) and gypsum also 0.5% the maximum dry density of soil-jute mixture and soil-jute-gypsum mixture increases with the decrease in optimum moisture content in jute-soil mixture and in jute- gypsum-soil mixture it slightly increases
4. In the UCS test, when length of jute fibre increases 1cm, 1.5cm and 2cm in soil mixture then the compressive strength increases progressively. But After the addition of gypsum in soil mixture, its compressive strength increases suddenly Both mixture samples i.e; Soil with jute and soil with jute & gypsum fails by formations

FUTURE SCOPE

The use of jute and gypsum for soil stabilization has shown promising results in improving the mechanical and physical properties of soil. However, there is still room for further research to explore the full potential of these materials in soil stabilization.

1. Optimal blend ratio: Further research can be conducted to determine the optimal blend ratio of jute and gypsum for different types of soil. This can help in achieving the maximum stabilization effect with the least amount of material required.
2. Long-term effects: Long-term studies can be conducted to investigate the durability and longevity of the soil stabilization effect with jute and gypsum. This can help in determining the optimal maintenance schedule for treated soil.
3. Combination with other materials: The combination of jute and gypsum with other materials such as lime, fly ash, or cement can be explored to determine the synergistic effect in soil stabilization. This can help in developing cost-effective and environmentally friendly solutions for soil stabilization.
4. Large-scale field trials: Large-scale field trials can be conducted to evaluate the performance of jute and gypsum in real-world scenarios. This can help in validating the laboratory findings and providing practical solutions for soil stabilization.
5. Ecological impact: Further studies can be conducted to evaluate the ecological impact of jute and gypsum on soil and plant growth. This can help in ensuring that the use of these materials for soil stabilization is environmentally sustainable.

6. Application in different fields: The application of jute and gypsum in different fields such as agriculture, forestry, and construction can be explored to determine their potential for soil improvement and erosion control.

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