International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

EFFECT OF RANDOM INCLUSION OF JUTE FIBRES ON STRENGTH CHARACTERISTICS OF LIME TREATED EXPANSIVE SOIL

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ABSTRACT

Increase in developmental activities and the limited availability of desirable sites for construction is greatly encouraging engineers to consider in-situ improvement of weak/marginal soil deposits for constructing infrastructures. Expansive/Clayey soils always create problems more for lightly loaded structures than moderately loaded structures. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. Numerous methods are available in the literature for soil stabilization. Generally admixing technique in soil has an effective ground improvement because of its easy adaptability. It is well known that lime is an effective agent to be mixed with fine grained soils with high plasticity and it improves certain properties of the soil due to its chemical action. In order to reduce the brittleness of soil stabilized by lime only, a recent study of a newly proposed mixture of jute fiber and lime for ground improvement is reported in this paper In this paper the experimental results obtained in the laboratory on soil treated with 5% lime and reinforced with varying percentage of jute are studied. A study was carried out to check the improvements in the properties to investigate the relative strength gain in terms of unconfined compressive strength and compaction of soil with jute fibers in varying percentages. Thus the present study attempts to investigate the effect of Jute fibres on engineering and strength properties of lime treated expansive soil.

Keywords: Expansive soil, stabilization, jute fibers, swelling behavior, strength

I. INTRODUCTION

Soil has been used as a construction material for buildings, roads, irrigation structure etc. all over the world. Because of weakness in mechanical properties and strength, soil needs to be improved according to the requirement which varies from site to site. For centuries mankind was wondering at the instability of earth materials, especially expansive/clayey soil due to

- Poor workability

ISSN (O) 2454-9665
ISSN (P) 2454-0663

- High compressibility
- Inadequate shear strength

One day they are dry and hard, and the next day wet and soft. Swelling soil always create problem by consolidating under load and by changing volumetrically along with seasonal moisture variation. As a result the superstructures usually counter excessive settlement and differential movements, resulting in damage to foundation systems, structural elements and architectural features. . It is due to this that the present work is taken up. Soil improvement is of major concern in the construction activities due to rapid growth of urbanization and industrialisation. . The purpose is to check the scope of improving geo engineering properties and reduce expansiveness by adding additives. Fiber reinforced soil is effective in all types of soils (i.e. sand, silt and clay). Use of natural material such as jute as reinforcing material in soil is prevalent. The main advantages of this material are

1. They are locally available in abundance and are very cheap.
2. Superior drapability, jute textile can perfectly shape itself to ground contour.
3. High moisture absorbing capacity. It can take water up to 5times its dry weight.
4. High initial strength
5. They are biodegradable.
6. Create no disposal problem.

Swelling soil always create problem for lightly loaded structure, by consolidating under load and by changing volumetrically along with seasonal moisture variation. As a result the superstructures usually counter excessive settlement and differential movements, resulting in damage to foundation systems, structural elements and architectural features. In a significant number of cases the structure becomes unstable or uninhabitable. Even when efforts are made to improve swelling soil, the lack of appropriate technology sometimes results volumetric change that are responsible for billion dollars damage each year. In India expansive soil cover about 0.8x106 km² area which is approximately one-fifth of its surface area. This soil covers about 51.8 million hectares of the land area. They are predominant in the states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh.

II. ANALYSIS AND RESULTS

The soil sample used in this experimental study was collected from the Uttar Pradesh state of India.

The various physical and index properties of expansive soil like moisture content, in-situ dry density, specific gravity ,particle size distribution, color, Atterberg limits are listed in below table. All the testes were performed as per relevant Indian Standards (2720)

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Property	Result
Moisture content (in-situ) %	29
Gravel size %	0
Sand size % Silt + clay %	45.6
Specific gravity Liquid limit (%) Plastic limit (%) Plasticity index (%)	54.4
Swelling index (%)	2.53
Plasticity index A line (%) Classification	51
Color	20
OMC (%)	21

In the present study jute thread and lime was collected from greater Noida market. The length of the jute thread is 2cm and 4cm uniformly selected. The black cotton soil was mixed with 5% lime and varying percentage of jute fibre.

2.1 Effect of fibre on compaction characteristics of expansive soil:

It is observed from the fig 1 and fig. 2 that the addition of lime and fibre leads to an immediate decrease in the maximum dry density of soil and an increase in the optimum moisture content, for the same compactive effort. The decrease in the maximum dry density of the treated soil is reflective of increased resistance offered by the flocculated soil structure. The increase in optimum moisture content is probably a consequence of additional water held within the flocculated soil structure resulting from lime, fibre and soil interaction.

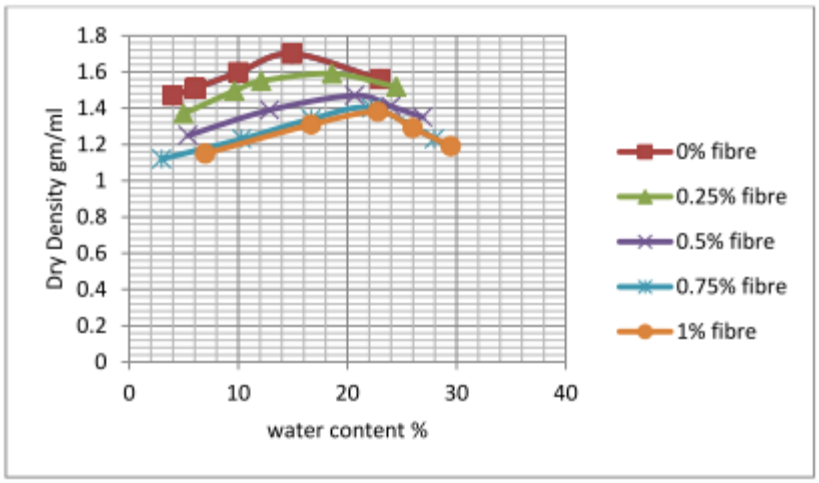

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Fig. 1: compaction curves for soil samples with different percentage of jute fibre

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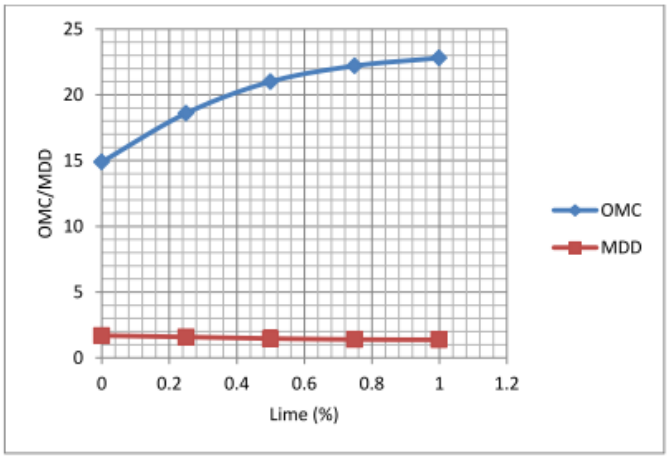
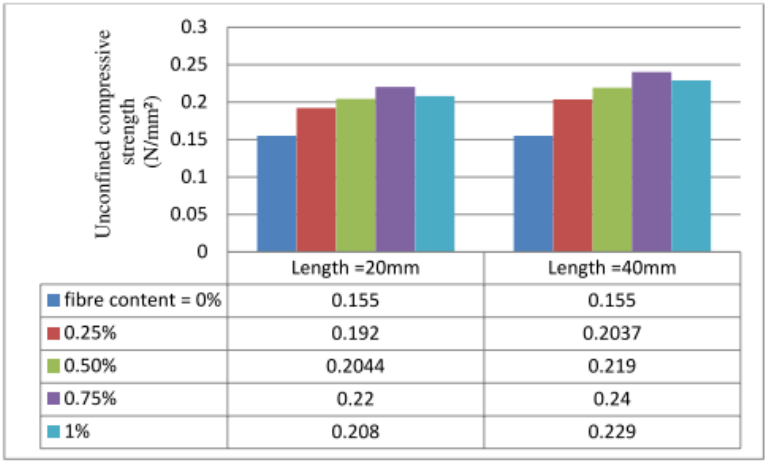


Fig.2: variation of OMC and MDD

2.2. Effect of fibre on strength characteristics of expansive soil:



	Length =20mm	Length =40mm
fibre content = 0%	0.155	0.155
0.25%	0.192	0.2037
0.50%	0.2044	0.219
0.75%	0.22	0.24
1%	0.208	0.229

Fig. 3: Effect of random inclusion of fibre on unconfined compressive strength of soil

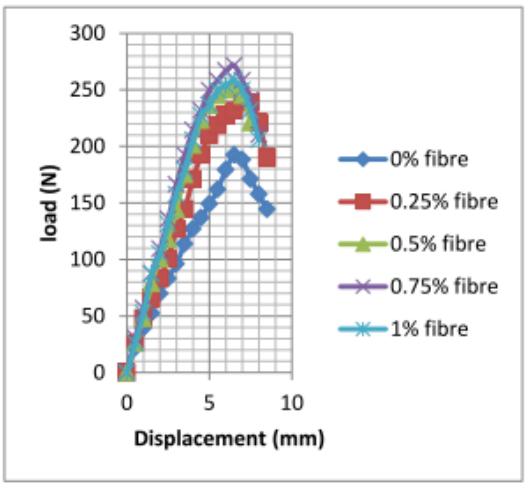


Fig.4: load vs. displacement graph for soil sample containing 20mm long fibres

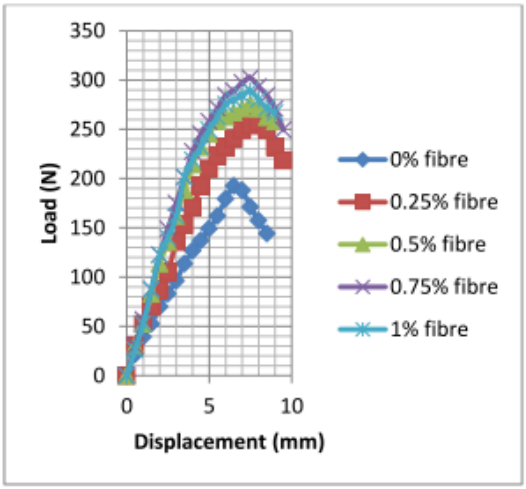


fig.5: load vs. displacement graph for soil sample containing 40mm long fibres

ISSN (O) 2454-9665
ISSN (P) 2454-0663

- Effect of fibre content

Results of unconfined compression test carried out at different fibre length and fibre content varying from 0% to 1% by dry weight of soil as shown in fig.4 and fig. 5 respectively. It is clear from the test results that the unconfined compressive strength of soil increases as the fibre content increases. Result shows that the maximum increase in unconfined compressive strength is observed at fibre content of 0.75%. Increase in the unconfined compressive strength is due to the reason that randomly oriented discrete inclusions incorporated into soil mass improves its load deformation behavior by interacting with the soil particles mechanically through surface friction and also by interlocking. Thus fibre reinforcement works as tension and frictional resistance elements. By the addition of lime and jute fibre to soil the stiffness of soil increases and may be due to thus reason there is improvement in the strength of expansive soil. The optimum fibre content corresponding to maximum strength is found to be 0.75%.

- Effect of length of fibre

It is observed from the fig.3 that the unconfined compressive strength value of soil reinforced with same fibre content and same lime content increases with increase in the length of fibre. This may be attributed to the fact that for shorter jute fibres the area of contact with the soil is less and hence there is less improvement in strength and stiffness of soil

III. CONCLUSION

From the series of tests conducted on black cotton soil mixed with lime and jute fibres, the following conclusions are drawn:

1. As the amount of jute fibre & lime increases there is apparent reduction in maximum dry density and increase in optimum moisture content.

2. There is significant increase in unconfined compressive strength values. The unconfined compressive strength from 0.155 N/mm²to 0.22N/mm² in case of 20mm long fibres and 0.155N/mm² to 0.24 N/mm² in case of 40mm long fibres . The variation is presented in figure 4 and 5 respectively.

3. From the test results it can be concluded that the addition of jute fibres to lime stabilized expansive soil decreases its swelling behavior and increases unconfined compressive strength properties.

4. It is also concluded that there is significant effects of length on the unconfined compressive strength value of soil. The strength value of soil increases with the increase in length of fiber.

There is substantial scope for carrying out further work in this area as the future of Jute geo- textile is very dynamic and it is be driven by various factors such as cost, performance and availability of resources.

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