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A Study on Properties of Expansive Soil Modified with Fly-Ash Reinforced with Jute Fibres

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***Abstract* - Rapid Increase in developmental activities and the restriction in availability of desirable sites for construction is greatly thought provoking issue for engineers to consider in-situ stabilization of weak/marginal soil deposits for constructing infrastructures. Expansive soils usually exhibit complications more for lightly loaded structures than moderately loaded structures. By consolidating under load and altering volumetrically accompanied by seasonal moisture variation, these complications are exhibited through shrinkage, swelling and unequal settlement. Innumerable methods are accessible in the literature for soil stabilization. Predominant admixing technique in soil has a productive ground improvement in view of its flexible adaptability. It is familiar that lime is a constructive agent to be varied with fine grained soils with high plasticity and it upgrades some definite properties of the soil due to its chemical influence. In order to lower the brittleness of soil stabilized by lime only, a recent study of a newly proposed mixture of jute fibre and Fly-ash for ground improvement is described in this paper In this paper the experimental results obtained in the laboratory on soil treated with fly-ash and reinforced jute are measured. A study was executed to inspect the improvements in the properties to explore the comparative strength gain in terms of California bearing ration (CBR) and compaction of soil with jute fibres in varying percentages. Thus the present studies strive to investigate the effect of Jute fibres on engineering and strength properties of lime treated expansive soil.**

Key words: Expansive soils, Fly-ash, Jute fibre, soil stabilization.

I. INTRODUCTION

Soil has been used as a construction material for buildings, irrigation structure, culverts, roads etc. all across the world. Because of fragility in mechanical properties and strength, soil needs to be enhanced accordingly to the demand which differ from site to site. For ages people were thinking about the instability of earth materials, predominantly expansive/clayey soil due to

- High compressibility
- Inadequate shear strength
- Poor workability

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 oppose excessive settlement and differential movements, in succession leads vandalisation of foundation systems, and structural elements. Due to this reason the present work is taken up. Soil improvement is of prime concern in the construction activities due to rapid growth of urbanization and industrialisation. . The purpose is to examine the scope of enhanced geo engineering properties and minimize expansiveness by adding additives. Fibre 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 soils by consolidating under load always generate complications by changing volumetrically throughout the length of seasonal moisture variation. As an effect the superstructures usually counter too much 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. Fly-ash being available in abundant quantity by using it in stabilisation there is reduction in solid waste which is being generated by industries.

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2. METHODOLGY

1. To evaluate the effect of fly ash data as a stabilizing additive in expansive soils series of tests were conducted, where the content of fly ash in the expansive soils was varied in values of 5%, 10%, 15%, 20%, 25%, and 30% respectively and jute fibre of size 20 mm was also added to the expansive soil. The jute fibre is 1.2% of jute fibre content by weight.

3. RESULTS AND DISCUSSIONS

Note: The below notations are used to mention the type of material used in the experiment and same notation is used in results tables and figures

BC-Black cotton soil, FA-Fly-ash, JF-Jute fibre

Table no: 1 Values of specific gravity and Atterberg's limits with variable percentage of fly-ash and jute fibre

Material	COMPACTION TEST		SWELL PRESSURE	CBR TEST	
	Water content	Maximum dry density	Free swell index	Un-soaked	Soaked
BC	21	1.53	51	7.52	4
BC + 5% FA+JF	21.5	1.52	48	10.35	3.2
BC + 10% FA+JF	20	1.49	23	12.83	3
BC + 15% FA+JF	22	1.45	20.5	18.53	2.5
BC + 20% FA+JF	23.5	1.5	17.3	6.52	2
BC + 25% FA+JF	24.1	1.47	15.7	7.13	1.5
BC + 30% FA+JF	24.5	1.4	12.3	7.1	2.2

Table no: 2 values of compaction and CBR test with varying percentage of fly-ash and jute fibre

Material		ATTERBERG LIMITS		
	Specific gravity	Liquid limit	Plastic limit	Shrinkage limit
BC	2.2	48.11	20.7	12.3
BC + 5% FA+JF	2.23	46	20.3	12.4
BC + 10% FA+JF	2.3	43	20	12.8
BC + 15% FA+JF	2.32	41.3	19.1	13.6
BC + 20% FA+JF	2.33	39.9	18.6	16.8
BC + 25% FA+JF	2.39	35.2	18.1	22.2
BC + 30% FA+JF	2.4	33.4	17	30.5

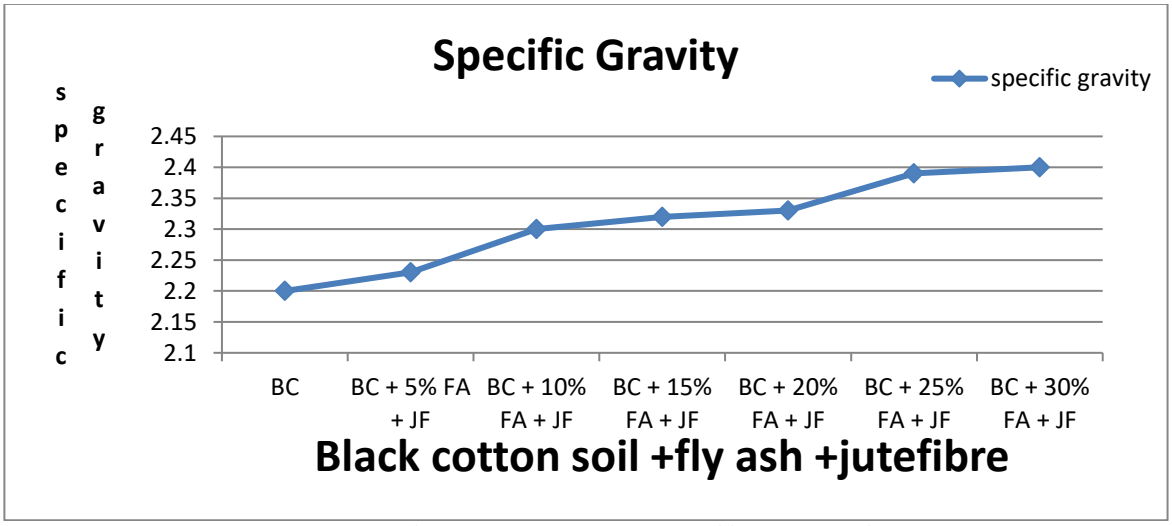

Fig no: 1.1 specific gravity variation with addition of fly ash and jute fibre

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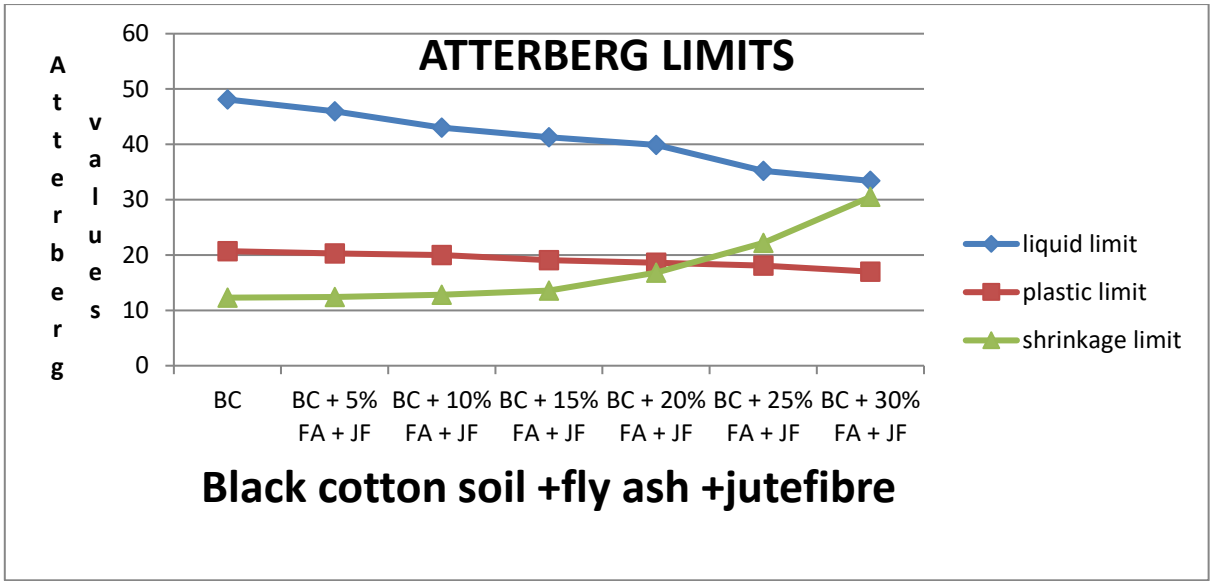

Fig no: 1.2 Atterberg limits variation with addition of fly ash and jute fibre

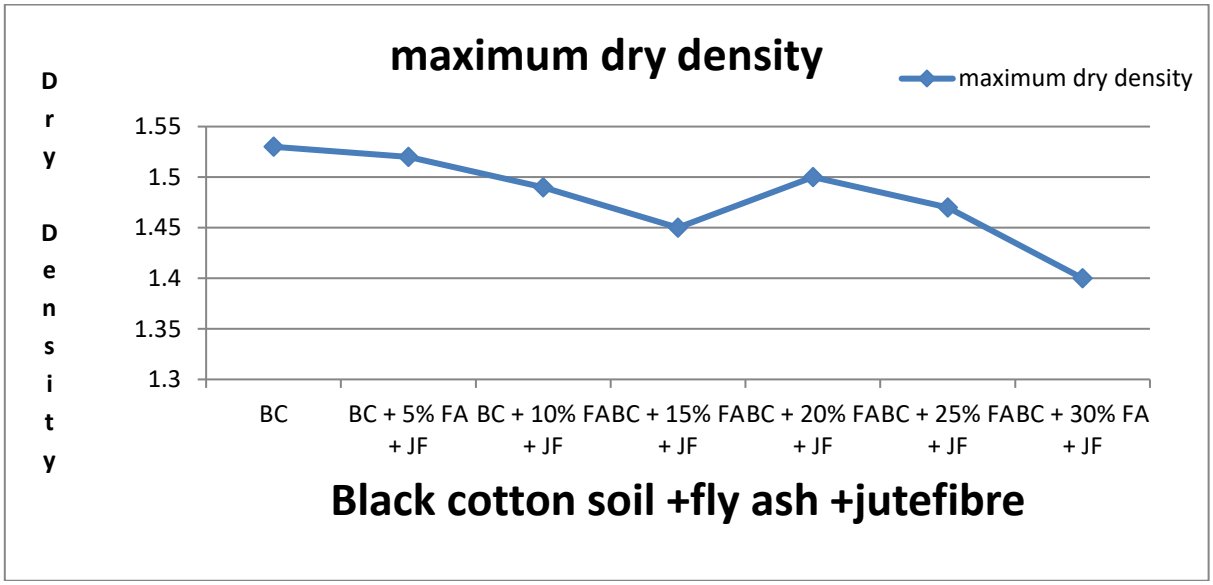

Fig no: 1.3 Maximum Dry density variations with addition of fly ash and jute fibre

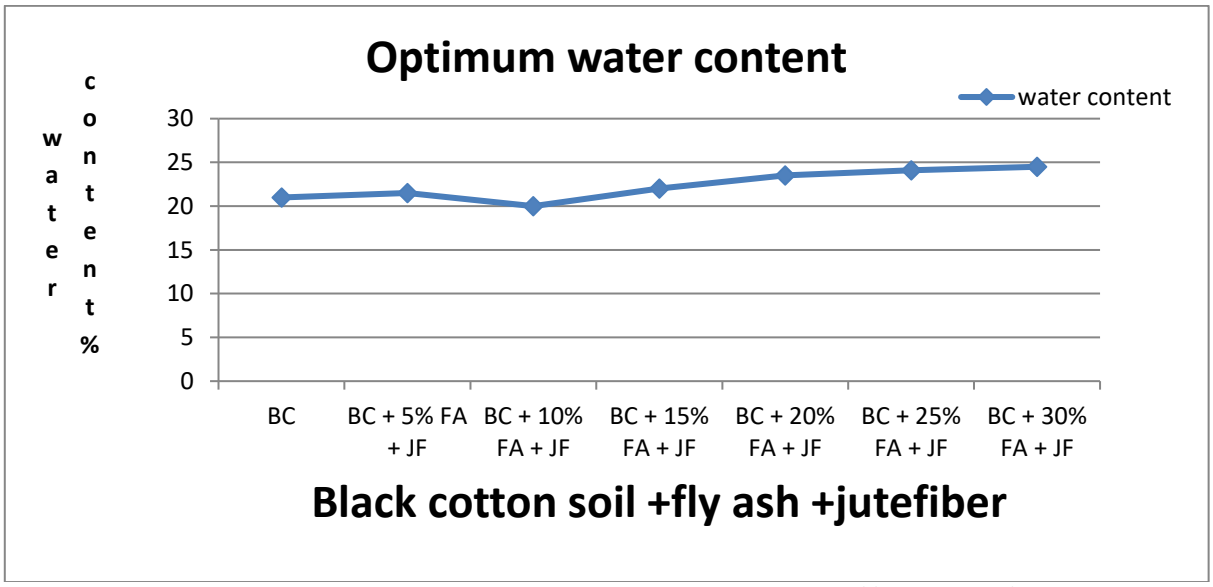

Fig no: 1.4 Optimum water content variations during compaction with addition of fly ash and jute fibre

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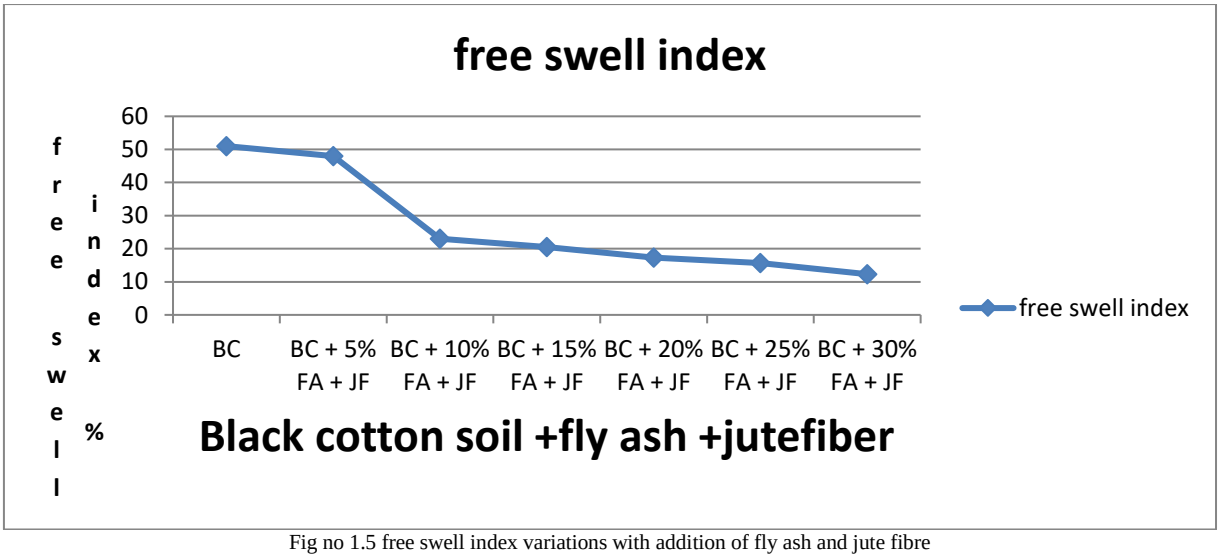

Fig no 1.5 free swell index variations with addition of fly ash and jute fibre

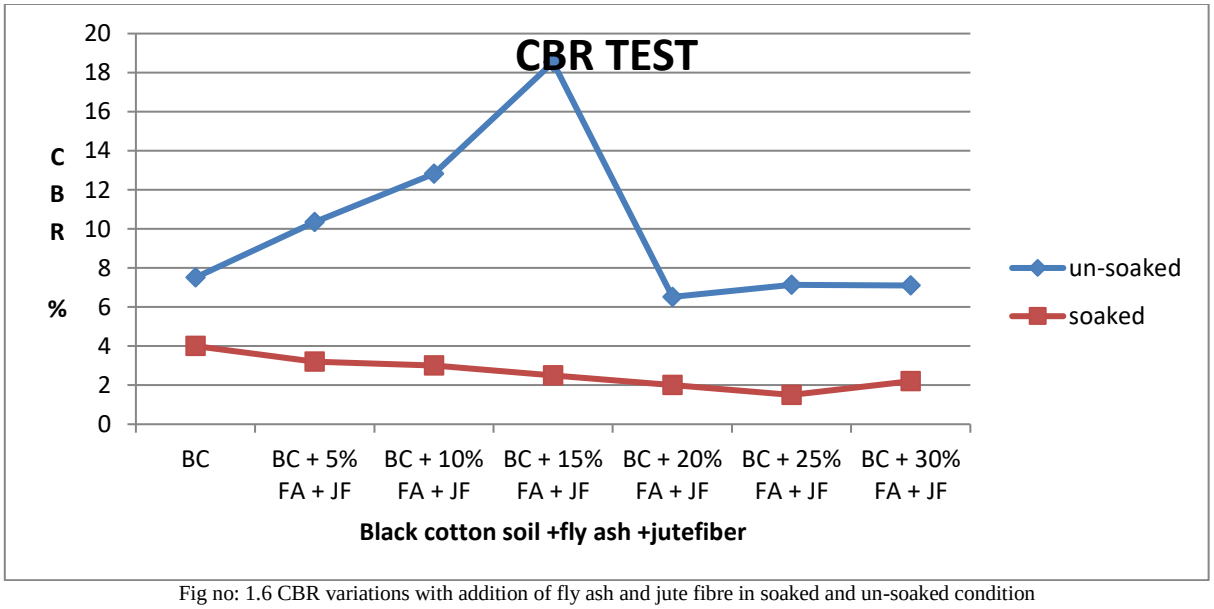

Fig no: 1.6 CBR variations with addition of fly ash and jute fibre in soaked and un-soaked condition

The results obtained from the experiments are tabulated in table no 1 and graphs are shown from fig no 1.1 to fig 1.6.

- From Fig 1.1 it is observed that with increase in fly ash and jute fibre percentage the specific gravity of the soil is increasing the specific gravity of soil sample is 2.2 and with addition of 40% of fly ash reinforced with jute fibre the specific gravity obtained is 2.4 i.e., the specific gravity is increased by 9% with addition of 30 % of fly ash reinforced with jute fibre.
- From Fig 1.2 it is observed that with increase in fly ash reinforced with jute fibre addition to the soil sample the, Atterberg limits i.e., liquid limit and plastic limit are decreased and shrinkage limit increased with increase in addition of fly ash reinforced with jut fibre to soil sample i.e., liquid limit is decreased by 30.6%, plastic limit decreased by 17.8%.
- From Fig 1.3 it is observed that with increase in addition of fly ash reinforced with jute fibre to the soil sample the Maximum dry density is decreased up to 15% of addition of fly ash reinforced with jute fibre by weight, and from then there is an increase in Maximum dry density from 25% of fly ash reinforced with jute fibre addition.
- From Fig 1.5 it is observed that with increase in fly ash reinforced with jute fibre addition the soil sample free swell index is decreased, the free swell index is decreased by 75.90% at 30% addition of fly ash reinforced with jute fibre.
- From Fig 1.6 it is observed that in soaked condition the CBR value is decreased by 25% up to 20% of addition of fly ash reinforced with jute fibre to the soil sample, and from then there is an increase in CBR value. In un-soaked condition the CBR value is increased by 40% up to 15% addition of fly ash reinforced with jute fibre from then there is decrease in CBR value with addition of fly ash with jute fibre.

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CONCLUSIONS

- Thus, Fly-ash reinforced with jute fibre as an additive for stabilization of expansive soil decreases the swelling, and increase the strength of expansive soil.
- The addition of Fly-ash reinforced with jute fibre reduces the plasticity characteristics of expansive soil. The liquid limit, plastic limit, decreased drastically and shrinkage limit increased with addition of fly-ash reinforced with jute fibre whereas the jute fibre is 1.2% of jute fibre content by weight.
- The Maximum dry density value of expansive soil initially decreased with addition of fly ash reinforced with jute fibre. Then, it showed increment with increase in addition of fly-ash reinforced with jute fibre content in soil sample. The Maximum value of dry density was observed for a mixture of soil at 20% of Fly ash reinforced with jute fibre addition whereas the jute fibre is 1.2% of jute fibre content by weight.
- Maximum CBR value of soil sample at 20% of Fly-ash reinforced with jute fibre whereas the jute fibre is 1.2% of jute fibre content by weight. In soaked condition the CBR value is decreased by 25% up to 20% of addition of Fly ash reinforced jute fibre to the soil sample and from then there is an increase in CBR value. In un-soaked condition the CBR value is increased by 40% up to 15% addition of Fly ash reinforced with jute fibre from then there is decrease in CBR value with addition of Fly ash reinforced with jute fibre. Whereas the jute fibre is 1.2% of jute fibre content by weight.

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