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A STUDY ON STRENGTH PROPERTIES OF EXPANSIVE SOIL TREATED WITH SILICA FUME AND NATURAL FIBRE (JUTE FIBRE)

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Abstract: Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The main objectives of the soil stabilization are to increase the bearing capacity of the soil,its resistance to weathering process and soil permeability. The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures, therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil. This paper studies that maximum improvement in the properties of Expansive soils for Silica fume with jute fiber tried in this investigation. A methodical process, involving experimentation on Atterberglimits (liquid limit, plastic limit), Proctor compaction test, Unconfined Compressive Strength(UCS) tests were conducted by adding 5%, 10%, 15% & 20% of C\Silica fume to the expansive soil by dry weight under controlled conditions in the laboratory. The percentages of jute fibers by dry weight of soil was taken as 0.5%, 1.0%, 1.5% and 2.0%. The first series of compaction, and UCS tests were conducted on the Expansive soil and the same tests were conducted in the second series on soil samples mixed with Silica fume and similarly tests were conducted in the third series on soil samples mixed with Silica fume andjute fiber.
Keywords: Expansive soil, CBR, UCS, jute fiber, Silica fume.

1. Introduction

Expansive soil is one among the risky soils that has a high potential for contracting or swelling because of progress of dampness content. Far reaching soils can be found on practically every one of the landmasses on the Earth. Dangerous outcomes brought about by this kind of soils have been accounted for in numerous nations. In India, huge tracts are secured by extensive soils known as dark cotton soils. The significant zone of their event is the south Vindhyachal range covering nearly the whole Deccan Level. These darts spread a region of around 200,000 square miles and consequently structure about 20% of the complete territory of India. The essential issue that emerges concerning sweeping soils is that distortions are altogether more prominent than the flexible misshapenness and they can't be anticipated by the old style versatile or plastichypothesis. Development is more often than not in an uneven example and of such an extent to make broad harm the structures laying on them. Appropriate healing measures are to be embraced to change the dirt or to decrease its unfavourable impacts if sweeping soils are distinguished in an undertaking. The therapeutic measures can be diverse for arranging and structuring stages and post development stages. Numerous adjustment systems are by and by for improving the extensive soils in which

the qualities of the dirts are modified or the risky soils are evacuated and supplanted which can be utilized alone or related to explicit structure choices. Added substances, for example, lime, concrete, calcium chloride, rice husk, fly fiery debris and so forth are likewise used to change the attributes of the broad soils. The qualities that are of worry to the plan designers are piousness, compressibility and solidness. The impact of the added substances and the ideal measure of added substances to be utilized are reliant chiefly on the mineralogical arrangement of the dirt's. The paper centres about the different adjustment strategies that are practically speaking for improving the broad soil for diminishing its swelling potential and the constraints of the technique for adjustment there on. In India, the region secured by far reaching soil is almost 20% of the

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absolute zone. The far reaching soils regularly spread over a profundity of 2 to 20m. In stormy season, they experience hurl and shed pounds. In summer, they psychologist and increase thickness and become hard. This substitute swelling and shrinkage harm the structures harshly. This is increasingly extreme for the light structures. During summer, polygonal breaks are show up at the surface, which may stretch out to a profundity of about 2m demonstrating the dynamic zone wherein volume change happens. The profundity of dynamic zone characterized as the thickness of the dirt beneath the ground surface inside which dampness content varieties and subsequently volume changes dotake place. Sustained endeavours are being made everywhere throughout the world on thruway research field to develop additionally encouraging treatment strategies for appropriate structure and development of asphalts running over broad soil sub grade.

2. Literature review

ShwethaPrasanna et al 2020, studied the potential of using jute fibers to improve the changeable compaction, shear strength and CBR of soil. In this study a Proctor Compaction test, direct shear test and California Bearing Ratio tests have been carried out on soil mixed with jute fiber. Jute fibers of length 30mm are mixed with soil in different percentage (0.5, 1.0, 1.5, and 2%) to find out the optimal quantity. On the basis of the experiments performed, it can be concluded that the stabilization of soil using 30mm pieces of jute as stabilizer improves the strength characteristics of the soil so that it becomes usable as one of the reinforcing material for the construction of roadways, parking areas, site development projects, airports and many other situations where sub-soils are not suitable for construction.

Yagya Sharma et al 2017, the improvement of engineering properties of soil by using jute fiber treating with the sand. Jute fiber is treated with the sand to enhance the engineering properties in case of pavement and earthen slopes. The aim of the present investigation is to determine the jute geo textile as soil reinforcement or soil stabilizer.This analysis discusses the potential of fine sand stabilization with jute is cut into approximately 20mm lengths as admixture. Present work has been taken up by addition of 20mm jute pieces as admixture. The varying percentage 0.5%, 1%, 1.5%, 2% of jute pieces of jute geotextile were mixed with fine sand of different densities and moisture content. All the Unconfined Compressive Strength Tests were conducted at different mix compositions of square pieces of plastic waste and fine sand of different dry densities as arrived from Standard Proctor Test. On the basis of the experiments performed, it is determined that the stabilization of fine sand using 20mm pieces of jute as admixture improves the strength characteristics of the fine sand so that it becomes usable as construction of embankment.

Prasad et al 2014, carried out studies on an expansive soil mixed with tile waste from 0 to 30% at an increment of 10%. From the analysis of test results, it was found that liquid limit, plastic limit, optimum moisture content, and swelling pressure decreased, maximum dry density and California bearing ratio increased with an increase in tile waste. It was also observed from CBR and swell pressure tests that the stabilized expansive soil has shown maximum improvement compared to untreated expansive soil and it is found that tile waste up to 20% can be utilized for strengthening the expansive soil sub grade of flexible pavement with a substantial save in cost of construction.

3. Materials

Soil: The black cotton soil collected from 'Thummalapalli' village near Amalapuram, East Godavari District in India.

Figure: 1 Black cotton soil

Silica fume (SF): Silica Fume is an ultrafine powder collected as a by-product of silicon metal and ferrosilicon alloy production. It is spherical in shape and the average particle size of silica fume is found to be 0.1-0.15μm. It is available in grey to off-white colours and in several product forms. Condensed silica fume is essentially silicon-dioxide (more than 90%) in non crystalline form. Specific surface area is about 20,000m²/kg. Silica fume is used as an artificial pozzolanic admixture in concrete. As far as the production of silica fume is concerned nearly 100,000 tons of micro silica is produced each year world wide. Iron also has a large amount of micro silica production.

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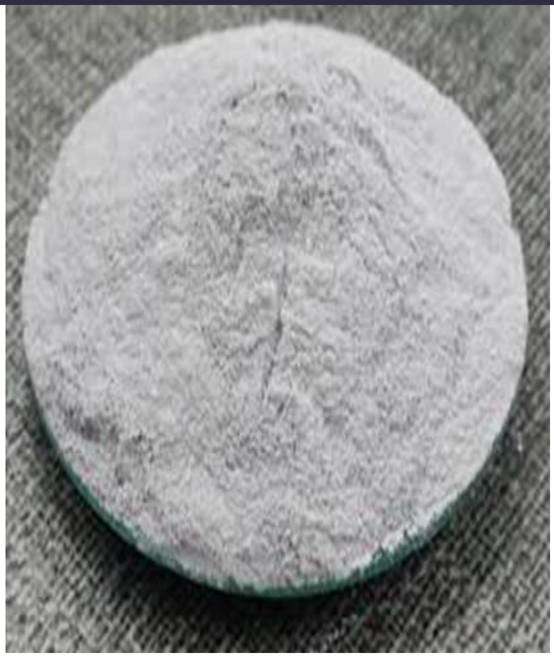

Figure: 2 Silica fume

Jute fibre: Jute fibre is used in this study and it is a synthetic material. Fibres possess good pliancy and render a high degree of flexibility and fineness to fabric construction. High initial modulus, consistency in tenacity (depends on thickness of the filament), high torsional rigidity and low percentage of elongation-at-break make Jute a suitable fibre for geosynthetics. The other remarkable property of Jute is its capacity to absorb water because of its high cellulosic content.

Figrure:3 jute fiber

4. Results

4.1 Effect of Atterberg's limits due SF added soil

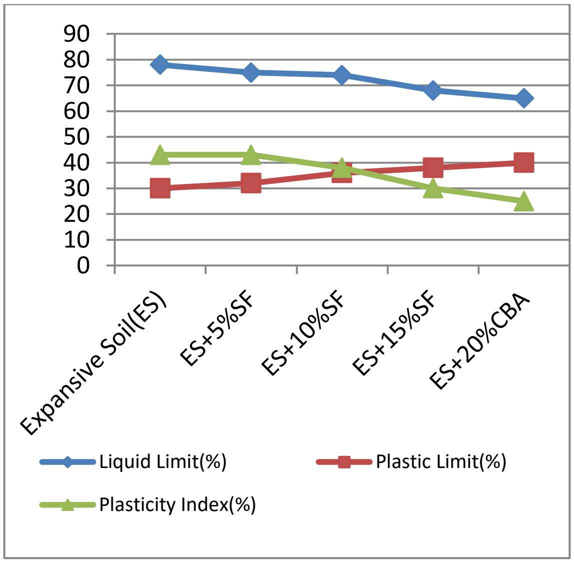

Figure: 4 variation of Atterberg limits with the addition of Silica fume

4.2 Effect of soil Compaction Properties due to SF

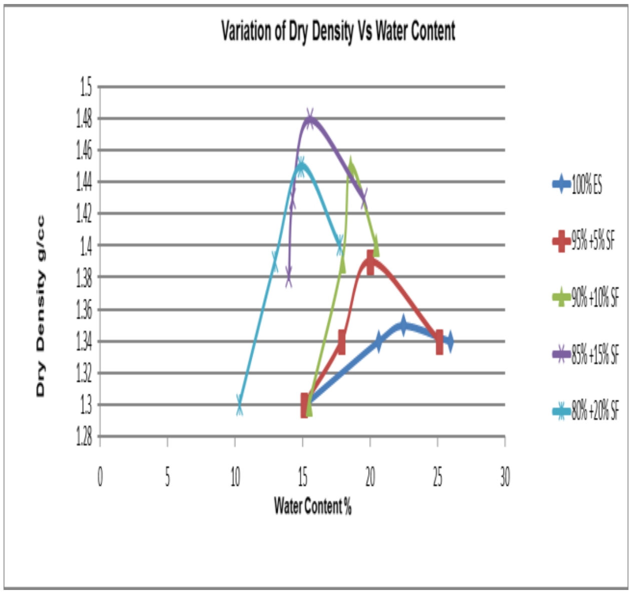

Figure: 5 Variation of OMC &MDD with the addition of SF

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4.3 Effect of UCS results of soil due to SF

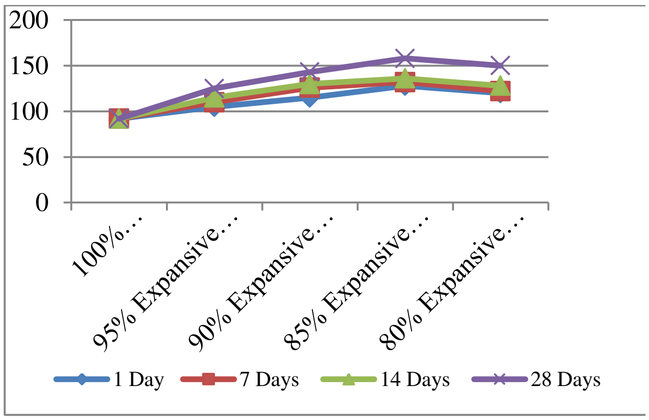

Figure: 56 Variation of UCS with the addition of Silica fume

As per IRC 37-2001 and 37-2012 the sub grade soil should possess the minimum CBR value of 6%. In the present study SF treated Expansive soil has exhibited the CBR value of 3.7% which is less as per codes of practice. To achieve required CBR value as per codes of practice, an attempt has been taken to improve the CBR value of SF treated Expansive soilreinforced with the percentage variation of Jute Fibre to suite it as sub grade for flexible pavements.

4.4 Effect of Atterberg's limits of 15 % SF treated soil with Jute fibers addition

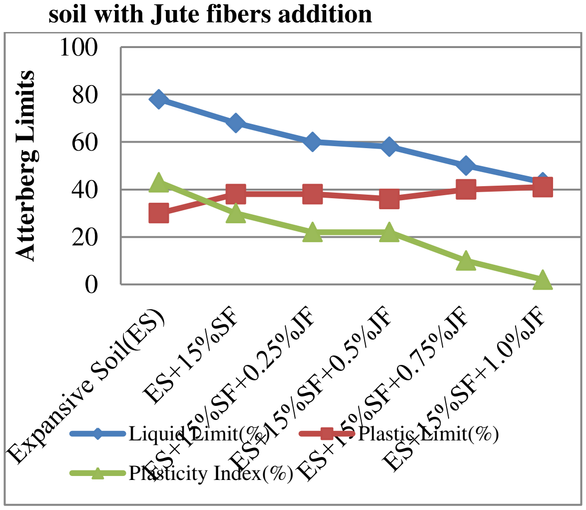

Figure: 7 Variation of Atterberg's limits of CBA treated soil with Jute fiber

4.5 Effect of OMC &MDD of 15 % CBA treated soil with Jute fibers addition

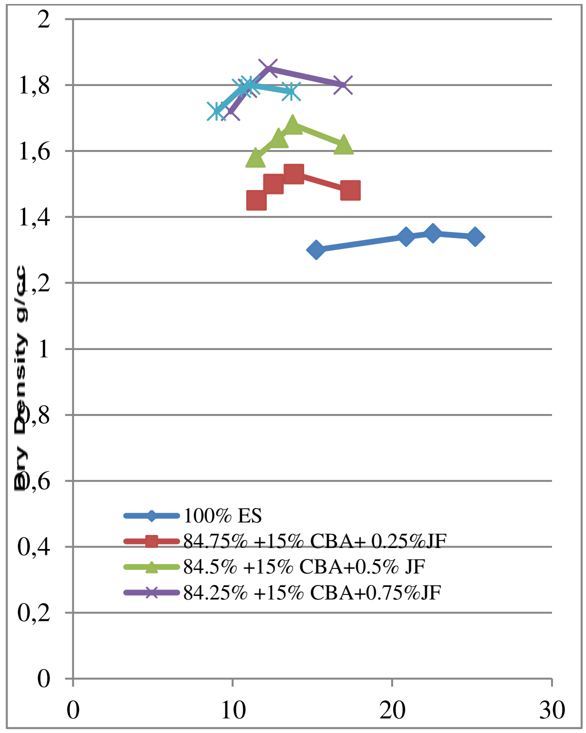

Figure: 8 Variation of OMC & MDD of SF treated soil with Jute fiber

4.6 Effect of UCS values of 15 % SF treated soil with Jute fibers addition

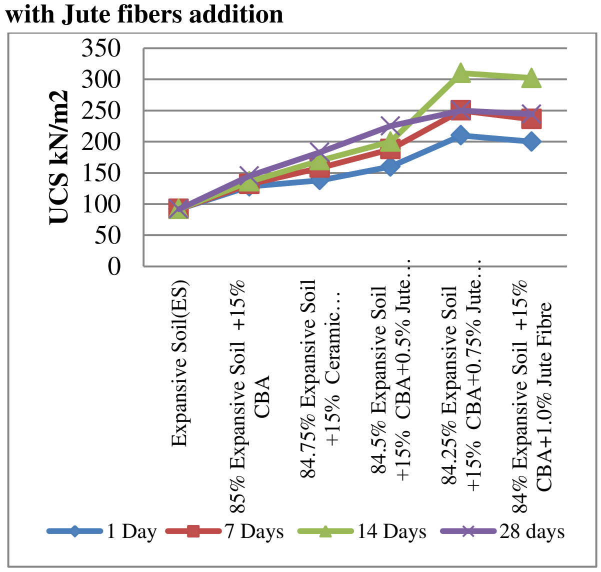

Figure: 9 Variation of UCS values of CBA treated soil with Jute fiber

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5. CONCLUSIONS

- **Atterberg Limits** of stabilized expansive soil with addition of different percentages of additives. It is can be observed that the Atterberg Limits are varying with increasing percentage of additives added to the expansive soil.
- It is observed that the decrease in the **liquid limit** is significant upto**15%SF+0.75%JF**, beyond that there is a nominal decrease. The percentages increase of liquid limit with treated soil is **56%.**
- Nominal increase in **plastic limit** of stabilized expansive clay is observed with increase the percentage of the additives. Fig .5.1. The percentages decrease of plastic limit with treated soil is **33.33%.**
- The increase in the plastic limit and the decrease in the liquid limit cause a net reduction in the plasticity index. It is observed that, the reduction in **plasticity indexes** decrease **330%** respectively for **15%SF+0.75%JF** added to the expansive clay.
- It is observed that the **DFS is decreasing** with increasing percentage of additives added to the expansive soil. Significant decrease in D.F.S. is recorded in stabilized expansive clay with addition of 20%SF+1.0%JF. The reductions in the DFS of stabilized expansive clay in percentages is **62.50%**
- It is can be seen that the CBR is increasing with increasing percentage of additives added to the expansive soil. Significant increase in CBR is recorded in stabilized expansive soil with addition of additives up to **15%SF+0.75%JF**, beyond this percentage the increase in CBR is marginal. The increase in the strength with addition of additives is **240%**
- Compaction tests were conducted to get the Optimum moisture content and Maximum dry density by adding different proportions of additivesto expansive soil using modified proctor compaction apparatus. The optimum percentages of both combinations are 15% of SFand 0.75% Jute Fiber, after this combination the value is decreases. The decrease of OMC is **44.230%.** The dry density values increases **37.03%.**
- It is observed that the unconfined compressive strength of the stabilized expansive soil is increasing with increase in percentage of additives added to the soil.The unconfined compressive strength of stabilized expansive clay is increased by 128.260%, 171.73% &236.95% for 1day, 7days and 14days when treated with Expansive Soil +20% SF+ 1.0% Jute Fiberrespectively after that the change of values are nominal.
- The static plate load tests were conducted on untreated and treated expansive soil sub grade foundation beds.
- The laboratory static plate load test results of Expansive Clay. The expansive soil alone has exhibited the ultimate static load of **244.368KN/m^2** with the deformation of **4.11mm** at OMC
- Shows The Expansive soil with gravel cushion has exhibited the ultimate static load of **649.659kN/m^2** with the deformation of **2.2 mm** at OMC
- The table 5.9 and the Graph 5.9 show the laboratory static plate load test results of Expansive soil. The jute fiber treated expansive

soil with SFwith gravel cushion has exhibited the ultimate static load of 986.22 kN/m2 with the deformation of 1.25mm at OMC

- The table 5.10 and the Graph 5.10 show the laboratory static plate load test results of Expansive Clay. The jute fiber treated expansive soil with 15% SFwith gravel cushion with geo textile as separator and reinforcement has exhibited the ultimate static load of 1654.6kN/m2 with the deformation of 1.12mm at OMC.

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