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A Laboratory Study on Effect of Random Inclusion of Jute Fiber on Strength Behavior of Alccofine Treated Red Soil for Pavement Subgrade

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Abstract— The purpose of this paper is to investigate whether or not it is possible to stabilise the soil by making use of Alccofine and jute fiber, so reusing the waste materials and creating a technique of soil stabilization that is both cost-effective and kind to the environment. A method of treating the soil in order to improve the functionality of the soil is known as soil stabilisation. Evaluation is being done to see whether rice husk ash may serve as a stabilising component to Red soil, with the goal of improving the engineering qualities of Red soil. The evaluation will involve a determination of the Red soil's swelling capacity, plastic limit, liquid limit, plasticity index, cohesion, and compaction properties. Numerous methods of soil stabilisation can be used on terrain that does not have an adequate amount of this quality. varying percentages of alccofine and jute fibre (ranging from 0.25 percent to 1 percent). The procedures were carried out using the sample in four proportions: 5%, 10%, 15%, 20%, and 25% respectively. The ratio of 15 alccofine to 0.75 percent jute fibre was determined to produce the best possible results in the evaluation. The load went up from 244.368 kN/m2 to 1654.60 kN/m2, but the settlement went down from 4.11mm to 1.120mm. The purpose of this paper is to investigate whether or not it is possible to stabilise the soil by making use of Alccofine and jute fibre, so reusing the waste materials and creating a technique of soil stabilisation that is both cost-effective and kind to the environment. A method of treating the soil in order to improve the functionality of the soil is known as soil stabilisation. Evaluation is being done to see whether rice husk ash may serve as a stabilising component to Red soil, with the goal of improving the engineering qualities of Red soil. The evaluation will involve a determination of the Red soil's swelling capacity, plastic limit, liquid limit, plasticity index, cohesion, and compaction properties. Numerous methods of soil stabilisation can be used on terrain that does not have an adequate amount of this quality. varying percentages of alccofine and jute fibre (ranging from 0.25 percent to 1 percent). The procedures were carried out on the following proportions with the sample: 5%, 10%, 15%, 20%, and 25%. The evaluation reveals that the proportion of 15 alccofine to 0.75 jute fibre yields the best possible value. The load increased from 244.368 kN/m2 to 1654.60 kN/m2, whereas the settlement decreased from 4.11 mm to 1.120 mm**.**

***Keywords*— Red soil, jute fiber, Alccofine, UCS, shear strength parameters and CBR.**

I. INTRODUCTION

Clay and sandy soils are the two primary categories that are used to classify the world's many types of soil. As a result of water permeating its mostly rock composition, the latter rarely presents any kind of challenge at all. Clayey soils, on the other hand, are the result of a process known as chemical weathering, which involves a series of chemical reactions including hydration, carbonation, and leaching. Clayey soils, as a result of these characteristics, expand during the winter months when they come into touch with water and contract during the summer months when water is lost as a result of evaporation. Clayey soils have been the subject of a significant amount of study by researchers interested in the modification of the swelling and shrinkage characteristics of clayey soils. The last choice is one that has been analysed and determined to be the most cost-effective alternative in specific circumstances, such as when the quantity of soil that has to be stabilised is greater, particularly in the case of constructing flexible pavement. Red soil can originate from the earth itself, where it is frequently combined with sand and clay, or it can be found as sediment in rivers and streams, where it is both suspended in water and deposited at the bottom of these bodies of water. The precise region of red dirt is average, and it has a texture that is often plastic-like but not sticky. When dry, red dirt often has the consistency of mud, but when wet, it may be rather slippery. Eighty percent of the particles in soil material have a size between 2 and 50 micrometres. The identification of the primary minerals that are carriers of naturally occurring trace elements in red soil is made possible by the use of particle size fractionation within this size range. This dampness might have been caused by rain, flooding, broken sewer lines, or the loss of surface evaporation that occurs when an area is covered by a structure or paved over with asphalt or concrete. Pavement, rails, highway embankments, road ways, foundations, and channel or reservoir linings are all susceptible to cracking and fracturing when Red soils are present. These soils can also cause a reservoir to overflow.

II. MATERIALS USED

Soil Sample

The red soil collected from '**Eluru**, West Godavari District in India. The properties of the soil are given in Table 1

Figure 1 Soil Sample

Properties of Soil Sample:

Table1:Properties of soil

S.No	Property	Value
1	**Atterberg'S limits** Liquid limit (%) Plastic limit (%) Shrinkage limit (%)	 38 26 22.78
3	**Compaction properties** Optimum Moisture Content, O.M.C. (%) Maximum Dry Density, M.D.D (g/cc)	 14.1 1.71
4	Specific Gravity (G)	2.62

Alccofine

Both Alccofine 1203 and Alccofine 1101 are kinds of Alccofine, however the former has a lower calcium silicate content than the latter. The Alccofine 1200 series consists of the 1201, 1202, and 1203 types, that each corresponds to a fine, micro fine, or ultrafine particle size. while Alccofine 1101 is a micro finer cementitious grouting material for soil stabilisation and rock anchoring, Alccofine 1203 is a slag-based SCM that has ultra fineness with optimum particle size distribution. Alccofine's performance is head and shoulders above that of any and all other admixtures that are utilised in India. ALCCOFINE 1203 is a highly processed product that is based on slag that has a high glass content and strong reactivity. This slag was obtained by the controlled granulation process. The principal constituents of the raw materials are low-calcium silicates. Because of its adjusted particle size distribution, Alccofine possesses distinctive qualities that improve the performance of concrete both while it is still fresh and after it has hardened. The calculated blain value based on PSD is around 12000 cm2 /gm, which indicates that the material is in fact ultra-fine. ALCCOFINE 1203 can also be used as a high range water reducer to increase compressive strength or as a super workability aid to improve flow. Both of these applications are intended to make the

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material easier to work with. The usage of Alccofine 1203 leads to the production of a dense pore structure, and the incorporation of CaO results in an increase in the amount of secondary hydrated product. As a consequence, the material exhibits an improvement in its strength gain both early on and later on in its age. The lime content in Alccofine 1203 is 34%, which results in a greater quantity of secondary products that are hydrated. This causes the chemical reaction to take place for a longer period of time and is responsible for the decreased amount of heat that is released during the hydration process. The better particle packing of Alccofine 1203 contributes to higher rheology, which in turn contributes to improved flow ability. ALCCOFINE 1203 has been manufactured in a manner that is compliant with ASTM C989-99.

Jute Fiber

Jute is one of the most reasonable regular strands, and second just to cotton in the sum delivered and assortment of employments. Jute filaments are made principally out of the plant materials cellulose and lignin. It falls into the bast fiber class (fiber gathered from bast, the phloem of the plant, in some cases called the "skin") alongside kenaf, mechanical hemp, flax (material), ramie, and so on. The modern term for jute fiber is crude jute. The strands are grayish to brown, and 1–4 meters (3–13 feet) in length. Jute is likewise called the brilliant fiber for its shading and high money esteem.

Figure 2 Jute Fiber

Properties of Jute Fiber:

Jute fiber is produced from plants in the genus *Corchorus*, family *Malvaceae*. Jute is a lignocellulosic fiber that is partially a textile fiber and partially wood. It falls into the bast fiber category (fiber collected from bast or skin of the plant). The chemical composition of jute fiber includes cellulose (64.4%), hemicellulose (12%), pectin (0.2%), lignin (11.8%), water soluble (1.1%), wax (0.5%), and water (10%). Jute fiber consists of several cells. These cells are formed out of crystalline microfibrils based on cellulose, which are connected to a complete layer by amorphous lignin and hemicellulose. Multiples of such cellulose and lignin/hemicellulose layers in one primary and three secondary cell walls stick together to form a multiple layer composite. These cell walls differ in their composition (ratio between cellulose and lignin/hemicellulose) and in the orientation of the cellulose microfibrils

Table 3Physical Properties of Jute Fiber

S.No.	Properties	Units	Values
1.	Length	mm	25
2.	Diameter	mm	2.0
3.	Specific Gravity	-	2.3
4.	Water Absorption	%	60-85%
5.	Density	KN/m^3	13.00
6.	Tensile strength	Mpa	340

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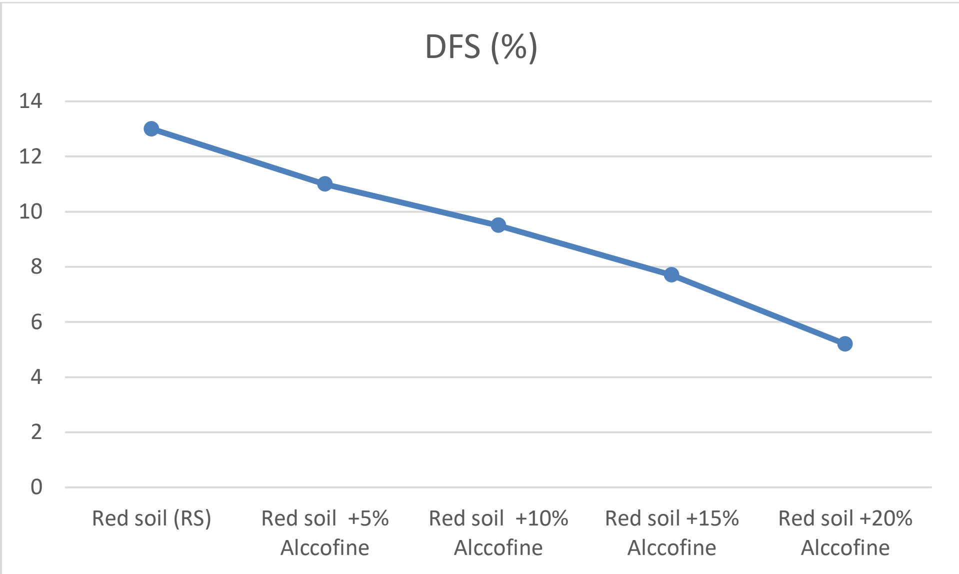
III.DISCUSSION AND RESULTS

In this part, a nitty gritty exchange on the outcomes acquired from different lab tests is displayed. This section shows the consequences of the tests directed on soil by expansion of differing level of molasses and changing level of jute fiber. The tests were led so as to decide the accompanying properties.

- Index properties and order the dirt as per Indian Standards
- Proctor compaction (MDD&OMC) attributes of the dirt.
- California Bearing Ratio (CBR) attributes of the dirt.
- Variation of compaction esteems (MDD&OMC) with differing in level of Alccofine Content.
- Variation of California Bearing Ratio (CBR) with differing in level of Alccofine content.
- Variation of UCS with shifting in level of LIME content.
- Variation of compaction esteems (MDD&OMC) with Optimum level of Alccofine content alongside differing in level of jute Fiber content.
- Variation of California Bearing Ratio (CBR) with Optimum level of Alccofine content alongside differing in level of jute Fiber content.
- Variation of UCS with Optimum level of Alccofine content alongside changing in level of Jute Fiber content
- Variation of Ultimate Cyclic Pressure and Settlement for Untreated Red soil subgrade with Model Flexible asphalt.
- Variation of Ultimate Cyclic Pressure and Settlement for Red soil soil subgrade treated with ideal rates of Alccofine and Jute Fiber for Model Flexible asphalt.

Differential Free Swell Index

Standard procedures recommended in the respective I.S. Codes of practice [IS:2720 (Part-5)-1985; IS:2720 (Part-6)-1972], were followed while finding the DFS viz.



Graph 1 Variation of DFS of RS with different % of Alccofine

Index Properties

Standard methods prescribed in the individual I.S. Codes of training [IS:2720 (Part-5)- 1985; IS:2720 (Part-6)- 1972], were pursued while finding the Index properties viz. Fluid Limit and Plastic Limit of the examples attempted in this examination. The consequences of Liquid Limit tests on far reaching soil treated with various rates of Alccofine can be seen that with increment in level of Alccofine the fluid furthest reaches of soil continue diminishing from 79% to 68%. The consequences of plastic Limit tests on far reaching soil treated with various rates of Alccofine can be seen that with increment in level of Lime the plastic furthest reaches of soil continues expanding from 38% to 52% when Alccofine is expanded from 0to 8% as appeared in fig 2.

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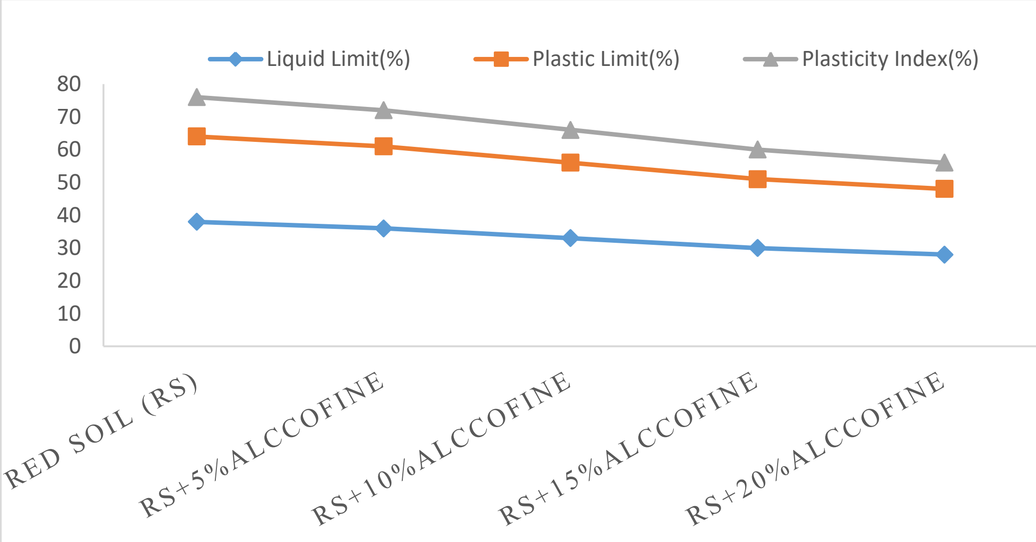
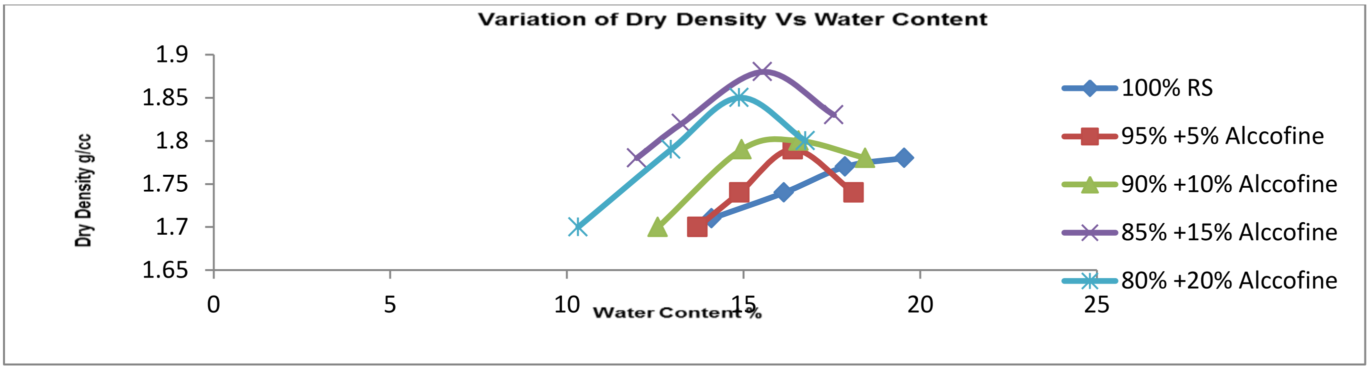


Graph 2 Variation of atterberg Limits of ES with different % of Alccofine

Compaction Test Results

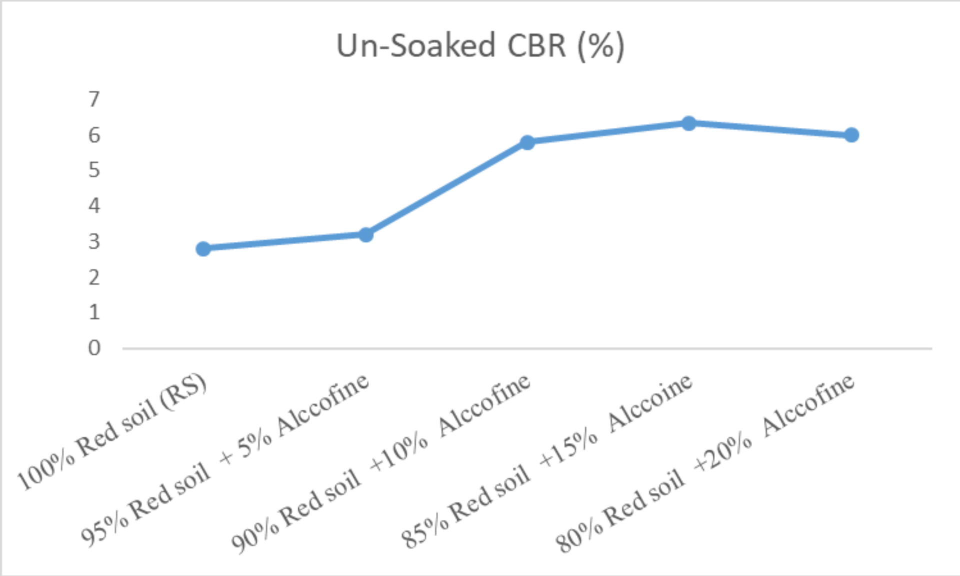
IS Modified Proctor compaction tests were directed according to Seems to be: 2720 (Part VIII). The Compaction test is completed for both Alccofine and Jute fiber. At first the far reaching soil Samples are blended with various rates of Lime and later with ideal of Alccofine blended with soil and various rates of jute fiber. Diagram are drawn between water substance and dry thickness for every rate augmentation of Lime and bamboo fiber to the far reaching soil, from these outcomes Optimum Moisture Content and Maximum Dry Density esteems are determined. The outcomes and diagram from these tests are introduced beneath:



Graph 3 Variations of OMC and MDD for RS with different % of Alccofine

California Bearing Ratio (CBR) Test Results

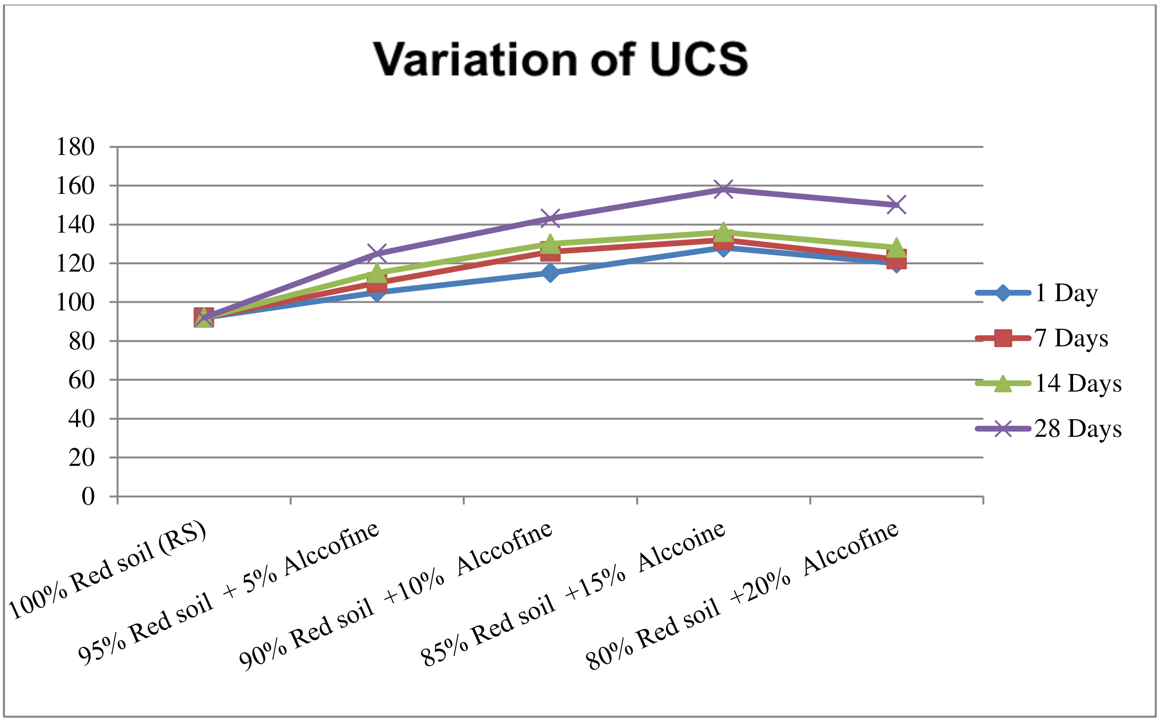
The CBR tests were directed in the research center for all the sweeping soil tests treated with various rates of Alccofine and Jute Fiber according to I.S.Code(IS:2720(part-16)- 1979).



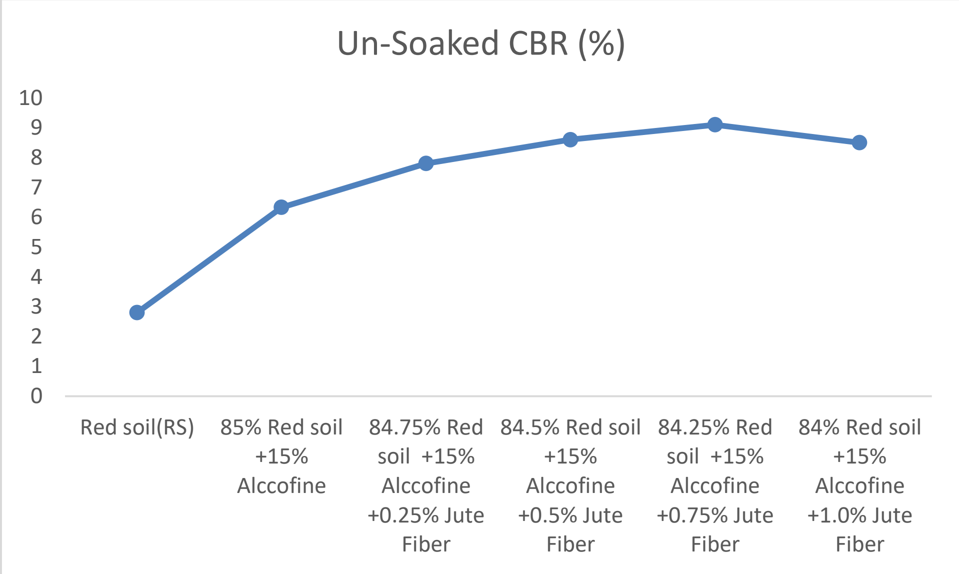
Graph 4 Variation of Un-Soaked and Soaked CBR for % RS with different % of Alccofine

Unconfined Compressive Strength Test Result

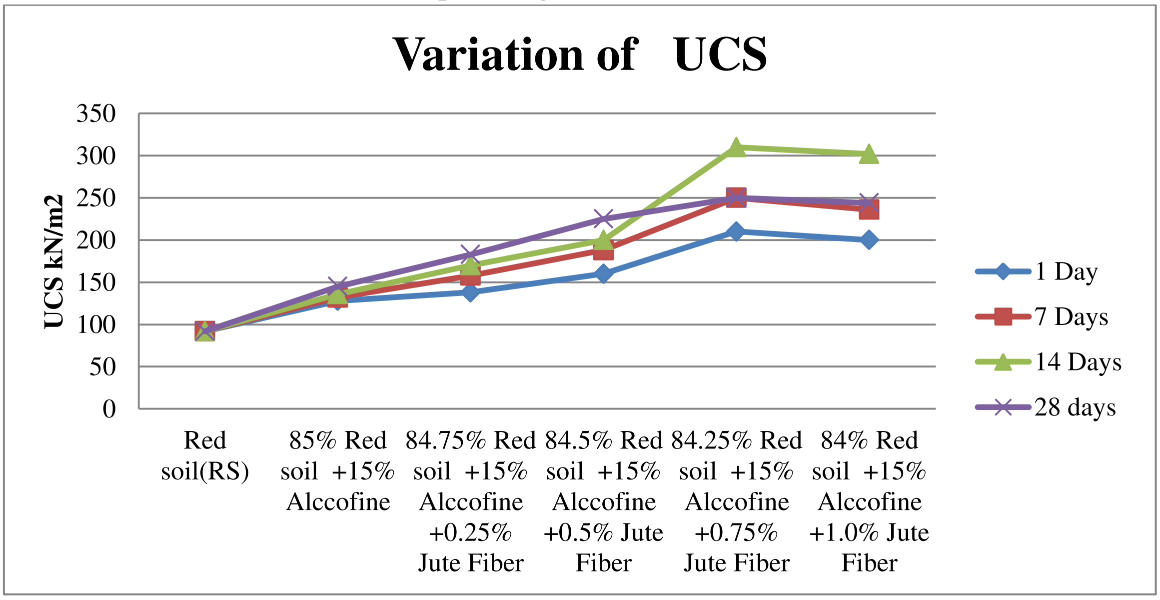
The unconfined compressive quality testing machine is utilized to direct the tests as per IS 2720-section X. The test was led with various level of lime to the broad soil. The test outcome demonstrates that the UCS esteem continues expanding upto15% of Alccofine. Distinctive relieving days for the dirt has been done (7, 14, and 28) days and the UCS esteems increments as days' increments.



Graph 5 Variation of UCS for RS with different % of Alccofine



Graph 6 Variation of CBR (Un-Soaked) of 15% Alccofine treated red soil treated and inclusion with Different percentages of Jute Fiber



Graph 7 Variation of UCS of 15% Alccofine treated red soil treated and inclusion with Different percentages of Jute Fiber

Cyclic plate load test

Cyclic plate burden tests were completed on untreated and treated Red soil asphalts in independent model tanks a woven Geotextile was utilized as fortification and separator between and subbase& base course under cyclic weights 500kPa, 560kPa, 630kPa, 700kPa, 1000kPa. The tests were directed until the disappointment of the Red soil model adaptable asphalts at OMC conditions.

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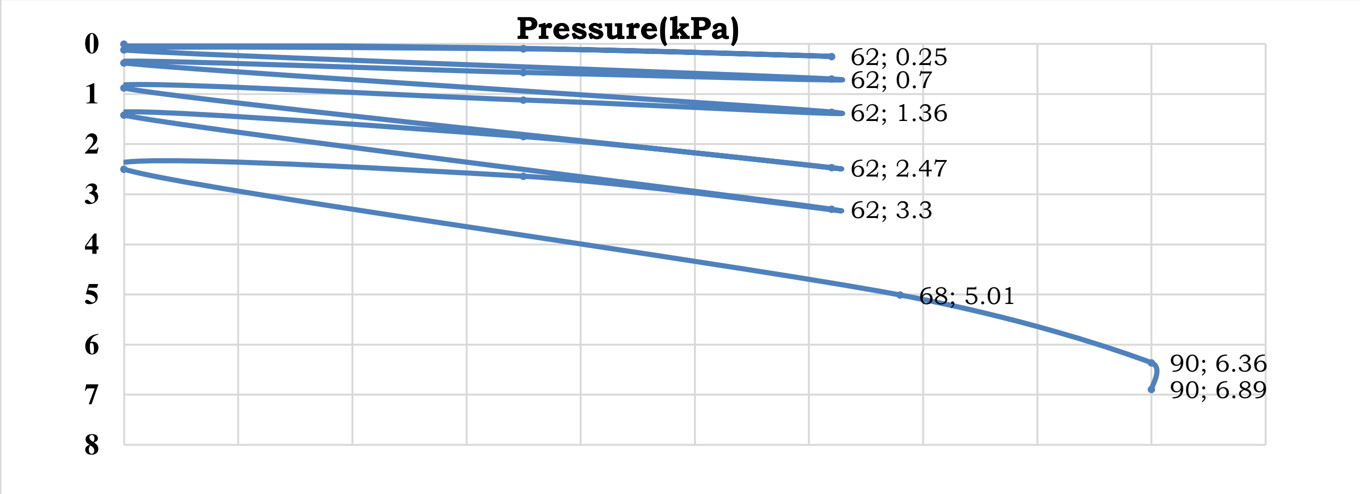
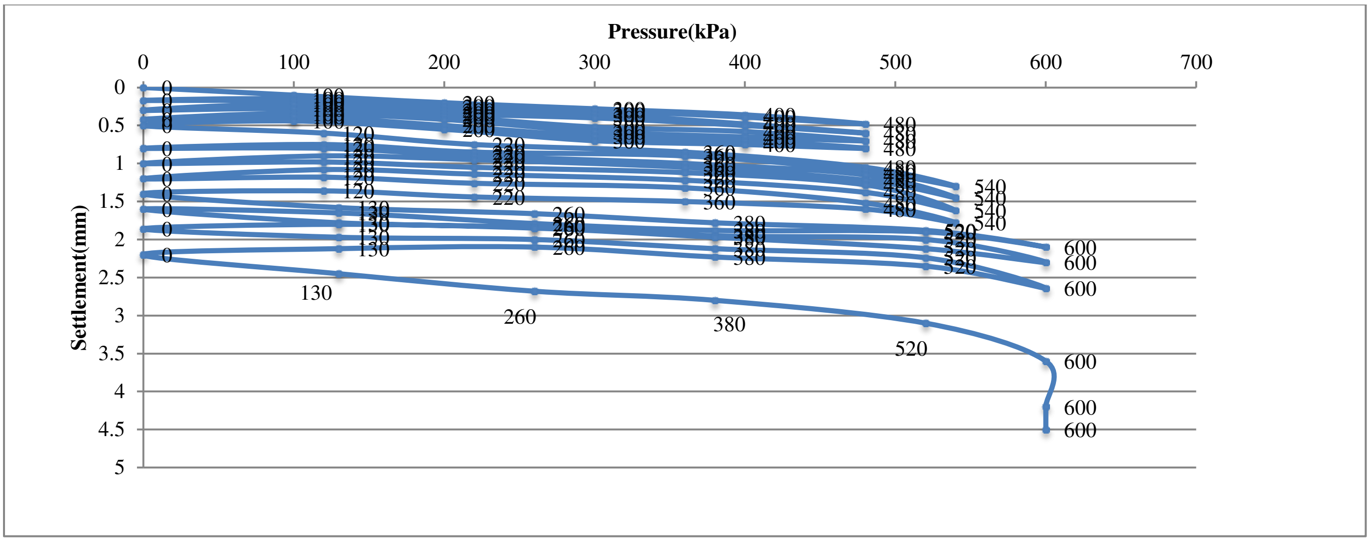
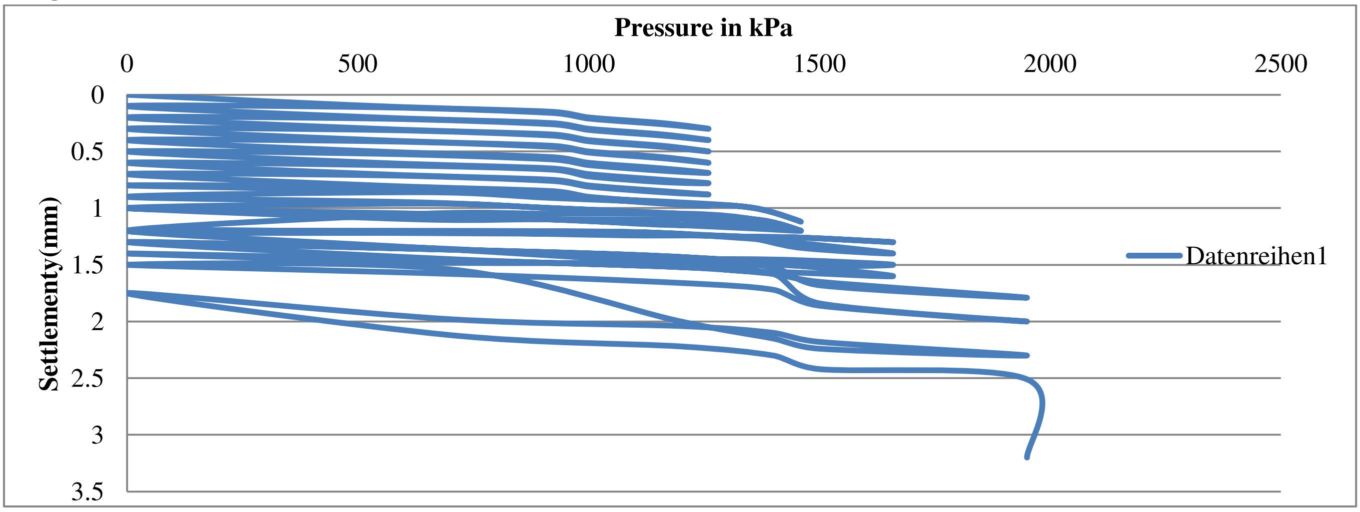


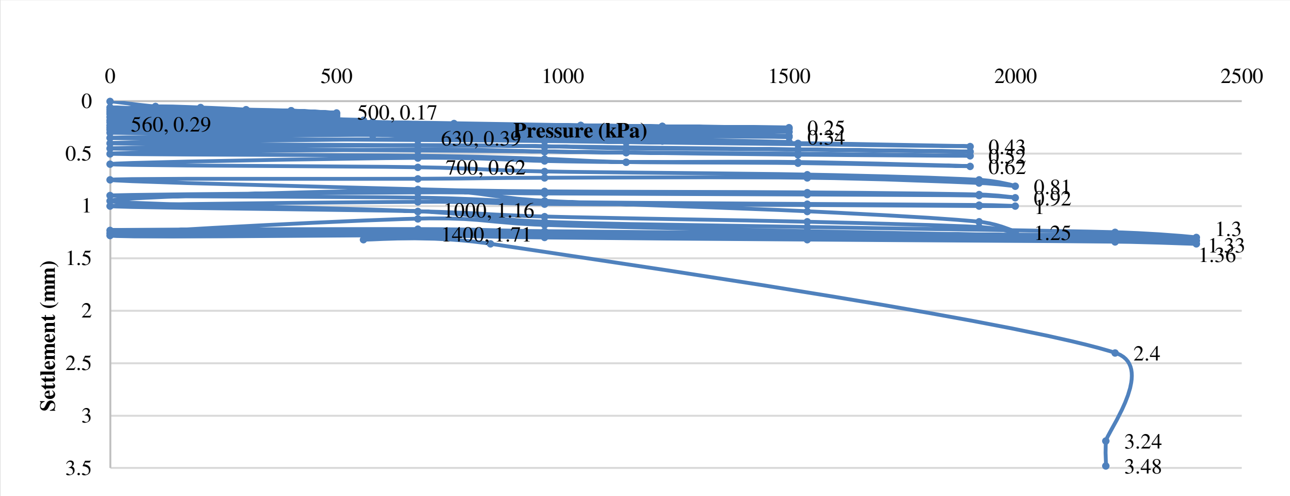
Graph8 Laboratory Cyclic Plate Load Test Results of Untreated Red Soil at OMC



Graph 9 Laboratory Cyclic Plate Load Test Results of Untreated Red soil for Model Flexible Pavement Subgrade at OMC



Graph.10 Laboratory Cyclic Plate Load Test Results of 15% Alccofine blended Exapansive soil + 1% Jute Fibre for Model Flexible Pavement Subgrade at OMC



Graph 11 Laboratory Cyclic Plate Load Test Results of 15% Alccofine Blended Red soil + 0.75% Jute Fibre+ Single Geotextile as Reinforecement and Seperator for Treated Red soil for Model Flexible Pavement Subgrade at OMC

IV. CONCLUSIONS

Based on *results* presented in this paper, *following* conclusions are drawn.

- Alccofine treated red soil strengthened with 0.75%% Jute fiber expands *quality* and lessens *weak* conduct of soil example, whereas different rates of strands utilized demonstrates a minimal increment.
- This paper assessed *impact* of Jute fiber on *quality* and compaction attributes of Alccofine treated dark cotton soil. A progression of tests was performed to think about *impacts* of Alccofine on quality attributes of dark cotton soil.
- For a given Jute fiber rate substance in *compaction* tests, greatest dry thickness of balanced out soil diminished and ideal dampness substance expanded. most extreme dry thickness of Jute fiber fortified with 15%Alccofine treated soil diminished *thickness* esteem and OMC esteem.
- Expansion of different rates of Alccofine to dark cotton soil gives expanded an incentive in *unconfined* compressive quality upto15% and expansion of Alccofine with Jute fiber likewise gave increment in compressive quality upto1.0% Jute fiber.
- relieving time frame with expansion of Alccofine and Jute fiber gave higher quality qualities. Consequently, 15% of Alccofine substance and 1.0% of Jute fiber is considered as ideal rates for dark cotton soil.
- Expansion of different rates of Alccofine to dark cotton soil gave expanded an incentive in *CBR* up to 15% as we can see in chart. At that point *expansion* of Jute fiber gave expanded estimation of CBR for 1.0 % Jute fiber.
- Mix of 15% Alccofine and 1.0% Jute fiber gives more expanded an incentive than expansion of Alccofine and Jute fiber. Subsequently, 4 of Alccofine substance and 1.0% of Jute fiber can be considered as ideal rates for dark cotton soil to build *CBR* esteem.
- Expansion of Alccofine has appeared in fluid point of confinement from 79% to 73% and improvement in plastic farthest point from 38% to 415% and versatility record decline from 41% to 29% when Alccofine substance fluctuates from 0% to 8% with an addition of 2% blended in far reaching soil because of cation particles from *Alccofine* which decreases *volumetric* changes.
- With expansion of differing level of Jute fiber with *ideal* estimation of Alccofine, as far as possible esteem diminishes to 79% to 59%, plastic limit increments to 38% to 48
- Expansion of Alccofine to dark cotton soil results declines MDD valuefrom 15.99 KN/m3 to 15.11 KN/m3 while OMC increments from 21.42% to 24.30% at 15% of Alccofine.
- Compaction qualities of treated far reaching soil-Alccofine blend at ideal 15% of Alccofine, OMC expanding from 24.39% to 31.40% and MDD diminishing from15.01 KN/m3 to 14.51KN/m3 with expansion of various rates of filaments ranges from 0.5 to 2 with an augmentation of 0.5% of Jute fiber.
- On looking at CBR esteems it is discovered that we showed signs of improvement CBR esteem when dirt is treated with both Alccofine and Jute fiber than untreated soil.

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- Expansion of Alccofine to far reaching soil, Unsoaked CBR esteems increments from 2.6% to 7.16% up to 15% of Alccofine and past esteem diminishes. Subsequently, ideal level of Alccofine is 15%.
- Expansion of Alccofine to far reaching soil, Soaked CBR esteems increments from 1.79% to 3.76% up to 15% of Alccofine and past esteem diminishes. Henceforth, ideal level of Alccofine is 15%.
- Unsoaked CBR esteem goes expanding from 7.16% to 11.65% up to addition of 1% fiber to Alccofine treated soil, past it is diminished with further expansion fibber. Henceforth, ideal level of fiber is 1%.
- Doused CBR esteem goes expanding from 3.76% to 11.65% up to addition of 1% fiber to Alccofine treated soil, past it is diminished with further expansion fibber. Henceforth, ideal level of fiber is 1%.
- From UCS test, it is acquired that unconfined compressive quality of far reaching soil is expanding with ideal of Alccofine i.e.15% and expansion of Jute fiber up to 1% and past it is diminished.
- At 0 Days, Unconfined compressive quality esteem increments from 350KN/m2 of dark cotton soil to 780 KN/m2 at 15% of Alccofine and came to 1110 KN/m2 at 1% Jute fiber with Alccofine mixed soil. From it is reasoned that 1% Jute fiber is ideal.
- At 7 Days, Unconfined compressive quality esteem increments from 420KN/m2 of dark cotton soil to 910 KN/m2 at 15% of Alccofine and came to 1370 KN/m2 at 1% Jute fiber with Alccofine mixed soil. From it is presumed that 1% Jute fiber is ideal.
- At 14 Days, Unconfined compressive quality esteem increments from 480KN/m2 of dark cotton soil to 1020 KN/m2 at 15% of Alccofine and came to 1560 KN/m2 at 1% Jute fiber with Alccofine mixed soil. From it is reasoned that 1% Jute fiber is ideal.
- At 28 Days, Unconfined compressive quality esteem increments from 500KN/m2 of dark cotton soil to 1180 KN/m2 at 15% of Alccofine and came to 1690 KN/m2 at 1% Jute fiber with Alccofine mixed soil. From it is presumed that 1% Jute fiber is ideal.
- It is seen from research facility test after effects of cyclic plate burden test that a definitive weight of treated Red soil sub level adaptable asphalt has been expanded by 225% regarding untreated Red soil sub level adaptable asphalts.
- It is seen from research center test consequences of cyclic plate burden test that Ultimate weight of treated Red soil sub level adaptable Pavement with separately fortified among subgrade and base coarse has been improved by 266.66% regarding untreated Red soil sub level adaptable asphalts.
- above perceptions give a lucidity that utilization of Alccofine and strands in soil adjustment can improve quality attributes impressively.

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