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Influence of Stone Dust on Compaction & Strenght Properties of Soil When Mixed With Juit Fiber

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Abstract: ***Over the past few years a lot of research has been done on stabilization of soil using conventional stabilizers like rice husk ash, lime etc. Studies have been made for stabilization of soil using Stone Dust and Jute Fibre individually but limited research has been carried out using the combination of S.D and Jute Fibre. Limited research has been carried on the effect of S.D and Jute Fibre on Shear Strength Test of clayey and expansive soil. The effects of stabilization on, consolidation properties, shear strength, splitting tensile strength, stiffness and hydraulic conductivity of expansive soil have not been studied by most of the researchers. A research was conducted using various percentages of stone dust (10%, 20%, 30% and 40%) and Jute Fibre (0.25%, 0.50%, 0.75% and 1.00%). Firstly tests were done on stone dust to fix the optimum percentage and further work was carried out jute fibre with variable percentages and fix percentage of Stone dust***

Keywords: Jute fibre, Stone Dust, CBR, MDD, OMC and Shear Strength.

I. INTRODUCTION

There are many waste products in India which are not utilized for any purpose. They are still getting disposed as waste without knowing that they can be used for many researches so that the method will be ecofriendly and may not harm any environmental conditions. Therefore, this research is made to use waste materials for the major problem that is instability of soil. As a consequence of tremendous fine quality and availability, extremely stone dust and Jute Fiber were both waste product of industry. As in the present situation, the soil present in region of site is utilized as fill material which may not be of good quality. With the addition of different waste material, the quality of fill material can be improved. The Stone dust and Jute Fibre, as these are byproduct and Jute industry respectively are available in abundant quantity are used for stabilization of soil. The optimum percentage of added substance material, Stone dust and Jute Fibre was found by trial study by including diverse percentage of Stone dust and Jute Fibre in clayey soil. After critically studying the literature review many gaps were drawn. Over the past few years a lot of research has been done on stabilization of soil using conventional stabilizers like rice husk ash, lime etc.

As using Stone Dust and Jute Fibre limited research has been done using it.

Studies have been made for stabilization of soil using Stone Dust and Jute Fibre individually but limited research has been carried out using the combination of S.D and Jute Fibre.Limited research has been carried on the effect of S.D and Jute Fibre on Shear Strength Test of clayey and expansive soil. The effects of stabilization on, consolidation properties, shear strength, splitting tensile strength, stiffness and hydraulic conductivity of expansive soil have not been studied by most of the researchers.

II. MATERIALS

Stone dust Stone dust is a byproduct from stone crushers and it can be used for different purposes. At one time, it was viewed as a waste material. Now days it is being used as in fertilizer industry and is also used to vary the ph value of the soil. Stone dust, otherwise called stone screenings, is the finest of the sorts of crushed stone. In spite of the fact that it is formed using a hazy kind of stone from the other two composes, it is pounded into a powder. At the point when consumed independent from anyone else material made from stone dust acts as a hard surface that is water safe.

At the point when consumed with a superior stone it goes about as a coupling whizz. In light of its capacity to shape a solid, non-permeable surface, S.D is often used as a part of between the stones or blocks in porches and walkways. In this application, it not just shields the base of the zone from dampness, in this way anticipating flinging or form development, yet it additionally adequately shields weeds and grass from mounting up between the pavers.

Stone dust an item from crusher unit comprises of basically sand size particles and have great C.B.R. values. Hence, the stone dust itself can be considered as a decent sub base material. Consequently it can be used for development of street bank. .Out from the compaction studies out on stone dust, it is discovered that the most extreme dry thickness and moisture content relationship is unaffectedly level at flat peeks. Thus the variety in water content when compared with ideal dampness content prompts slight change in most extreme dry density. As in table 1 chemical composition of stone dust can be visualized.

Table 1: Chemical composition of Stone dust

Compounds	% in Stone dust
SiO_2	60
Al_20_3	17
Fe_2O_3	8
CaO (Lime)	9
MgO	5
SO_3	>1

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Jute is second material that is to be mixed in soil. Utilization of industrial waste is considered more in industrialized and developed countries. There is rapid increase in solid waste generation in many countries. Due to this there serious environmental issues are Created in that region because of improper solid waste management. The materials that are

Generally used for road construction becomes costly day by day due to increasing demand. Many researchers have done various experiments to utilize waste material in constructing roads. If the waste material is utilized then it will not only decrease cost but also solve environmental issues related to solid waste management. In this study Jute Fibre is used as stabilizing material for soil mixed with Stone dust to improve properties of soil. It behaves like rock material and hence it can strength to sub grade. The main objective of this experimental study is to evaluate the performance of Jute as stabilizing material.

Properties of Jute

- Specific gravity -1.3 to 1.7
- Ultimate tensile strength - 3250 N/mm^2
- Modulus of Elasticity - 75 N/mm^2

Test results and discussions of soil

The index properties test on the clayey soil used is as shown in Table below.

Table: 2 Index properties of the clayey soil

Water content w.c=weight of water/weight of dry soil	Liquid limit of soil	Plastic limit of soil	Plasticity index L.L – P.L	Specific gravity Of soil
18%	34	19	15	2.67

Standard Proctor test was conducted to determine Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) of soil specimen. SPT values concluded that MDD is to be obtained when 14% water is added i.e., 1.82.California Bearing Ratio test for standard soil was calculated. It has been concluded that the value for clayey soil at 2.5 and 5.0 penetrations are:-

CBR (2.5) = 5.47

CBR (5.0) = 4.76

California Bearing Ratio Test (IS 2720-16-1987)

The California Bearing Ratio (CBR) test is a simple strength test that compares the bearing capacity of a material with that of a well-graded crushed stone (thus, a high quality crushed stone material should have a CBR @ 100%). It is primarily intended for, but not limited to, evaluating the strength of cohesive materials having maximum particle sizes less than 19 mm (0.75 in.) (AASHTO,2000).

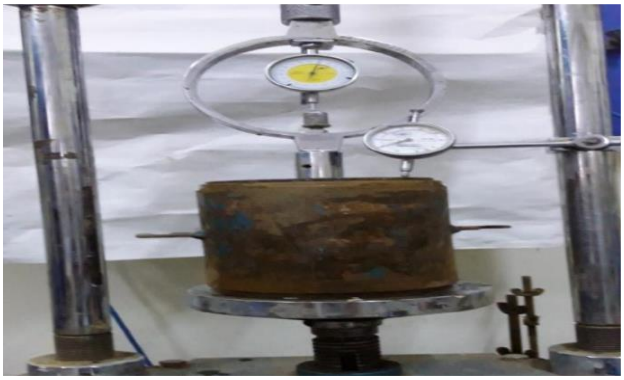


Fig. 1 Sample under testing

Equation

Values obtained are inserted into the following equation to obtain a CBR value:

$$\text{CBR (\%)} = 100 \left[\frac{x}{y} \right]$$

Where: x = material resistance or the unit load on the position (pressure for 2.54 mm (0.1”) or 5.08 mm (0.2”) of penetration

Y = standard unit load (pressure) for well graded crushed stone

= for 2.54 mm (0.1”) penetration = 6.9 MPa (1000 psi)

= for 5.08 mm (2.0”) penetration = 10.3 MPa (1500 psi)

Various tests were conducted as per IS codes in this study to determine the engineering properties of stabilized soil and effect of S.D and Jute Fibre on the soil sample.

Based on the test results, Addition of Jute Fibre enhance the Geo-technical properties of the original soil and it also has nice results at the energy traits of the soil. Jute Fibre is an agricultural waste that is cheaper and environmental friendly, so as a powerful stabilizer, fibre could have been a very good opportunity at the opposite while we blended soil with dust as it is proved that the blended results of the each admixture is pretty handful compare to use any single admixture.

III. RESULTS AND DISCUSSION

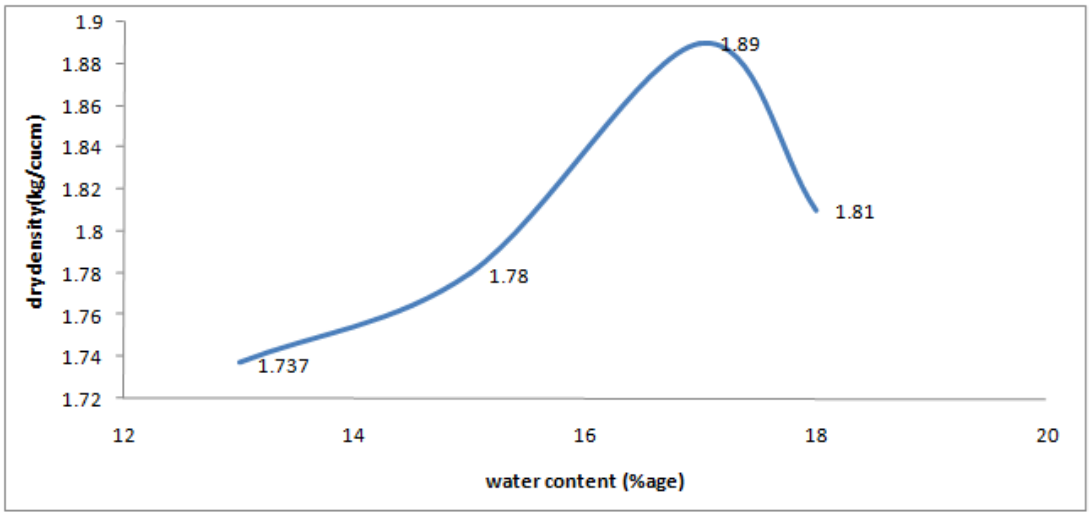
The aim of this study is to analyze the improvement in the geotechnical properties of clayey soil like Compaction Characteristics, California Bearing Ratio (soaked and unsoaked) values with utilization of Stone Dust and Jute Fibre at different proportions. The various tests were conducted in this regards such as Liquid Limit Test, Plastic Limit Test, Specific Gravity, Standard Proctor Test (SPT) and California Bearing Ratio Test (CBR).The results of all these tests were collected.

OMC and MDD with addition of Stone dust

The tests were performed at CBR (2.5) as it gave maximum value. Standard Proctor Test values were obtained for different proportions of Stone Dust i.e., at 1%, 2%, 3% and 4% mixed with different amount of soil. Table 3 shows the values of SPT for stone dust to obtain MDD.

Table 3: MDD and water content value at various percentages of Stone Dust

Stone Dust (%)	10	20	30	40
Water content (%)	13	15	17	18
dry density kg/cm3	1.737	1.780	1.890	1.810



Graph 1: Graph between MDD and Water content at different percentages of Stone Dust

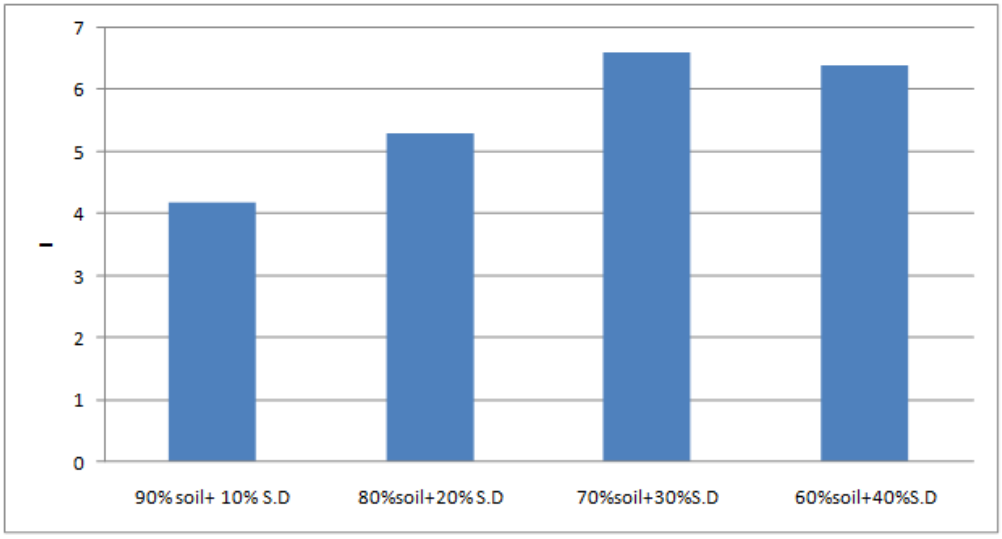
CBR value with addition of Stone Dust

After calculated the SPT values for stone dust, CBR was performed to obtain the particular amount or proportion of Stone Dust which gives the maximum strength to the soil for stabilization.

Study was conducted on soil samples with various percentages of stone dust. This experiment determines C.B.R. percentage of Soil-Stone Dust. On addition of stone dust the CBR value goes on increasing which signifies that the strength goes on increasing.

Table 4: CBR results for stone dust at various percentages.

SOIL + STONE DUST (%)	CBR (2.5mm)
90% Soil + 10% S.D	4.2
80% Soil + 20% S.D	5.3
70% Soil + 30% S.D	6.6
60% Soil + 40% S.D	6.4



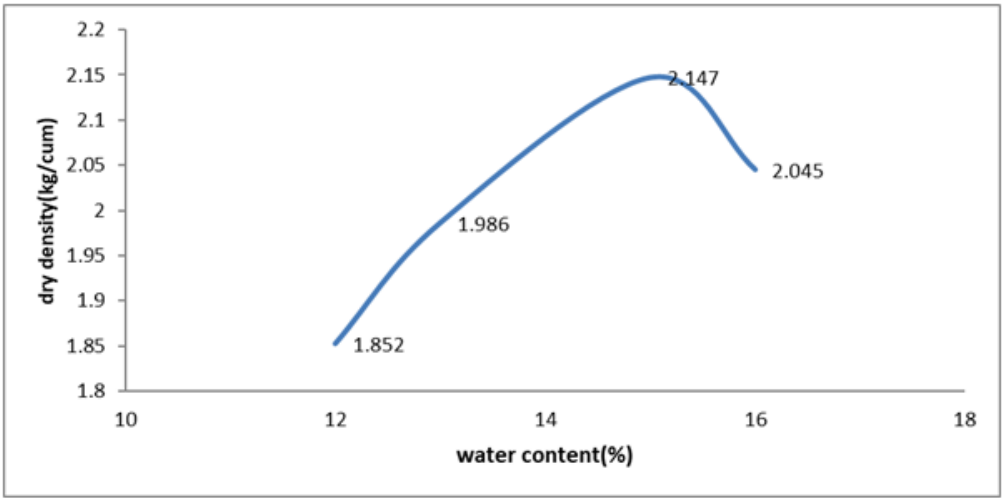
Graph 2: Graph of CBR on addition of various percentages of Stone Dust

Addition of Jute fibre with Stone dust

Stone Dust will be added as 3% for further experimental investigations. After the calculation of the optimum percentage of Jute fibre, following results were obtained as shown in Table 5.

Table 5: MDD and water content values at various percentages of Jute Fibre with Stone Dust

Stone Dust + Jute Fibre (%)	WATER CONTENT (%)	D.D (kg/cum)
30% S.D + 0.25% J.F	12	1.852
30% S.D + 0.50% J.F	13	1.986
30% S.D + 0.75% J.F	15	2.147
30% S.D + 1.00% J.F	16	2.045



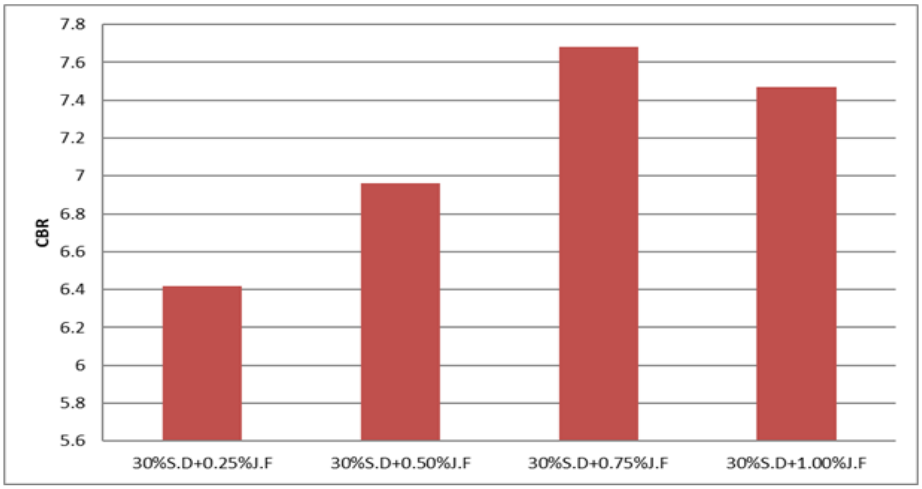
Graph 3: Graph between MDD and Water content at different percentages of Jute Fibre with Stone Dust

CBR with addition of 3% stone dust and various percentages of jute fibre (Soaked)

Tests were conducted on soil samples with 30% S.D and various percentages of J.F under Soaked condition. The soil sample was prepared and the mould was filled with the soil sample and was placed under curing period of 4 days or 96 hours. It was observed that the California Bearing Ratio increases as the curing period increases. With addition of 3% Stone dust and 0.75% J.F the CBR value shows the maximum strength and thereafter the strength decreases. So the optimum percentage of J.F is fixed as 0.75% for soaked condition after calculating the values of SPT with Stone dust and J.F, CBR tests were performed for the same. Following values were obtained after performing CBR soaked and unsoaked.

Table 6: CBR (soaked) results for Stone Dust and varying percentages of Stone Dust

Stone Dust + Jute Fibre (%)	CBR (soaked) (%)
30% S.D + 0.25% J.F	6.42
30% S.D + 0.50% J.F	6.96
30% S.D + 0.75% J.F	7.68
30% S.D + 1.00% J.F	7.47



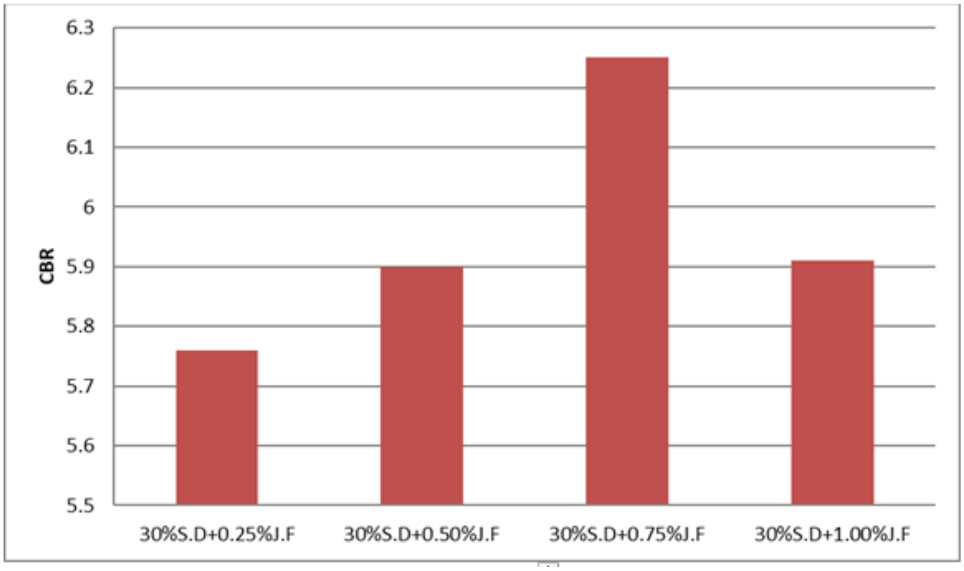
Graph 4: Graph of CBR values on addition of 30% with various percentage of Jute Fibre (soaked Condition)

CBR on addition of 3% Stone dust with various percentage of Jute Fibre (Unsoaked)

Tests were conducted on soil samples with 30% S.D and various percentages of J.F under unsoaked condition. On addition of 30% S.D with 0.75% J.F the CBR value shows the maximum strength and thereafter the strength decreases. So the optimum percentage of J.F is fixed as 0.75% for un-soaked condition.

Table 7: CBR (unsoaked) results for Stone Dust and varying percentages of Stone Dust

Stone Dust + Jute Fibre (%)	CBR (unsoaked) (%)
30% S.D + 0.25% J.F	5..76
30% S.D + 0.50% J.F	5.90
30% S.D + 0.75% J.F	6.26
30% S.D + 1.00% J.F	5.91

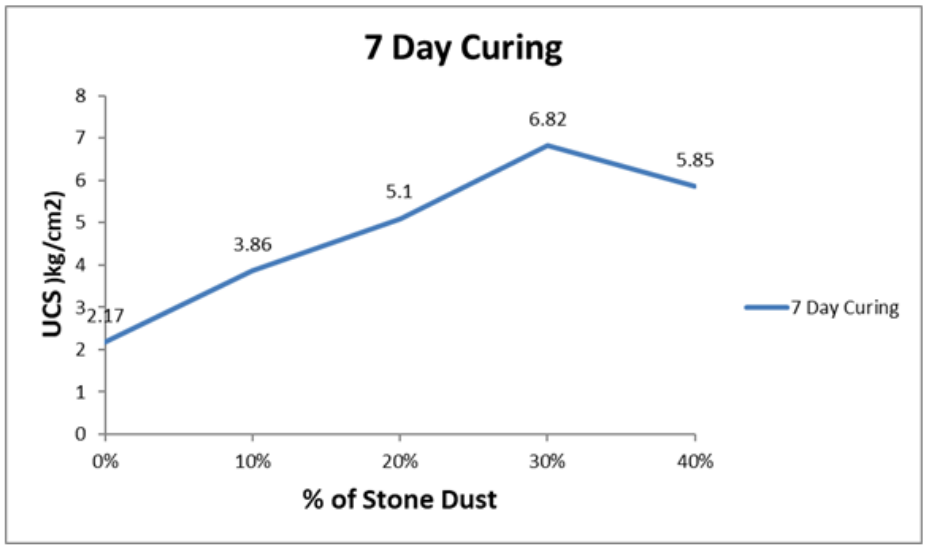


Graph 5: Graph of CBR values on addition of 30% S.D with various percentage of J.F (Unsoaked Condition)

Tests were conducted on soil samples with 30% S.D and various percentages of J.F The percentage relative increase in strength was maximum between 30% and 40%. Hence 30% stone dust was taken as the optimized amount.

Table 8: Results of U.C.S with various percentage of S.D after 7 Days curing

Sr. no.	Proportions	UCS(kg/cm^2)
1	Virgin soil	2.17
2	Soil: S.D = 90:10	3.86
3	Soil: S.D = 80:20	5.10
4	Soil: S.D = 70:30	6.82
5	Soil: S.D = 60:40	5.85

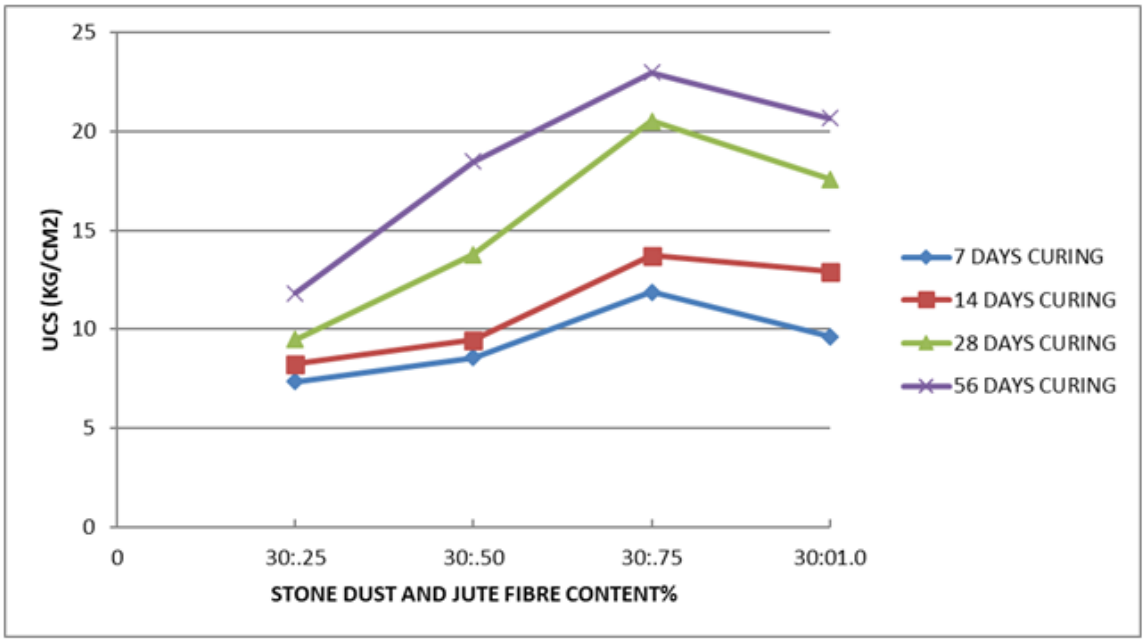


Graph 6: Graph showing increase in UCS of soil for different proportions of Stone Dust

Table 9: Results of U.C.S with Stone Dust and Jute Fibre after 7, 14, 28 & 56 Days curing

Sr. No.	Proportion	Curing Period	U.C.S. (kg/cm^2)
1	S.D:J.F = 30:0.25	7 14 28 56	7.352 8.246 9.482 11.807
2	S.D:J.F = 30:0.5	7 14 28 56	8.576 9.448 13.784 18.479
3	S.D:J.F = 30:0.75	7 14 28 56	11.866 13.725 20.527 22.973
4	S.D:J.F = 30:1.0	7 14 28 56	9.632 12.915 17.576 20.681

Out from the tabular values a graph 4.7 shows the values of UCS on 7.14,28 and 56 days curing by taking stine dust 30% and varying the percentages of Jute Fibre.



Graph 7: Combined graph showing UCS of soil for different proportions of jute fibres with 3% stone dust at 7, 14, 28 and 56 days curing period.

IV. CONCLUSION

- From the test results we came to a conclusion that addition of Jute Fibres enhances the geo-technical properties of the original soil.
- OMC of soil increases with increase in the percentages of Stone dust and Jute fibre. MDD of clayey soil decreases with increase in the percentages of Stone dust and Jute fibre content in clayey soil.
- Specific gravity increases with increase in percentage of Stone Dust and Jute fibre in clayey soil, also stone dust and jute fibre reduces the plasticity of clayey soil. It is observed that addition of fibre enhances not only the strength development but also the durability of stone dust stabilized soil. Treatment with fibre showed a general decrease in the MDD and increase in OMC with increase in the jute fibre content.
- It is also be concluded that for the improvement in strength using stabilization in practical purposes, these optimum percentage values of jute fibre and stone dust can be recommended for construction. But addition of stone dust and fibre beyond this limit to the soil is not beneficial and workable.
- The percentage relative increase in strength was maximum between 0.3 to 0.75%. Hence 30% stone dust was taken as the optimized amount.
- The increase in U.C.S due to addition of stone dust to soil may be due to pozzolanic reactions between alumina or silica from clayey soil and lime, which forms the cementious products.
- The results shows that addition of 0.75% jute fibre content with 3% stone dust in soil at 7 days, 14 days, 28 days and 56 days curing period, maximum unconfined compressive strength value is achieved. Further addition of jute fibre content with 3% stone dust does not contribute towards strength.

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