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# Study of Stabilization of Soil with Stone dust, Fly Ash and Coir Fiber

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**ABSTRACT-** In this paper, the individual as well as combined use of stone dust, fly ash and coir fibre in the soil stabilisation is investigated. Fly ash and stone dust was nixed in the soil at individual percentage varying from 5% to 20% and coir fibre was mixed with percentage varying from 0.5% to 2%. Five different samples of each replacement were made at different percentages based on the individual results the five different samples with combination of stone dust, fly ash and coir fibre was made and tested for optimum moisture content, maximum dry density, california bearing ratio and unconfined compressive strength. The values of all testes performed by mixing soil withstone dust, fly ash and coir fibre was then compared with soil sample and it was found that mix of soil with up to coir fibre 2%, fly ash 15% and stone dust 20% gives maximum value of dry density, soil mix with coir fibre 1%, fly ash 20% and stone dust 20% has given maximum cbr value 24.52 and maximum ucs value 168.59 was found with mixture of soil with coir fibre 2%, fly ash 15% and stone dust 20%.

**KEYWORDS-** Soil, Coir Fibre, Stone Dust, Fly Ash, Soil Stabilization, CBR

## I. INTRODUCTION

The process of improving the numerous engineering features of a specific soil and making it more stable for construction purposes is known as soil stabilisation. When the soil that is available for building purposes is inappropriate for the purpose, it is required [1].

Along with other technical developments, progress in the construction industry and infrastructure industry is also necessary for a country's growth [2]. With our nation's urbanisation, it has become difficult to locate acceptable soil quality for building and engineering applications. As a result, engineers face a difficult problem in coming up with innovative concepts that would allow experts to operate with even poor soil quality without risking structural failure[3]. With the variety of soil types accessible in our nation, one of the most common is expansive soil, which poses a number of challenges to the structures created on it [4]. This research focuses on the improvement of expansive soils and how various soil geotechnical characteristics may be improved via the usage of various soil geotechnical factors by the use of Stone Dust, Fly Ash andCoir Fibre.

The main goal of soil stabilization is to improve the strength properties and reducingthe value settlement. Soil stabilization isunfailing and efficient technique to enhance soil strength and soil firmness [5]. The material which is used to mix with soil for stabilization of soil is known as the soil stabilizer [6].

It is illustrious that mechanism of stabilization of soil by easily available materials like Stone Dust, Coir fiber and Fly Ash is a worthy method of ground improvement, which leads to increase in UCS, CBR value of expansive soil, hence it increases the stability of structures, i.e. subgrade and foundation [7].

## II. REVIEW OF LITERATURE

Abrahan et.al. (2001) studied the use of quarry dust which is obtained by cutting of rocks. They discovered that the quarry dust has high shear strength value and specific gravity, the soaked CBR values for modified compaction efforts and standard compaction are found to be around 49% and 23% respectively [8].

Chaple et al. (2013)in his experiment studied effect of reinforcing the soil with coir fiber on the bearing capacity and settlement of isolated square footing, with 1.00%, 0.75%, .50% and 0.25% of coir fiber. The square footing which was supported on compressible clayey soil reinforced with coir fiber distributed randomly in soil. It was observed with use of coir fibre the bearing capacity of footing was increased. The ultimate bearing capacity for reinforced soil with 0.50% coir for 25 mm, 50 mm and 100 mm depth were 665 kN/m², 495 kN/m² and 425 kN/m² respectively which waslarger than virgin soil having a value of 250 kN/m². The bearing capacity of the footing was increases only up to a fiber content of 0.50% and when coir fibre content was further increasedthe bearing capacity started decreasing [9].

Dasaka et al. (2011) reinforced the soil by using coir fiber with various percentage and he examined that ifaverage length of coir fibre present is 15 mm, the UCS of soil increases with the increase in coir fiberand the improved soil shows ductile behaviour with the addition of the coir fiber. It was also found that maximum compressive strength inceases up to the fiber content of 1.5% and after that, the compressive

strength stops increasing. From this study, it is stated that increase in coir-fiber cause slow failure in soil and samples behave like ductile material and good failure surface could not be found anywhere in soil sample due to increase in its ductile behaviour [10].

Dutta et al. (2012) studied the effect of addition of coir fiber in the UCS Value of the soil. He took NaOH,Dry coir fiber and carbon tetrachloride treated coir fibers for the study. The specimen for the UCS tests were prepared by unreinforced and reinforced dry coir fiber with fiber content0.4%, 0.8% and 1.6%. An increase in axial UCS stress from 63.98 kPa to 79.67 kPa was observed in this study and when the specimen was reinforced with 0.4% dry coir fibre this value increased to 114.77 kPa. Similarly, for the NaOH treated fiber the peak stress of clay specimen with 0.4% coir-fibers was 81.47 kPa which after increasing content of fiber upto 1.6% raised to 130.03 kPa. Further, when the soil mix was reinforced with 0.4% Calcium tetra Chloride treated fibers, the maximum stress found was 70.69 kPa, which further increased tupo 245.78 kPa when content of fiber was raised to 1.6% [11].

Dasaka et al. (2011) reinforced the soil with the coir fiber at various fiber content and found that with the fiber length of 15 mm, unconfined compressive strength increases with the increase in the fiber content and the soil shows a ductile behaviour with the addition of the fiber. It was found that peak compressive strength increased up to the fiber content of 1.5% and after that, the compressive strength does not increase considerably. From the study, it can be stated that with the increase in the fiber content the failure would take place slowly and samples behave like ductile material and well-defined failure surface could not be seen due to increased ductile behaviour [12].

Dutta et al. (2012) studied the effect of inclusion of coir fiber (15 mm in length) in the unconfined compressive strength of the soil. Dry fiber, sodium hydroxide and carbon tetrachloride treated coir fibers were taken for the study [13].

## III. MATERIALS USED

The main objective of this study is to investigate the change in the behaviour of soil when Coir Fibre, Stone Dust and Fly Ash at varying percentages was mixed in clayey soil through the various geotechnical tests conducted in the laboratory [14].

### *A. Soil*

350 kg sample of soil used in the mix was collected from the fields of BUMORA (KATHUA DISTRICT), J&K. It will be combined with Coir Fibre, Fly Ash and Stone Dust in different proportions for further analysis.

The soil collected from the site was pulverized to break the lumps with wooden hammer and then dried in air under covered area [15]. Then it was sieved through 2.35mm IS sieve and mixed thoroughly. The properly mixed soil was stored in polythene bags. For each test required quantity of soil was taken from polythene bags and dried in an oven at 100˚ C ± 5˚C for 24 hours. The soil was allowed to cool at room temperature.

### *B. Coir Fibre*

These fibers are biodegradable and environmentally friendly [16]. It has the greatest tearing strength among all-natural fibers and retains this property in wet conditions. Therefore, coconut fiber is selected as the reinforcement material for this study. Coir used for the study was cut into 30 mm length. Coir fiber will be purchased from Anand mattress manufacturing company GANGYAL (JAMMU DISTRICT), J&K.

Cellulose, hemicellulose, lignin, pectin, waxes, and water-soluble compounds are all components of natural fibres. Natural fibres are made up of three main components: cellulose, hemicellulose, and lignin.

### *C. Fly Ash*

It is waste material extracted from the gases exiting from thermal plants and coal fired furnaces. After the burning of coal in the power generation process the material residue which is left behind is the fly ash [17]. The Electro-Static Precipitator (ESP) of the power installed in the chimineas of plants collect these fly ashes. Which essentially consistof silica, alumina and iron, fly ashes are very small micro-sized particles generally spherical in the size, and this property makes it convenient for them to blend and flow, to make a suitable mixture of various ingredients. Both crystalline as well as amorphous nature of these minerals are the content of generated fly ash [18]. The Composition of different content in fly ash varies by the change in nature of coal used in process of burning, but it is basically a silt of non-plastic. For the purpose of investigations in this study Fly Ash was purchased from Varinder Fly Ash Products Yard no. 52, Bari Brahmana, Near Sidco Industrial Lain in District Jammu (Jammu and Kashmir). this fly ash was screen through a 2 mm sieve. The samples were dried in the oven for about 24 hours before further usage.

### *D. Stone Dust*

Stone dust was obtained from the Crusher industry situated at Ravi River, Kathua, India. the main crystalline mineral present in Stone dust.

## IV. METHODOLOGY

The clayey soil will be mixing with four different content of coir fibers and Fly Ash in order to prepare various samples.

In order to investigate the various geotechnical properties of soil tests were conducting in soil and soil mixed with the various percentages of coir fiber, the various tests conducting are listed as:

- Standard proctor’s test
- Unconfined compression test
- California bearing ratio

In order to determine the content of coarse grain soil and fine grain soil this test was conducted in two steps:

- Sieve analysis
- Sedimentation analysis
- Sieving was used to determine the coarser content of the soil, which revealed the proportion of gravel and sand in

the sample. So, according to IS: 2720 (Part IV) -1985, this was done by utilising several sieves ranging in size from 40 mm to.075 mm, as well as a hydrometer test to assess the content of silt and clay in the soil.

### *A. Consistency of Soil*

Consistency is the term used to describe the ability of the soil to resist rupture and deformation. It is commonly described as soft, stiff or firm, and hard.
Three tests will be conducted in consistency limits:

- Liquid limit
- Plastic limit
- Plasticity index

### *B. Specific Gravity Determination*

The specific gravity of the soil fraction was calculated using a Pycnometer and a 4.75 mm IS sieve, as per the instructions of IS: 2720 (Part III) 1980. It is defined as the weight of a certain volume of solids divided by the weight of an equivalent amount of water at 4 degrees Celsius.

### *C. Proctor's Standard Compaction Test*

The optimum water content (OMC) and maximum dry density (MDD) will be obtained by conducting Standard Proctor's Test as per IS:2720 (Part 7) –1980. The relation between moisture content and dry density is obtained from compaction test.

### *D. California Bearing Ratio Test*

This test will be conducted to determine the CBR values under soaked and unsoaked conditions. The apparatus includes cylindrical mould with a detachable collar, displacer disc, metal rammer, steel collar, surcharge weight, filter paper and loading device. CBR values are calculated for penetration of 2.5mm and 5mm for unsoaked.

### *E. Unconfined Compression Test*

The unconfined compression test will be used to measure the shearing resistance of expansive soils which may be undisturbed or remoulded specimens. An axial load is applied using either strain-control or stress-control condition.

## V. RESULTS AND ANALYSIS

After the soil was completely oven dried, the following different tests were performed on the sample:

- Standard Proctor Test (IS: 2720 Part VII-1980)
- Atterberg's limit analysis test (IS: 2720 Part V-1985)
- Specific Gravity Test or Pycnometer test (IS: 2720 Part III-Section I/II-1980)
- Unconfined compressive strength (UCS) test (IS: 2720 Part X-1991)
- California bearing ratio (CBR) test (IS: 2720 Part XVI-1987)
- The Value of liquid limit of soil was observed as 37.5%.
- Plastic limit of the soil sample was 21.5%.
- Specific Gravity of the soil sample was 2.86

First of all, Standard penetration test is conducted with different proportions and samples of Soil , Fly Ash , Coir Fibre & Stone Dust and Various Figures are obtained between Moisture Content and Dry Density .
For example figure 1 shows us the SPT Values with Soil 68.0%, Fly Ash 15.0%, Coir Fibre 2.0% & Stone Dust 15.0%. Similarly various Figures are obtain with different values with different proportions of Fly Ash , Coir Fibre & Stone Dust.

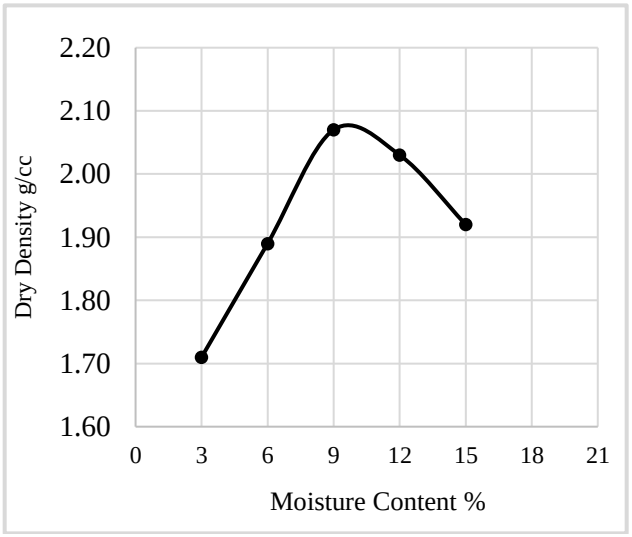


Figure 1: SPT with Soil 68.0%, Fly Ash 15.0%, Coir Fibre 2.0% & Stone Dust 15.0%

Similarly California Bearing Ratio Test For Different samples of soil is done with different proportions of Fly Ash , Coir Fibre & Stone Dust and Various Figures with different values are obtained .
For Example Figure (2) shows us the CBR result of Soil with Coir Fibre 1.0%, Fly Ash 5.0% and Stone Dust 10.0%.

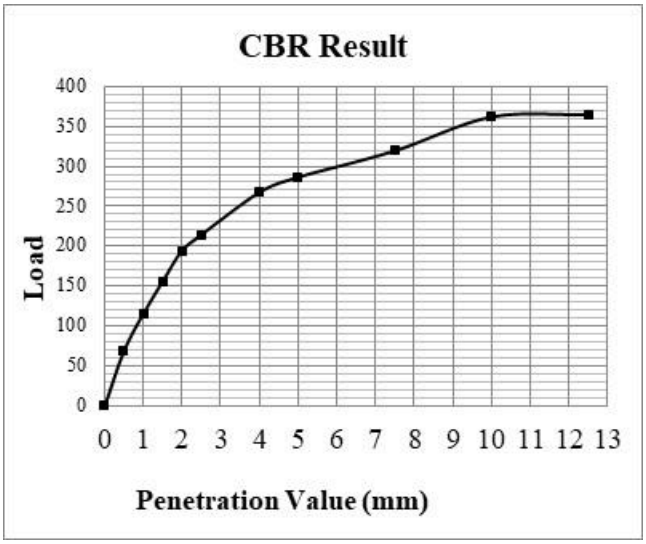


Figure 2: CBR Plot Soil 84.0%, Coir Fibre 1.0%, Fly Ash 5.0% and Stone Dust 10.0%

Table 1: CBR at 2.5 & 5mm

| Penetration Value | Load | CBR Value (%) | |
|---|---|---|---|
| | | | |
| 2.5 mm | 214.37 | 15.65 | 15.65 |
| 5.0 mm | 286.32 | 13.93 | |

Again Soil Samples are made for Unconfined Compressive Strength Test (UCS test )and various figures for different soil samples with different proportions of Fly Ash , Coir Fibre & Stone Dust and are obtained .Example Figure (3) shows us the UCS Value with Soil 68.0%, CF 2.0%, Fly Ash 15%, Stone Dust 15.0%.

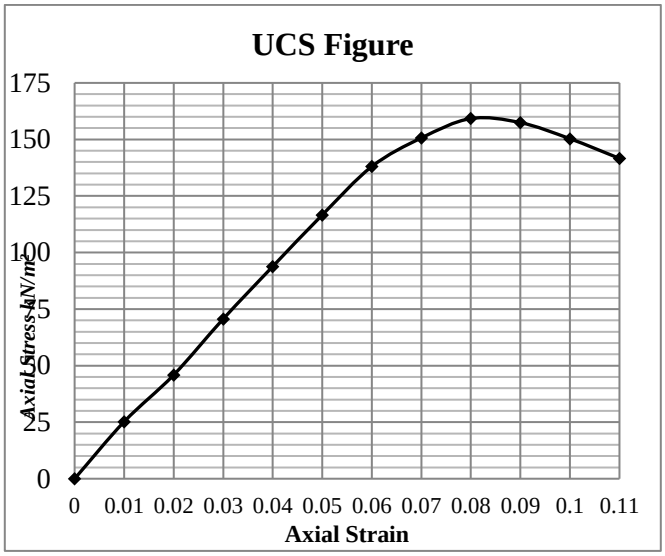


Figure 3: UCS Value Soil 68.0%, CF 2.0%, Fly Ash 15%, Stone Dust 15.0%

## VI. CONCLUSION

On the basis of experimentations, the following conclusions have been drawn:

### *A. Standard Proctor Test Results*

Based on optimum values found in individual results five different combinations of Coir fibre, Fly Ash and Stone dust with soil was made and the maximum MDD value was found with Coir fibre 2%, Fly Ash 15% and Stone Dust 20%. Figure (4) shows us the result.

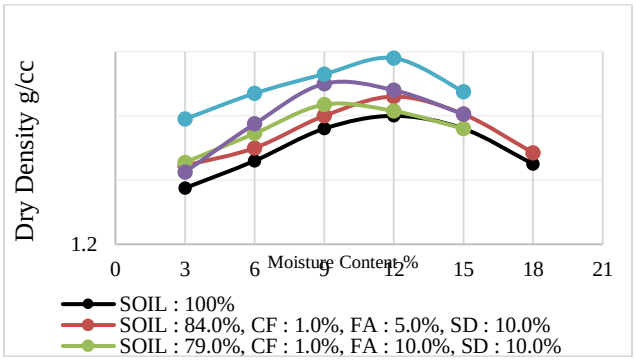


Figure 4: Standard Proctor Test Results of Soil with Coir Fibre, Fly Ash and Stone Dust Mix

### *B. CBR Test Results*

Based on optimum values found in individual results five different combinations of Coir fibre, Fly Ash and Stone dust with soil was made and the maximum CBR value was found with Coir fibre 1%, Fly Ash 20% and Stone Dust 20%. Figure (5) - shows us the CBR Values of Soil with Combined Coir Fibre, Fly Ash & Stone Dust Mix. An increase of CBR value was observed 8.29% to 15.89% when the percentages of Fly Ash is mixed as 5, 10 and 15% respectively after that it starts decreasing.

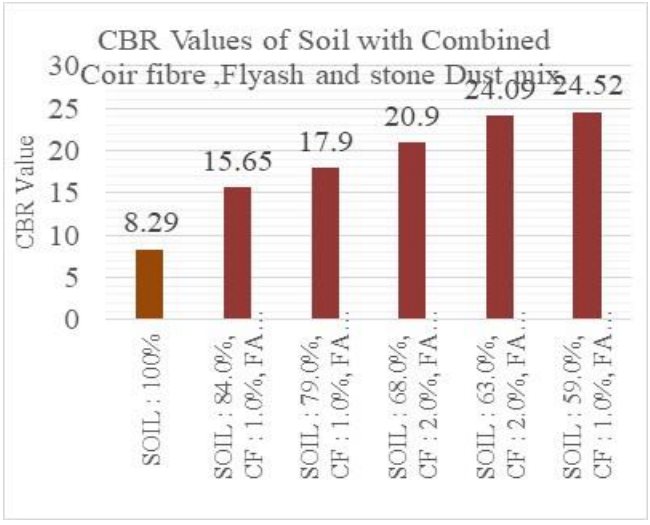


Figure 5: CBR Values of Soil with Combined Coir Fibre, Fly Ash & Stone Dust Mix

### *C. Unconfined Compressive Strength (UCS) Test Results*

Based on optimum values found in individual results five different combinations of Coir fibre, Fly Ash and Stone dust with soil was made and the maximum UCS value was found with Coir fibre 2%, Fly Ash 15% and Stone Dust 20% after that it starts decreasing.

Figure (6) shows us the UCS Values of Soil with Combined Coir Fibre, Fly Ash & Stone Dust Mix.

An increase of UCS value was observed 86.57N/mm² to 181.31 N/mm² when the percentages of Coir Fibre is mixed as 0.5, 1.0 1.5 and 2.0% respectively.

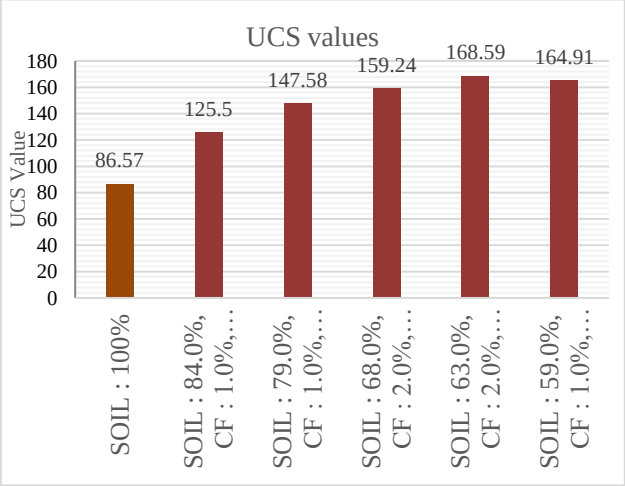


Figure 6: UCS Values of Soil with Combined Coir Fibre, Fly Ash & Stone Dust Mix

So, from Experiments and results it was found that mix of soil with up to Coir fibre 2%, Fly Ash 15% and Stone Dust 20% gives maximum value of Dry Density, Soil mix with Coir fibre 1%, Fly Ash 20% and Stone Dust 20% has given maximum CBR Value 24.52 and Maximum UCS Value 168.59 was found with Mixture of soil with Coir fibre 2%, Fly Ash 15% and Stone Dust 20%.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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