

# SOIL STABILIZATION USING DIFFERENT FIBRES WITH ALCCOFINE

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**Abstract:** Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical to produce an improved soil material which has all the desired engineering properties. In this paper, coconut coir fibre and human hair fibre were used at varying percentages with Alccofine to stabilize the soil. Various geotechnical laboratory tests like Atterberg's limit, compaction, unconfined compression test and California bearing tests were carried by the varying percentage of coconut coir fibre (0.5%, 0.75% and 1%) and human hair fibre (0.5%, 1% and 1.5%) respectively with 10% of Alccofine. The optimum results of configuration of soil, Alccofine and coir fibre and soil, Alccofine and human hair fibre will be compared for the increment in properties to arrive at the best end.

**IndexTerms** - Alccofine, Human Hair Fibre, Coconut Coir Fibre.

## I. INTRODUCTION

### 1.1 Soil Stabilization and its Importance and Need:

Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is being used for a variety of engineering works, the more common application being in the construction of road and air-field pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Methods of stabilization may be grouped under two main types:

- a) Modification or improvement of a soil property of the existing soil without any admixture, and
- b) Modification of the properties with the help of admixtures.

Compaction and drainage are the examples of the first type, which improve the inherent shear strength of soil. Examples of the second type are: stabilization with cement lime, coconut coir fibre, human hair fibre, Alccofine and various other chemical products. This project employs the use of human hair fibre, coir fibre and Alccofine in stabilizing the soil. Coir or coconut fibre and human hair fibre belong to the group of structural fibres which will be playing a role of reinforcement in the soil. Alccofine is a new generation micro fine material of particle size much finer than other hydraulic materials like cement, fly ash, etc. manufactured in India. So Alccofine is the binding material which will maintain the proper orientation of the fibres with which the soil is reinforced.

T.Subramani and D.Udayakumar(2016) studied Experimental Study On Stabilization Of Clay Soil using Coir Fibre. The tests performed were UCS test and CBR test. The results mention that CBR and UCS values of soil-coir Fibre mix increases with increasing percentage of Fibre. [1] Renju R Pillai and Ayothiraman Ramanathan (2012) in their research on An Innovative Technique of Improving the Soil Using Human Hair Fibres. UCS test was performed. Results of these experiments were that, MDD initially reduces slightly due to addition of light weight hair fibre and then practically remains same. OMC increases marginally due to moisture absorption of hair fibres. [2] K. Shankar Narayanan and S. Mary Rebekah Sharmila (2017) studied Stabilization of Clay With Human Hair Fibre. The tests performed were UCS test and CBR test. The results mention that the UCS and CBR values increased upto a certain percentage of HHF percentage then they decrease. [3] Tom Elias et.al (2016) in their research on Comparative Study of Soil Stabilization Using Human Hair and Lime. UCS test was performed. Results of these experiments were that, there was an increase in the values of UCS up to a certain percentage of hair and then decreased.

[4] Wajid Ali Butt et.al (2014) studied Soil Sub- grade Improvement Using Human Hair Fibre. The tests performed were UCS test and CBR test. The results mention that the CBR values substantially up to a certain dosage and then decreases. [5] Sonu Singh and Vijay Kumar Dwivedi (2018) in Characterization Of Clay Soil Reinforced With Human Hair For Pavement Design. UCS test was performed. Results of these experiments were that, MDD initially reduces slightly due to addition of light weight hair fibre and then practically remains same. CBR value increases with inclusion of HHF in clay soil. [6]

## II. MATERIALS USED

2.
  - 1 Alccofine
  - 2 Coconut Coir
  - 2 Fibre
2.
  - 3 Human Hair Fibre

## 2.1 Alccofine:

It is a specially processed product based on slag of high glass content with high reactivity obtained through process of controlled granulation. Figure 2.1 show



**Figure 2.1 Alccofine**

Moreover, cement and lime are used for soil stabilization since the inception of this concept. But by meeting the requirements of construction industry itself, the cement production is leading to a good chunk of emission harmful gases. Cement production sector is the second largest CO<sub>2</sub> producer of the world. So, to take a step in reducing the emission of CO<sub>2</sub>, we are avoiding the use of cement of stabilization. In fact, nowadays cement is being substituted partly by new fine materials as mentioned above. Lime has also been used profoundly in soil stabilization, but it has some negative aspects too. One of them is, at site the labourers have to use special gears which provide adequate safety from corrosive nature of lime. It also leads to increased heat of hydration when mixed with water which is found to be problematic for the workers at site. None the less, lime treatment has several disadvantages such as carbonation, sulphate attack and environment impact. Owing to these reasons of cement and lime as binding materials, we thought of using new material, Alccofine which is available easily and economically and, does not take a toll on environmental pollution.

## 2.2 Coconut Coir Fibre:

It is a natural fibre extracted from the husk of coconut. It is the fibrous material found between the hard, internal shell and the outer coat of a coconut. The fibrous husks are soaked in pits or in nets in a slow-moving body of water to swell and soften the fibres. The long bristle fibres are separated from shorter mattress fibres underneath the skin of nut, a process known as wet milling.

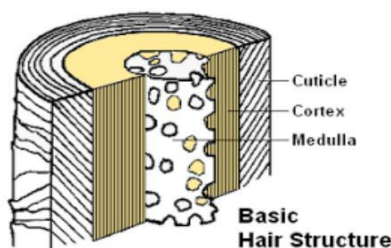
We selected coir fibre because of its stability in the soil, easy availability in our area and considering the economic aspect too.



**Figure 2.2 Coconut Coir Fibre**

## 2.3 Human Hair Fibre:

Hair as a chief reinforcing agent is abundantly available as a waste product from saloons and is facing a major disposal issue. This study aims at comparing hair stabilized soil with normal soil and to test the suitability of human hair as a sustainable source of soil stabilization. In present world, human hair fibre (HHF) is considered as a waste material in most parts of the world and it creates many environmental problems. As it is a non-biodegradable, it is creating disposal problems and using it as reinforcing fibre, it can minimize this problem. It is also available widely and economically. Moreover, an environmental concern as a civil engineer is also included by utilization of HHF.



**Figure 2.3 Human Hair Fibre**

### III. METHODOLOGY

#### 3.1 Sample Preparation:

We prepared a sample using virgin soil of different size fractions mentioned in the IS Code. Further we've added 10 percent Alccofine with 0.5,1 and1.5 % of Human Hair Fibre by weight of soil. Also, we have used 0.5, 0.75 and 1 % of Coconut Coir Fibre by weight of soil for the preparation of sample used to perform the below mentioned experiments to obtain results.

#### 3.2 Tests on Soil Stabilization:

The different tests which were performed are:

- 1) Determination of Grain size distribution by sieving-and also classifying the soil by IS classification system
- 2) Determination of water content of soil sample by oven drying method.
- 3) Determination of specific gravity by pycnometer.
- 4) Determination of liquid limit of soil.
- 5) Determination of plastic limit of soil.
- 6) Determination of shrinkage factors of soil.
- 7) Determination of compaction properties by standard proctor test.
- 8) Determination of unconfined compressive strength of soil.
- 9) Determination of California bearing ratio.

These tests were performed referring to the relevant I.S. Standards.

### IV. RESULTS AND DISCUSSION

#### 4.1 Results for Virgin Soil:

A series of conventional laboratory tests including Standard Compaction tests, California Bearing Ratio Tests and the Unconfined Compressive Strength Tests were carried out on the soil mixed with different percentages of coir fibre and human hair fibre with alccofine. Table 4.1 showed that results of virgin soil.

**Table 4.1 Results for Virgin Soil**

| Parameter                         | Value                   |
|-----------------------------------|-------------------------|
| Specific gravity                  | 2.12                    |
| Natural water content             | 27%                     |
| Liquid limit                      | 30%                     |
| Plastic limit                     | 23.68%                  |
| Plasticity index                  | 0.234                   |
| Soil type as per IS:<br>1498-1970 | CL                      |
| Shrinkage Limit                   | 17.04%                  |
| Maximum dry density               | 1.52 gm/cm <sup>3</sup> |
| Optimum moisture content          | 16.54 %                 |
| Unconfined compressive strength   | 0.635 MPa               |
| C.B.R. Value                      | 1.82                    |

#### 4.2 Results of Soil + Alccofine + Human Hair Fibre:

Table 4.2 showed the results of Soil + Alccofine + Human Hair Fibre with different percentage 0, 0.5, 1 & 1.5.

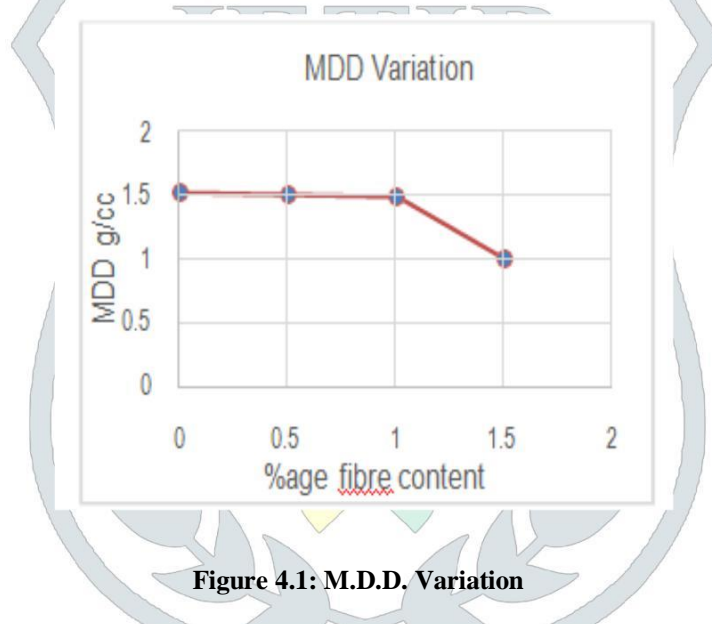
**Table 4.2 Results of Soil + Alccofine + Human Hair Fibre**

| Particulars | Human Hair Fibre Percentage (%) |       |       |       |
|-------------|---------------------------------|-------|-------|-------|
|             | 0                               | 0.5   | 1     | 1.5   |
| MDD (g/cc)  | 1.52                            | 1.5   | 1.49  | 1.463 |
| OMC (%)     | 17.6                            | 14.58 | 19.58 | 22.6  |

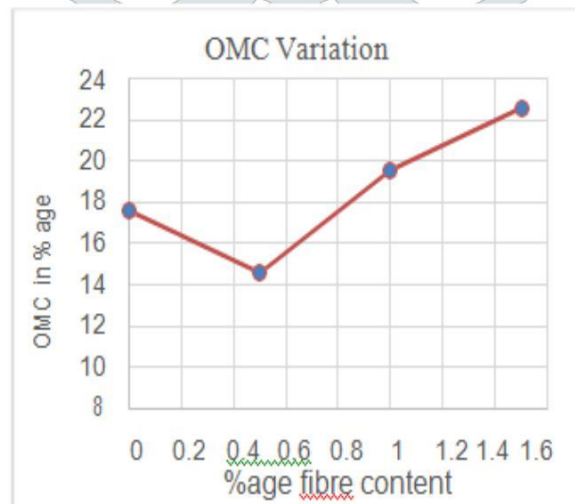
|           |       |       |       |       |
|-----------|-------|-------|-------|-------|
| UCS (MPa) | 0.635 | 0.844 | 0.919 | 0.934 |
| CBR       | 1.82  | 3.49  | 5.41  | 3.88  |

**4.2.1 Variation in Maximum Dry Density and Optimum Moisture Content (MDD & OMC):**

The figure 4.1 showed that MDD variation of human hair fibre and figure 4.2 showed that OMC variation of human hair fibre with different percentage as 0, 0.5, 1 & 1.5 %.



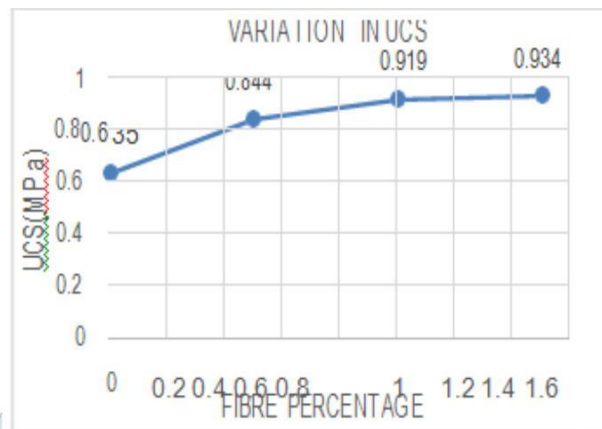
**Figure 4.1: M.D.D. Variation**



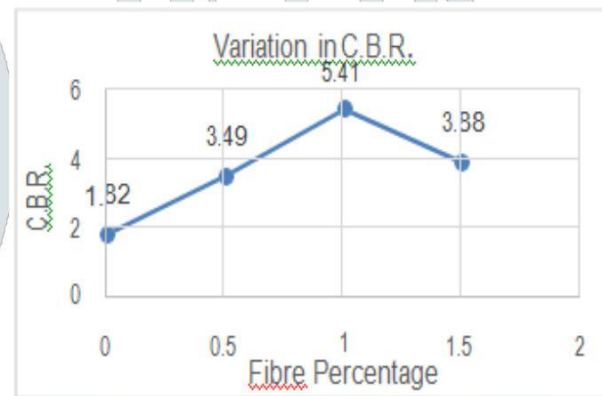
**Figure 4.2 O.M.C. Variation**

**4.2.2 Variation in Unconfined Compressive Strength:**

Here it can be seen that the human hair fibres increase the shear strength of the soil. The increase in original strength is of about 47.1% at 1.5% fibre content. It can also be seen that the increase in improvement of shear strength approaches to a constant value with the increase in the percentage fibre content. The figure 4.3 showed that variation in unconfined compressive strength.



**Figure 4.3 Variations in Unconfined Compressive Strength**



**Figure 4.4 C.B.R. Variation**  
**4.2.3 Variation in C.B.R:**

From the figure 4.4 it can be seen the human hair fibres help in increasing the C.B.R. value of the virgin soil. The increase in C.B.R. value is of about 1.97 times of the original value at 1% fibre content. It can also be seen that there is an increase in the value up to a fibre inclusion of 1% and thereafter a decrease in C.B.R. value starts. Thus 1% inclusion of human hair fibres can be considered to be optimum for improving the C.B.R. value of the soil.

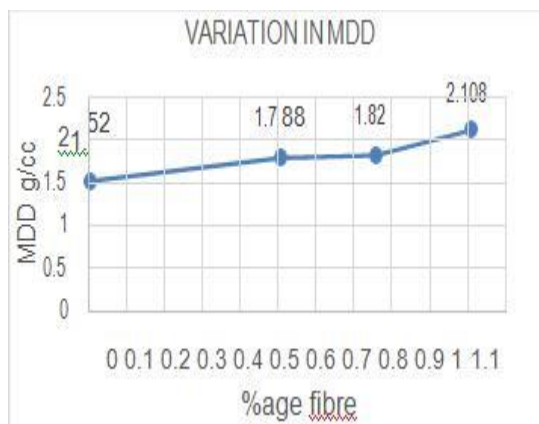
Hence from the above results of the Standard Proctor Test, Unconfined Compressive Strength Test and the California Bearing Ratio Test, it can be concluded that Alccofine in combination with Human Hair Fibres can be used for stabilizing red soil. Thus, the blend giving the optimum results is Stabilization of Soil Using 10% Alccofine and 1% Human Hair Fibre.

**4.3 Results of Soil + Alccofine +Coconut Coir Fibre:**

Table 4.3 showed that the results of Soil + Alccofine + Human Hair Fibre with different percentage 0, 0.5, 1 & 1.5. **Table 4.3: Results of Soil + Alccofine +Coconut Coir Fibre**

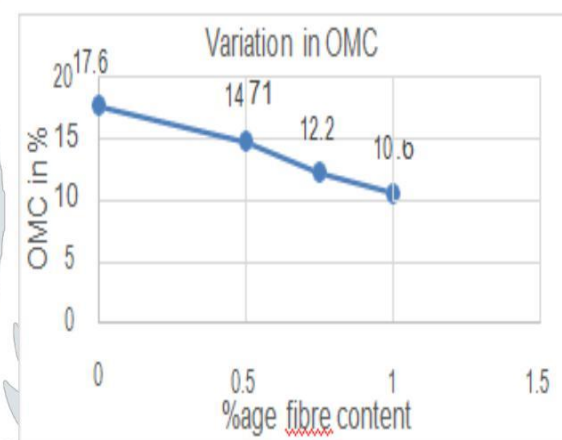
| Particulars | Coconut Coir Fibre Percentage (%) |       |        |       |
|-------------|-----------------------------------|-------|--------|-------|
|             | 0                                 | 0.5   | 0.75   | 1     |
| MDD (g/cc)  | 1.52                              | 1.788 | 1.82   | 2.108 |
| OMC (%)     | 17.6                              | 14.71 | 12.2   | 10.6  |
| UCS (MPa)   | 0.635                             | 0.315 | 0.332  | 0.482 |
| CBR         | 1.82                              | 9.63  | 23.474 | 31.29 |

**4.3.1 Variation in Maximum Dry Density and Optimum Moisture Content:**



**Figure 4.5 Variations in Maximum Dry Density**

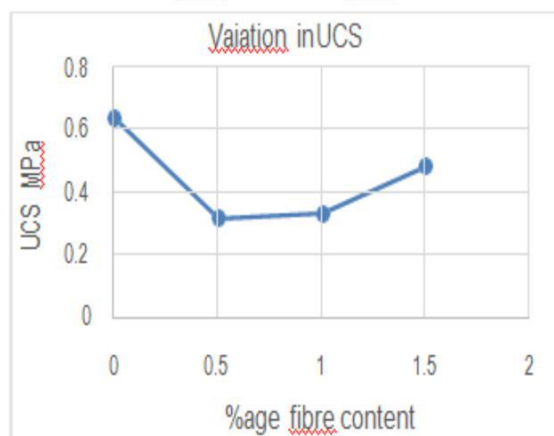
From the figure 4.5, we can say that coconut coir fibres help in increasing the maximum dry density of red soil. The MDD increases with the increase in fibre content. The improvement in MDD is of about 38.684% at 1% inclusion of fibres.



**Figure 4.6 Variations in Optimum Moisture Content**

From the figure 4.6, we can say that coconut coir fibres help in decreasing the optimum moisture content of red soil. The OMC decreases with the increase in fibre content. The improvement in OMC is of about 7% at 1% inclusion of fibres.

**4.3.2 Variation in Unconfined Compressive Strength:**



**Figure 4.7 Variations in Unconfined Compressive Strength**

From the figure 4.7, we can say that coconut coir fibres helps in increasing the unconfined compressive strength of red soil. The UCS decreases initially but increases with subsequent addition in fibre content. The improvement in UCS is of about 0.167 MPa at 1% inclusion of fibres.

### 4.3.3 Variation in California Bearing Ratio:

From the figure 4.8, we can say that coconut coir fibres help in increasing the California Bearing Ratio of red soil. The CBR increases with the increase in fibre content. The improvement in CBR is of about 29.47 at 1% inclusion of fibres.

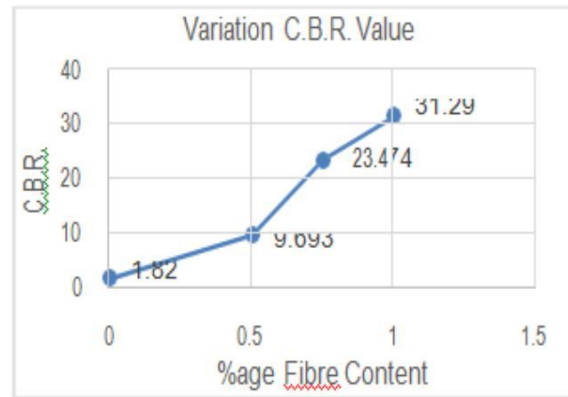


Figure 4.8 C.B.R. Variation

After showing all these results we can conclude that after addition of the different fibres and Alccofine with soil, the properties of the soil definitely improve.

Table 4.4 Final Overview

| Sr. No | Particulars | Optimum Values of (Soil + Alccofine + Fibre) |                          |
|--------|-------------|--|--------------------------|
|        |             | Human Hair Fibre at 1%                       | Coconut Coir Fibre at 1% |
| 1.     | MDD (g/cc)  | 1.49   | 2.108                    |
| 2.     | OMC (%)     | 19.58  | 10.6                     |
| 3.     | UCS (MPa)   | 0.919  | 0.482                    |
| 4.     | C.B.R       | 5.41   | 31.29                    |

The above table gives a comparative idea about the influence of inclusion of Human Hair Fibre and Coconut Coir Fibre along with Alccofine in the soil.

### V. CONCLUSION

- The results of every experiment are on varying dosages of coir fibre like 0.5%, 0.75% and 1% with 10% of Alccofine were compared amongst themselves. The results were also compared with the experiments conducted on virgin soil. The different graphs were used to conclude the optimum dosages of coir fibre. And the same was performed for the human hair fibre.
- After evaluating the results, we came to know that these fibres along with Alccofine were successful in stabilizing our soil.
- In case of human hair fibres, we came to know that its utilization in stabilizing the soil helped in increase of the Unconfined Compressive Strength and the California Bearing Ratio of the soil.
- In case of coconut coir fibres, we came to know that its utilization in stabilizing the soil helped in increase of all the above- mentioned properties of the soil.
- Hence after performing a comparative study we can conclude that **Coconut Coir Fibre not only improved the properties of Virgin Soil but also showed better increment in properties than the Human Hair Fibre.**

### REFERENCES

- 1) T.Subramani and D.Udayakumar (2016), "Experimental Study On Stabilization Of Clay Soil Using Coir Fibre", International Journal of Application or Innovation in Engineering & Management (IJAEM), Volume 5, Issue 5.
- 2) Renju R Pillai and Ayothiraman Ramanathan (2012), "An Innovative Technique of Improving the Soil Using Human Hair Fibres", Third International Conference on Construction In Developing Countries (ICCIDC-III).
- 3) K. Shankar Narayanan and S. Mary Rebekah Sharmila (2017), "Stabilization of Clay with Human Hair Fibre", International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 4.
- 4) Tom Elias, Sreekumari T K, Sonia George, Abraham Zachariah, SaifudeenSulfi and Sreedevi P S(2016), "Comparative Study of Soil Stabilization Using Human Hair and Lime", International Journal of Scientific & Engineering Research, Volume 7, Issue 2.
- 5) Wajid Ali Butt Karan Gupta, Hamidullah Naik and Showk at Maqbool Bhat (2014), "Soil Sub- grade Improvement Using Human Hair Fibre", International Journal of Scientific & Engineering Research, Volume 5, Issue 12.
- 6) Sonu Singh and Vijay Kumar Dwivedi (2018), "Characterization Of Clay Soil Reinforced With Human Hair For Pavement Design", International Journal of Natural Research in Science and Engineering, Volume No. 7, Special Issue No. 3.