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A Study on Soil Stabilization using Cement and Coir Fibres

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Abstract: ***In India the soils available in coastal regions and in arid regions are expansive in nature and are found to be expansive for construction purposes. Soil stabilization provides a capping layer thereby increases the CBR of the soil to the desired level. The cement and coir fibre are used here as stabilization additives. The usage of the above coir fibre materials in civil engineering field has led to the development of new techniques particularly in stabilizing the soils. Studies were carried out to evaluate improvement of CBR values by the use of cement and randomly distributed coir fibre separately and the combination of both. The results clearly indicates that, 1.5% cement and 0.5% coir fibre have noticeable influence on CBR value of expansive soils compared to the results obtained on cement, and coir fibre materials used separately. This is due to the change in brittle behaviour of the soil to ductile behaviour.***

Keywords: CBR value, Coir fibre, Maximum dry density (MDD), Optimum moisture content (OMC)

1. Introduction

Soil stabilization is the process of improving the engineering properties of the expansive soil and thus making it more stable. It is required when the soil available for construction is not suitable for intended purpose. However, the term stabilization is generally are restricted to the process which alter the soil materials itself for improvement of its properties.[1] A cementing material or a chemical is added to a natural soil for the purpose of stabilization. Soil stabilization is used to reduce the permeability and compressibility of soil mass in earth structures and to increase its strength. It is required to increase the bearing capacity of foundation soils. However, the main use of stabilization is to improve the natural soils for the construction of highway and air fields. Soil stabilization is used to make an area trafficable within a short period of time for military and other emergency purposes. Sometimes, soil stabilization is used for city and sub-urban street to make them more noise absorbing.[2]

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a) Modification or improvement of the soil properties without any additives (mechanical stabilization).
b) Modification or improvement of the soil properties with the help of additives (chemical stabilization).[3]

In this project the soil is stabilized both mechanically and chemically i.e., the soil is stabilized mechanically using dispersed coir fibers and stabilized chemically using cement and a comparison is made between the performances of both.

2. Objectives

- To stabilize the soil using coir fibres and cement mixture
- To study the effect of inclusion of coir fiber as a reinforcement in the soil and its effect on CBR value of soil.
- To compare the performance of cement and coir fibres in soil stabilization

3. Materials and methods

3.1 Materials

The soil is collected from Otthakuthirai near Gopichettipalayam along the state highway since the project is oriented to improve the bearing capacity of the soil for highway construction. The coir fibre is collected from the coir industry near Thalavapalayam, Karur and the cement of OPC 53 grade is purchased from the vendors.

A typical picture of soil sample and coir fibre is shown below in Fig 1 & 2.

Figure 1: soil sample

Figure 2: coir fibre

3.2 Method

The required samples were prepared in accordance with the provision of concerned code of practice and as per prescribed procedure. The various properties like Index properties, compaction parameters and CBR value were determined.

3.2.1 Index properties of soil.

Initially the index properties, SPCT and CBR value of natural sandy soil were determined.

Table 1: Index properties of soil

Description	*Results*
Fraction of soil passing on 75 µ sieve	72 %
Specific gravity of the soil	2.68
Liquid limit	54%
Plastic limit	23%
Soil type	Clay
Maximum dry density (MDD) g/cc	1.308
Optimum moisture content (OMC) %	10

3.2.2 California Bearing Ratio (CBR) Test

The CBR for the collected soil sample is conducted as per the standard procedure. The CBR values are as follows,

CBR2.5 = 1.18%

CBR5.0 = 1.36%

4. Results and Discussions

4.1 Comparison of SPCT results

4.1.1 Variation of OMC on addition of Coir fibres

The OMC of the soil keep on increasing for addition of fibers. This is because of the water absorbing capacity of the natural fibers.

Table 2: Variation of OMC on addition of fibers

Mix proportion	*OMC (%)*
Soil + 0% CF	10.0
Soil + 0.5% CF	18.8
Soil + 1.0% CF	19.6
Soil + 1.5% CF	20.2

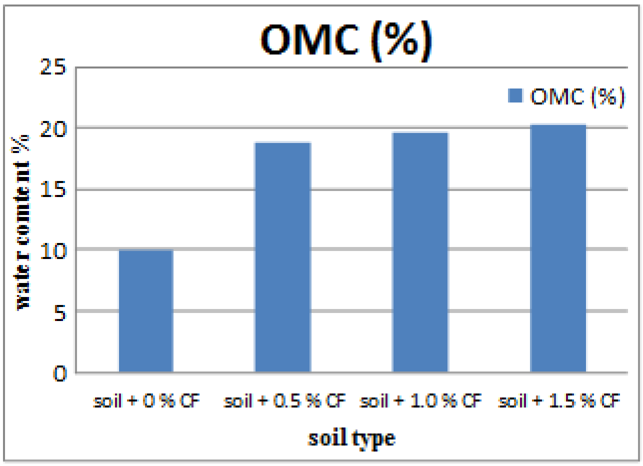

Figure 3: Variation of OMC on addition of fibers

4.1.2 Variation of OMC on addition of cement.

Table 3: Variation of OMC on addition of cement

Mix proportion	*OMC (%)*
Soil + 0% CF	10.0
Soil + 0.5% CF	10.5
Soil + 1.0% CF	11.3
Soil + 1.5% CF	11.8

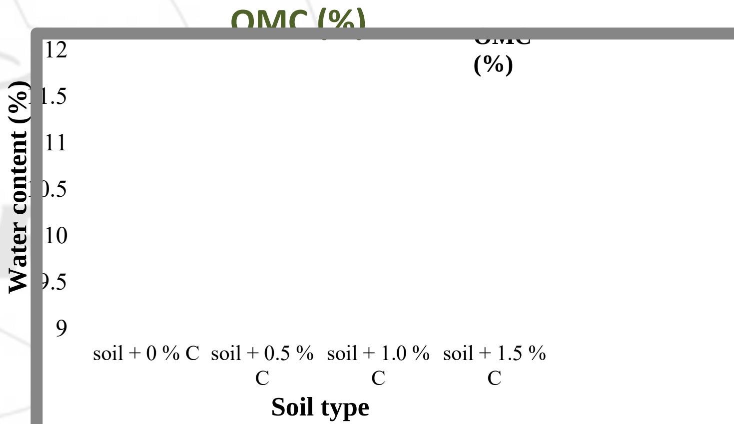

Figure 4: Variation of OMC on addition of cement

4.1.3 Variation of OMC on addition of cement and fibre.

Table 4: Variation of OMC on addition of cement and fibers

Mix proportion	OMC (%)
Soil + 0% CF + 0% C	10
Soil + 0.5% CF + 1.5% C	20.20
Soil + 1.0% CF + 1.5% C	21.40
Soil + 1.5% CF + 1.5% C	21.80

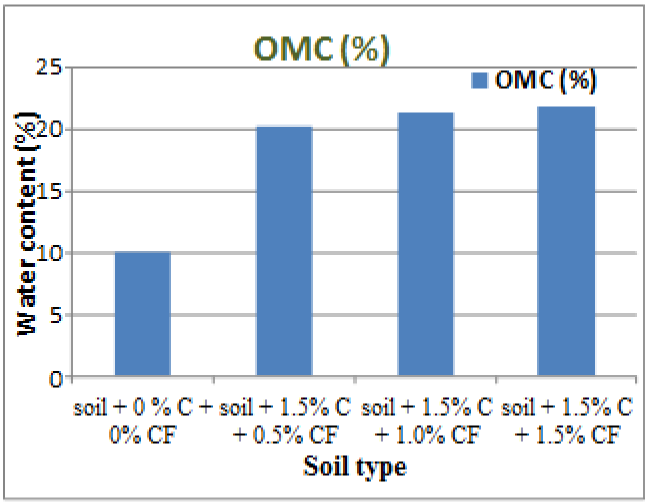

Figure5: Variation of OMC on addition of cement and fiber

4.1.4 Variation of MMD on addition of Coir fibres

Table 5: Variation of MMD on addition of fibers

Mix proportion	*MDD (g/cc)*
Soil + 0% CF	1.308
Soil + 0.5% CF	1.297
Soil + 1.0% CF	1.275
Soil + 1.5% CF	1.254

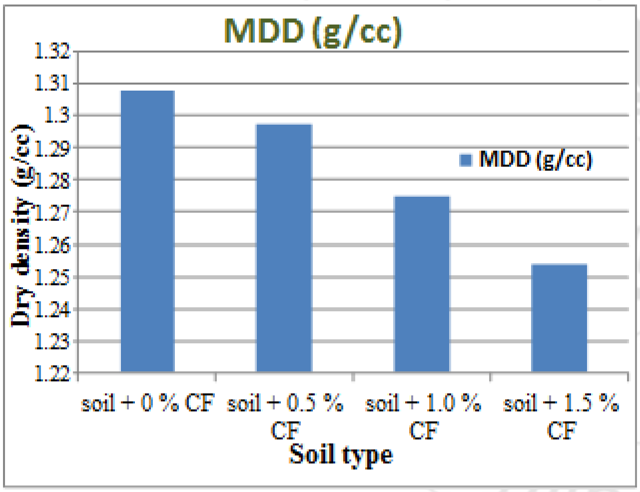

Figure 6: Variation of MMD on addition of fibers

4.1.5 Variation of MMD on addition of cement

Table 6: Variation of MMD on addition of cement

Mix proportion	*MDD (g/cc)*
Soil + 0% C	1.308
Soil + 0.5% C	1.335
Soil + 1.0% C	1.375
Soil + 1.5% C	1.387

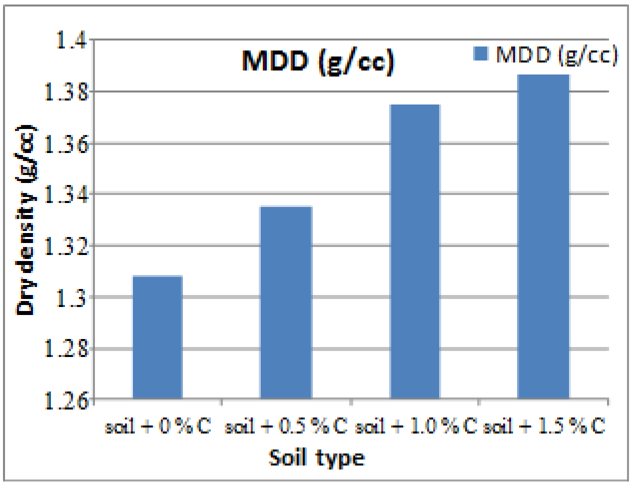

Figure 7: Variation of MMD on addition of cement

4.1.6 Variation of MDD on addition of cement and fibre.

Table 7: Variation of MDD on addition of cement and fibre

Mix proportion	*MDD (g/cc)*
Soil + 0% CF + 0% C	1.308
Soil + 0.5% CF + 1.5% C	1.289
Soil + 1.0% CF + 1.5% C	1.271
Soil + 1.5% CF + 1.5% C	1.248

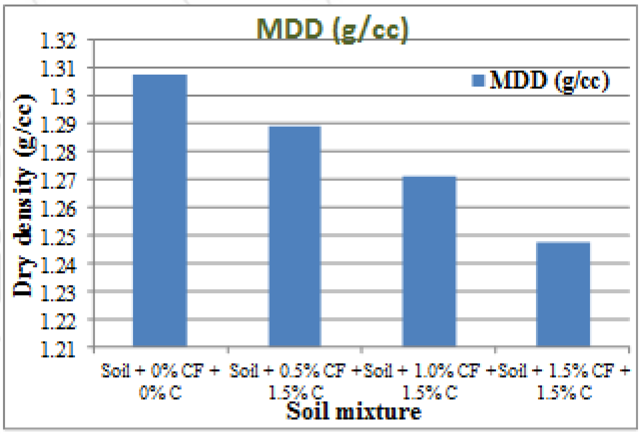

Figure 8: Variation of MDD on addition of cement and fiber

4.2 Comparison of CBR results

4.2.1 Variation of CBR on addition of Coir fibres

Table 8: Variation of CBR on addition of Coir fibres

Mix proportion	*CBR (%)*
Soil + 0% CF	1.26
Soil + 0.5% CF	2.84
Soil + 1.0% CF	8.87
Soil + 1.5% CF	8.87

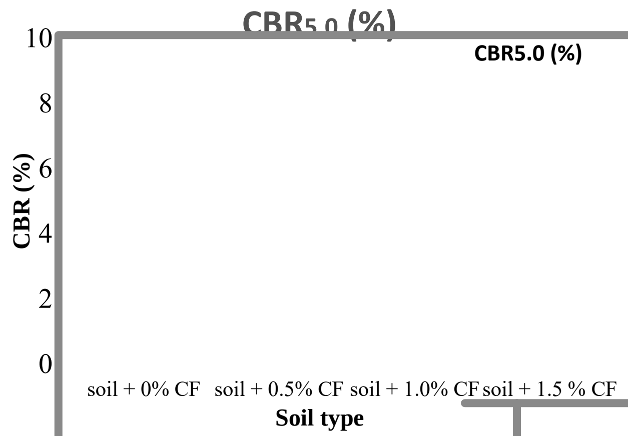

Figure 9: Variation of CBR on addition of Coir fibres

4.2.2 Variation of CBR on addition of Cement

Table 9: Variation of CBR on addition of cement

Mix proportion	CBR (%)
Soil + 0% C	1.26
Soil + 0.5% C	2.05
Soil + 1.0% C	8.84
Soil + 1.5% C	10.26

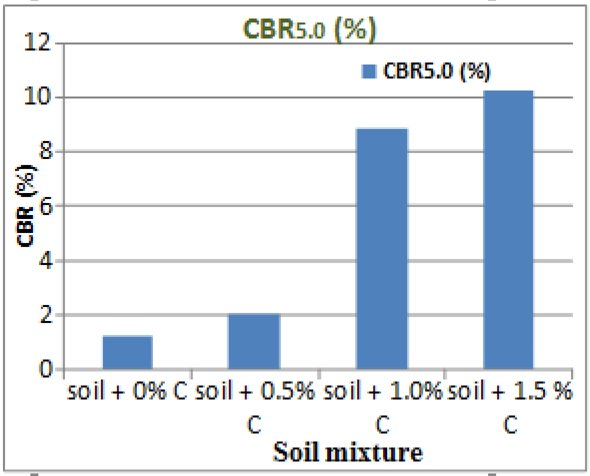

Figure 10: Variation of CBR on addition of cement

4.2.3 Variation of CBR on addition of cement and fibre.

Table 10: Variation of CBR on addition of cement and fibers

Mix proportion	*CBR (%)*
Soil + 0% CF + 0% C	1.26
Soil + 0.5% CF + 1.5% C	13.90
Soil + 1.0% CF + 1.5% C	10.10
Soil + 1.5% CF + 1.5% C	9.63

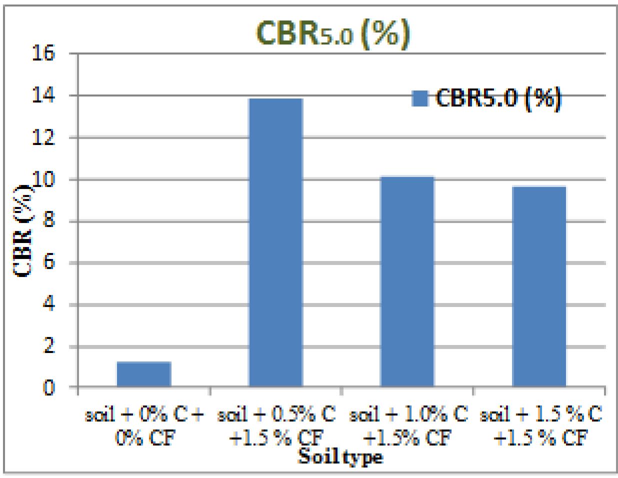

Figure 11: Variation of CBR on addition of cement and fiber

4.3 Comparison of CBR values of various mixtures

The CBR for various mixtures are shown in the below graph and the highest value was found to be for the mixture of both cement and fibers.

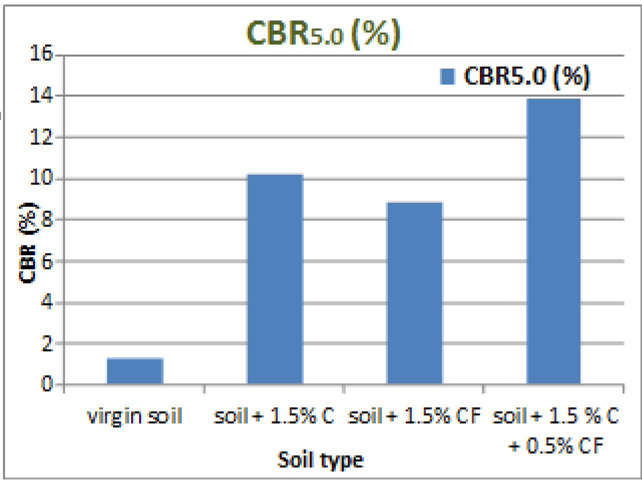

Figure 12: Comparison of CBR values of various mixtures

5. Conclusion

- The addition of 1.5% of cement has increased the CBR value by 88% and addition of 1.5% fibres has increased the CBR value by 85%
- OMC increases with increase in percentage of cement and coir fibers. This is because of replacement of certain volume of soil by absorptive chemosphere of cement and dry coir fiber.
- MDD value increases with Increase in percentage of cement, while it decreases with increase in percentage of coir fibres. As cement has higher specific gravity, the addition of cement increases the density and addition of fiber decreases the density as they are light in weight.
- The optimum percentage for stabilizing weak subgrade is 0.5% of coir fibres and 1.5% cement.

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