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Study on the Stabilization of Soil Using Coir Fibers

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Abstract: - **Civil Engineers are in search of new competitive material, which can be suitable and effectively used to face many challenges that have cropped up with time in the world. In India the soils available in coastal regions and in arid regions are expansive in nature. These soils are found to be expensive for construction as well as maintenance of roads. The need for soil stabilization in road construction has great significance as there is a need to provide a capping layer to increase CBR of the soil to the desired level .The cement is a widely produced material; a Coir Fiber (CF) is an abundantly available waste material in coastal India. The usage of the above coir fiber materials in the Civil Engineering field has led to the development of new techniques particularly in stabilizing the soils. A study is carried out for improvement of CBR values for the effect of cement and randomly distributed Coir Fiber separately and the combination of both. The results clearly indicates that, 1.5%cement and 0.5%coir fiber have noticeable influence on CBR value of expansive soils compared to the results obtained on cement, and CF materials used separately. This is because of composite effect of waste materials changes the brittle behavior of the soil to ductile behavior**.

Index Terms: - **Soil Stabilization, Coir Fibres, Construction, CBR.**

I. INTRODUCTION

Rising Land costs and decreasing availability of areas or urban fill has established the situation that previously underdeveloped areas are now being considered for the foundation of new facilities. However, these underdeveloped areas often possess weak underlying foundation materials – a situation that presents interesting design challenges for geotechnical engineers. To avoid the high cost of deep foundations, modification of the foundation or the addition of a structural fill is essential.

Problematic soils, low bearing capacity, foundation overloading, non-appropriate interaction between soil and super structure and etc. always make too many troubles during the construction procedure or the occupation life of the structures. Many methods are now applied or under studying in order to defeat such problems. Soil improvement in its broadest sense is the alteration of any property of a soil to improve its engineering performance. This may be either a temporary process to permit construction of a facility or may be a permanent measure to improve the performance of the completed facility. The result of an application of a technique may be increased strength, reduced compressibility, reduced permeability, or improved found water condition. Soils can be classified into two categories – cohesion less and cohesive soils. It has been observed predominantly.

Koteswara Rao (2011) studied the efficacy of Reinforcement technique on the fly ash stabilized expansive soil as a subgrade embankment for highways. In this study they used geotextile as a subgrade reinforcement and it is subjected to cyclic plate load test. Calcium chloride with optimum amount of fly ash is used for stabilization in this study. Results indicate that geotextile as reinforcement increased the load carrying capacity and reduced the deformation in the soil.

Venkata Koteswara Rao Pasupuleti, Satish Kumar Kolluru and Blessing Stone T (2012) studied the effect of fiber on Fly ash stablilized Sub grade Layer thickness. In this study fly ash is used for stabilization and polypropylene fibres were used as a reinforcement to improve the strength of the subgrade soil. Results revealed that the CBR value increased about 2% for 1.5% addition of fibers and also can save 8610 mt^3 of earth for one kilometre length of road.

A. Ramesh, M. Kumar (2009) studied an Experimental Investigation on coir fiber and fly ash in stabilized mechanistic pavements. In this study, coir fibres randomly distributed along with the stabilized fly ash has been used and soil properties were checked. Results clearly show that 15% fly ash along with 1.5% of coir fiber shows increase in CBR value compared to virgin soil and also when they were used separately. Study also suggest that there was significant reduction in cost in terms of thickness.

S.M. Prasanna Kumar (2012) studied the Silica and Calcium effect on Geo-Technical Properties of Expansive soil Extracted from Rice husk Ash and Lime. Results shows that addition of RHA does not increase the bearing capacity of soil due to the addition of reactive silica without lime content in RHA. Addition of lime content in RHA shows significant increase in bearing capacity of soil, but it shows a limiting value of 3%.

Onyelowe Ken C, Okafor F. O and Nwachukwu D.G (2012) made a review on Geophysical use of Quarry dust as admixture as applied to soil stabilization and modification. Review results shows that use of quarry dust improves the engineering properties of the soil and effectively stabilizes the soil. Quarry dust will make expansive soil more porous, less durable and reduce cohesion and also causes increase in strength due to better interlocking.

II. Methodology

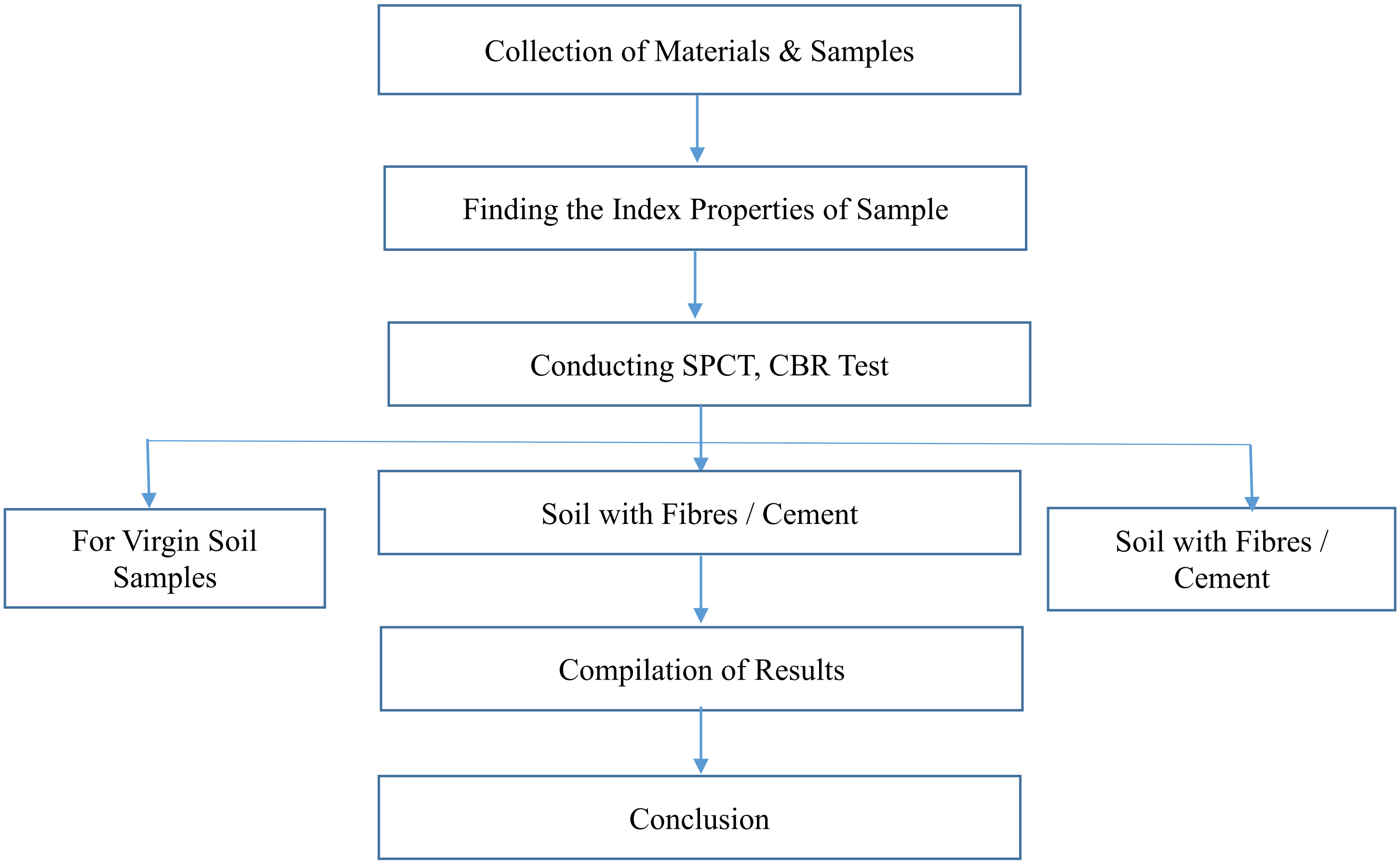

Fig. 1 Flow Diagram of the Proposed Methodology

III. Material Properties

a) Soil

Table I Description of Soil and its Parameters

DESCRIPTION	SOIL
Fraction of soil passing on 75 µ Sieve	72%
Fraction coarser than 4.75mm sieve	NIL
Specific Gravity of the soil	2.68
Liquid Limit	54%
Plastic Limit	23%
Soil Type	CH

b) Coir Fibre

TABLE II DESCRIPTION OF COIR AND ITS PARAMETERS

DESCRIPTION	COIR
Length (cm)	12
Aspect Ratio (L/d)	275
Diameter (mm)	0.45
Specific Gravity	0.7
Water Absorption (%)	73.5
Aspect Ratio (L/d) adopted	45

IV. EXPERIMENTAL WORK

a) Standard Proctor Compaction Test

Standard Proctor Compaction test showing the variation of moisture content is presented in the table 3. From the test results it shows there is significant increase in OMC for 1.5% addition of coir fibers and cement which is presented in the graph below.

TABLE III STANDARD PROCTOR COMPACTION TEST FOR MODIFIED SOIL SAMPLE

MIX PROPORTION	OMC (%)
Soil +0%C+ 0% CF	19.64
Soil +1.5%C+ 0.5% CF	20.20
Soil +1.5%C+ 1.0% CF	21.40
Soil +1.5%C+ 1.5% CF	21.80

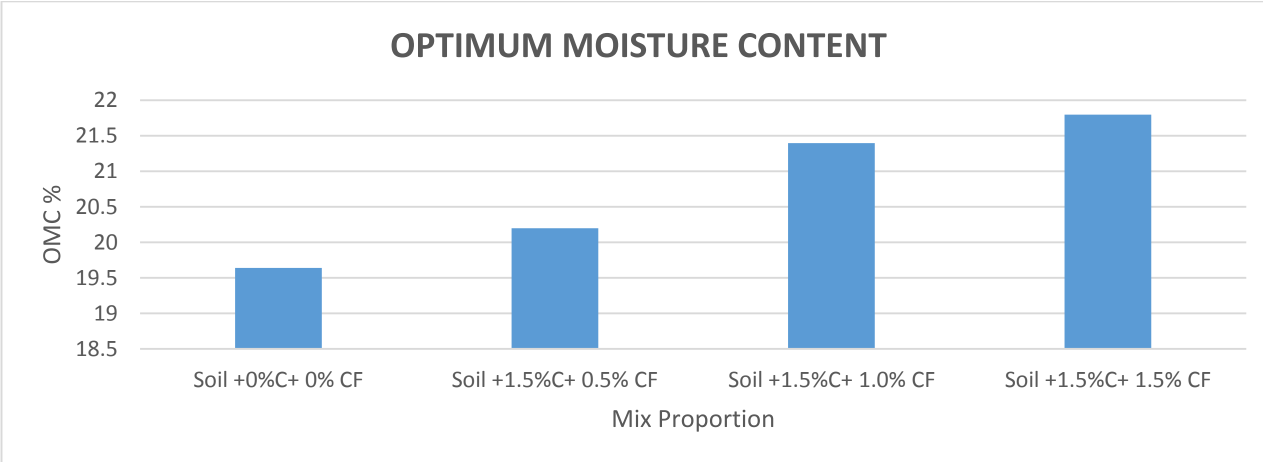

Fig. 2 Standard Proctor Compaction Test for Modified Soil Sample

b) Maximum Dry Density

Maximum dry density test showing the variation of moisture content is presented in the table 4. From the test results it shows there is significant increase in OMC for 0.5% addition of coir fibers and cement which is presented in the graph below.

TABLE IV MAXIMUM DRY DENSITY TEST FOR MODIFIED SOIL SAMPLE

MIX PROPORTION	MDD (%)
Soil +0%C+ 0% CF	1.308
Soil +1.5%C+ 0.5% CF	1.289
Soil +1.5%C+ 1.0% CF	1.271
Soil +1.5%C+ 1.5% CF	1.248

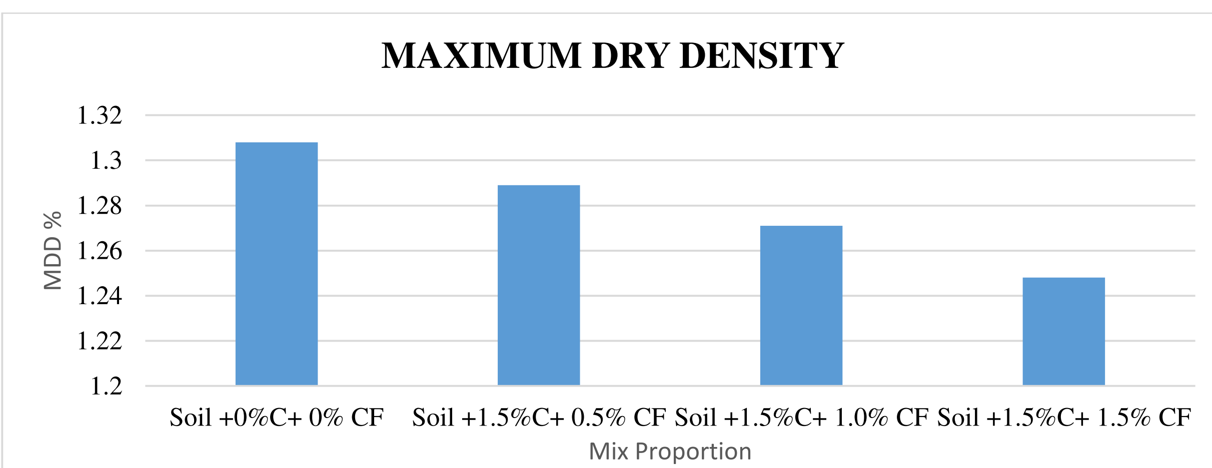

Fig. 3 Maximum Dry Density Test for Modified Soil Sample

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c) California Bearing Ratio Test

California bearing ratio test is done to determine the bearing capacity of the soil. CBR test is done to determine the bearing capacity of the soil. In this paper CBR test is done for soil and coir fibre mixture, soil and cement mixture and mixture of soil, coir fiber and cement mixture and values are tabulated.

TABLE V VARIATION OF CBR VALUE FOR SOIL AND COIR FIBRE MIXTURE

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

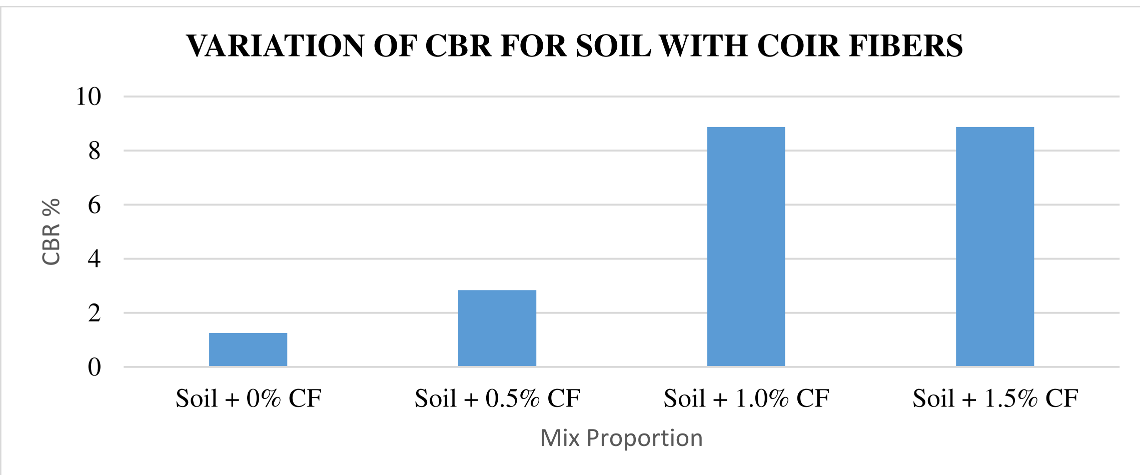

Fig. 4 Variation of CBR Value for Soil and Coir Fibre Mixture

TABLE VI VARIATION OF CBR VALUE FOR SOIL AND 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

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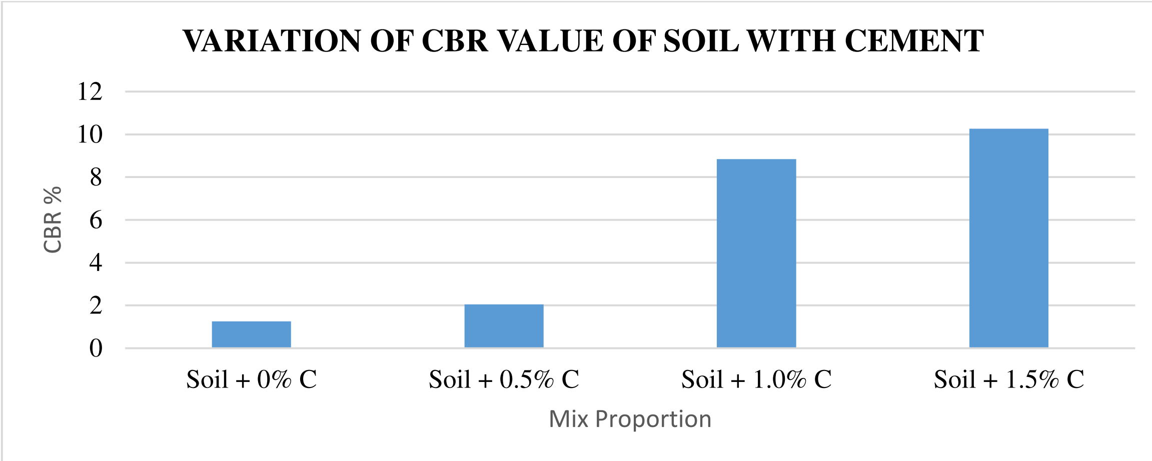

Fig. 5 Variation of CBR Value for Soil and Cement

TABLE VII VARIATION OF CBR WITH ADDITION OF FIBRES AND CEMENT

MIX PROPORTION	CBR (%)
Soil + 1.5%C+ 0% CF	1.26
Soil +1.5%C+ 0.5% CF	8.87
Soil + 1.5%C+1.0% CF	10.26
Soil +1.5%C+ 1.5% CF	13.90

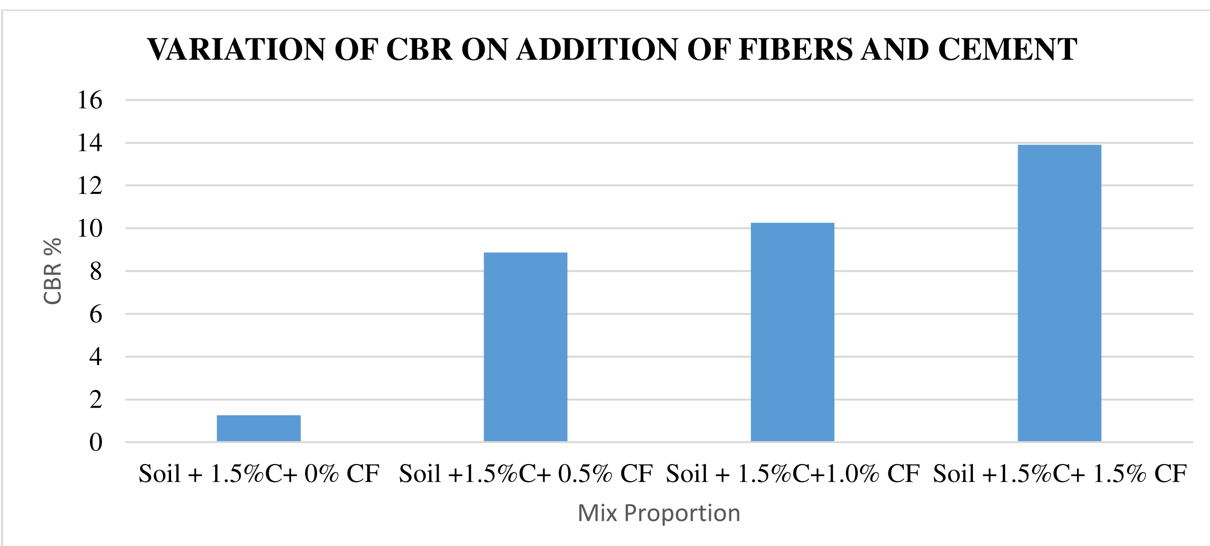

Fig. 6 Variation of CBR with Addition of Fibres and Cement

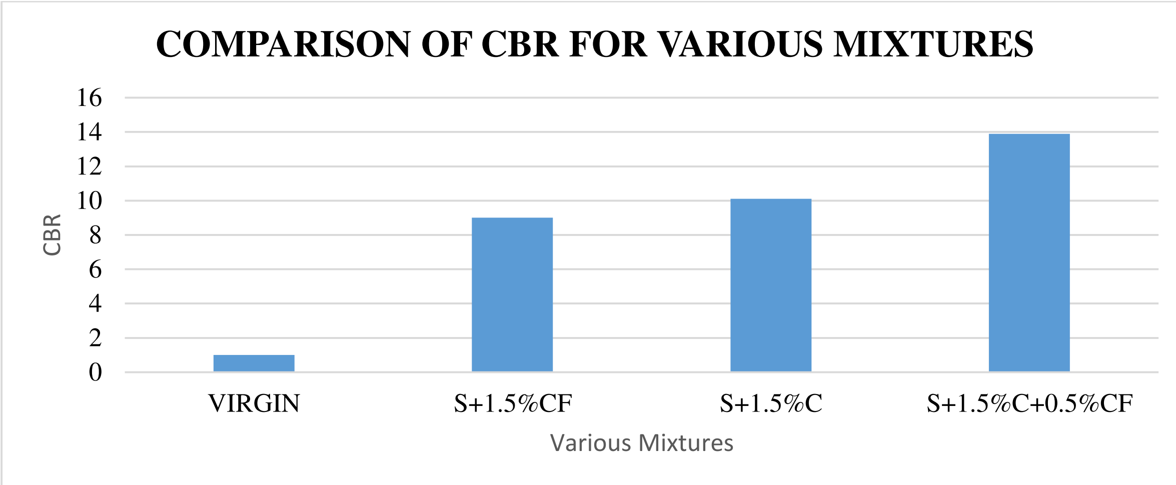

Fig. 7 Comparison of CBR for Various Mixtures

d) Cost Efficiency And Reduction In Thickness

About 35% of the pavement thickness is reduced by coir fiber stabilization and 35% of the pavement thickness is reduced by cement stabilization and about 40% of the pavement thickness is reduced by the combination of coir fibers and cement stabilization. About 1155m^3 /Km^{2}of soil can be saved if the Weak subgrade is stabilized using 1.5% Coir fibers, 1225 m^3/ Km^2 of soil can be saved if the weak subgrade is stabilized using 1.5% of Cement and about 1400 m^3 / Km^2 of soil can be saved if the weak subgrade is stabilized using 0.5%Coir and 1.5%cement.

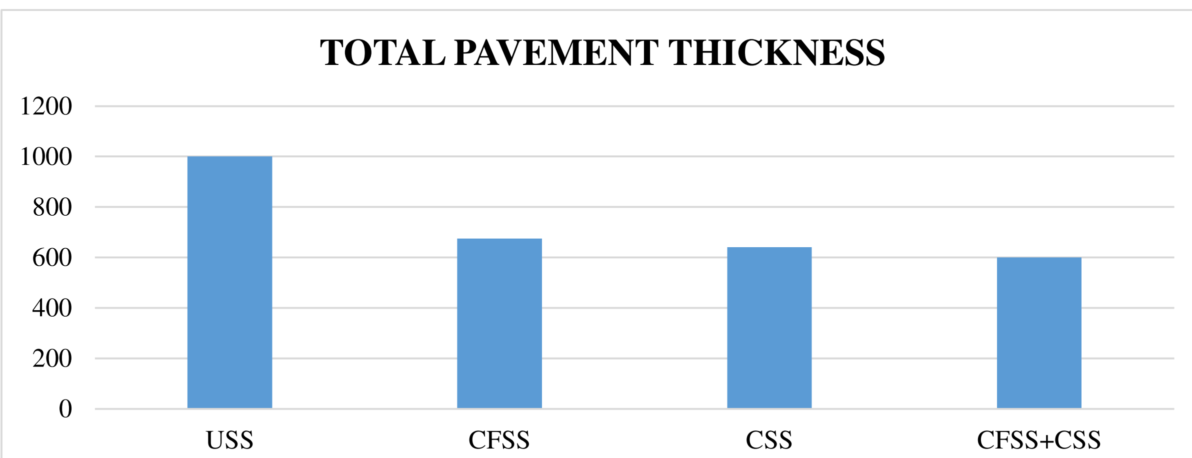

Fig. 8 Total Pavement Thickness for Various Stabilized Subgrades

V. Conclusion

By addition of Cement and Coir Fibers to the weak subgrade soil the CBR of those soils are greatly increased OMC increases by increase in percentage of cement and percentage of coir fiber. It is due to the volume of soil is replaced by absorptive chemosphere of cement and dry coir fiber. MDD increases by Increase in Percentage of cement and decreases with increase in percentage of coir fibers. This is due to the density of material, since cement has higher specific gravity the addition increased the density and the coir is very light in weight and hence the density of soil decreased. The addition of cement increased the CBR of the soil and it is increased with every percentage addition of cement and CBR value of 10% is achieved for 1.5% addition of cement to the total volume. The addition of coir fibers increased the CBR value of the soil but the CBR attains a constant value after 1.0% addition of fibre. One of the main advantages of using randomly distributed fiber is the maintenance of strength isotropy and absence of potential planes of weakness that can develop parallel to the oriented reinforcement. From the studies it is concluded that 0.5% of coir fibers and 1.5% cement is the optimum percentage for stabilizing weak subgrade. Since the pavement thickness is greatly reduced at this percentage. The requirement of pavement thickness is greatly reduced due to composite effects of the waste materials on the sub-grade expansive soil compared to individual effect of these waste materials. This reduction in thickness of pavement is directly proportional to the reduction in cost of construction. By doing the modification we can reduce the excessive usage of the mother earth thus avoiding the pollution.

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