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A COMPARATIVE STUDY ON SOIL STABILIZATION USING NATURAL AND ARTIFICIAL FIBRE

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Abstract: A major part of the construction works is done on red soil. But the problem associated with red soil is that it is loosely packed and void space is more which results in reducing the strength of the soil. Hence to rectify this we need to stabilize the soil. An effective method of soil stabilization is to add additives. These additives bind the particles together thereby reducing the void space. But there comes a question that which additive is the best whether natural or artificial fibre. In this study, a comparative analysis on the increase in strength of soil by adding natural as well as artificial fibre in various concentrations of fibre (0.5%, 1%, 2%) is done. As a natural fibre, a mixture of coir fibre and sugarcane fibre is used and as an artificial fibre, polyester fibre is used. Various tests such as plastic limit and liquid limit test, standard proctor test, UCC, direct shear test are done to find out the strength parameters of soil by adding additives. From the study, we have concluded that by adding natural as well as artificial fibre the strength increases. There is not much difference between natural and artificial fibre hence natural fibre can be used.

Index Terms **- Natural fibre, artificial fibre, soil stabilization, red soil.**

I. INTRODUCTION

It is very important to have a study on the geotechnical aspect of a site before construction work starts. It is rare to get a land for construction which meets all the design aspects. There may be modifications to be made on the site. Soil stabilization aims at such a modification that is to improve strength and make the land fit for construction. How does adding additives improve the strength of the soil is an emerging question. The fibre acts in a similar way as the roots behave in a plant, the fibre provides anchorage to the soil, bind them together reducing the void space in the soil hence improving strength. There are a number of natural fibre used for soil stabilization such as bamboo fibre, coir fibre, sugarcane fibre, saw dust, banana peel, orange peel etc, out of which we have opted for coir fibre and sugar cane fibre as they are cheap, easily available and the transportation cost is less. Sugarcane fibre and coir fibre are the waste products produced after the effective utilisation of sugarcane and coconut. Hence it is an effective method of waste disposal. Similarly, there are a number of artificial fibres like polyester fibre, glass fibre, out of which we have taken polyester fibre because of its availability in huge amount. Polyester fibre is a by-product from the textile industry, soil stabilization in a way help in the disposal of this too. These materials have good binding properties and they hold together the soil and which increases the bearing capacity of the soil. Red soil is used for the experiment as most of the time red soil is been selected for the construction work. The properties of the fibres used are as follows:

Table 1: properties of fibre

properties	Coir fibre	Sugarcane fibre	Polyester fibre
Specific gravity	0.87	0.33	1.22
Absorption (%)	10	61	5
Density (g/cc)	1.4	1.2	1.39

II. RESEARCH METHODOLOGY

Sample preparation: Coir and sugarcane fibre are collected, sun-dried and ground to the required size. Polyester fibre is collected and crushed to the required size. The index properties of the soil were tested after cleaning the soil. The fibre are added to the soil in varying proportion of 0.5%, 1%, and 2% of weight of soil as per common practice and various tests were conducted to determine the strength parameters of soil added with natural fibre as well as artificial fibre. Optimum moisture content and maximum dry density are obtained from the standard proctor test. The following are the tests conducted during the experiment:

- Classification of soil by sieve analysis as per Indian Standard of the Soil Classification System (ISSCS)
- Determination of moisture content by oven drying
- Determination of liquid limit and plastic limit
- Determination of optimum moisture content by Standard proctor test
- Determination of compressive strength by Unconfined compression test
- Determination of angle of internal friction by Direct shear test

Table 2: parameters and relevance of each test conducted

Name of the test	Parameters tested	Relevance to the study
Sieve analysis	Effective size, uniformity coefficient, coefficient of curvature	To find out the particle size distribution of soil and to categorise the soil.
Determination of moisture content	Moisture content	It is important for compaction of soil and also affect permeability
Determination of plastic and liquid limit	Plastic limit, liquid limit	They can be used as a guide indicating how much soil is likely to settle or consolidate under load.
Standard proctor test	Optimum moisture content, dry density	To determine the compaction of soil
Unconfined compression test	Unconfined compressive strength	To obtain a measure of compressive strength
Direct shear test	Angle of internal friction	Useful to study friction between two materials

III. RESULTS AND DISCUSSION

The following are the results of the test conducted to determine various strength parameters using natural as well as artificial fibre as additives on soil.

3.1 Plastic and liquid limit

The plastic limit and liquid limit of soil sample increase when natural and artificial fibre are added. However, artificial fibre added to soil shows more increase. Both the plastic limit and liquid limit increase first and reduce at 2% which signifies that the optimum concentration of fibre added is 1%. There is no much variation between natural and artificial fibre so the natural fibre can be used. . Here the difference of liquid limit and plastic limit is greater than 17 in all cases, hence the soil is highly plastic. As the liquid limit is greater than 50 the soil is highly compressible.

Table 3.1: Plastic limit and liquid limit of soil reinforced with natural and artificial fibre

Concentration of fibre added	Natural fibre		Artificial fibre	
	plastic limit (%)	liquid limit (%)	plastic limit (%)	liquid limit (%)
without fibre	25	51	25	51
0.50%	27	55	28	57
1%	33	57	35	59
2%	30	55	32	58

3.2 Standard proctor test

For natural fibre, there is only a slight variation in the water content but there is a huge variation for bulk density in case of 1% fibre. Hence the optimum value is obtained for 1%. Similarly, for artificial fibre also optimum value is obtained when 1% fibre is added. Comparing natural and artificial fibre highest value is obtained for artificial fibre. But there is not much difference in the values. The optimum moisture content varies in the range 24 to 12 hence the soil is inorganic clay type.

Table 3.2: OMC and MDD of soil reinforced with natural and artificial fibre

Concentration of fibre added	Natural fibre		Artificial fibre	
	OMC (%)	MDD (g/cc)	OMC (%)	MDD (g/cc)
without fibre	16	1.284	16	1.284
0.50%	17.5	1.38	18	1.39
1%	18.2	1.648	18.4	1.663
2%	18	1.48	18.5	1.5

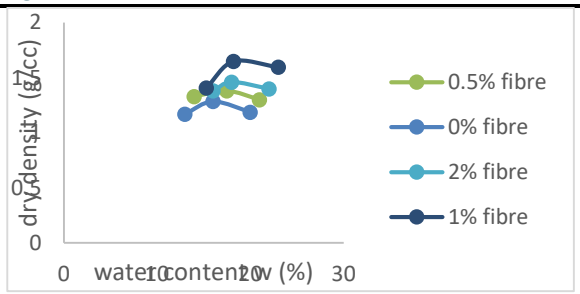

Fig 1: Soil reinforced with natural fibre

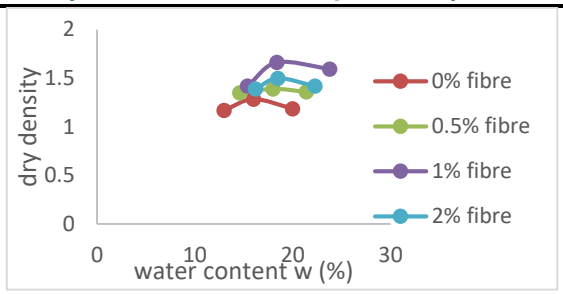

Fig 2: Soil reinforced with artificial fibre

3.3 Unconfined compression test (UCC)

The compressive strength of the soil reinforced with natural fibre goes on increasing with the increase in the concentration of fibre. As per the experiment, the maximum value is obtained for 2% fibre. Similarly, for soil reinforced with artificial fibre, the maximum value is obtained for 2%. While comparing the results of soil reinforced with natural and artificial fibres the maximum value is obtained for artificial fibre. But there is no much variation. The values of UCC is greater than 80KN/m² in all the cases which implies that the soil is strong.

Table 3.3: UCC of soil reinforced with natural and artificial fibre

Concentration of fibre added	UCC (KN/m²)	
	Natural fibre	artificial fibre
without fibre	137.6	137.6
0.50%	172.3	178.32
1%	182	189.32
2%	200	220

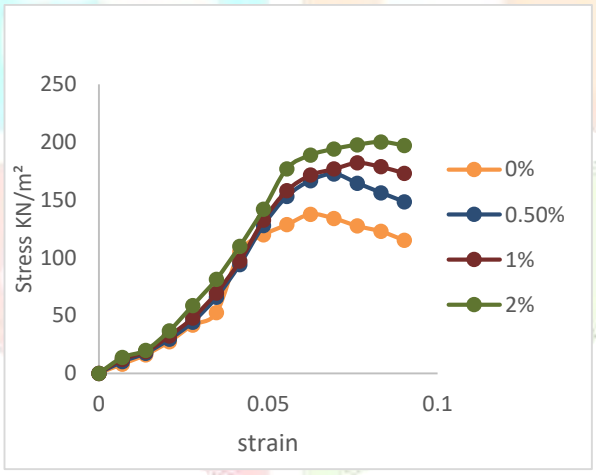

Fig 3: Soil reinforced with natural fibre

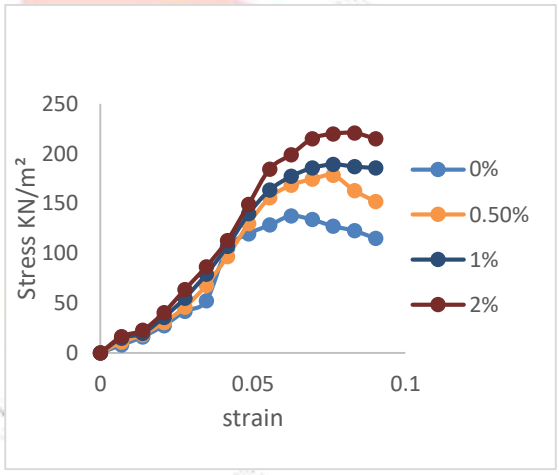

Fig 4: Soil reinforced with artificial fibre

3.4 Direct shear test

The shear strength of a soil is its maximum resistance to shearing stress at failure on the failure plane. Shear strength increases as the concentrations of fibres increase from 0% to 1% but it reduces by 2%, this is because the fibre begins to replace the soil. The maximum result was obtained for artificial fibre, but the difference is small.

Table 3.4: Shear strength of soil reinforced with natural and artificial fibres

Concentration of fibre added	Φ (°)	
	Natural fibre	artificial fibre
without fibre	79.8	79.8
0.50%	81.1	81.38
1%	82.5	83.2
2%	81.8	80.53

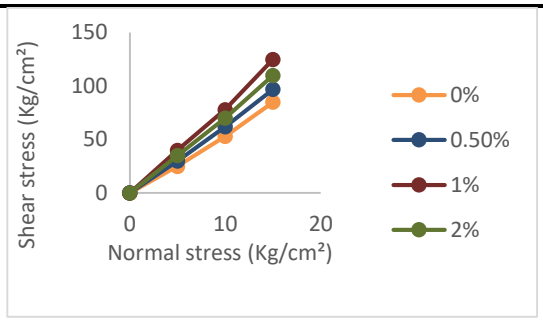

Fig 5: Soil reinforced with natural fibre

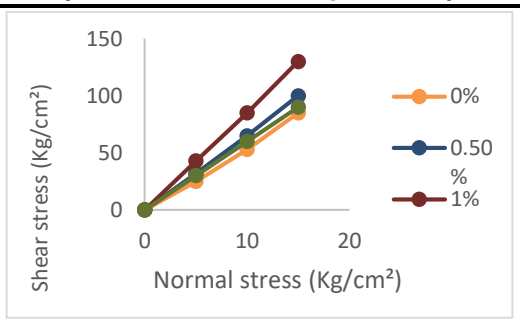

Fig 6: Soil reinforced with artificial fibre

IV. CONCLUSION

It is concluded from the study that by reinforcing soil with both natural as well as artificial fibres the strength of the soil increases. From the fibres used in the study are easily available and are common waste generated in the localities. Hence utilizing these for stabilization can be an efficient way of waste management. With the increase in the concentration of fibres, the strength also increases. But the optimum value is obtained for 1% of fibre. Both natural as well as artificial fibre can be effectively utilized for stabilization as the variation obtained is negligible.

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