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Effect of Recron Fiber on Compaction Characteristics of Kaolinite Clay

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***Abstract*: Soil reinforcement is defined as a technique to improve the engineering characteristics of soil. Consequently, randomly distributed fiber reinforced soils have recently attracted increasing attention in geotechnical engineering. The main objective of this study is to investigate the effect of fibers in geotechnical applications. The fibers are cut in length of 6mm mix randomly in varying percentages (0.5%, 1%, 2%, and 4%) by dry weight of soil and compacted to maximum dry density at optimum moisture content. The test results indicate an increase in the maximum dry density of soil due to the addition of Recron fiber.**

***Keywords*: Recon fiber, compaction**

1. Introduction

In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. One of the common methods of stabilization includes the mixing of natural coarse grained soil and fine grained soil to obtain a mixture that develops adequate internal friction and thereby providing a material that is workable during placement (Kharade et al., 2014).

Soil reinforcement is a procedure where natural or synthesized additives are used to improve the properties of soils. Earth reinforcement has become routine in geotechnical engineering to enhance the bearing capacity of geostructures such as airfields, foundations, embankments, and pavement roads built on soft soils, and to stabilize engineered soil slopes and loosely filled retaining walls. Using fibers ranging from steel bars, polypropylene, polyester, glass fibers, and biodegradable fibers such as coir and jute, has been proven to be particularly effective for soil reinforcement. Soil reinforcement is defined as a technique to improve the engineering characteristics of soil in order to develop the parameters such as shear strength, compressibility, density. The standard fiber- reinforcement soil is defined as a soil mass that contains randomly distributed, discrete elements, i.e., fibers which provide an improvement in the mechanical behaviour of the soil composite. One of the soil reinforcement techniques is the fiber reinforcement method. Fiber reinforcement in soils can be observed in nature that the roots of a tree strengthen the foundation soil for its long term stability. The presence of plant roots is a natural means of incorporating randomly distributed fiber inclusions within the soil mass. With learning from the root reinforcements, the fiber reinforcement concept has also become significant in engineering construction practice. In fact, the soil strengthening effects of natural fibers as the roots of vegetation may be replicated artificially by including different types of natural and synthetic fibers or as fibers from waste materials within the soil mass. In some cases, materials like cement, lime, fly ash or bituminous products are also added to the soil along with fibers for achieving additional improvement in the engineering properties of soil.

There are mainly two types of inclusions ideally inextensible (metal strips, bars etc) and ideally extensible (natural and synthetic fibers, roots etc). Soil reinforced with synthetic or natural fibers is classified as mechanical stabilization group; this is a developed technique for enhancing strength behavior of soil (Canakci et al.,2016; Freitag, 1986; Kumar and Yadav, 2016; Prabakar and Sridhar, 2002; Soundara and Kumar, 2015; Tang et al., 2007).

Fiber reinforced soil behaves as a composite material in which fibers of relatively high tensile strength are embedded in a matrix of soil. Shear stresses in the soil mobilize tensile resistance in the fibers, which in turn imparts greater strength to the soil (Hejazi et al., 2011). Fiber is generally divided into two categories: one is the plant fiber like wheat straw, coir, bagasse, sisal, and jute etc. Other one is the synthetic or manmade fiber like polypropylene, polyester, recron fiber etc. Many researchers have recently studied the synthetic fibers in soil reinforcement due to its uniformity and reproducibility. However, from the viewpoint of the environment, waste natural fibers should be widely utilized due to its renewability and sustainability. In addition, the surface of the synthetic fibers is smooth; it results in weak bonding surface in soil stabilization. In contrast, natural fibers have the rough surface, which produces better bonding strength of fiber and soil particles in the fiber-soil matrix. The aims of this study are to examine the effect of Recron fiber with variations of fiber content on compaction characteristics of Kaolinite clay.

2. Materials

A. Soil

The soil was collected from English India clay limited, Trivandrum. Its properties are tabulated in table 1.

Table 1
Initial properties of soil

Soil property	Kaolinite
Specific gravity	2.67
Liquid limit(%)	33
Plastic limit (%)	20.6
Shrinkage limit(%)	19.06
Plasticity index (%)	12.3
Optimum moisture content (%)	24.5
Maximum dry density (g/cc)	1.65
%clay	68
%silt	24.8
% sand	7.2
IS Classification	CL

B. Recron 3S Fiber

Recron 3S is modified polyester. It is generally used as reinforcing material in concrete and soil to increase their performance. Polyester (Recron) fibre used for the test having different sizes 6mm and 12mm. These fibers were made from polymerization of pure teraphthalic acid and Mono Ethylene Glycol using a catalyst. These fibers were found to be widely used in concrete technology which has a special triangular cross-section and equivalent diameter of fiber was about 32 µm– 55 µm. The properties are shown in Table 2.

Table 2
Properties of Recron Fiber

Properties	Values
Length (mm)	6 mm
Cross-section	Triangular
Diameter (µm)	32µm
Specific gravity	1.34
Chemical composition	Modified polyester
Water absorption (%)	<1%

C. Laboratory studies

The experimental work has been done to investigate the influence of fiber content on the unconfined compression strength of clayey soil. Unconfined compressive strength test is one of the cheapest and fastest methods of measuring the compressive strength of cohesive soils. For this purpose various percentages of recron fiber (0.5,1,2 and 4%) were randomly mixed with the clayey soil. Compaction test were carried out by adopting IS light compaction method as specified as in IS 2720(Part VII)Here it is shown how to style a subsection and sub sub-section also

3. Results and discussion

A. Compaction characteristics

The influence of fiber content on OMC and dry density are shown in table 3.

From the table it can be observed that the addition of fibers

Table 3
Compaction results

Percentage of fiber	OMC (%)	MDD (g/cc)
.5	24.04	1.657
1	23.3	2.18
2	22	2.226
4	21.5	1.53

with the fiber content increasing from 0.5 to 2% resulted in the increase of dry density and the decrease of OMC. This may happen due to the reduction of the voids in the fiber soil matrix. Further increasing the fiber content (4%) OMC and dry density decreased. A reasonable explanation for the decrease of dry density was that fibers presenting in the matrix stuck together to form lumps which caused pockets of low density in the matrix (Prabakar and Sridhar, 2002). Besides, the water absorption of fiber is less than 1% and makes the OMC decreased.

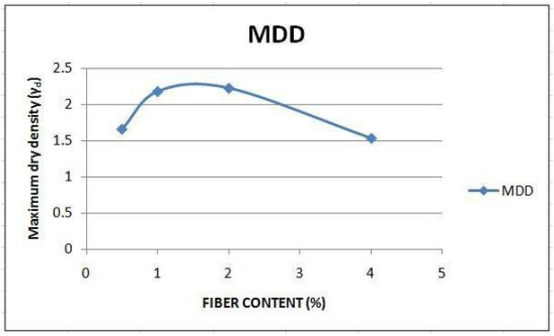

Fig 1. Variation of MDD with fiber content

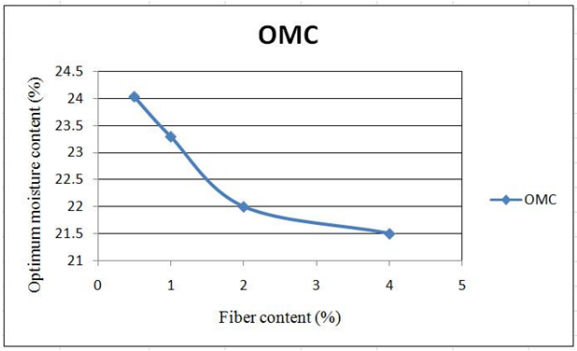

Fig 2. Variation of OMC with fiber content

4. Conclusion

The geotechnical properties of clay reinforced with Recron fiber were investigated by conducting compaction test and unconfined compression test. The following conclusions were drawn from the experimental results:

- The content of fibers in soil matrix has a significant effect on OMC and MDD. The OMC of the soil decreases with the addition of the fiber content
- MDD of the soil increases up to 2% and then decreases
- The optimum dosage of fiber is obtained as 2%.

- Soil stabilization with recron fiber improves the strength behavior of clayey soil and can be potentially useful in time and cost savings.

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