Improvement of Strength Reinforced by Sugarcane Fibre

Hasan M. Rangwala[1[0000-0001-8936-9880]], Lavkush Agrawal[1], Vivek Makhecha[1], and Ishan Gondaliya[1]

[1]Department of Civil Engineering, Nirma University, Ahmedabad - 382 481, Gujarat, India
hasan.rangwala@nirmauni.ac.in.com

Abstract. Soil is a base of structure, which supports the structure from beneath and distributes the load effectively. If the stability of the soil is not adequate then failure of structure occurs in form of settlement, cracks etc. Which can be prevented by soil reinforcement which is introduced in the field of geotechnical engineering by improving properties of soil. Which is the most popular techniques used for the improvement of poor soil. It causes significant improving in shear strength, bearing capacity, as well as economy. Many research has been conducted for stabilization of soil by using cementing, chemical materials e.g. Fly ash, cement, Calcium chloride, etc. Today world is facing severe problem of disposal of agricultural waste. There are many natural fibre and synthetic fibre available in the market like Jute fibre, coconut fibre, palm fibre, sugar cane fibre, and glass fibre, nylon fibre, polypropylene fibre, etc. Sugar cane fibre have chosen for soil stabilization in this study. Sugar cane fibre have been taken from sugarcane waste that is after extrusion of juice. In this experimental study, the fibre content has been taken 0.2%, 0.4% and 0.6% of the soil. After conducting series of experiment concluded that after mixing sugar cane fibre 0.6% of soil that is optimum fibre content, significant increment in angle of friction and decrement in the cohesion of soil is obtained.

Keywords: Ground Improvement, Sugarcane Fibre, Triaxial Test.

1 Introduction

Geotechnical engineers often encounter problems in designing foundations of structures on highly compressible clayey soil due to its poor bearing capacity, low shearing strength, etc. Soil reinforcement is an effective and reliable technique for improving strength and stability of soils.

Reinforced earth is a composite material, a combination of soil and reinforcement duly placed to bear the tensile stresses developed and to improve the resistance of soil in the direction of maximum stress. Fibre reinforcement is one of the novel emerging soil reinforcement techniques. Randomly distributed fibres provide interlocking and friction resistance to resist the movement of soil particles, which considerably increase the load carrying capacity. These reinforcement is widely used in the embankment, slope stabilization, pavement application in the current times. For efficient application of fibre reinforcement, proper understanding of effect of different parame-

ters like fibre parameters and soil parameters on the behavior of fibre reinforced soil is required.

Use of natural fibres such as cotton, bamboo, jute, coir, etc. as soil reinforcing materials has been prevalent for a long time. The concern in natural fibre reinforcement in soil has increased rapidly due to the growing environmental consciousness and understanding of the need for sustainable development to replace man-made artificial fibres.

Various researches have performed experimental studies on randomly distributed fibres using natural fibres and synthetics fibres. Hejazi et al. (2012), Gowthaman et. al. (2018) and Shukla et. al. (2019) discusses the studies performed on various materials for randomly distributed fibres.

In this study, an attempt has been made to evaluate the strength of a soil-fibre mix using sugarcane waste fibre as reinforcing material. It has also attempted to find an optimal dose of fibre for the soil in consideration to achieve highest possible strength.

2 Test Sample

2.1 Soil Sample

The soil sample was obtained from Nirma University campus from a depth of 1.5 meter below the ground level. Characteristics of soil is given in Table 1.

Table 1. Soil Properties

Sr. No.	Property	Value
1	Percentage Fines	36%
2	Plastic Limit	23%
3	Liquid Limit	20%
4	Soil Type	SM
5	Bulk Density	1.89 gm/cc
6	Field Moisture Content	9 %

2.2 Sugarcane waste fibre

Sugar cane waste was obtained from local juice shop. The waste was washed by normal water to remove residual glucose and also its odour. Washing sugarcane waste would also increase durability of the fibre due to removal of biodegradable bacteria attach to the waste. A proper drying of sugarcane was done of air drying for 3-days and oven drying at 70˚C for 1 day.

The dried fibre was cut to the length of 2 – 3 cm length and their average diameter is around 0.5 mm. Hence, aspect ratio of fibre is around range of 40-60.

3 Experimental Study

An experimental study was devised to arrive at the optimum value of percentage of sugarcane waste fibre in the soil that can be added to achieve higher strength. Standard Proctor test was performed to get OMC and MDD. Triaxial compression tests was then performed on sample prepared at the water content as OMC and the dry density of MDD.

3.1 Standard Proctor test

Series of standard proctor tests were performed to determine the optimum value at which the soil-fibre mixture will have the highest dry density. the parametric study was carried out considering various fibre content. Fibre content of 0% (i.e. unreinforced soil), 0.2%, 0.4%, 0.6% and 0.8% are considered in this study. Results of the standard proctor test for various fibre content is illustrate in Figure 1. It has been observed from results of standard proctor test that the density of soil-fibre mix decrease for 0.8% fibre and hence it has not been considered in the further study.

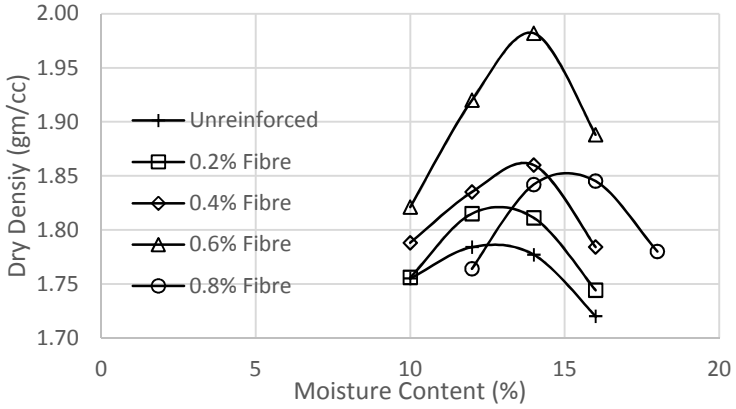

Fig. 1. Compaction curves for various soil mixes

3.2 Triaxial Compression Test

Series of triaxial compression tests were performed to observe the effect of sugarcane waste fibre on shear strength of soil mix. In order to determine the optimum doses of fibre content, the parametric study was carried out considering various fibre content. Fibre content of 0% (i.e. unreinforced soil), 0.2%, 0.4% and 0.6% are considered in the study.

4 Results and Discussion

This section included the discussion on the results and observation of test performed to discover the effect of inclusion of the sugarcane waste fibre and its optimized dose based on compaction and shear parameters.

4.1 Standard Proctor Test

A illustrated in Fig. 2, Optimum Moisture Content (OMC) increase with an increase in the fiber content. This may be due to the fact that sugarcane waste fiber would also soak the water from the mix. Fi. 3 shown variation of Maximum Dry Density (MDD) with an increase in fibre content. MDD is observed to be increasing up to 0.6 % of sugarcane waste fiber and decreased with the futhther increase in the fibre. This may be due to the fact that soil material is replaced by a light material of sugarcane waste fiber.

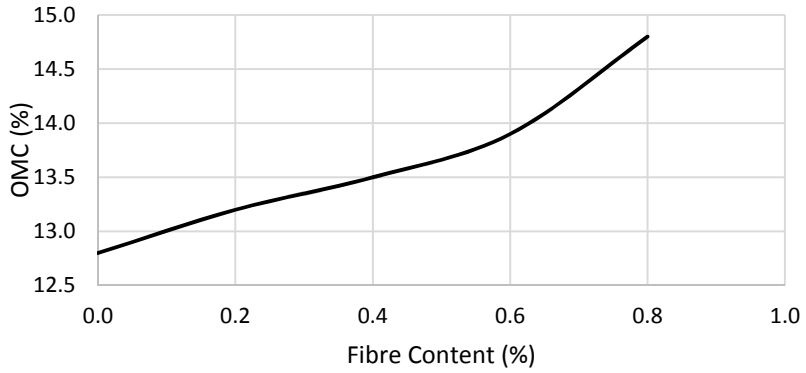

Fig. 2. Variation of OMC with Fibre Content

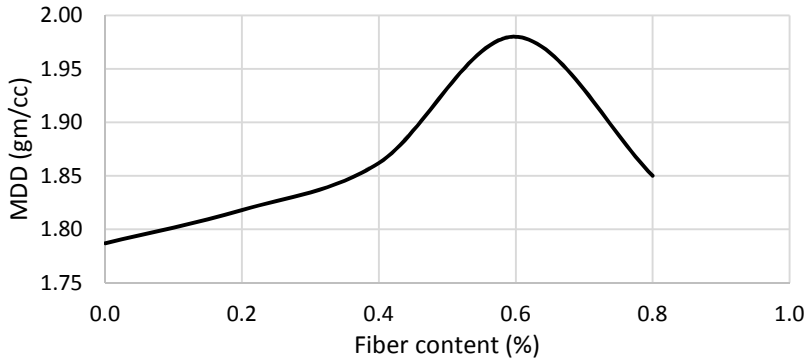

Fig. 3. Variation of OMC with Fibre Content

4.2 Triaxial Compression Test

Shear Parameters were found for each of the soil-fibre mix by plotting he Mohr's circle from the data observed during the triaxial compression test performed on a sample with 38 mm diameter and 76 mm height. Fig. 4 shows he variation of cohesion (c) with fibre content. The cohesion decreases with an increase in the fibre content, this is due to the fact that the attraction between the soil particles is blocked by the sugarcane waste fibre. Fig. 5 shows he variation of angle of internal friction (φ) with fibre content. The angle of internal friction increase with an increase in the fibre percentages, this is due the fact that the inclusion of friction between soil and fibre. The increase was observed to be as high as 500% in the angle of internal friction while the decrease in the cohesion was also observed up to 50% in comparison to the unreinforced soil, i.e. % fibre.

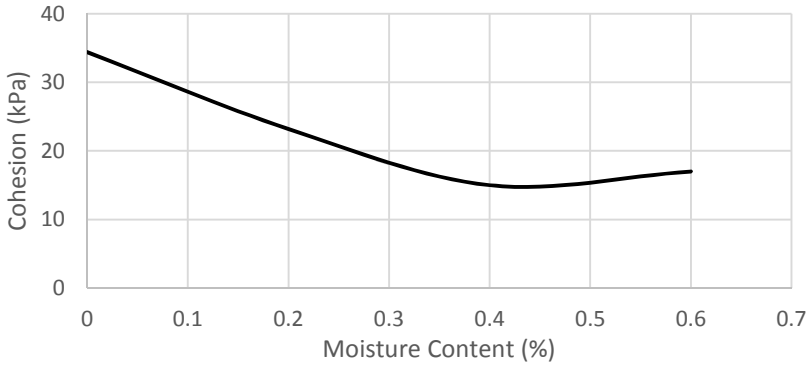

Fig. 4. Variation of Cohesion with Fibre Content

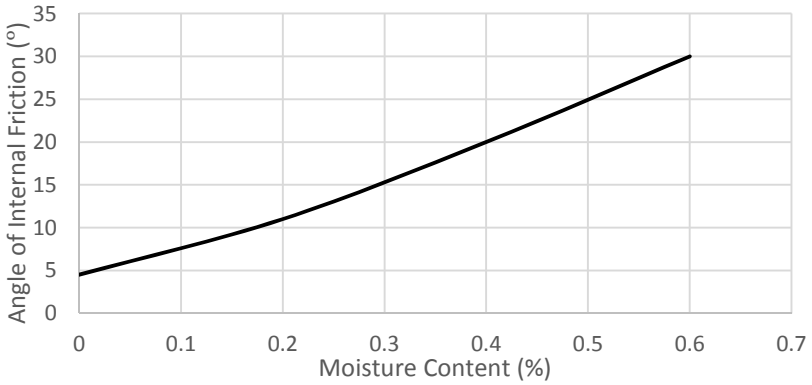

Fig. 5. Variation of angle of internal friction with Fibre Content

5 Conclusion

An experimental study to the effect of sugarcane waste fibre as an alternative sustainable reinforcement material for the improvement if shear strength was performed. The study was carried out using the fibre obtained from the sugarcane waste, obtained after the piling the same to make its fresh juice.

The compaction an shear parameters for the soil-fibre mix were determined for various mixes of soil and fibre considered for the study. The fibre was taken as 0%, 0.2%, 0.4% and 0.6% by weight of the soil, for the determination of shear strength. It was found that the shear strength increases significantly with an increase in the fibre content. Moreover from study it was also observed that 0.6% sugarcane waste fibre gives the maximum strength,

The advantages of the considered fibres include low density, easy availability, low (zero) price and minimal pre-treatment to increase durability of fibre . Further, fibres are biodegradable and carbon dioxide neutral and their energy can be recovered in an environmentally acceptable way. The main advantage of these materials is that they are locally available and cost effective.

References

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