ENHANCEMENT OF SOIL CHARACTERISTICS USING GLASS FIBERS

[1] **Munnangi Ravi Teja**, [2] **B. Pavan Kalyan**, [3] **S. Gopi Krishna** [4] **D. Mahendar**

[1] Assistant professor, Department of Civil Engineering, Vignana Bharathi Institute Of Technology, Aushapur (V), Ghatkesar (M), Medchal (D) ,Hyderabad, INDIA

[2,3,4]U.G student Department of Civil Engineering Vignana Bharathi Institute Of Technology, Aushapur (V), Ghatkesar (M) ,Medchal (D) ,Hyderabad, INDIA

Abstract: Soil reinforcement has been introduced into the field of geotechnical engineering for many years in order to enhance the properties of ground soil in specific engineering projects. Traditional geosynthetics such as geotextile, geogrid etc. have been proved to be efficient, and they are being increasingly used in geotechnical engineering but the use of glass fibers in soil have only started recently. Though some research have been done with a few types of soil, still the volume of study is rather scanty compared to other soil reinforcing materials. Moreover, the effect of randomly distributed glass fibers acting as reinforcement material seems to be an interesting concept due to the absence of potential planes of weakness that can develop parallel to oriented reinforcement. This study reveals around the reinforcement of soil by glass fiber and the comparison between engineering properties before and after stabilization. The study is carried out to evaluate the effects of glass fiber on shear strength of soil by carrying out unconfined compression test and CBR tests on soils. Disturbed samples are collected from a location near the pond at Ghatkear Hyderabad. In laboratory, testing of liquid limit, specific gravity along with grain size distribution is carried out for the classification of soil. For different percentage of glass fiber, CBR test and unconfined compression test are carried out for different fractions of glass fiber. The experimental results with and without glass fiber reinforcement are compared to obtain optimum quantity of fiber reinforcement (% of soil sample) required to stabilize a weak soil along with the inference about effect on bearing capacity and shear strength.

IndexTerms **- CBR, Glass fiber, reinforcement, unconfined compression test.**

I. INTRODUCTION

Soil stability is one of the most important topics in geotechnical engineering practices. With frequent failures of soil mass, whether it is on a slope or level ground, have proved to be costly in terms of both life and property. Various soil stabilization techniques including fiber reinforcement have been in use for a while and the results in some of them has been quite satisfactory. Reinforcing soils using tension resisting elements is an attractive means of improving the performance of soil in a cost effective manner. The use of random discrete flexible fibers mimics the behavior of plant roots and gives the possibility of improving the strength and the stability of near surface soil layers. Practicing engineers are employing this technique for the stabilization of thin layers of soil, repairing failed slopes, soil strengthening around footings and earth retaining structures. However, more research is needed to further understand the potential benefits and limitations and to allow its application to more complex geotechnical structures.

Silty Soil being a major type of soil in India the aim of this project is to find the effects of glass fibers on the properties of silty soil extracted from a particular site in Telangana. The properties include liquid limit, plastic limit, and plasticity index, and maximum dry density, optimum moisture content and unconfined compressive strength of the soil.

The addition of randomly distributed glass fiber Resulted in substantially reducing the consolidation settlement of the soil. Length of fibers has an insignificant effect on this soil characteristic, whereas fiber contents proved more influential and effective. Addition of fiber resulted in decrease in plasticity and increase in hydraulic conductivity. Glass fiber is one such fiber having a durable, inert nature possessing high tensile and compressive strength.

II. MATERIALS

A. Soil

The materials used in the experiments are soil and glass Fiber The soil used in the experimental work was brought from site of pond near Ghatkesar, (T.S), India. The geo- technical properties of the soil are:

Table-1: Physical characteristics of Soil

S No	Soil Properties	Test values
1.	Free swell index	15%
2.	Specific gravity	2.59
3.	Liquid limit %	47
4.	Plastic limit %	30
5.	Plasticity index	17
6.	Uniformity coefficient, Cu	10
7.	Coefficient of curvature, Cc	1.307
8.	Compaction characteristics Maximum dry density (gm/cc) Optimum moisture content %	 1.78 19
9.	Unconfined compression strength (kpa)	0.6
10.	California Bearing Ratio CBR (%)	2.7
11.	IS classification	MI

B. Glass fiber

Glass fiber also called as fiber glass is made from extremely fine fibers of glass. Fiber glass is a light weight, extremely strong and robust material. Glass fibers are among the most versatile industrial material known today. They are easily and readily produced from raw materials derived from composition containing silica. They showing bulk properties such as hardness, transparency, resistance to chemical attack, stability and inertness, as well as desirable fiber properties such as strength , flexibility, stiffness and durability.

The fiber is cut into pieces of 3cm to 5cm, as those percentage remains 1%,2%, and 3%.

III. TESTING PROCEDURE

For studying, the effect of glass Fiber on silty soil, the glass fiber was added from 0 to 3 % at an increment of 1 %.The following tests were conducted on silty soil and fiber mixes as per relevant IS code practice.

The experiments conducted are:

An unconfined compression test IS: 2720(PART10)-1991

Un-Soaked California bearing Ratio (CBR) IS:2720(PART16)-1979

IV. TEST RESULTS

The various tests were conducted on silty soil mixed with glass fiber in different proportions as per relevant IS Code of practice. The test results obtained from various laboratory investigations are summarized in table 2.

Table 2 – Results of variation of properties

S NO	PROPERTIES	Soil+ 0%	Soil+ 1%	Soil +2%	Soil + 3%
1.	UCC kpa	0.6	1.44	1.7	1.15
2.	C.B.R %	2.7	3.46	7.35	14.12

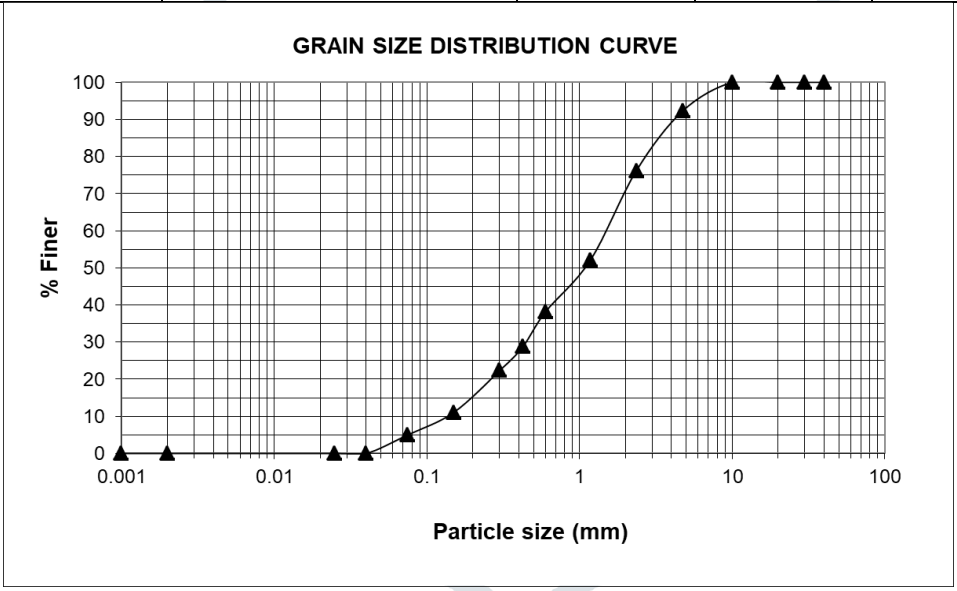

Fig 2 Grain Size Analysis of soil

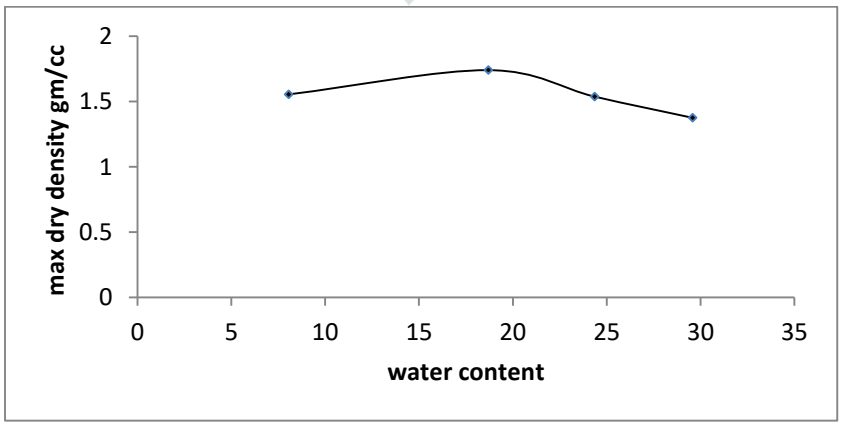

Fig 3 compaction curve

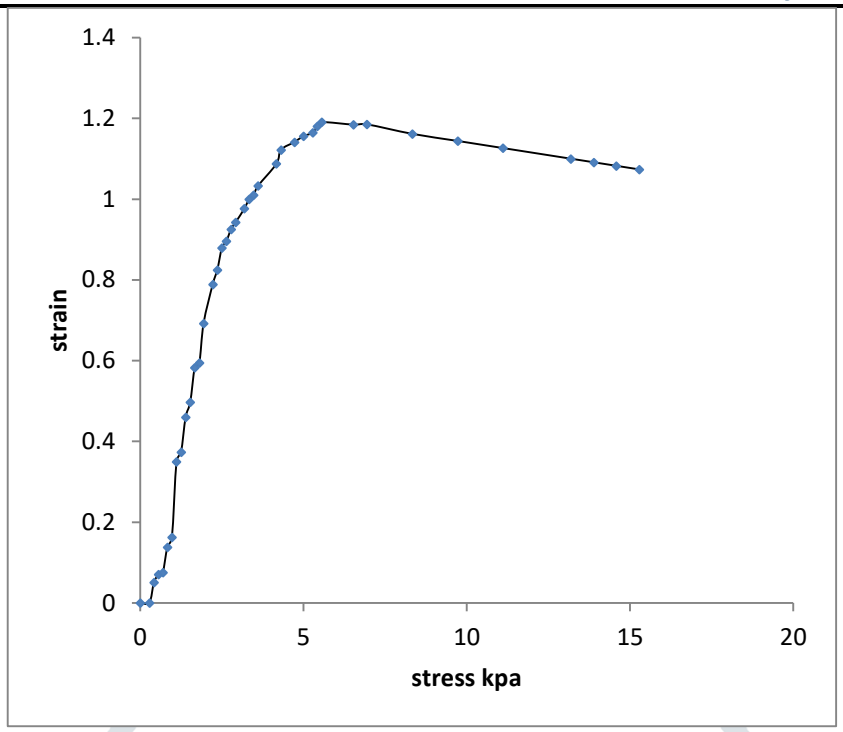

Fig 4 unconfined compression curve without fiber

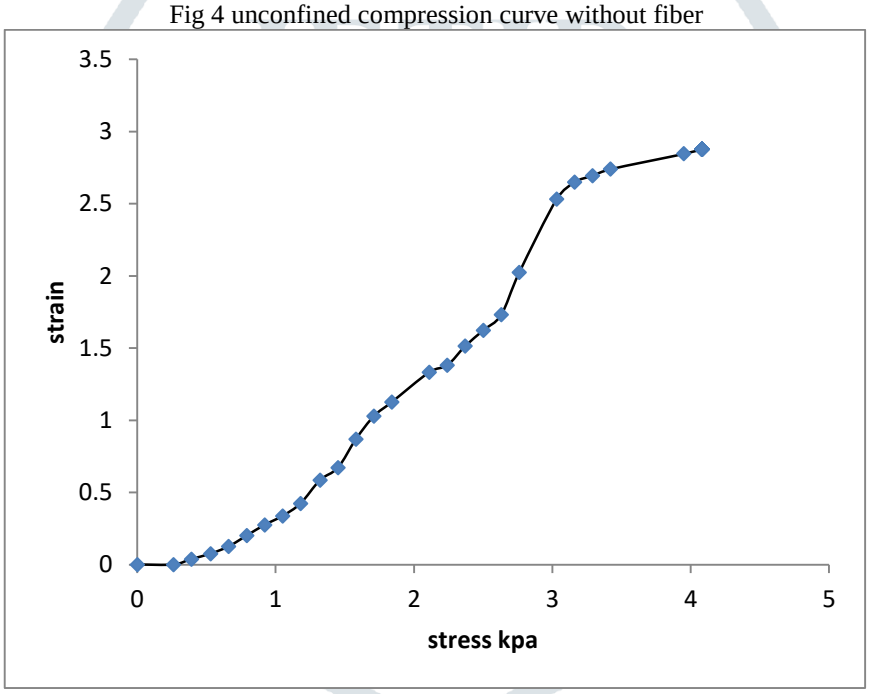

Fig 5 unconfined compression curve with 1% fiber

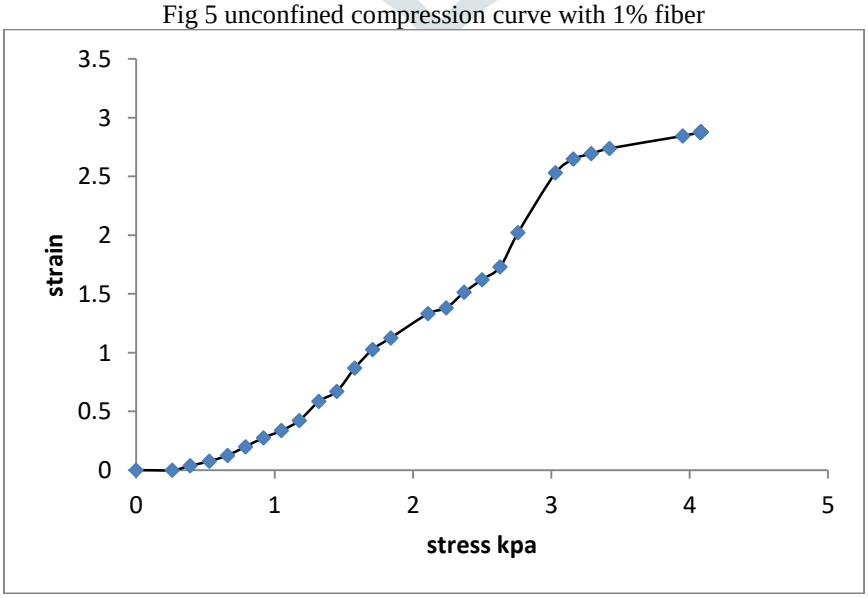

Fig 6 unconfined compression curve with 3% fiber

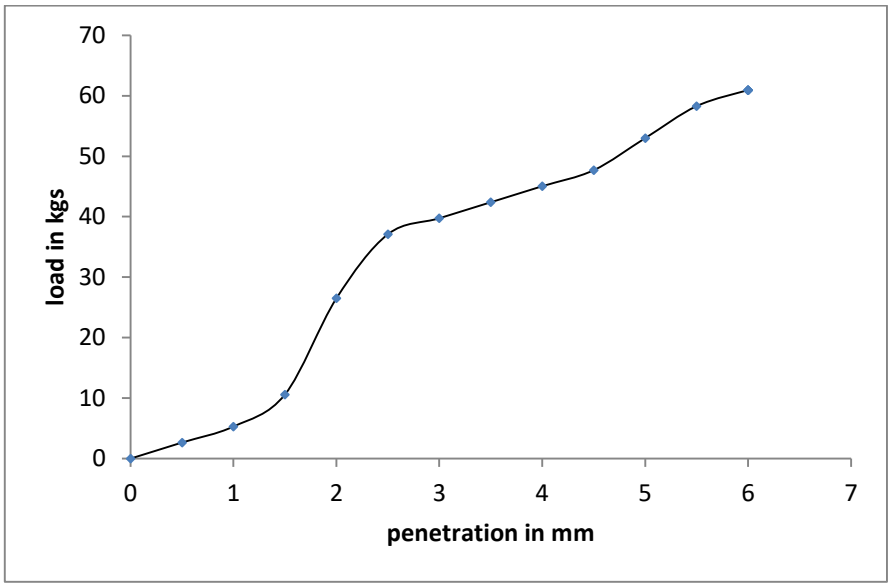

Fig 7 CBR curve without fiber

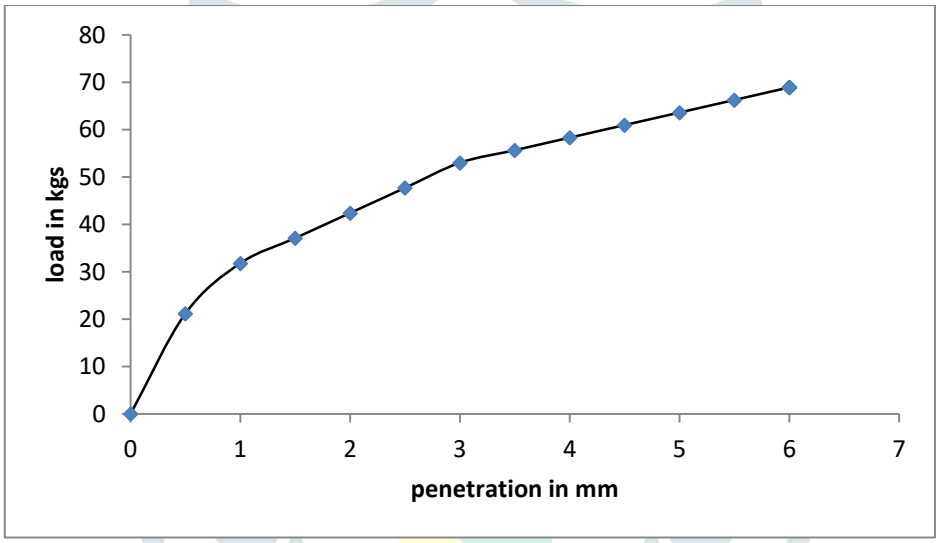

Fig 8 CBR curve with 1 % glass fiber

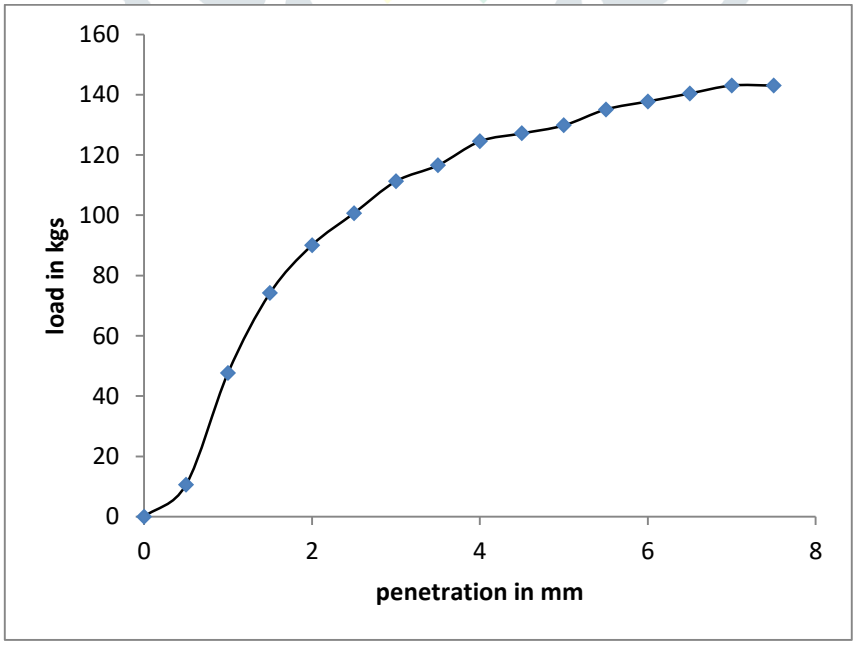

Fig 9 CBR curve with 2 % glass fiber

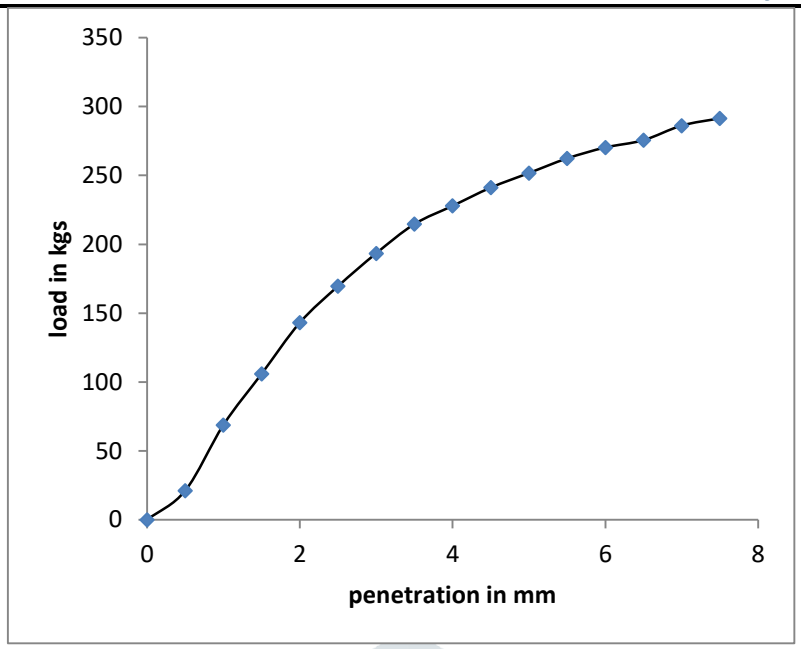

Fig 10 CBR curve with 3 % glass fiber

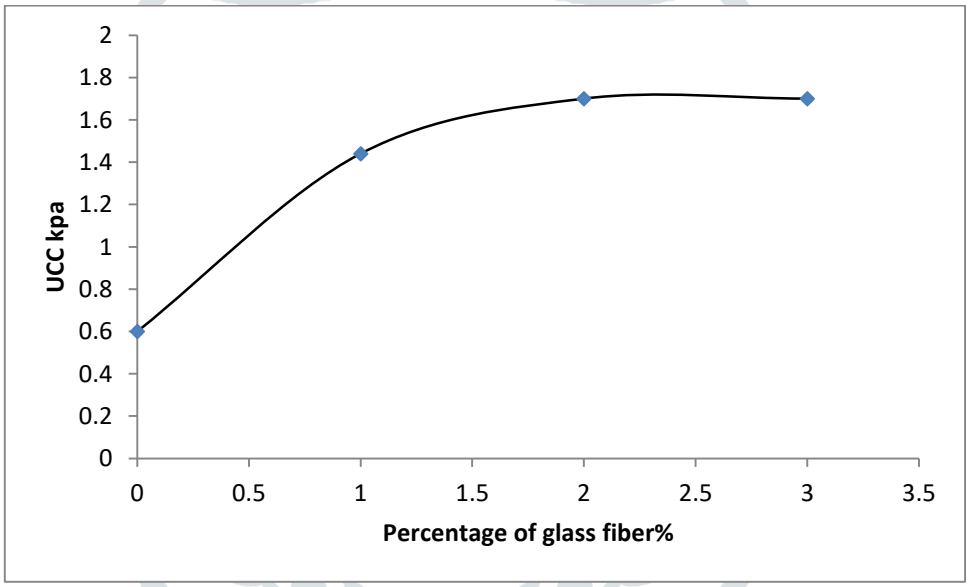

Fig 11 unconfined compression value of soil with glass fiber

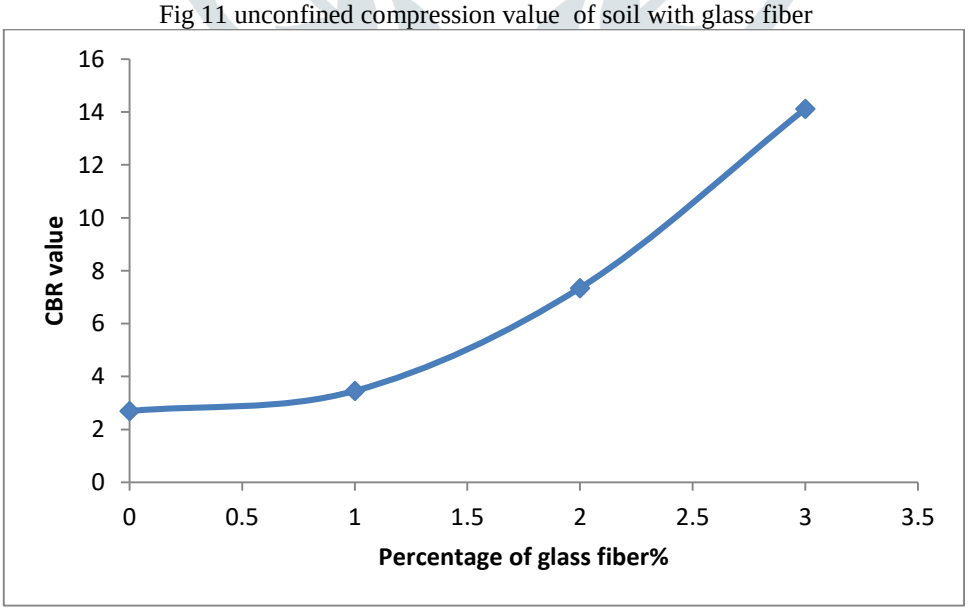

Fig 12 CBR of soil with glass fiber

IV. RESULTS AND DISCUSSION

Based on the results obtained from various tests conducted on silty soil, glass fiber mixes. The variations in various engineering characteristics of the soil are discussed below. The unconfined compression test results showed a increase ucs value with the addition of glass fiber content from 0% to 3%. The variation in ucc values are presented in figure11 .The unsoaked CBR test results indicates that the values increase from 2.7 % to 14% as the glass fiber content increase from 0% to 3%. The load penetration curves and the variation of CBR with glass fiber are presented in figure 12

V. CONCLUTIONS

Based on above laboratory investigations conducted on soil-glass mixes the following conclusions can be drawn: The addition of glass fiber into the silty soil has changed the shear parameters. The unsoaked CBR values have also increased significantly with the addition of glass fiber content. The addition of 3% glass fiber into the soil, increase the CBR values from 2.7% to 14% .From the above laboratory investigation it can be concluded that the industrial waste like glass fiber has a potential to modify the engineering behavior of soil which has a lack of strength properties and to make it suitable in many geotechnical application like slope stability, retaining wall, foundation and also in pavement application.

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