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Improvement in CBR Values of Soil Reinforced with Jute Fibre

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***Abstract*— In this study five soil samples were prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould with and without reinforcement. The percentage of Jute fiber by dry weight of soil was taken in a fraction of 1.0%, to 5.0% in increment of 1. In the present investigation the lengths of fiber was taken as 20, 40, 60, 80 and 100 mm, without considering diameters of fiber. The laboratory CBR values of soil and soil reinforced with Jute fiber were determined under unsoaked condition. The effects of lengths of fiber on CBR value of soil were also investigated. Tests result indicates that CBR value of soil increases with the increase in fiber content. It was also observed that increasing the length of fiber further increases the CBR value of reinforced soil and this increase is substantial at fiber content of about 1.5 to 2.0 %. This significant increase in CBR value of soil reinforced with Jute fiber can be used to substantially reduce the thickness of pavement subgrade and significant reduction in the cost of construction.**

***Index Terms*— Stabilization, Natural, Fibre, Bearing Capacity, Moisture etc.**

I. Introduction

Soil has been used as a construction material for buildings, roads, irrigation structure etc. all over the world. Because of weakness in mechanical properties and strength, soil needs to be improved according to the requirement which varies from site to site. The stabilization of soils has been performed since many past centuries to improve engineering properties of soil. The main method of Stabilization includes mixing the soil with soil of higher strength or binding materials like limestone / cement /calcium or reinforcing with suitable element / fibre. Soil reinforcement increases soil strength, bearing capacity, ductility and inhibits deformations Soil can be reinforcement by inclusion of high strength metal strips / wire and relatively low modulus natural and/or synthetic fibers. During last few decades, much work has been done to improve the engineering properties of soil and it has been established that addition of fibre is an efficient way to enhance the overall engineering performance of soil. Fiber reinforced soil is effective in all types of soils (i.e. sand, silt and clay). The concept of reinforcing soil with natural fibers is ancient one. Natural fibers are locally available, can make composites with cement / lime, cheaper, biodegradable and environmental friendly. There are many fibre e.g. Coconut (coir), Sisal, palm, Jute, rice husk, barley straw etc., are in use for soil stabilization. In the Bhojpur area (along the bank of River Betwa) soil is composed of silt and clay fraction. The soil has high value of liquid limit and small value of CBR and hence exhibits swelling during the summer. In present study use of juteis made to stabilize the local soil material which is supposed to improve the soil quality economically. The objective of present work is to study the most appropriate proportion of jute (with a particular length and diameter) which will give maximum value of CBR at the optimum moisture content and maximum dry density.

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II. Literature Review

In the 21th century application of jute fibre in civil construction work has attend pace especially for subgrade of flexible pavement. Savastano et al. (2000) used waste jute fibers as reinforcement for cement-based composites in construction work instead of concrete. Dhariwal (2003) carried out performance study on California bearing ratio (CBR) of fly ash reinforced with jute and non-oven fibers. Sanyal (2005) studied soil improvement by using jute fibre and applied Jute Geotextiles in Rural Roads. Chandra et al. (2008), studied CBR and shear values of Jute fibre for preparation of fibre reinforced flexible pavements. Saran (2010) gives brief discussion about the reinforced soil and its engineering applications. Islam and Iwashita, (2010) used jute reinforced material to construct earthquake resistance building for low income stack holders. Aggarwal and Sharma (2010), used bitumen coated jute with different fibre lengths and varying percentages to reinforce soil and found that jute fiber reduces the MDD with the increases the OMC. They obtained Maximum CBR value (2.5 times than plain soil CBR) with 10 mm long and 0.8% jute fiber. Islam and Ivashita (2010) showed that jute fibers are effective for improving the mortar strength as well as coherence between block and mortar. Singh (2012) studied improvement in CBR value of soil reinforced with jute and coir fiber in comparative manner and suggested dominance of jute fibre. Singh and Bagra (2013) studied the influence of different length and diameter of Jute fiber on the CBR value of Itanagar, A.P., India soil used in the construction of embankments and pavement subgrade and results were compared with that of unreinforced soil. Pandey et al. (2013) studied soil stabilization using pozzolanic material and Jute fibre.

III. Materials

A. *Soil:* The soil used in this study was collected from the bank of Betwa River near Bhojpur, Bhopal, and Madhya Pradesh, India. The various index properties and compaction properties (maximum dry density and optimum moisture content) of soil were determined in the laboratory which is given in Table 1. The grain size distribution curve of soil is shown in Fig.1.

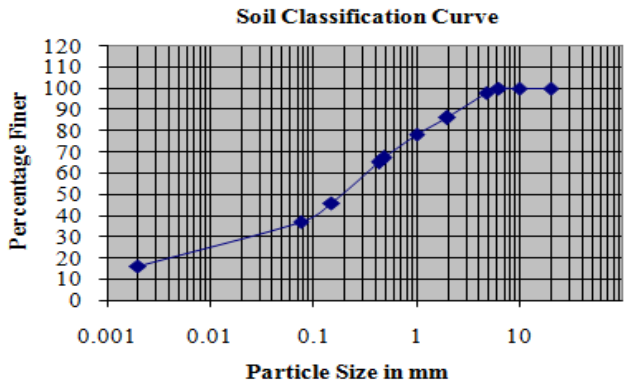


Fig.1. Soil Classification Curve

Table I: Index and Compaction Properties of Soil

Specific Gravity (G)	2.58
Liquid Limit, LL (%)	34
Plastic Limit, PL (%)	22
Gravel Size (> 4.75 mm)	2
Sand Size (0.075- 4.75 mm)	33 %
Silt Size (0.002-0.075 mm)	49%
Clay Size (<0.002 mm)	16%
Coefficient of uniformity (Cu)	8
Coefficient of curvature (Cc)	1.53
Maximum Dry Density (kN/m^3)	17.30
Optimum Moisture Content, OMC (%)	16.45

B. Reinforcement: The reinforcing material used in this study is Natural Jute fiber of diameters 1 mm, and 2mm. The length of fiber corresponding to each diameter of fiber was taken as 20, 40 mm, 60 mm, 80 mm and 100 mm. A typical view of Jute fiber is shown in Fig. 2.

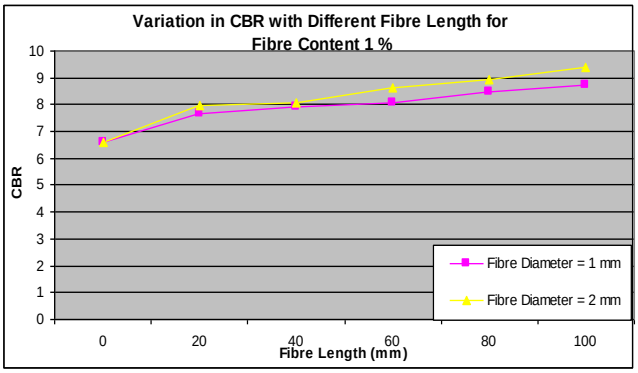
Figure 2: Jute Fiber (D = 2mm, L = 30 mm)

IV. Test Procedure

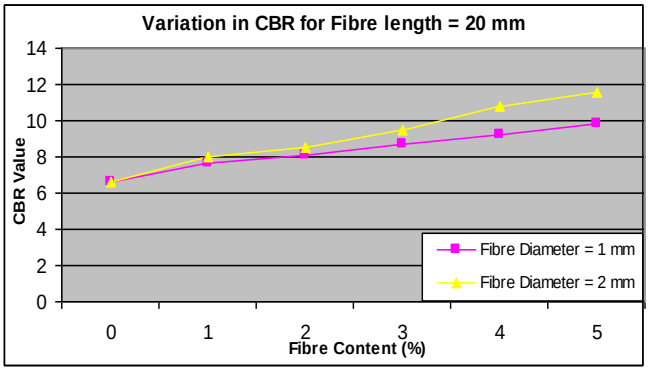
The soil samples of unreinforced and reinforced soil for CBR test were prepared as per standard procedure laid down in IS:2720-XVI, (1974). The desired amount of oven dried (100-105°C) soil was taken and mixed thoroughly with water corresponding to its optimum moisture content (OMC) in the CBR mould for unreinforced CBR. The soil was then compacted to its maximum dry density obtained by laboratory standard Proctor test. For the preparation of soil samples of reinforced soil the desired amount of fiber was mixed in dry state before the addition of water and then compacted to same Proctor density. The top surface of the specimen in the CBR mould was made level and a filter paper and a perforated metallic disc were placed over the specimen. With spacer disc placed inside the mould, the effective height remains only 127.3 mm and the net capacity is2250 cm^3. The CBR values of the test samples of unreinforced and reinforced soil were determined corresponding to plunger penetrations of 2.5 mm and 5 mm as per the standard procedure laid down.

V. Test Results and Discussions

The CBR values of soil and soil reinforced with different combinations of Jute fiber determined in the laboratory are plotted in figure 3 for two set of experiments using jute fibre of 1 mm and 2 mm diameters. The effect of jute fibre reinforcement is studied for two types of variation i.e. in fibre length and in fibre contents. The CBR values are worked out for each diameter size of jute fibre for varying fibre lengths i.e. from 20, 40, 60, 80 and 100 mm. For each combination of fibre diameter and length once again the fibre content is varied in fraction of 1% of dry weight of soil to 5% of dry weight of soil in increment of 1% fibre weight. The interpretation of tests result such as effects of fiber content, length of fiber and diameter of fiber on CBR value of soil have been discussed in the following sections.



(a)



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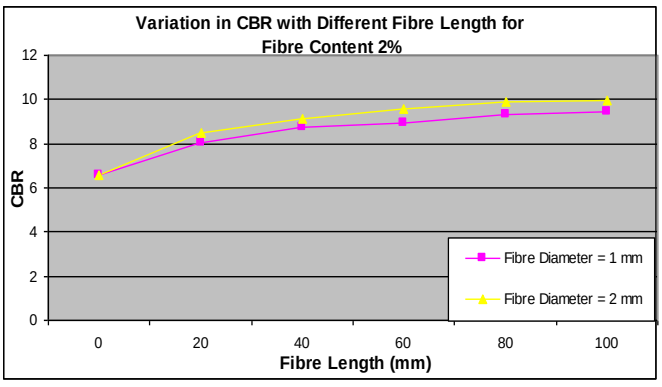

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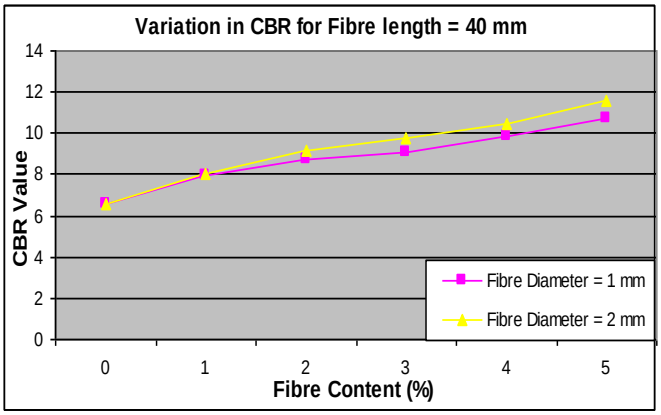

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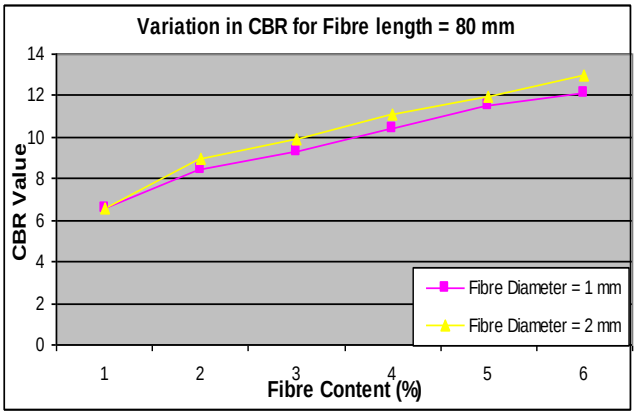

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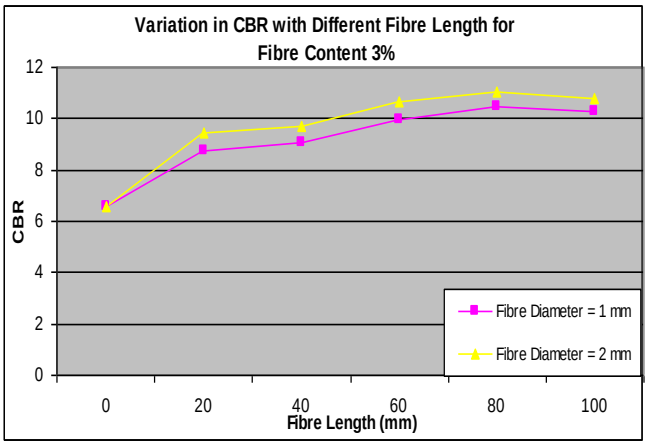

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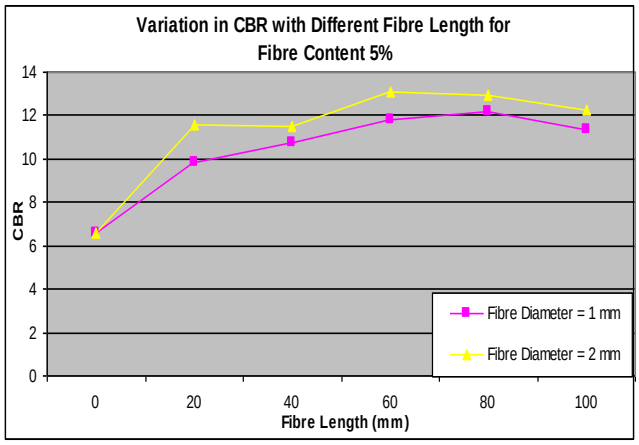
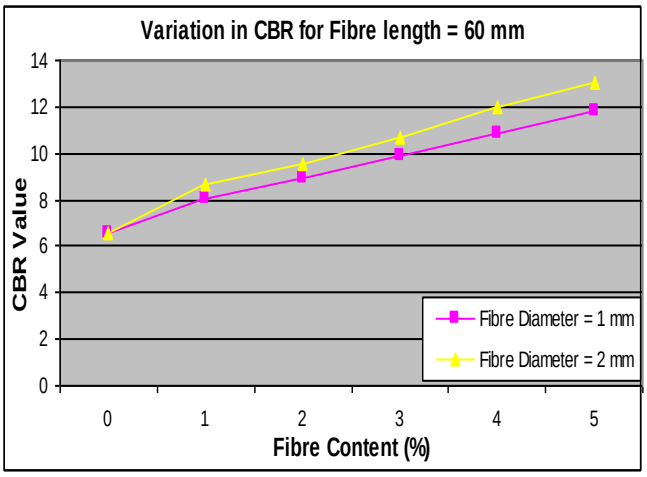


(i)



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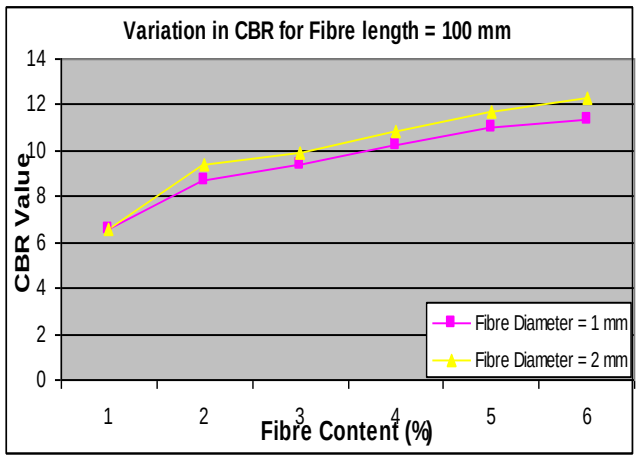
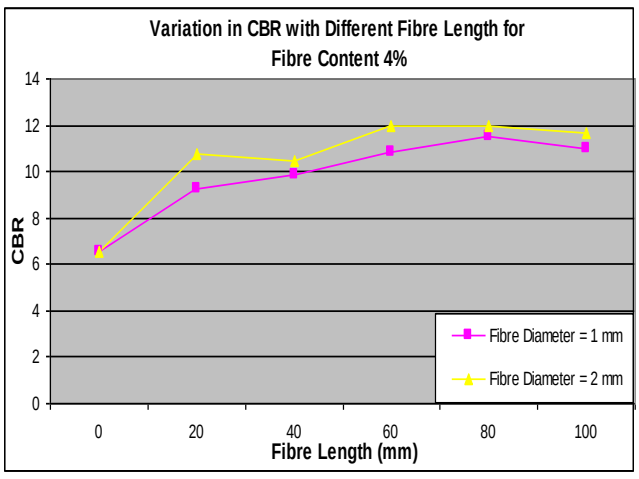


(j)



(g)

Figure 3: (a)-(j) Variation in CBR Values with reference to Fibre Length and Fibre Content

VI. CONCLUSIONS

Based on the present investigation it is concluded that CBR value of soil increases with the inclusion of Jute fiber. When the Jute fiber content is increases, the CBR value of soil is further increases and this increase is substantial up to fiber content of 5 %.It was also found that preparation of identical soil samples for CBR test beyond 5 % of fiber content is not possible and optimum fiber content is expected to be between 4-5 % by dry weight of soil. The optimum length of fibre is somewhere between 60 to 80 mm. It is also concluded that there is significant effects of length and diameter of fiber on the CBR value of soil. The CBR value of soil increases with the increase in length and diameter of fiber. Further, addition of Jute fiber makes the soil a composite material whose

strength and stiffness is greater than that of unreinforced soil. The strength and stiffness of reinforced soil increases with the increase in fiber content and may be due to this reason also the CBR value of reinforced soil was observed to be greater than that of unreinforced soil.

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