Effect of Polypropylene Fiber on CBR Value of Sand

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Abstract- **The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction, proportioning and the addition of suitable admixture or stabilizer, but the stabilization using waste plastic is an economic method as they are easily and cheaply available. This paper presents the CBR test conducted on fine sand reinforced with randomly distributed polypropylene fibers, under both soaked and unsoaked conditions with varying fiber content. Results of CBR tests demonstrate that inclusion of polypropylene fibers in sand with appropriate amounts improves strength and deformation behaviour of sub grade soils .The fiber addition rate varies from 0% to 2.5% at 0.5% interval. In this paper CBR value of reinforced sand increases by 113% compared to unreinforced sand. The optimum fiber content was found to be 2.5% (w/w). The addition of fiber becomes impractical after 2.5%.The proposed technique can be used in embankment, road construction, industrial yards etc.**

Keywords: CBR Value, Polypropylene Fiber, Pavement, Fiber Reinforced

I. INTRODUCTION

Reinforcement aids the strength and stability of soil. Reinforcement of soils with fibers is possibly one of the most effective techniques for increasing soil strength. Therefore, a number of laboratory experimental studies have been carried out, wherein soil is mixed with polypropylene fibers. The present work discusses the behavior of a CBR test on soil specimen of fine sand (SP) reinforced with randomly distributed discrete polypropylene fibers, under both soaked and unsoaked conditions, when compared to a non reinforced soil specimen under similar conditions. In this paper it is shown that the sand reinforced with the polypropylene fibers have more strength then the non-reinforced sand

II. EXPERIMENTAL WORK

2-1. Laboratory Testing Program:

CBR test were carried out on fine sand (SP) reinforced with randomly distributed discrete polypropylene fibers under both soaked and unsoaked conditions. For soaking, the samples were kept submerged in water for 4 days before testing. The tests were conducted on remolded soil samples prepared at standard Proctor's density and optimum moisture content (IS-2720-7-1980, Light compaction).

2-2. Materials:

2-2-1. Soil:
(As Per IS:2720(IV):1985 Methods of test for soils, determination of grain size Analysis)

Co-Efficient of Uniformity(Cu)	Co-Efficient of Curvature(Cv)	Type	Maximum Dry Sensity	Optimum Dry Sensity
2.33	0.964	SP (Poorly Graded)	1.715g/cc	13%

2-2-2. Plastic:

Fiber Properties (Source:- ShreeHari Fiber Products Ltd. Ahmedabad)						
Type	Diameter	Length	Tensile Strength	Softening Point	Density	Elongation at Break
Polypropylene	0.1mm	20mm	450 MPa	170°C	0.91 GM/C.C	10-45%

Fig:1 Polypropylene Fibers

2-3. Methodology

The CBR test is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub base, and base course material for design of thickness for highways and airfield pavement.

The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

As per ISI, the CBR test was performed on remolded soil by static compaction. Required amount of fibers as well as soil was first weighed and then the strips randomly mixed with dry soil at obtained moisture content. The soil was compacted in three equal layers by applying75 evenly distributed blows with 4.89Kg hammer at free fall. Due care was taken to ensure a homogeneous mix. A surcharge weight of 2.5 Kg was placed over the specimen, clamped over the base plate and the whole mould with the weight is placed under the testing machine. The penetration plunger is seated at the center of the specimen and is brought in contact with the top surface of the soil sample. The dial gauge for measuring the penetration values of the plunger is fitted in position. The dial gauge of the proving ring (for load reading) and the penetration dial gauge are set to zero. The load is applied through the penetration reading of 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 4.5, 5.0, 7.5, 10.0 and 12.5mm.

III. TEST RESULTS AND DISCUSSION

Load penetration behavior of reinforced/non reinforced sandy soil was examined. The load penetration curve has been plotted for each specimen. Fig.2(a) shows the typical plots of load-penetration curves for reinforced fine sand under soaked conditions. Also, Fig.2(b) presents the typical plots of load-penetration curves for fine sand reinforced with polypropylene fibers under Un-saoked condition. The CBR values have been calculated for the load corresponding to the penetration of 2.5 mm and 5.0 mm. The higher of these values have been adopted as CBR value (IS-2720-16-1979). Generally the CBR value at 2.5 mm penetration is higher. However, in the present study the CBR values of fiber reinforced sand at 5.0 mm penetration are found to be higher than those at 2.5 mm penetration, under both soaked and unsoaked conditions. This indicates that at larger deformations the fiber reinforcement is more effective in improving the strength of sandy soils by increasing the resistance to penetration.

Table-1 CBR VALUES

CBR values			Increase in CBR %	
Fiber Content	Un-Soaked	Soaked	Unsoaked	Soaked
%				
0	15.88	13.76	0	0
0.5	25.41	22.24	60.01	61.62
1	27.53	24.35	73.36	76.96
1.5	31.77	27	100.06	96.22
2	32.82	30.71	106.67	123.18
2.5	33.38	32.89	113.35	139.01
3	32.82	31.77	106.67	130.88

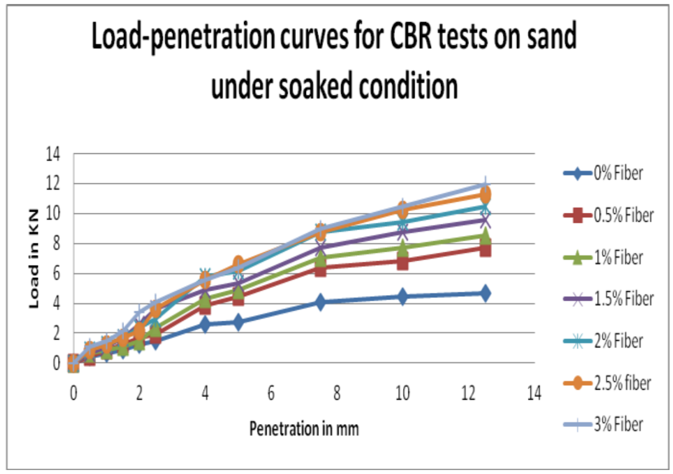

Fig-2(a) Load-Penetration curves for CBR test on sand under soaked conditions

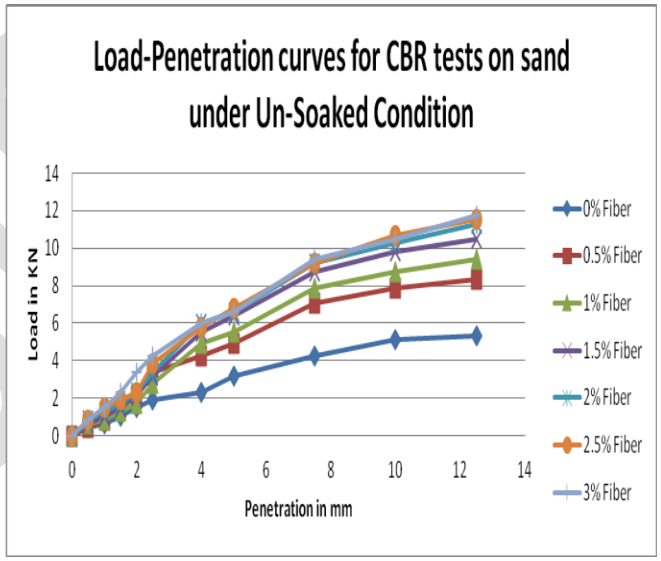

Fig-2(b) Load-Penetration curves for CBR test on sand under Un-soaked conditions

IV. CONCLUSION

The following observations and conclusions are made regarding the engineering properties and behavior of propylene fiber reinforced/nonreinforced specimens of a sandy soil from CBR tests carried out in the Metalab Laboratory, Ahmadabad. The polypropylene fiber-reinforced specimens shows improvement in CBR values of sandy soils under soaked and unsoaked conditions. The CBR values are increase by 60%, 73%, 100%, 106%, 113% of that of the unreinforced sand with 0.5%, 1%, 1.5%, 2% and 2.5% of polypropylene fibers inclusions respectively, under unsoaked condition. The CBR values for soaked condition are improved by 61.6%, 76.9%, 96.2%, 113.2% and 139% of that of unreinforced sand, with 0.5%, 1%, 0.5%, 2% and 2.5% fiber content respectively. The CBR test results showed that the addition of polypropylene Fibers significantly improved the behavior of soil. A noticeable stiffer response with increasing penetration was observed. This improvement of soil behavior due to fiber addition suggests the potential application of randomly distributed discrete fibers to reinforce soft soil subgrade/sub base under heavy loads for improving the strength which may suffer excessive deformation otherwise. The other areas of applications of randomly distributed fibers technique may be shallow foundations, embankments over weak soils and other earthworks.

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