EFFECT OF COIR FIBRES ON CBR STRENGTH AND LOAD BEARING CAPACITY OF GUWAHATI SOIL SUBGRADE

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Abstract - *Improvement of strength of the soil may be undertaken by a variety of ground improvement techniques like stabilization of soil, adoption of reinforced earth techniques etc. Reinforced earth technique is considered as an effective ground improvement method because of its cost effectiveness, easy adaptability and reproducibility. This paper is an experimental study on the utilization of coir fibres on soil subgrade. Coir fibres provide a reinforcement action to the sub-grade soil. Coir fibres are natural material obtained from coconut husk which is commonly seen in India. Coir fibres of varying length from 38.1mm and 76.2 mm at the rate of 0.25 %, 0.50% and 0.75%, of total weight of soil were mixed with the soil. Soil is compacted to Modified Proctor's maximum density with low percentage of reinforcement (0 to 0.75% by weight of sun-dried soil). CBR tests were conducted on un-reinforced as well as fibre-reinforced soil to investigate the strength characteristics of fibre-reinforced soil and un-reinforced soil. The test results reveal that the inclusion of randomly distributed coir fibres in soil shows an increasing trend in CBR value/strength of soil.*

Key Words: Modified Proctor Test, Maximum Dry Density, Optimum Moisture Content, California Bearing Ratio (CBR), Indian Standards (IS), Soil Subgrade and Coir fibres.

1. INTRODUCTION

Reinforced soil is one of the techniques of ground improvement, the concept of which was first given by Vidal of France in 1966. Since then significant advances have been made in the design and construction of geotechnical structures such as retaining walls, foundations, embankments, pavements, etc. The function of the reinforcements in the soil matrix is to increase the strength and reduce the deformation. The primary advantages of randomly distributed fibres are the absence of potential planes of weakness that can develop parallel to oriented reinforcement.

The technique of soil reinforcement using synthetic materials and products is being widely used at present in a variety of applications and is fast replacing the conventional ground improvement techniques. These products generally have a long life and do not undergo biological degradation, but are liable to create environmental problems in the long run. In effecting this, the use of biodegradable natural materials is gaining popularity. Use of natural materials such as jute, cotton, coir, etc. as reinforcing materials in soil started in the early nineties. The main advantage of these materials is that they are locally available with practically no cost. They are biodegradable, which is an added advantage from the viewpoint of sustainable development. Out of all the natural fibres coir has the greatest tearing strength and retains this property even in wet conditions. India produces annually 175,000,000 kg of coir fibre which is 66% of the world production. This fibrous material is usually thrown out or is used as fuel. Hence, it can be used extensively in noncritical civil engineering applications and thereby the cost of civil engineering construction can be brought down to a great extent. It is in this context that use of natural materials like coir for ground improvement becomes significant.

In present study coir fibres are made use of to study the variation of CBR strength and load bearing capacity of Guwahati soil which is supposed to improve the soil subgrade quality economically.

2. MATERIALS

2.1 Coir Fibres

The coir is purchased from market. It is the fibrous portion of the coconut extracted mainly from the green nut. Coir extracted consists of rotting the husk in water and removing the organic material binding the fibre. Diameter is 5mm. The coir is cut into pieces of 38.1mm and 76.2mm in percentages of 0.25%, 0.50% &0.75%.

Table -1: Properties of coir fibres

Sl. No.	Description	Value
1	Diameter	5mm
2	Length	38.1mm & 76.2mm

2.2 Soil sample

The soil used in this investigation is obtained from Jalukbari located in the South of Guwahati city. According to Indian Standard of soil classification (IS 383:1970) the soil is classified as well graded gravel soil. Specific gravity of soil sample is determined as per IS 2720(Part 3: 1980).Liquid limit, plastic limit and plasticity index of soil sample were determined as per IS: 2720 (Part 5)-1985. Modified Proctor compaction were carried out to determine the optimum moisture content and maximum dry density of the sample as per IS: 2720 (Part 8)-1983.

Table -2: Properties of soil sample

Sl. No.	Description	Value
1	Specific gravity	2.62
2	Liquid Limit (%)	30.00
3	Plastic Limit (%)	24.53
4	Plasticity Index (%)	5.47
5	Uniformity coefficient (C_U)	3.5
6	Maximum Dry Density (g/cc)	1.751
7	Optimum moisture content (%)	19.1

3. METHODOLOGY

The soil sample was locally collected from Jalukbari, Guwahati. The soil lumps were broken into small pieces and screened through 4.75 mm size IS sieve to make it free from roots, pebbles, gravel etc.

The coir fibre ropes were obtained from local vendor. These fibres were cut into uniform pieces of sizes 38.1mm and 76.2mm. The average diameter of the coir fibres are noted for both the set of samples.

The following test were conducted on the collected soil sample:

- Specific Gravity test as per IS 2720(Part 3)-1980.
- Liquid Limit test as per IS 2720(Part 5)-1985.
- Plastic Limit test as per IS 2720(Part 5)-1985.
- Plasticity Index as per IS 2720(Part 5)-1985.
- Grain Size Analysis as per IS 383-1970.
- Modified proctor test for obtaining Maximum Dry Density and Optimum Moisture Content for un-reinforced sample as per IS 2720(Part 8)-1983.

The sieved soil samples were randomly mixed with 38.1mm fibre length and 76.2 mm fibre length at the rate of 0.25%, 0.50% and 0.75% by the weight of the soil sample.

Modified proctor test was performed on these 6 sets of reinforced soil sample to obtain the Maximum Dry Density and Optimum Moisture Content as per IS 2720(Part 8)-1983.

To determine the effect of coir fibres on the strength of sub-grade soil and study the corresponding deformation behaviour California Bearing Ratio test was performed on the unreinforced and the 6 reinforced soil samples adopting dynamic compaction method under soaked condition as per IS 2720(Part 16)-1987 .

The variation of CBR value of the sub-grade soil with varying lengths and percentage fibre content are studied.

4. RESULTS AND DISCUSSIONS

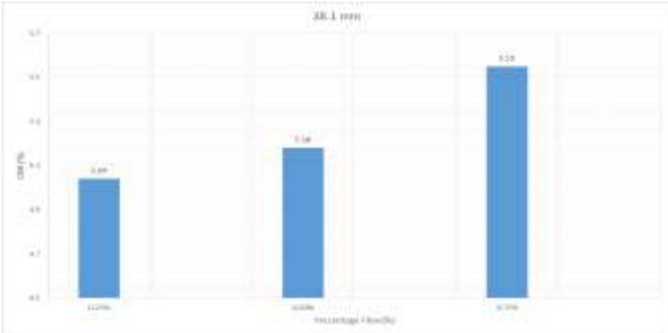

Chart -1: Variation of CBR strength of subgrade with % of fibres added for 38.1mm fibre length

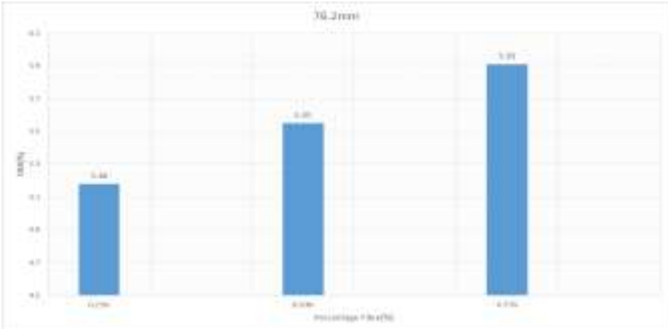

Chart -2: Variation of CBR strength of subgrade with % of fibres added for 76.2mm fibre length

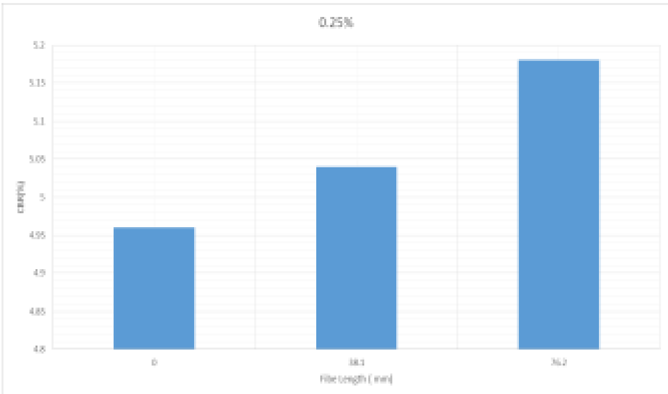

Chart -3: Variation of CBR strength of subgrade with fibre length for 0.25% fibre content

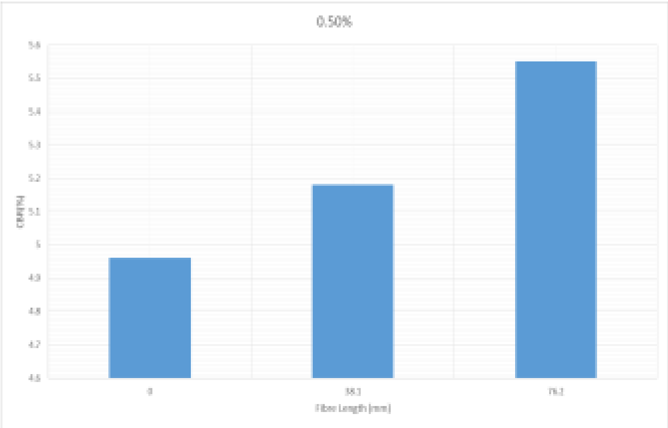

Chart -4: Variation of CBR strength of subgrade with fibre length for 0.50% fibre content

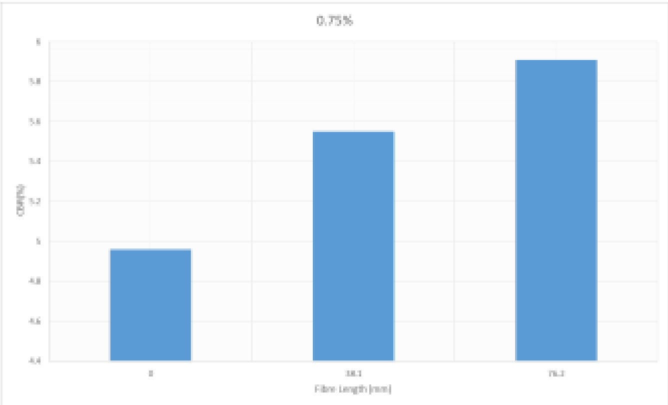

Chart -5: Variation of CBR strength of subgrade with fibre length for 0.75% fibre content

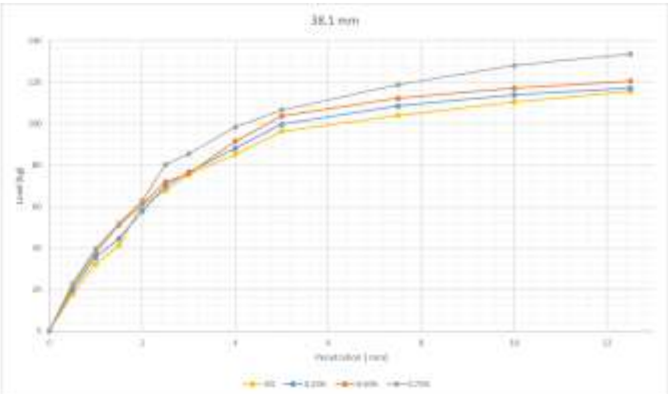

Chart -6: Variation of Load bearing capacity of subgrade soil for various fibre content with 38.1 mm fibre length

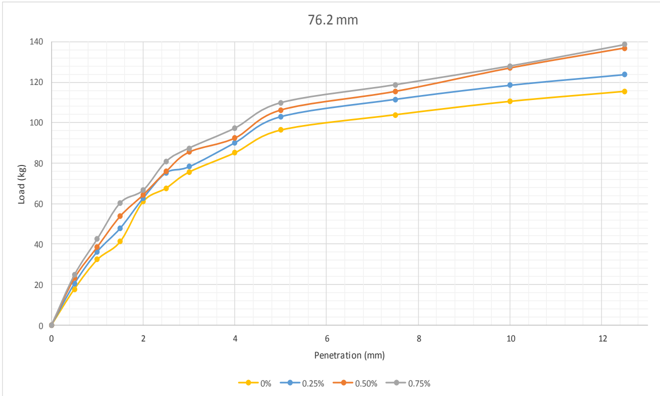

Chart -7: Variation of Load bearing capacity of subgrade soil for various fibre content with 76.2 mm fibre length

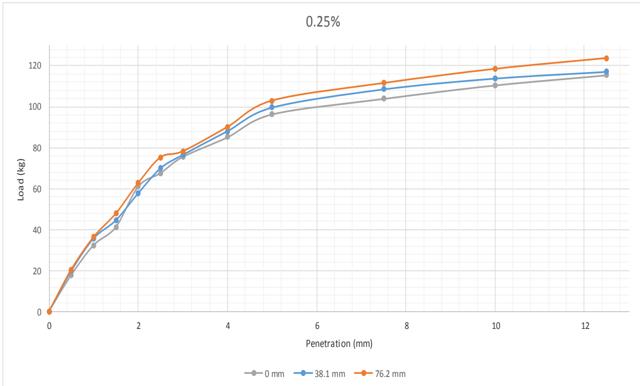

Chart -8: Variation of Load bearing capacity of subgrade soil for various fibre length with 0.25% fibre content

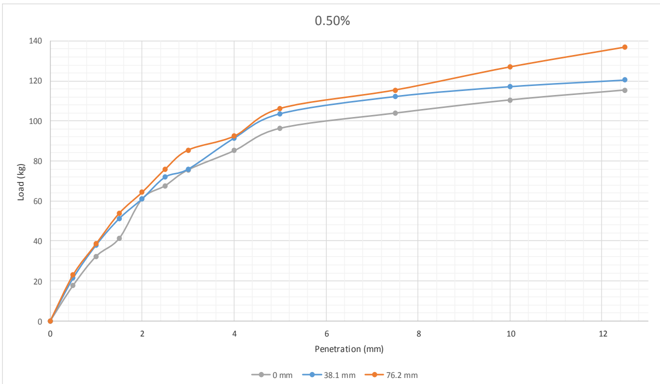

Chart -9: Variation of Load bearing capacity of subgrade soil for various fibre length with 0.50% fibre content

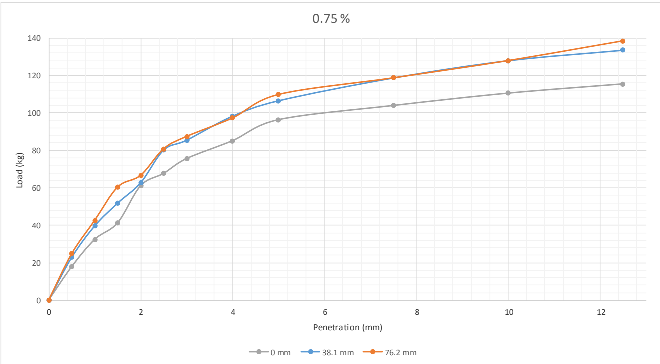

Chart -10: Variation of Load bearing capacity of subgrade soil for various fibre length with 0.75% fibre content

Table -3: CBR strength for various Fibre length in mm and Fibre content in %

For 38.1 mm		For 76.2 mm	
CBR value (%)	**Fibres (%)**	**CBR value (%)**	**Fibres (%)**
5.04	0.25	5.18	0.25
5.18	0.5	5.55	0.5
5.55	0.75	5.91	0.75

It is clear from the tests results that CBR value of soil shows an increasing trend as the fibre content increases. Results show that CBR strength of reinforced soil is greater for 76.2mm fibre length at a fibre content of 0.25 %. Further, CBR strength of reinforced soil is greater for 76.2mm fibre length at a fibre content of 0.50% and CBR strength of reinforced soil is greater for 76.2mm fibre length at a fibre content of 0.75 %. The test results also shows that the load bearing capacity of reinforced soil is more than that of unreinforced subgrade soil and as the percentage of fibre content increase from 0% to 0.75%, the deformation of subgrade shows a decreasing trend for both 38.1 mm and 76.2 mm fibre length respectively. The test results show that the CBR strength of subgrade shows a decreasing trend as the length of fibre mixed with the subgrade soil increases from 0mm to 76.2 mm for 0.25%, 0.50% and 0.75% fibre content respectively. This probably may be due to the reason that randomly oriented discrete inclusions incorporated into soil mass improves its load deformation behaviour by interacting with the soil particles mechanically through surface friction and also by interlocking. Thus, fibre reinforcement works as frictional and tension. Further, addition of coir fibre 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 fibre 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.

5. CONCLUSIONS

The present study has shown quite encouraging results and following important conclusions can be drawn from the study:

1. CBR strength of sub-grade soil shows an increasing trend on addition of coir fibres in the soil.
2. The load bearing capacity of soil shows an increasing trend on addition of coir fibres in the soil.
3. As the length of coir fibres used in sub-grade soil increases from 0 mm to 38.1 mm and 78.2 mm, the CBR strength of the soil shows an increasing trend in each case respectively.
4. As the percentage of coir fibres used in sub-grade soil increases from 0 % to 0.25%, 0.50% and 0.75% respectively, the CBR strength of the soil shows an increasing trend in each case.
5. As the length of coir fibres used in sub-grade soil increases from 0 mm to 38.1 mm and 78.2 mm, the load bearing capacity of the soil shows an increasing trend in each case respectively.
6. As the percentage of coir fibres used in sub-grade soil increases from 0 % to 0.25%, 0.50% and 0.75% respectively, the load bearing capacity of the soil shows an increasing trend in each case.

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