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# Variation in CBR Strength of Dibrugarh Soil Subgrade by partial replacement of soil with varying percentages of Waste Plastic Strips

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**ABSTRACT:** Improvement in the CBR strength of the soil subgrades may be undertaken by a variety of ground improvement techniques like stabilization of soil, adoption of reinforced earth techniques etc. Use of waste plastic in soil subgrades can be considered as an effective ground improvement method because of its cost effectiveness, easy adaptability and sustainability. This paper is an experimental study on the utilization of waste plastic on soil subgrade. Waste plastic strips provide a reinforcing action to the sub-grade soil. Locally available waste plastic bottles are collected and trimmed down to thin strips of uniform dimensions for the experiment. Plastic fibres of varying sizes and mixed at suitable proportions with the soil samples collected. Soil is compacted to Modified Proctor's maximum density with percentage of reinforcement 1%, 2%, 3% and 4% respectively by weight of sun-dried soil. CBR tests were conducted on un-reinforced as well as reinforced soil to compare the change in CBR strength characteristics of reinforced soil and un-reinforced soil. The test results reveal that the inclusion of randomly oriented waste plastic strips of different percentage by weight in soil shows an increasing trend in CBR value/strength of soil within the limits of the test.

**KEYWORDS:** Modified Proctor Test, Maximum Dry Density, Optimum Moisture Content, California Bearing Ratio (CBR), Indian Standards (IS), Soil Subgrade .

## I. 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 strips 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 and hence if waste plastic can be recycled as a construction material in soil subgrade, the goal of sustainable infrastructure development can be achieved. The main advantage of these materials is that they are locally available with practically no cost. They are non-biodegradable and weather resistant to quite some extent, which is an added advantage from the viewpoint of sustainable development. India is generating about 3.5 million tonnes of plastic waste annually and the per capita plastic waste generation has almost doubled over the last five years. Hence, it can be used extensively in 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 waste plastic materials for ground improvement becomes significant.

In present study, locally available plastic waste bottles are trimmed down to uniform strips and they are mixed in various percentage by weight of the soil sample to study the variation of CBR strength and load bearing capacity of Dibrugarh soil subgrade.

## II. MATERIALS

The soil used in this investigation is obtained from Lahowal, Near National Highway 2, located in Dibrugarh District of Assam. 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.

Sl. No.	Description	Value
1	Specific gravity	2.63
2	Liquid Limit (%)	29.00
3	Plastic Limit (%)	23.50
4	Plasticity Index (%)	5.5
5	Uniformity coefficient ( $C_U$ )	3.5
6	Maximum Dry Density (g/cc)	1.732
7	Optimum moisture content (%)	20.3

Locally available waste plastic bottles( PET Plastic) are collected and these are trimmed down to uniform shapes with varying lengths.

### III. METHODOLOGY

The soil sample is sun-dried. 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 dried soil sample is then weighed.

The waste plastic strips of sizes are sampled in proportions of 1%, 2% and 3% by weight of the dried soil sample for each of the plastic strip 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.

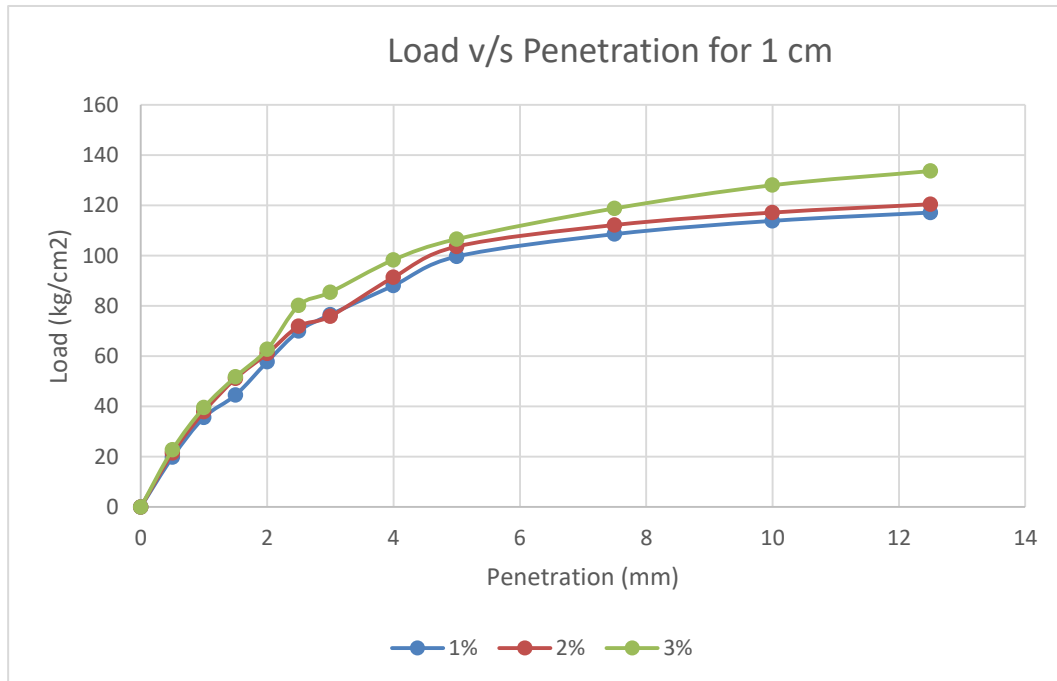
The sieved soil samples was first tested un-reinforced . The dried sample were randomly mixed with plastic strip at the rate of 1%, 2% and 3% by the weight of the soil sample respectively.

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

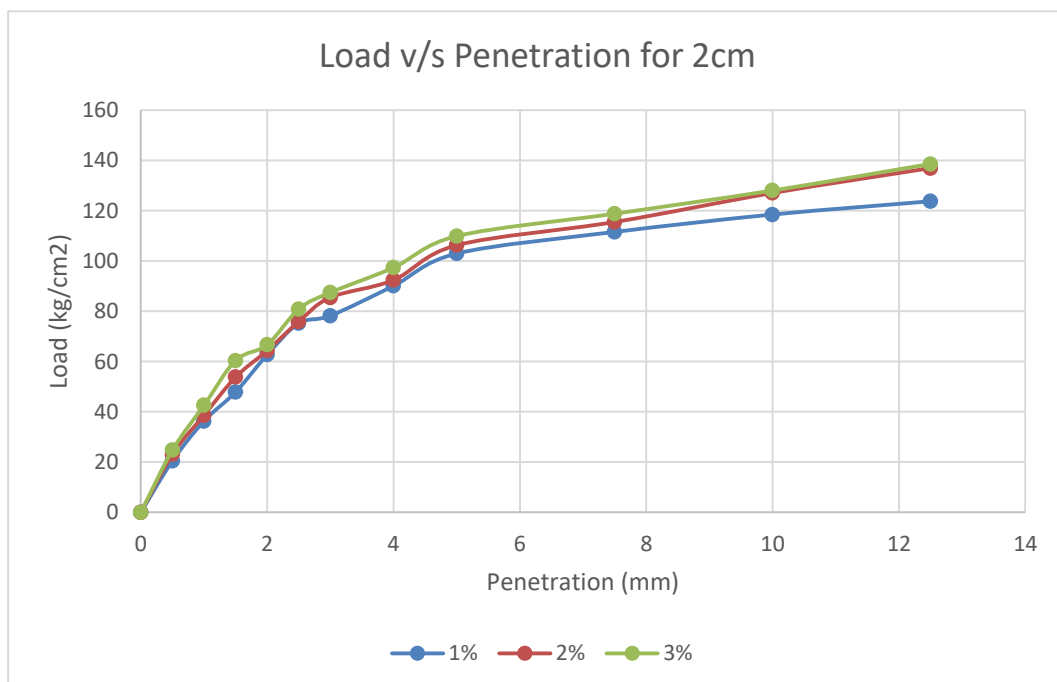
To determine the effect of waste plastic strips on the strength of sub-grade soil and study the corresponding deformation behaviour California Bearing Ratio test was performed on the un-reinforced and all thereinforced soil samples adopting dynamic compaction method under soaked condition as per IS 2720(Part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

The variation of CBR value of the sub-grade soil by partial replacement with varying percentage of waste plastic content are studied.

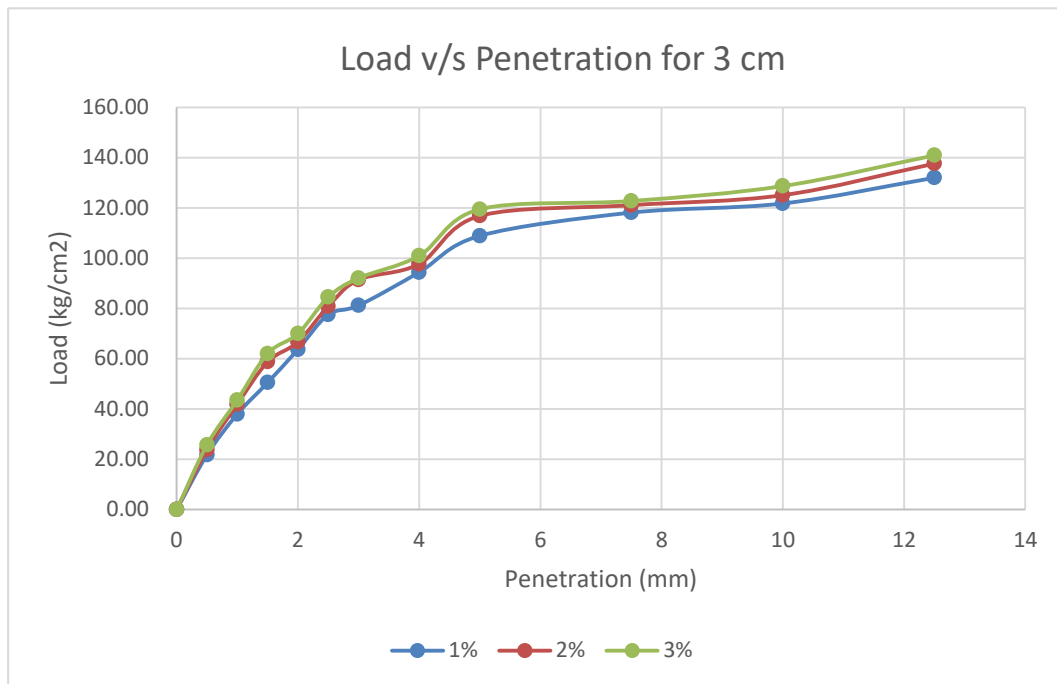
#### IV. EXPERIMENTAL RESULTS



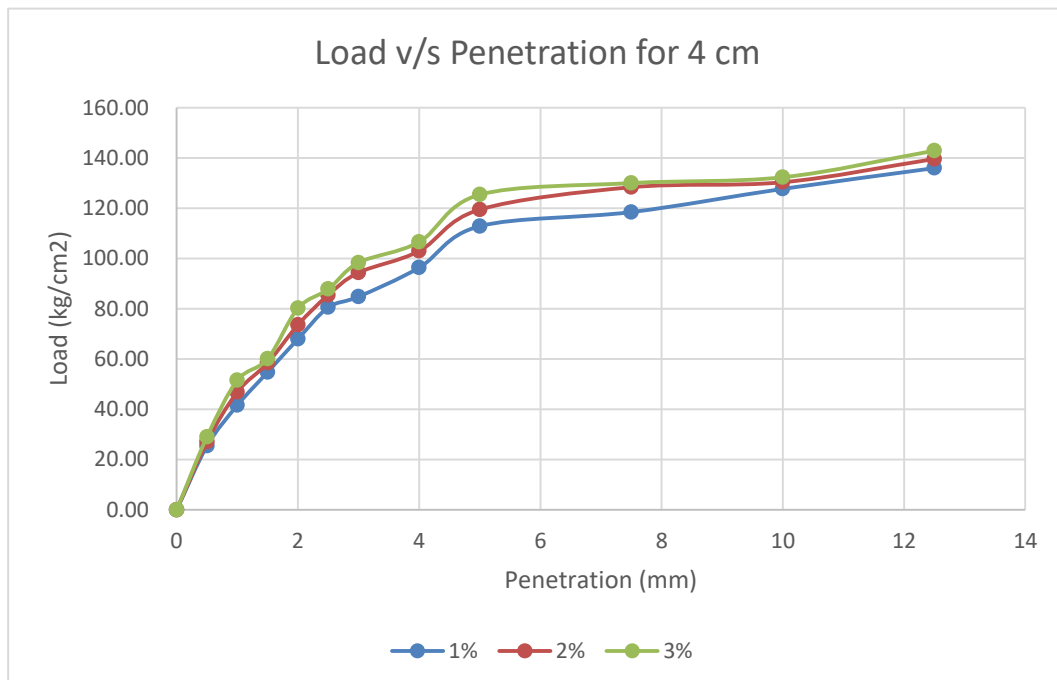
(a)



(b)



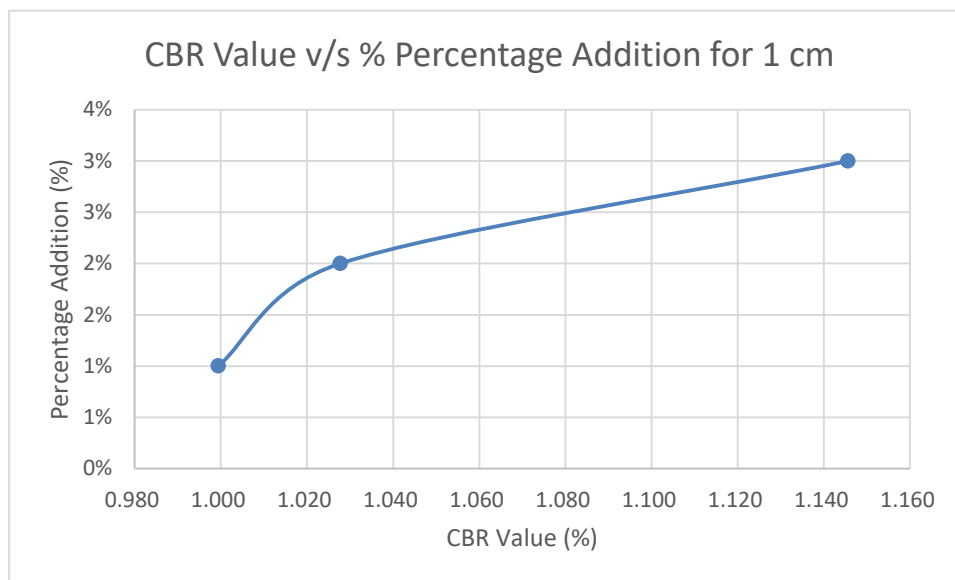
(c)



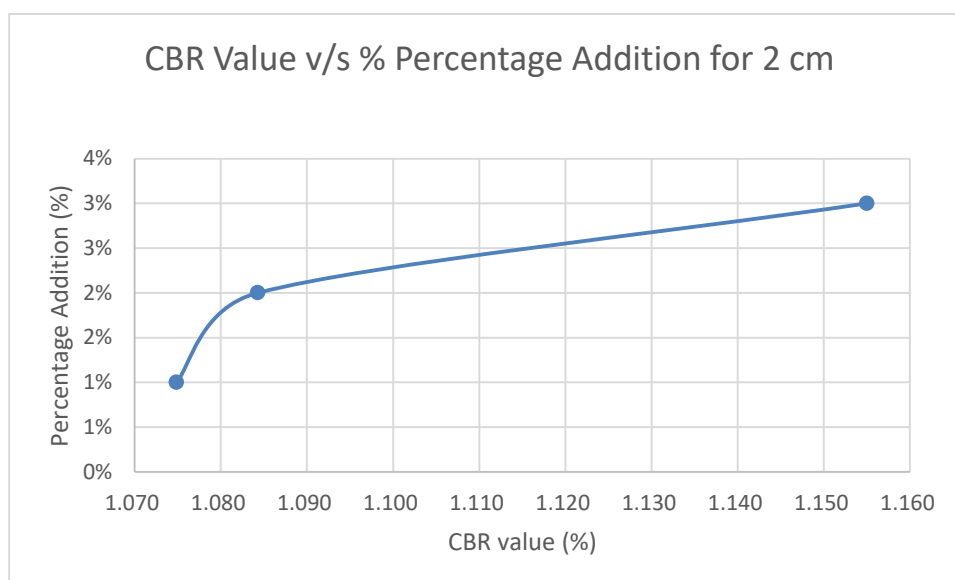
(d)

Fig. 1. Load v/s Penetration curve for soil sample added with 1% , 2% and 3% waste plastic strip with (a) 1cm length of waste plastic strip (b) 2cm length of waste plastic strip (c) 3cm length of waste plastic strip (d) 4cm length of waste plastic strip

Figures shows the experimental results of the CBR test conducted as per IS 2720(Part 16)-1987. Fig. 1 shows the Load v/s Penetration for soil sample added with 1% ,2% and 3% waste plastic strip with (a) 1 cm length of waste plastic strip, (b) 2 cm length of waste plastic strip, (c) 3 cm length of waste plastic strip and (d) 4 cm length of waste plastic strip.

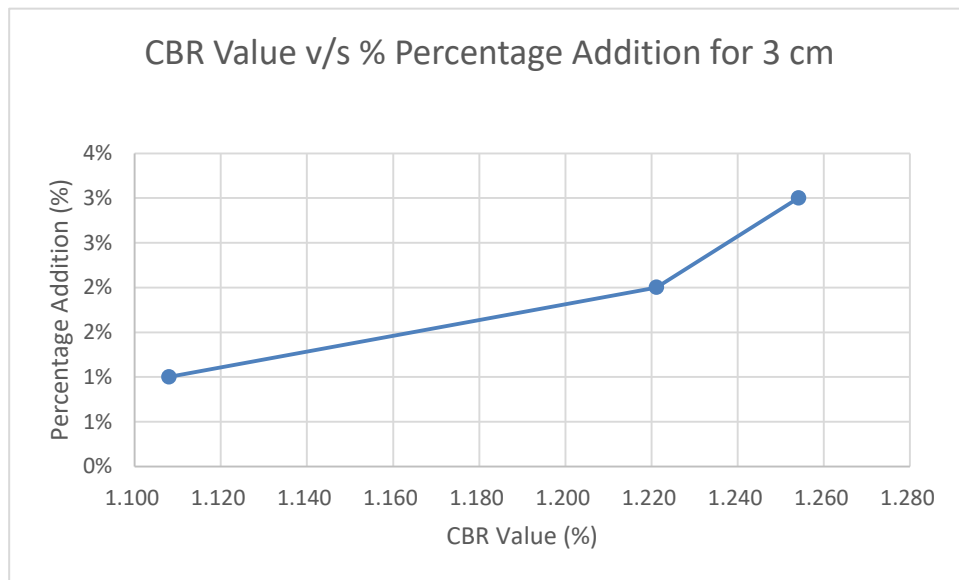


(a)

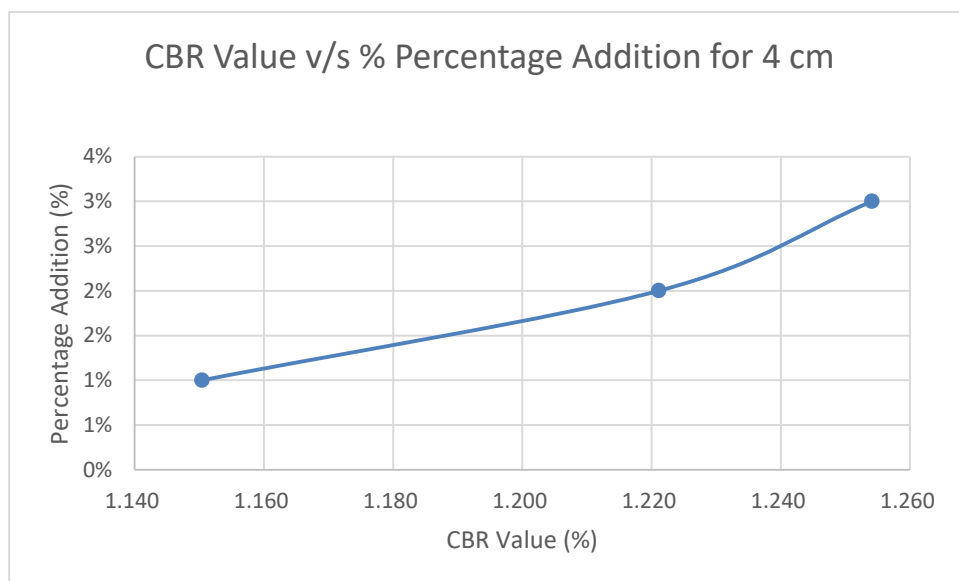


(b)





(c)



(d)

Fig. 2. Variation of CBR Value of soil sample added with 1 %, 2% and 3% by weight of the dried sample with (a) 1cm length of waste plastic strip (b) 2cm length of waste plastic strip (c) 3cm length of waste plastic strip (d) 4cm length of waste plastic strip

Fig. 2 shows the CBR values of soil sample added with 1%, 2% and 3% by weight of the dried sample with (a) 1cm length of waste plastic strip, (b) 2cm length of waste plastic strip, (c) 3cm length of waste plastic strip, and (d) 4cm length of waste plastic strip.

It is clear from the test results that CBR value of soil shows an increasing trend as the waste plastic strip content in the soil sample increases. Results show that CBR strength of reinforced soil is greatest when the soil sample is added with 3% by weight of the dried weight of the soil sample among the test samples taken. The test results also show that the load bearing capacity of reinforced soil is more than that of unreinforced subgrade soil. 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 waste plastic strips 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 waste plastic strip 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.

## V. CONCLUSION

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 waste plastic strips in the soil.
2. The load bearing capacity of soil shows an increasing trend on addition of waste plastic strips in the soil.
3. As the percentage of waste plastic strips used in sub-grade soil increases from 1% , 2% to 3%, the CBR strength of the soil shows an increasing trend in each case respectively.
4. As the percentage of waste plastic strip used in sub-grade soil increases from 1%, 2% to 3%, the load bearing capacity of the soil shows an increasing trend in each case respectively.

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