Influence of Mould Size on CBR Values in the construction of Pavements on Expansive Clayey Subgrades

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ABSTRACT

In this paper, emphasis is given to investigate the feasibility of using abundantly available indigenous resource, jute in road construction. In addition, the effect of mould size on CBR values is also studied. In the soil reinforcement inclusion system, mould of atleast five times the plunger diameter should be adopted since the diameter of standard CBR mould which is only three times that of the loading plunger will lead to under estimation of CBR value because of inadequate anchorage. The diameter of modified mould considered herein is 250 mm, which is five times the diameter of the loading plunger. CBR method is employed for the design of flexible pavements in most of the design offices even though it is empirical in nature, since the method is simple and convenient to apply and the CBR value of the subgrade indirectly gives the strength of subgrade soil. The results are analyzed effectively by introducing two non-dimensional factors namely, Effective Depth Ratio (EDR) and Strength Benefit Ratio (SBR). The experimental work is concentrated on CBR tests to study the optimum location of reinforcement for both modified mould and standard mould. The results of modified mould of size 250 mm were compared with the results of standard mould of size 150 mm. Based on the favorable results obtained, it can be concluded that there is improvement in the CBR value for the modified mould compared to that of standard mould.

Key words: Standard mould**,** Modified mould, Expansive clay, California Bearing Ratio, Effective Depth Ratio and Strength Benefit Ratio.

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INTRODUCTION

Design and construction of roads on expansive soils is a difficult task because of its low load carrying capacity, high compressibility, high swelling and shrinkage. The properties of these soils can be improved by stabilization with admixtures and geofabrics. But, in stabilization using admixtures technique, it is necessary to select proper stabilizer and it is very difficult to stabilize huge quantity of soil in the field. With the advent of synthetic fibres, soil reinforcement is found to be dynamic in improving load bearing capacity of soft soils. The geofabric reinforcement system prevents the failure of the pavement due to penetration of road crust into subgrade soil or intrusion of soft subgrade soils into base course and inadequate drainage of subbase and base course by acting as separator as well as drainer within the pavement apart from reinforcing function. In practice, the geofabrics are laid over weak subgrade soils and the aggregate is placed directly on it. But in this system sharp angular aggregates puncture through the fabric during the imposition of traffic loads. Moreover, the stressed soil tries to push the fabric into voids in between the aggregates. So, to avoid above discrepancies and to achieve positive contribution of geofabric, Shroff(1989) has suggested the placement of geofabric at optimum depth below the surface of weak subgrade[5]. In the soil reinforcement inclusion system, mould of at least five times the plunger diameter should be adopted since the diameter of standard CBR mould which is only three times that of the loading plunger will lead to under estimation of CBR value because of inadequate anchorage. The diameter of mould considered herein is 250 mm which is five times the diameter of the loading plunger.

MATERIALS AND METHODS

Soil

The soil used in this study was obtained from Gajulamandyam near Tirupati. Disturbed but representative soil samples were collected from trial pits at a depth of about 2.0 m from ground level. The soil collected from the site was pulverized with wooden mallet to break lumps and then air-dried. The soil falls under the CH category i.e., clay of high compressibility as per I.S Classification System (IS 1498-1970) [1]. The soil passing through I.S 425μ sieve has very high Liquid Limit and Plasticity Index. Based on Differential Free Swell Index, Liquid Limit and Plasticity Index, the soil comes under the category of high degree of expansiveness. The properties of soil are presented in Table 1.

Jute

Jute is prepared from jute bags like sugar bags, rice bags etc, of 1.5 mm thick. 15cm and 25 cm diameter circular pieces are cut from the jute bag. A jute geofabric of 3mm thick is prepared by joining two pieces of jute bag.

Tests conducted on Unreinforced Soil

The compaction tests and UCC tests on unreinforced soil are conducted in accordance with I.S.2720:1980 and I.S.2720:1991[2, 3]. CBR tests are conducted in accordance with I.S.2720:1987[4].

Tests conducted on Reinforced Soil

The main emphasis in the present study is the influence of jute on CBR values of expansive clays, since the thickness of pavement depends on CBR value. Hence CBR tests are conducted for determining optimum depth (location effect). The locations chosen for this purpose were top, H/6, 2H/6, 3H/6, 4H/6 and 5H/6 respectively, H being the total thickness of the soil specimen. The CBR tests have been carried out as per I.S.2720-1987 with some modifications. In standard CBR tests, the soil is compacted in three layers at 55 blows per each layer for light compaction. The above procedure has been modified by compacting in six layers at 76 blows per layer, keeping the compactive effort imparted to the soil same. In the present study, the reinforcing material employed is jute. The tests were conducted for both standard mould and modified mould.

Table 1 Properties of Soil

CHARACTERISTICS	VALUE
Specific gravity	2.69
Particle Size distribution a) Gravel (%) b) Sand (%) c) Silt+Clay (%)	 Nil 12 88
Liquid limit (%)	98
Plastic limit (%)	13
Plasticity index (%)	85
Differential Free Swell Index (%)	150
Classification of soil	CH
Maximum dry unit weight (kN/m^3)	17.99
Optimum moisture content (%)	14
Unconfined Compressive Strength (kN/ m^2)	145
Unsoaked CBR (%)	6.84

RESULTS AND DISCUSSION

The results are analyzed effectively by introducing two non-dimensional factors namely, Effective Depth Ratio (EDR) and Strength Benefit Ratio (SBR). Strength Benefit Ratio (SBR) is defined as the per cent increase in CBR value of soil due to the presence of reinforcement when compared to the CBR value of unreinforced soil.

$$SBR = \frac{CBR_{(Reinforced)} - CBR_{(Unreinforced)}}{CBR_{(Unreinforced)}} \times 100$$

The Effective Depth Ratio (EDR) is defined as the ratio of depth of reinforcing layer from the top to total height of soil specimen.

$$EDR = \frac{\text{Depth of reinforcing layer from the top}}{\text{Total height of soil specimen}}$$

To study the location effect, CBR tests are conducted with standard mould and modified mould at different locations such as top, H/6, 2H/6, 3H/6, 4H/6, 5H/6 from top, H being the total thickness of the soil specimen**.** The load-penetration curves for the soil reinforced with jute are plotted at different locations with standard mould and modified mould are shown in Figs.1 and 2 respectively. The load-penetration curve for the unreinforced soil is also shown in the same figures. It is found that CBR values of the reinforced soil at all locations considered herein are higher than that of the unreinforced soil. The optimum depth of location of jute is found at

H/6 for both standard mould and modified mould. The CBR and SBR values for the standard and modified mould (location effect) are presented in Table 2. In case of modified mould, SBR value is 114% whereas in the case of standard mould, its value is 74% even though the optimum location is H/6, from the top in both the cases. The improvement in CBR and SBR values for modified mould when compared to standard mould is due to adequate anchorage.

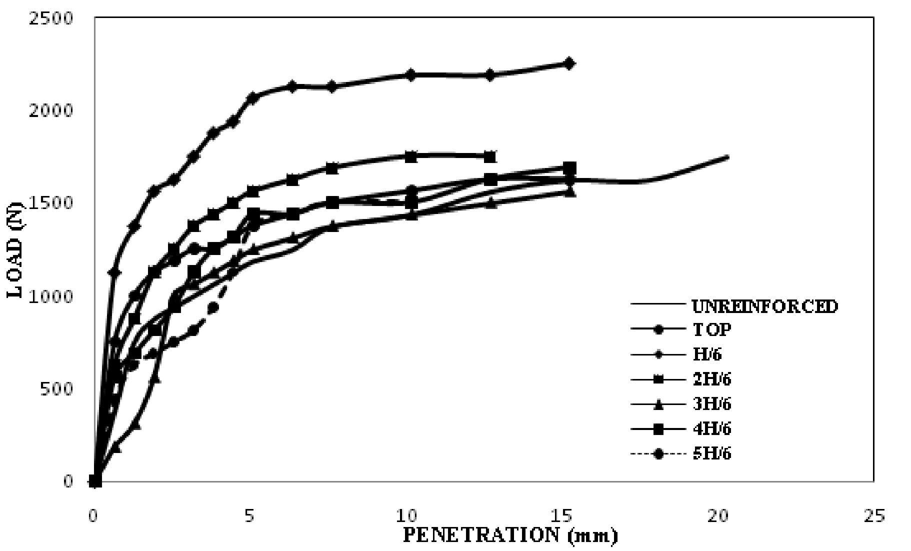

Fig. 1 LOAD Vs PENETRATION CURVES OF SOIL REINFORCED WITH JUTE AT DIFFERENT LOCATIONS (STANDARD MOULD)

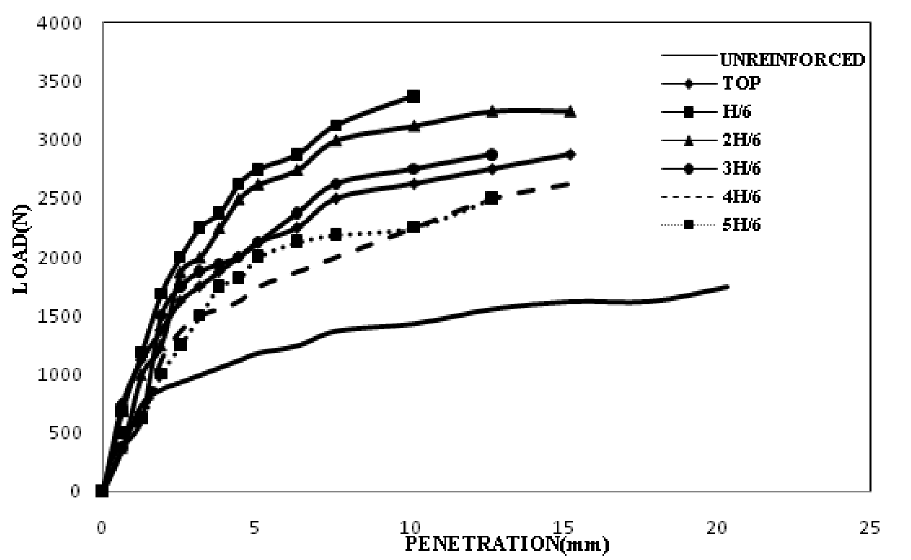

Fig.2 LOAD Vs PENETRATION CURVES OF SOIL REINFORCED WITH JUTE AT DIFFERENT LOCATIONS (MODIFIED MOULD)

Table 2 CBR and SBR Values for standard mould and modified mould (location effect)

Location of jute fabric	CBR value for standard mould	SBR (%)value for standard mould	CBR value for modified mould	SBR (%)value for modified mould
Top	8.7	27.19	11.8	72.51
H/6	11.9	73.98	14.6	113.45
2H/6	9.12	33.33	13.68	100
3H/6	7.3	6.72	12.77	86.7
4H/6	7	2.34	10	46.19
5H/6	7	2.34	9.7	41.81

CONCLUSIONS

1. The results of CBR tests showed that for the standard mould, the optimum depth for single reinforcing layer is at Effective Depth Ratio (EDR) of 1/6 for the soil reinforced with jute, which is nearly equal to half the diameter of the plunger/ half the maximum width of dual tyre assembly of a vehicle in the field.
2. The optimum depth is at EDR 1/6 for the jute, even in the case of modified mould.
3. If a CBR test is used for study of any soil reinforcement inclusion system, a modified mould of at least five times the diameter of the plunger should be adopted to have adequate anchorage.

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