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Behavior of Soil Subgrade Strength with Saturation

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Abstract:- The traffic volume counts to be carried and the strength of the subgrade soil are used to design the different levels of pavement that must be placed over it. The strength of the subgrade is commonly expressed as a ratio known as the California Bearing Ratio, abbreviated as CBR. When the subgrade is weaker, thicker layers are required, whereas when the subgrade is stronger, thinner layers are sufficient. When we can understand how the strength of these soils is affected by variations in saturation, it will be much easier to design and maintain stronger structures. CBR resistance values for soils utilized in the subgrademay vary to a greater extent due to the saturation of the subgrade. Hence, throughout this study,variation in the soaking degreehas been tried and in turn the saturation level in twosoiltypes and engineering properties of soils and CBR at different levels of saturation are studied. The engineering properties that wereevaluated after the soaking of three days were worst and consideringfine-grained soils, it is found to be same after the end of day 4.

Keywords:- *Compaction, CBR (California Bearing Ratio), subgrade, saturation levels.*

I. INTRODUCTION

The top layer of pavement, be it flexible or rigid, ultimately rests itself on soil foundation or cutting or an embankment, just under the pavement's top layer, bring forthanappropriate foundation for the pavement. The subgrade in the mould is tamped in two layers, usually to a larger limit than the lower portion of the mound. The subgrade is characterized by its robustness for the analysis and design of the pavement.

The performance of subgrade generally depends on three of the basic characteristics, which are Shrinkage or swelling, Load bearing capacity, and Moisture content, The necessary properties of subgrade soil to be selected as highway material should be able to

- Withstand capability (Stability)
- dexterity in compaction
- Strength persistence
- least changes in volume during adverse conditions of the groundwater table and weather conditions
- Good draining property
- Resistant to compressibility

The CBR test is performed for samples on a small-scale penetration of dial reading with proving ring divisions. The highest Load and respective penetration are noted, if it occurs for penetration of less than 12.5 mm. The curve for the test comes out to be convex upwards although the initial portion of the curve may be concave upwards due to the irregularities on the surface. A tangent is drawn to the curve at the point of the greatest slope for applying the correction. The point where the tangent meets the abscissa will be the corrected origin. CBR values are generally evaluated for 2.5mm and 5mm penetrations. Typically, the values of CBRat the penetration of 2.5 mm will be greater than that of 5mm penetration and in such a case the former is taken as the CBR value for design purposes. The test is repeatedif the CBR value corresponding to the 5mm input exceeds that of 2.5mm. If the same results follow, a folding report corresponding to a 5 mm input is considered a design. With this in mind, it has been proposed in this project to study the different strengths of the two types of soils made in different waters and concentrations and to consider the common characteristics of saturation conditions in determining different energy parameters, in order to achieve maximum efficiency. and a cost-effective paving design.

II. TESTING AND METHODOLOGY

A. Sample Collection from field

Disturbed from 2 locations within the UT of J&K viz Anantnag and Pulwama District. The collection of samples was donein NOVEMBER of the year 2020. First, the top layer at the sample collection site was removed and cleaned and then undisturbed samples were collected using a core cutter, the core cutter samples were properly sealed and taken to the laboratory to avoid change in structure and loss ofwater content of the sample. Disturbed samples were also collected at the same depth from both locations.

B. Laboratory Testing

The samples were taken to the engineering laboratory atthe National Institute of Technology Srinagar and all basic tests for the characterization of soils were performed for both sites. Indian Standards (IS): 2720 'Methods of Tests for Soils' outlines in separate parts the standardized procedures to be followed to conduct various geotechnical laboratory tests on soils. For this study, geotechnical laboratory tests have been performed in compliance with IS: 2720 (1973) and subsequent revised versions Initially experiments were done in the lab to evaluate various Soil characteristics such as exponential characteristics, particle size distribution, and differential free swelling index. After that, a rigorous compression test was performed to find the optimum moisture content and the corresponding maximum dry density. CBR tests were then performed at different moisture levels, including OMC, and analyzes were performed to examine CBR variability on different soaking days. H. From day 0 (not soaked) to the daynumber 5 (soaked). In addition to different positions, the moisture content of different layers has also changed.

Soil characteristics such as Index properties, particle size distribution, and differential free swelling index. After that, a compression test was performed to find the optimum

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moisture content and the corresponding maximum dry density. CBR tests were then performed at different moisture levels, including OMC, and analysis was performed to examine CBR variability on different soaking days. From day 0 (not soaked) today 5 (soaked). In addition to different positions, the moisture content of different layers has also changed (all directions along with center positions) and changes in the water content were also observed depending on the different days of soaking. A direct Shear Test was also performed in the lab on the soil samples collected from both the sites.

III.RESULTS AND DISCUSSION

A. TYPE 1 SOIL FROM ANANTNAG DISTRICT

a) Index Properties

The index properties such as Liquid Limit, Plastic Limit and Plasticity Index value are presented in Table 1.

Index property	ExperimentalValue
Liquid Limit of Sample	54.29%
Plastic Limit of Sample	35.04%
Plasticity Index of Sample	22.25%
Specific Gravity of Sample	2.64
Differential SwellIndex of Sample	53%

Table 1: Index properties of type – 1 soil

b) Particle Size Distribution

The grain size distribution of this soil sample has been shown in Table 2

I.S Sieve no.	Weight retained in gm	Percentage Weight retained	Percentage weight passing
4.75(mm)	4.5	0.45	99.55
2(mm)	14.6	1.46	98.54
1(mm)	20.0	2.0	96.5
0.6(mm)	5.2	0.52	95.7
0.425(mm)	9.6	0.96	94.3
0.3(mm)	5.2	0.52	94.1
.212(mm)	21.2	2.12	91.2
.015(mm)	15.7	1.57	90.2
0.075(mm)	30.3	3.03	87.5

Table 2: Grain size distribution of type - 1 soil

Considering the above properties for this soil sample and according to the IS Soil Classification the soil sample tested is ‘OH’

c) Modified Proctor Compaction Test

The results of the modified proctor compaction test are represented in figure 1

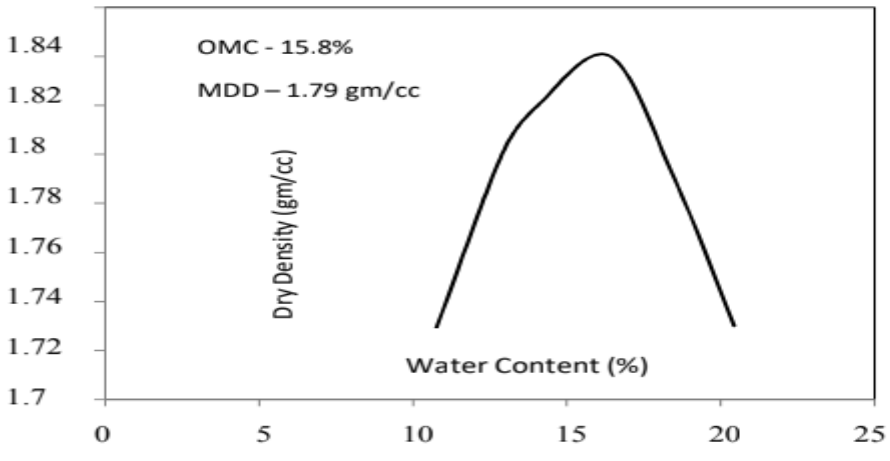

Figure 1: Modified proctor compaction test for type – 1 soil

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d) California Bearing Ratio Test Results

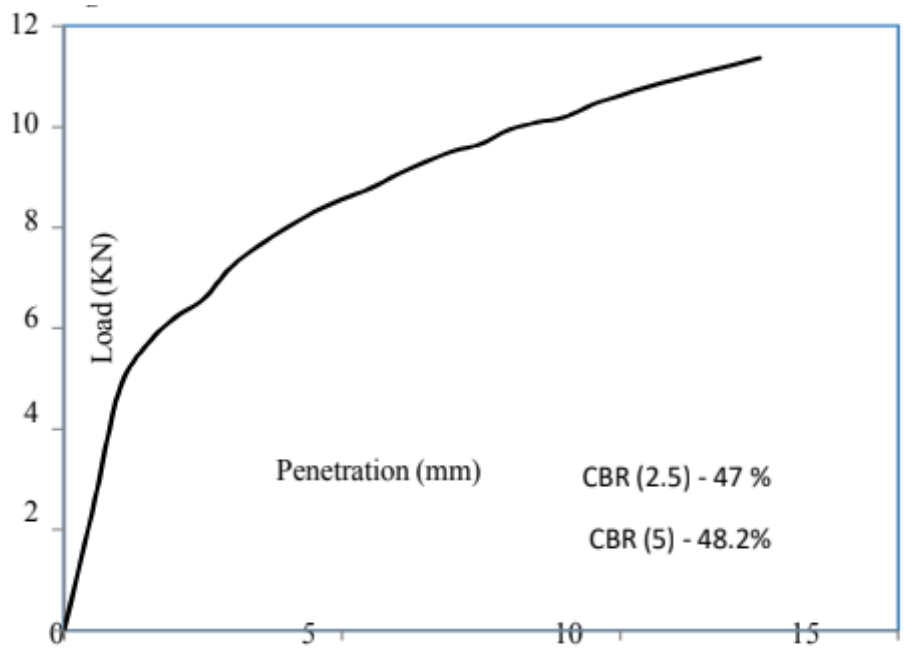

Figure 2: Load vs penetration graph for 1st Test, type-1 soil for unsoaked condition

B. TYPE 2 SOIL FROM PULWAMA DISTRICT

a) Index Properties

The values of index properties obtained such as Liquid Limit, Plastic Limit, and Plasticity Indexvalue are in Table 3

Description of index property	Experimental Value
Liquid Limit of Sample	45.66%
Plastic Limit of Sample	29.33%
Plasticity Index of Sample	18.43%
Specific Gravity of Sample	2.67
Differential SwellIndex of Sample	32.48%

Table 2: Index properties of type-2soil

b) Particle Size Distribution

The GSD of this soil sample has been shown in Table 4

I.SSieveno.	Weightretainedingm	PercentageWeight	Percentageweight
4.75 (mm)	0	0	100
2 (mm)	1.2	0.12	99.88
1 (mm)	3.7	0.37	99.63
0.6 (mm)	5.2	0.52	99.48
0.425 (mm)	3.6	0.36	98.63
0.3 (mm)	5.7	0.57	98.43
0.212 (mm)	8.4	0.84	97.16
0.015 (mm)	10.2	1.02	96.98
0.075 (mm)	33.0	3.3	92.7

Table 4: GSD of type-2 soil

Considering the above properties for this soil sample and according to the IS Soil Classification the soil sample tested is **'CI'.**

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c) Test Results of

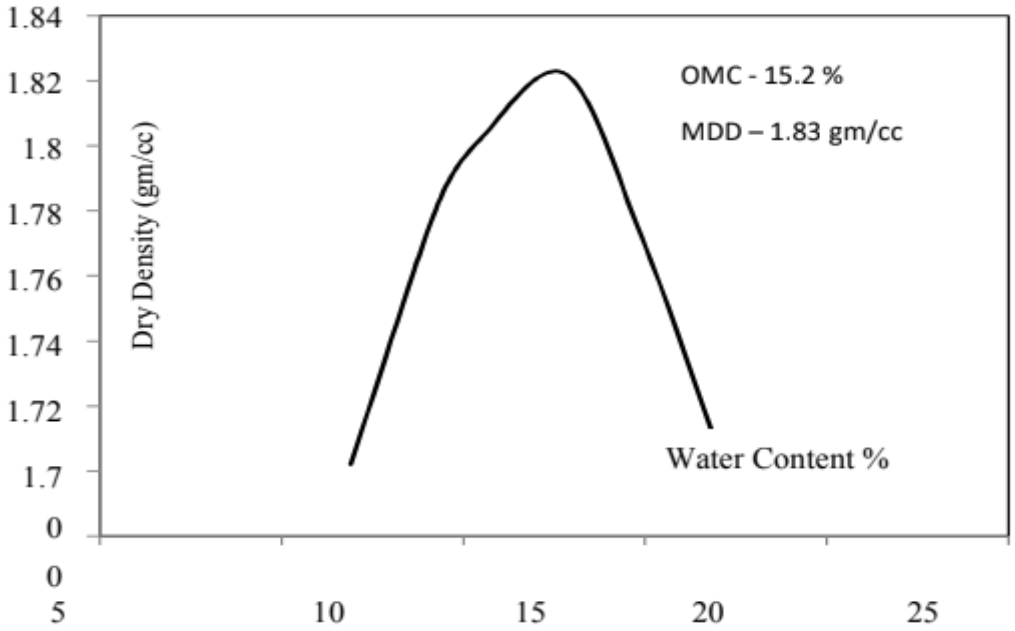

Figure 3: Compaction test for type-2 soil

d) California Bearing Ratio Test Results

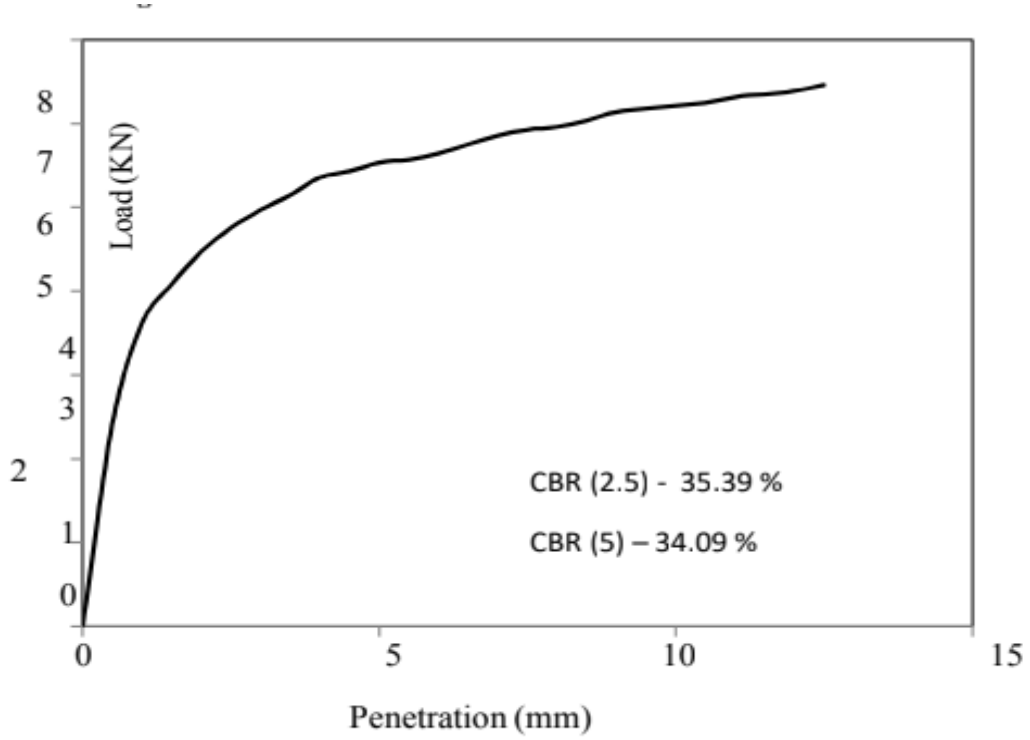

Figure 3-1:Load vs penetration graph for test –1, type – 2soil for unsoaked condition

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IV.CONCLUSIONS

This whole work done was meant to gain the knowledge of effect of saturation that is soaking on the properties of strength of soil subgrade, like CBR which is commonly used measure for designing all types of pavements. Here, three types of soils are made to be in consideration. In this study the effect of soaking on the degree of saturation has also been considered on different parts of soil sample. Analyzing all the results and discussions that were presented earlier, we arrived at following conclusions in nutshell.

From the observations made we find that CBR of clayey soil sample with "OH" as BIS classification that was prepared at particular density shows rapid decrease with soaking time of up to one day and after which decreasing rate is very small. However, CBR value got reduced by near about 20 times in comparison to the unsoaked condition, 4-day loss of CBR value is only half in comparison to that of after one day. It can also be observed that there are less variations in values of CBR from day 3rd to day 4th of soaking. From the given CBR sample, when samples for observation are taken from different points and later tested for their moisture content, it can also be seen that moisture content variations are less significant in condition of unsoaking and one day of soaking. For longer time soaking, it is observed that top layer shows high moisture content as in comparison to that of lower layers.

As the type 2nd of soil which is considered was found to be of soil classification "CI", we observed the similar trend almost to that of type 1 soil to be used.

As such we found decreased CBR value with increased number of soaking days, the decreasing rate is not much enough as that in type 1 and type 2 soil under consideration.

Now for both type 1 and type 2 soil wet side of OMC gives results good than that of dry side of OMC.

From observations made it is clear that with a decrease in compaction degree the angle of friction and cohesion both decreases.

V. FUTURE SCOPE OF WORK

- In addition to the properties which are basic, certain engineering properties like direct shear, unconfined compression and triaxial test should also be brought under consideration for saturation percentages.
- Stabilization effects with that of weak clayey soil at different levels of saturation need to be explored for engineering properties.
- Engineering properties consideration as discussed above can be made in application to variety of soils so that adatabase can be prepared to know the soaking period of soil for CBR value or some other engineering property that can be used for design of pavement.

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