Effect of Saturation on Bearing Capacity of Subgrade Soil

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Abstract

The pavement layers to be laid over sub grade soil starts off with the estimation of sub grade Bearing capacity and the volume of traffic to be carried. Design of the pavement layers are highly dependent on the strength of the sub grade soil over which they are going to be laid. Sub grade strength is mostly expressed in terms of CBR (California Bearing Ratio). Feeble sub grade essentially requires course layers whereas stronger sub grade goes well with lean pavement layers. The sub grade is always subjected to change in saturation level due to precipitation, capillary action, flood or abrupt rise of water table and frost action due to climate. Change in sub grade causes change in the sub grade strength. And it becomes utterly essential for an engineer to understand the exact nature of dependence of sub grade strength on moisture variation. An understanding of the dependence of the CBR value of local soils on water content will contribute towards better design and maintenance practices. Normally CBR test is an easy and well adopted method conducted on soil samples in-situ or in laboratory to measure the strength of sub grade. However, many other tests are also considered for assessing the sub grade bearing capacity.

Keywords: Sub-Grade Soil, Sub-Grade Bearing Capacity, Moisture Variation, CBR Test

I. INTRODUCTION

As per MORD Specifications, subgrade can be defined as a compacted layer of local soil or transported soil, assumed to be 250 mm in thickness, just beneath the pavement crust, providing a suitable foundation for the pavement. The sub-grade on embankment is compacted in two layers, usually to a higher standard than the lower part of the embankment. At cuttings, the cut formation, which serves as the subgrade, is treated similarly to provide a firm foundation for the pavement. Where the naturally occurring local subgrade soils have poor engineering properties and low strength in terms of CBR, for example in Black Cotton/clay soil areas, improved sub-grades are provided by way of lime/cement/bitumen treatment or by mechanical stabilization and other similar techniques. The subgrade, whether at cutting or in embankment, should be well compacted to utilize its full strength and to economize on the overall pavement thickness by getting 96%To 98%. The current MORTH Specifications require that the subgrade should be compacted to 100% Maximum Dry Density achieved by the Modified Proctor Test (IS 2720-Part 7). The material used for subgrade construction should have a dry unit weight of not less than 16.5kN/m^3.

A subgrade's performance generally depends on following three basic characteristics:

1) Load bearing capacity: The sub-grade must be able to support loads transmitted from the pavement structure through base and sub-base course layer. This load bearing capacity is often affected by degree of compaction, soil type and moisture content. A sub-grade that can resists a high amount of loading without excessive deformation is considered good.
2) Moisture content: Moisture affect a number of sub-grade properties including shrinkage and swelling, load bearing capacity. Moisture content can be influenced by a number of things such as drainage, infiltration groundwater table, or pavement porosity (which can be assisted by cracks in the pavement). Generally, excessively wet sub-grades will deform enormously under load.
3) Shrinkage and/or swelling: Some soils shrink or swell depending upon their moisture content. Additionally, soils with excessive fines content may be susceptible to frost heave action in northern climates. Shrinkage, swelling and frost heave will results deform and crack and rutting any pavement type constructed over them.

II. EXPERIMENTAL WORK

Initially experiments are conducted to find out different properties of soil such as index properties, grain size distribution and differential free swelling index. Later on heavy compaction tests are conducted to find out the optimum moisture content & corresponding maximum dry density. Then CBR tests are made at different moisture contents including OMC and analysis made to investigate the variation of CBR with respect to different days of soaking.

III. RESULTS

A. Index Properties of Soil

Table - 1
Index Properties of soil

Index property	*Experimental Value*
Liquid Limits	*55.40%*
Plastic limit	*33.65%*
Plasticity Index	*21.30%*
Specific gravity	*2.62%*
Differential Swell Index	*58%*

B. Grain Size Distribution of Type Soil

Table - 2
Grain size distribution of type soil

I.S Sieve no.	*Weight retained gm*	*% Weight Retained*	*Passing weight %*
4.75	*4.5*	*0.46*	*99.54*
2	*14.6*	*1.45*	*98.09*
1	*20.1*	*2.02*	*96.07*
.6	*5.1*	*.51*	*95.58*
.425	*9.8*	*.98*	*94.59*
.300	*5.1*	*.51*	*94.08*
.212	*21.1*	*2.11*	*91.17*
.015	*15.6*	*1.56*	*90.41*
.075	*30.49*	*3.049*	*87.361*

Based on the above properties the IS Soil Classification for the soil is 'OH'

C. California Bearing Ratio Test Results

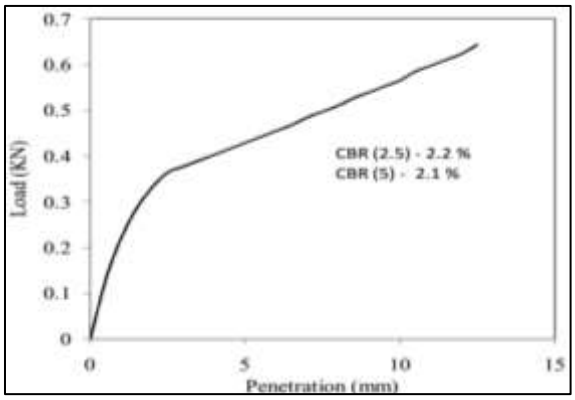

Fig. 1: California Bearing Ratio Test Results

D. Direct Shear Test Results

Direct shear test was carried out at different dry densities and moisture contents.
Results of direct shear test of soils are:

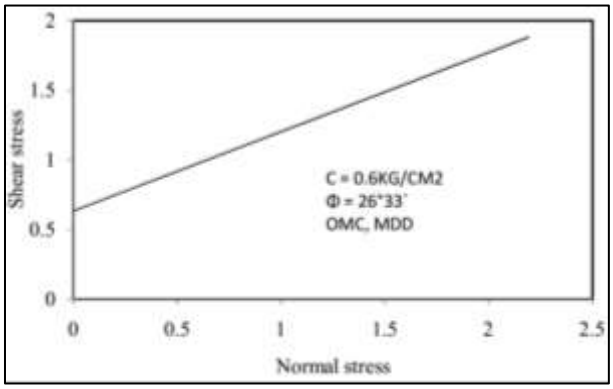

Fig. 2: Direct shear test

IV. CONCLUSIONS

An attempt has been made in this project work to discover the effect of saturation, i.e. permeating on the strength properties of subgrade soil, namely CBR which is widely used as a measure of design of all kind of pavements. for this three kind of soils have been considered. The effects of permeating on degree of saturation on different parts of the soil sample have also been considered in this study. It has been observed that as usual with decrease in degree of compaction (either on wet or dry) cohesion and angle of friction decreases.

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