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ISSN : 2454 – 308X | Volume : 04 , Issue : 02 | January – March 2018

Analysis and Evaluation of soil-sub grade and base course materials

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1. Abstract

The roads being highly complex and because of their high importance in proper development of the nation by properly connecting various parts of the country/economy/society and hence, can be termed as a "Strategic Infrastructure Sector" also for a country/economy/society. Not only roads can be compared as life line when we talk about economic sustainability and growth of a country but because of its uniqueness of providing support as well as linkages to all other sectors of economy and social activities, it attains a much more important & critical role similar of nerve veins running across the length and breadth of a living being. This paper deals with analysing and evaluating soil sub grade and base course material and checking its properties to find its suitability by using California Bearing Ratio test. It is done as a part of the tender work for the improvement of by widening from 5.50 meter to 10.00 meter staging and C. C. Block on Rewari Dadri road upto Lula Ahir in Rewari District including shifting of utility of P. H. and Electrical (Road ID: 1339, 4656 and 1682) including HSAMB Portion with an objective to tailor the functionality of this framework. In this paper results of the soil test conducted to evaluate the strength properties of soil are presented.

Key words: CBR Test, Strength, Soil

1. Introduction

Highway engineering [1] plays a pivotal role in development of a nation as it acts as an interconnection between different places. Along with the development of the highways there maintenance also plays an important role in maintaining its usefulness over due course of time [2]. Sub grade soil is an essential and most vital component of the road pavement structure as it grants the proper strength to sustainthe pavement from underneath [3]. The sub grade soil and its related properties are of critical importance in the planning of pavement structure. The main job of the sub grade is to give ample sustainability to the pavement and for this purpose the sub grade should have enough stability even in adverse climatic and loading conditions [4]. Therefore, it is of utmost importance to analyse and evaluate the sub grade by performing suitable tests to find out the strength and the related properties of the materials used for the construction in order to know whether they will be able to handle the roads constructed over them properly. Hence, for this analysis proper testing of the samples is carried out in advance, to check suitability of base course material.

2. Soil Tests

The tests [5]which are conducted to assess the strength of soils are generally classified into three categories, these are as described below:

a) Shear tests

Shear tests are by and largeconducted on comparatively smaller soil samples in the laboratories. In this test, in order to access the strength properties of soil, a large amount of representative samples are taken from different locations and are tested in the labs. Direct shear test [6], unconfined compression test, tri axial compression test are some types of the shear tests.

b) Bearing tests

Another type of loading test is known as bearing test which is conducted by means of a load bearing area on sub grade soils and it is carried out in-situ. By slight variations in the soil properties of the sample on which the test is being conducted the values of the bearing test also vary. As it is conducted by taking load bearing area consequently the overall stability of the component of the soil mass stressed may perhaps be deliberated.

c) Penetration tests

Bearing tests conducted on a smaller scale may be termed as penetration test. In this test, the size of the loaded area is comparatively much smaller as compared to the bearing tests. The penetration tests may be conducted in the field or in the laboratory.

2.1 California Bearing Ratio Test

California Bearing Ratio (CBR) [7] test was devised by the California Division of Highway as a means of categorizing and assessing soil-sub grade and base course materials designed for flexible pavements. CBR test, an experiential test, is carried out to decide the material properties for pavement design. As an empirical test it measures only the strength but on the other hand it cannot be taken as a true representation of the resilient modulus. It is a type of penetration test in which a standard piston, comprising an area of 3 in^2 (or 50 mm diameter), is taken to penetrate the soil sample taken for the test at a modelled rate of 1.25 mm/minute as shown in Fig. 1. California bearing ratio is the ratio of pressure which is applied to carry out a penetration of 12.5 mm and bearing value of a standard crushed rock.

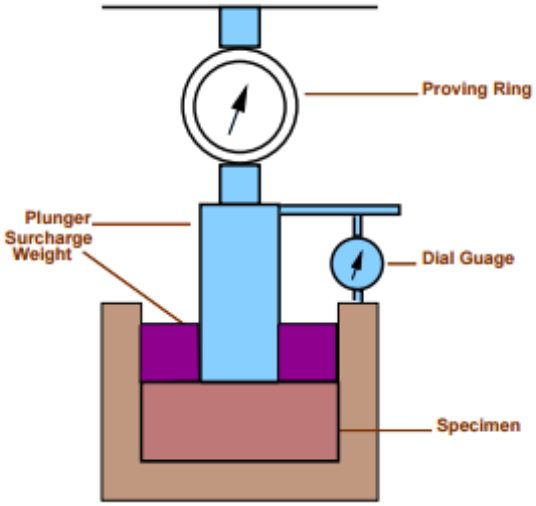

Figure 1 CBR Test

For mostly all the samples and cases, CBR value decreases as the value of penetration increases. The ratio at 2.5 mm penetration is generally used as the CBR value but in some cases, the CBR ratio at 5 mm may possibly be greater than that at 2.5 mm. Under this circumstance, the ratio which is found at 5 mm is used. The CBR is anevaluation of resistance of a sample to penetration of standard plunger under controlled density and moisture conditions. For carrying out this test, a set procedure should be strictly followed to get the best and most accurate results. The CBR test might be carried out in re-moulded or undisturbed specimen in the lab. The test is easy, uncomplicated and has been comprehensively examined for field correlations of flexible pavement thickness prerequisite.

2.1.1 Test Procedure

a) The CBR apparatus used for performing this test has a mould 150 mm diameter with a base plate and a collar, a loading frame and dial gauges which are used to measure different penetration values andenlargement on drenching in water.

b) The sample which is kept in the mould is drenched in water for four days and the swelling i.e. the enlargement of the sample is noted along with water absorption values. The increase in weight of the sample is placed on the top of the sample in the mould and the assembly is employedbelow the plunger of the loading frame.
c) Load is smeared on the specimen by a standard plunger with dia of 50 mm at the rate of 1.25 mm/min. A load penetration curve is drawn. The load values on standard crushed stones are 1370 kg and 2055 kg at 2.5 mm and 5.0 mm penetrations respectively.
d) CBR value is conveyed as a measurement of the actual load producing the penetrations of 2.5 mm or 5.0 mm to the standard loads which are as mentioned above.
e) So, from the calculations we can calculate CBR as, CBR = (load carried by the sample /load carried by standard sample) × 100
f) From this calculation, two different values of CBR will be generated after calculation. If the assessed value of 2.5 mm is greater than that for 5.0 mm penetration, the previous value is implemented. If the CBR value found from test at 5.0 mm penetration is higher than that at 2.5 mm, then the test is to be reiterated for checking. If the check test again gives alike results, then higher value obtained at 5.0 mm penetration is testified as the CBR value. The average CBR value of three test samples is reported as the CBR value of the specimen.

2.1.2 CBR Test Data - Observations and Calculations:

TEST REPORT

Data known from Modified Proctor test:
Maximum dry density =2.20 g/ cc
O.M.C = 8%

DRY DENSITY AND CBR DATA FOR 10 BLOWS

MOISTURE CONTENT		DRY DENSITY	
Container #	B 10	Weight of the mould (g)	7384
Weight of Container (g)	95.6	Wt. of mould+ Compacted Soil(g)	11843
Wt. of Cont. + Wet Soil (g)	888.59	Volume of the mould (cm^3)	2109
Wt. of Cont. + Dry Soil (g)	831.01	Bulk Unit Wt. (g/cc)	2.09
Moisture Content (%)	7.62	Dry Unit Wt. (g/cc)	1.97

CBR TEST DATA

PENETRATION (in)	PROVING RING DIAL READING	PISTON LOAD (lb)	AREA OF PISTON (in^2)	PENETRATION STRESS (psi)
0	0	0	3.01	0
0.025	5.4	112.24	3.01	37.41
0.05	11.1	225.51	3.01	75.18
0.075	14.5	293.06	3.01	97.70

0.1	16.9	346.97	3.01	115.64
0.125	19.7	404.12	3.01	134.69
0.15	22.1	449.09	3.01	149.66
0.175	23.7	485.81	3.01	161.89
0.2	24.6	504.09	3.01	168.02
0.3	30.1	616.39	3.01	205.46
0.4	31.9	653.10	3.01	217.69
0.5	34.9	714.29	3.01	238.12

3. Conclusion

The study presented in this project report is conducted to evaluate design and cost aspects of the work improvement of by widening from 5.50 meter to 10.00 meter staging and C. C. Block on Rewari Dadri road upto Lula Ahir in Rewari District including Shifting of utility of P. H. and Electrical Road (ID: 1339, 4656 and 1682) including HSAMB Portion for the contract price of Rs 42,64,77,750/-.For the selected stretch of study on Rewari Dadri road upto Lula Ahir on 25.96 kms project length, the CBR value of the soil sample taken for this construction work is under four days soaking condition is 5%, results were tested and cross checked**.**

4. Scope for Further Research

Though the study covers many of the parameters of design and cost aspects, there is scope for further improvement. A few of the possible related aspects for further research are:

a) The present study has been done for plain cement. Further studies can be carried out for roller compacted cement and plasticized flexible pavements.

b) The present study has been done by taking only cement in concrete pavement. Further study can be done by taking fly ash plus cement in concrete pavement thereby further reducing the cost of rigid pavement.

c) Further study can be carried out on roads with more number of lanes.

d) A similar study can be taken up for different values of CBR of soil and traffic volume on the road.

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