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Determination of CBR of Subgrade Soil at field density (Un soaked) and Saturate density (Soaked) condition from DCP Test

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Abstract— ***Laboratory CBR test in Un soaked and Soaked condition is time consuming, expensive and indirect representation of filed condition, so there is a need of performing direct monitoring of strength at site for subgrade soil to design flexible Pavement and also for verification of quality of subgrade during construction and also under operation period which demands fast & easy way to verify subgrade strength parameters The present study reflects on experimental investigation on various soils at F.D.D. and FMC by correlating DCP with CBR test results in Un soaked as well as soaked condition at Field density that will helpful to the highway engineer in estimate Un soaked and Soaked CBR value at Field Density from DCP results obtained from site. Hence time will be saved and site condition assessed properly.***

Keywords— CBR, FMC, FDD, DCP

I. INTRODUCTION

The Pavement Design and strength of the flexible road or runways depends to a large extent on the CBR or MR Value of subgrade. To carryout techno economic Flexible Pavement design, an accurate and representative material testing technique is very important; such technique would be more accurate and acceptable if it is simple, rapid and economic. The evaluation of subgrade strength is an important for the road pavement during design, construction and service stages.

The use of CBR is mandatory parameters for flexible pavement design, to estimate the CBR for the subgrade soil. The laboratory determination of CBR tests demand significant effort, time and expense, in strength of subgrade determination, initially the California Bearing Ratio (CBR) test was developed by the California Division of Highway. The CBR is a measure of shearing resistance of material under controlled density & moisture condition, it is a ratio of the force per unit area required to penetrate a soil mass with a standard circular piston of 50 mm diameter at the rate of 1.25 mm/min to that required for the corresponding penetration of a standard material. The CBR value obtained is an integral part of several flexible pavement design method, as per the test method standard one CBR test will take minimum 7 days.

In view of present flexible pavement design procedures, it reflect that there is a need of performing direct monitoring of strength at site for subgrade soil to design flexible Pavement and also verification of quality of subgrade during construction and operation period which demands fast & easy way to verify subgrade strength parameters, It become easier to evaluate the strength parameters by correlating the results of CBR at field density & DCP in soaked as well as Un soaked condition.

II. PROBLEM STATEMENT

The properties of subgrade play an important role on the performance of Road and Highway during Design, Construction and Serviceability during its design period. Instead of using indirect method using time consuming laboratory method of subgrade strength determination, it is the need of road infrastructure industries to develop direct method of determining the CBR value that will be rapid, accurate and economic technique, so attempt is made to determine CBR value in un-soaked and soaked condition by using DCP test at subgrade soil on site which make strength determination process accurate, fast and economic.

III. SCOPE OF STUDY

In a fast-growing economy of developing country like India development of infrastructure network related to realignment, widening of adjusting roads or runways are fast growing. In design of flexible road pavement, soil strength parameter is essential. In our project subgrade soil of North Gujarat region is considered having variation in physical and strength properties

The present study reflects on experimental investigation on various soils at F.D.D. and correlation were developed between CBR and DCP test results in soaked as well as un soaked condition that will helpful to the engineer in estimate CBR value from DCP results. Hence time will be saved and site condition assessed properly with numbers of DCP.

IV. DATA COLLECTION

(1) mm/blow (DCP Test) at field condition on subgrade soil at various locations

(2) Conducting FDD-FMC at selected locations for regression analysis and validation

(3) Collection of Subgrade soil samples for laboratory test as under

 (a) Gradation

 (b) Liquid limit

 (c) Plastic limit

 (d) CBR in Un soaked condition at FDD

 (e) CBR in soaked condition at FDD

(4) Laboratory DCP test in soaked condition at FDD

TABLE I

Sr. No	Side	FSI (%)	Grain Size Analysis (%)			Atterberg Limit (%)			Soil Identification	FDD	FMC	DCP Unsoaked (mm/blow)	CBR un-soaked	DCP Soaked Lab (mm/blow)	CBR soaked
			Gravel	Sand	Silt/Clay	LL	PL	PI		gm/cc	%				
1	LHS	0	0	51	49	26	NP	NP	SM	1.62	8.82	50.20	10.3	59.4	5.8
2	RHS	15	0	5	95	38	23	15	CI	1.82	10.9	40.67	11.2	55.7	4.2
3	RHS	0	6	90	4	19	NP	NP	SP	1.72	2.48	15.75	13.2	19.5	7.1
4	LHS	0	3	80	17	26	NP	NP	SM	1.6	8.5	9.20	17.5	13.5	7.8
5	LHS	0	2	80	18	24	NP	NP	SM	1.55	2.64	12.00	17.8	16.8	7.4
6	LHS	0	0	80	20	26	NP	NP	SM	1.62	8.2	20.50	14.2	26.3	6.3
7	LHS	0	0	79	21	27	20	7	SC,SM	1.66	5.2	21.50	13.9	27.6	6
8	LHS	0	0	84	16	26	NP	NP	SM	1.66	5.69	16.50	14.8	22.3	6.8
9	LHS	0	0	88	12	25	NP	NP	SP,SM	1.71	7.41	19.50	15.3	25.8	6.4

V. DATA ANALYSIS

Quick and rapid determination of strength properties of subgrade requires simple testing procedures and simple empirical correlations. These empirical correlations are to be developed by identifying the appropriate parameters, which has major dependency. Therefore, developments of empirical correlations require accurate laboratory and field investigations. Therefore, in this chapter based on the laboratory and field investigations, empirical correlations were developed by simple and multivariate parametric regression analysis using MS-Excel tool.

These empirical correlations were developed by simple parametric regression analysis based on the fundamental principle. These correlations were developed to estimate CBR value at Field density in both soaked and unsoaked conditions for natural subgrade soil.

TABLE II

Sr No	DCP Unsoaked	CBR Unsoaked Lab	DCP Soaked Lab	CBR Soaked Lab
1	9.2	17.5	13.5	7.8
2	12	17.8	16.8	7.4
3	15.75	13.2	19.5	7.1
4	16.5	14.8	22.3	6.8
5	19.5	15.3	25.8	6.4
6	20.5	14.2	26.3	6.3
7	21.5	13.9	27.6	6
8	40.67	11.2	55.7	4.2
9	50.2	10.3	59.4	5.8

1. Development of empirical correlations for estimating CBR value at field density using DCP field values of natural subgrade soils in un soaked conditions.

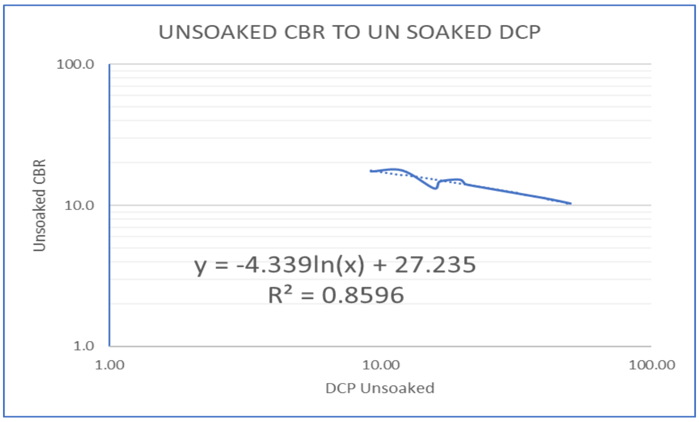

Fig. 1 Un soaked CBR to Un soaked DCP

2. Development of empirical correlations for estimating DCP lab (Soaked) at field density using DCP (field - Unsoaked) values of natural subgrade soils

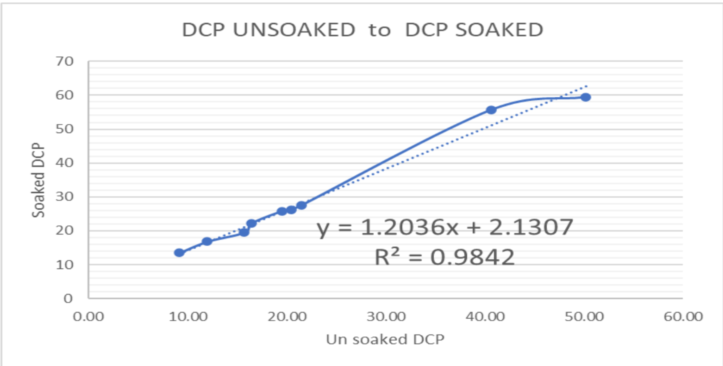

Fig. 2 DCP Un soaked to DCP soaked

3. Development of empirical correlations for estimating CBR value (Soaked) field density using DCP (Soaked) values of natural subgrade soils

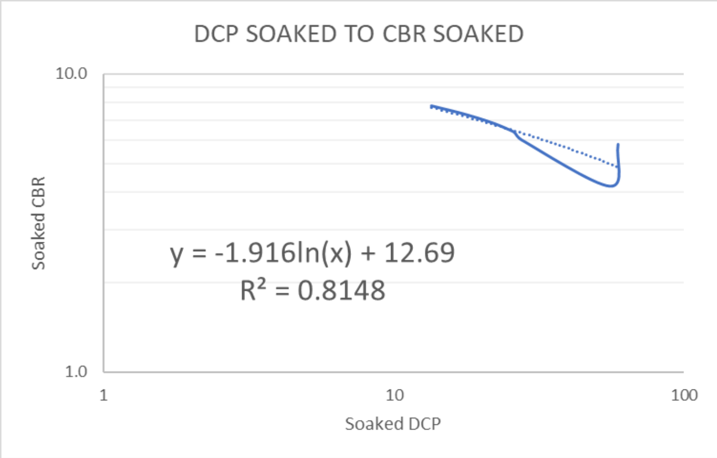

Fig. 3 DCP soaked to CBR soaked

TABLE III

Sr No	DCP Unsoaked	CBR Unsoaked Lab	CBR Unsoaked by Regression	DCP Soaked Lab	DCP Unsoaked to DCP Soaked Regression	CBR Soaked Lab	CBR Soaked Regression
1	9.2	17.5	17.61	13.5	13.2	7.8	7.75
2	12	17.8	16.45	16.8	16.57	7.4	7.31
3	15.75	13.2	15.27	19.5	21.09	7.1	6.85
4	16.5	14.8	15.07	22.3	21.99	6.8	6.77
5	19.5	15.3	14.35	25.8	25.6	6.4	6.48
6	20.5	14.2	14.13	26.3	26.8	6.3	6.39
7	21.5	13.9	13.92	27.6	28.01	6	6.3
8	40.67	11.2	11.16	55.7	51.08	4.2	5.15
9	50.2	10.3	10.24	59.4	62.55	5.8	4.77

4. Also, the formula developed are validate by conducting various tests

VI. CONCLUSIONS

The objective of this study is to evaluate the potential use of non-destructive testing devices such as modified DCP to measure the in-situ strength parameters of natural soils during and after construction. To assess this series of field and laboratory tests were conducted on selected locations in the North Gujarat. samples were analyzed of different classification like sandy soils, sand-clay soils and clayey soils nature. The field-testing program include conducting tests using the investigated devices, in addition to some standard tests, which included the Dynamic cone penetration (DCP) and California Bearing Ratio (CBR) tests. Statistical analysis was conducted to correlate soaked and unsoaked CBR at FDD (at given density) obtained by modeled developed based on soaked/ un soaked FDD samples in laboratory by using DCP.

The results of the statistical analysis show that good correlation do exist between the devices under evaluation (DCP) and the standard tests (CBR). The relations obtained from statistical analysis, were linear for some models and non-linear for others. All regression models had an adjusted R2, and a significance level greater than 0.80. The result of this study suggests that modified DCP can be reliably used to predict the soaked and un soaked CBR on field density value.

This research study primarily focused on the development of empirical correlations for estimating the subgrade strength parameters such as CBR in un soaked and soaked condition by using DCP values. It is quick decision-making tool for a policy makers, concessionaires, designers and quality control engineers.

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