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AN EXPERIMENTAL STUDY ON CORRELATION BETWEEN CALIFORNIA BEARING RATIO (CBR) AND DYNAMIC CONE PENETRATION TEST (DCPT)

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Abstract- The paper is revealing the results of a laboratory study carried out to find the correlations between the Dynamic Cone Penetration test value and the unsoaked CBR value at different moisture content. A series of test was carried out different types of soil (sand,silt,clay) at different moisture content, for each soil sample to find out the correlation in CBR value. Samples were compacted manually (Modified proctor compaction) to obtain the pre-determined conditions. The laboratory results indicated that there is variation in CBR values at same moisture content. The CBR variation of same water content goes higher to lower with the variation of water content.

Key word- CBR Test, DCP Test, Dry Density, Moisture content

I. INTRODUCTION

The Dynamic cone penetration (DCP) is an instrument that can be used to evaluate California Bearing Ratio (CBR) value of road pavement subgrade. The DCP has many advantages over the traditional CBR test. It is an in situ test, simple to use and inexpensive. Hence its possible to introduce this instrument to local read authorities that deal with rural road contruction and maintenance work, with a limited budget. It is very rarely that a local authority valuates the subgrade in maintenance work or designing of overlay the subgrade in maintenance work or designing of overlay thickness. However the DCP, which can also be produced by local authorities for those themselves at low cost, can be introduced for those rural road projects as an effective road evaluation tool.

II. OBJECTIVES OF STUDY

The objectives of this thesis are listed below:

1. To determine the correlation between CBR (California bearing ratio) and DCPT (Dynamic cone penetration test) for different soils e.g Clayey, silt and Sandy Soil
2. To ascertain the effect of moisture on correlation between CBR and DCPT value
3. To ascertain the effect of compaction on correlation between CBR and DCPT value
4. To compare the results with the correlation given in IRC 37 : 2012

Log_{10} CBR = 2.465-1.12Log_{10} N

III. EXPERIMENTAL PROCEDURE

A series of tests were conducted in the laboratory under controlled conditions as required .Soil samples were prepared of clay ,sand, silty soil at different moisture content. The CBR test was conducted in a mould of diameter 150mm. The Modified Proctor Compaction test was carried out for each soil sample to find out the dry density and MDD, then DCP test was carried out by varying the moisture content and

the dry density. About five test were carried out for each soil sample. Sample were compacted manually and extreme case was taken to maintain the pre-determined conditions. This shows the effect of moisture content on CBR value.

IV. TEST RESULTS AND DATA ANALYSIS

COMPARISON OF RESULT OF CBR (UNSOAKED) ON CLAYEY SOIL (CI)
OPTIMUM MOISTURE CONTENT – 11%

WATER CONTENT (%) (1)	CBR BASED ON LABORATORY TESTS (%) (2)	CBR VALUE BASED ON DCPT INDEX (%) (3)	DIFFERENCE IN CBR VALUES (%) (3 - 2)	PERCENTAGE VARIATION (%)	CHANGE IN VARIATION WITH INCREASING IN MOISTURE CONTENT
8	15.57	18.19	+2.62	+16	_
11	27.32	30	+2.68	+9.80	7.02
14	06	6.74	+0.74	+12.33	2.03
17	2.5	3	+0.5	+20	7.67

COMPARISON OF RESULT OF CBR (UNSOAKED) ON SANDY SOIL (SP)
OPTIMUM MOISTURE CONTENT - 6%

WATER CONTENT (%) (1)	CBR BASED ON LABORATORY TEST (%) (2)	CBR VALUE BASED ON DCPT INDEX (%) (3)	DIFFERENCE IN CBR VALUES (%) (3 - 2)	PERCENTAGE VARIATION	CHANGE IN VARIATION WITH INCREASING IN MOISTURE CONTENT
4	38.39	30	-8.39	-21.85	_
5	43	36.30	-6.97	-16.20	5.65
6	52.55	42.65	-9.9	-18.83	2.63
7	43.26	36.30	-6.96	-16	2.83
8	36.78	33.11	-3.67	-9.97	6.03

COMPARISON OF RESULT OF CBR (UNSOAKED) ON SILTY SOIL (ML)
OPTIMUM MOISTURE CONTENT - 10%

WATER CONTENT (%) (1)	CBR VALUE BASED ON LABORATORY TESTS (%) (2)	CBR VALUE BASED ON DCPT INDEX (%) (3)	DIFFERENCE IN CBR VALUES (%) (3 - 2)	PERCENTAGE VARIATION	CHANGE IN VARIATION WITH INCREASING IN MOISTURE CONTENT
6	23.12	26.91	+3.79	+16.39	_
8	27.15	30	+2.85	+10.49	5.9
10	33.11	36.30	+3.19	+9.65	0.84
12	09	9.77	+0.77	+8.58	1.07
14	06	07	+01	+16.66	8.08

COMPARISON OF RESULT OF CBR ON (SOAKED) SPECIMEN

WATER CONTENT (%) (1)	TYPE OF SOIL (2)	CBR VALUES BASED ON LABORATORY TESTS (%) (3)	CBR VALUE BASED ON DCPT INDEX (%) (4)	DIFFERENCE IN CBR VALUES (%) (3 – 4)	PERCENTAGE VARIATION
11	CI	10.33	12.58	+2.24	+21.68
10	ML	20.14	21.37	+1.23	+6.10
6	SP	26.27	23.98	-2.29	-8.71

V. RESULT AND DISCUSSION

The soil samples were tested to examine their physical properties. The liquid limit and plastic limit values were determine, Maximum Dry Density and Optimum Moisture Content of the soil were obtained from Modified Proctor's Compaction Test. The sieve analysis of sandy soil was also performed and results are presented in Table no 4.10. After examining the physical properties of clayey, sandy and silty soil. The soil was mixed with different percentages of water and CBR values and DCP test values determined.

1. For Clayey soil it is observed that the maximum CBR (unsoaked) is obtained corresponding to soil at Optimum Moisture Content and Maximum Dry Density conditions. The CBR at moisture content both below and higher than OMC value are lesser. This is as expected. Similar trend is also observed in DCP test values. The variation between CBR value derived from DCPT and CBR value is more prominent as the water content deviates more w.r.t OMC, both on lower as well as higher side. The variation is more prominent on lesser water content values compared and higher water content values. Percentage variation near OMC value is in the range of 10 to 12% noting that value determined from DCP test values are higher than the directly observed CBR values.

2. For Sandy soil it is observed that the maximum CBR (unsoaked) is obtained corresponding to soil at Optimum Moisture Content and Maximum Dry Density conditions. The CBR at moisture content both below and higher than OMC value are lesser. This is as expected. Similar trend is also observed in DCP test values. The variation between CBR value derived from DCPT and CBR value is more prominent as the water content deviates more w.r.t OMC, both on lower as well as higher side. The variation is more prominent on lesser water content values compared and higher water content values. Percentage variation near OMC value is in the range of 16 to 19% noting that value determined from DCP test values are lesser than the directly observed CBR values.

3. For Silty soil it is observed that the maximum CBR (unsoaked) is obtained corresponding to soil at Optimum Moisture Content and Maximum Dry Density conditions. The CBR at moisture content both below and higher than OMC value are lesser. This is as expected. Similar trend is also observed in DCP test values. The variation between CBR value derived from DCPT and CBR value is more prominent as the water content deviates more w.r.t OMC, both on lower as well as higher side. The variation is more prominent on lesser water content values compared and higher water content values. Percentage variation near OMC value is in the range of 8.5 to 10% noting that value determined from DCP test values are higher than the directly observed CBR values.

4.The result investigation soaked specimen, in Clayey soil at Maximum Dry Density and Optimum Moisture Content, it is observed that the variation between CBR value derived from DCPT and CBR is +21.68%. while in soaked Silty soil at Maximum Dry Density and Optimum Moisture Content, it is observed that the variation between CBR value derived from DCPT and CBR is +6.10. Similarly in soaked Sandy soil at Maximum Dry Density and Optimum Moisture Content, it is observed that the variation between CBR value derived from DCPT and CBR is -8.71%. Where as difference in CBR values is +2.24 CI, +1.23 ML and -2.29 SP soil.

VI. CONCLUSION

Based on the study, following conclusions can be drawn:

1. While comparing the variation observed at soaked and unsoaked conditions it is observed from the Table 4.39,4.40,4.41 that DCPT index is higher in cohesive soil, where as DCPT index is less in cohesive less soil. This shows that apparent resistance is higher in SP and minimum in CI and ML soil.

2.Test data indicates that equation given in IRC-37-2012 is not suitable for cohesion less soil at different water content as difference in CBR value is in the range of (-8 to -10 %). Maximum variation is in sandy soil and minimum variation is in cohesive soil for clayey soil (+ 0.5 to +2.68%) and silty soil (+0.77 to 3.79%).

3. Investigation data proves the effect of moisture on DCPI is significant. DCPI decrease with increasing moisture for all types of soil. The variation on DCPI is more prominent as the water content deviates more w.r.t OMC, both on lower as well as higher side.

4. A significant correlation exists between the DCPI value and the moisture content for all types of soil.

5. The CBR value of cohesive soil can be determined quickly and with adequate accuracy using the DCPT results.

6. The variation is minimum at near optimum moisture content values for cohesive soils.

VII. SCOPE FOR FUTURE STUDY

1. Further investigation of similar nature may be carried out using various other soil types.
2. Similar investigation can be done on specimen under soaked conditions.

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