

Evaluation of Field CBR by Using Dynamic Cone Penetrometer Test

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Abstract - The Road Network is an important factor for economic growth of the country. Worldwide there are so many projects are going on the construction of road and the present studies is based on the evaluation of field California Bearing Ratio for assessment of sub-grade strength. For present study all procedure of tests is followed as per American Society for Testing and Materials (ASTM). Dynamic Cone Penetrometer Test (DCPT) is the easy way to obtain the sub-grade strength of field in the less time. However, there are also available laboratory testing for determination of CBR value but is consume more time and based on the disturbed sample.

keywords - DCPT, Geo-technical, Road Network

I. INTRODUCTION

In Developing country like India, the road networks are increasing day by day and there so many tests are required to build a road network in many places. For construction of road network, it is required to check strength of different layer of road surface before providing final coat of bitumen. More than thousands of times wheel load repeated per day on roads, so there should be provide a good strength to the sub-grade layer by heavy compaction. For provide better strength of road, the tests are required to evaluate the sub-grade strength whether it have good strength or not. The California bearing ratio test gives an idea about the strength of sub-grade, there are both field test as well as lab test are available. The present studies are based on the performing field test to evaluated CBR value. The test conducted on the edge of Dehradun to Rishikesh road for the research purpose to know about the sub-grade strength. However, few quantities of sample were taken for the laboratory test to determine the geotechnical properties of soil.

II. MATERIALS & METHODS

In present studies the Dynamic Cone Penetrometer Test performed in the field, while the geotechnical properties of soil determine after conducts laboratory experiments. Materials and methods describe as follows:

A. Materials: Total five soil samples were collected from the different location of Dehradun - Rishikesh road i.e. Harrawala, Lachhiwala, Doiwala, Bhaniawala and Chidderwala. The all locations are situated in the Dehradun district of Uttarakhand. The soil samples taken for the water content were in the airtight plastic bag. And the Dynamic Cone Penetrometer test were conducted in these five locations which are mention above and DCPT data recorded in the field data sheet.



Fig.1: Field Samples collected in the laboratory

B. Methods: The methods used in the present studies are mentioned below:

1. Dynamic Cone Penetrometer Test: The tests were performed as per ASTM D6951-09. The 8 kg hammer dropped from the 575 mm height and the penetration of cone (which is connected to the 5/8-inch diameter steel rod) is recorded in the field data sheet. In the past studies many researchers developed different relationship between DCP vale and CBR. In present studies Livneh's formula used for evaluation of CBR vale. The Linvneh's formula is show as:

$$\text{Log}_{10}(\text{CBR}) = 2.465 - 1.12 \text{ log}_{10}N$$

Where N = mm/blow (DCPT Index)

2. Geo-technical Properties of Soil:

- a. Grain Size Analysis:** Grain Size Analysis test were performed in the laboratory by using different size of sieve. The test procedure was based on the as per ASTM D422.
- b. Atterberg’s Limit:** Atterberg’s limit is used to calculate liquid limit, plastic limit and plasticity index of soil. The Standard methods follow as per ASTM D4318 in the laboratory.
- c. Specific Gravity:** Specific gravity test of soil was evaluated by the pycnometer as per ASTM D854.
- d. Water Content:** Water content of soil calculated by oven dry method. The standard tests were followed as per ASTM 2216.
- e. Soil Classification:** The soil classification was done by the soil classification chart (ASTM D2487) which was based on Atterberg’s Limit.
- f. Standard Proctor Test:** Maximum dry density and optimum moisture content by using Standard Proctor test and the standard procedure were following as per ASTM D968.
- g. Tri-Axial Test (Unconsolidated Undrained):** It was used to calculate cohesion and angle of internal friction of disturbed sample. The test methods were followed as per ASTM D2850.



Fig.2: Equipment’s for the tests of soil sample in the laboratory

III. RESULTS & DISCUSSION

Dynamic Cone Penetrometer test were performed in the field, while the test on sample were conducted in the laboratory. The detail results of the test are described following:

1. Laboratory results of Soil Samples tested in the laboratory: The Soil samples of Harrawala, Lachhiwala, Doiwala, Bhaniawala and Chidderwala tested in the soil laboratory. The test results are summarized as following:

TABLE1. Geo-technical Properties of Soil Sample

S. No.	Parameter	Test Methods	Results				
			Harrawala	Lachhiwala	Doiwala	Bhaniawala	Chidderwala
1.	Water Content of field sample	ASTM 2216	3.24 %	5.24 %	4.63 %	1.29 %	1.49 %
2.	Soil Classification	ASTM D2487	ML-CL	ML-CL	ML-CL	CL	ML
3.	Specific Gravity	ASTM D854	2.65	2.52	2.69	2.45	2.52
4.	Liquid Limit	ASTM D4318	17.26 %	19.24 %	16.23 %	21.73 %	15.27 %
5.	Plastic Limit	ASTM D4318	11.24 %	12.89 %	11.29 %	12.48 %	11.29 %
6.	Plasticity Index	ASTM D4318	6.02 %	6.35 %	4.94 %	9.25 %	3.98 %
7.	Consistency Index	--	2.33 %	2.20 %	2.35 %	2.21 %	3.46 %
8.	Liquidity Index	--	1.33 %	1.20 %	1.35 %	1.21 %	2.83 %
9.	Maximum Dry Density	ASTM D968	15.29 KN/m ³	15.81 KN/m ³	15.18 KN/m ³	16.02 KN/m ³	14.21 KN/m ³
10.	Optimum Moisture Content	ASTM D968	13.88 %	14.02 %	14.88 %	15.88 %	13.02 %

11.	Cohesion	ASTM D2166	11.24 kPa	10.28 kPa	12.31 kPa	14.21 kPa	7.21 kPa
12.	Angle of internal friction	ASTM D2166	21°	25°	24°	19°	28°

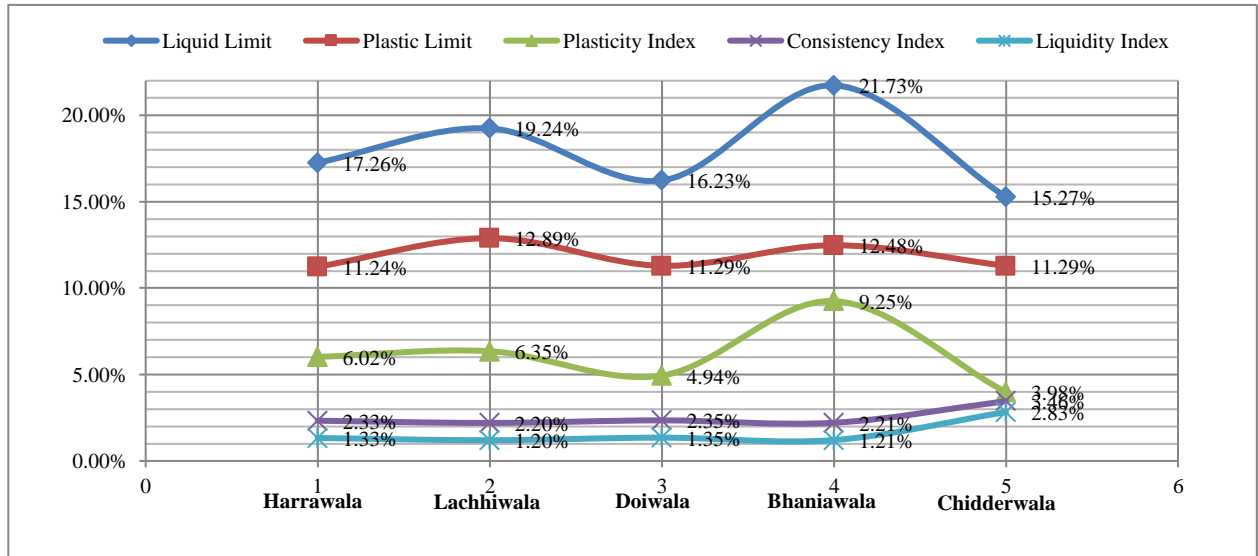


Fig.3: Graphical representation of Atterberg's Limit

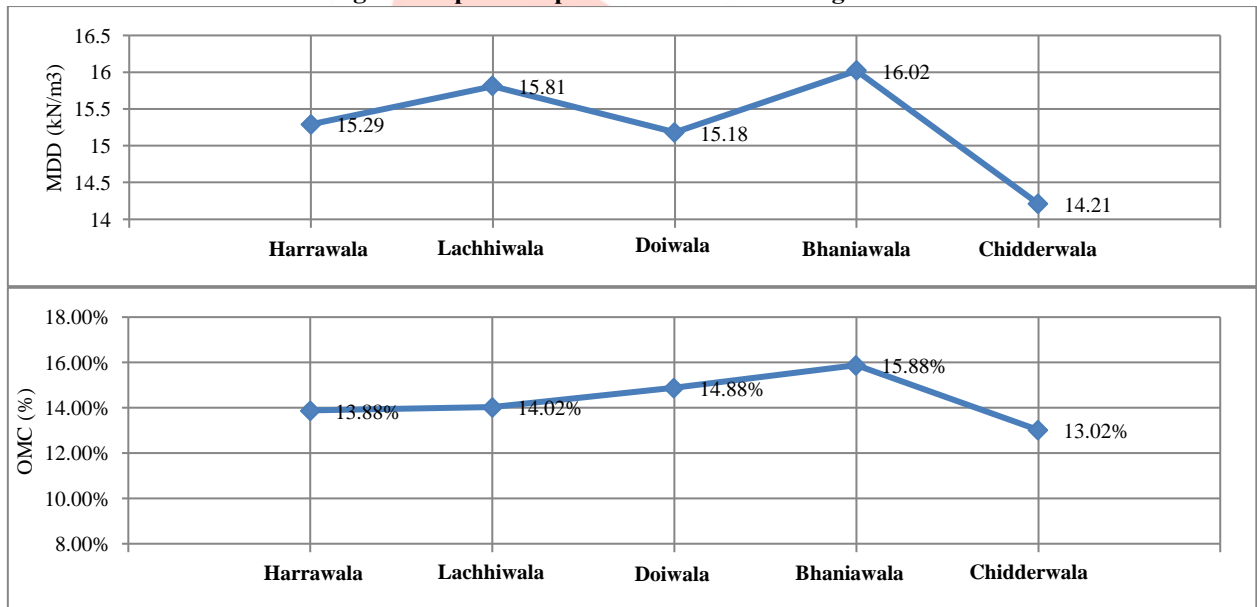


Fig.4: Graphical representation of OMC and MDD

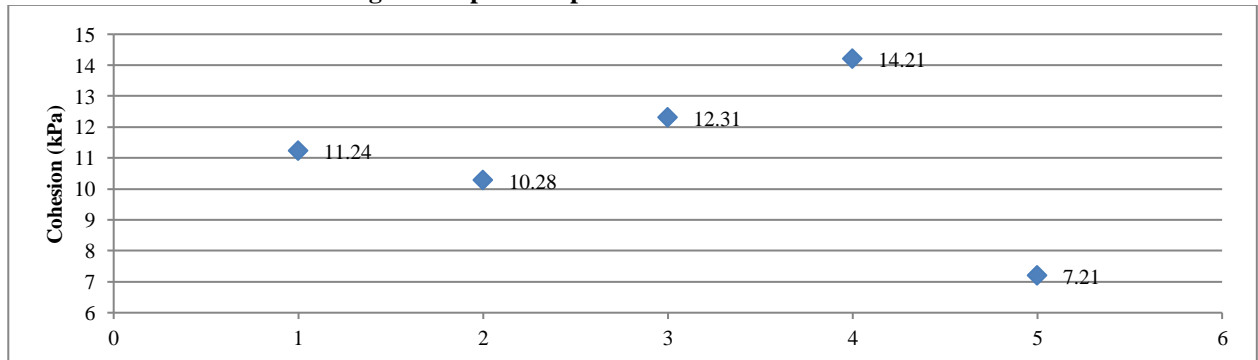


Fig.5: Graphical representation of Cohesion and Internal Friction

2. **Field Date results of Dynamic Cone Penetrometer Test:** The field tests were conducted by Dynamic Cone Penetrometer for 20 cm layer of soil to evaluate the CBR value. The details result of DCPT summarized as following:

TABLE2: CBR Value of Field Tests

S. No.	Number of Blows		Penetration		DCPT Index (mm/blow)	CBR Value (%)	Average CBR (%)
	No of Blow (N)	Total No of Blow (N)	Penetration (mm)	Total Penetration (mm)			
CBR value of Harrawala Site							
1.	4	4	26	26	6.50	4.73	6.17
2.	4	8	14	40	3.50	6.40	
3.	4	12	15	55	3.75	6.18	
4.	4	16	12	67	3.00	6.89	
5.	4	20	16	83	4.00	5.99	
6.	4	24	13	96	3.25	6.63	
7.	4	28	14	110	3.50	6.40	
8.	4	32	16	126	4.00	5.99	
9.	4	36	18	144	4.50	5.66	
10.	4	40	17	161	4.25	5.82	
11.	4	44	15	176	3.75	6.18	
12.	4	48	15	191	3.75	6.18	
13.	4	52	11	202	2.75	7.19	
CBR value of Lachhiwala Site							
1.	4	4	26	26	6.50	4.73	6.17
2.	4	8	14	40	3.50	6.40	
3.	4	12	11	51	2.75	7.19	
4.	4	16	16	67	4.00	5.99	
5.	4	20	15	82	3.75	6.18	
6.	4	24	22	104	5.50	5.13	
7.	4	28	13	117	3.25	6.63	
8.	4	32	14	131	3.50	6.40	
9.	4	36	16	147	4.00	5.99	
10.	4	40	12	159	3.00	6.89	
11.	4	44	17	176	4.25	5.82	
12.	4	48	18	194	4.50	5.66	
13.	4	52	11	205	2.75	7.19	
CBR value of Doiwala Site							
1.	4	4	25	25	6.25	4.82	5.91
2.	4	8	14	39	3.50	6.40	
3.	4	12	16	55	4.00	5.99	
4.	4	16	17	72	4.25	5.82	
5.	4	20	19	91	4.75	5.51	
6.	4	24	14	105	3.50	6.40	
7.	4	28	15	120	3.75	6.18	
8.	4	32	16	136	4.00	5.99	
9.	4	36	18	154	4.50	5.66	
10.	4	40	19	173	4.75	5.51	
11.	4	44	15	188	3.75	6.18	
12.	4	48	14	202	3.50	6.40	
CBR value of Bhaniawala Site							
1.	4	4	32	32	8.00	4.28	5.13
2.	4	8	22	54	5.50	5.13	
3.	4	12	21	75	5.25	5.25	
4.	4	16	24	99	6.00	4.92	
5.	4	20	18	117	4.50	5.66	
6.	4	24	19	136	4.75	5.51	
7.	4	28	23	159	5.75	5.02	
S. No.	Number of Blows		Penetration		DCPT Index (mm/blow)	CBR Value (%)	Average CBR (%)
	No of Blow (N)	Total No of Blow (N)	Penetration (mm)	Total Penetration (mm)			
8.	4	32	21	180	5.25	5.25	5.13
9.	4	36	22	202	5.50	5.13	
CBR value of Chidderwala Site							
1.	4	4	21	21	5.25	5.25	6.40
2.	4	8	15	36	3.75	6.18	

3.	4	12	14	50	3.50	6.40
4.	4	16	16	66	4.00	5.99
5.	4	20	12	78	3.00	6.89
6.	4	24	11	89	2.75	7.19
7.	4	28	13	102	3.25	6.63
8.	4	32	17	119	4.25	5.82
9.	4	36	19	138	4.75	5.51
10.	4	40	12	150	3.00	6.89
11.	4	44	13	163	3.25	6.63
12.	4	48	14	177	3.50	6.40
13.	4	52	11	188	2.75	7.19
14.	4	56	13	201	3.25	6.63



Fig.6: Dynamic Cone Penetrometer Set-up in the field

IV. CONCLUSIONS

1. Dynamic Cone Penetrometer Test is suitable to calculate CBR value in the field for assessment of sub-grade strength.
2. Present study was based on the both field test as well as laboratory test. The laboratory tests were conducted to determine the geotechnical properties of Soil.
3. All tests were conducted for the enhancing the knowledge about the transportation engineering as well as geotechnical engineering subject.
4. All tests were conducted in the area of Dehradun district (Uttarakhand, India) and tests were based on the American Society for Testing and Materials (ASTM) guidelines.
5. The average value of CBR for 20 cm depth of soil layer were 6.17%, 6.17%, 5.91%, 5.13% and 6.40% for Harrawala, Lachhiwala, Doiwala, Bhaniawala and Chidderwala location.

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