DEVELOPMENT OF CORRELATION BETWEEN DIFFERENT ENGINEERING PROPERTIES OF SUBGRADE SOIL

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Abstract: - Road connectivity is essential for socio-economic growth of the country. Proper construction and choice of suitable material for embankment are the main criterion to reduce the early distresses in the pavement structure. In flexible pavements, sub-grade is considered to be an ideal layer to resist wheel load and its California bearing ratio (CBR) value is considered as the strength measuring parameter. Conducting CBR test is an expensive and time-consuming test, moreover, it is very difficult to mould the sample at a desired in-situ density in the laboratory.

In the present study, an attempt has been made to establish a relationship between different engineering properties of soil subgrade like DCPT value, CBR and Unconfined compressive strength (UCS). The different types of soil sample have been collected from different region of Rajkot like Lodhika, Mavdi, Hadala, Ring Road 1,Ring Road 2.Their index properties and* subgrade strength parameters like *California bearing ratio (CBR)* (soaked & unsoaked), *dynamic cone penetration test (DCPT) & Unconfined compressive strength (UCS) have been determined. T*he correlations between different engineering properties of subgrade soil like CBR, *DCPT*& UCS *have been* developed.The developed relationships have been easy to get information about the strength of subgrade over the length of the road. Use of these correlations will prove cost effective and reduce considerable time.***

Key words:- California bearing ratio, Dynamic Cone Penetration, unconfined Compressive strength, Subgrade Soil

I. INTRODUCTION

The design of flexible pavement (IRC-37-2012) is based on the sub-grade soil strength is estimated with California Bearing Ratio test (CBR) IS 2720 part. This test can be done in the laboratory as well as in the field. But this conventional CBR testing has low repeatability. It is an expensive and time-consuming test. Moreover, it is very difficult to mould the sample at desired in-situ density in the laboratory. Therefore, to overcome these problems, the other method Dynamic Cone Penetrometer (DCP) is used in this study this is an instrument used to evaluate insitu strength of pavement base, sub-base and sub grade materials. Even IRC 37 (2012) recommends the following equation to be used to determine in-situ CBR of sub grade soil based on DCP test:

$$LOG_{10}\ CBR = 2.465 - 1.12\ LOG_{10}N$$

Where N= mm/blow

The equation given by IRC may vary for different soil types. Looking to this it is required that the relationship is to be developed for specific soil type. Various engineering properties of sub grade soil like CBR, DCPT, and UCS will be analyzed and correlations will be developed for two different regions of Gujarat state having different soil characteristics. With the help of this developed relationship, it will be easy to get information about the strength of sub grade. The performance of pavements depends to a large extent on the strength and stiffness of the sub grades. Subgrade strength (CBR) plays a major role in pavement design. Since determination of CBR value in field requires need of equipment and also time consuming alternatively one can be predicted CBR value of subgrade in field from other soil support tests namely Dynamic Cone Penetrometer Index (DCPI) which has evolved as the most versatile rapid, in situ evaluation device currently available for use in determining sub grade properties. Correlations of DCPT index to CBR and its use in performance evaluation of pavement layers make it an attractive alternative to more expensive and time-consuming procedures. In this paper, an attempt has been made to develop relationship equations between DCPT index to Index and engineering properties of few subgrades with low plasticity characteristics. The tests include determination of DCP index in field and engineering properties in the lab. Studies are extended for both pre-monsoon and post-monsoon periods to know the effect of moisture on all properties.

The soil sub grade is a layer of natural soil prepared to receive the layers of pavement materials placed over it. The loads on the pavement are ultimately received by the soil sub grade for dispersion to the earth mass. It is essential that at no time the soil sub-grade is over stressed. It means that the pressure transmitted on the top of subgrade is within the allowable limit, not to cause excessive stress condition to deform the same beyond the elastic limit. Therefore it is desirable that at least top 50 cm layer of subgrade soil is well compacted under controlled conditions of optimum moisture content and maximum dry density. It is necessary to evaluate the strength properties of the soil subgrade.

II. OBJECTIVE

- To classify the soil samples of the different region based on index properties.
- To determine the subgrade strength parameters like California bearing ratio (CBR) (soaked & unsoaked), dynamic cone penetration test (DCPT) & Unconfined compressive strength (UCS).
- To develop the correlation between different engineering properties of subgrade soil like CBR, DCPT& UCS.

III. SCOPE

- Based on this investigation we conclude some empirical equation which is very helpful for consultants and engineers for road construction.
- The overall testing program consist of
  1. Sieve analysis of soil
  2. Liquid limit & plastic limit
  3. Standard proctor test
  4. Dynamic cone penetration test (DCPT)
  5. Laboratory CBR test (Soaked &Unsoaked)
  6. Unconfined compressive strength test of soil (UCS)

IV. CBR TEST RESULTS

Table 1 CBR TEST RESULTS

SR NO.	LOCATION	CBR TEST			
		Soaked (%)	Avg.	Unsoaked (%)	Avg.
1	Lodhika	1.29	1.26	2.43	2.66
		1.28		2.89	
		1.21		2.67	
2	Mavdi	1.09	1.08	2.29	2.36
		1.04		2.35	
		1.12		2.45	
3	Hadala	1.18	1.18	2.38	2.39
		1.16		2.48	
		1.2		2.31	
4	Ring Road 1	1.65	1.65	4.97	5.34
		1.55		5.48	
		1.75		5.58	
5	Ring Road 2	1.31	1.35	4.05	4.19
		1.38		4.56	
		1.35		3.95	

- Also above table can show the average value of CBR (Soaked & Unsoaked) and Average Soaked CBR value of Ring Road 1 is 1.65%.its quite good. So CBR of Ring Road 1 is so much high compare to other four Soil Sample.

V. DCPT TEST RESULTS

Table 2 DCPT TEST RESULTS

Sr. No.	Location	DCPI Value	Avg.
1	Lodhika	9.85	9.54
		8.58	
		10.2	
2	Mavdi	15.25	16.36
		16.58	
		17.25	
3	Hadala	11.36	11.30
		12.33	
		10.23	
4	Ring Road 1	7.98	7.03
		6.87	
		6.25	
5	Ring Road 2	8.12	7.85
		7.85	
		7.58	

- Here we can see that DCPT result of the different type of soil sample is as above mention in the table. and value of DCPI is so higher of Mavdi sample.
- So based on DCPI results we can conclude that soil of Mavdi is so poor in strength parameter. And DCPI of ring road 1 sample is 7.03.
- So the strength of ring road 1 sample is quite higher with respective to DCPI.

VI. UCS TEST RESULTS

Table 3 UCS TEST RESULTS

Sr. no.	Location	UCS test	Avg.
1	Lodhika	1.55	1.47
		1.45	
		1.42	
2	Mavdi	1.4	1.37
		1.3	
		1.42	
3	Hadala	1.42	1.41
		1.41	
		1.41	
4	Ring Road 1	2.59	2.56
		2.45	
		2.65	
5	Ring Road 2	1.56	1.79
		1.98	
		1.85	

- So here as seen in table different values of UCS for different soil sample it has been varying. Actually it has been indicating the shear parameter of soil & it will differ from sample to sample.
- So the shear value of Ring road 1 sample is quite acceptable and good compare to another soil sample.

VII. DELOPMENT OF CORRELATION BETWEEN DIFFERENT SOIL PROPERTIES

Table 4 CORRELATION OF SOIL PROPERTIES

Sr.No.	Correlation between properties	Regression analysis	R^2 value
1	SCBR V DCPI	y = -0.260x + 0.350	0.845
2	UCBR V DCPI	y = -1.516x + 1.995	0.892
3	SCBR V UCS	y = 1.094x - 0.379	0.716
4	SCBR V L.L	y = -0.004x + 1.430	0.850
5	SCBR V P.I	y = -0.010x + 1.373	0.746
6	SCBR V OMC	y = -0.022x + 1.675	0.338

- So above table can give the value of R^2 for different correlation of soil properties. So here based on that Regression analysis can get the model equation of different correlation of properties.
- So from this model equation, we can get the value of Soak CBR from other properties of soil. So it's easy to use & applicable.

Figure 1 SCBR V UCS

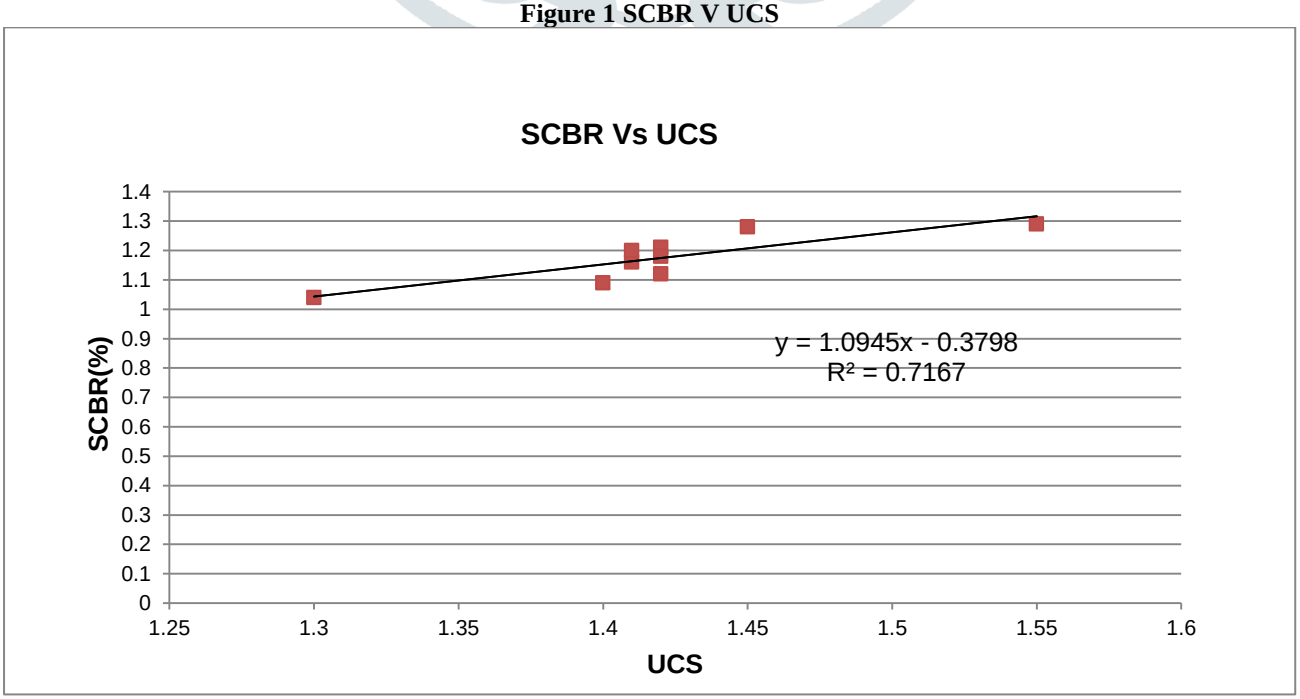
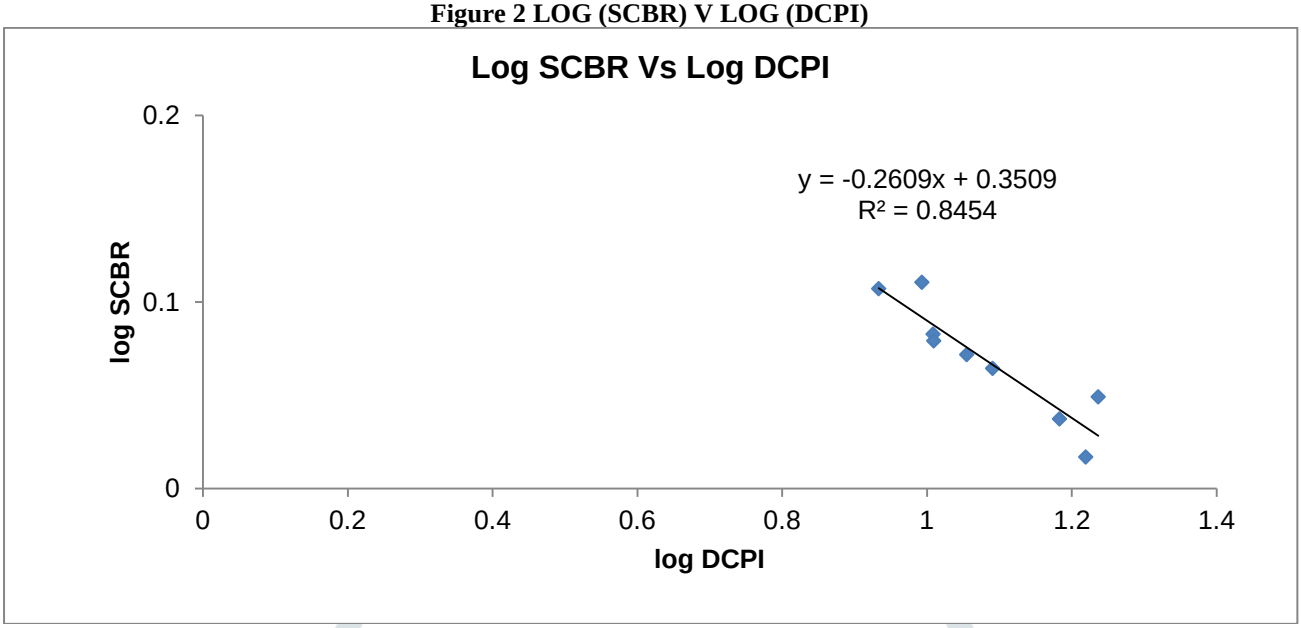


Figure 2 LOG (SCBR) V LOG (DCPI)



VIII. CONCLUSION

- The soak CBR of the different soil of Lodhika, Mavdi, Hadala, Ring Road 1, and Ring Road 2 is 1.26, 1.08, 1.18, 1.65 and 1.35 respectively. And the Soak CBR of Ring Road 1 is higher than the other Sample.
- The Unsoaked CBR of the different soil of Lodhika, Mavdi, Hadala, Ring Road 1, and Ring Road 2 is 2.66, 2.36, 2.39, 5.34 and 4.19 respectively. And the Unsoaked CBR of Ring Road 1 also higher than the other sample.
- The DCPI value of different soil of Lodhika, Mavdi, Hadala, Ring Road 1, and Ring Road 2 is 9.54, 16.36, 11.30,7.03 and 7.85 respectively. So from the result of DCPT and its index we can conclude that value of DCPI is lower of Sample Ring Road 1 it means strength of soil is so higher.
- The UCS value of different soil of Lodhika, Mavdi, Hadala, Ring Road 1, and Ring Road 2 is 1.47, 1.37, 1.41, 2.56 and 1.79 respectively. So from the result, the value of UCS of Ring Road 1 is quite better than other 4 sample.

IX. REFRENCES

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