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"Correlation between Index Properties and Cbr Test Values of Soil in Mangalore Region"

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Abstract: *In highway design, sub grade strength is mostly affected by thickness of pavement. One of the methods to determine the sub grade strength in India is CBR (California Bearing Ratio) test. CBR testing in the laboratory on soaked and un-soaked conditions to simulate the field soil conditions. In this project work the comparisons between CBR soaked test results for CBR un soaked in some variation of silt+clay content in soil of Mangalore region and make simple comparisons between CBR soaked for CBR un-soaked by considering the soil properties whereas can be predicted the CBR soaked value based on the CBR un soaked test results. The results showed that there was a linear correlation between the CBR soaked and CBR un-soaked also influenced by the nature of the index (the properties of the soil). The maximum value of CBR ranges of 0.3% to 1.4% percent silt+clay content.*

Keywords: *California bearing ratio, Soaked CBR, Unsoaked CBR, Correlation, Silt/clay.*

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I. Introduction

Sub-grades play an important role in imparting structural stability to the pavement structure as it receives loads imposed upon it by road traffic. Traffic loads need to be transmitted in a manner that the sub-grade deformation is within elastic limits, and the shear forces developed is within safe limits under adverse climatic and loading conditions. The sub-grade comprises unbound earth materials such as gravel, sand, silt and clay that influence the design and construction of roads. The assessment of properties of soil sub-grades, in terms of density, soil stiffness, strength, and other in-situ parameters is vital in the design of roads, and their performance.

It is common in India that the sub-grade strength for highway pavement design is determined by CBR test measurement. This can be from the laboratory CBR test or directly from field CBR test. These tests are much simpler and faster to perform. The correlation between the result of CBR un-soaked test and CBR soaked value is hardly found. Moreover, this correlation should be beneficial for the determination of soil bearing capacity of Mangalore region. This research is aimed to obtain a local correlation between the results of CBR laboratory test without soaked and CBR soaked value. The correlation is based on the comparison of CBR unsoaked test results and CBR soaked value which has same fraction of sand and clay in soil.

II. Materials Used

A preliminary survey was carried out in different locations in and around Mangalore to select the soil samples for the present study. Mangalore is a city and district in the Indian state of Karnataka. The soil samples were taken from different locations by removing the top 1.5m. The soil samples are collected from Surathkal (soil sample S1) shown in figure 1, Ullal (soil sample S2) shown in figure 2, Mudipu (soil sample S3) shown in figure 3 and from Vitla (soil sample S4) shown in figure 4.

Fig 1: Soil sample from surathkal (S1)

Fig 2: Soil sample from ullal (S2)

Fig 3: Soil sample from mudipu (S3)

Fig 4: Soil sample from vitla (S4)

III. Literature Review

- **S. Muthu Lakshmi et al., [2015]** have studied **"Evaluations Of Soaked And Un-Soaked Cbr Value Of Soil Based On The Compaction Characteristics".** Soaked and un soaked CBR values of soil increased as the OMC decreased and MDD increased due to the presence of lesser voids with increasing compactness of soil. Percentage decreases in soaked CBR".
- **Dr. Dilip Kumar Talukdar [2014]** has studied **"A Study Of Correlation Between Califoria Bearing Ratio Value With Other Properties Of Soil".** He has concluded that "CBR value decreases with increase in the plasticity index and optimum moisture content of soil but increases with the increase in the maximum dry density".
- **Ramasubbarao et al., [2013]** have studied **"Predicting Soaked Cbr Value Of Fine Grained Soils Using Index And Compaction Characteristics".** They have concluded that "Use of index properties such as grain size analysis, plasticity characteristics and compaction characteristics appears to be reasonable in the estimation of soaked CBR value of fine grained soils
- **Sathawara Jiger K et al., [2013]** have studied **"Comparision Between Soaked And Unsoaked Cbr".** They have concluded that "Four days soaking period is very long time and quickly derivation of CBR for pavement design. Each soil CBR depends on the grain size analysis and Atterberg Limits and their classification".
- **Mukesh A. Patel et al., [2012]** have studied **"Correlation Between Physical Properties And California Bearing Ratio Test On Soils Of Gujarat Region In Both Soak And Unsoak Condtion".** They have concluded that "Research has been performed to analyze the effect of silt/clay proportion on physical properties of soil and establish multiple variable correlations between CBR un-soaked test results and CBR-soaked test values".
- **Soewignjo Agus Nugroho, Muhamad Yusa and Sri Rahayu NINGSIH [2012]** have studied **"Correalation Between Index Properties And California Bearing Ratio Test Of Pekanbaru Soils With And Without Soaked".** They have concluded "Research has been performed to find local correlation between

CBR un-soaked test results and CBR soaked values and correlation can be used for predicting difference CBR values from the CBR with and without soaked test for in organic soils".

IV. Methodology

Index properties of soil samples were found out and CBR tests were conducted at maximum dry density (MDD) and optimum moisture content (OMC) for un-soaked and soaked conditions of the collected soil samples. Figure 5 shows CBR testing machine and figure 6 shows soaked soil sample.

Fig 7: CBR testing machine

Fig 8: Soaked soil sample

V. Results And Discussion

The result of index properties of soil samples can be seen in table 1 and the results for engineering properties are tabulated in table 2.

Table 1: Index properties of soil samples

Soil samples	Sieve analysis % by weight			Specific gravity	Atterberg limits (%)			
	Gravel	Sand	Silt/clay		LL	PL	SL	PI
S1	28.1	71.4	0.5	2.3	29	20	10.15	9
S2	14.3	85.4	0.3	2.5	NP	NP	24.98	NP
S3	36	63.1	0.9	2.2	44	33.3	8.55	10.7
S4	34.6	64	1.4	2.17	68	40	8.03	28

From table 1 it can be seen that soil samples used in this research have specific gravity values between 2.17 – 2.5, silt/clay content value between 0.3% - 1.4% and plasticity index between 9% – 28%.

Table 2: MDD, OPC & CBR values of soil samples

Soil samples	Maximum dry density (g/cc)	Optimum water content (%)	CBR values of un soaked soil (%)	CBR values of 24 hrs soaked soil (%)
S1	1.83	12	11.34	7.49
S2	1.81	17	5.25	3.4
S3	1.89	10	12.99	10.65
S4	1.97	14	16.15	14.06

From table 2 it can be seen that soil samples used in this research have water content between 10% - 17%, dry density between 1.81 – 1.97 and CBR values between 5.25% – 16.15% for un-soaked condition and 3.4% – 14.06% for soaked condition of soil samples.

5.1.Regression Analysis of CBR, index properties and unit weight density

Effect of variation in proportion of silt/clay content on index properties and soaked and un-soaked values of CBR is analyzed using regression analysis. The results of regression analysis are shown in figure 7 to figure 11. Figure 7 shows regression results for specific gravity on variation in proportion of silt/clay content. This shows that as proportion of silt/clay content in soil increases the specific gravity decreases.

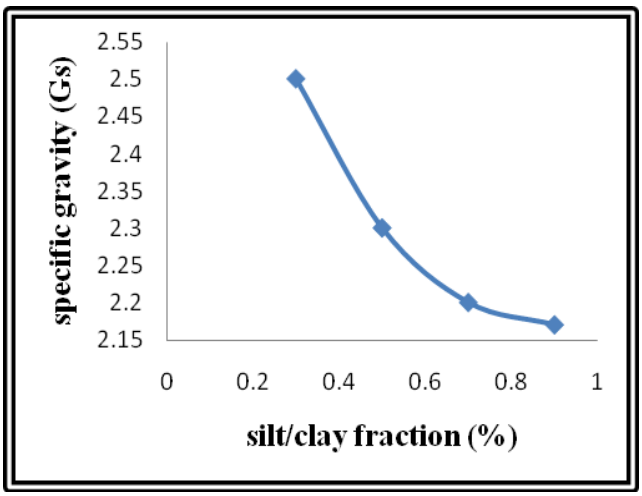

Fig 7: Relation between specific gravity and silt/clay content of soil

Figure 8 shows that the values of liquid limit, plastic limit and plasticity index of soil samples increase with the increase in silt/clay fraction of soil samples. But the shrinkage limit of the soil samples decreases with the increase in silt/clay fraction of the soil samples and the optimum moisture content of soil does not depend on the silt/clay fraction of soil. Fig 27 also shows that variation in liquid limit is similar to the plastic limit but the gradient of the plastic limit is less than that of liquid limit. The variation in plasticity index is also similar to the plastic limit but the gradient of plasticity index is less than that of liquid limit and plastic limit of soil samples. But the variation in shrinkage limit is different from other Atterberg limits i.e. the value of shrinkage limit decreases with increase in the silt/clay fraction of the soil samples.

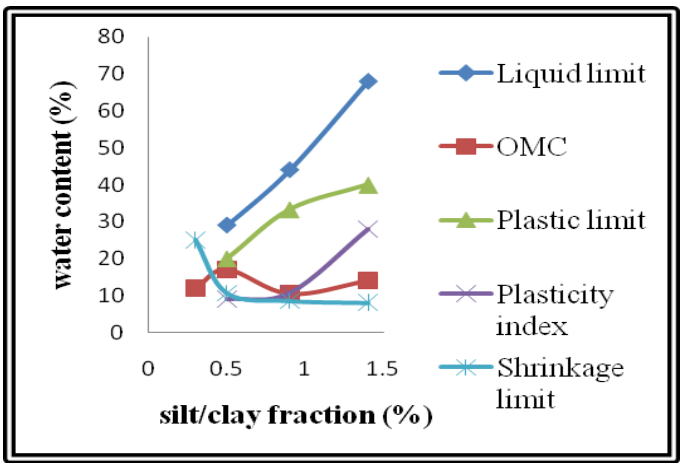

Fig 8: Relation between OMC, Atterberg limits and silt/clay fraction

It can be seen from figure 9 that the maximum dry density of the soil increases with increase in the fraction of the silt/clay fraction. From this relation it can be concluded that the maximum dry density of soil sample S4 is higher than other soil samples as S4 soil sample contains more silt/clay fraction than other soil samples and the maximum dry density of soil sample S2 is lower than other soil samples as S2 soil sample contains less silt/clay fraction than other soil samples.

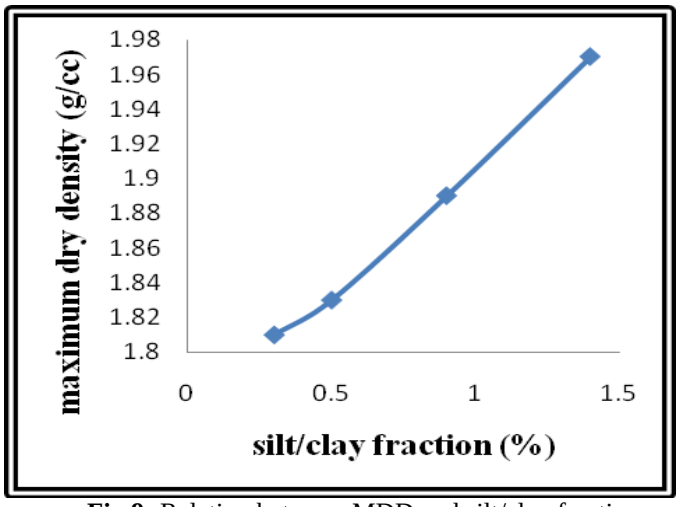

Fig 9: Relation between MDD and silt/clay fraction

Fig 10 shows that the CBR values of soil samples increase with the increase in the silt/clay fraction of soil sample. This shows that the CBR values of soil samples increase with the increase in liquid limit, plastic limit as these values increase with increase in silt/clay fraction of the soil samples. But the CBR values decrease with increase in the values of shrinkage limit as this decreases with increase in the silt/clay fraction of soil samples.

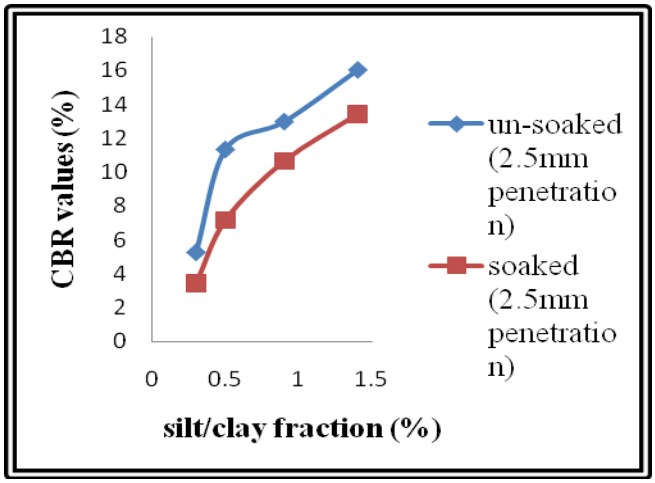

Fig 10: Relation between CBR values and silt/clay fraction

VI. Conclusions

1. From the sieve analysis it can be concluded that the soil in and around the Mangalore region consists of more sand content and least silt/clay content and these soils are uniformly graded.
2. The CBR values of soil mainly depend on grain size distribution i.e. CBR values are less for the soil consisting of more sand and gravel content.
3. The CBR values of soil increases with the increase in dry density of soil but decreases with increase in water content of soil.
4. The liquid limit and plastic limit of soil is high for the soil with high silt/clay content and less for the soil with high sand content.
5. The shrinkage limit of soil increase with the increase in sand content and decreases with increase in silt/clay content.

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