CBR Determination on Subgrade Soil by Replacement of Additives

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Abstract- The California Bearing Ratio Test (CBR Test) is a test first developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of sub grade soil for design of flexible pavement. The CBR value of the sub grade soil is being used widely since a long time in design of pavement structure and is critical in deciding the overall thickness of the pavement. Additionally, for good drainage, a typical specification for the pavement foundation design requires the value of permeability coefficient of the sub grade material to be specified. Thus, permeability and CBR constitute two important parameters in the design and assessment of long-term performance of the pavement. In this project only strength aspects of pavement subgrade have been considered. Preliminary tests, such as index tests and particle size distribution tests, used for soil classification, have been taken up followed by Proctor compaction and CBR tests. CBR tests have been conducted for same samples under various conditions of soaking, with due emphasis on moisture content parameters in the soil sample.

Keywords - CBR, Flexible Pavement, Sub Grade Soil

I. INTRODUCTION

A pavement is a durable surface having materials laid down on an area subjected to sustain mainly the vehicular traffic, such as a road or highway. A pavement is typically a structure of various layers resting over soil either in embankment or in cutting. In the past, cobblestones and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete now-a-days. A pavement is classified in general in two categories, i.e. namely a flexible pavement and a rigid pavement. The flexible pavement consists of granular layers of superior quality in upper layers with a preferably bituminous topping, while a concrete pavement consists of a cement concrete slab over occasional granular layers. The design of pavement has seen several modifications over the years. Traditionally the design of either kind of pavement is based on the strength of the compacted soil in the pavement, called subgrade. The design of the pavement layers laid over the subgrade soil starts off with the determination of subgrade strength and the traffic volume which is to be carried. The design of pavement is very much dependent on the subgrade strength of soil. Design criteria mainly needs thickness of layers. Weaker subgrade needs thicker layers whereas stronger subgrade needs thinner pavement layers. The Indian Road Congress (IRC) provides the exact procedures for the pavement layers design which based upon the subgrade strength. The strength of a subgrade soil is normally expressed in terms of the California Bearing Ratio (CBR).

Due to variable nature of soil, the subgrade strength changes inconsistently, as a result engineers face so many difficulties or challenges during the design of a pavement. The subgrade strength is very much dependent on moisture content. As the subgrade is intended to variation of moisture due to flood, precipitations or all other climatic changes, so it is necessary to enable or understand the subgrade according to the variation of moisture. The CBR is the only test which can figure out the strength of a subgrade. By this test we can compare the strength of different subgrade materials .The CBR test is done in a standard manner by which one can find out or design the strength or thickness of subgrade layer. CBR value is inversely proportional to thickness of the pavement layer. If the subgrade is stronger, the higher is the CBR value, so lesser thickness is required and vice-versa.

II. LITERATURE REVIEW

Use of local available cheap material with proper engineering to make them suitable functionally and cost effective manner may be a welcome solution. Railway authorities are making serious and sincere efforts to further passenger comfort. In that direction efforts have to be made from improving the railway tracks and many problem appear for the tracks due to deformation and malfunctioning of the blanket and the subgrade below rather than from the track itself. Main functions of the blanket lies in spreading the load on formation, limiting the subgrade stress within the subgrade strength, eliminating the mud pumping and containing the seasonal moisture content variation in the subgrade [1].

Moorum can be easily available in different parts of Indian country sides. However the quality of Moorum varies with locations of the quarry. Moorum is generally a residual soil decomposed from Laterite rock is red to reddish brown in color. It is widely used material in different civil engineering construction works in highways and railways. It is considered to be locally available good materials for blanket [4].

Under their study, effect of addition of quarry dust on properties of red earth and two different cohesive soils; viz. kaolinite, Cochin marine clay was studied in detail. The results indicate that compaction characteristics and CBR of soils are improved by addition of quarry dust. Problems associated with the construction of highways over clayey sub grade can be reduced significantly by mixing with quarry dust [8].

III. EXPERIMENTAL INVESTIGATIONS

The entire investigations have been conducted on two type of soil, .i.e. 1.Red Moorum Soil (from PMGSY Road site of kuduli 3 KM. Tq-Bhokardan Dist-Jalna) & 2.Black Cotton Soil (from Paithan Road site Dist. - Aurangabad). Initially experiments were conducted to find out different properties of soil such as index properties, grain size distribution etc. Later on heavy compaction tests were conducted to find out the optimum moisture content & corresponding maximum dry density. Then CBR tests were made at different moisture contents including OMC and analysis made to investigate the variation of CBR with respect to different days of soaking, i.e. from unsoaked (day 0) to soaked (day 5). The variations were also made with regard to moisture content at different layers along with different positions (east, west, north, south, center positions) and also the variations of moisture content with respect to different days of soaking were observed.

IV. RESULTS AND DISCUSSIONS

4.1 Effect of Murrum on MDD and OMC of soil

The Standard proctor test was conducted on untreated soil, the values of MDD and OMC were found to be 1.43 g/cm3 and 25.93% respectively. The Standard Proctor test was also carried out on mixes of soil: whos MDD and OMC, were found out.

Using the moisture content and corresponding dry density the amount of soil used for CBR was calculated. The sample was tested using the CBR instruments and each soil sample was soaked for 1 day, 2 day, 3 day, 4 day, 5 day and corresponding CBR values was found out. Unsoaked CBR was also determined for every sample. Also the moisture content at different points (i.e., at different height &at its different locations like north, south, east, west and centre) was determined.

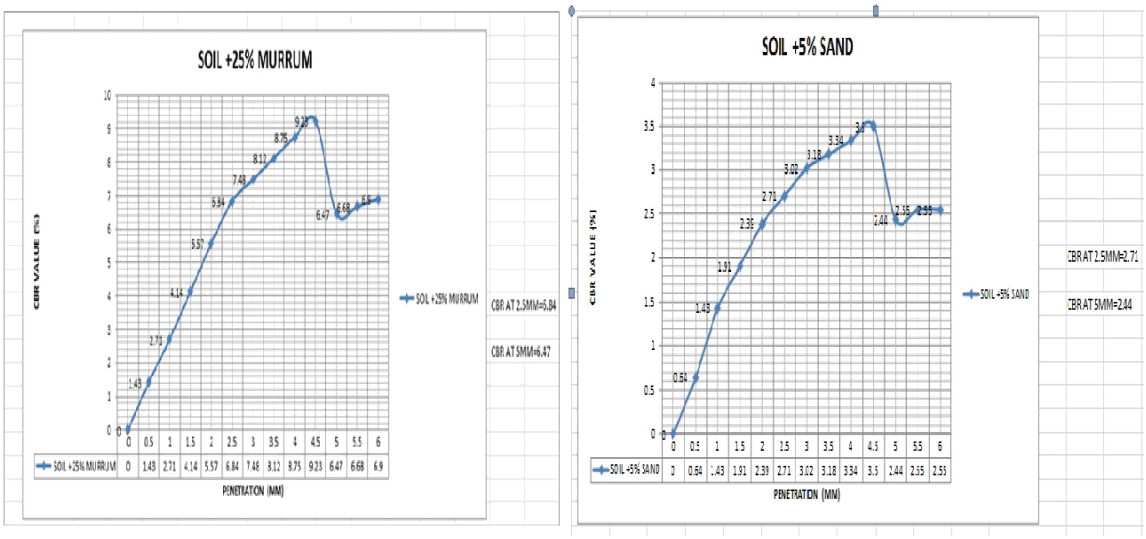

Figure 1. MDD is 1.596gm/cc@18.13%of OMC MDD is 1.492gm/cc@22.96%of OMC

CBR value decreases with the increase in the plasticity index and optimum moisture content of soil but increases with the increase in the maximum dry density. There is a slight difference between the CBR value determined in the laboratory and computed by using multiple linear regression model involving LL, PL, PI, MDD and OMC.The type of soil used in this study is ML and MI Further study may be made on other type of soil.

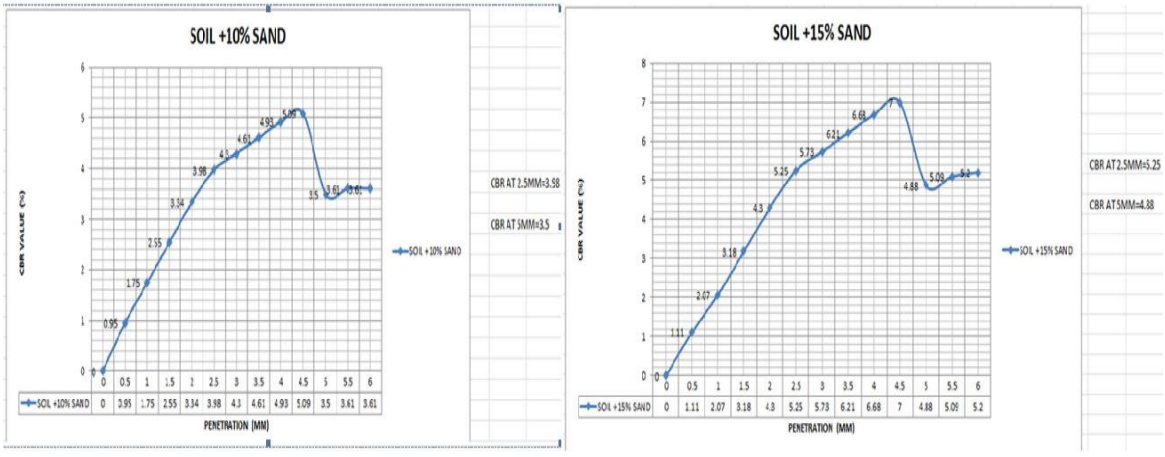

Figure 2. MDD is 1.535gm/cc@19.84%of OMC MDD is 1.574gm/cc@18.14%of OMC

The study shows that Moorum (25%) and Medium sand (75%) composite is well within the two enveloping thus is suitable as blanket material. For other combination of sand and moorum donot fulfil the specification of blanket material but can be used as subgrade material.

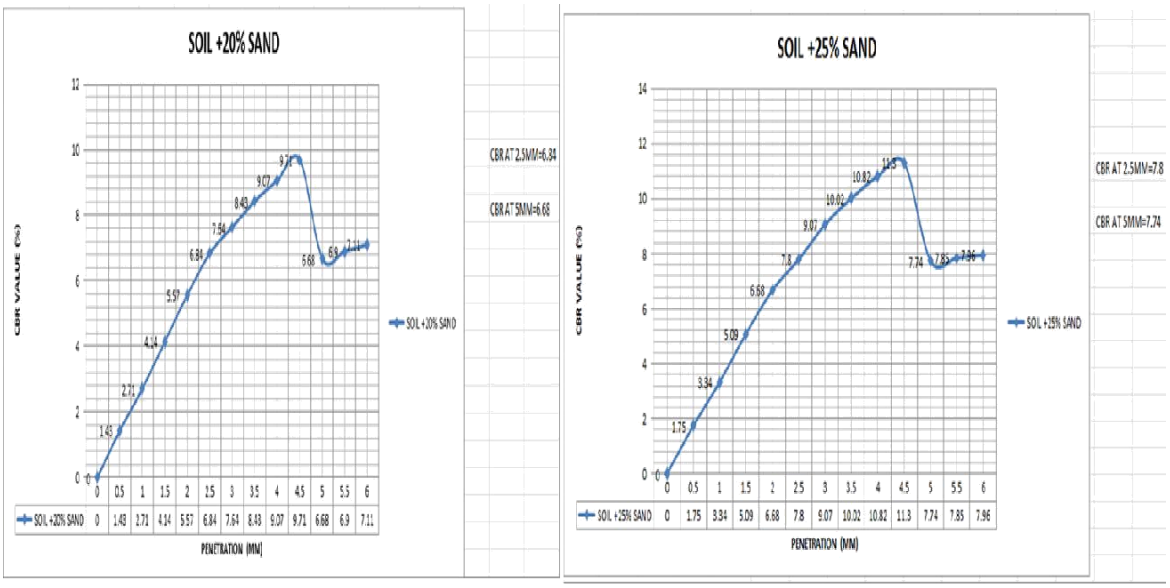

Figure 3. MDD is 1.611gm/cc@17.31%of OMC MDD is 1.656gm/cc@16.26%of OMC

CBR Test for Sand

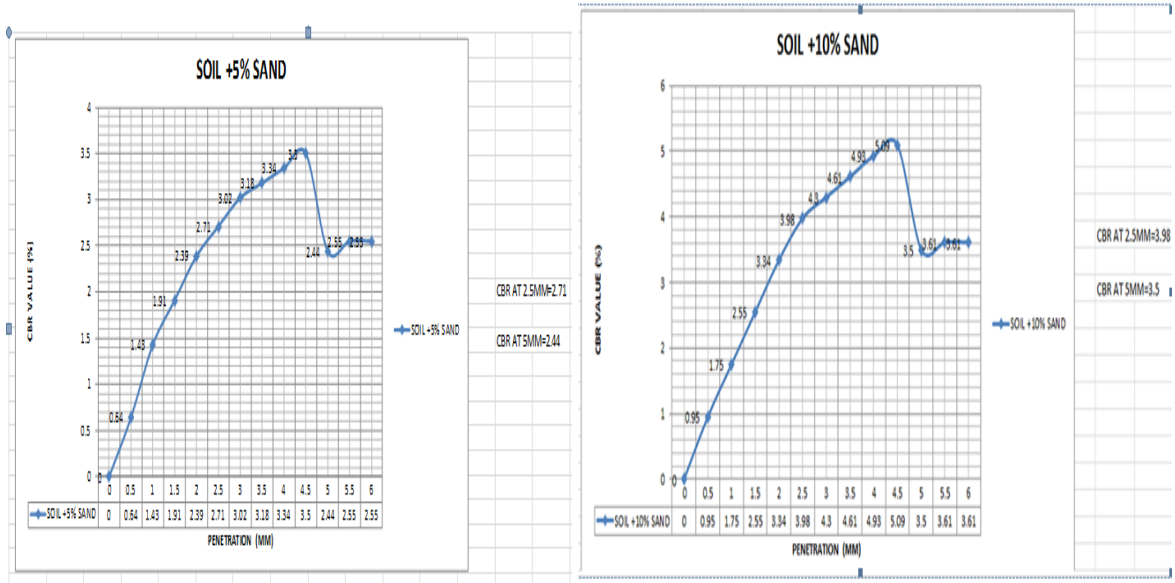

Figure 4. Soaked CBR Value @5%of Sand is 2.44% Soaked CBR Value @10%of Sand is 3.50%

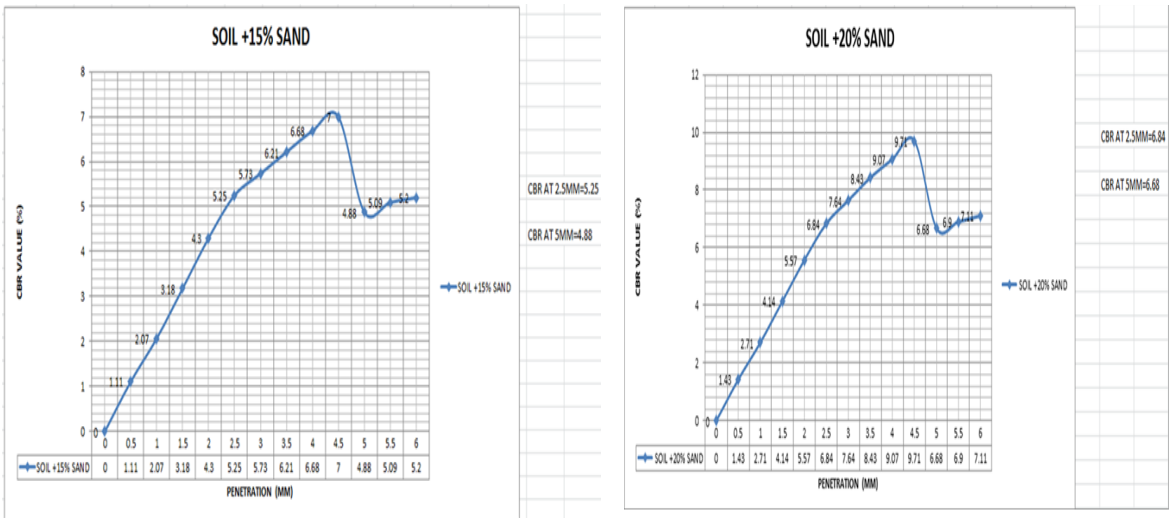

Figure 5. Soaked CBR Value @15%of Sand is 4.88% Soaked CBR Value @20%of Sand is 6.68%

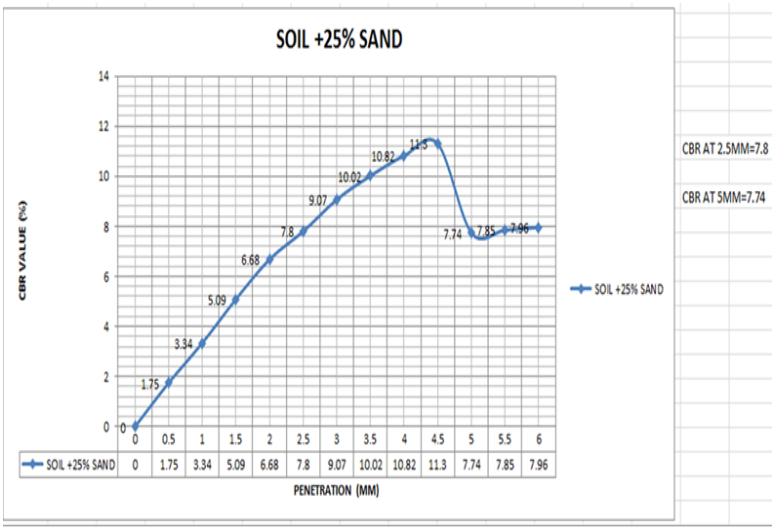

Figure 6. Soaked CBR Value @25%of Sand is 7.74%

V.CONCLUSION

Based on investigation, the following conclusions have been drawn.

1. For all three types of sand used in this investigation remarkable increase in the CBR values was observed with the increase of moorum mixed for various percentage (%) by weight of the sand-fiber mix. These sand -fiber composite mixed with 25% of moorum by weight of sand may suit best as subgrade material for Railway track having CBR greater than 20%.
2. It can also be noticed that Moorum (25%) and Medium sand (75%) composite is well within the two enveloping curves given in fig. 3, and thus is suitable as blanket material. For other combination of sand and moorum donot fulfil the specification of blanket material but can be used as subgrade material.
3. The statistical parameters indicate that the model developed by Simple Linear Regression Analysis (SLRA) for correlating soaked CBR value with Maximum Dry Density (MDD) has shown better performance.
4. The other models developed by SLRA for correlating soaked CBR value with Plastic Limit (PL), %Fines (F), %Sand (S), Liquid Limit (LL) and Optimum Moisture Content (OMC) have shown relatively good performances.

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