A LABORATORY STUDY ON USE OF BITUMEN EMULSION IN BLACK SOIL

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Abstract - Starting from the base, soil is one of nature's most abundant construction materials. Almost all type of construction is built with or upon the soil. The most important part of a road pavement is subgrade soil and its strength. If strength of soil is poor, then stabilization is normally needed.

Subgrade is sometimes stabilized or replaced with stronger soil material so as to improve the strength. Such stabilization is also suitable when the available subgrade is made up of weak soil. Increase in sub grade strength may lead to economy in the structural thicknesses of a pavement. Cement, fly ash, lime, fibers etc. are very commonly used for soil stabilization.

The main objective of this experimental study is to improve the properties of the black soil by adding bitumen emulsion. An attempt has been made to use emulsion for improving the strength of black soil expressed in terms of CBR values which may prove to be economical.

In this study, the whole laboratory work revolves around the basic properties of soil and its strength in terms of CBR. A little cement added to provide better soil strength. It is observed that excellent soil strength results by using cationic bitumen emulsion (CMS) with little quantity of cement used as filler. The appropriate mixing conditions for black soil with CMS Bitumen emulsion have been attempted. This is followed by deciding four particular material conditions to show the variation in dry density and CBR value to achieve the best possible strength properties of black soil. Here we use ideal soil of passing 600 microns IS Sieve.

Key Words: *bitumen emulsion, bitumen stabilization, black soil, CBR, liquid limit test, modified proctor test, particle size distribution, plastic limit, pycnometer, sieve analysis, specific gravity*

1. INTRODUCTION

Soil is a standout amongst the most abundant construction materials of nature. Just about all kind of construction is based with or upon the soil. Long term performance of pavement structures is altogether affected by the strength and durability of the subgrade soils.

In-situ sub-grades frequently don't provide the support required to achieve acceptable performance under the traffic loading with increasing environmental demands. Despite the fact that stabilization is a well-known option for improving soil engineering properties yet the properties determined from stabilization shift broadly because of heterogeneity in soil creation, contrasts in micro and macro structure among soils, heterogeneity of geologic stores, and because of chemical contrasts in concoction interactions between the soil and utilized stabilizers. These properties require the thought of site-specific treatment alternatives which must be accepted through testing of soil-stabilizer mixtures.

Whether the pavement is flexible or rigid, it rests on a soil foundation on an embankment or cutting, normally that is known as subgrade. It may be defined as a compacted layer, generally occurring local soil just beneath the pavement crust, providing a suitable foundation for the pavement. The soil in subgrade is normally stressed to certain minimum level of stresses due to the traffic loads. Subgrade soil should be of good quality and appropriately compacted so as to utilize its full strength to withstand the stresses due to traffic loads for a particular pavement. This leads the economic condition for overall pavement thickness. On the other hand the subgrade soil is characterized for its strength for the purpose of design of any pavement.

Improvement of soil engineering properties is referred to soil stabilization. There are two primary methods of soil stabilization. One is mechanical method and the other one is chemical or additive methods. Soil is a gathering or store of earth material, determined regularly from the breakdown of rocks or rot of undergrowth that could be uncovered promptly with force supplies in the field or disintegrated by delicate reflex means in the lab. The supporting soil beneath pavement and its exceptional under course is called sub grade soil. Without interruption soil underneath the pavement is called regular sub grade. Compacted sub grade is the soil compacted by inhibited development of distinctive sorts of substantial compactors.

Presently every road construction project will use one or both of these stabilization strategies. The most well-known type of mechanical soil stabilization is compaction of the soil, while the addition of cement, lime, bituminous or alternate executors is alluded to as a synthetic or added substance strategy for stabilization of soil. American Association of State Highway and Transportation Officials (AASHTO) classification system is a soil classification system specially designed for the construction of roads and highways used by transportation engineers. The system uses the grain-size distribution and Atterberg limits, such as Liquid Limits and Plasticity Index to classify the soil properties. There are different types of additives available. Not all additives work for all soil types.
Generally, an additive may be used to act as a binder, after the effect of moisture, increase the soil density. Following are some most widely used additives: Portland cement, Quicklime or Hydrated Lime, Fly Ash, Calcium Chloride, Bitumen etc. But, mechanical soil stabilization alludes to either compaction or the introduction of sinewy and other non-biodegradable reinforcement of soil.
Any land-based structure depends upon its foundation characteristics. For that reason, soil is a very critical element influencing the success of a construction project. Soil is the earliest part of the foundation or one of the raw materials used in the whole construction process. Therefore the main thing related to us soil stabilization is nothing but the process of maximizing the CBR strength of soil for a given construction purpose. So many works have been done on cement, lime or fly ash stabilization. But very few works have been found on bitumen soil stabilization.

1.1 Types of bitumen emulsion

Bitumen emulsion is of two types-

1- Cationic bitumen emulsion
2- Anionic bitumen emulsion

1.1.1 Cationic bitumen emulsions

The cationic emulsifiers are generally based on long hydrocarbon nitrogen compound, such as alkyl amines. The alkyl amines are powerful surface active compounds with great influence on the surface tension.

1.1.2 Anionic bitumen emulsion

Anionic emulsifier is normally based on fatty acids. A fatty acid molecule consists of a long hydrocarbons chain and terminates with carboxyl group. The emulsifier solution is prepared by reaction the anionic emulsifier with sodium hydroxide. This reaction is called saponification.

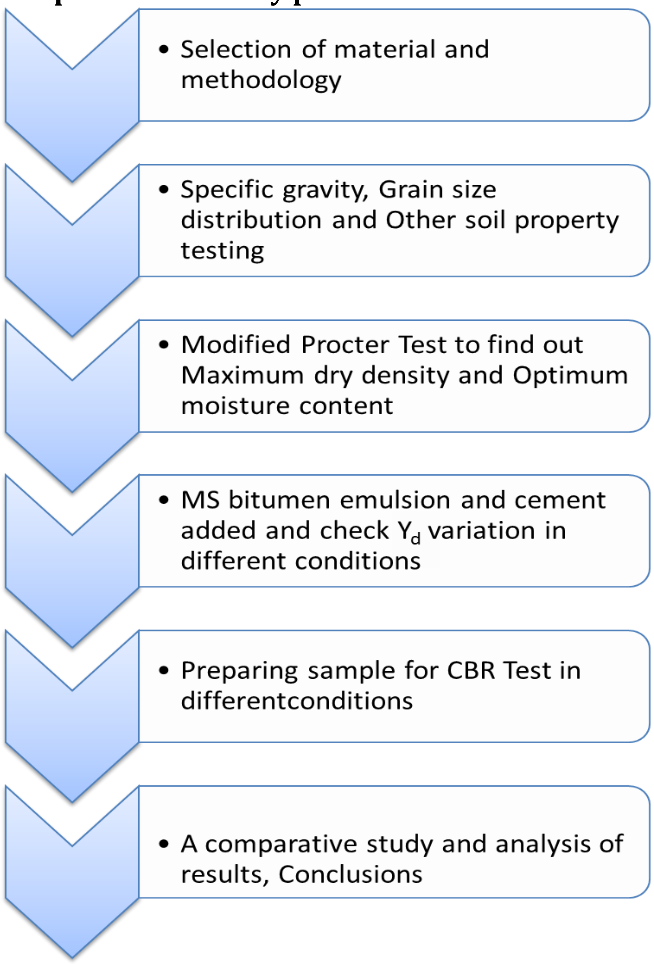
2 Objective of the study

1- The main objective of this experimental study is to improve the properties of soil by adding bitumen emulsion as stabilizing agent and little bit cement as filler

2.1 scope of the work

1. Experimental study is conducted to know the physical property of soil
2. In the experiment bitumen emulsion is used with filler material (cement) first sample without mixing any material secondly we mix 3% emulsion thirdly we mix 3% emulsion and 2% cement and fourthly 3% emulsion and 2% cement and wait for the experiment
3. Analyze the test result with accurate data.

3 experimental study procedure



4 Detail Experiments

4.1 Specific gravity test

Specific gravity of soil is very important property to understand the soil condition. As previously discussed here M1 is empty bottle weight, M2 is mass of bottle and dry soil, M3 is weight of bottle dry soil and water and M4 is the weight of bottle with water.

Sample No.	M1 (gm.)	M2 (gm.)	M3 (gm.)	M4(gm.)	Specific gravity
1.	654.3	854.3	1663.2	1552.5	2.23
2.	649.4	849.4	1660.8	1547.6	2.30
3.	658.8	859.8	1676.8	1557.0	2.49

4.2 Liquid limit and Plastic limit

The soil used in this study was fine soil obtain from local field from chittorgarh district. The soil was tested for specific gravity, liquid limit test, plastic limit and grain size distribution as to be well known physical properties of soil material.

Liquid limit (WL) =16.26%
Plastic limit (WP) =13.7%
Plasticity index (IP) =2.58%

4.3 Grain size distribution (Sieve analysis)

Various physical and engineering properties with the help of which soil can be properly identified are called index properties. Soil grain property depends to individual's solid grain and remains unaffected by the state in which a particular soil exists in nature.
Here 2000 gms of sample soil was taken and dried in oven for 12 hours. Mostly used test for grain size distribution analysis is sieve analysis. Ten types of sieve were used and he result from sieve analysis of the soil is plotted on a semi log graph with particle diameter or the sieve size in X-axis and percentage finer in Y-axis.

Sieve Size	**Mass of Soil retained in each sieve(gm)**	**Percent retained (%)**	**Cumulative retained (%)**	**Percent finer(%)**
10.0 mm	0	0	0	100
4.75 mm	90.4	4.52	4.52	95.48
3.35 mm	187.9	9.395	13.915	86.085
2.36 mm	260.1	13.005	26.92	73.08
1.70 mm	314.2	15.71	42.63	57.37
1.18 mm	495.8	24.79	67.42	32.58
600 mics	267.5	13.375	80.795	19.205
300 mics	176.8	8.84	89.635	10.395
150 mics	93.2	4.66	94.295	5.705
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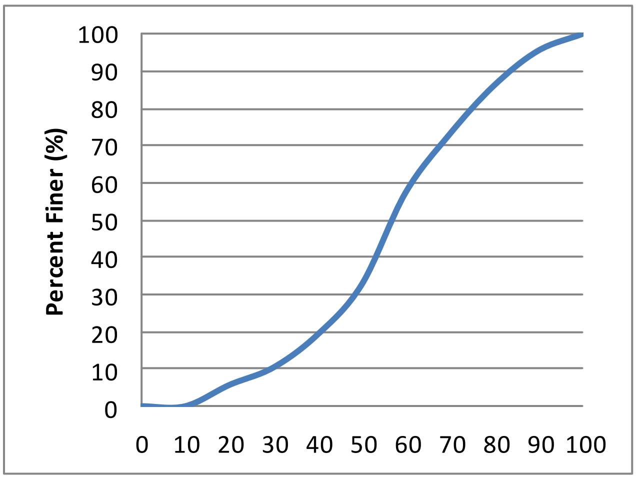
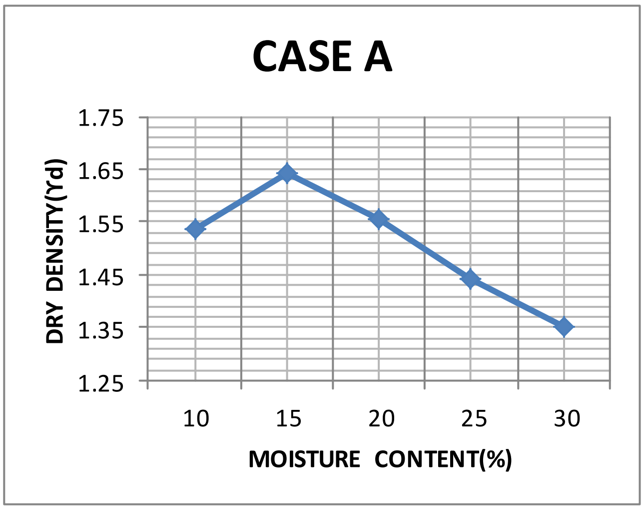


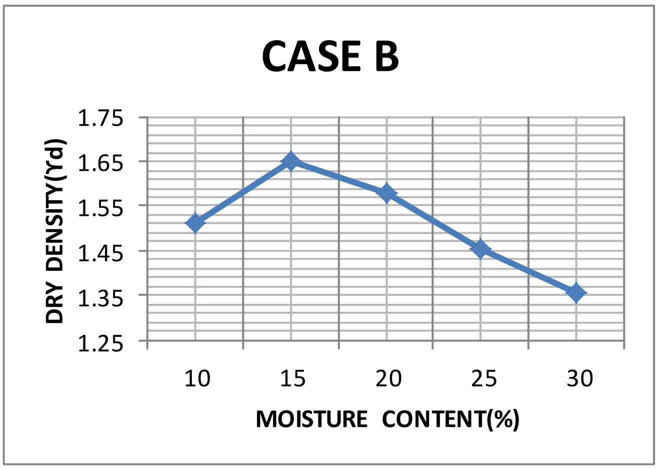
4.4 Compaction test

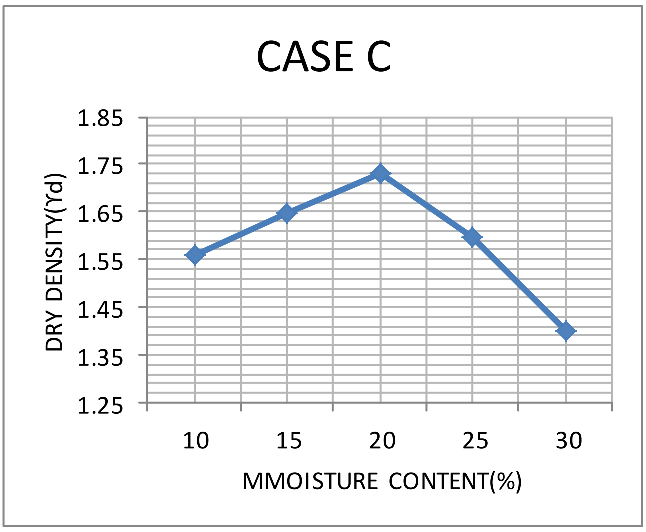
Very commonly used modified proctor test has been executed for 3000 gm. soil sample taken for each trial. Modified proctor test was followed according to IS standard. From this test maximum dry density if the specimen was found.

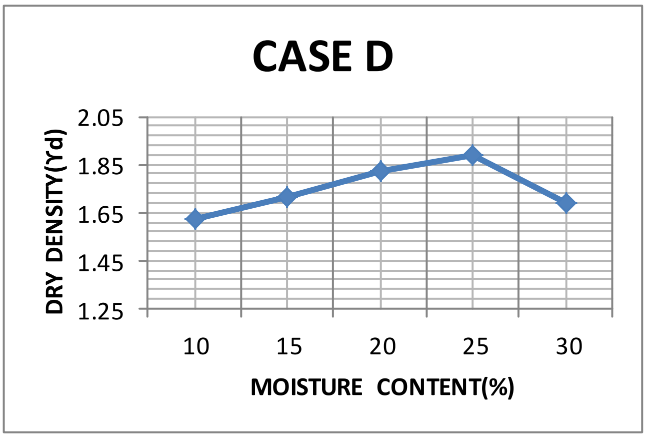
As I previously said very few works dad done on bitumen stabilization. Only bitumen sand stabilization IS code is available. So how to mix the soil with emulsion is the main problem. Therefore four particular conditions for testing are used to check the variation of maximum dry density of this gravel soil mixing with emulsion.

Case A- Normal available tested soil is used for testing.
Case B- normal available soil tested with 3% emulsion added
Case C-normal available soil tested with 3% emulsion and 2% cement.
Case D- normal available soil tested with 3% emulsion and 2% cement added and for 4 hours before testing.









4.5 CBR test

Here testing is done two different testing condition on previously four cases. So total eight number of CBR value is measured by moulding eight different specimens, two different type of specimen for each case. The corresponding CBR value for each type of specimen is written on left above corner of each graph. In this comparative experimental study it is shown that how bitumen content and mixing procedure effect on CBR value of a particular soil. CBR value and the CBR graph is case wise shown below.

Case A- normal available tested soil is used
Used proctor test result of case A
Maximum dry density- 1.642 gm/cc
Optimum moisture content- 10%

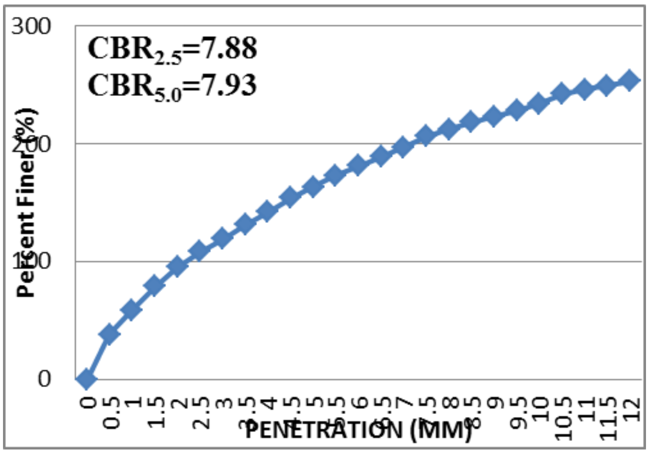


Fig 4.5.1. CBR test result (un-soaked condition)

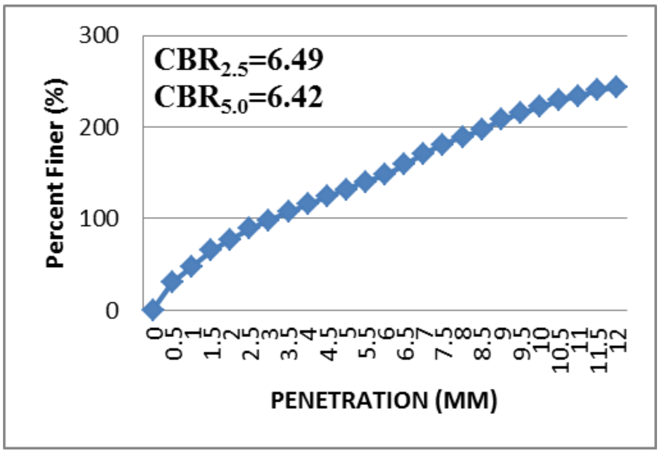


Fig 4.5.2 CBR test result (2 day soaking)

Case B- normal available soil tested with 3% emulsion added.
Used proctor test result of case B.
Maximum dry density value- 1.668
Optimum moisture content- 15%

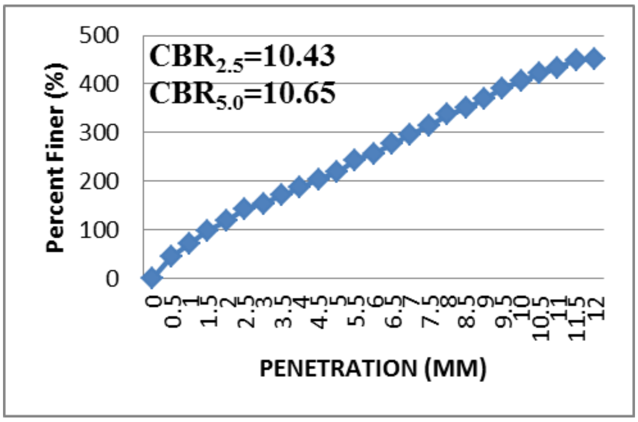


Fig 4.5.3 CBR test result (un-soaked condition)

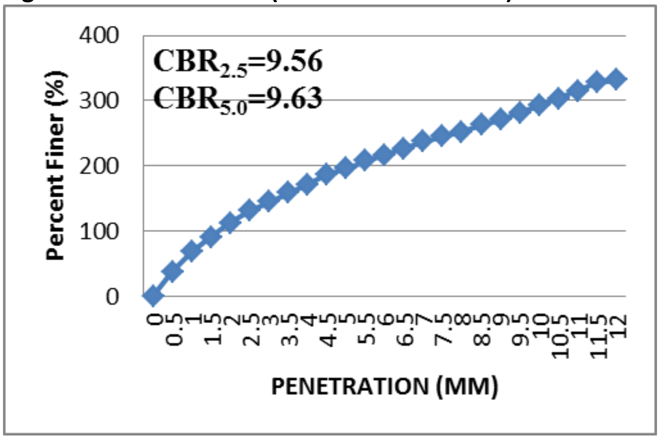


Fig- 4.5.4 CBR test result (2 day soaking)

Case C- normal available soil tested with 3% emulsion and 2% cement added
Used proctor test case C
Maximum dry density-1.732 gm/cc
Optimum moisture content-20%

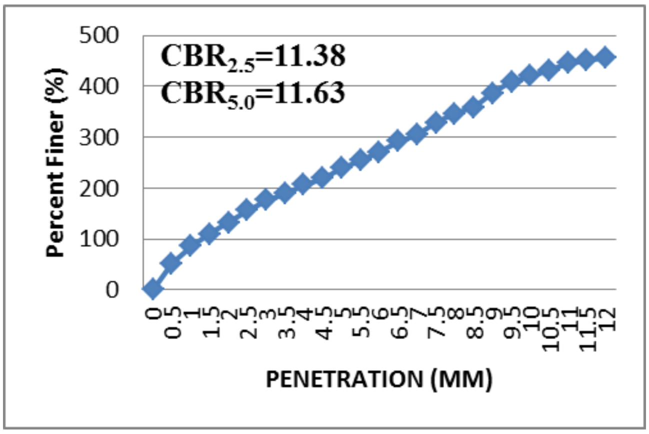


Fig 4.5.5- CBR test(un-soaked condition)

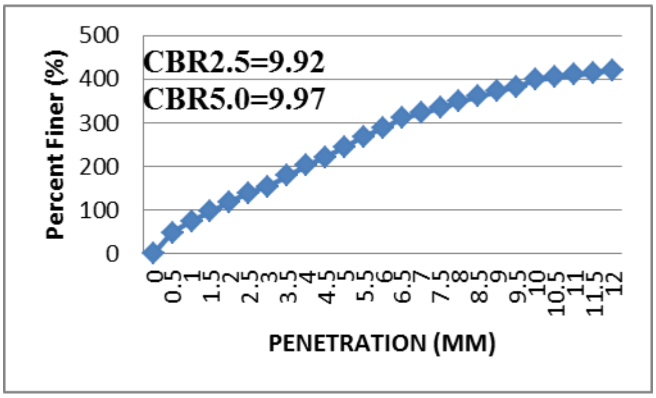


Fig4.5.6-CBR test (2 days soaked)

Case D- normal available soil tested mixing with 3% emulsion and 2% cement and wait for four hours before test.
Used proctor test result case D
Maximum dry density value-1.886gm/cc
Optimum moisture content-25%

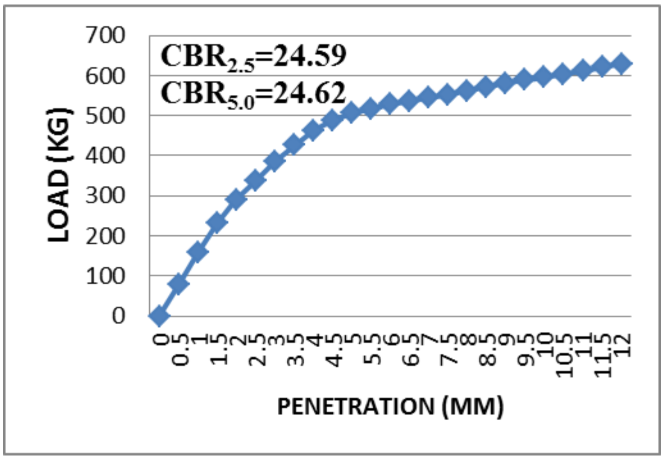


Fig-4.5.7 CBR test(un-soaked condition)

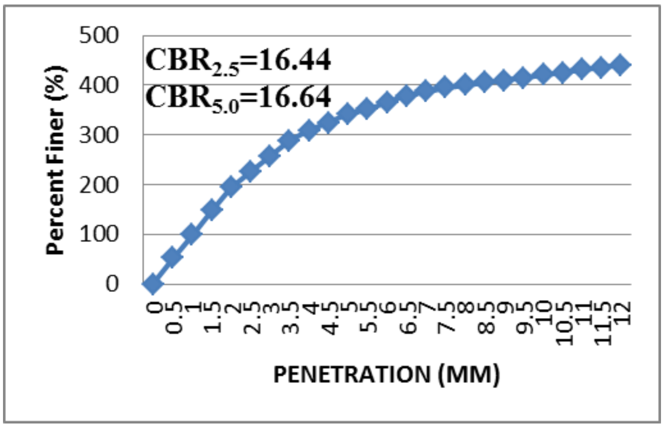


Fig-4.5.8 CBR test (2 day soaked)

5. CONCLUSIONS

From this study it is clear that there is a considerable improvement in California Bearing Ratio (CBR) of subgrade due to use of bitumen emulsion if proper mixing is done, it is seen that it best result are obtained if the soil emulsion mix is left for four hours after mixing. In each case state of condition it was found that CBR value has increased consecutively from case A TO case D. in this particular experimental study CBR value has increased. It is clear that this type of stabilization may be applicable in soil or in shoulder portion of highways. Results are followed-

- Specific gravity of soil is 2.32 its means it is not organic or inorganic soil. (specific gravity of inorganic soil is between 1 to 2 and specific gravity of organic soil is in between 2.3 to 2.6)
- Liquid limit of the soil is 16.28% and plastic limit of soil is 13.7% and plasticity of index of the soil is 2.58%.
- Modified result is strictly showing how the dry density value for the same material is going to increase from case A to case D, which is the maximum dry density value from 1.642 to 1.886gm/cc. little bit of fluctuation in optimum moisture content value in different cases.
- subgrade may be defined as a compacted soil layer, generally of naturally occurring local soil , assumed to be 300 mm in thickness, just below the pavement crust provides a suitable foundation for the pavement

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