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A STUDY ON BITUMINOUS STABILIZATION OF CLAY SOILS FOR ROAD CONSTRUCTION

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ABSTRACT

Soil stabilization may be roughly divided into four types: heat, electric, pneumatic, and chemical. Chemical stabilizers are the most often used in the road building business and are roughly grouped into three groups: classic stabilizers, non-traditional stabilizers, and by-product stabilizers. Clay soil treatment to increase engineering qualities is well known and commonly used. Among the several stabilizing substances studied by multiple researchers, lime is the most prominent, followed by Portland cement.A study was done to investigate the geo - technical characteristics of Bitumen-stabilized clay soil in the lab using the California bearing ratio (CBR) test. The CBR value increased consecutively from Case Study A to Case Study D in each step of condition. In this particular experimental study, the CBR value increased by up to 50% when compared to the CBR of unaltered soil.

***KEY-WORDS:* Soil Stabilization, CBR, Bitumen , Clay Soil.**

INTRODUCTION

Soil stabilization is the modification of soils to improve their physical qualities. Stabilization can raise a soil's shear strength and/or manage its shrink-swell qualities, enhancing the load-bearing capability of a sub-grade to sustain pavements and substructure. Soil stabilization and soil remodeling are both connected to improving soil qualities so that they may be used for a certain purpose. Soil modification often refers to soil improvements that occur during or immediately following mixing. Modified soils have enhanced consistency, gradation, and/or swelling qualities to the appropriate level, and strength has been raised to a certain extent. Soil stabilization may be roughly divided into four types: heat, electric, pneumatic, and chemical. Chemical stabilizers are the most often used in the road building business and are roughly grouped into three groups: classic stabilizers, non-traditional stabilizers, and by-product stabilizers. Clay soil treatment to increase engineering qualities is well known and commonly used. Among the several stabilizing substances studied by multiple researchers, lime is the most prominent, followed by Portland cement.

The flexibility of soil is decreased, it becomes more manageable, and its compressive strength and load-bearing qualities are increased as a result of stabilisation. These enhancements are the consequence of a multitude of chemical events that occur in the presence of a stabiliser. These processes can be classified into two distinct categories. The impact of cation exchange and flocculation is usually noticeable within the next few hours. Other processes, including as pozzolanic reactions, structural development owing to cement hydration, carbonation, and the production of new materials, have time-dependent impacts that can last for a long time. Cation exchange and flocculation are two factors that are significantly connected with the successful stabilisation of clay soils within the time restrictions usual in the field. While other processes contribute to the stabilisation process, their impacts on clay soils are secondary. However, the additional advantages that are time-dependent should be welcomed and may even be included into the design.

SOILS AND CONSTRUCTION

In India, the soil used as the foundation for highway building is often fine-grained, with clay qualities predominating over silt. The land base is a critical component of long-term road damage in road building. This layer has both good and bad qualities, one of which is impacted during compaction activity.

A high level of spatial homogeneity of a subgrade and sub-base in terms of important technical characteristics including shear strength, elasticity, volumetric stability, and permeability is critical for the successful functioning of the pavement system. A multitude of environmental factors, including as temperature and moisture, have an impact on these geotechnical properties, both in the near and distant future. The subgrade and sub-base serve as the basis for the higher layers of the pavement system, and they are critical in resisting the negative impacts of climate as well as static and dynamic pressures created by traffic. Furthermore, extensive research has been conducted on remediation technologies, such as the use of recyclable plastic, geotextiles, and polymer grids for the design and construction of homogeneous and stable subgrades and sub-bases..

OBJECTIVES OF THE STUDY

The objectives of this study are

1. To investigate the geo - technical characteristics of Bitumen-stabilized clay soil in the science lab using the California bearing ratio (CBR) test.

2. Clay - rich soils, instead of well components, are most typically found in humid tropics leached soils. Laterite is a superficial deposit in hot and humid tropical environments that is rich in iron and aluminium and forms as a result of extensive and long-term weathering of the underlying parent rock.

3. Because of their diverse qualities, they have limits in their application on various building sites.

LITERATURE REVIEW

Michael (1993)[1] suggested that different waste materials may be used in the soil to improve the strength of the soil to a great extent

Razoukiet al. (2002) [2] also did a study and found that soil characterises can be improved by different methods and can be made waterproof by using some additives in the soil.

Cockaet al.(2003) [3] did research on the topic of soil stabilization and found that different materials may be amalgamed to uncrease the strength of the soil. He ut forward the use of asphaltic emulsions.

A. P.Chritz (2006) [4] put forward his experimenent to find out the effect of the bitumen mixing with the clay soils and it was found it is highly effective.

Hussain (2008) [5] did a research It was found that shear force has a great impact on the overall CBR values. In his research he related the two and found both are inversely related.

Martinet al.(2009) [6]did a study and it was revealed that 3 % bitumen when added with the soil gives good strength and overall improves the characteristics of the soil.

Yuehuan et al. (2010) [8] worked0on the topic of soil stabilization and according to him apart from the cement stabilization the most effective way is to use bitumen to improve the quality of the soils.

L. Lauren (2011) [9] performed an experimental study on the topic and revealed that polymeric emulsions can be used to improve the strength of the soil to a great extent.

Paul et al. (2011) [10] did a splendid research on the role of bitumen and found that it is very important building material that can be used to improve the overall strength of the soils.

Jones et al. (2012) [11]performed an experimental0study on bitumen soil stabilization. The research put forward that the good amount of bitumen improves the friction and braking in the roads.

EXPERIMENTAL STUDY

In my research, locally accessible Jammu Alluvial soil as an experimental material. In this investigation, medium setting emulsion (MS) was utilised as a stabilising agent. Bitumen sand stabilisation is an efficient procedure because bitumen strengthens soil and enhances resistance to water and frost. Actually, bitumen is a highly good agent for sand stabilisation, but it is quite expensive for soil stabilisation. There is no precise procedure or method for soil bitumen stabilisation, and, more critically, no code for bitumen soil stabilisation in Indian Standard. This experiment research is concerned with several particular tests such as the Modified Compaction Test

The initial criterion for each form of experimental research is the selection of material and methodology.. The real purpose, though, is to gain strength. So CBR tests are performed in many circumstances and settings in order to conduct a comparative experimental analysis.

SPECIFIC GRAVITY TEST

The Specific Gravity is computed as the ratio of the weight in air of a given volume of soil particles at a stated temperature to the weight in air of an equal volume of distilled water at the same temperature.

Sample No.	W1 g	W2 g	W3 g	W4 g	Specific Gravity Found
1.	113.96	163.76	383.65	351.96	2.74
2.	114.69	164.56	384.15	361.62	2.71
3.	113.1	163.51	382.86	353.26	2.66
4.	115.3	165.36	385.65	345.66	2.81
5.	115.9	165.96	385.99	352.94	2.67

GRAIN SIZE DISRIBUTION

Grain size analysis is a common laboratory technique in the field of geotechnical engineers. The study' goal is to determine the particle size distribution of soils.

The data calculation is the most important part of the work and various test were done and the results were recorded for the same. The gain size distribution results were written down as:

Sieve	Size	Soil Mass Retained in Each Sieve (g)	Percentage Retained (%)	Cumulative Retained (%)	Percentage Finer (%)
1/2 Inch	12.5 mm	0	--	0	100
3/8 Inch	9.5 mm	98.1	4.96	4.96	95.06
1/4nInch	6.3 mm	317.6	15.93	19.99	78.15
4	4.75 mm	396.6	19.87	40.56	59.56
8	2.36 mm	511.2	25.47	67.21	33.76
16	1.18 mm	254.2	12.67	78.9	21.00
30	600 micron	165.2	7.93	86.34	13.12
50	300 micron	131.6	6.96	94.59	6.07
80	150 micron	47.9	2.65	95.36	3.62
Pan	--	72.6	3.56	100	0

Grain size Distribution Results

COMPACTION TESTING

The Proctor compaction test is the most often used laboratory test for soil compaction. R. R. Proctor. The procedure, which replicates the in-situ compaction processes commonly used during the development of earth dams or earthworks, is the most popular laboratory test used to determine soil elastic modulus.

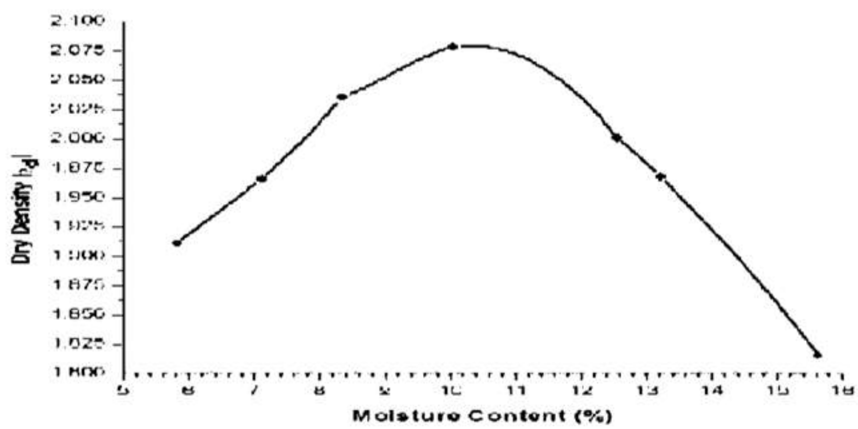
After World War II, in the 1950s, when heavier machinery might result in more compaction, a modified version of the test was adopted. 0 The cylindrical mould stays unchanged in the new method, but the drop weight is raised to 4,5kg and the falling height is increased to 450 cm. Furthermore, the dirt is compressed in 5 levels with a total of 025 blows each layer. The test is carried out for 5 moisture contents to determine the optimal water0content0 (wopt), for which the dry unit weight is maximal (d,max).

According to the results of this test, the maximum dry density of the specimen was 2.026gm/cc, with an OMC of 10.52 percent. The connecting thread in both efforts is to deliver the best value on bitumen content percentages ranging from 3% to 4%. After testing in varied percentages of 3%, 5%, and 7%, it was discovered that the maximum dry density of this soil was not significantly affected. Because it is employed as a stabilising agent, it should be cost effective. In this particular investigation, a 3% emulsion is used. As previously stated, relatively few studies on bitumen soil stabilisation had been conducted. IS code is only provided for bitumen sand stabilisation. So, the primary issue is how to combine the Alluvial soil with the emulsion.

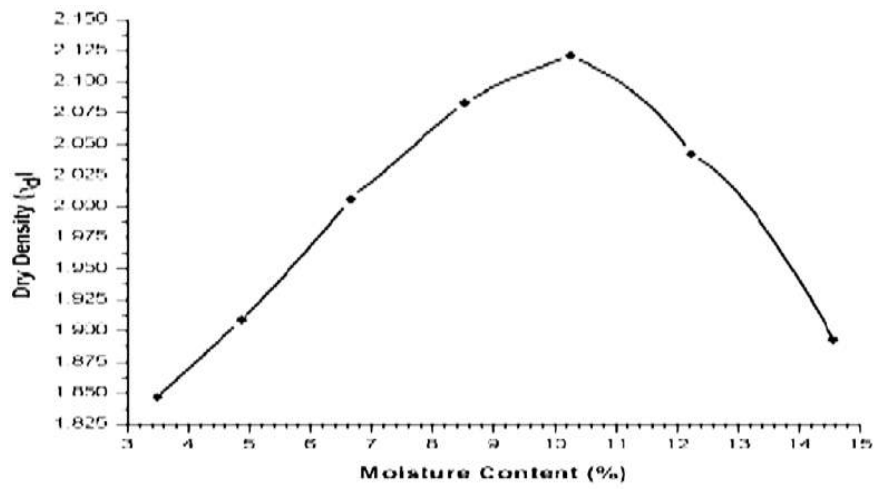
RESULTS OF COMPACTION TESTS

4.3.1 Case Study 1: Normal Soil

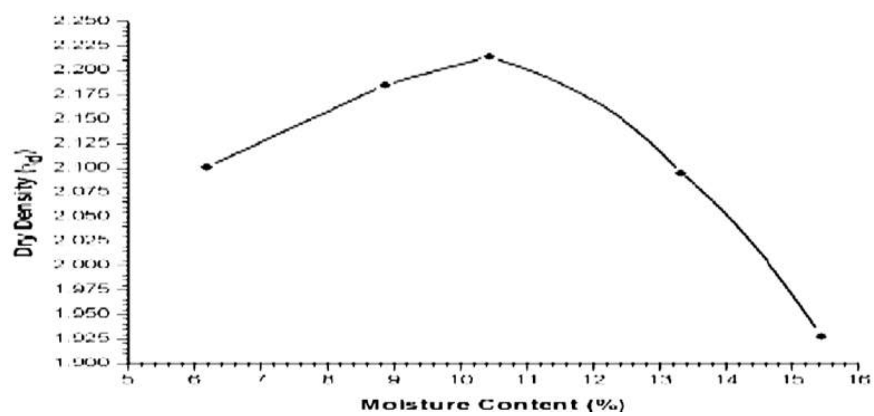
Case Study 2: Normal Soil with 3% Bitumen Emulsion.



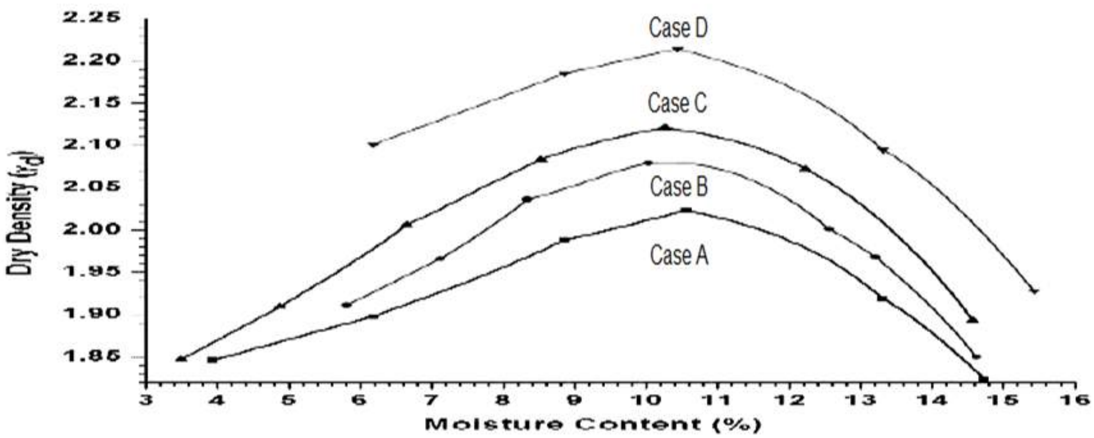
Case Study 3: Normal Soil with 3 % Bitumen emulsion and 2 % cement added



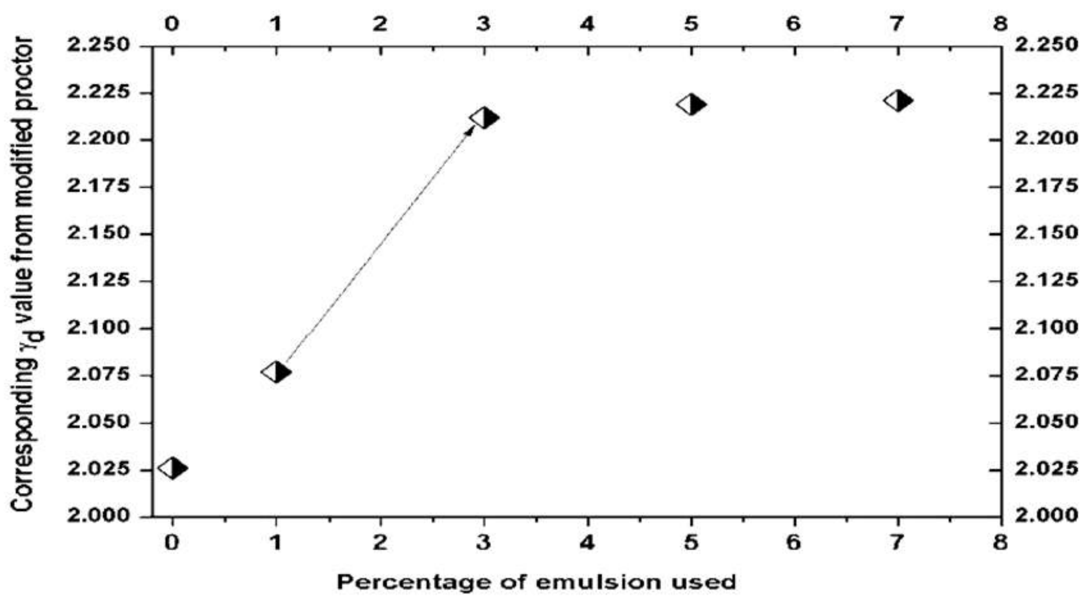
Case Study 4: Ordinary soil with 3% bitumen emulsion and 2% cement injected and left for 4 hours before testing



The above modified proctor result clearly shows how the dry density value for the same material would rise from Case Study A to Case Study D, which is a change in maximum dry density value from 2.026 gm/cc to 2.212 gm/cc. In some circumstances, the ideal moisture content value varies somewhat. This Yd value is a very essential physical feature



So, another modified proctor test is performed, this time altering the bitumen concentration by 1%, 3%, 5%, and 7% using mixing process D. This result provides us with a clear picture of the 3 percent bitumen concentration that was used



CBR TESTING

The CBR test is determined by measuring the pressure required to fracture a soil sample with a conventional plunger. The measured pressure is then divided by the pressure necessary to achieve equivalent penetration through normal crushed rock material.

The greater the CBR rating, the harder the surface. A CBR value of 2% typically corresponds to clay, although other sands may have a CBR value of 10%. A high-quality sub-base will have an 80-100 percent worth (maximum).

The CBR test is performed on soils with a particle size of no more than 20mm.

Tests are often conducted at base level or at depths ranging from 500 to 1000mm at 20-30m intervals along the projected construction centerline. At every location, a minimum of 3 tests are typically performed.

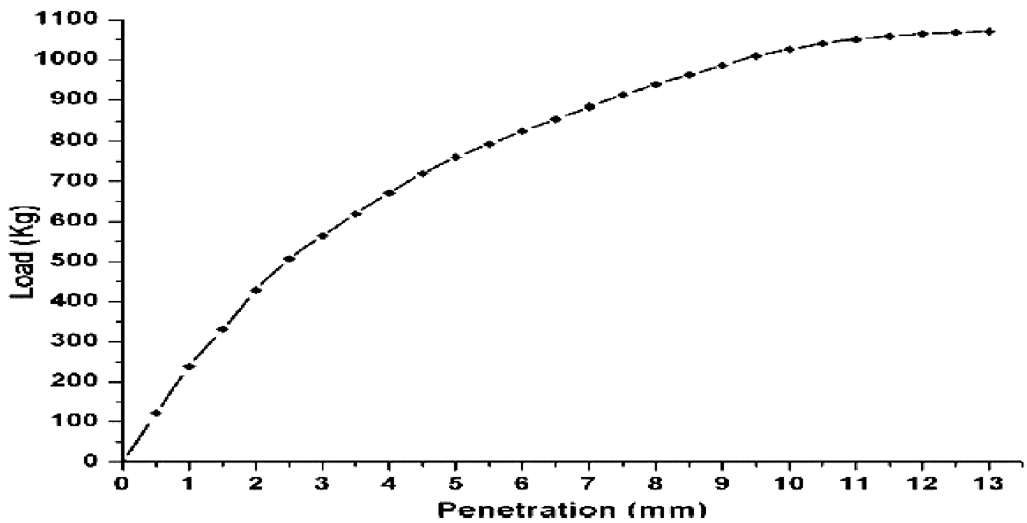
Case Study A: Normal available tested soil000000

Maximum Dry Density: 2.026 gm/cc

Optimum Moisture Content: 10.52 %00000000

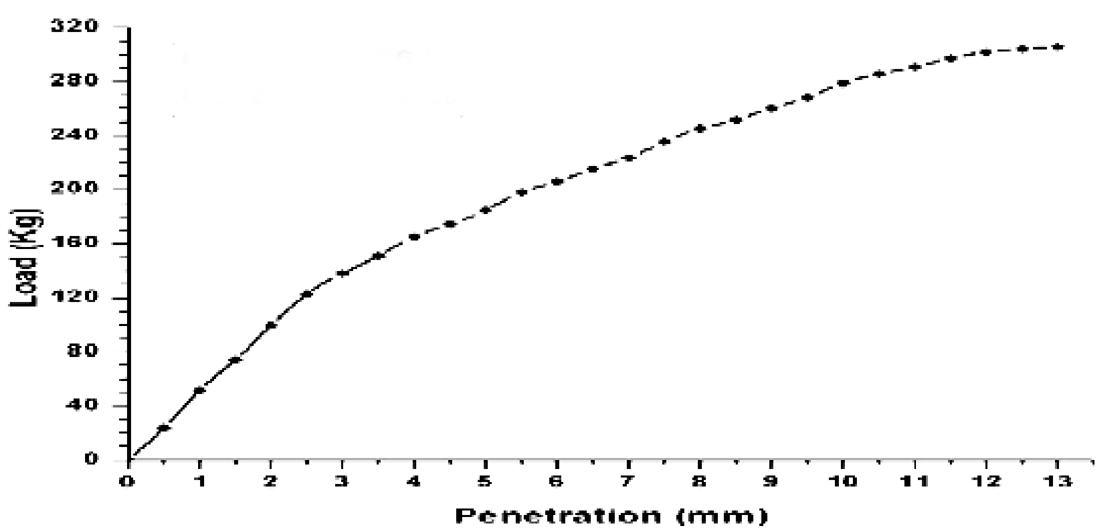
Condition 1: Unsoaked Condition00000000

CBR $_{2.5}$**:** 36.3 % **CBR** $_{5.0}$**:** 36.11%



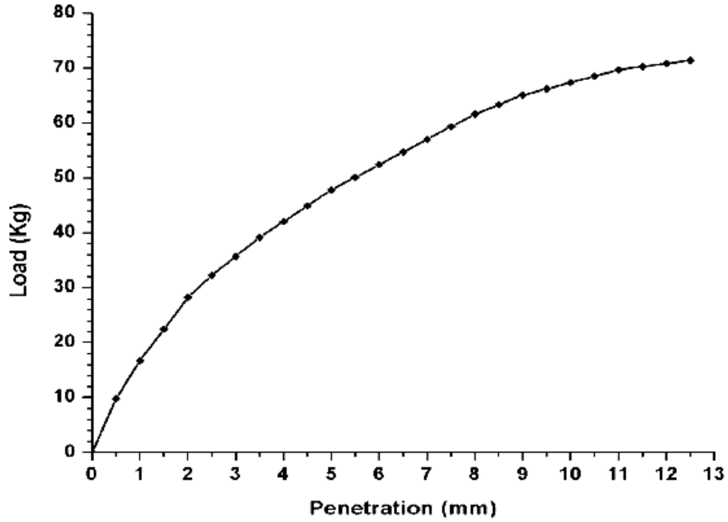
Condition 2: Two daysSoaking

CBR $_{2.5}$**: 9 %**0**CBR** $_{5.0}$**: 9.03 %**00000



Condition 3: Five0Days0Soaking

CBR $_{2.5}$: 2.36 % CBR $_{5.0}$: 2.29 %



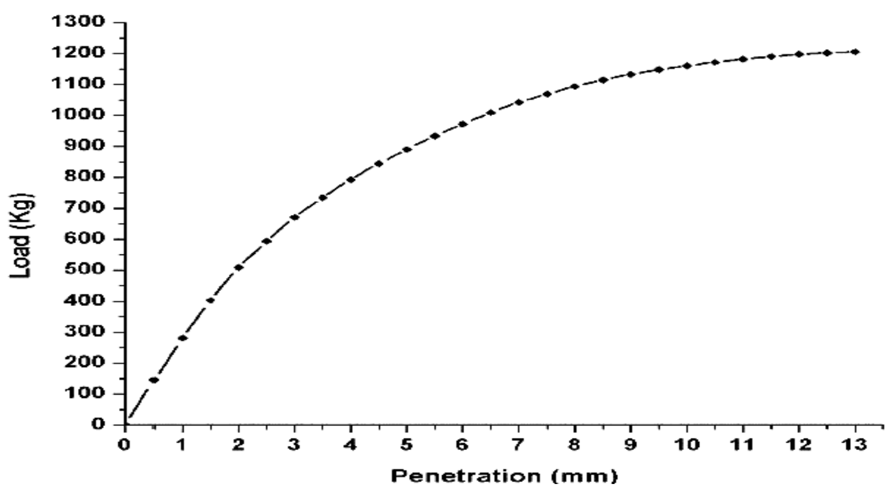
Case Study B: Normal available tested soil with03 % Bitumen0Emulsion

Maximum Dry Density: 02.09 gm/cc

Optimum Moisture Content: 010.50 %

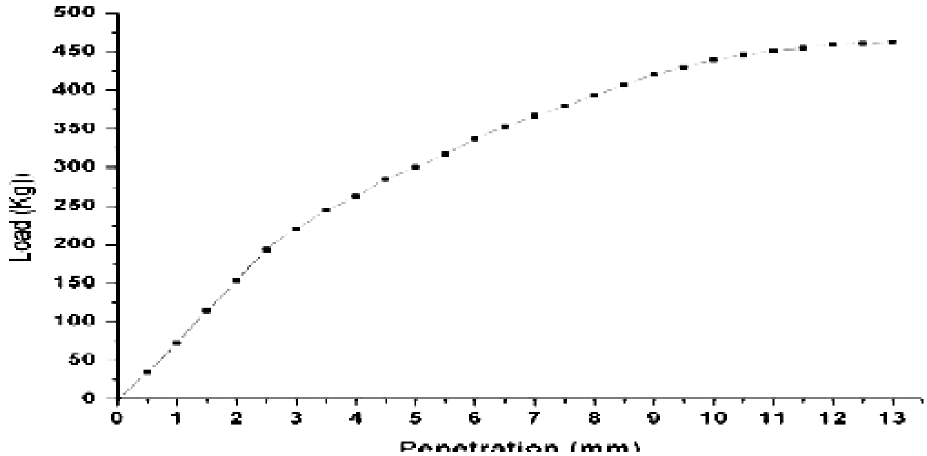
Condition 1: UnsoakedCondition

CBR $_{2.5}$: 42.9 % **CBR $_{5.0}$:** 43.2 %



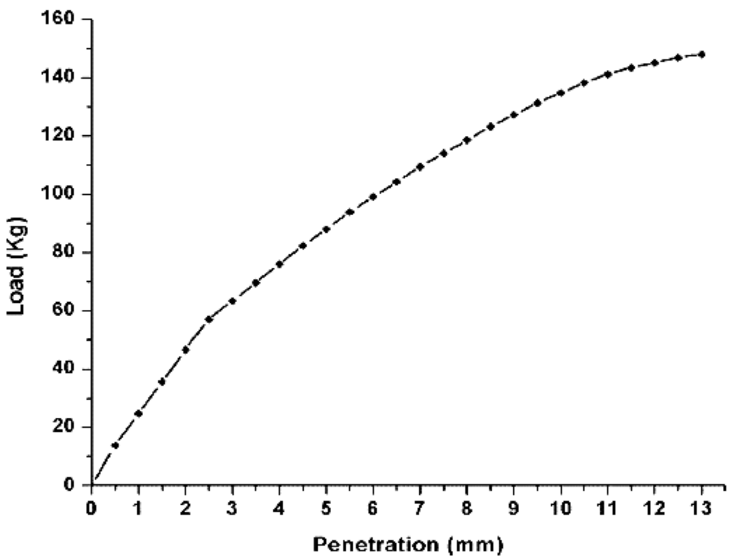
Condition 2: Twodays Soaking

CBR $_{2.5}$: 13.9 % CBR $_{5.0}$: 14 %



Condition 3: FiveDaysSoaking

CBR $_{2.5}$: 4.17 % CBR $_{5.0}$: 4.2 %



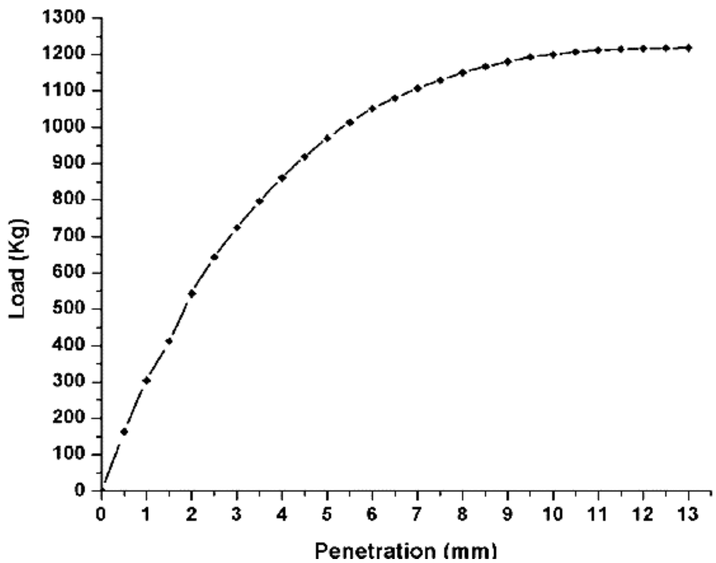
Case Study C: Normalavailabletested soil with 3 %BitumenEmulsion and 2 %OPC

Maximum Dry Density: 2.124 gm/cc

OptimumMoistureContent: 10.26 %

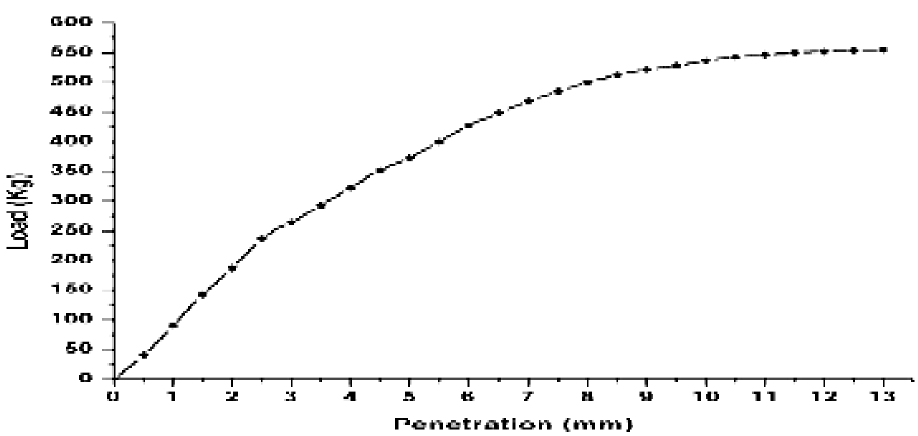
Condition 1: UnsoakedCondition

CBR $_{2.5}$: 45.9 % **CBR $_{5.0}$:** 46.5 %



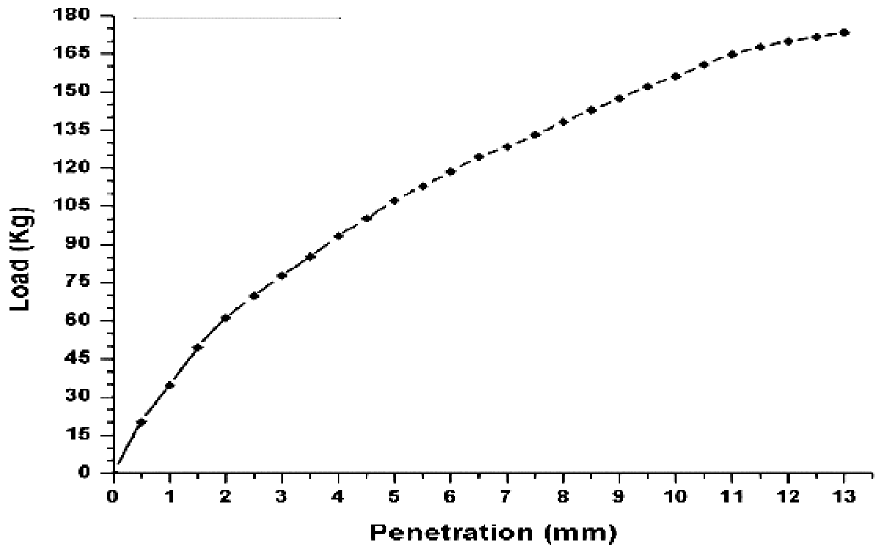
Condition 2: TwodaysSoaking

CBR $_{2.5}$: 16.9 %CBR $_{5.0}$:17.2 %



Condition 3: FiveDaysSoaking

CBR $_{2.5}$: 4.17 % CBR $_{5.0}$: 4.2 %



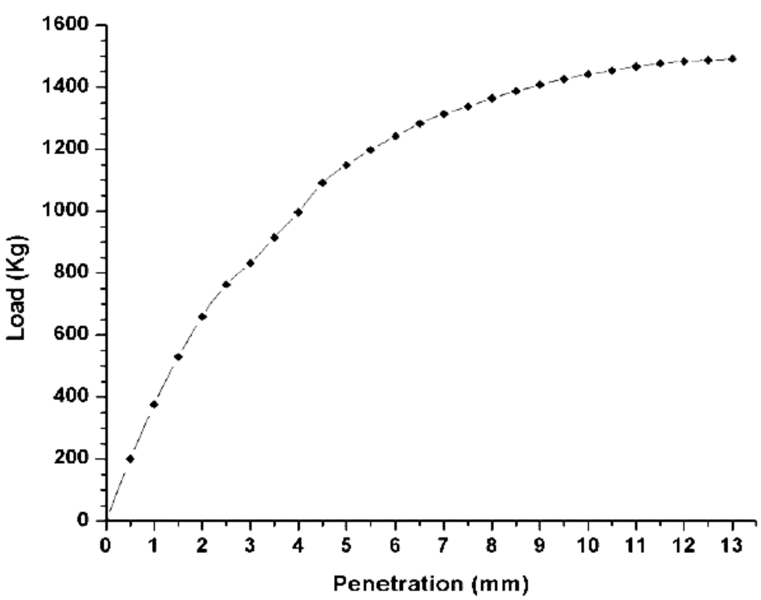
Case Study C: Normal available tested soil with 3 % Bitumen Emulsion and 2 % OPC but tested after 5 hours

Maximum Dry Density: 2.215 gm/cc

Optimum Moisture Content: 10.61 %

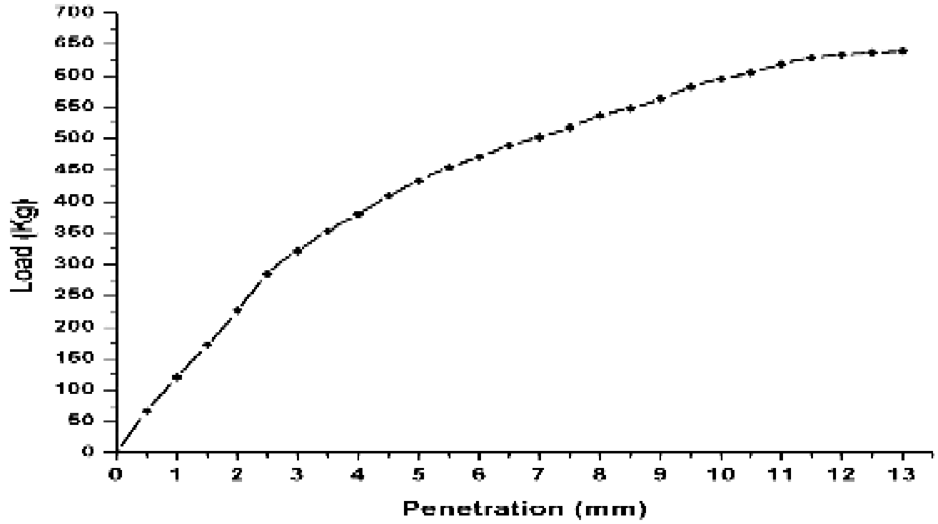
Condition 1: UnsoakedCondition

CBR $_{2.5}$: 56.1 % **CBR $_{5.0}$:** 56 %



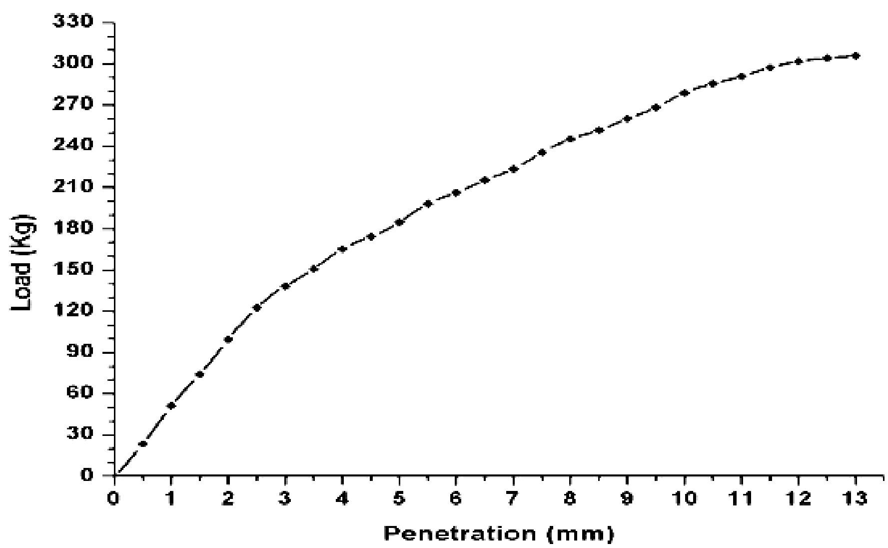
Condition 2: Two daysSoaking

CBR $_{2.5}$: 19.9 % CBR $_{5.0}$: 20.2 %



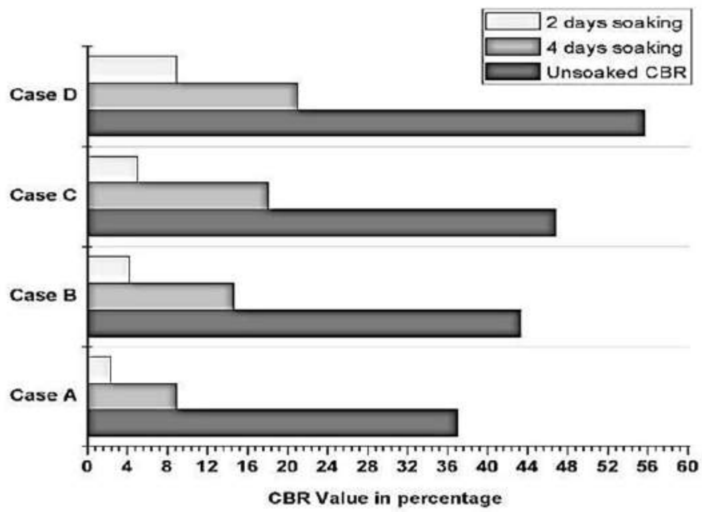
Condition 3: Five Days Soaking

CBR $_{2.5}$: 8.90 % CBR $_{5.0}$: 8.95 %



DISCUSSION

The bottom most layer of the pavement which is known as sun grade must be strong enough to withstand various loads. It may be noted that all the loads that come from the vehicles is transferred to the subgrade. Thus from that point of view it is very important that the sub grade should be strong. The most efficient test is the CBR test to find the strength of the soil. The details of the tests done are summed in the graph as



RECOMMENDATION AND CONCLUSION

The conclusions are summed as follows:

1. According to this study, there was a increase in the California bearing ratio of the soil after the soil was mixed with bitumen emulsion.
2. Better results were obtained when the samplemixed with bitumen was kept for more time duration.
3. The CBR value increased consecutively from Case Study A to Case Study D in each step of condition. In this particular experimental study, the CBR value increased by up to 50% when compared to the CBR of unaltered soil.
4. Given its cheap economic cost and increased stabilization quality, this type of stabilisation is obvious for usage in alluvial soil or on highway shoulders.

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