Experimental Study on the Behaviour of the Soil Strength Using Bitumen Emulsion

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Abstract: ***Soil is used sub base and base material, if strength of soil is poor, then stabilization is normally needed. Sub grade is sometimes stabilized or replaced with stronger soil. Sub grade quality is generally communicated as far as CBR. Consequently, in all, the pavement and the sub grade together must sustain the activity volume. In this research locally available red coloured literate type gravel soil is taken as experimenting material. Medium setting emulsion (MS) is used as stabilizing agent in this particular study. Bitumen sand stabilization is an effective process as bitumen makes soil stronger and improves resistance capacity against water and frost. Actually, bitumen is a very effective agent for sand stabilization but for soil stabilization it is being very costly. There is no any particularly following process or method for soil bitumen stabilization and most importantly there is no any code for bitumen soil stabilization in Indian Standard. This experiment study deals with some specific tests like Modified Compaction Test, CBR Test and the main objective is to optimize the strength of soil or improve the dry density property.***

Keywords — ***Medium setting emulsion, red colour literate type gravel soil, Bitumen emulsion.***

I.INTRODUCTION

Starting from the base, 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. 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. 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.

Soil stabilization can be done by two methods, one is mechanical method and the other one is chemical or additive methods. 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.

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. This practice does not oblige compound change of the soil and it is regular to utilize both mechanical and concoction intends to attain detailed stabilization.

II.LITERATURE REVIEW

Bitumen emulsion is used as chemical stabilizer. Cement is used here as a binder only to improve strength of road. Previously lots of work was done on sand bitumen stabilization and gravel soil bitumen stabilization in different places. This study is being inspired from those researches. Here gravel red coloured soil is used, as it is available in many states of India. Some similar works, done before, is discussed below:

Michael (1993) had proposed about Bench -Scale Evaluation of Asphalt Emulsion Stabilization of Contaminated Soils. In this study, it was discussed about the application of ambient temperature asphalt emulsion stabilization technology and discussed to

the environmental fixation of soils contaminated by organic contaminants.

Razouki et al. (2002) propose an experimental study on Granular Stabilized Roads. Bitumen was used as a stabilizing agent may act as a binder or as a water-proofing material. Soil-bitumen systems had found the greatest used in road bases and surfaces.

Cokca et al. (2003) concentrated on the impacts of compaction dampness content on the shear quality of an unsaturated mud. In this study, the impacts of compaction dampness substance and soaking on the unsaturated shear quality parameters of mud were investigated. Experiments were carried out on specimens compacted at optimum dampness content, on the dry side of optimum and on the west side. It was found that edge of erosion reductions quickly with increasing dampness substance, the union segment of shear quality attained its top worth at around optimum Moisture substance and afterward diminishes.

A. P. Chritz (2006) discussed about performance evaluation of mixed in place bituminous stabilized shoulder gravel. Here it was showed an economical maintenance of gravel shoulders, a very common problem is facing by highway agencies.

Hussain (2008) did an excellent work to establish the correlation between CBR value and undrained shear strength value from Vane Shear Test. It was shown that undrained shear strength value and CBR value increased with increasing plasticity index. Finally, it was achieved that shear strength and CBR value is inversely proportional to the water content of that material.

Marandi and Safapour (2012) worked on Base Course Modification through Stabilization using cement and bitumen. The main objective of this research was to analyze the use of bitumen emulsion in base course stabilization. So that it was examined as replacement with conventional pavement in regions with low quality materials. Stabilization of soils and aggregates with bitumen shows it differs greatly from cement stabilization. The basic mechanism involved in bitumen stabilization was a waterproofing phenomenon.

III.PROBLEM FORMULATION

- Reduction in the strength of soil & also the soil bearing capacity.
- Uneconomical in terms of cost & energy
- Instability to the soil in slopes or other such places.
- Rapidly increase in the soil volume due to change in Temperature.

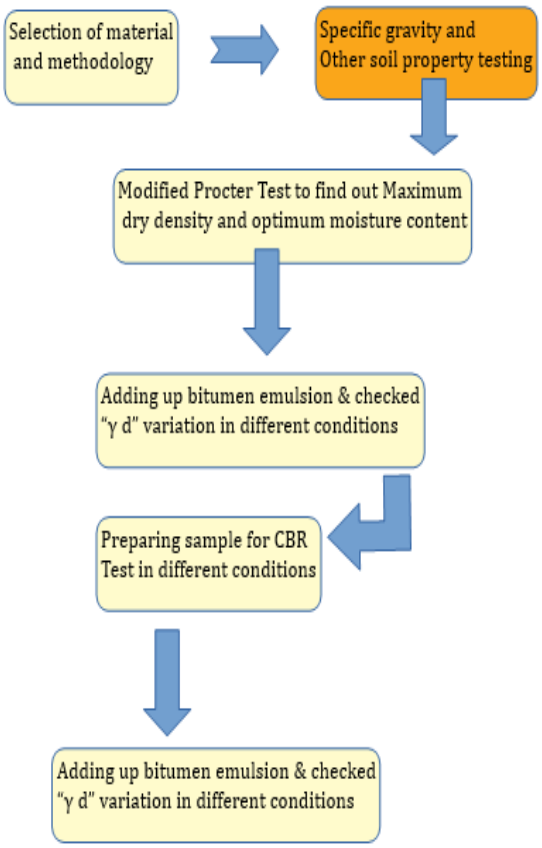
IV.OBJECTIVE AND SCOPE OF WORK

The main objective of this experimental study is to improve the properties of the gravely soil by adding bitumen emulsion as stabilising agent. An attempt has been made to use emulsion for improving the strength and geotechnical properties of gravel soil. The experiments which to be conducted are Specific Gravity of the soil sample, Standard Proctor test to obtain maximum dry density and optimum moisture content of soil sample, CBR test of soil sample mixing with emulsion. So the main objective is to maximise the CBR value by checking some conditions to increase the CBR value of soil sub grade.

V.FRAMEWORK OF THE STUDY

To know the soil physical properties following tests are conducted like specific gravity. After that the important part is to choose mixing procedure and the cases or different conditions for conducting the next tests. To determine the maximum dry density of the material modified proctor test has been conducted. But the actual goal is to increase the strength. So CBR test are conducted in different cases and conditions and make a comparative experimental study. So, the methodology is how to achieve maximum bearing capacity or maximise the CBR value.

A. *Process of Experiment:*



VI.EXPERIMENT WORK

B. *Specific Gravity:*

The specific gravity experiment for gravel soil is done in pycnometer method as per IS: 2720 (Part -3) (1980) and Le - Chatelier's apparatus was used for bitumen emulsion gravel soil.

C. *Compaction Test (Modified Proctor Test)*

In modified proctor all the procedures remain same with only a few little changes. Here the compaction load is higher with rammer size 4.5 kg and dropped from height of 31cm. Generally, these lab tests are consisting of compacting soil at recognised moisture content into a cylindrical mould of standard measurements. Materials was filled in five equivalent layers with 25 blows in each one layer.

Fig. 1. Modified Proctor test apparatus

D. *Bitumen Emulsion*

Emulsified Bitumen usually consists of bitumen droplets suspended in water. Most emulsions are used for surface treatments. Because of low viscosity of the Emulsion as compared to hot applied Bitumen, The Emulsion has a good penetration and spreading capacity. The type of emulsifying agent used in the bituminous emulsion determines whether the emulsion will be anionic or cationic. In case of cationic emulsions there are bituminous droplets which carry a positive charge and Anionic emulsions have negatively charged bituminous droplets.

Fig. 2. Sample of bitumen emulsion

E. *California Bearing Ratio Test*

CBR is the proportion of force for every unit region needed to enter a soil mass with standard load at the rate of 1.25 mm/min to that needed for the ensuing penetration of a standard material. The accompanying table gives the standard loads utilized for diverse penetrations for the standard material with a CBR quality of 100%. This standard load is taking limestone as a standard material and its CBR value at 2.5 mm, 5 mm, 7.5mm & 10mm penetration are fixed as standard load for CBR value determination.

C.B.R. = (Test load /Standard load) 100 %

The CBR test is done on a compacted soil (by 55 blows) in a cylindrical CBR mould of 150 mm diameter and 175 mm height gave separable collar of 50 mm and a separable punctured base plate of hard metal. A displacer plate, 50 mm profound inside the mold throughout the example readiness by which example of 125 mm profound is acquired as actual depth.

F. *Soil Mix Proportion*

The Bitumen Emulsion is mixed with soil in a series like 7%, 10%, & 13%. The soil mixing is an in-situ soil treatment technology whereby the soil is blended with bituminous materials in order to improve shear strength of a soil. The bituminous slurry is prepared in manually mixed & hence the complete soil mixing process is monitored.

VII.RESULTS AND DISCUSSION

G. *Specific Gravity of Soil*

Specific gravity of soil is very important property to understand the soil condition. As previously discussed here W_1 is empty bottle weight, W_2 is mass of bottle and dry soil, W_3 is weight of bottle, dry soil and water and W_4 is weight of bottle with water.

Table 1: Specific gravity test result

S.N.	Sample	Specific Gravity
1.	Normal soil Sample	2.05
2.	Soil with 7% Bitumen Emulsion	2.17
3.	Soil with 10% Bitumen Emulsion	1.94
4.	Soil with 13% Bitumen Emulsion	2.02

Here soil material is tested three times. And the average specific gravity value comes 2.045. But here no temperature correction is done. This test has been done in room temperature nearly 25°C.

H. *Compaction Test*

Table 2 Compaction Test Result

S.No	Sample	Max.Dry Density (g/cc)	Optimum Moisture Content (%)
1	Normal Soil Sample	2.05	12
2	Soil with 7% Bitumen Emulsion	1.75	2
3	Soil with 10% Bitumen Emulsion	2.2	7
4	Soil with 13% Bitumen Emulsion	1.96	6

The compaction characteristics of soil and bitumen emulsion mixture, showing optimum moisture content (OMC) and maximum dry density (MDD) of the compacted soils in Table 2.

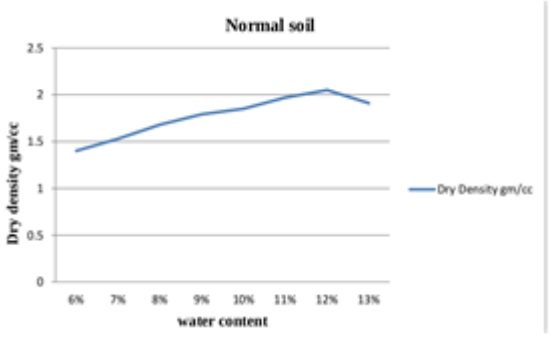


Fig. 3. Normal Soil

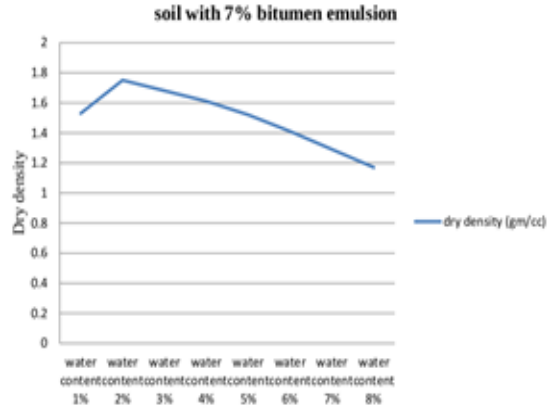


Fig. 4. Soil with 7% Bitumen Emulsion

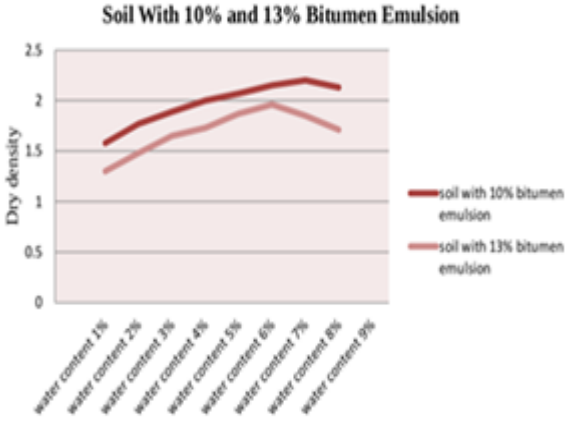


Fig. 5. Soil with 10% & 13% Bitumen Emulsion

I. CBR Test

The test comprises of bringing on a round and cylindrical plunger of 50mm diameter to penetrate a pavement part material at 1.25mm/minute. The loads, for 0.5mm, 1mm, 1.5mm, 2mm, 2.5mm, 5mm, 5.5mm, 6mm, up to 12mm to 13 mm are recorded in every 0.5mm of gaping. Penetration in mm is plotted in X axis and load expressed in kg with corresponding points are plotted in Y axis and prepare graph for different specimen.

The CBR values at 2.5mm and 5.0mm penetrations are calculated for each specimen from the corresponding graphs which is shown below. Generally, the CBR value at 2.5mm penetration is higher and this value is adopted. CBR is defined as the ratio of the test load to the standard load, expressed as percentage for a given penetration of the plunger. This value is expressed in percentage.

CBR Value for
Normal Soil:

$CBR_{2.5} = 3.275\%$
$CBR_{5} = 7.09\%$

For 7% bitumen emulsion:

$CBR_{2.5} = 1.25\%$
$CBR_{5} = 2.05\%$

For 10% bitumen emulsion:

$CBR_{2.5} = 13.4\%$
$CBR_{2.5} = 14.44\%$

For 13% bitumen emulsion:

$CBR_{2.5} = 1.75\%$
$CBR_{2.5} = 2.2\%$

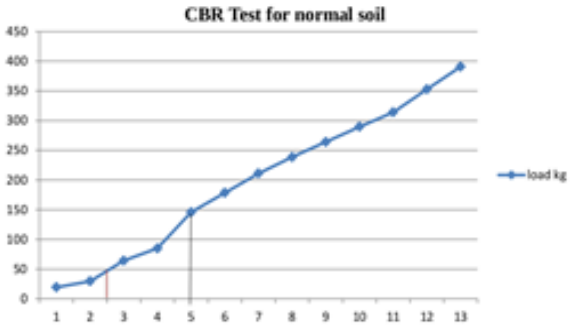


Fig.5. CBR Test for Normal Soil

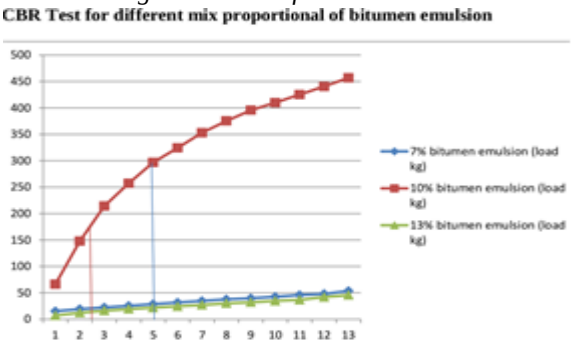


Fig. 6. CBR Test for 7% 10% & 13% Bitumen Emulsion with Soil

For 7% bitumen emulsion:

$CBR_{2.5}$ *= 1.25% ,CBR 5 = 2.05%*

For 10% bitumen emulsion:

$CBR_{2.5}$ *= 13.4%, CBR 2.5 = 14.44%*

For 13% bitumen emulsion:

$CBR_{2.5}$ *= 1.75%, CBR 2.5 = 2.2%*

VIII.CONCLUSION & DISCUSSION

J. Conclusion

From this study it is clear that there is a considerable improvement in California Bearing Ratio (CBR) of sub-grade due to use of bitumen emulsion if proper mixing is done. It is seen that it best results are obtained if the soil is mixed with Bitumen emulsion. It was found that CBR value has been obtained maximum at 10% Bitumen Emulsion with soil. In this particular experimental study CBR value has increased nearly two times of the normal soil. Observing its economic cost and quality of stabilization improvement, it is clear that this type of stabilization may be applicable in gravel soil road or in shoulder portion of highways.

K. Discussion

Sub-grade may be defined as a compacted soil layer, generally of naturally occurring local soil, assumed to be 300 mm in thickness, just below of the pavement crust. It provides a suitable foundation for the pavement. So it is very important to improve strength of subgrade soil, it may be by replacing good soil or by stabilization of existing soil. To check the subgrade soil stability CBR test is very commonly used test. The all CBR results are plotted in a bar to check whether the improvement of CBR is done or not and if done then what would be that condition where CBR value become maximum.

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