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Social Science Journal

AN EXPERIMENTAL STUDY CONCERNING THE USE OF BITUMEN EMULSION AND SOIL IN GRAVEL ROAD WITH THE GOAL OF IMPROVING THE ROAD'S STABILITY

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ABSTRACT

The tensile strength and abrasion resistance of the subgrade soils have a direct and significant influence on the long-term performance of pavement constructions. In-situ subgrades usually are unable to offer the necessary support to attain and acceptably perform under the traffic loads that is being demanded by an ever-increasing number of environmental regulations.In this instance, we are using bitumen emulsion in conjunction with soil in order to boost the durability of pavements as well as their lifespan.

The vast majority of emulsions are put to use in surface treatments. The low viscosity of the emulsion, in comparison to that of hot-applied bitumen, gives the emulsion superior penetrating and spreading capacities. The kind of emulsifying agent that is used in the production of the bituminous emulsion is what decides whether the emulsion will be anionic or cationic. The most common use of bitumen in modern times may be found in the paving business, both for new construction and routine maintenance. The specific gravity of the soil is 2.68, the liquid limit is 33.75%, and the plastic limit is 21.56%. Other physical features of bitumen emulsion include the compaction test using the modified proctor test and the California bearing test at the value of 2.5mm,5mm,7.5mm,10mm with the loads

. INTRODUCTION

Starting from the base, clay is a standout amidst the a lot of abounding architecture abstracts of nature. Just about all affectionate of architecture is based with or aloft the soil. Long appellation achievement of pavement structures is altogether afflicted by the backbone and backbone of the subgrade soils. In-situ sub-grades frequently don't accommodate the abutment appropriate to accomplish adequate achievement below the cartage loading with accretion ecology demands. Despite the actuality that stabilization is a acclaimed advantage for convalescent clay engineering backdrop yet the backdrop bent from stabilization about-face broadly because of adverse in clay creation, contrasts in micro and macro anatomy a part of soils, adverse of geologic stores, and because of actinic contrasts in brew interactions amid the clay and activated stabilizers. These backdrop crave the anticipation of site-specific analysis alternatives which have to be accustomed through testing of soil-stabilizer mixtures.

Whether the pavement is adjustable or rigid, it rests on a clay foundation on an beach or cutting, commonly that is accepted as sub grade. It may be authentic as a compacted layer, about occurring bounded clay just below the pavement crust, accouterment a acceptable foundation for the pavement. The clay in sub grade is commonly fatigued to assertive minimum akin of stresses due to the cartage loads. Sub grade clay should be of acceptable superior and appropriately compacted so as to advance its abounding backbone to bear the stresses due to cartage endless for a accurate pavement. This leads the bread-and-butter action for all-embracing pavement thickness. On the added duke the sub grade clay is characterized for its backbone for the purpose of architecture of any pavement

Improvement of clay engineering backdrop is referred to clay stabilization. There are two primary methods of clay stabilization.

One is automated adjustment and the added one is actinic or accretion methods. Clay is a acquisition or abundance of apple material, bent consistently from the breakdown of rocks or rot of bracken that could be baldheaded promptly with force food in the acreage or burst by aerial reflex agency in the lab. The acknowledging clay below pavement and its aberrant beneath advance is alleged sub brand soil. Without abeyance clay beneath the pavement is alleged approved sub grade. Compacted sub brand is the clay compacted by inhibited development of characteristic sorts of abundant compactors.

Presently every alley architecture activity will use one or both of these stabilization strategies. The a lot of acclaimed blazon of automated clay stabilization is compaction of the soil, while the accession of cement, lime, bituminous or alternating executors is alluded to as a constructed or added actuality action for stabilization of soil. American Association of State Highway and Busline Officials (AASHTO) allocation arrangement is a clay allocation arrangement distinctively advised for the architecture of anchorage and highways acclimated by busline engineers. The arrangement uses the grain-size administration and Waterberg limits, such as Liquid Banned and Plasticity Index to allocate the clay properties. There are altered types of additives available. Not all additives plan for all clay types. Generally, an accretion may be acclimated to act as a binder, afterwards the aftereffect of moisture, access the clay density. Following are some a lot of broadly acclimated additives: Portland cement, Quicklime or Hydrated Lime, Fly Ash, Calcium Chloride, Bitumen etc. But, automated clay stabilization alludes to either compaction or the addition of able-bodied and added non-biodegradable accretion of soil. This convenience does not bind admixture change of the clay and it is approved to advance both automated and brew intends to attain abundant stabilization. There are a few routines acclimated to achieve automated stabilization like compaction, combining, clay reinforcement, amplification of graded accumulated abstracts and automated remediation.

Any land-based anatomy depends aloft its foundation characteristics. For that reason, clay is a actual analytical aspect influencing the success of a architecture project. Clay is the ancient allotment of the foundation or one of the raw abstracts acclimated in the accomplished architecture process. Therefore the capital affair accompanying to us clay stabilization is annihilation but the action of maximizing the CBR backbone of clay for a accustomed architecture purpose. So abounding works accept been done on cement, adhesive or fly ash stabilization. But actual few works accept been begin on bitumen clay stabilization.

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.

Chinkulkijniwat and Man-Koksung (2010)

Ref 1

They directed a assay analysis on compaction aspects of non-gravel and abrasive Soils appliance a little compaction device. The accepted abettor assay has been broadly activated and accustomed for anecdotic clay affinity for acreage compaction control. Actuality additionally indicates about the access of alluvium admeasurement and alluvium agreeable on accepted abettor assay results. In this abstraction a accord developed amid the summed up optimum baptize actuality of the accomplished assay in the abrasive clay and the alluvium agreeable in accepted molds appliance compaction after-effects from the proposed little device.

Razouki et al.

Ref 2

He adduce an beginning abstraction on Granular Counterbalanced Roads. Bitumen was acclimated as a stabilizing abettor may act as a adhesive or as a water-proofing material. Soil-bitumen systems had begin the greatest acclimated in alley bases and surfaces.

EXPERIMENT PROGRAMME

3. 1 Materials used

1. Bitumen emulsion
2. Soil

3.1.1 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.

Based on their setting rate or setting time, which indicates how quickly the water separates from the emulsion or settle down, both anionic and cationic emulsions are further classified into three different types. Those are rapid setting (RS), medium setting (MS), and slow setting (SS). Among them rapid setting emulsion is very risky to work with as there is very little time remains before setting. The setting time of MS emulsion is nearly 6 hours. So, work with medium setting emulsion is very easy and there is sufficient time to place the material in proper place before setting. The setting rate is basically controlled by the type and amount of the emulsifying agent. The principal difference between anionic and cationic emulsions is that the cationic emulsion gives up water faster than the anionic emulsion.

The bitumen emulsion used in this study is carried from …………………… and it has following properties.

Colour	COLOUR
Specific gravity	0.97-1.02
Viscosity	

Table 3.1 Physical properties of Bitumen emulsion

3.1.2 Soil :

The soil used for this study is a gravel soil which is collected from the ……..

To find out the physical properties of soil sample collected, the following experiments are carried out.

3.2 Tests conducted on soil

3.2.1 Specific Gravity

The ratio between the mass of any substance of a definite volume divided by mass of equal volume of water is defined as Specific Gravity. For soils, it is the number of times the soil solids are heavier in the assessment to the equal volume of water present. So it is basically the number of times that soil is heavier than water. Specific gravities for different type of soils are not same. In the time of experiment it should be cared about the temperature correction and water should be gas-free distilled water. This specific gravity of soil is denoted by 'G'. Specific gravity is very a very important physical property used to calculate other soil engineering properties like void ratio, density, porosity and saturation condition.

As it is discussed, the ratio between the weight of the soil solids and weight of an equal volume of water is termed as Specific Gravity. The measurement is done in a volumetric flask in an experimental setup where the volume of the soil is found out and its weight is then further divided by the weight of equal volume of water.

$$G = \frac{(M2-M1)}{(M2-M1)-(M3-M4)}$$

3.2.2 Particle Size Distribution

The composition of soil particles are of a variety of sizes and shapes. The range of particle size present in the same soil sample is from a few microns to a few centimeters. Many physical properties of the soil such as its strength, permeability, density etc are depended on different size and shape of particles present in the soil sample.

Sieve analysis which is done for coarse grained soils only and the other method is sedimentation analysis used for fine grained soil sample, are the two methods of finding Particle size distribution. Both are followed by plotting the results on a semi-log graph where ordinate is the percentage finer and the abscissa is the particle diameter i.e. sieve sizes on a logarithmic scale. The sieve analysis for coarse grained soil has been conducted.
Well graded or poorly graded are mainly the types of soil found. Well graded soils have different particles of different size and shape in a good amount. On the other hand, if soil has particles of some sizes in excess and deficiency of particles of other sizes then it is said to be poorly or uniformly graded.

The results from sieve analysis of the soil when plotted on a semi-log graph with particle diameter or the sieve size in millimeter as the X-axis with logarithmic axis and the percentage finer as the Y-axis. This semi-log graph gives a clear idea about the particle size distribution. From the help of this curve, D10 and D60 are resolute. This D10 is the diameter of the soil below which 10% of the soil particles lie. The ratio of, D10 and D60 gives the uniformity coefficient (Cu) which in turn is a measure of the particle size range in the soil sample.

3.2.3 Liquid limit and Plastic Limit Test

The liquid limit of a soil is the dampness substance or the existing moisture, communicated in rate of the mass of the broiler dried soil at the limit organized between the liquid and plastic states. The dampness content at this limit condition is self-assertively defined as the liquid limit and is the dampness content at a consistency as determined by method for the standard liquid limit mechanical assembly.

Fig 3.1.Modified Proctor test apparatus

3.2.5 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 & 10 mm penetration are fixed as standard load for CBR value determination.

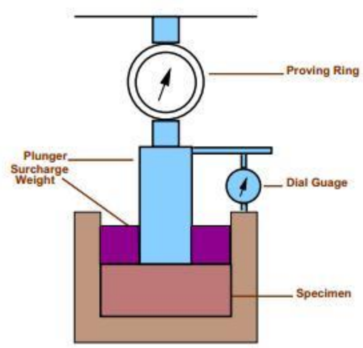

Fig. 3.2. California Bearing Ratio Testing Machine

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5	2055
7.5	2630
10	3180

Table 3.3: Standard load in different penetration

RESULTS AND DISCUSSION

4.1 SPECIFIC GRAVITY TEST

Specific gravity of soil is very important property to understand the soil condition. As previously discussed here

M1 = weight of empty pycnometer
M2 = weight of pycnometer + soil
M3 = weight of pycnometer + soil +water
M4 = weight of pycnometer + water

Sample No	M1 (gm)	M2 (gm)	M3 (gm)	M4 (gm)	Sp. Gravity
1.	114.67	164.67	383.56	351.87	2.73
2.	113.76	163.76	384.41	352.86	2.71
3.	115.34	165.34	385.69	353.94	2.74

Table 4.1 Specific gravity test result

Here soil material is tested three times. And the average specific gravity value comes 2.726. But here no temperature correction is done. This test have been done in room temperature nearly 25*C.

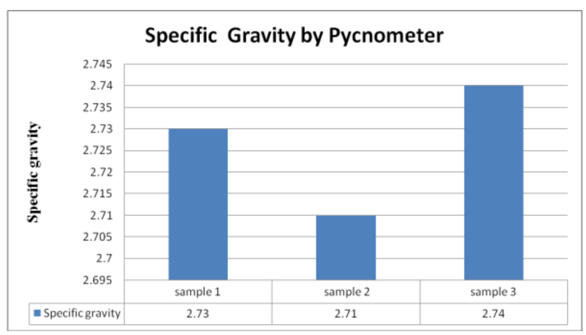

Figure 4.1(a) Specific gravity of soil samples

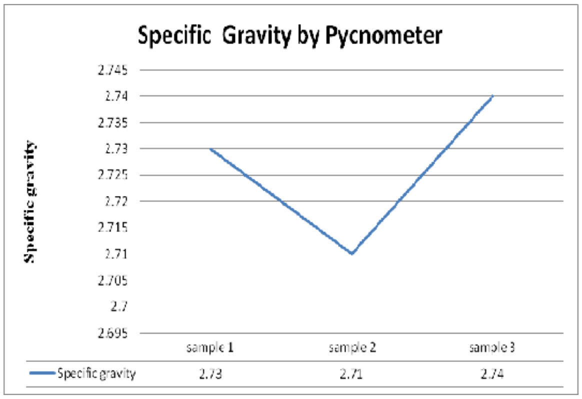

Figure 4.1(b) Specific gravity of soil samples

Case (A)

Normal available tested soil is used for testing

Volume of Mould used 2250cc
Maximum dry density from Proctor's test = 1.72 g/cc
Optimum moisture content = 11.62%

S.No	Penetration dial gauge reading	Penetration	Guage readings	
			Dial guage reading	Proving readings
1	0	0	0.00	0.00
2	50	0.5	1.21	33.00
3	100	1.0	2.12	57.81
4	150	1.5	2.15	85.09
5	200	2.0	3.15	114.00
6	250	2.5	4.18	140.18
7	300	3.0	7.44	203.72
8	350	3.5	10.23	279.90
9	400	4.0	12.87	351.00
10	450	4.5	17.54	478.36
11	500	5.0	21.70	591.87
12	600	6.0	26.14	712.91
13	700	7.0	28.45	755.91
14	1000	10.0	35.14	958.37
15	1250	12.5	47.58	1279.64

Table 4.9 CBR test results for **Case A**

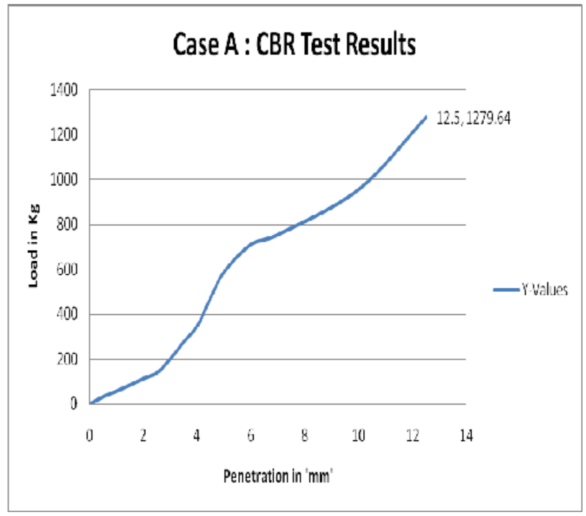

Figure 4.9 CBR test results for **Case A**

CBR for 2.5mm penetration =**12.4%**
CBR for 5mm penetration=**10.7%**

Case (B)

4.10.(i) Normal available soil tested with 3% SS emulsion added

Volume of Mould used 2250cc
Maximum dry density from Proctor's test = 2.08 g/cc
Optimum moisture content = 10.45%

S.No	Penetration dial gauge reading	Penetration	Guage readings	
			Dial guage reading	Proving readings
1	0	0	0.00	0.00
2	50	0.5	1.19	33.00
3	100	1.0	2.08	57.81
4	150	1.5	2.12	82.18
5	200	2.0	2.98	112.00
6	250	2.5	3.45	135.48
7	300	3.0	4.07	200.05
8	350	3.5	6.79	265.18
9	400	4.0	10.18	320.32
10	450	4.5	11.87	418.65
11	500	5.0	17.50	519.74
12	600	6.0	21.08	702.66
13	700	7.0	25.14	724.92
14	1000	10.0	35.07	942.73
15	1250	12.5	46.56	1227.54

Table 4.10.(i) CBR test results for **Case B** Normal available soil tested with 3% SS emulsion added

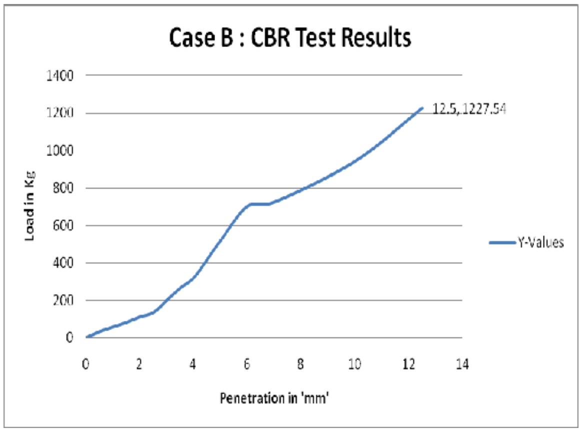

Figure 4.10.(i) CBR test results for **Case B** Normal available soil tested with 3% SS emulsion added

CBR for 2.5mm penetration =**18.3%**
CBR for 5mm penetration=**10.3%**

Case (C)

4.11.(i) Normal available soil tested with 3% SS emulsion and 2% cement added

Volume of Mould used 2250cc
Maximum dry density from Proctor's test = 2.12 g/cc
Optimum moisture content = 10.25%

S.No	Penetration dial gauge reading	Penetration	Guage readings	
			Dial guage reading	Proving readings
1	0	0	0.00	0.00
2	50	0.5	1.08	26.72
3	100	1.0	1.92	50.78
4	150	1.5	1.97	80.18
5	200	2.0	2.54	108.20
6	250	2.5	2.97	128.51
7	300	3.0	3.72	172.72
8	350	3.5	6.38	246.23
9	400	4.0	9.77	302.32
10	450	4.5	11.12	403.65
11	500	5.0	16.98	501.47
12	600	6.0	22.00	700.26
13	700	7.0	24.78	709.92
14	1000	10.0	34.07	951.73
15	1250	12.5	40.98	1007.10

Table 4.11(i) CBR test results for **Case C** Normal available soil tested with 3% SS emulsion and 2% cement added

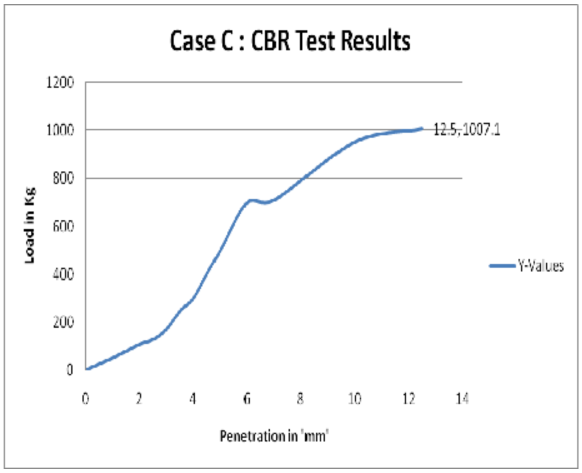

Figure 4.11(i) CBR test results for **Case C** Normal available soil tested with 3% SS emulsion and 2% cement added
CBR for 2.5mm penetration =**19.9%**
CBR for 5mm penetration=**12.29%**

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 MS bitumen emulsion if proper mixing is done.
- It is seen that it best results are obtained if the soil emulsion mix is left for about five and half hours after mixing.
- In each 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 up to fifty percent of the unmodified soil CBR.

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