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Detailed Study Of Bitumen Emulsion In Gravel Road

Jegannathan. S (761525301)

PG Student, Prist University, Thanjavur

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 gravel soil by adding bitumen emulsion. An attempt has been made to use emulsion for improving the strength of gravel 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 gravelly soil with CMS Bitumen emulsion have been first 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 gravel soil.

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. 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.

Objective

The main objective of this experimental study is to improve the properties of the gravely soil by adding bitumen emulsion as stabilizing agent and little bit cement as filler. An attempt has been made to use emulsion for improving the strength and geotechnical properties of gravel soil. Very mostly, use of use of bitumen emulsion is environmentally accepted. To achieve the whole project some experimental investigation is needed in laboratory. The experiments which to be conducted are Specific Gravity of the soil sample, Grain size Distribution of soil sample and liquid limit plastic limit test to identify the material and Standard Proctor test to obtain maximum dry density and optimum moisture content of soil sample, CBR test of soil

sample mixing with emulsion and cement. So the main objective is to maximize the CBR value by checking some conditions to increase the CBR value of soil subgrade.

Framework of the Study

Selection of material and methodology those are the first criteria for any type of experimental investigation. To know the soil physical properties following tests are conducted like specific gravity test, grain size distribution test by sieve analysis and plastic limit and liquid limit test. 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 maximize the CBR value.

Experimental Investigations

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.

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.

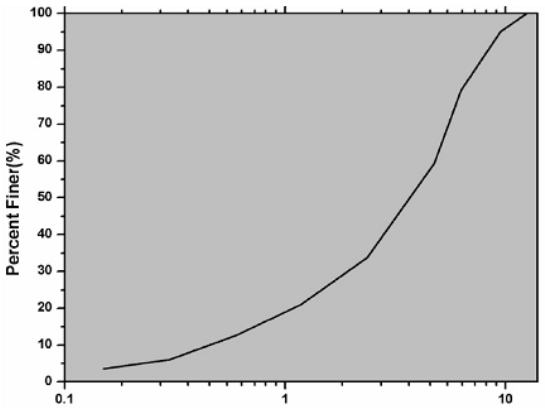
Bitumen Emulsion

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.

Sieve analysis result

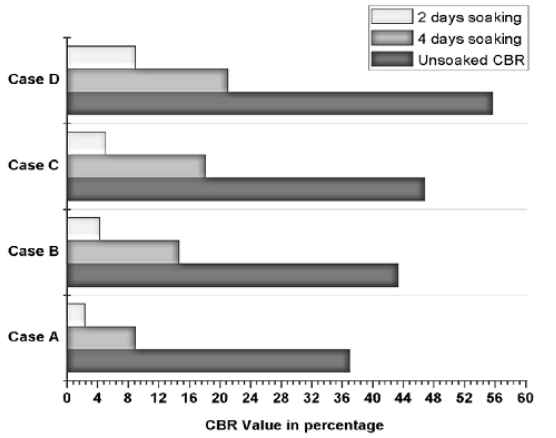
Sieve No. #	Sieve size	Mass of soil retained in each sieve (gm)	Percent retained (%)	Cumulative retained (%)	Percent finer (%)
1/2 Inch	12.5 mm	0	-----	0	100
3/8 Inch	9.5 mm	99.1	4.95	4.95	95.05
1/4 Inch	6.3 mm	318.8	15.94	20.84	79.16
#4	4.75 mm	397.5	19.88	40.77	59.33
#8	2.36 mm	510.2	25.51	66.28	33.72
#16	1.18 mm	255.1	12.71	79.03	20.97
#30	600 micron	166.2	8.31	87.34	12.66
#50	300 micron	132.1	6.61	93.95	6.05
#80	150 micron	48.7	2.44	96.39	3.61
Pan	-----	72.3	3.6	100	0



Grain size distribution graph

Summary

Subgrade 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.



Conclusions

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. 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.

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