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### *Strengthening of Soil by Bitumen Emulsion*

#### **Abstract**

Soil is one of nature's most abundant construction materials. Almost all type of constructions is built with or upon soil. If the sub-grade is not good enough, cracks may appear in the whole structure which may ultimately lead to failure. Conventionally, the sub-grade is normally replaced with stronger soil materials to improve the strength, but this practice is not economical. Instead of replacing it with stronger soil, an attempt has been made to strengthen the shear strength by adding bitumen emulsion. The soil has been classified by conducting soil tests such as sieve analysis, liquid limit test, plastic limit test, shrinkage limit test, standard proctor test. The initial strength of soil has been determined by conduction soil tests such as California bearing ratio tests and compression test. The results obtained is then compared with various proportions (10%, 20% and 25%) prepared of soil of bitumen emulsion mixed with soil and conclusion is drawn which proportion would be suitable for the chosen soil.

**Keywords:** Soil Improvement, Bitumen Emulsion, Shear strength, CBR, Sub-grade improvement.

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#### **I. Introduction**

The foundation is very important and has to be strong enough to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, we need to have proper knowledge about their properties and factors which affect their behaviour to work with the soil. The process of soil stabilization helps to achieve the required properties in a soil needed for the type of construction work. Hence an emulsifier (a surface-active agent) is added with In this thesis, the strength of soil is improved by using bituminous emulsion. Bitumen emulsion is a mixture of water and bitumen. As bitumen is in oil product it cannot be mixed with water. water before adding bitumen. Addition of emulsifier with water before adding bitumen into minuteparticles and keeps is dispersed in suspension.

1. The term emulsion means that dispersion of small droplets of one liquid in another liquid. Types of emulsion are oil-in-water (continuous phase in water and the disperse phase in an only) and water-in oil (continuous phase in oil and the disperse phase in water). Here the emulsifier is used as kerosene with water. Initially the properties of soil are determined by using conducting sieve analysis, plastic limit, liquid limit, specific gravity and shrinkage limit. The strength of soil is determined by modified proctor, compaction and California bearing ratio tests and the results are compared with soil after threatened with bituminous emulsion.

#### **Problem Statement**

The safety of any geotechnical structure is dependent on the strength of soil, if the soil fails, the structure founded on it can collapse. Understanding shear strength is the basic to analyse soil stability problems like: lateral pressure on earth retaining structure, slope stability, bearing capacity, according to above study we are able to know the importance of shearing strength of soil. While constructing any structure, structure may be of any form. It directly depends upon the relation between soil, structure and its loading.

## II. Objectives

### The objectives of this study are: -

1. to find the shear strength of natural soil using compressive test.
2. To find the bearing strength of natural soil using CBR test.
3. To find the shear strength of soil mixed with bitumen emulsion using compressive test.
4. to find bearing strength of soil mixed with bitumen emulsion using CBR test.
5. To compare the shear strength of natural soil with that of soil mixed with bitumen emulsion.
6. To compare the bearing strength of the natural soil with that of soil mixed with bitumen emulsion.
7. To suggest the optimum grade of bitumen emulsion for soil improvement.

## III. Methodology

Methodology involves collection of soil sample (laterite soil) from the, study of soil properties by conducting tests (particle sieve analysis, Atterberg's limits, direct shear tests, relative density, unconfined compression test, California bearing ratio, modified proctor compaction, specific gravity), addition of bitumen Emulsion to the soil at different proportions, testing of bitumen emulsion added soil and comparison of test results

### Physical Properties of Bitumen.

Adhesion: Bitumen has the ability to adhere to a solid surface in a fluid state depending on the nature of the surface. The presence of water on the surface will prevent adhesion.

2) Resistance to Water: Bitumen is water resistant. Under some conditions water may be absorbed by minute quantities of inorganic salts in the bitumen or filler in it.

3) Hardness: To measure the hardness of bitumen, the penetration test is conducted, which measures the depth of penetration in tenths of mm. of a weighted needle in bitumen after a given time, at a known temperature. Commonly a weight of 100gm is applied for 5 sec at a temperature of 77 °F. The penetration is a measure of hardness. Typical results are 10 for hard coating asphalt, 15 to 40 for roofing asphalt and up to 100 or more for water proofing bitumen.

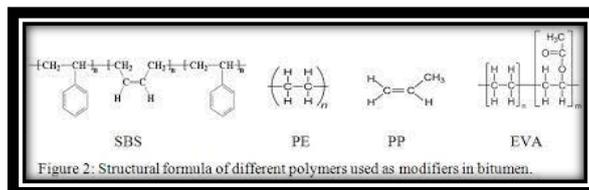
4) Viscosity and Flow: The viscous or flow properties of bitumen are of importance both at high temperature during processing and application and at low temperature to which bitumen is subjected during service. The flow properties of bitumen's vary considerably with temperature and stress conditions. Deterioration, or loss of the desirable properties of bitumen, takes the form of hardening. Resultantly, decrease in adhesive and flow properties and an increase in the softening point temperature and coefficient of thermal expansion.

5) Softening point: Softening point is the temperature at which a steel ball falls a known distance through the bitumen when the test assembly is heated at a known rate. Usually the test consists of a (3/8) in die steel ball, weight 3.5 gm, which is allowed to sink through a (5/8) in die, (1/4) in thick disk of bitumen in a brass ring. The whole assembly is heated at a rate of 9 °F per min. Typical values would be 240 °F for coating grade asphalts, 140 °F to 220 °F for roofing asphalt and down to 115 °F for bituminous water proofing material.

6) Ductility: Ductility test is conducted to determine the amount bitumen will stretch at temperature below its softening point. A briquette having a cross sectional area of 1 in<sup>2</sup> is placed in a tester at 77 °F. Ductility values range from 0 to over 150 depending on the type of bitumen

### Chemical Properties of Bitumen

Molecular weight wise bitumen is a mixture of about 3000-2000 chemical compounds, with an average of around 500-700. Elementally, it is around 95% carbon and hydrogen (=87% and = 8% hydrogen), and up to 5% sulphur, 1<sup>^</sup>5 nitrogen, 1% oxygen and 2000ppm metals.



### Necessity of soil stabilization.

- Proper stabilization of black cotton soil is necessary as it causes differential settlement and hence collapse of structure.
- Utilization plastic waste which causes environmental problems
- Uses of alkalis which is measure content of chemical industries effluents and harmful to environment.

**What is Soil Stabilization**

- It is the alteration of any property of soil to improve its engineering performance.
- A technique aimed at maintaining or improving the stability, load carrying capacity or resistance to water absorption of soil.
- Stabilization can be done for surface and deep deposits of soil masses.

**Principle of Soil Stabilization.**

- Evaluating the properties of soil under consideration.
- Deciding the property of soil which needs to be altered to get the design value to choose the effective and economical proportion for stabilization.
- Designing the stabilized soil mix sample and testing it in the lab for intended stability and durability values.

Sr No.	Characteristics	80/100	60/70	30/40	10/20
1	Specific gravity at 27°C min	0.98	0.99	0.99	1.00-1.05
2	Water percent.	0.2	0.2	0.5	-
3	Flash point, °C	175	175	175	225
4	Softening point °c	35-50	40-55	50-65	65-80
5	Penetration at 25°C, 100 g 5 sec in 1/100 cm.	80-100	60-70	30-40	10-20
6	Ductility at 27°C, in cm. min	75	75	50	2.5
7	Loss on heating, percentage.	1	1	1	0.10
8	Penetration of residue.	60	60	60	-
9	Percent by water soluble in carbon di-sulphide, min.	99	99	99	99

**Advantages of Stabilization.**

- It improves strength of soil and hence increases bearing capacity of soil.
- It is more economical in terms of cost and energy to increase the bearing capacity rather than going for deep foundation or raft foundation.
- Also used to provide more stability to soil slopes.
- Sometimes it is also done for preventing soil erosion or formation of dust.
- Helps to reduce soil volume.
- It is also done for soil water-proofing.
- It improves the workability and durability of the soil.

**Why Bituminous Emulsion.**

- Promotes surface interactions
- Reduces atmospheric pollution
- Water can also add before use to dilute as per requirement
- It's mixture of aggregate attains full strength
- Economical and saves energy
- Rain cannot affect it at time of use and after use
- It can be used for road surfacing without much heating