

IMPROVEMENT OF SHEAR STRENGTH OF SOIL USING BITUMEN EMULSION

¹Ajit Alat, ²Prathamesh Gaikwad, ³Aniket Ingle, ⁴Mrudul Sonar, ⁵Rahul Patil,

¹Student, ²Student, ³Student, ⁴Student, ⁵Assistant Professor,

¹Department of Civil Engineering,

¹Pimpri-Chinchwad College of Engineering and Research, Ravet, Pune, India

Abstract: The civil engineers must study the properties of soil, such as its origin and ability of water content, compressibility, shear strength and load bearing capacity. The civil engineering proposes the soil is unbonded (un-cemented) material. 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 construction is soil and its strength. If strength of soil is poor, then stabilization is normally needed. The foundation of structure is most important of entire structure. The foundation must have more strength to support the entire structure. The stability of the structure depends upon the soil which one is used as the foundation. Every structure- building, bridge, highway, tunnel, canal or dam is founded in or on the soil surface of the earth. Therefore, the sub-grade soil normally replaced with stronger soil which is not economical. In this study an attempt has been made to increase the soil strength by adding the bitumen emulsion. In this study an attempt to find out the comparative results of various strength increasing tests on laterite soil by using the admixture bitumen emulsion. The bitumen emulsion is added in laterite soil at 10%, 12%, 14% proportions. The initial strength of the laterite soil is determined through various tests like Water content, Specific Gravity, Compaction, Unconfined Compression, and Direct Shear tests. The same tests have been conducted with laterite soil added with bitumen emulsion. The results obtained are then compared with laterite soil without emulsion and laterite soil added with emulsion.

IndexTerms – Laterite soil, Bitumen Emulsion, Shear Strength.

I.INTRODUCTION

The foundation 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. Every man-made structure resting on the ground needs safe and stable soil. To attain this safety and stability requirements the engineering properties of the soil beneath the structure or on the structure must be identified.

Modifying the properties of a soil to improve its engineering performance is referred to as soil stabilization. Methods of stabilization may be grouped under two main types: (a) modification or improvement of a soil property of the existing soil without any admixtures. Examples for this kind of stabilization are compaction and drainage which improve the inherent shear strength of soil (b)modification of the properties with the help of admixtures Examples for second type stabilization are Mechanical stabilization, stabilization with cement, lime and chemicals etc.

Currently all pavement construction projects are using either one or both of these stabilization procedures. The most familiar type of mechanical soil stabilization is compaction of the soil, while the addition of lime, cement, fibres, bituminous or alternate executors is suggested to as a synthetic or added substance procedure for stabilization of soil. The process of soil stabilisation helps to achieve the required properties in a soil needed for the type of construction work. In this study, the strength of the soil is improved by using bituminous emulsion and in various proportions.

1.1 MATERIAL:

Bitumen Emulsion-

An attempt has been made to use emulsion for improving the strength and geotechnical properties of soil. Very mostly, use of bitumen emulsion is environmentally accepted. Bitumen emulsion consists of three basic ingredients such as bitumen, water, and an emulsifying agent i.e., Kerosine. Based on the specifications it may contain other additives, such as stabilizers, coating improvers, anti- strips, or break control agents. It is well known that water and asphalt will not mix, except under carefully controlled conditions using highly specialized equipment and chemical additives.

Laterite Soil-

Laterite is a soil and rock type rich in iron and aluminum and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterite is of rusty-red coloration, because of high iron oxide content. They develop by intensive and long-lasting weathering of the underly the parent rock. Tropical weathering (laterization) is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils. Laterites are a source of aluminum ore; the ore exists largely in clay minerals and the hydroxides, bauxites which resembles the composition of bauxite. In Northern Ireland they once provided a major source of iron and aluminum ores. Laterite ores also were the early major source of nickel.

1.2 OBJECTIVES OF THE PROPOSED WORK:

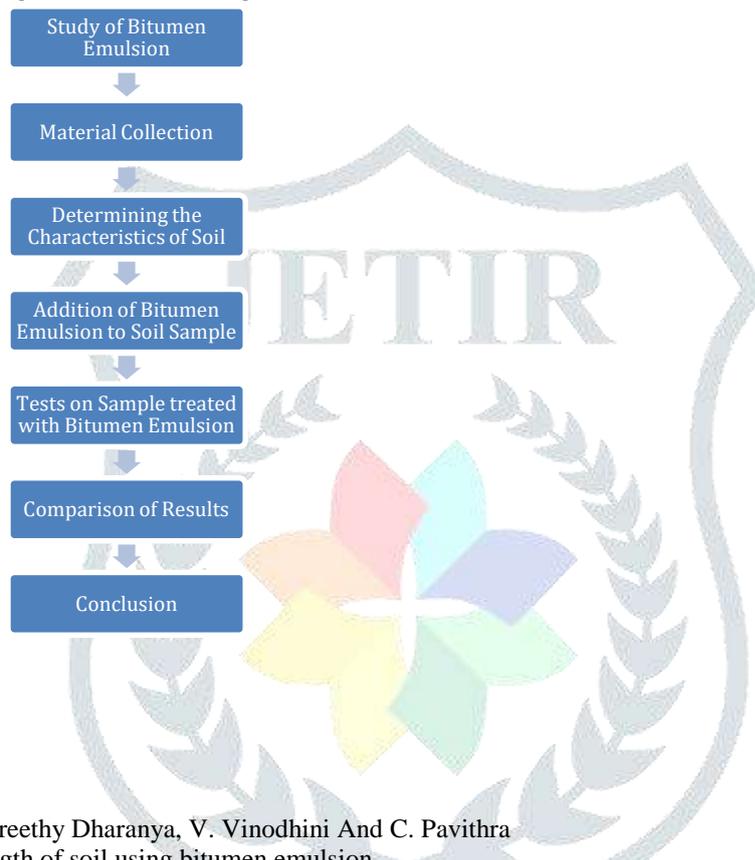
- Determining the index properties of soil (water content, specific gravity, dry density, optimum moisture content) without using the bitumen emulsion.
- Observing the variation of strength in the performance of soils by using Bitumen Emulsion (Different proportions).

1.3 SCOPE OF THE PROPOSED WORK:

- An attempt has been made to use emulsion for improving the strength and index properties of laterite soil. Very mostly, 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, Water content of soil sample to identify the material and Standard Proctor test to obtain maximum dry density and optimum moisture content of soil sample, compression test, Direct shear test, of soil sample mixing with emulsion. So, the main objective is to improve index properties by checking at different proportions to improve the strength of soil.

1.4 RESEARCH METHODOLOGY OF THE STUDY:

Methodology involves collection of soil sample (laterite soil) from the site (Mahad), study index properties of soil by conducting tests (water content, direct shear tests, unconfined compression test, standard 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. The methodology of this study is given in the following flow chart.



II. LITERATURE REVIEW:

1. Reby Linsha, Y. Preethy Dharanya, V. Vinodhini And C. Pavithra
Improvement of shear strength of soil using bitumen emulsion

Test result indicate that with the increase of bitumen emulsion in the soil sample till 10% proportion ratio the soil strength is increased and after certain percentages (20% and 30%) its getting decrease. The results are shown that the strength of the soil is good when 10% bitumen emulsion is added.

2. N. Vijay Kumar, S S. Asadi, A.V.S. Prasad, G Pradeep Kumar
Study on strength of laterite soil using bitumen emulsion and ESP, CSA

The results which came after carrying out all tests found successful which indicates that the admixtures added (bitumen and ESP and CSA) can be surely used as a laterite soil stabilizer. From the results it is proved that these admixtures were effective in stabilizing the soil at 10% and with further increase in admixtures lowers the strength of soil.

3. Mr. Ghosh, Mr. Rabindranath Ghosh, Mr. Love Gupta, Mr. Ankur Kumar

A review paper on stability of soil block using bitumen emulsion

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. But the cost of emulsion is so high so the amount of emulsion also depends upon budget and importance of structure.

4. Shubham Langer, Er Paramjeet

A review study on the use of bitumen emulsion in the soil sample

The unconfined compressive strength of soil increased by the addition of admixtures such as bitumen emulsion. Addition of bitumen emulsion with soil reduces their plastic indices significantly the use of bitumen emulsion to stabilize uniform grained soil can create improved ground layer but also a surface base. 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. Specific gravity of the soil is increased when the bitumen emulsion is mixed with gravel.

III. RESULT:**3.1 MOISTURE CONTENT TEST:****Objective:**

To determine the water content of soil solids by Oven Drying method.

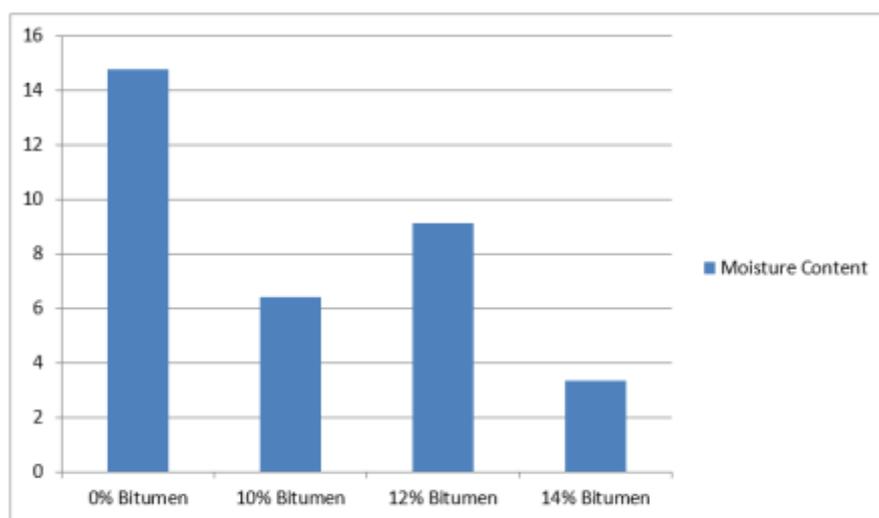
The water content (w) of a soil sample is equal to the mass of water divided by the mass of solids.

Specification:

This test is done as per IS: 2720 (Part II) – 1973.

Equipments Required:

- Non-corrodible airtight containers.
- Balance weighting to accuracy of 0.04% of the weight of the soil taken for test.
- Desiccators with suitable desiccating agent.
- Thermostatically controlled oven to maintain temperature $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- other accessories.

**3.2 SPECIFIC GRAVITY TEST:****Objective:**

To determine the specific gravity of soil solids by Pycno-meter bottle method.

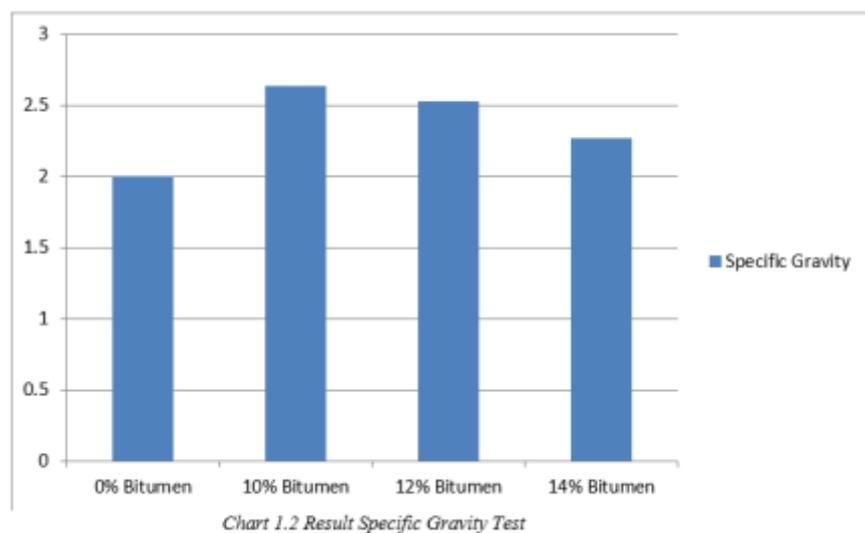
Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature.

Specification:

This test is specified in IS: 2720 (Part 4) – 1985.

Equipments Required:

- Pycnometer of about 1 liter capacity
- Balance accurate to 1 g, glass rod, de-aired distilled water etc.

**3.3 STANDARD PROCTOR TEST:****Objective:**

To determine moisture content – dry density relationship by standard proctor test.

Compaction is the application of mechanical energy to a soil so as to rearrange its particles and reduce the void ratio. It is applied to improve the properties of an existing soil or in the process of placing fill such as in the construction of embankments, road bases,

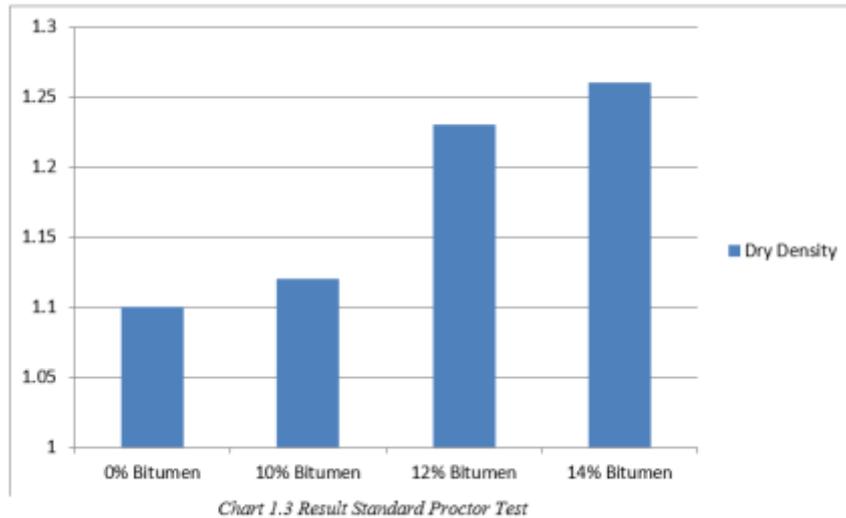
runways, earth dams, and reinforced earth walls. Compaction is also used to prepare a level surface during construction of buildings. There is usually no change in the water content and in the size of the individual soil particles.

Specifications:

The experiment is conducted as per IS 2720-7(1980).

Equipment Required:

- a) Typical equipment for proctor test is given in figure.
- b) Other accessories are: Balance, oven, straight edge, sieves, metal hammer, etc.



3.4 UNCONFINED COMPRESSION TEST:

Objective:

To determine the unconfined compression test of soil.

It is not always possible to conduct the bearing capacity test in the field. Sometimes it is cheaper to take the undisturbed soil sample and test its strength in the laboratory. Also to choose the best material for the embankment, one has to conduct strength tests on the samples selected. Under these conditions it is easy to perform the unconfined compression test on undisturbed and remoulded soil sample.

Specifications:

The test is conducted as per IS 2720-10 (1991).

Equipment Required:

1. Loading frame of capacity of 2 t, with constant rate of movement. What is the least count of the dial gauge attached to the proving ring!
2. Proving ring of 0.01 kg sensitivity for soft soils; 0.05 kg for stiff soils.
3. Soil trimmer.
4. Frictionless end plates of 75 mm diameter (Perspex plate with silicon grease coating).
5. Evaporating dish (Aluminum container).
6. Soil sample of 75 mm length.
7. Dial gauge (0.01 mm accuracy).
8. Balance of capacity 200 g and sensitivity to weigh 0.01 g.
9. Oven, thermostatically controlled with interior of non-corroding material to maintain the temperature at the desired level. What is the range of the temperature used for drying the soil.
10. Sample extractor and split sampler.
11. Dial gauge (sensitivity 0.01mm).

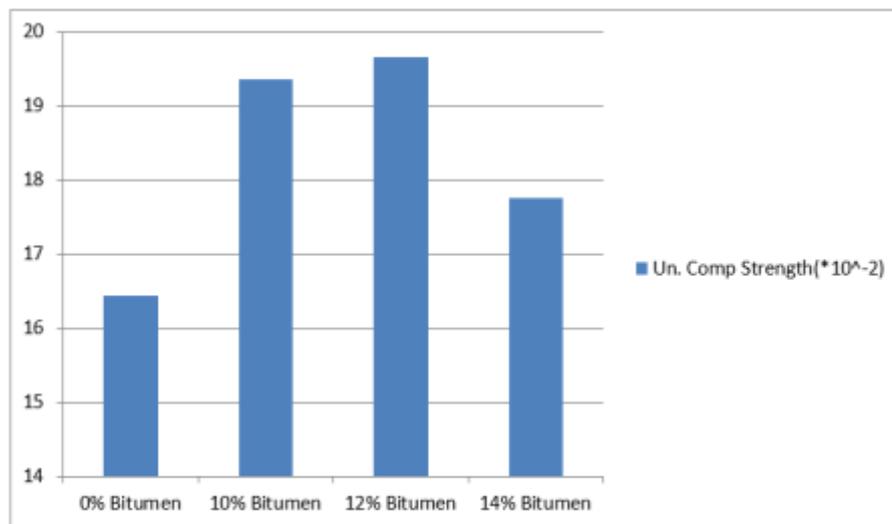


Chart 1.4 Result Compression Test

3.5 DIRECT SHEAR TEST:

Objective:

To determine the shear strength of soil using the direct shear apparatus.

In many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are required for the design. Direct shear test is used to predict these parameters quickly. The laboratory report covers the laboratory procedures for determining these values for cohesion-less soils.

Specifications:

The test is conducted as per IS: 2720- 13 (1986), method of tests for soils. One kg of air-dry sample passing through 4.75mm IS sieve is required for this test.

Equipments Required:

Shear box apparatus consisting of

- Shear box 60 mm square and 50 mm deep,
- Grid plates, porous stones, etc.
- Loading device
- Other accessories.

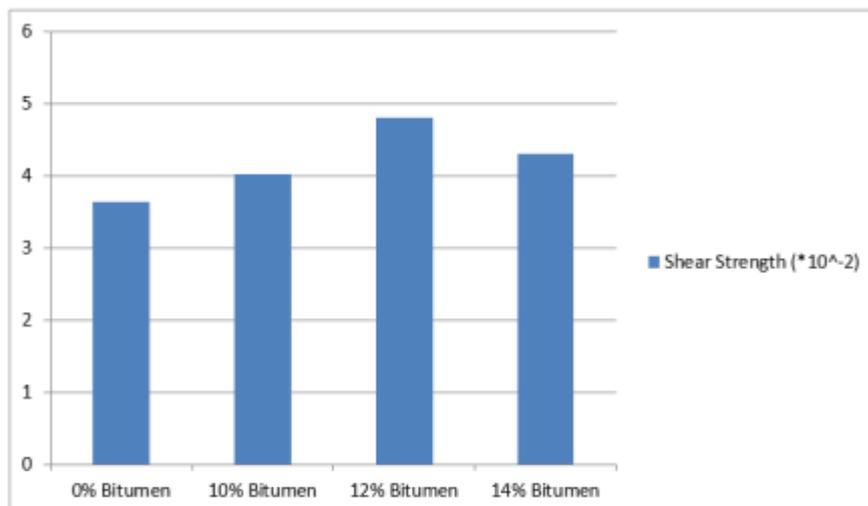


Chart 1.5 Result Direct Shear Test

IV. CONCLUSION:

The study made a comprehensive examination of the effectiveness of soils on the performance of bitumen emulsion. The characteristics of soil sample were known from the tests conducted and the similar tests are conducted for the soil sample mixed with three different proportions of bitumen emulsion (10%, 12% and 14%). Test result indicate that with the increase of bitumen emulsion in the soil sample till 12% proportion ratio the soil strength is increased and after certain percentage (14%) its getting decrease. The results shows that the strength of the soil is good when 12% bitumen emulsion is added.

The results which came after carrying out all tests found successful which indicates that the admixtures added (bitumen emulsion) can be surely used as a soil stabilizer.

By considering its economic cost and quality of stabilization improvement, hence it is clear that this type of bitumen emulsion stabilization may be applicable in Sub-grade soil road or at foundation of structure.

V. ACKNOWLEDGMENT:

It gives me an immense pleasure to submit this project report on "IMPROVEMENT OF SHEAR STRENGTH OF SOIL USING BITUMEN EMULSION." We tried our level best to represent this topic into compact and to the point framework. Wish to express our sincere thanks with profound gratitude to our project guide Prof. Rahul Patil for his valuable guidance and constant encouragement without which it would have been impossible for us to present and complete this project successfully.

We would like to extend our sincere and true thanks to our Head of Department Dr. Sameer Sawarkar and principal Dr. H.U. Tiwari as well as all the staff members for imparting us the best of their knowledge and guidance. Last but not the least; we also thank Asst. Prof. Omkar Bhalekar, all our beloved friends, Department Staff and respected Teachers for their assistance and help.

REFERENCES:

- 1) R. Deby Linsha, Y. Preethy Dharanya, V. Vinodhini and C. Pavithra, IMPROVEMENT OF SHEAR STRENGTH OF SOIL USING BITUMEN EMULSION, IJCIET, Volume 7, Issue 6, November-December 2016
- 2) N. Vijay Kumar, S S. Asadi, A.V.S. Prasad, G. Pradeep Kumar, STUDY ON STRENGTH OF LATERITE SOIL, Technical research organization India
- 3) M.Udaya Sri, P.M.S.S. Kumar, An Experimental Study on Laterite Soil Stabilization Using Bitumen Emulsion, International Journal of Innovative Research in Science, Engineering and Technology Vol. 6, Issue 2, February 2017
- 4) E. Kowaski and Dale Starry, Jr. Wirtgen America, Inc., (2007) Modern Soil Stabilization Techniques. NORMALSOIL 10%20% 25%.
- 5) Maheswari g. Bismal and Ravi Kumar badiger (July 2015) Study on Stabilization of Soil Using Sea and Bitumen Emulsion.
- 6) K. Prashanth Kumar (october2014) Stabilization of Soil using Bitumen Emulsions.
- 7) Tridib Goswami (May 2014) A laboratory Study on Use of Bitumen Emulsions in Gravel Road ridib Goswami (May 2014) A Laboratory Study on Use of Bitumen Emulsion in Gravel Road.
- 8) SK. Wasim Anwar, Experimental Investigations on Mar shall and Modified Marshall Specimens by using Neat Bitumen. International Journal of Civil Engineering and Technology (IJCIET), 7(5), 2016, pp.409–419

