e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 5, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505025 |

Improvement of Soil Properties by Using Bitumen Emulsion

Asst. Prof.Mayur Tanpure[1], Sidhant Patil[2] , Rohan Ransing[3], Sarthak Borde[4] , Nikhil Kale[5]

Professor, Dept. of Civil Engineering, Dr. D. Y. Patil School of Engineering and technology, Lohegaon, Pune, India[1]

Student (U.G.), Dept. of Civil Engg., Dr. D. Y. Patil School of Engineering and technology, Lohegaon, Pune, India[2345]

ABSTRACT: Soil is one of nature's most abundant construction materials. Almost all type of constructions arebuilt 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. In this project, an attempt has been made to increase the strength of soil by adding bituminous emulsion instead of replacing it with stronger soil. 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 conducting soil tests such as Californiabearing ratio tests and unconfined compression test. The results obtained is then compared with the soil treated with 7% (by weight) of bitumen emulsion at different grades of bitumen emulsion and conclusion were drawn on to which grade would be suitable for the chosen soil.

KEYWORDS: Soil improvement, Bitumen emulsion, Shear strength, CBR, Subgrade improvement.

1.INTRODUCTION

Background.

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 behavior to work with soil. The process of soil stabilization helps to achieve the required properties in a soil needed for the type of construction work.

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 analyze 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.

Proposed Solution.

In this report, the soil is improved by using bituminous emulsion. Bitumen emulsion is a mixture of water or oil & bitumen. As bitumen is an oil product it cannot be mixed with water. Hence an emulsifier (a surface-active agent) is added with water before bitumen. Addition of emulsifier with water before adding bitumen into minute particles and keeps it dispersed in suspension.

The soil sample for the project is taken from the AIKTC vicinity. The work has been carried out by performing different experiments related to soil. The shear strength of the soil is tested by Unconfined compression test. The soil which is used for testing is taken from different location of campus vicinity.

The term emulsion means that dispersion of small droplets of one liquid in another liquid. Types of emulsion are oil –in-water (continuous phase is water and the disperse phase is an oily) and water-in-oil (continuous phase is an oil and the disperse phase is water). Here the emulsifier is used as kerosene with water.

1.1 Objective:

The objectives of this study are:

1. To find the shear strength of natural soil using unconfined compressive test.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

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 confined compression test.
4. To find the 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 natural soil with that of soil mixed with bitumen emulsion.
7. To suggest the optimum grade of bitumen emulsion for soil improvement.

II.LITERATURE REVIEW

Introduction

During the literature review for this work, we referred quite a few books on soil, technical and research papers from various national and international journals. This part focuses on the literature on improvement of soil using bitumen emulsion and on various studies related to improvement of soil using bitumen emulsion.

Summaries of Relevant Literature :

ElifasBunga (2011), has analyzed the effect of soil stabilization with emulsified asphalt on soil characteristics that can increase its strength. The soil used in this study was sandy clay loam. Soil sample was taken in its original and disturbed forms. Emulsified Asphalt type CSS-1S used for soil stabilization. Disturbed soil sample was mixed up with emulsified asphalt, cast and kept for three days then tested. The concentrations of emulsified asphalt used in this study were 1.5%, 3%, and 4.5% respectively toward dry soil weight. Test performed was Atterberg's limits, direct shear tests. The results of the study indicate that stabilization material for emulsified asphalt can improve physical, chemical, and mechanic characteristics of sandy clay loam. Plasticity and shear strength of soil increase in line with the increase of emulsified asphalt concentration.

ParithoshaPerika (2015), has improve the shear strength of soil by using Bitumen Emulsion. Medium Setting Emulsion (MS) is used as a stabilizing agent. Bitumen sand stabilization is an effective process as bitumen makes soil stronger and improves resistance capacity against water and frost. Attempt made to improve Geotechnical properties of soil and Bitumen Emulsion is environmentally accepted. Main objective is to maximize CBR value by checking conditions to increase the CBR value of soil subgrade. Cationic emulsions are positively charged bituminous droplets and Anionic emulsions have negatively charged bituminous droplets. Best results are obtained if soil emulsion mix is left for five and half (5&1/2) hours after mixing.

III.METHODOLOGY

Methodology involves collection of soil sample from Dr. D.Y. Patil School Of Engineering And Technology Campus, study of soil properties by conducting tests (particle sieve analysis, Atterberg's limits, water content, unconfined compression test, California bearing ratio, modified proctor compaction, specific gravity), addition of bitumen Emulsion to the soil of different grade, and comparison of test results.

Standard Proctor Compaction Test

In accordance with IS 2720 (Part 7):1980.

Apparatus for Standard Proctor Compaction Test

Cylindrical mould& accessories [volume = 1000cm3], Rammer [2.6 kg], Balance [1gaccuracy], Sieves [19mm], Mixing tray, Trowel, Graduated cylinder [500 ml capacity], Metal container.

Procedure for Standard Proctor Compaction Test

1.5 Kg. of soil was taken and the water was added to it to bring its moisture content to about 4 % in coarse grained soils and 8% in case of fine grained soils with the help of graduated cylinder 2.The mould with base plate attached was weighed to the nearest 1 gm (M_1). The extension collar was to be attached with the mould.

3. Then the moist soil in the mould was compacted in three equal layers, each layer being given 25 blows from the 2.6 Kg rammer dropped from a height of 310 mm. above the soil.
4. The extension was removed and the compacted soil was leveled off carefully to the top of the mould by means of a straight edge.
5. Then the mould and soil was weighed to the nearest 1 gm. (M_2).

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

6. The soil was removed from the mould and a representative soil sample was obtained water content determination.
7. Steps 3 to 6 were repeated after adding suitable amount of water to the soil in an increasing order.

Unconfined Compressive Strength Test

In accordance with IS 2720 (Part10)-1991.

Apparatus for Unconfined Compressive Strength Test

Unconfined compressive test, proving ring type. Proving ring, capacity 1 KN, accuracy 1 N, Dial gauge, accuracy 0.01 mm, Weighing balance, Oven, Stopwatch, Sampling tube, Split mould, 38mm diameter, 76mm long, Sample extractor, Knife, Vernier calipers, Large mould.

Procedure for Unconfined Compression Test

1. Soil was mixed with water. This sample was than filled in the mould which was oiled in advance. The mould was having the same internal diameter as that of specimen which was tested.
2. The mould was opened carefully and sample was taken out
3. Two or three such samples were prepared for testing.
4. The initial length and diameter of the specimen was measured.
5. The specimen was kept on bottom of the loading device. Adjusted upper plate to make contact with the specimen. The dial gauge (compression) was set to zero. The dial gauge reading provides the deformation in the sample and in turn strain.
6. The specimen was compressed until crakes are developed or the strain curve was well past its peak or until a vertical deformation of 20% was reached. The dial reading was taken approximately at every 1 mm deformation of the specimen.
7. The proving ring reading provides the corresponding load in- turn axial stress on the sample.
8. The procedure were repeated for three times.

California Bearing Ratio

In accordance with IS 2720 (Part 16) – 1987.

Apparatus for California Bearing Ratio

CBR mould, inside diameter = 150 mm, total height =175 mm, with detachable extension collar, 50 mm high, and detachable base plate, 10 mm thick. Spacer disc, 148 mm diameter, 47.7 mm high. Rammers, light compaction, 2.6 kg, drop 310 mm, heavy compaction, 4.89 kg, drop 450 mm. Slotted masses, annular, 2.5 kg each, 147 mm diameter, with a hole of 53 mm diameter in the center. Cutting collar, steel which can fit flush with the mould both outside and inside. Expansion measuring apparatus, consisting of a perforated plate, 148 mm diameter, with a thread screw in the center and an adjustable contact head to be screwed over the stem, and a metal tripod. Penetration piston, 50 mm diameter, 100 mm long. Loading device, capacity 50 KN, equipped with a movable head (or base) at a uniform rate of 1.25 mm minute. Two dial gauges, accuracy 0.01 mm. IS sieve, 4.7 mm and 20 mm size.

Procedure for California Bearing Ratio

Preparation of test specimen:

Remoulded specimen: The remoulded specimen at Proctors maximum dry density or any other density was prepared at which C.B.R was required. The specimen was maintained at optimum moisture content. The material used were pass through 20 mm I.S. sieve and it is retained on 4.75 mm I.S. sieve. The specimen was prepared either by dynamic compaction.

Procedure for Penetration Test:

1. The mould assembly with the surcharge weights was placed on the penetration test machine.
2. The penetration piston were set at the center of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample was established.
3. The stress and strain dial gauge were set to read zero. The load was applied on the piston so that the penetration rate was about 1.25 mm/min.

4.The load readings were recorded at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 and 12.5 mm. The maximum load and corresponding penetration was noted.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

Table 3.1 Quantity of soil required in kg or gm for above tests

TEST	QUANTITY(gm)
Grain size analysis	800
Water content	100
Standard proctor test	5000
Liquid limit	120
Plastic limit	30
Total	6050
CBR test	20000
Unconfined compressive strength test	500
Total	20500
Total= 6050+ (20500)	**26550**

Table 3.2 Quantity of bitumen required in kg or gm

TEST	QUANTITY
CBR test	7% of soil sample 385 gm/grade
Unconfined compressive test	7% of soil sample 35 gm/grade
Total	**420 gm/grade**

IV.RESULT AND DISCUSSION

The characteristic study on the collected soil sample was conducted and then the respective tests are conducted for the bitumen emulsion mixed soil sample of three different grades. The test results are compared and given below.

Table 4.2.1 Liquid Limit.

Observation	1	2	3	4
No. of blows	15	27	18	30
Wt. of empty can	15.04	15.63	15.05	15.14
Wt. of can plus wet soil	26.03	27.28	28.16	25.81
Wt. of can plus dry soil	21.91	23.1	23.22	21.98
Wt. of water	4.12	4.18	4.94	3.83
Wt. of dry soil	6.87	7.47	8.17	6.84
Water content	59.97089	55.95716	60.46512	55.99415

Table 4.2.2 Plastic Limit Test.

Observation	1
Wt. of empty can	15.1
Wt. of can plus wet soil	18.1
Wt. of can plus dry soil	17.26
Wt. of water	0.84
Wt. of dry soil	2.16
Water content	38.88889

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

From Table 4.2.2 it was calculated that Plastic Limit was 38%. Liquid limit of the soil is 57% and plastic limit of soil is 38% and plasticity index is 19%. Therefore, soil is MH or OH (Inorganic silt of high compressibility or organic clay of medium to high plasticity)

Standard Proctor Compaction Test.

Table 4.4 Standard Proctor Compaction Test.

Determination no.	1	2	3	4
Volume of mould (cm^3)	1000	1000	1000	1000
Wt. of mould, W1 (g)	7705	7705	7705	7705
Wt. of mould + compacted soil, W2 (g)	9480	9665	9600	9575
Wt. of compacted soil, W = W2-W1	1775	1960	1895	1870
Bulk density, =W/V g/cm^3	1.775	1.96	1.895	1.87
Water Content, w	0.169	0.2546	0.2436	0.2715
Dry density,	1.518392	1.562251	1.523802	1.470704

Unconfined Compression Test.

Table 4.5.1 Soil Without Bitumen Emulsion

Sample no.	**DGR**	**PRR**	**Deformation = DGR * G/10**	**Load = PRR * CF**	**Strain**	**Concentrated Area**	**Compressive stress P/A**
1	30	6.2	0.03	1.426	0.003947	11.38594452	0.125242135
	60	12.7	0.06	2.921	0.007895	11.43124668	0.255527685
	95	15	0.095	3.45	0.0125	11.48455696	0.300403404
2	40	10.1	0.04	2.323	0.005263	11.40100529	0.203753962
	70	9	0.07	2.07	0.009211	11.44642762	0.180842449
3	40	4.8	0.04	1.104	0.005263	11.40100529	0.096833566
	68	11.3	0.068	2.599	0.008947	11.44338821	0.227118049

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

From table 4.5.1 which shows UCT results (q_u) of normal soil the maximum value which comes out was 0.227 kN/m^2, so the shear strength was (q_u/2) = 0.113 kN/m^2.

Sample no.	DGR	PRR	Deformation = DGR * G/10	Load = PRR * CF	Strain	Concentrated Area	Compressive stress P/A
1	50	4.2	0.05	0.966	0.006579	11.41610596	0.084617294
	100	6.5	0.1	1.495	0.013158	11.49221333	0.130088083
	150	7.8	0.15	1.794	0.019737	11.56934228	0.155064995
2	50	3.8	0.05	0.874	0.006579	11.41610596	0.076558505
	100	8.1	0.1	1.863	0.013158	11.49221333	0.162109765
	150	9	0.15	2.07	0.019737	11.56934228	0.178921148
	200	9.1	0.2	2.093	0.026316	11.64751351	0.179695005
3	50	3.5	0.05	0.805	0.006579	11.41610596	0.070514412
	100	8.2	0.1	1.886	0.013158	11.49221333	0.16411112
	150	9.8	0.15	2.254	0.019737	11.56934228	0.19482525
	200	13.8	0.2	3.174	0.026316	11.64751351	0.272504513
4	50	0.4	0.05	0.092	0.006579	11.41610596	0.00805879
	100	1.2	0.1	0.276	0.013158	11.49221333	0.024016261
	150	3.4	0.15	0.782	0.019737	11.56934228	0.067592434
	200	8	0.2	1.84	0.026316	11.64751351	0.157973631
	250	12	0.25	2.76	0.032895	11.7267483	0.235359362
	300	14.9	0.3	3.427	0.039474	11.80706849	0.290249862
	350	15.9	0.35	3.657	0.046053	11.88849655	0.307608282

From table 4.5.2 which shows UCT results (q_u) of Soil with Rapid Setting (RS) Bitumen Emulsion the maximum value which comes out was 0.307 kN/m^2, so the shear strength was (q_u/2) = 0.15 kN/m^2.

V.CONCLUSION

5.1 Concluding Remark

From this experimental study it is clear that there is a considerable improvement in California Bearing Ratio (CBR) and Shear strength property of soil due to use of bitumen emulsion. In case state of condition, it was found that CBR and Unconfined compression test (UCT) value has increased consecutively From Case 1 to Case 3. It is studied that best result are obtain if the mixture of soil and bitumen emulsion is left for four hours. This type of stabilization may be applicable in roadways.

Future scope

After adding bitumen emulsion, it can be studied what will be the effect of bitumen emulsion on other soil properties such as liquid limit, plastic limit, shrinkage limit, Dry density, etc.

REFERENCES

1. ElifasBunga, H. Muh. Saleh Pallu, Mary Selintung, M. ArsyadThaha, “Stabilization of Sandy Clay Loam with Emulsified Asphalt”, International Journal of Civil & Environmental Engineering (IJCEE), October 2011, Volume No. 11, Issue No. 5, Page no. 52.
2. ParithoshaPerika, Prof G. Venkataratnam, “Laboratory Study on Use of Bitumen

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 5, May 2022 |

| DOI:10.15680/IJMRSET.2022.0505022 |

Emulsion in Gravel Road", International Journal for Technological Research in Engineering, December-2015, Volume 3, Issue 4, Page no. 674.

3. Satyendra Kumar Verma, "A Laboratory Study on Use of Bitumen Emulsion in Black Soil", International Research Journal of Engineering and Technology (IRJET), Sep-2015, Volume: 02, Issue: 06, Page no. 548.
4. Simarpreet Singh Batra, Jashandeep Singh Arora, "Effect of cationic bitumen emulsion on shear strength parameters of soil", International Journal of Research in Engineering and Technology (IJRET), Sep-2016, Volume: 05, Issue: 09, Page no. 156.

Impact Factor
7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com