International Journal of Multidisciplinary and Current Research ISSN: 2321-3124
Research Article Available at: http://ijmcr.com

An Experimental Study on the Behaviour of a Sandy Soil by using Cutback Bitumen

Vijender Kumar* **and R.K. Bansal**

Department of civil Engineering, Geeta Institute of Management And Technology, Kurukshetra, India

Received 10 June 2017, Accepted 10 Sept 2017, Available online 20 Sept 2017, **Vol.5 (Sept/Oct 2017 issue)**

Abstract

The key point of a stable and well-constructed structure is the stability and strength of its foundation. Whether it is a building or a road pavement both require a good substructure. Fine grained soils are susceptible to expansion, contraction and high compressibility and course grained soils may have a high permeability and are also susceptible to erosion. Subgrade is the most important part of a road pavement structure as it provides support to the pavement as its foundation. The formation of waves, corrugations and rutting in black top pavements are generally attributed to poor Subgrade conditions. Gullies and cutting edges are also due to poor shear strength and high permeability of subgrade. Many types of binders are helpful in improving the shear strength of subgrade soils. Sand as a subgrade soil may have low shearing strength and high permeability. The improvement of sub-grade soil will increase its durability and the performance of road structure as a whole. In the present study, MC-30 bituminous cutback has been used as a stabilizer to improve the properties of a locally available cohessionless soil. The percentage of bituminous cutback added to the sandy soil has been varied from 4% to 18%. A uniform compaction was provided to all the samples prepared. Unconfined Compressive Strength and CBR value of the soil samples were studied. From the UCS test, it is observed that maximum unconfined compressive strength is obtained at 12% cutback content further increase of cutback in the soil leads to decrease in UCS value due to excessive fluidity causing decrease in density. A sharp increase in CBR value of sand was observed with a small increment in cutback bitumen content (about 8 %). Further increase in cutback content (8% to 10%) increased the C.B.R value moderately to reach a peak and then still further increase in cutback content (i.e more than 10%) reversed the trend.

Keywords: *Subgrade, Cohessionless Soil, Unconfined Compressive Strength etc.*

Introduction

Modification or improvement in the engineering properties of soils is required, wherever the soils encountered for various engineering projects are unsuitable. Many engineering projects such as improvement of subgrades under highways and airport runways, stabilization of slopes in cuts and embankments, increasing soil bearing capacity under foundations etc. require some or other form of soil stabilization. There are many methods of soil stabilization applicable to different types of soils, for stabilizing weak sandy deposits - compaction, cement stabilization; lime stabilization has become very popular.

In this study, bituminous cutback has been used as a stabilizer to improve the properties of locally available cohesionless soil. Bituminous stabilization is preferred over other type of stabilizers because bituminous stabilization helps to increase the shear strength and also decreases the permeability of sandy soil.

*Corresponding author's ORCID ID: 0000-0003-1930-9262
DOI: https://doi.org/10.14741/ijmcr.v.5.5.17

Experimental study

Materials used in experimentation
The materials used in this project were locally available sand, bitumen and diesel oil.

Soil

Nearly 50 Kg of locally available sand was collected from Kurukshetra and thoroughly hand sorted to eliminate the vegetative matter and pebbles. Then, the soil was sieved through 4.75mm sieve to remove the gravel fraction. Soil was oven dried for 24 hours before execution of geotechnical tests. Physical Properties of Soil are shown in table 1.

Bitumen

Properties of binder used in this study are shown in table 2.

Solvent

Bitumen is dissolved in solvent for the formation of cutback. In this study, diesel is used as a solvent.

Diesel was procured from a Hindustan Petroleum dealer. The details of Specification are shown in table 3.

Cutback

Properties of cutback used in this study were as shown in table 4.

Table 1 Physical Properties of Soil

S. No	Parameters	Result
1	Proctor Test results (Light Compaction) MDD (g/cm^3) OMC (%)	1.62 12.24
2	Specific Gravity	2.67
3	Fineness Modulus	2.37
4	Coefficient of curvature	4.27
5	Coefficient of uniformity	0.651
6	Soil Group	SP-SM

Table 2 Properties of Bitumen

Property	Range/Value
Penetration(mm)	31
Softening point (°C)	55
Fire point (°C)	234
Flesh point (°C)	220
Ductility (cm)	27
Viscosity (sec)	65

Table 3 Properties of Diesel (Solvent)

1	Density	0.84-0.86
2	Flesh point (°c)	68-94
3	Viscosity @4°c	2.04-3.23
4	Sulphur ppm	1-10
5	Stability	Good
6	Oxygen content %	0
7	Lubricity	Good
8	Distillation	307-352

Table 4 Properties of cutback Bitumen

S.No	Property	Range/Value
1	Viscosity@10mm (sec)	45
2	Penetration (mm)	125
3	Ductility (cm)	138
4	Solvent (%)	26
5	Cutback grade	MC-30

Experimental Result & Discussion

Nine specimens were prepared to investigate the properties of soil. These specimens were prepared by adding 2%, 4%, 6%, 8%, 10%, 12%, 14%, 16%, 18% of cutback bitumen stabilizer. Standard Proctor Test, Unconfined Compressive Strength Test and California Bearing Ratio Test were conducted to determine the optimum moisture content (OMC), Maximum dry density (MDD) and compressive strength of the stabilized soil.

Proctor test

Proctor test on parent soil.

Light Compaction Proctor Test was conducted on the soil used in this study. Water content-Dry density relationship is as shown in fig 1, Maximum dry density of soil comes out to be 1.611 g/cm^3 at an OMC of 12.24%.

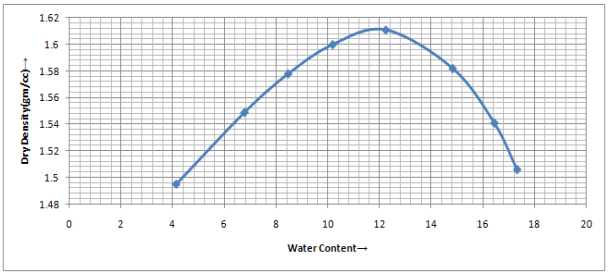

Fig 1 Graphical Result of Proctor Test on Parent Soil

Proctor test on parent soil with stabilizer.

Various compaction tests (at the same compaction) were conducted with varying percentage of cutback bitumen. The maximum dry density was found to be 1.728 g/cm^3 at optimum cutback content of 12% as shown in fig 2.

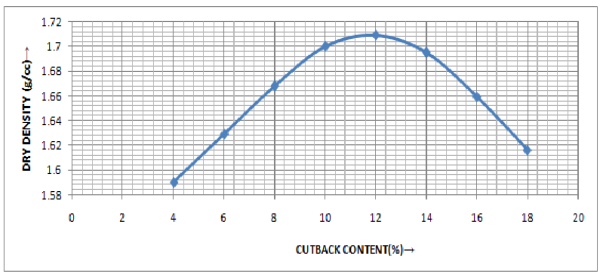

Fig 2 Graphical Result of Proctor Test on Test Soil

Unconfined compression test

This test was also conducted on test soil with different percentage of cutback bitumen content. As,it is well known that the unconfined compressive strength of sandy soil specimen is negligible or practically zero. Hence, specimen with different range of cutback content varying from 4% to 16% is prepared to enhance the strength and compressive strength of parent soil.

Table 5 Comparison between UCS value of different specimens under different conditions

S.No	Cutback Content (%)	Compressive Stress $(\frac{kg}{cm^2})$
1	4	0.258
2	6	0.381
3	8	0.572
4	10	0.593
5	12	0.631
6	14	0.445
7	16	0.341

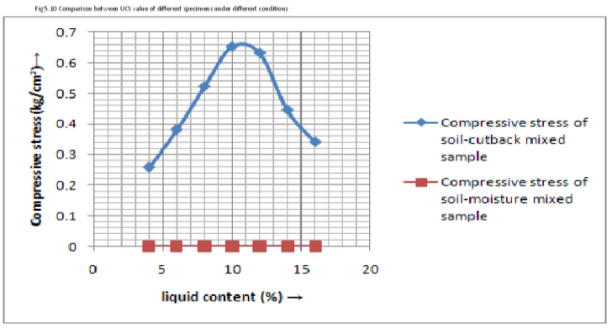

Fig 3 UCS value of different specimens under different conditions

California bearing ratio test

Figure, graph has been plotted between CBR Value corresponding to 2.5mm and 5mm penetration and Cutback content. Where Cutback content is on x axis varying from 4% to 16% and CBR Value is on y axis from 0 to 25 with an interval of 5. The graph shows that maximum CBR Value is obtained at 10% Cutback content. Maximum Dry CBR Value is 15.74 for 2.5mm penetration and 21.85 for 5mm penetration. Hence CBR Value is 21.85

Table 5 Comparison Table of CRB Test

Testing Condition	CRB Value At 2.5mm Penetration	CRB Value At 5mm Penetration	CBR Value in Percentage
At 12.24% (OMC)	12.3	16.1	16.1
At 4% cutback	8.6	8	8.6
At 6% cutback	8.5	9.4	9.4
At 8% cutback	11.8	14.7	14.7
At 10% cutback	15.74	21.85	21.85
At 12% cutback	12	14.3	14.3
At 14% cutback	10.8	11.3	11.3
At 16% cutback	7.7	9.3	9.3

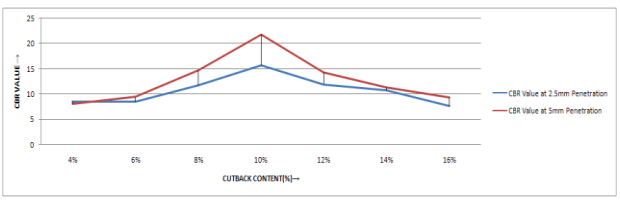

Fig 4 Graphical Representation of CRB test with various cutback percentage

Discussion

In all the tests conducted to determine the max dry density with change in stabilizer content, it was found as under:

Compaction Characteristics

From the proctor test, it has been observed that the maximum dry density (MDD) increases by the addition of cutback upto 12% in the parent soil, with a futher increase in the percentage of cutback, the Max dry density decreases as shown in fig.1 and 2.

Unconfined Compressive Strength Test

From UCS tests conducted for the various samples moulded at different percentage of cutback bitumen but at the same compaction, strength increased when the cutback bitumen added ranged from 4% to 16%. Maximum UCS value was observed at 12% stabilizer content as shown in fig.3

California Bearing Ratio Test

For the California Bearing Ratio test, it has been observed that CBR value at 2.5mm and 5mm penetration increases with increase in cutback content. The specimen achieved maximum CBR value at 10% of stabilizer content and after that CBR value decreased rapidly due to increase in fluidity which resisted compactive effect as shown in fig.4

Conclusion

In this study, strength characteristics of local Sandy soil with about 10% silt content with Cutback stabilizer have been studied. The study lead to the following conclusions:

1. In proctor test (low compactive effort), Maximum dry density of 1.61 g/cm^3 was achieved at a moisture content of 12.24%. Further increase in moisture content tends to decrease dry density of the specimen.
   For soil-cutback specimens, maximum dry density of 1.72gm/cc is achieved at a cutback content of 12%.
2. The unconfined compressive strength of sandy soil was practically zero when no stabilizer was added in the soil. The unconfined compressive strength increased upto 0.68 kg/cm² when 12% stabilizer was mixed, with futher increase in cutback bitumen content the unconfined compressive strength decreased.
3. The maximum CBR value of soil-stabilizer mix was observed at 10% stabilizer and came out to be 21.85%. Further increase in cutback content decreased the CBR value.

References

[1]. Elifas Bunga, H.Muh.Saleh Pallu, Mary Selintung and M.Arsyad Thaha (2011)Study on effect of sandy clay loam stabilization with emulsified asphalt on chemical characteristics, Atterberg consistency, and soil strength.

[2]. Ali J. Kadhim (2014) The study is to examine the effect of cut-back asphalt (MC-30) on the geotechnical properties of gypseous soil as stabilizing agent and investigate the ability of construct the road on this type of soil

[3]. Parithosha Perika , Prof G.Venkataratnam (2015) In this study, it was discussed about the application of ambient temperature asphalt emulsion stabilization technology and discussed to the environmental fixation of soils contaminated by organic contaminants.

[4]. Maheshwari G.Bisanal1, Ravikumar Badiger(2015) In this current investigation sea shell powder and bitumen emulsion were added with soil and its unconfined compressive strength characteristics were studied.

[5]. Avinash. P, Praneeth. S and Manish (2015) carried out research to study with key objective is to enhance the properties of black cotton soil using cutback asphalt MC-30.

[6]. Simarpreet Singh Batra , Jashandeep Singh Arora(2016) A experiments carried out on the soil sample to study the effect of Bitumen Emulsion on Shear Strength parameters using Direct Shear Test.

[7]. R. Deby Linsha, Y. Preethy Dharanya, V. Vinodhini and C. Pavithra (2016) in this thesis, the strength of the soil is improved by using bituminous emulsion.

[8]. ASTM D 854-00 – Standard Test for Specific Gravity of Soil Solids by Water Pycnometer.

[9]. Hindustan Petroleum Specificatiojn AS PER IS 73:2006.

[10]. Soil Mechanics and Foundation Engineering by Dr.K.R.Arora.

[11]. Soil Mechanics and Foundation Engineering by B.C. Punmia.

[12]. IS: 2720 Part-SC(1970):Determination of Liquid Limit and plastic limit.

[13]. IS: 2720 part – 8 (1983): Determination of dry density and optimum moisture content.

[14]. IS; 2720 part-16 (1997): Determination of California Bearing Ratio.

[15]. Dilip Kumar Talukdar A Study of Correlation Between California Bearing Ratio (CBR) Value With Other Properties of Soil.