ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 2, February 2015

Study on Effect of Molasses on Strength of Soil

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Abstract: The study aims to find the effectiveness of uses of unconventional liquid soil stabilizer i.e. Molasses for improving the shear strength and CBR value of two types of fine grained soils. In case of molasses, the experimental variables were soil type (intermediate compressible clay and highly compressible clay), amount of molasses and treatment duration. The results showed that with use liquid stabilizer, there was appreciable increment in unconfined compressive strength and CBR value of both soils. The unconfined compressive strength of soil increased with increment ratio in range of 1.57-2.01 for both types of soils. CBR value of soils had increment ratio of 2 – 3.5 in both types of soils. The values increased with increase in treatment duration. Based on this study, optimum amount of liquid additive to be added to respective soil types for higher strength increments were determined.

Key Words: Molasses, Shear strength, CBR, Strength, Fine grained soils.

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I. INTRODUCTION

Due to increasing urbanization, land for construction is getting scarcer and now is very important to utilize the limited land. For construction purposes, it is very essential that limited available land is suitable and provides a strong foundation for the structure. But, if soil is not suitable for construction, then suitability of soil has to be increased to provide strong foundation for construction, this process is called Soil Stabilization.

Foundation of a structure is one of the most important aspects of a construction project and it is very important that land used for construction is suitable and can provide strong foundation for structure. Site feasibility studies for construction projects are very important before a project can take off.But with growing population and urbanization, soil improvement is getting very common. Soil improvement or soil stabilization involves improvement of soil characteristics or parameters such as strength, compressibility and permeability.

II. MATERIALS

Intermediate Compressible Clay – CI

First soil sample was collected from Guduvancheri (Chennai). The sample was collected from depth of 1 - 2m from ground level. The collected sample was disturbed sample. The soil was collected by excavation. From Atterberg's plasticity chart it was found that the soil type was intermediate compressible clay (CI). The soil sample was thoroughly dried and then pulverised properly for their tests.

Tests on virgin soil for basic properties and strength characteristics were done. The soil sample was treated with varying proportions of both additives according to experimental programme. Then the strength characteristics of untreated soil sample and treated soil sample were compared.

Highly Compressible Clay – CH

Second soil sample was collected from Rajiv Salai (Chennai). The sample collected was disturbed and was collected by excavation from 1.5 – 2m depth from ground level. From Atterberg's plasticity chart, the soil type was found to be highly compressible clay (CH).

The soil sample was thoroughly dried and then pulverised properly for their tests. Tests on virgin soil for basic properties and strength characteristics were done. The soil sample was treated with varying proportions of both additives according to experimental programme.

Then the strength characteristics of untreated soil sample and treated soil sample were compared.

Table – 1: Soil Samples – Basic Properties

Description	Symbol	Soil Sample 1	Soil Sample2
Gravel		0.3%	0.24%
Sand		47.1%	17.48%
Fines(silt + clay)		53.6%	82.28%
Liquid Limit %	W_L	45.4%	61.38%
Plastic Limit%	W_p	16.83%	28.21%
Plasticity Index%	I_p	28.57%	33.20%
Shrinkage Limit%	W_S	8.26%	7.61%
Specific Gravity	G	2.27	2.31
Soil Classification		CI	CH
Optimum Moisture Content	OMC	18.2%	19.7%
Maximum Dry Density	γ_{dmax}	1.86 g/cc	1.64 g/cc
Unconfined Compressive Strength	q_u	0.99 kg/cm^2	1.28 kg/cm^2

Molasses

Molasses, which is a dark brown syrupy viscous liquid, was used in this study. Molasses was brought from Jalgaon, Maharashtra. It was used as a liquid additive for this study. It was mixed uniformly in soil in varying proportions. Both soil samples were treated with Molasses. After treatment, proposed tests were performed on treated soils to determine the unconfined compressive strength and CBR value of treated soil.

Table -2: Property of Molasses

Property	Value
Colour	Dark Brown

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Appearance	Liquid
Sucrose	41.9%
pH	4.4-5.4
Organic Matter	59.4%
Crude Protein & Glucose	5.3% & 2.3%
Glucose	2.8%

III. Experimental Programme

The experimental programme for molasses treated soil are given in the below Table – 3.

Table – 3: Experimental Programme

IV. Results And Discussions

The Methodology used for treatment of soil using molasses includes direct homogeneous mixing of molasses into soil and proper compaction. Concentration of dosage was varied by dry soil weight.

The amount of molasses to be added depends on the soil dryness. First soil sample being Intermediate compressible clay, was varied with 5-8% of molasses, while second soil sample was highly compressible clay had relatively high optimum moisture content was varied with 9-12% molasses by dry soil weight.

UCC and CBR Testing were performed in strict accordance with IS Codes.

4.1 Unconfined Compressive Strength

Both the soil samples were treated with molasses. Molasses have syrupy liquid appearance and are slightly viscous than water. They were directly added in dry soil at required proportions and were uniformly and homogeneously mixed.

Sample 1: Intermediate Compressible Clay

For sample 1 that denoted the property of Intermediate Compressible Clay. The UCC test results are showed in graphical format for this type of soil sample below.

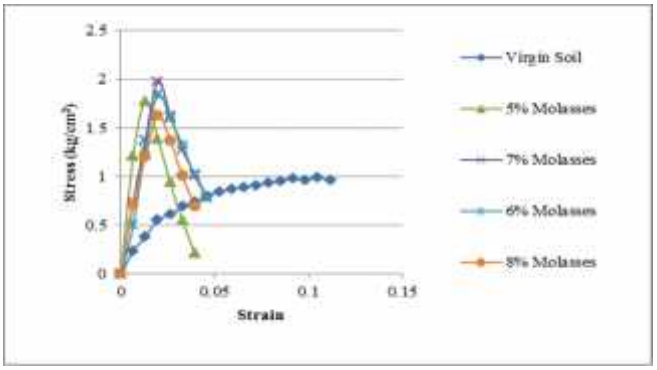

Fig - 1 Variation of influence of molasses treatment on UCC value for soil sample 1

Fig-1 represents the variation of effect of molasses on soil sample. Highest increment was observed on addition of 6% Molasses to soil sample 1, UCC strength increased by 94%. Molasses enhanced soil cohesion (shear strength parameter) which leads to strong cementation of soil particles. Figure 2 represents the failure pattern observed in soil sample 1 treated with molasses.

Soil	Molasses	UCC	CBR Unsoaked	CBR Curing	CBR soaked
CI	5%	6	6	6	6
	6%	6	6	6	6
	7%	6	6	6	6
	8%	6	6	6	6
CH	9%	6	6	6	6
	10%	6	6	6	6
	11%	6	6	6	6
	12%	6	6	6	6

Fig - 2 Failure pattern observed for soil sample 1 treated with molasses

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Sample 2: Highly Compressible Clay

For sample 2 that denoted the property of Highly Compressible Clay. The UCC test results are showed in graphical format for this type of soil sample below. The highest strength increment was obtained by addition of 10% Molasses to soil sample 2.

	Molasses	CBR unsoaked	CBR curing (3 days)	CBR soaked (4 days)
Soil Sample 1 (CI)	5%	13.41%	18.01%	2.07%
	6%	13.48%	19.60%	2.16%
	7%	13.90%	20.39%	2.21%
	8%	14.08%	20.98%	2.17%
Soil Sample 2 (CH)	9%	10.60%	14.83%	3.07%
	10%	10.76%	16.01%	3.30%
	11%	11.62%	16.95%	3.48%
	12%	11.21%	16.15%	2.59%

The UCC strength increased by 85%, which is presented in Figure 3. Molasses enhanced soil cohesion (shear strength parameter) which lead to strong cementation of soil particles.

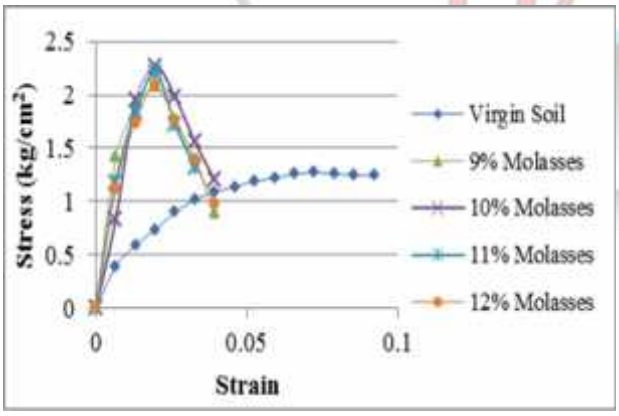

Fig- 3 represents the failure pattern in soil sample 2.

Fig - 4 Failure pattern observed for soil sample 2 treated with molasses

4.2 California Bearing Ratio (CBR)

This test was conducted according to IS: 2720 (Part – XVI). This test is a penetration test which is performed for evaluation of the mechanical strength and penetration resistance of given soil.

The CBR value of virgin soil sample 1 (CI) and for virgin soil sample 2 (CH) was found to be 6.37% and 9.31% respectively found. The variation in their value for cured, soaked and unsoaked teat values are given below,

Table – 4: CBR Test Results

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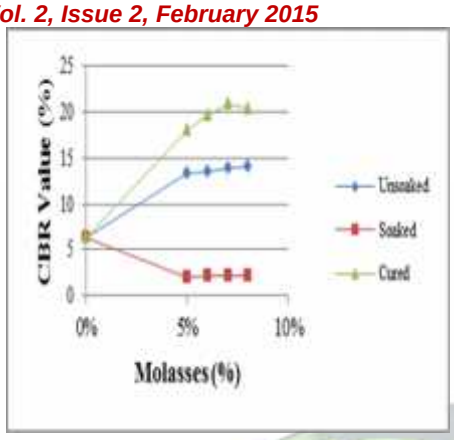

Fig - 5 Comparison of variation of influence of molasses treatment on CBR values for soil sample 1

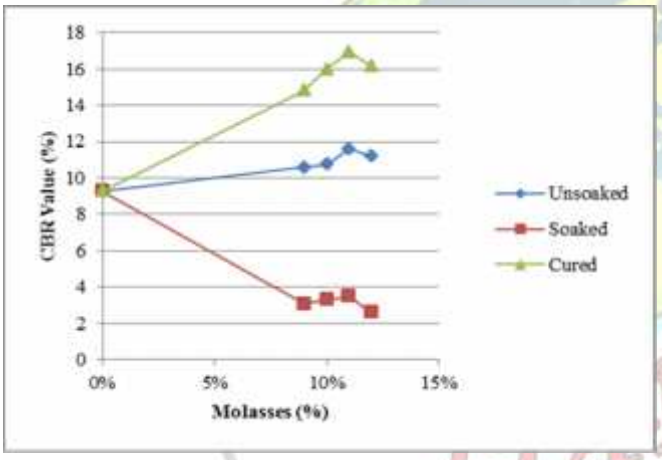

Fig - 6 Comparison of variation of influence of molasses treatment on CBR values for soil sample 2

V. Conclusion

- Use of molasses increased the unconfined compressive strength and CBR value of both soils.
- Effect of molasses on CI soil was more as compared to CH soil. Comparatively lower increment in CH can be attributed to high clay content which didn't allow molasses to penetrate soil matrix properly.
- It can be said that molasses played a role in enhancement of soil cohesion, which is a shear strength parameter which ultimately lead to increment in unconfined compressive strength and resistance to penetration during CBR Test.
- In both CI and CH soil, there was positive effect of curing, as the CBR value increased, while the CBR value considerably decreased on soaking.

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