Studies on Stabilization of Clayey Soil & Gravely Sand Soils Using Non-Conventional Stabilizers

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Abstract - Suitable Soil required for construction activity may not be available all along the alignment. It therefore becomes necessary either to procure soil from far off barrow areas or to stabilize the locally available soils to improve their engineering properties. The Stabilization of locally available soil proves to be economical. In this study, laboratory investigations were carried out on two types of Soil samples viz., Clayey Soil (Black Cotton Soil) and Gravely Sand Soil, blended with Non Conventional Stabilizers (Stabilig A and Stabilig B). Soil samples blended with 2%, 4% and 6% stabilizers were subjected to tests like Unconfined Compressive test, Triaxial test, Durability test etc., No significant changes in the basic properties were observed but there was a considerable change in the strength values of the stabilized soils.

Keywords - Stabilig A, Stabilig B, Non Conventional Stabilizers, Clayey Soil, Gravely Sand, Stabilizers, Modulus of Elasticity.

1. INTRODUCTION

Soil is the most widely used principle material for the construction of embankments and subgrades of a highway. Pavement layers are laid over the prepared soil subgrade which provides the support to the pavement. The design and performance of the pavement, particularly that of the flexible pavement mainly depends on the type of subgrade soil used and its properties including stability value. Subgrade layer is supported by soil of the fill or the ground. Therefore soil is an essential highway material.

But when the locally available soil is not suitable for construction and procuring of soil from other sources becomes expensive it is very much necessary to stabilize the local soil. Stabilization of soil is modifying the characteristics of soil such that the modified soil has the desired properties for a specific use. The different processes of stabilizing soils are mechanical stabilization, Chemical Stabilization (cement, lime, bitumen etc). The most commonly used additives for the stabilization of soil are lime and cement, which are also economical.

The stabilized soil will have the following benefits,

- Increased strength and stiffness
- Better volume stability
- Increased durability

The scope of the study was to investigate the index properties and strength & performance characteristics of Clayey Soil and Gravely Soil stabilized with two commercially patented stabilizers namely Stabilig A and Stabilig B. In order to study the required properties, Clayey Soil and Gravely Sand Soil were blended with 2%, 4% and 6% stabilizers (Stabilig A and Stabilig B) and the required tests were carried out on them.

2. LITERATURE REVIEW

Nadgouda, K.A et al. (2010) observed that soil stabilization is a collective term for any chemical or physical or biological or any combination of such methods that may be used to improve certain properties of a natural soil to make it serve adequately an intended engineering purpose. It is the process of blending and mixing materials with a soil to improve certain properties. The process may include, blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter gradation, plasticity, texture or act as a binder for cementation of the soil. The main benefits of using lime to stabilize clays are improved workability, increased strength, and volume stability.

Dhawan et al. (1988) observed that various forms of lime have been successfully used as soil stabilizing agents. But, monohydrated dolomite lime, hydrated high-calcium lime, dolomitic quicklime, Calcitic quicklime etc., were commonly used. Most often used was Lime (Hydrated) because it is much less caustic than quick lime. However, the use of quicklime for soil stabilization has increased in recent years mainly with slurry type applications.

3. EXPERIMENTAL INVESTIGATIONS

The experimental investigations were carried out on soil stabilized with stabilig A, stabilig B and also on native soil.

The various experimental investigations carried out and the results obtained are listed below.

GRAIN SIZE DISTRIBUTION:

Wet sieve analysis of the soil samples were carried out as per IS 2720 (Part 4) and the results are tabulated in table below,

Table 3.1, Wet sieve analysis of Clayey Soil

Stabilizer used	Gravel %	Sand %	Fines %
Native soil	1.05	21.40	77.54
2 % Stabilig A	1.07	21.60	77.20
4 % Stabilig A	1.40	21.30	77.20
6 % Stabilig A	1.90	34.50	63.50
2 % Stabilig B	0.70	19.40	79.80
4 % Stabilig B	0.70	23.10	76.10
6 % Stabilig B	1.40	24.40	74.10

Table 3.2, Wet sieve analysis of Gravely Sand Soil

Stabilizer Used	Gravel %	Sand %	Fines %
Native soil	21.10	51.80	27.10
2 % Stabilig A	14.00	49.00	37.00
4 % Stabilig A	17.00	50.00	33.00
6 % Stabilig A	15.00	41.00	44.00
2 % Stabilig B	21.00	40.00	39.00
4 % Stabilig B	13.00	46.00	46.00
6 % Stabilig B	20.00	45.00	35.00

ATTERBERG LIMITS:

Liquid and Plastic limit tests of the soil samples were carried out as per IS 2720 (Part 5) and results are shown below,

Table 3.3, Atterberg Limits of Clayey Soil

Stabilizer Used	LL	PL	PI
Native soil	63.15	28.42	34.73
2 % Stabilig A	53.00	35.10	17.80
4 % Stabilig A	43.30	33.70	9.50
6 % Stabilig A	17.80	9.50	11.40
2 % Stabilig B	51.00	33.80	17.20
4 % Stabilig B	49.50	33.50	15.90
6 % Stabilig B	45.00	32.10	12.80

Table 3.4, Atterberg Limits of Gravely Sand Soil

Stabilizer Used	LL	PL	PI
Native soil	54.00	27.00	27.00
2 % Stabilig A	53.00	28.00	25.00
4 % Stabilig A	47.00	28.00	19.00
6 % Stabilig A	45.00	31.00	14.00
2 % Stabilig B	48.00	31.00	17.00
4 % Stabilig B	41.00	32.00	9.00
6 % Stabilig B	38.00	30.00	8.00

COMPACTION TEST:

Modified proctor test was carried out as per IS 2720 (Part 8) and results are shown below,

Table 3.5, Compaction test results of Clayey Soil

Stabilizer Used	OMC (%)	MDD (g/cc)
Native soil	18.80	1.88
2 % Stabilig A	27.60	1.60
4 % Stabilig A	22.90	1.67
6 % Stabilig A	23.20	1.70
2 % Stabilig B	31.90	1.73
4 % Stabilig B	31.80	1.56
6 % Stabilig B	29.80	1.50

Table 3.6, Compaction test results of Gravely Sand Soil

Stabilizer Used	OMC (%)	MDD (g/cc)
Native soil	10.50	2.14
2 % Stabilig A	13.90	1.97
4 % Stabilig A	14.80	1.87
6 % Stabilig A	14.90	1.83
2 % Stabilig B	13.00	2.03
4 % Stabilig B	13.50	2.09
6 % Stabilig B	13.90	2.10

CALIFORNIA BEARING RATIO (CBR) TEST

CBR tests was carried out as per IS 2720 (Part 16) and results are shown below,

Table 3.7, CBR Test Results of Clayey Soil

Stabilizer Used	CBR (%)
Native soil	3.00
2 % Stabilig A	4.90
4 % Stabilig A	11.70
6 % Stabilig A	21.70
2 % Stabilig B	6.00
4 % Stabilig B	9.60
6 % Stabilig B	11.20

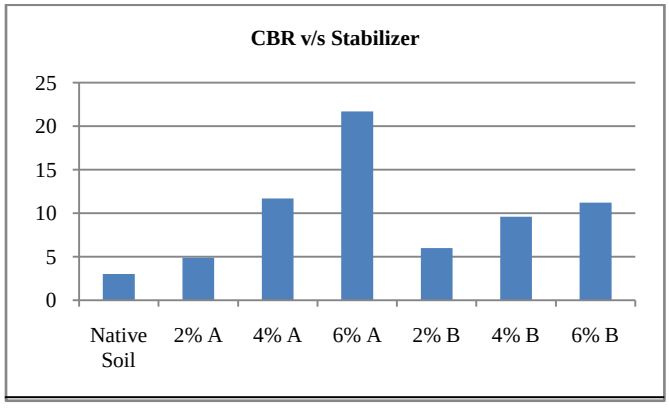
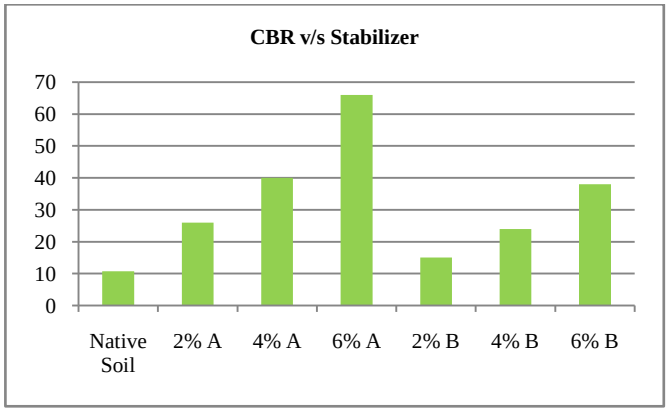


Table 3.8, CBR test results of Gravely Sand Soil,

Stabilizer Used	CBR (%)
Native soil	10.70
2 % Stabilig A	26.00
4 % Stabilig A	40.00
6 % Stabilig A	66.00
2 % Stabilig B	15.00
4 % Stabilig B	24.00
6 % Stabilig B	38.00



UNCONFINED COMPRESSIVE STRENGTH (UCS) TEST:

UCS test was carried out as per IS 2720 (Part 10) and results are shown below

Table 3.9, UCS test results of Clayey Soil,

Stabilizer Used	0 days	28 days	Soaked for 28 days	Modulus of Elasticity (MPa)
Native soil	125	--	--	2.30
2% Stabilig A	--	210	23	7.50
4% Stabilig A	--	283	133	13.00
6% Stabilig A	--	436	306	22.50
2 % Stabilig B	--	354	114	8.10
4 % Stabilig B	--	463	189	12.50
6 % Stabilig B	--	632	300	18.00

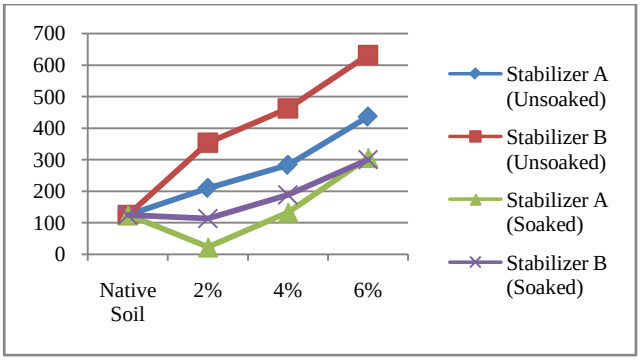
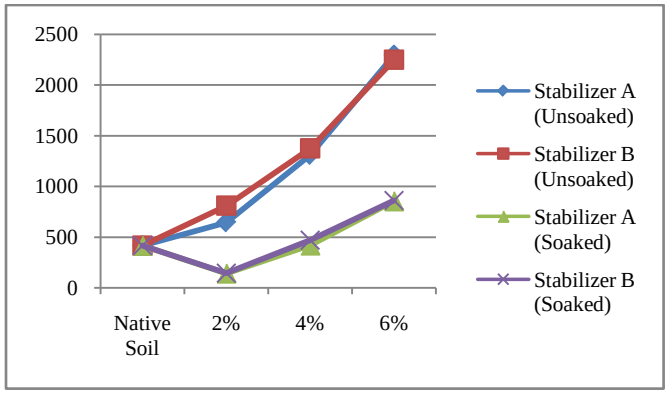


Table 3.10, UCS test results of Gravely Sand Soil,

Stabilizer Used	0 days	28 days	Soaked for 28 days	Modulus of Elasticity (MPa)
Native soil	417	--	--	16
2% Stabilig A	--	645	143	32
4% Stabilig A	--	1309	420	49
6% Stabilig A	--	2295	856	57
2% Stabilig B	--	810	145	37
4% Stabilig B	--	1375	470	48
6% Stabilig B	--	2248	861	102



4. RESULTS AND DISCUSSIONS

- From wet sieve analysis we can infer that there were no significant changes in gradation of stabilized soils.
- Liquid Limit of Clayey Soil was found to reduce by 3.55 times when 6% Stabilig A was used; and by 1.40 times when 6% Stabilig B was used.
- Liquid Limit of Gravely Sand Soil was found to reduce by 1.20 times when 6% Stabilig A was used and by 1.42 times for 6% Stabilig B being used.
- OMC of the stabilized soils were found to increase 1.27 times (Clayey Soil) and 1.42 times (Gravely Sand Soil) when Stabilig A was used.
- OMC of the stabilized soils were found to increase 1.58 times (Clayey Soil) and 1.32 times (Gravely Sand Soil) when Stabilig B was used.
- CBR values of soils stabilized with Stabilig A were found to increase by 7.23 times and 6.16 times for Clayey Soil and Gravely Sand Soils respectively.
- CBR values of soils stabilized with Stabilig B were found to increase by 3.73 times and 3.55 times for Clayey Soil and Gravely Sand Soil respectively.
- Modulus of Elasticity of soils stabilized with Stabilig A was found to increase by 9.78 times and 3.56 times for Clayey Soil and Gravely Sand Soil respectively.

- Modulus of Elasticity of soils stabilized with Stabilig B was found to increase by 7.82 times and 6.375 times for Clayey Soil and Gravely Sand Soil respectively.

5. CONCLUSIONS

From the present study we can conclude that, Stabilig-A and Stabilig-B is effective in stabilizing both Clayey Soil and Gravely Sand Soil. No significant changes were found in the basic properties of stabilized soils. However, from CBR test and UCS test, it was seen that there was a considerable increase in strength values and Modulus of Elasticity values of the stabilized soil, with the increase in percentage of stabilizer. The durability characteristics of stabilized soil was seen to the better than native soil especially when stabilig B was used. Overall both the stabilizers stabilig A and stabilig B shows good results both in terms of strength and durability hence it can be effectively used as a stabilizer for both Clayey Soils and Gravely Sand Soils.

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