Strength Characteristics of Clayey Soil Stabilized Using Nontraditional Stabilizer

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Abstract- *A land based structure of any sort is just as solid as its foundation. Therefore, soil is a basic component impacting the accomplishment of a0construction0project extend. Soil0is either part of the establishment or one of the crude materials utilized as a part of the development procedure. therefore, undertaking the engineering properties of soil is significant to get strength and economic permanance. Soil adjustment is the way toward augmenting the appropriateness of the soil for a given construction purpose.*

Soil Stabilization is the alteration of soils to improve their physical properties.

Stabilization can build the shear quality of soil as well as control the shrinks well properties of soil, thus enhancing the load bearing limit of a sub grade to help pavements and foundations. Stability can be utilized to treat an extensive variety of sub grade materials, changing from expansive clays to granular materials.

Keywords- Soil stabilization, RBI, CBR

I. INTRODUCTION

Soil0Stabilization

Non0Traditional0Stabilizers

There are assortments of non-conventional soil adjustment/change added substances accessible from the business part, for example, polymer.

Emulsions, acids, lignin subordinates, catalysts, tree gum emulsions, silicates and so forth. These added substances might be in fluid or strong frame and are regularly guaranteed to be appropriate for the vast majority of the dirt sorts. Non-customary stabilizers are normally gathered into seven classifications as recorded beneath.

Chlorides (chloride, salts, calcium chloride, magnesium chloride, sodium chloride). Clay added substances (earth added substances, dirt, filler, betonies, montmorillonite). Electrolyte emulsions (electrolyte stabilizers, ionic0stabilizers, electrochemical stabilizers, acids) Enzymatic emulsion (enzymatic emulsions, enzymes). Lignosulfonates (Lignosulfon ate, lignin, lignin sulphate, lignin sulphides) Synthetic polymer emulsions(engineered polymer emulsions, polyvinyl acetic acid derivation and vinyl acrylic). Tree resin emulsions(tree-pitch emulsions, tall-oil emulsions, pine-tar emulsions).

1.3 Principle of Stabilization:

The basic principles in soil stabilization are as follows:

- Evaluating the properties of given soil
- Deciding the system for supplementing the lacking property by the suitable and moderate strategy for change.
- Designing the offset soil mix for arranged soundness and strength regards.
- Considering the procedure by adequately compacting the stabilized layers.

1.4 Scope and Objective of Present Studies

To study the Unconfined compressive strength, pressure quality, Flexural0strength of soil treated with RBI-81 new substance stabilizer

To associate the compressive and flexural quality of balanced out soil with versatile modulus.

The report is sorted out into five parts. Section One covers the prologue to the venture. Writing audit is canvassed in Chapter Two. Section Three portrays the tests done and test result. The investigation of result is introduced in Chapter Four and exchange and conclusion in part five.

II. LITERATURE REVIEW

2.1 Soil Structure

The mud particles in the dirt structure are organized in sheet-like structures made out of silica tetrahedra and alumina octahedra. The sheets shape a wide range of mixes yet there are three primary sorts of arrangements. The first is kaolinite, which comprises of rotating silica and Alumina sheets fortified together. This type of dirt structure is exceptionally steady and does not swell obviously when wetted. The following structure is montmorillonite, which is made out of two layers of silica and one alumina sheet making a feeble bond between the layers.

2.2 Stabilization0and Modification

Conventional, stable sub-levels, sub-bases and bases have been developed by utilizing chosen, all around reviewed totals, making it genuinely simple to anticipate the heap bearing limit of through built layer. By utilizing chose material, the designer realizes that the establishment will have the capacity to help the outline stacking.

The way toward lessening versatility and enhancing the surface of dirt is called soil change. Monovalent cations, for example, sodium and potassium are normally found in sweeping earth soil and these cations can be traded with cations of higher valences, for example, calcium, which are found in lime, fly cinder and Portland concrete. This particle trade handle happens quickly, frequently inside a couple of hours. The calcium cations supplant the sodium cations around the dirt particles diminishing the measure of the bound water layer and empowering the earth molecule to flocculate.

2.7.3 RBI-81[19]

RBi-81 is a remarkable, coat-successful, condition benevolent mechanical leap forward in soil adjustment, squander official and asphalt layer plan for the street and roadway building world. RBI-81 is an exceptional and exceedingly successful characteristic inorganic soil stabilizer for Infrastructure improvement and repair.

RBI-81 was initially created by RBI for South African Army Road Building International for the in the start of 1990's for asphalt designing applications.

RBI-81 is a characteristic inorganic soil-stabilizer which re-builds and alters the properties of the dirt quality it for streets, clearing and streets and asphalt. Chemist Technology is the restrictive producer and merchant of RBI-81 in India.

III. LABORATORY STUDIES

3.1 Soil Used in the Studies

Clayey soil (Black cotton soil) from Davangere dist in Karnataka, is selected for the studies. Theproperties of soil are presented in Table 3.1. The grain0size distribution of soil is presented0in0Fig 3.1

Table 3.1: Properties0of0soil used in the

Sl no	Properties	Result		Test method
1	Grain size			IS 2720 : part 4 :1985
	Gravel (%)	3.6		
	Sand (%)	67.7		
	Silt or Clay (%)	28.7		
2	Altenburg limits			IS 2720 : part 5: 1985
	Liquid Limit (%)	52.5		
	Plastic Limit (%)	32.3		
3	Compaction	Modified Proctor	Standard Proctor	Modified Proctor as per IS : 2720 : part 7 : 1980 Standard Proctor as per IS : 2720 : part 8 :1983
	OMC (%)	16.6	17.4	
	MDD (g/cc)	1.74	1.40	
4	CBR (%)	5.2		IS : 2720 : Part 16
5	Soil Classification	MH (Inorganic silt and clay high compressibility)		IS soil classification
		A-7-5 (Clayey soil with high LL>40% and PI >10%)		HRB classification

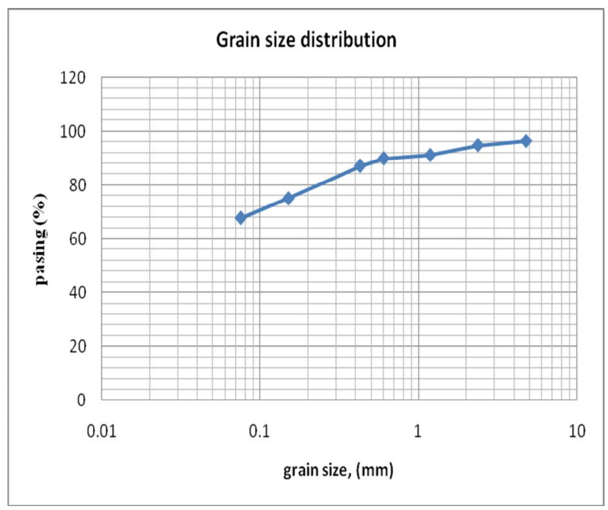

Fig 3.1 Gradation Chart –Clayey soil

3.2 Stabilizer

RBI-81 chemical stabilizer is used for stabilizing soil. The physical and chemical properties of stabilizer as per manufacture is presented in0Table 3.2 and0Table 3.3

Table 3.2: Physical properties

Properties	Results
Odour	Odourless
P^H	12.5
Specific gravity	2.5
Solubility	In water 0.2pts/100pts
Bulk density	$700kg/m^3$

Table 3.3: Chemical properties of RBI-81 stabilizer

0Chemical composition	
0Powder	
0Properties	!% by mass
0Ca	0CaO- 52-56
0Si	0SiO_2 15-19
0S	0SO_3 9-11
0Al	0Al_2O_3 5-7
0Fe	$Fe_2O_3$0-2
0Mg	0MgO 0-1
0Mn, K, Cu, Zn	0Mn+K+Cu+Zn 0,1-0,3
0H_2O	)1-3
0Fibres (polypropylene)	!0-1
Additives	!0-4

3.2.1Preparation of stabilized samples

The soils were dried and RBI-81 stabilized was then added. The stabilized and soil mixed thoroughly in dry condition till uniform mix is obtained. Water was then added and mixed thoroughly. The sample were then compacted

3.2.2 Curing of stabilizer soil

Specimen of UCScompression and flexural test stabilized with RBI-81 stabilizer were prepared and covered in Polythene bags for cured period of 28 days. Such moister cured specimens were tested for compressive, flexural strength and repeated load tests. The moist curing of specimens were carried out as per manufacturer recommendation.

3.3 CBR of stabilized using RBI-81

CBR0tests0were0carried0out0on0samples0treated0with 1.0%, 2.0% and 4.0% of RBI-81 and cured for 7days. The result obtained are presented in Table 3.4

Table 3.4: CBR test result on soil treated with RBI-81

Soil type	Test property	Stabilizer(%)			Test method
Black cotton soil	CBR(%), 7days moist cured and 4 days soaked	1.0	2.0	4.0	IS : 2720 : part 16 : 1987
		20	42	63	

3.4 UCS for soil treated with RBI-81

UCS tests were carried out on soil stabilized with 1.0%, 2.0% and 4.0% dosage of stabilizer. These stabilized cylindrical specimens of 38 x 76mm size were subjected to various curing duration of 7days, 14days and 28days. The result obtained is present in Table 3.5

Table 3.5: UCC strength (kg/cm^2) test results of clayey soils treated with RBI -81

Sl No	RBI-81 with different dosages(unsoaked)	UCS value for samples, (Kg/cm^2)			Average Modulus of elasticity of samples, (kg/cm^2)
1	Native black cotton soil	33	35	35	34
2	(1%),7days moist curing	42	31		37
3	(1%),14days moist curing	39	49		44
4	(1%),28days moist curing	63	58	68	63
5	(2%%),7days moist curing	49	50	51	50
6	(2%),14days, moist curing	62	57	67	62
7	(2%),28days moist curing	71	74		73
8	(4%),7days moist curing	63	65		64
9	(4%),14days moist curing	70	85		78
10	(4%),28days moist curing	145	143	150	146

3.5 Compression Test

Compression test was carried out on soil stabilized with 1.0%, 2.0% and 4.0% dosage of stabilizer. The tests were conducted on cube specimens of 150 x 150mm size which were cured for 7, 14and 28days. The compressive strength test results obtained is present in0Table 3.6'

Table!3.6:!Compression0strength0of stabilized soil.

Percentage	Curing period(days)	Compression strength, (kg/cm^2)
		ISH
0%	0	215.6
1%	7	743.92
	14	849.33
	28	1143.33
2%	7	848.02
	14	971.28
	28	1312.32
4%	7	866.32
	14	1149.86
	28	1530.97

3.6 Flexural Strength Test

The Flexural strength tests were carried out on soil stabilized with 1.0, 2.0 and 4.0% dosage of stabilizer. The specimens of size 600 x 100 x 100mm were cured for 7, 14 and 28days before testing. The flexural beams were compacted to IS Light and IS Heavy efforts compacted. The loading on beam are as presented in Fig 3.2. The results is obtained are presented in Table 3.2

Table 3.7: Flexural strength of stabilized soil.

Stabilizer (%)	**Curing period (days)**	**Flexural strength(kg/cm²)**		**Moisture**		**Modulus of rupture (R) (Kg/cm²)**	
		ISH	ISL	ISH	ISL	ISH	ISL
0%	0 days	10.5	10.9	18.3	18.4	23.4	24.2
1%	7 days	4.2	3.6	18.5	18.7	9.4	8.0
	14 days	5.5	6.3	16.1	11.3	12.4	14.2
	28 days	9.2	10.6	13.3	10.6	20.6	23.0
2%	7 days	5.8	4.5	17.4	18.7	13.9	10.0
	14 days	7.2	7.4	15.5	13.3	16.0	16.6
	28 days	9.7	11.0	13.6	11.5	21.5	24.5
4%	7 days	6.2	4.7	17.2	17.6	7.9	10.5
	14 days	7.5	7.4	12.5	12.4	14.2	16.5
	28 days	9.2	10.8	13.1	10.4	20.6	24.0

IV. ANALYSIS OF TEST RESULTS

4.1. Plasticity characteristics of stabilized soils

The plasticity properties obtained for soil stabilized with 1.0 , 2.0 and 4.0 RBI-81 stabilizer are presented0in0Table!4.1.

Table 4.1 Properties of stabilized soils treated with RBI -81stabilizer

Sl no	**Test properties**	**Dosage of stabilizer (%)**			
		0	1.0	2.0	4.0
1	Liquid limit (%)	52.5	54.4	5.35	52.5
2	Plastic limit(%)	32.3	37.2	37.9	39.4
3	Plasticity index	20.2	17.2	15.6	13.1

4.2 Compaction Characteristics of stabilized soil

The density characteristic of stabilized soil treated with 1.0, 2.0 and 4.0% stabilizer is represent in Table 4.2.

Table 4.2 Compaction Properties stabilized soils

Sl no	**Test properties**	**Dosage of stabilizer (%**			
		0	1.0	2.0	4.0
1	Max dry density (g/cc)	1.75	1.76	1.78	1.79
2	Optimum moisture content (%)	16.6	16.54	14.8	13.5

4.3 CBR Test

CBR results obtained for stabilized soil sample stabilized with 1.0, 2.0 and 4.0% of RBI-81 stabilizer after 7 day curing and 4 day soaking in water is presented in0Table04.3

Table 4.3 CBR of stabilized soil

Test property	**Dosage of stabilizer (%)**			
	0	1.0	2.0	4.0
CBR value, % (7 days moist cured and 4 days soaked)	5.2	20	42	63

Note: The soils without stabilizer (zero percent of RBI -81) are not moist cured. The specimens were soaked in water for 4 days

4.4 Compressive! Strength

The0relationship obtained0between curing period and compressive strength for stabilized soil with 1.0, 2.0 and 4.0 % of stabilizer is presented in Fig 4.1

It is observed that0compressive0strength increased0by 12% and 34% for 14 and 28 days cured samples compared to 7 days cured specimens stabilized with 1.0% RBI-81

Similarly, compressive strength increased by 14% and 35% for 14 and 28 days cured sample compared to 7 days cured specimens stabilized with 2.0% RBI-81
Similarly, compressive strength increased by 24% and 44% for 14 and 28 days cured sample compared to 7 days cured specimens stabilized with 4.0% RBI

4.5 Flexural strength

The relationship between curing period and flexural strength obtained for stabilized soil sample with varying dosage of stabilizer compacted to IS Heavy and IS Light compaction efforts are presented in Fig 4.2 and Fig 4.3 respectively.

For soils stabilized at IS Heavy compaction effort, It is observed that the flexural strength has increased by 24% and 60% for soil stabilized with 1.0% stabilizer cured for 14 and 28 days respectively as compared to 7 days cured soil sample.
Similarly the increased in strength is about 20% and 41% for soil stabilized with 2.0% stabilizer and cured for 14 and 28 days respectively.

For soils stabilized at IS Light compaction effort It is observed that the increased in flexural strength is about 26% and 23% for soil stabilized with 1% stabilizer for 14 and 28 days cured specimen respectively. Similar increased is about 15% and 15% for soil stabilized with 2% stabilizer.

V. DISCUSSIONS AND CONCLUSIONS

Table 5.1: Comparison of compressive strength

Curing period (days)	1.0 %		2.0 %		4.0 %	
	Compressive strength (MPa)	% increment	Compressive strength (MPa)	% increment	Compressive strength (MPa)	% increment
7	73	246	83.19	295	84.98	303
14	83.31	295	95.28	351	112.80	435
28	112.18	432	128.73	510	150.18	612

- **Flexural strength**

The flexural strength found to be 0.91, 0.95 and 0.98 MPa for soil stabilized with 1.0, 2.0 and 4.0% stabilizer respectively for 28 days cured specimen. Table 5.2 indicates percentage in increased in strength with respect to curing period for specimen compacted to IS Heavy compaction effort.

Table 5.2: Comparison of Flexural strength under ISH

Curing period (days)	1.0 %	2.0 %		4.0 %	
	Flexural strength (MPa)	Flexural strength (MPa0)	% increment	Flexural strength (MPa)	% increment
7	0.41	0.56	36	0.61	49
14	0.54	0.70	30	0.74	37
28	0.91	0.95	4	0.98	7

Similarly Table 5.3 indicates percentage increased in strength for specimen compacted to IS Light compaction efforts.

Table 5.3 Comparison of Flexural strength under ISL

Curing period (days)	1.0 %	2.0 %		4.0 %	
	Flexural strength (MPa)	Flexural strength (MPa)	% increment	Flexural strength (MPa)	% increment
7	0.35	0.44	21	0.46	24
14	0.62	0.73	17	0.73	17
28	1.01	1.08	7	1.05	4

5.2 Conclusions

- Decreased in plasticity index and increased in CBR, UCS were found for soil stabilized with RBI-81 stabilizer.
- The significant increased in compressive strength and flexural strength was observed for stabilized sample.
- It is observed that the Resilient modulus and Elastic strain in increased for stabilized soil sample.

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