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STABILIZATION OF BLACK COTTON SOIL USING COIR PITH

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Abstract - *Black cotton soil is typical expansive soil have inherent property of shrinking when they are dried and swelling water is absorbed. For all structure, the foundation is very important and it has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. To work on soils, we need to have proper knowledge about their properties and factors which affect their behavior. Expansive soils always create problems more for lightly loaded structures than moderately loaded structures. In this paper the experimental results obtained in the laboratory on expansive soils treated with industrial waste Coir Pith (CP) treated with 5% of NaOH as a stabilizer are presented. A study is carried out to check the improvements in the properties of expansive soil with Coir Pith in varying percentages. The test results such as liquid limit, Modified proctor compaction, and Unconfined Compression strength test obtained on black cotton soil mixed at different proportions of Coir Pith as an admixture ranging from 2%, 2.5%, 3%, 3.5% and 4%. The plasticity index (PI) of 2% & 3% addition of coir pith is less compared to untreated BC Soil. The max dry density (MDD) of 2% &3% addition of coir pith is more compare to untreated BC Soil, optimum moisture content (OMC) is reduced compare to BC Soil. The unconfined compressive strength (UCS) for BC Soil treated with 2%and 3% compare to untreated BC soil.*

***Key Words*: Coir pith, Black cotton soil, Strength Test, Maximum dry density, Optimum moisture content.**

1. INTRODUCTION

Engineers are often faced with the Problem of constructing facilities on or with soils, which do not possess sufficient strength to support the loads imposed upon them either during construction or during the service life of the structure. Many areas of India consist of soils with high silt contents, low strengths and poor bearing capacities. Stabilization of soils is an effective method for improving the properties of soil and pavement system performance. For any given soil many stabilization methods, using different stabilizing agents, may be effective to improve the soil properties in-place rather than removing and replacing the material. Availability or financial considerations may also be the determining factor on which a stabilizing agent is selected. This paper aims to present the studies on chemical stabilization of an expansive soil using coir pith. The investigations done earlier on untreated coir pith on soil indicate that strength properties soils decrease but when the NAOH is added with coir pith the strength is increase randomly. Then coir pith added with soil it increase the bearing capacity of foundation soil. Coir pith, a fluffy and spongy material, is a part of coir waste that is dumped near the coir manufacturing units in Pollachi. These are conventionally disposed of by burning which leads to many environmental problems. So finding out an efficient way for the disposal of coir waste is of critical importance.

2. OBJECTIVE OF THE STUDY

Roads running on black cotton soils are known for bad condition and unpredictable behavior. Modification of black cotton soils by chemical admixtures is a common method for stabilizing the swell- shrink tendency of expansive soils. Advantages of chemical stabilization are that they reduce the swell-shrink tendency of the expansive soils and also render the soils less plastic. Stabilization of problematic black cotton soil with coir pith and NaOH agent is neither economical nor ecofriendly and increases carbon footprints.

In this project, Coir pith was used as one such stabilization material, in the construction of foundation and pavement work. The improvement of the soil stability due to coir pith has been attributed to main mechanisms reduce the voids on soil. The soil used in this

Test was collected in bulk at pollachi near our college campus. The physical and engineering properties soil were determined. Proctor's Compaction tests,CBR tests, unconfined compressive strength tests were performed in the soil and in the black cotton soil with various Percentages of coir pith ranging from 2%,2.5%, 3%, 3.5% and 4%.The test were conducted under light compaction. The results obtained were compared.

3 LABORATORY INVESTIGATION

3.1 Soil sampling

i) Representative soil samples were Collected from an open pit at a depth of 1m which is clear of organic soil.

ii) The soil used for analysis is cohesive soil predominantly clay.

3.2 Laboratory Tests of Soil Sample

Laboratory test were conducted in the Geotechnical laboratory with the collected soil sample to classify the soil, to evaluate its physical and engineering properties and to study the compaction characteristics.

3.3 Coir Pith Treated With NaOH

Coir pith were collected from the P.A.M Coir factory at Devanallur, Pollachi. The Coir pith is treated with NaOH.

4 EXPERIMENTAL STUDY AND TESTS

4.1 Standard Proctor Compaction Tests

Standard Proctor Compaction Tests is conducted on soil with 2%, 2.5%, 3%, 3.5%, 4% coir pith to determine the optimum moisture content and maximum dry density of soil with varying coir pith content. The following are the compaction values obtained from the standard proctor compaction tests.

4.1.1 Standard Proctor Compaction Curve For Soil With Coir Pith

The comparison of untreated and treated coir pith compaction curve obtained from addition of coir pith 2%, 2.5%, 3%, 3.5%and 4% shown in Table 1.

Table -1:

Dry Density Values Of Treated And Untreated Coir Pith		
Water Content (%)	Dry density of Untreated Coir Pith on Soil (g/cc)	Dry density of treated Coir Pith on Soil (g/cc)
8	1.05	1.65
10	1	1.8
12	0.7	1.9
14	0.8	1.7
16	0.9	1.6

The optimum moisture content andmaximum dry density of soil with addition of coir pith 2%,2.5%,3%,3.5% and 4% obtained are given in Table-2 and 3.

Table-2:

Standard Proctor Compaction Results For Treated Coir Pith					
Coir pith (%)	2	2.5	3	3.5	4
Optimum Moisture Content (OMC) in %	12	12	12	12	12
Maximum Dry Density (MDD) in g/cc	1.76	1.83	1.91	1.79	1.64

Table-3:

Standard Proctor Compaction Results For Untreated Coir Pith					
Coir Pith (%)	2	2.5	3	3.5	4
Optimum Moisture Content (OMC) in %	12	12	12	12	12
Maximum Dry Density (MDD) in g/cc	1.05	1.01	0.82	0.86	0.92

4.1.2 California Bearing Ratio Tests

California Bearing Ratio Tests are conducted on soil samples prepared under Light compaction to determine CBR value of soil with varying coir pith content. The test is conducted on soil samples with 2%, 2.5%,3%, 3.5%and 4% coir pith to determine the optimum coir pith content.

Fig-1: California Bearing Ratio Tests

Table-4:

CBR Test Results of Treated Coir Pith					
Coir pith (%)	2	2.5	3	3.5	4
CBR at 2.5 mm Penetration (%)	4.29	5.36	6.57	7.28	8.28
CBR at 5 mm Penetration (%)	4	4.95	5.62	6.57	7.14
CBR	4.29	5.36	6.57	7.28	8.28

Table-5:

CBR Test Results of Untreated Coir Pith					
Coir pith (%)	2	2.5	3	3.5	4
CBR at 2.5 mm Penetration (%)	3.82	4.13	4.87	5.1	5.45
CBR at 5 mm Penetration (%)	3.3	3.76	4.2	4.6	4.9
CBR	3.82	4.13	4.87	5.1	5.45

4.1.3 Unconfined Compressive Strength Test

This test are conducted on soil samples prepared under Light compaction to determine unconfined compressive strength value of soil, when is then used to calculate the unconsolidated undrain shear strength of clay under unconfined condition with varying coir pith content. The test is conducted on soil samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith to determine the unconsolidated undrain shear strength.

Fig-2: Unconfined Compressive Strength Test

Table-6:

UCC Test Result of Different Percentage of Coir Pith on Soil		
Percentage of Coir Pith (%)	Unconfined Compressive Strength KN/m²	Cohesion KN/m²
2	68.26	34.13
2.5	70.8	35.4
3	74.8	37.4
3.5	76.76	38.38
4	66.94	33.47

5. RESULTS AND DISCUSSION:

5.1 Properties of Soil

The various properties of the soil namely natural moisture content, specific gravity, liquid limit, plastic limit, shrinkage limit, grain size distribution, optimum moisture content , maximum dry density ,unconfined compressive strength and CBR obtained through tests are summarized in table 7.

Table-7:

Properties of Soil with result		
S.No	Properties	Result
1	Natural Moisture Content	8 %
2	Specific Gravity	2.25
3	Percentage of Sand	21.55%
	Percentage of Silt	23.74 %
	Percentage of Clay	54.71 %
4	Soil Classification	CH
5	Optimum Moisture Content	12 %
	Maximum Dry Density	1.78g/cc
6	Unconfined Compressive Strength	68.82 KN/m²
	Cohesion	34.41 KN/m²

5.2 STANDARD PROCTOR COMPACTION TEST

5.2.1 Result

Standard Proctor's Compaction tests are conducted on soil samples and on soil samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith. The Maximum dry density and optimum moisture Content corresponding to various percentages of treated and untreated coir pith were elaborated in experimental study and tests. The variation in maximum dry density and optimum moisture content with addition of treated coir pith under light compaction and the variation in maximum dry density and optimum moisture content with addition of treated under light compaction.

Table-7:

STANDARD PROCTOR COMPACTION TEST RESULT COMPARISON		
Percentage of Coir Pith (%)	MDD of soil(g/cc0	MDD 0f Untreated coir pith
2	1.78	1.05
2.5	1.78	1.01
3	1.78	1
3.5	1.78	0.96
4	1.78	0.92

5.2.2 DISCUSSION

i) From table 1.8 addition of treated coir pith it is observed that the maximum dry density decrease from 1.91KN/m³ to 1.64 KN/m³ in standard proctors compaction tests. The decrease in maximum dry density is due to increase in percentage of coir pith.

ii) It is also observed that the optimum moisture content remains same as 12% for soil sample.

5.3 CALIFORNIA BEARING RATIO TEST

5.3.1 Result

California bearing ratio tests are conducted on soil samples and on soil Samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith. The tests were carried out on samples prepared under light compaction.
The tests were carried out on samples under unsoaked condition. The CBR

Values corresponding to various percentages of coir pith were elaborated in experimental study.

Table-8:

Unsoaked CBR test result			
Percentage of coir pith (%)	CBR value of soil (%)	CBR value of treated coir pith (%)	CBR value of Untreated coir pith (%)
2	4.64	4.29	3.82
2.5	4.64	5.36	4.13
3	4.64	6.57	4.87
3.5	4.64	7.28	5.1
4	4.64	8.28	5.45

5.3.2 DISCUSSION

i) From Table 1.9 it is seen that the unsoaked CBR of soil sample prepared with light compaction is 4.64% and the CBR of sample with treated coir pith 2%,2.5%, 3%, 3.5% and 4% are 4.29, 5.36, 6.57,7.28 and 8.28 respectively. This shows the addition of treated coir pith under light compaction and soaked condition showed significant improvement in CBR value.
ii) The CBR value increases with increase in percentage of treated coir pith.

5.4 UNCONFINED COMPRESSION STRENGTH

5.4.1 RESULT

UCC tests are conducted on soil samples and on soil samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith. The tests were carried out on samples prepared under light compaction. The tests were carried out on samples under soaked condition. The UCC values corresponding to various percentages of coir pith were elaborated in experimental study. The variation in UCC Value with addition of coir pith under light compaction and soaked condition is shown in table 9.

Table-9:

UCC test result		
Percentage of coir pith (%)	**UCC value of soil (KN/m^2)**	**UCC value of treated coir pith (KN/m^2)**
2	68.82	68.26
2.5	68.82	70.8
3	68.82	74.8
3.5	**68.82**	**76.76**
4	**68.82**	**69.92**

5.4.2 DISCUSSION

From table 9 it is seen that the UCC of soil sample prepared with light compaction is $68.82KN/m^2$ and the UCC of sample with treated coir pith 2%,2.5%,3%,3.5% and 4% are $68.2682KN/m^2$,$70.882KN/m^2$,$74.882KN/m^2$,$76.7682KN/m^2$ and $66.9482KN/m^2$ respectively. This shows the addition of treated coir pith under light compaction and soaked condition showed significant improvement in UCC value.

6 CONCLUSION

Based on the laboratory tests and experimental studies in the above study the following conclusions were drawn.

1. The proctor compaction and CBR values increased for 2%, 2.5%, 3% and 3.5% of coir pith.
2. 2. The optimum moisture content and maximum dry density of the untreated soil were 12% and $17.46KN/m^3$.
3. Addition of 2%, 2.5%, 3% and 3.5% of treated coir pith increased the CBR value respectively 4.29, 5.3, 6.57 and7.28%.When compared to the CBR value of untreated coir pith which is about 3.82,4.13,4.87and5.1.
4. Increase in percentage of treated coir pith also contributed to the increase in CBR value. But increase in the percentage of CBR value by adding untreated coir pith is greater than that of treated coir pith.

5. Coir pith increases the CBR value up to double times.
6. The CBR value increases with increase in percentage of treated coir pith.
7. Addition of 2%, 2.5%, 3% and 3.5% of treated coir pith increased the UCC value respectively 68.26, 70.8, 74.8 and 76.76KN/m^2.

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