Stabilization of Black Cotton Soil using Stone Dust and Xanthan Gum Biopolymer

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Abstract- *Soil stabilization has become a major issue in construction engineering and the researches regarding the effectiveness of using industrial wastes. The present experimental work briefly describes the suitability of the locally available Stone Dust (SD) to be used in the local construction industry in a way to minimize the amount of waste to be disposed to the environment causing environmental pollution. The common soil stabilization techniques are becoming costly day by day due to rise of cost of the stabilizing agents like, cement, lime, etc. The cost of stabilization may be minimized by replacing a good proportion of stabilizing agent using SD. It will minimize the environmental hazards also. Soil sample taken for the study is clay with High plasticity (CH) which truly requires to be strengthened. The soil is stabilized with different percentages of Stone Dust and a small amount of Xanthan Gum Biopolymer. Observations are made for the changes in properties of the soil such as Maximum dry density (MDD), Optimum moisture content (OMC) and Unconfined compressive stress (UCS). UCS of soil are considerably improved with the Stone Dust content and Biopolymer.*

Keywords: Soil Stabilization, Clay Soil (CH), Xanthan Gum (XG), Stone Dust, Optimum Moisture Content (OMC) Unconfined Compressive Stress (UCS).

I. INTRODUCTION

Soil is a good and comfortable material for the construction purposes so it also very important to know about the properties and feasibilities of used soil before use in any kind of construction process. One parameter of the main parameters is that the variation in the properties and characteristics of the soil is changed according to the change in the area and environment of the soil for any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order to strong the foundation, the soil around it plays a very critical role. So, to work with the soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil which are needed for the construction work. From beginning of the construction work, the necessity of enhancing soil properties has come to the light. Some types of soils have low bearing capacity and do not fulfill the engineering works. So to improve the engineering properties of soils and make it suitable for engineering works soil stabilization is needed. Soil stabilization is the process which improves the engineering properties of the soils and makes it stable. The main objective of soil stabilization is to improve the strength and stability of the soils and mainly to lower the construction cost. The stability and bearing capacity of soil depends on the shear strength, which is directly proportional to the type and conditions of the soil. In some of the situations where two materials do not have the desired engineering properties, but when they mix together, they produce satisfactory material for the strength of the soils. These new stabilized materials will be more stable and fulfil the desired conditions.

II. OBJECTIVES OF THE STUDY

1) Improvement in stability of the soils for the good building construction in civil engineering.
2) Making the foundation process cheap, comfortable and economically.
3) Observe a right concentration mixture of the additional components like stone dust and Xanthan Gum (XG).
4) Use of wastage material which is producing in high potential and also having disposal problems.

III. LITERATURE REVIEW

Akinmusuru (1991) observed the cause of mixing of GGBS on the consistency, compaction characteristics and strength of lateritic soil. He observed a decrease in both the limits that is in liquid and plastic limits. The compaction, cohesion and CBR improved with increasing GGBS up to 10% then if add 15% of GGBS decrease strength. The angle of internal friction decreases with increase GGBS percentage.

Wild et al. (1995) studied the results of laboratory testing on lime-stabilize kaolinite containing different quantities of added sulphate to which different quantities of GGBS have been added. The experiment determines the strength increase of compacted cylinders, moist cured in a humid temperature at 30 and the linear growth of these moist cured cylinders on soaking in water. The results clarify that slight additions of GGBS to the sulphate containing clays which are stabilized with decrease their expansion.

Hogan and Meusel (1981) studied the assessment of a ground granulated blast furnace slag is a limited replacement for the Portland cement in mortars and concrete. The ground slag was evaluated for the strength-constructing properties as well as durability concert by replacing 40 to 65% Portland cement with it. This study presented that the ground slag when used to interchange 40 to 65% Portland cement expressively improved strengths, resistance, sulphate, and alkali aggregate also.

Higgins (2005) made a study on the soil stabilization in ground granulated blast furnace slag. In this paper lime and ground granulated blast furnace slag are added in the soil to stabilize the soil. Lime and GGBS is the ideal option where there are sulphate and sulphides are present in the soil mass.

Manjunath (2011) made a study on the mixing of blast furnace slag (an industrial waste) with hydrated lime is used to stabilize atypical black cotton soil. The addition of the blast furnace slag and lime to increase the geotechnical property of soil.

Sayida and Saijamol (2011) studied the improving engineering properties of the soil. They added chemical then react with the cementing compound. The present analysis is kaolinite clay is mixed with different proportions of fly ash and sea sand .Then they observed that the addition of sand raise the CBR value.

IV. MATERIALS USED

Soil used Soil used in the experiments has been collected from village Charghat, Rewa district (Madhya Pradesh). Soil sample is collected from 0.3-0.5 m below the ground surface.

Table-1.

S.NO.	Properties	Typical Value
1.	I.S. Classification	CH
2.	Plastic Limit	42.35
3.	Liquid Limit	61.23
4.	Plastic Index	18.88
5.	Specific Gravity	2.68

Stone Dust: The Stone Dust was collected from Locally STONE CRUSHER.

Xanthan Gum: The Xanthan Gum was purchased from the shop Urban Platter, New Delhi.

V. EXPERIMENTAL PROCESS

1) Analysis of standard proctor test.

2) Unconfined Compressive Strength (UCS).

A. Standard Proctor Test: To perform the Standard Penetration Test for Clay soil, stone dust and Xanthan Gum with variation in composition in quantity sample are prepared that are shown below in table no. 1. Individually test for all samples so to perform the test we have made 25 sample of different – 2 compositions.

Table-2: Composition of 25 samples

Sample Name	Particulars of the Sample
Sample 1	CH+ SD-0% + XG-0%
Sample 2	CH+ SD-0% + XG-0.5%
Sample 3	CH+ SD-0% + XG-1.0%
Sample 4	CH+ SD-0% + XG-1.5%
Sample 5	CH+ SD-0% + XG-2.0%
Sample 6	CH+ SD-5% + XG-0%
Sample 7	CH+ SD-5% + XG-0.5%
Sample 8	CH+ SD-5% + XG-1.0%
Sample 9	CH+ SD-5% + XG-1.5%
Sample 10	CH+ SD-5% + XG-2.0%
Sample 11	CH+ SD-10% + XG-0%
Sample 12	CH+ SD-10% + XG-0.5%
Sample 13	CH+ SD-10% + XG-1.0%
Sample 14	CH+ SD-10% + XG-1.5%
Sample 15	CH+ SD-10% + XG-2.0%
Sample 16	CH+ SD-15% + XG-0%
Sample 17	CH+ SD-15% + XG-0.5%
Sample 18	CH+ SD-15% + XG-1.0%
Sample 19	CH+ SD-15% + XG-1.5%
Sample 20	CH+ SD-15% + XG-2.0%
Sample 21	CH+ SD-20% + XG-0%
Sample 22	CH+ SD-20% + XG-0.5%
Sample 23	CH+ SD-20% + XG-1.0%
Sample 24	CH+ SD-20% + XG-1.5%
Sample 25	CH+ SD-20% + XG-2.0%

B. Unconfined Compressive Test: The unconfined compressive tests were conducted on the stone dust and Xanthan Gum Biopolymer clay soil samples. it is noted that unconfined compressive value of the stone dust and Xanthan Gum in various proportions has increased gradually from 0kg/mm2 to maximum compressive strength and materials combinations is optimum percentages of unconfined compressive value is find out.

VI. RESULTS AND DISUSSION

A. Standard Proctor Test Comparison

The Standard Proctor Test were conducted on the stone dust and Xanthan Gum with clay soil samples. It is noted that dry density value increase with the decreasing of water content. The various results for Standard Proctor Test are compared in graphical presentation in below graphs.

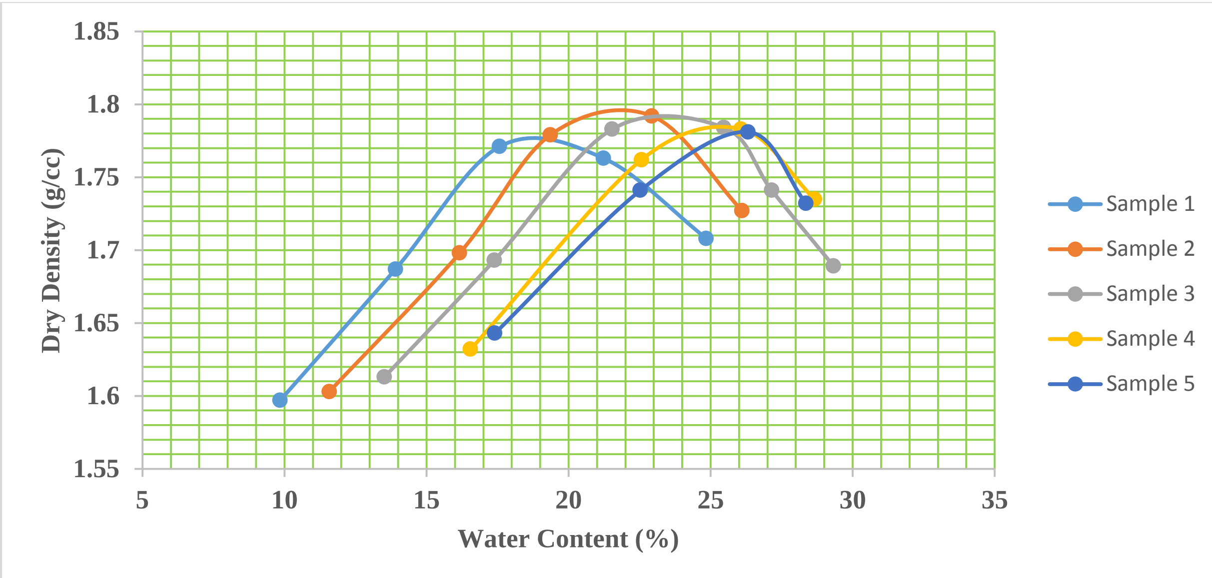
Table-3: Comparisons between Maximum Dry density and Maximum water content

Result for All		
Maximum Dry density and Maximum water content		
Sample	Maximum Dry Density Yd	Maximum Water Content w (%)
Sample 1	1.771	14.57
Sample 2	1.792	22.93
Sample 3	1.784	25.47

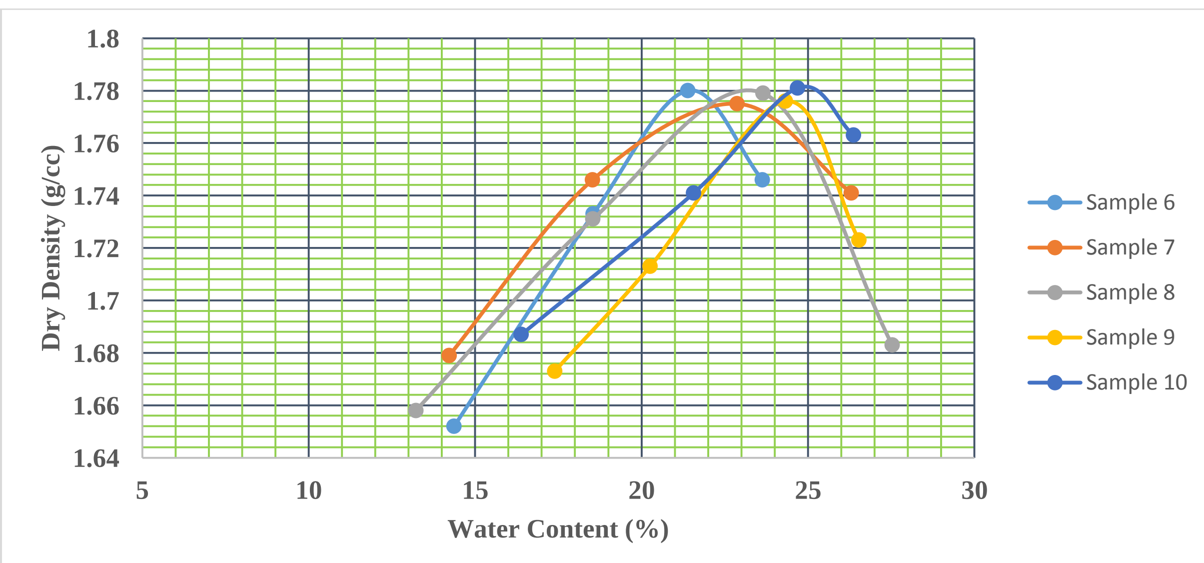
Sample 4	1.783	26.08
Sample 5	1.781	26.32
Sample 6	1.780	21.39
Sample 7	1.775	22.87
Sample 8	1.779	23.65
Sample 9	1.776	24.32
Sample 10	1.781	24.69
Sample 11	1.793	21.73
Sample 12	1.791	22.07
Sample 13	1.775	22.51
Sample 14	1.771	23.68
Sample 15	1.784	24.12
Sample 16	1.803	20.07
Sample 17	1.811	20.87
Sample 18	1.785	21.63
Sample 19	1.776	22.57
Sample 20	1.779	23.86
Sample 21	1.758	19.87
Sample 22	1.753	20.08
Sample 23	1.750	20.58
Sample 24	1.747	21.68
Sample 25	1.739	22.36

The table shows the maximum dry density and maximum water content for Standard Proctor test. The maximum water content values for Standard Proctor test is selected from the curve height. While performing the Standard Proctor test we plot various curves with combination of Clay soil, Stone Dust and Xanthan Gum.

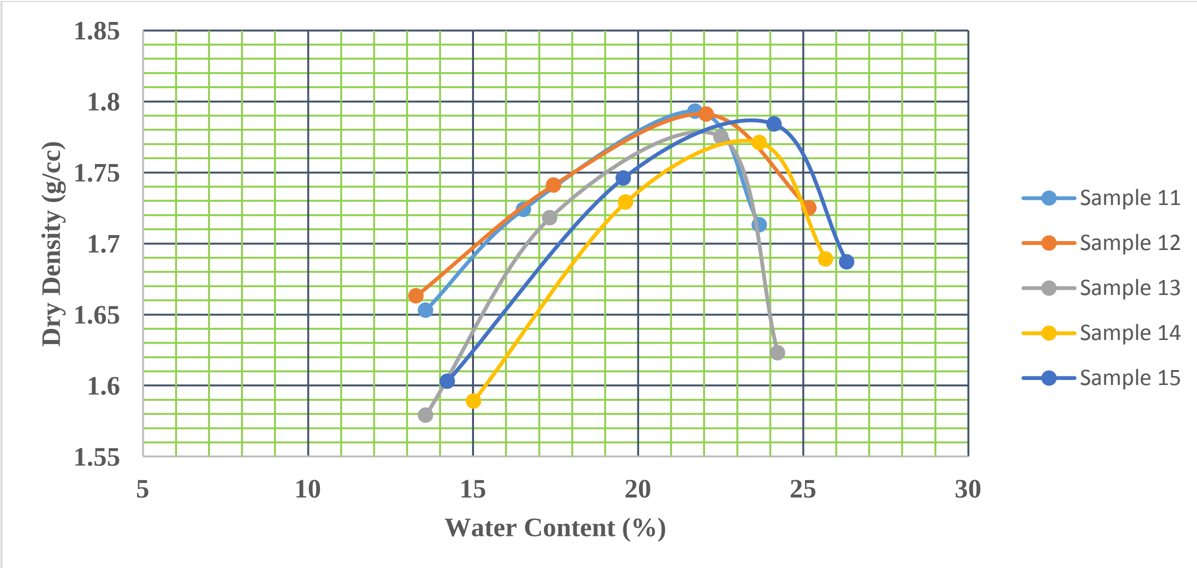
Graph 1. Graphical presentations of comparison between Maximum dry density and maximum water content for the soil when amended with SD - 0 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



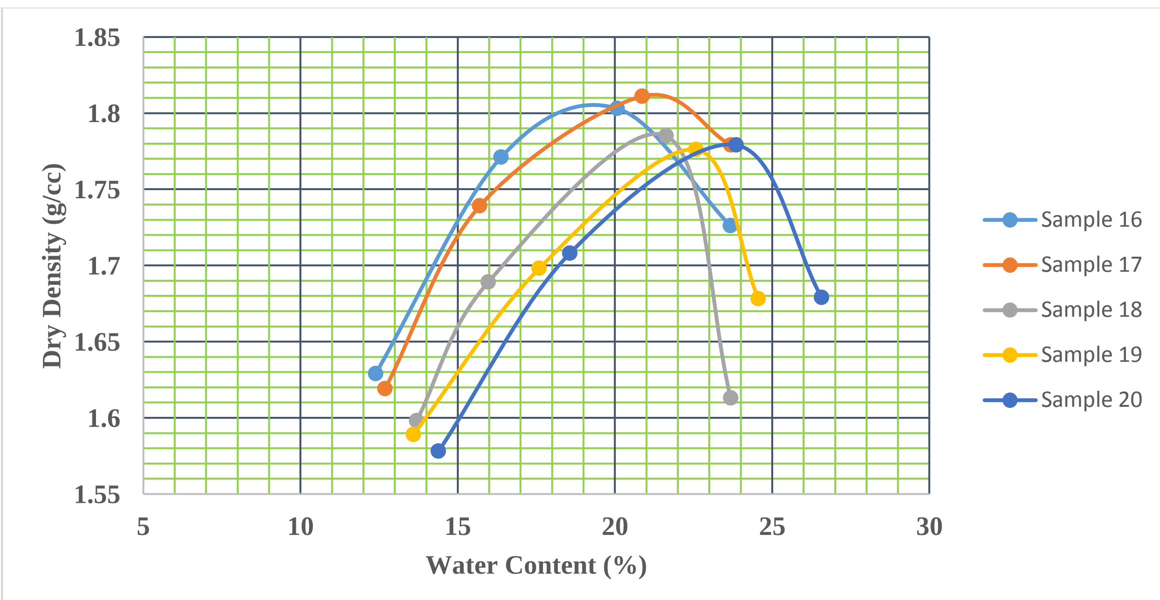
Graph 2. Graphical presentations of comparison between Maximum dry density and maximum water content for the soil when amended with SD - 5 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



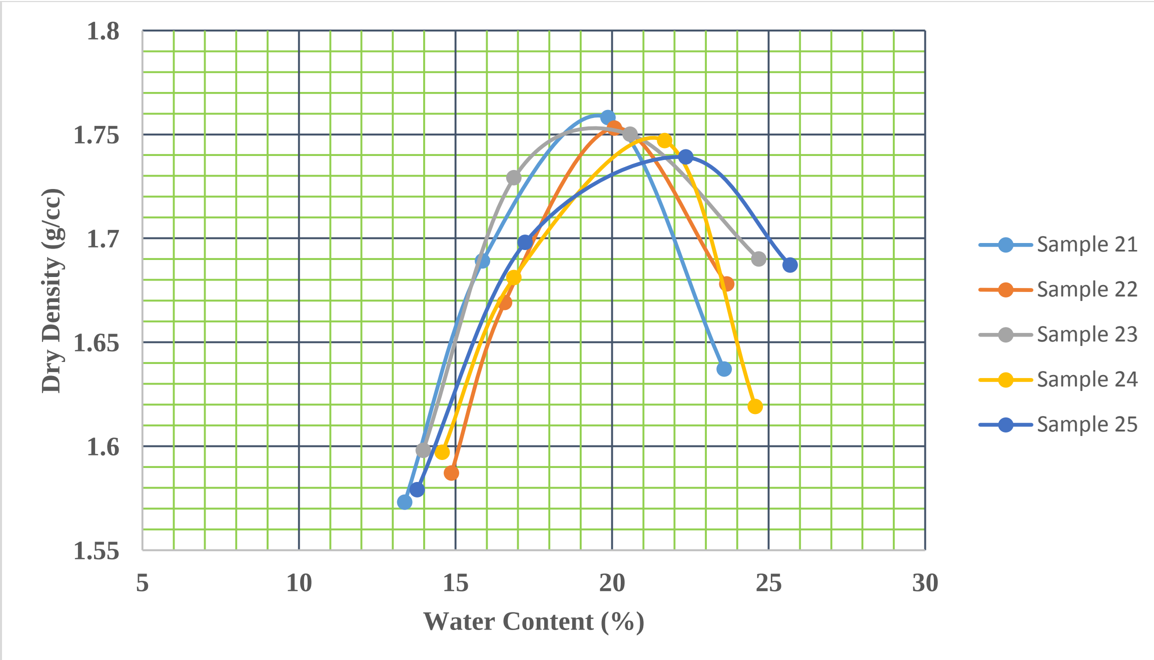
Graph 3. Graphical presentations of comparison between Maximum dry density and maximum water content for the soil when amended with SD - 10 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



Graph 4. Graphical presentations of comparison between Maximum dry density and maximum water content for the soil when amended with SD - 15 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



Graph 5. Graphical presentations of comparison between Maximum dry density and maximum water content for the soil when amended with for SD - 20 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



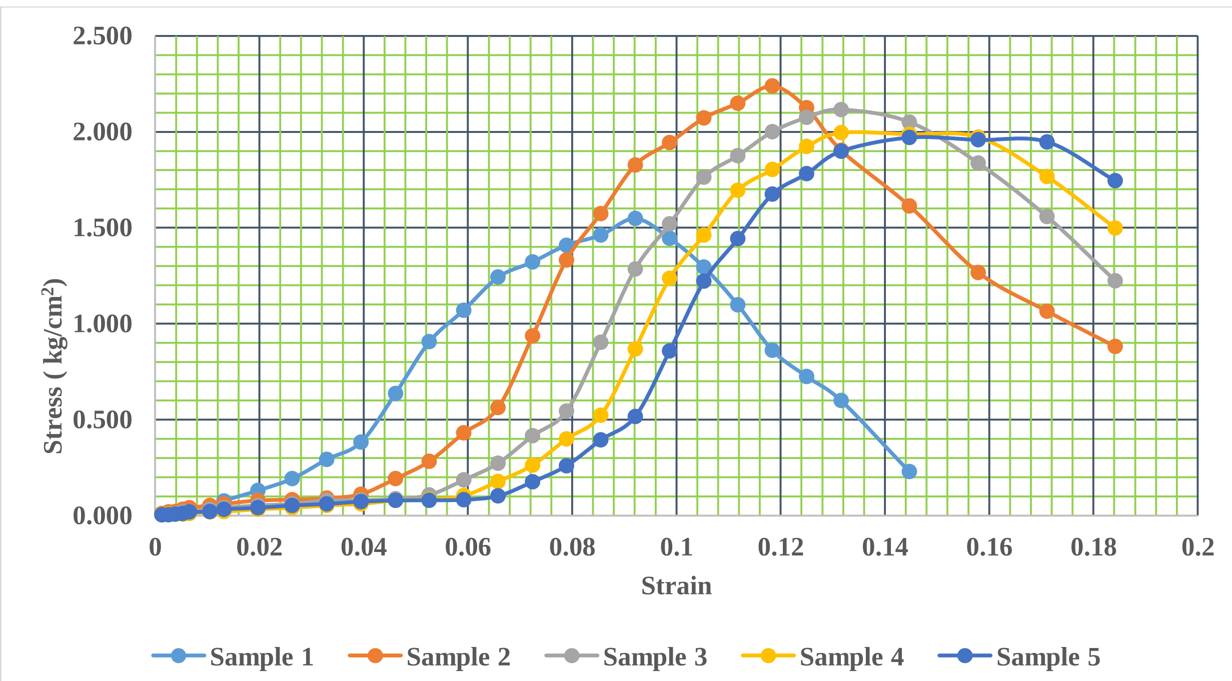
B. Unconfined Compressive Strength Test comparison: The Unconfined Compressive Strength Test were conducted on the stone dust and Xanthan Gum amended clay soil samples. It is noted that UCS value increase with the increasing of the Stone Dust proportion. The various results for Unconfined Compressive Strength Test are compared in graphical presentation in below graphs.

Table-4: Comparisons between UCS value and corresponding strain value for different soil samples

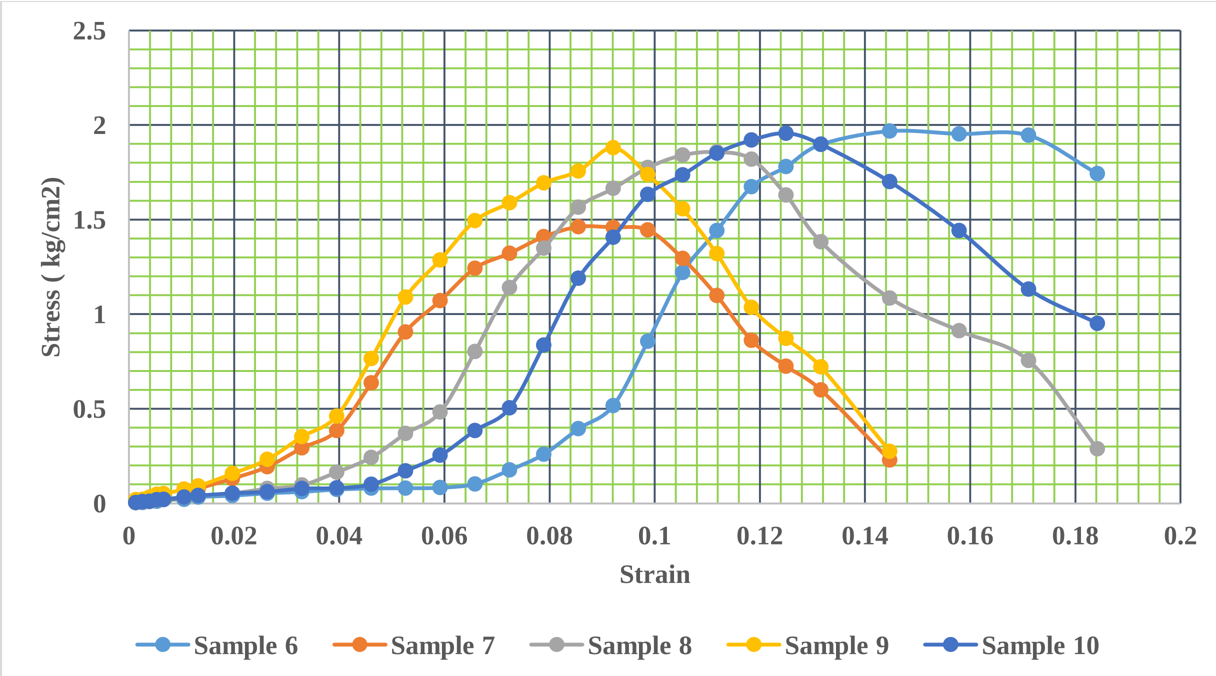
Result for All		
Maximum Unconfined Compressive Strength (kg/cm2) and corresponding value of strain		
Sample	Maximum Unconfined Compressive Strength (kg/cm2)	Corresponding strain value
Sample 1	1.548	0.0921
Sample 2	2.238	0.1184
Sample 3	2.115	0.1316
Sample 4	1.995	0.1316
Sample 5	1.970	0.1447
Sample 6	1.967	0.1447
Sample 7	1.462	0.0855
Sample 8	1.857	0.118
Sample 9	1.880	0.0921
Sample 10	1.956	0.1250
Sample 11	2.237	0.0987
Sample 12	2.226	0.0955
Sample 13	1.658	0.0987

Sample 14	1.448	0.1118
Sample 15	2.077	0.1118
Sample 16	2.426	0.0855
Sample 17	2.254	0.0921
Sample 18	2.135	0.0855
Sample 19	1.568	0.1053
Sample 20	1.926	0.1184
Sample 21	1.467	0.0855
Sample 22	1.365	0.0921
Sample 23	1.278	0.0987
Sample 24	1.168	0.0921
Sample 25	1.124	0.0855

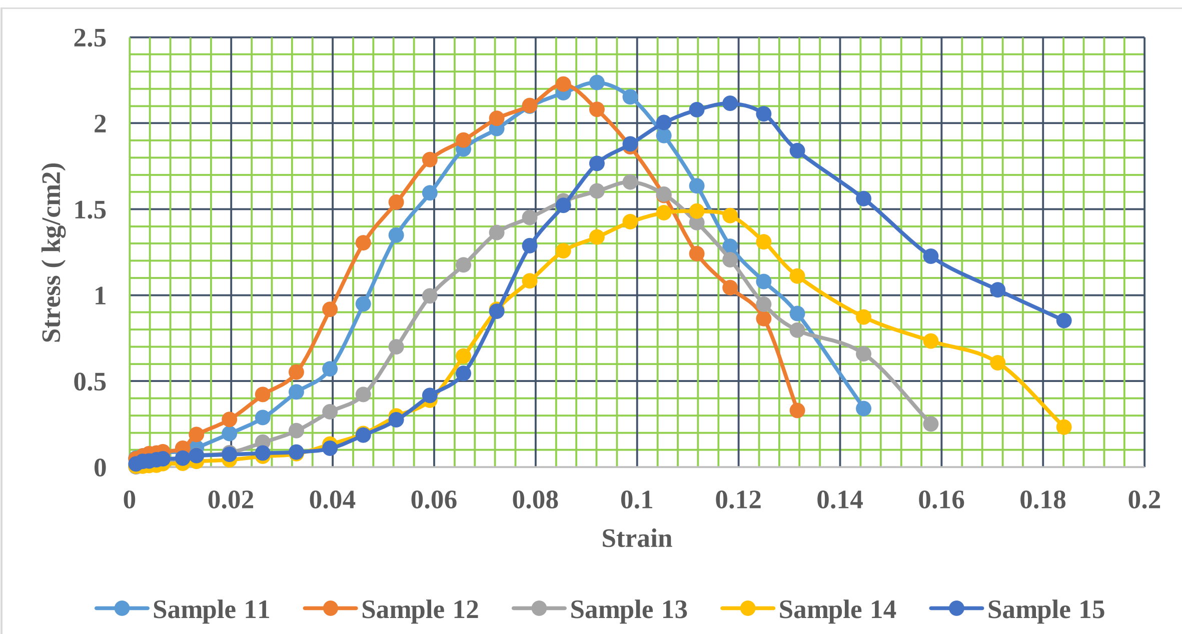
Graph 1. Graphical presentations of comparison between UCS Value and corresponding strain value for the soil when amended with SD - 0 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



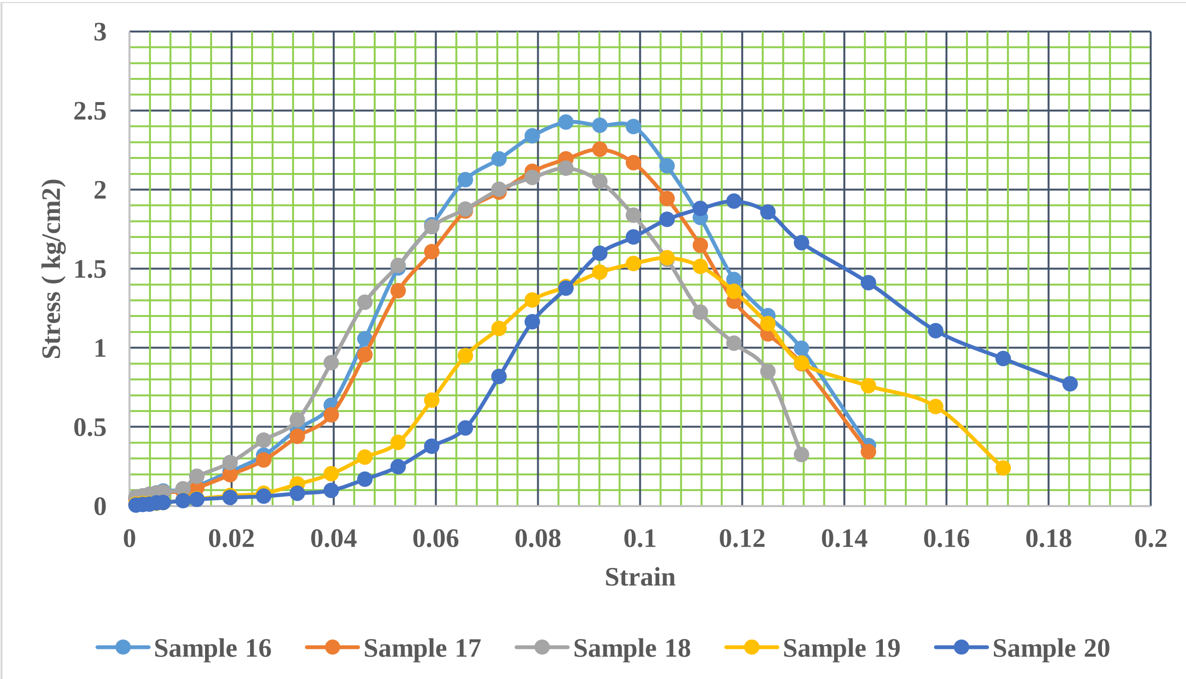
Graph 2. Graphical presentations of comparison between UCS Value and corresponding strain value for the soil when amended with SD - 5 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



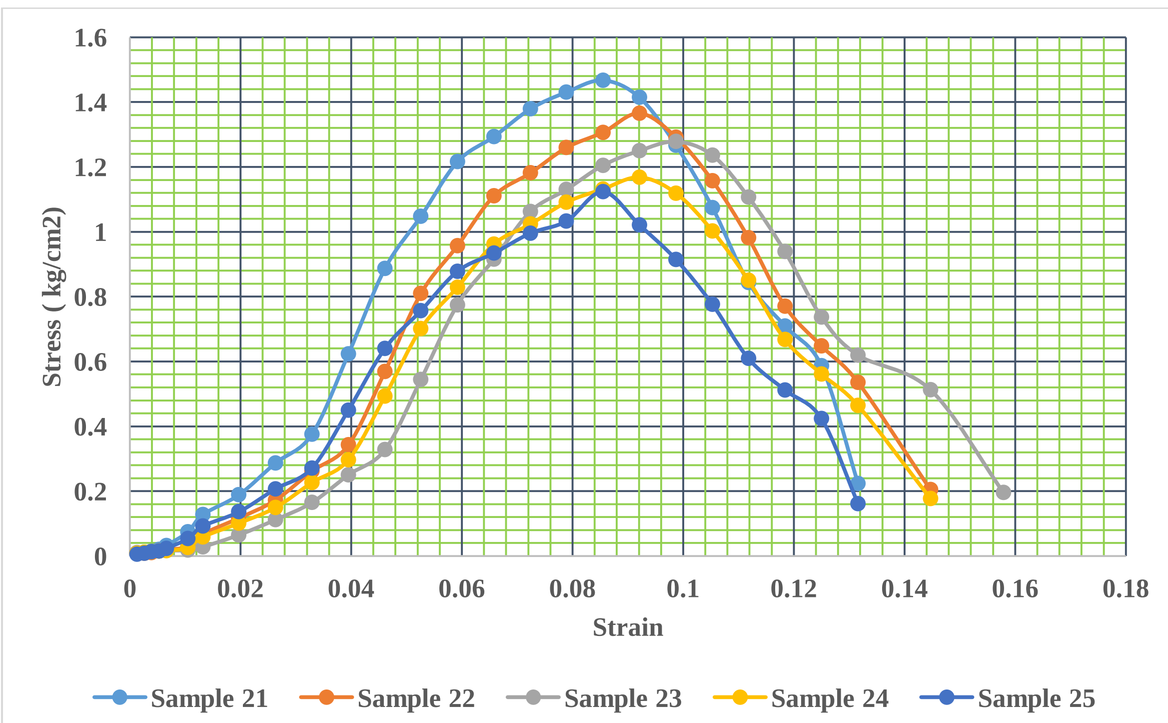
Graph 3. Graphical presentations of comparison between UCS Value and corresponding strain value for the soil when amended with SD - 10 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %.



Graph 4. Graphical presentations of comparison between UCS Value and corresponding strain value for the soil when amended with SD - 15%, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



Graph 5. Graphical presentations of comparison between UCS Value and corresponding strain value for the soil when amended with SD -20 %, XG-(0.0, 0.5, 1.0, 1.5, and 2.0) %



CONCLUSIONS

During test performance we found that Standard Proctor Test and Unconfined Compression Test (UCS) are very important for testing the properties of used soil for the construction process. All of the results were described above in detail, some conclusion were taking out from this study are given below:-

- The maximum dry density of the blended is found to be for the sample 17 that is when the soil is mixed with stone dust (15%) and Xanthan Gum (0.5%).
- Maximum water content during performing SPT excepting parent soil is found to be for sample 5 that is when soil is blended with Xanthan Gum 2.0%, which is 26.32%.
- Minimum water content during performing SPT excepting parent soil is for sample 21 that is when soil is blended with Stone Dust (20%) and Xanthan Gum is 0% and minimum water content for this composition is 19.87%.
- Mixing material like Stone Dust must be available in high potential for this type of soil treatment.
- Maximum strength of mixture 2.426 kg/cm2 with 0.0855 strain for sample 16 that is from the composition of 15% SD and 0.0% Xanthan Gum (XG).
- The compressive strength of used mixture is increases for a particular composition that is for sample 17, after that it goes falling down.
- For this kind of the soil treatment mixing of soil with right composition is not very easy process it is also a very important process for best performance at lowest coast.

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