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STRENGTH IMPROVEMENT OF SOIL WITH SUGARNCANE BAGASSE ASH AND SISAL FIBRE

Ajaz Ahmed[1], Anoop Sharma[2]

[1]PG student, Dept. of Civil Engineering, Sri Sai College of Engineering and technology, Badhani,Pathankot,Punjab
[2]Assistant Professor, Dept. of Civil Engineering, Sri Sai College of Engineering and technology, Badhani,Pathankot, Punjab

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Abstract - In the field of civil engineering, stabilization of soil is a procedure to improve and enhance the engineering properties of soil in such a manner that it can withstand heavy loads without any failure. In a well-organized environment, disposal of waste poses a great threat as regards where and how to effectively dispose the waste material without any harmful effect to society. In the recent times, utilization of solid waste materials in soil stabilization has gained eminence as an effective means to manage wastes generated from various industries. In this paper, a review is given on utilization of different solid waste materials which have been used to stabilize soft soils. Though, there are lots of methods and techniques are available to stabilize these soil. This study provides how waste materials can be used to stabilize the soft soil. The increasing construction cost of conventional stabilizers as well as requirement for the cheap consumption of industrial and agricultural wastes for valuable trade has provoked an exploration into the stabilizing prospective of Bagasse Ash and Sisal Fiber for highly compressible clayey soil. Today, sustainable construction is in demand hence the new studies focused on trends of sustainable utilization of resources. To achieve we can use waste products, natural and biodegradable resources. In this study an extensive lab work have been done to investigate the utilization of agricultural, industrial waste and natural fibers for enhancing the engineering properties of the moderately compressible clay. This study aimed to access the appropriateness of Bagasse Ash and Sisal Fiber for stabilization of clayey soil. Consistency limits, Maximum Dry Density.

***Key Words*:** Natural fibre, Sisal Fibre, CBR test, UCS test

INTRODUCTION:

Soil is the uppermost unconsolidated material of the earth present naturally in the universe. It is formed by the decomposition of rocks under the influence of naturally occurring conditions such as wind, rain, snow, heat, etc. It is abundantly available and is the cheapest construction material. It is a complex material because of its highly variable composition and characteristics. The characteristics of soil change according to topography and its location. For safer construction the properties of soil should match with the design requirements of an engineering structure. Geotechnical engineer plays an important role in this work for checking whether the requirements of the structure are fulfilled by the soil or not. Construction of engineering structures on poor soil involves a great risk. These soils show settlements, low shear strength and high compressibility. Very often the available soil is not suitable for construction purposes.Strength, permeability and stability on the soil.

Literature Review

Singh Baleshwar (2011)

performed compaction test and UCS test on clayey-silt. He showed the effects of using low calcium Sugarcane Bagasse Ash and ordinary portland cement in improving the strength of a clayey silt soil. He determined that with increment of Sugarcane

Bagasse Ashin soil, MDD decreases and OMC increases. When only Sugarcane Bagasse Ash is added, the soil mixes are to be used for constructing road embankments and subgrade layer of pavements. When 1% cement is added to the soil-Sugarcane Bagasse Ash mixes, these are be used even for sub-base of low-volume roads.

Manjunath K.R. et al. (2013)

Studied the effect of sisal fiber on compaction and strength characteristics of black cotton soil treated with lime. They reported that for a particular fiber percentage, the MDD of stabilized soil increases and OMC decreases. The maximum dry density and OMC of sisal fiber reinforced soil increased with 3% lime. 3% of lime content and 0.75% sisal fiber were considered as optimum percentage for black cotton soil to increase the California bearing ratio value.

SavithaA.L. et al. (2013)

Conducted compaction tests and UCS tests on Black Cotton soil using coarse and fine fly ash. They varied the percentage of flyash from 5% to 25% with increase of 5% at a time. Curing was done for 1,7,14,28 days. They reported that the strength obtained by fine Sugarcane Bagasse Ashwas 25% more than that of coarse fly ash.On increasing water contentupto 30%, the dry density decreases and if water content is increased further the dry density decreases gradually.The MDD was 1.35 g/cc for 5% Sugarcane Bagasse Ashmixed with 95% soil and lowest density was 0.6g/cc for 30% Sugarcane Bagasse Ashmixed with 70% soil.

Agrawal M.L. et al. (2013)

Performed compaction tests and CBR test on black cotton soil. They varied the percentage of fly ash from 10% to 50% with increase of 10% at a time. They investigated that the MDD increases with increment in Sugarcane Bagasse Ash up to 20% , and with more addition it decreases. The increase in CBR value and dry density is maximum for 30% Sugarcane Bagasse Ash mixture with black cotton soil. On increasing percentage of fly ash, there is decrease in the liquid limit of black cotton soil, resulting in reduced swelling of soil.

Ruprai B.S. et al (2013)

Conducted compaction test and California bearing ratio test on black cotton soil. They used varying percentages of Sugarcane Bagasse Ashi.e. 10, 20, 30, 40, 50% and observed the effect of Sugarcane Bagasse Ashon moisture –density relationship and CBR value of soil. They reported that as compared to other mixes the CBR value is higher for 20% fly ash.Moreover the dry density was also more at 20% Sugarcane Bagasse Ashcontent..

Yanbin Li et al. (2014)

Performed compaction test and triaxial shear test on silty clay. They used 0.5%, 1%, 1.5% sisal fiber with lengths 5mm, 10mm and 15 mm. They reported that the stress increased with increase in strain when 1.0% fiber content is taken and they observed no decrease in stress when the strain exceeded 1.0%.They reported that silty clay reinforced with sisal fiber has 20% more strength than non-reinforced clay when 1.0% fiber content of length 10 mm is considered.

S.M Kavitha et al., (2019)

Geotechnical engineers face various problems while designing foundation because of clayey soil due to poor bearing capacity and excessive settlement. So, we rectify that with various engineering works but in this project we choose fibers for improving soil parameters, this method is cost-effective and eco-friendly one. The clay sample was collected from Desakota, Tamil Nadu, and India. Sisal, polypropylene, and hybrid of these two fibers were used for soil stabilization. The sisal fiber was mixed 0 .1%, 0.2%, 0.3% and 0.4% by weight of the soil samples. Similarly, polypropylene fiber was mixed 0.5%, 1%, 1.5% and 2% by weight of the soil samples and hybrid fiber mixed soil samples randomly distributed.

1. Materials and Methods

Mechanical Stabilization

In this method of stabilization gradation of the soil is changed to improve its properties. Proper blending of aggregates and binders is done so that the soil is properly graded. On proper compaction, the material that is blended becomes mechanically stable and load bearing capacity of soil is increased. The mechanical stability of soil depends upon mineral composition, mechanical strength of aggregates, gradation, plasticity characteristics and compaction. It is the simplest method of soil stabilization and used on a large scale in the construction of bases, sub bases and road surfacing.

Source of Sugarcane Bagasse Ash

Sugarcane Bagasse Ash used in this research work was collected from mukerian sugarcane mill . The Sugarcane Bagasse Ash was dried in oven and then it was sieved for the removal of foreign particles. Then it was packed in polythene bags to protect it from moisture and used further in the study.Properties and composition of Sugarcane Bagasse Ash as obtained from the thermal plant.

Source of Sisal fiber

The sisal fiber used in this study was obtained from Jindaram Exports, Sirsa. Sisal is a natural fiber having greater tensile strength and can be used as an effective reinforcing material in soil stabilization. The properties and composition of sisal fiber are discussed.

Table -1: Chemical properties of sugarcane bagasse ash

S.No	Costituents	Value (%)
1	Sio2	62.43
2	Al2O3	4.38
3	Fe2O3	6.98
4	CaO	11.80
5	MgO	2.51
6	So3	1.48
7	K2o	3.53
8	LOI	4.73

Table -2: Properties of Sisal fiber

S.No.	Property	Value(%)
1.	Colour	white
2.	Specific gravity(kg/m3	1370
3.	Water Abosrption(%)	110
4.	Length of fiber(mm)	30
5.	Diameter of sisal fiber	0.2
6.	Tensile strength (MPa)	347
7.	Modulus of electricity	15

Results and Discussion

This chapter contains the results of various tests conducted on the soil in the laboratory. After determining the properties of virgin soil, the amount of Sugarcane Bagasse Ash was optimized by California bearing ratio test. This quantity of Sugarcane Bagasse Ash that has been optimized was mixed with varying content of sisal fiber. The soaked CBR values were obtained for soil- fly ash-sisal fiber mix. Then compressive strength test was done by mixing different proportions of soil, Sugarcane Bagasse Ash and sisal fiber for 7 days and 14 days curing period

Tests conducted in the laboratory for different objectives areas follows:

1. Liquid Limit Test (Casagrande's method)
2. Plastic Limite test (Thread method)
3. Standard Proctor test (OMC and MDD)
4. California Bearing Ratio test
5. Unconfined Compression strength test

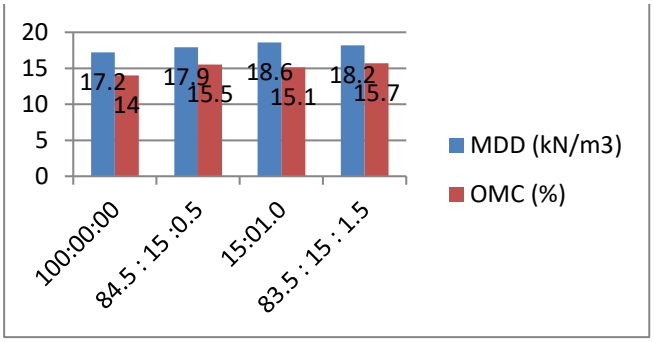
EXPERIMENTAL RESULTS

Section 1 Standard Proctor Test

Table no. 3: Results of OMC and MDD for mix proportions of SCBA AND SF

SOIL:SCBA:SISAL FIBER	MDD (kN/m³)	OMC (%)
100:0:0	17.2	14
845:15:0.5	17.9	15.5
84:15:1.0	18.6	15.1
83.5:15:1.5	18.2	15.7

Fig :1 Variation of MDD and OMC of SF and SCBA

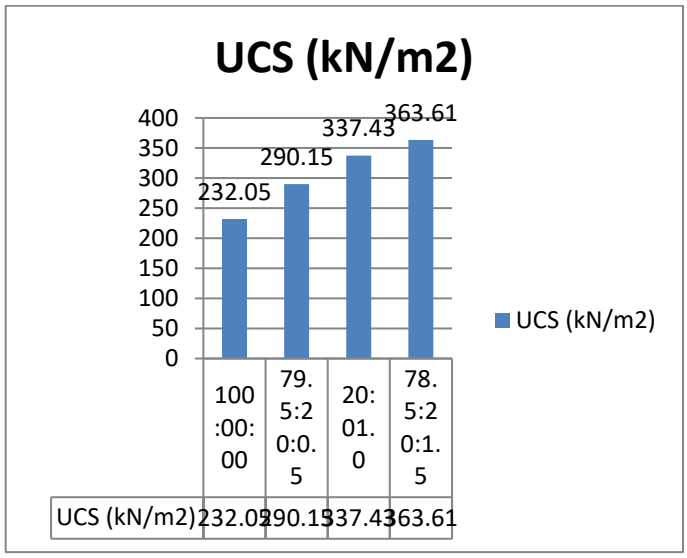


Section 2 Unconfined Compression Strength Test

Table no. 4: Results of UCS of B K and PSA with Soil

Clayey Soil:SCBA :S.F	Curing Period (Days)	UCS (Kg/cm^2)
100:00	7	232.05
79.5:20:0.5	7	290.15
79:20:1.0	7	337.43
78.5:20:1.5	7	363.61

Fig:2 variation b/w values o clayey soil ,SCBA and S.F



Section 3 California Bearing Ratio Test

Table no. 5: Results of CBR of SCBA and S.F Mix with Soil

CS:SCBA:S.F	CBR (%)
100:00:00	3.82
79.5:20:0.5	5.17
79:20:1.0	5.52
78.5:20:1.5	6.16

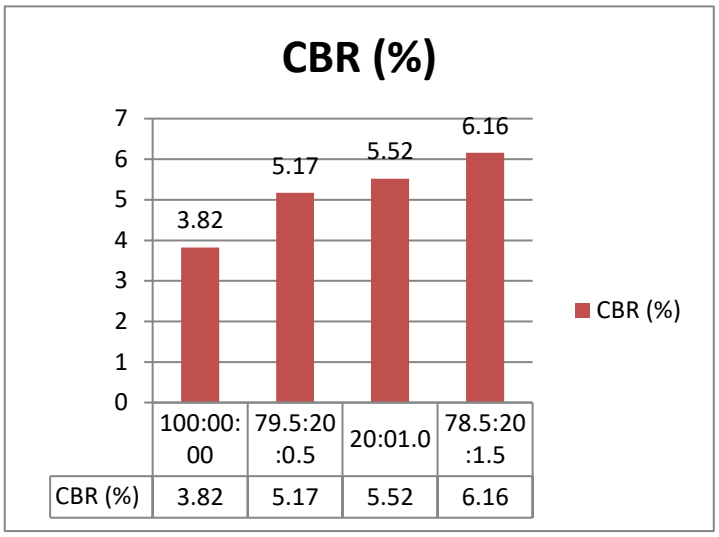


FIG 3: Variation b/w CBR values odf CS,SCBA and Sisal Fibre

DISCUSSIONS

MODIFIED PROCTOR TEST:

There is an also increase of OMC from 14.0 to 15.6 and decrease of MDD from 17.2 to 16.3% when the percentage of sugarcane bagasse Ash are used as 10%,15% and 20% respectively.

There is an also decrease of OMC from 15.5 to 15.10% and increase of MDD from 17.20 to 18.6% when the percentage of sisal fibre vary from 0.5%,1.0% and 1.5% and sugarcane bagasse ash is fixed at 15%

With sugarcane Bagasse Ash kept constant at 15% MDD increase with an addition of Sisal Fibre content in soil and sugarcane bagasse Ash mix. The reason behind of such behavior is Sugarcane Bagasse Ash is lighter in weight and it has high water absorption properties because of presence of calcium oxide and hence OMC decrease with increase of Sugarcane bagasse Ash content.

CBR TEST:

Presence of pozzolanic compounds in Sugarcane bagasse Ash and CaOH available in soil might be increase the CBR value due to formation of cementitious compounds in soil. Due to excess of Sugarcane Bagasse ash in soil ultimately occupies spaces within sample because of this sugarcane bagasse ash could not be mobilized for the reaction at 15% of sugarcane bagasse ash .

The CBR value of virgin soil is 3.82 and it increase to

1.31 times with addition of 15% SCBA and Sisal Fibre 1.5% is added to virgin soil. This enhancement in CBR may be because of the gradual formation of hydration compounds in the soil due to the reaction between the stabilizers and the essentials particle present in the soil.

UCS TEST:

UCS value of virgin soil enhances fundamentally with expansion of Sugarcane Bagasse Ash contents. The UCS value increment from 232.05kN/m² to 312.73kN/m² with expansion of Sugarcane Bagasse Ash upto 15% in the wake of curing time of 7 days. U.C.S. value decreases with more expansion of Sugarcane Bagasse Ash. The expansion in U.C.S. value might be a direct result of the slow advancement of the cementitious mixes in the soil by the response between pozzolanic mixes in Sugarcane Bagasse Ash and CaOH accessible in soil.

The UCS values of virgin soil also improve considerably with expansion of Sugarcane Bagasse Ash 15% and Sisal Fibre 1.5%. The value increases from 232.05kN/m² to 363.61kN/m² with addition of Sugarcane Bagasse Ash and Sisal Fibre.

The reason behind of this when Sugarcane Bagasse Ash and Sisal Fibre comes in contact with water, pozzolanic reactions takes place during the curing period.

Conclusions

Following conclusions can be inferred on the basis of theexperiments performed:

1. Sugarcane Bagasse Ash is a waste product of cement manufacturing process which can be effectively used in the stabilization process of soil due to its cementitious properties that helps in increasing the strength of soil.
2. Sisal fiber on the other hand is a cheaply available material which can be added to soil in less quantity to make big changes in its strength parameters.
3. The optimum value of Sugarcane Bagasse Ash is used for this work was 15% because of the optimum value of C.B.R. is found at 15% of Sugarcane Bagasse Ash when added to soil.
4. The C.B.R value increases with increase of Sisal Fibre along with fixed quantity of Sugarcane Bagasse Ash. It increased 1.59 times from the untreated soil.
5. The optimum value of Sisal Fibre and Sugarcan Bagasse Ash required for soil stabilization is 1.5 % and 15% by weight of soil respectively
6. Unconfined compressive strength increases with increase of quantity of Sisal Fibre and with fixed quantity of Sugarca

Addition of Sugrcane bagasse Ash and Sisal Fibre stabilizer makes the soil mixes durable, low cost and effective for soil improvement. If these two materials are easily available near to the site.

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