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Comparison on the Behaviour of Banana and S-Glass Fibre in Soil Stabilization

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Abstract: This (In natural state), The expansive soils are unsuitable for direct engineering applications because of their shrink-swell characteristics. Using stabilizing techniques, an effort has been made to enhance the soil's qualities. Fibres are one of the most often employedfor stabilizing soil in recent years due to their low cost and accessibility. Black cotton soil has been stabilized using treated banana and S- glass fibres as natural and synthetic fibres. The 4% NaOH solution is used to treat banana fibre, which results in a roughened surface that improves compatibility, tensile strength, bonding, etc. The soil is replaced with treated banana fibre from 0.5% to 2.5% at the interval of 0.5% and the same is repeated by replacing the soil with 1% to 3% of S-glass fibre at an interval of 0.5%. In this experimental investigation, there is marginal increase in dry density and strength at an optimum 1.5 % of treated banana fibre and strength for 2.5% optimum for strengthof S-glass fibre were obtained when mixed with soil. The soil stabilized with treated banana fibre showed better results when compared withthe s-glass fibre.
Keyword: soil stabilization, banana fibre, S-glass fibre.

I. INTRODUCTION

The process of soil stabilization modifies the physical properties of a soil before construction. Stabilized soils showbetter behaviour than non-stabilized soils during construction of different structures. A solid monolith is created by stabilized soil reduces permeability, enhances strength, and reduces the likelihood of shrinkage and expansion as well asthe detrimental effects of freeze-thaw cycles. Soil stabilization is less expensive by improving the soil, hence reducing the need for more expensive ones. An extensive area of central India and a small area of southern India, including Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, South Gujarat, and Uttar Pradesh, are infested with black mould. It is necessary to use soil stabilization techniques with an effort to enhance certain soil qualities. Stabilization can be accomplished in different ways, including chemical, physical, and polymer approaches. One of the components used to stabilize soil is fibre. Treated Banana fibre and S-glass fibre is been used as natural and synthetic fibre.

The phrase natural fibre is used to describe fibres that come from (or are produced by) animals and plants. The majority of natural fibres are renowned for being effective perspiration and other liquid absorbents. Vegetable fibre includes banana fibre and its main chemical constituent is cellulose. Vegetable fibres are consequently also referred to as cellulosic fibres. Because it comes from plants, vegetable fibre is sometimes referred to as plant fibre. Vegetable fibres based on cellulose arrangements include cotton, hemp, jute, flax, abaca, pia, ramie, flax, sisal, and bagasse, typically with lignin. Man-made fibres are known as synthetic fibres. They are frequently employed to stabilize the soil. The synthetic fibres nylon, polypropylene, polyethylene, and glass are examples. S-glass fibre is used because it is less expensive, locally available and has a high silica content, and has higher tensile strength than E-glass fibre. The optimum dosage of banana fibre varies from 0.5%-2.5% and S-glass fibre varies from 1%-3% to improve the compaction properties, consistency and compressibility properties of the soil. Fibre stabilized soil shows great potential in various engineering fields. The performance of S-glass fibre and banana fibre when mixed with soil is been compared and demonstrated in this project.

II. MATERIALS

A. SOIL

The soil sample used for this project work was collected from Industrial biotech block backside of Government college of technology, Coimbatore. A disturbed sample of dark grey in colour for about 15kg was collected from a test pit at a depth below 1.2 m below the natural ground level in order to avoid the inclusion of organic matter. The obtained soil was air dried, pulverized manually and soil passing through 4.75 mm IS sieve.

Table 1: Soil Properties of subgrade soil

S.NO	TEST CONDUCTED	PROPERTIES	RESULTS
1	Determination of moisture content	Moisture content (%)	17
2	Determination of Specific Gravity	Specific Gravity	2.75
3	Grain Size Distribution	%Gravel (>4.75 mm)	0
		%sand (4.75-0.075 mm)	27.96
		%silt and clay (<0.075mm)	72.04
4	Atterberg's Limit	Liquid Limit (W_L)%	43
		Plastic Limit (W_P)%	21
		Plasticity Index (I_P)%	22
		Shrinkage limit (W_S) %	17
5	Standard Proctor Compaction Test	Optimum Moisture Content (%)	16
		Maximum Dry Density(g/cc)	1.60
6	Determination of compressive Strength	Unconfined Compressive Strength(N/mm²)	15
		Cohesive Strength(N/mm²)	7.5
7	IS Classification		Cl

B. Banana Fibre (Natural Fibre)

The The pseudo-stem of the banana plant (Musa sepientum) yields banana fibre, a ligno-cellulosic fibre with good mechanical qualities. It can reach heights of 3.0–12.2 metres with 8–12 thick leaves around it. The leaves can growup to nine and a half feet tall (2.7 metres and 0.61 meter). Banana plants are available in Thailand, Southeast Asia, India, Bangladesh, Indonesia, Malaysia, the Philippines, Hawaii, and other Pacific islands. The three main components of banana fibre are cellulose, hemicellulose, and lignin. It is a thin fibre with extraordinary strength. It is biodegradable andhas no negative effects on the environment.

Fig 2: Banana fibre

C. S-Glass Fibre (Synthetic Fibre)

Glass fibre is obtained by extruding small glass fibres with small diameters from thin glass strands that are silica-based or made from another glass formulation. S-glass, a high-performance glass fibre, differs from E-glass primarily because of its higher silica concentration. S-glass typically contains the oxides of silicon, aluminium, and magnesium. S- fiberglass is 10% stiffer and has tensile strength and elastic modulus that are noticeably higher than those of E-glass. Furthermore, significant are outstanding temperature resistance, strong moisture resistance, a wide range of tolerance, and other distinctive characteristics. Fig 3 and table 3 represents S-glass fibre and its properties.


Fig 3: S-Glass fibre

Table 2: Properties of banana fibre

S.NO	PROPERTIES	VALUES
1.	Appearance	Gold brown fibre
2.	Length (mm)	12
3.	Diameter (mm)	0.08
4.	Density (g/cm3)	1.3
5.	Tensile strength (MPa)	650-780
6.	Fineness	17.15
7.	Moisture regains	13%
8.	Total cellulose (%)	65
9.	Lignin (%)	21
10.	Aspect ratio(L/d)	15

Table 3: Properties of glass fibre

S.NO	PROPERTIES	VALUES
1.	Appearance	Shiny white
2.	Length (mm)	12mm
3.	Diameter (mm)	0.06mm
4.	Density (g/cc)	2.4
5.	Tensile strength (GPa)	4.6
6.	Aspect ratio (L/d)	20

III. EXPERIMENTAL PROGRAM

A. Treatment Of Banana Fibre

The stabilized materials were combined with the soils in a variety of weight ratios that included banana fibre that had undergone chemical (NaOH) treatment. The dry mixing method is used for this study. Natural fibres progressively lose strength and other properties as they become part of the soil mass. With the proper treatment methods, such as alkali and other chemical treatments, the biodegradability issue with natural fibres can be resolved. The inquiry uses an alkali treatment. Cut to the proper length, the fibres are then submerged in 4% NaOH solution for 48 hours. Lastly, oven drying is used to dry the fibres completely unavoidable.

B. Standard Proctor Compaction Test

The optimum moisture content and maximum dry density was obtained by conducting Standard ProctorCompaction Test as per IS: 2720 (Part 7)- 1980. The relation between moisture content and dry density obtained from compaction test. The Proctor compaction test determines the highest unit load that can be compacted into a certain kind of soil using a regulated compact force and an appropriate water content. All engineered compact soil placements for embankments, pavements, and structural mills are based on the findings of this soil test, which is the most common laboratory soil test. Comparing the Proctor test findings to the measured densities of the compacted filled area allows one to determine the level of soil density. The Optimum Moisture Content and Maximum Dry Density for each sample is found with varying percentages of chemically treated banana fibre 0.5%, 1%, 1.5%, 2%, 2.5% and S-Glass fibre 1%, 1.5%, 2%, 2.5%, 3%.

C. *Unconfined Compression Test*

The Unconfined Compression test was conducted as per IS 2720(Part 10):1991. The greatest axial compressive stressthat a cohesive soil specimen can support with no confining force is known as unconfined compressive strength (UCS).

IV. RESULTS AND DISCUSSION

A. *Standard Proctor Compaction Test*

The effect of soil sample with NaOH treated banana fibre andS-glass fibre in different proportions is calculated to found OMC and MDD.

TABLE 4: Standard Proctor Compaction Test for NaOH treated banana fibre with soil

S.NO	SOIL + PERCENTAGE OF BANANA FIBER ADDED	OPTIMUM MOISTURE CONTENT (%)	MAXIMUM DRY DENSITY (g/cc)
1	Untreated soil	16	1.66
2	Soil + 0.5% banana fibre	16	1.68
3	Soil + 1% banana fibre	16	1.69
4	Soil + 1.5% banana fibre	16	1.80
5	Soil + 2% banana fibre	18	1.75
6	Soil + 2.5% banana fibre	18	1.70

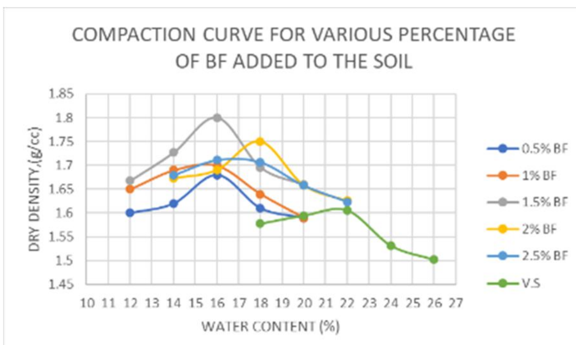

Fig 4: Compaction curve for various percentage of banana fibre added to the fibre

The table 4 explains the individual effect of banana fibre. Forthis case, the OMC has no significant effect till first additionof banana fibre and the variation in each 0.5% addition of banana fibre is about reaches maximum at 1.5% banana fibre and the MDD value also reaches maximum because void ratio decreases and increase in depth of the soil in addition of fibre to the soil. The Fig. 4. explains the effect of compaction on various percentages of banana fibre treated with soil.

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TABLE 5: Standard Proctor Compaction Test for NaOH treated banana fibrewith soil

S.NO	SOIL + PERCENTAGEFIBER OF S-GLASS ADDED	OPTIMUM MOISTURE CONTENT (%)	MAXIMUM DRY DENSITY (g/cc)
1	Untreated soil	16	1.66
2	Soil + 1% S-glass fibre	18	1.69
3	Soil + 1.5% S-glass fibre	16	1.70
4	Soil + 2% S-glass fibre	16	1.73
5	Soil + 2.5% S-glass fibre	18	1.75
6	Soil + 3% S-glass fibre	18	1.70

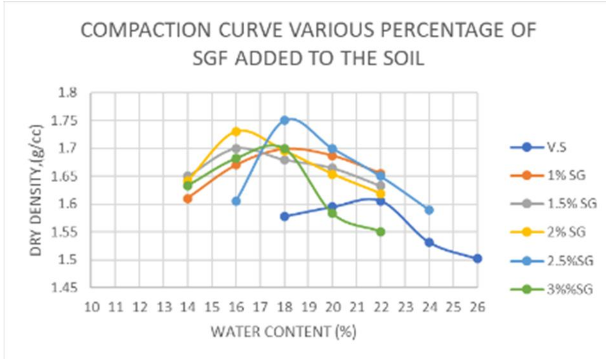

Fig 5: Compaction curve for various percentage of S -Glass fibre added tothe fibre

The table 5 explains the individual effect of S-Glass fibre. Atfirst, the soil was treated with S-Glass fibres at variouspercentages. For this case, the OMC value reachesmaximum at 2.5% and the MDD value reaches maximum byadding S-Glass fibre to the soil. The Fig. 5 explains the effectof compaction on various percentages of S-Glass fibre treatedwith soil.

B. Unconfined Compression Test

The effect of soil sample with NaOH treated banana fibreand S-glass fibre in different proportions is calculated to found UCS.

TABLE 6 Unconfined Compression Test for banana fibre with soil

S.NO	SOIL + PERCENTAGE OF BANANA FIBER ADDED	UNCONFINED COMPRESSIVE STRENGTH, UCS (kN/m^2)
1	Untreated soil	15
2	Soil + 0.5% banana fibre	17.2
3	Soil + 1% banana fibre	24.7
4	Soil + 1.5% banana fibre	47.6
5	Soil + 2% banana fibre	35.1
6	Soil + 2.5% banana fibre	29.3

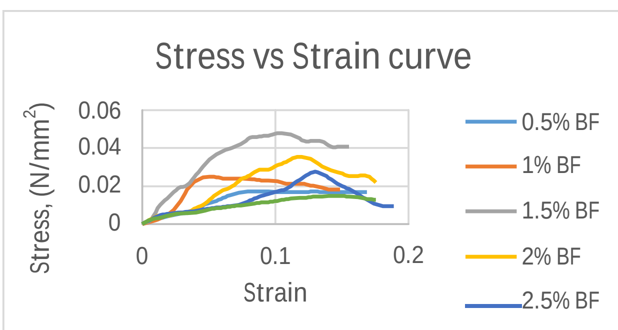

Fig 6 Stress vs strain curve for soil mixed with varying % of treated banana fibre.

The table 6 explains about the unconfined compression test when soil is treated with NaOH treated with banana fibre is added in different percentages. The unconfined compressive strength value of soil treated with banana fibre was found to be 47.6kN/m2 at 1.5% which increases the strength of the soil in addition of fibre to the soil.

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TABLE 7 Unconfined Compression Test for S-Glass fibre with soil

S.NO	SOIL + PERCENTAGE OF S-GLASSFIBER ADDED	UNCONFINED COMPRESSIVE STRENGTH, UCS (kN/m^2)
1	Soil + 1% S-glass fibre	14.2
2	Soil + 1.5% S-glass fibre	12.7
3	Soil + 2% S-glass fibre	19.6
4	Soil + 2.5% S-glass fibre	22.5
5	Soil + 3% S-glass fibre	21.0

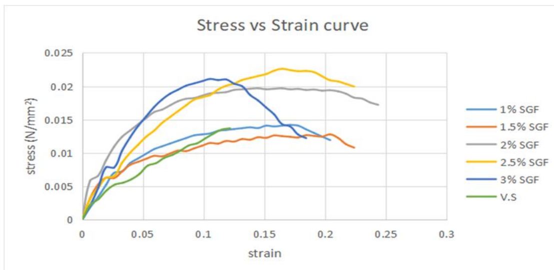

Fig 7 Stress vs strain curve for soil mixed with varying % of treated S-Glass Fibre.

The table 7 explains about the unconfined compression test when soil is treated with NaOH treated with S-Glass fibre is added in different percentages. The unconfined compressive strength value of soil treated with S-glass fibre was found to be 22.5kN/m2 at 2.5%

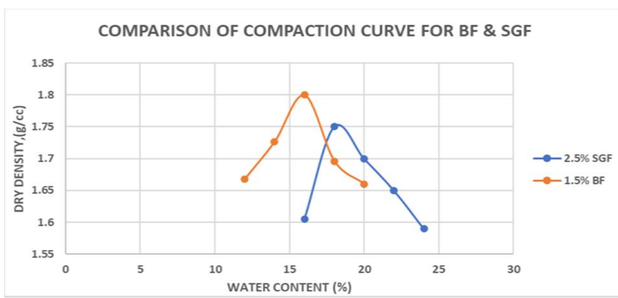

Fig 8 Comparison of compaction curve for banana fibre and S-Glass fibre

Fig 8 explains the comparison of compaction curve for banana fibre and S-Glass fibre in the addition of optimum percentage of fibres.

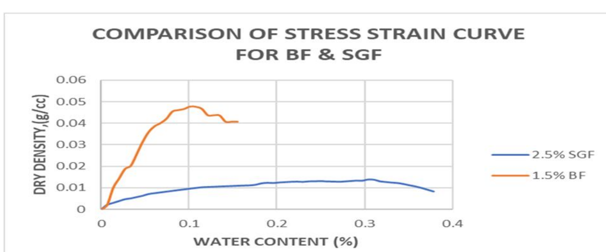

Fig 9 Comparison of stress strain curve for banana fibre and S-Glass fibre

Fig 9 explains the comparison of compaction curve for banana fibre and S-glass fibre in the addition of optimum percentage of fibres. From the comparison of fibres banana fibre shows higher strength than S-Glass fibre. This is due to the alkali treatment of natural fibres which enhances the ductility of fibres and reduced the progressive loss of strength.

V. CONCLUSION

In this study, two different types of fibres used to improvethe strength characteristics of the soil. The following conclusions has been shown below

1) The UCS results demonstrated that the strength of banana fibre (BF) is higher than that of S-Glass fibre (SGF)used in reinforcing the soil.
2) This might be as a result of the natural fibers being alkali- treated, which increases their ductility and slows down the loss of strength and other properties when theyare incorporated into the soil mass.
3) It was observed that, there is marginal increase in dry density of the treated soil samples and reduction compressibility at an optimum 1.5% of treated banana fibre and S-Glass fibre.
4) The maximum Unconfined Compressive Strength (UCS) was obtained for optimum 2.5 % of treated banana fibre and S-Glass fibre were obtained when mixed with soil.
5) The performance of banana fibre showed betterresults than S-Glass fibre.

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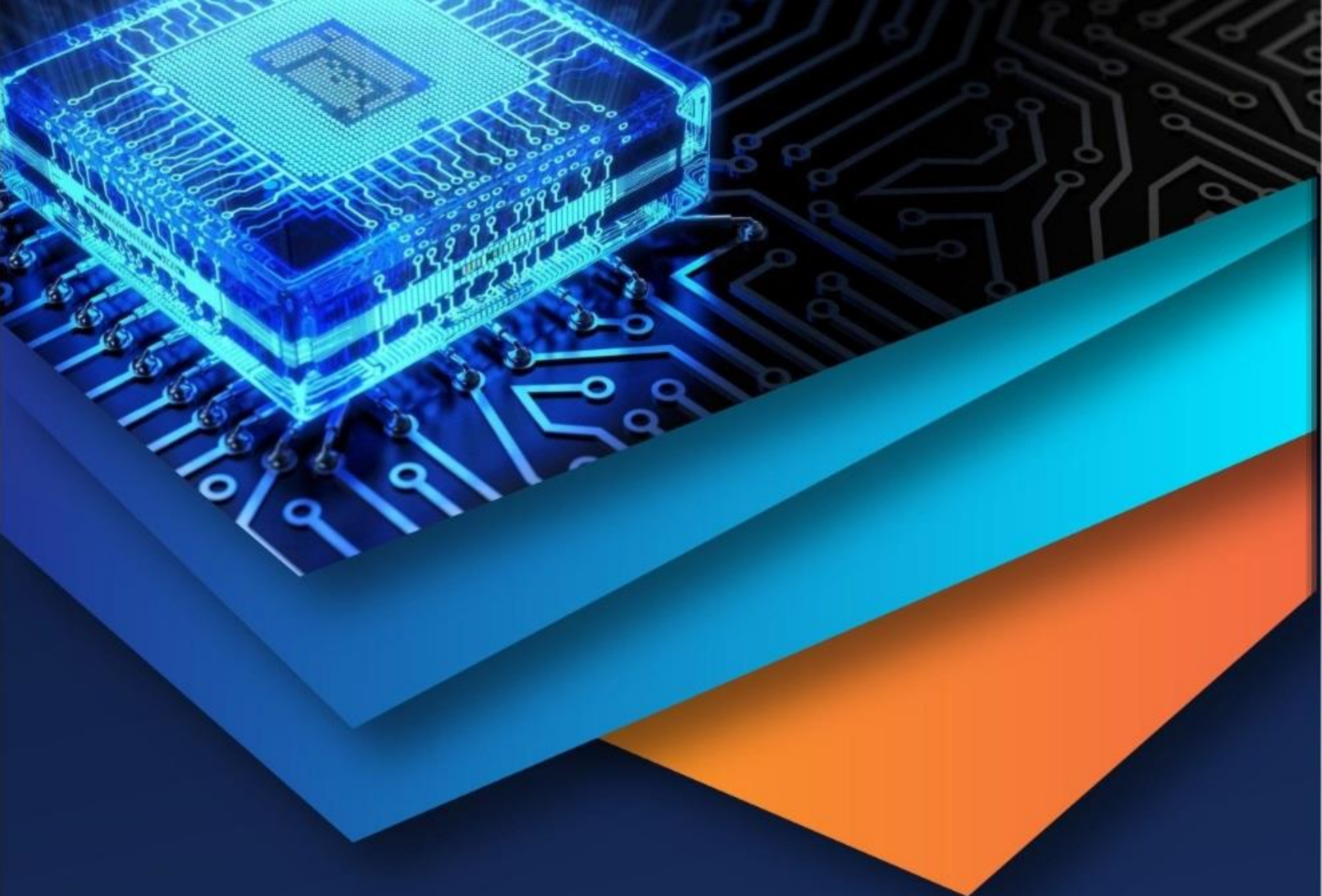

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