"A study on Shear Strength and Permeability of Sand Reinforced with Bagasse fibre "- Review

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ABSTRACT:

Several researchers have developed Sand reinforcement methods in order to enhance engineering properties and their Index properties of Sand over the last few decades. The aim of this study was to see how adding randomly oriented bagasse fibres to a loose alluvial fine to medium sand affected its behaviour. The effect of fibre inclusion on the shear strength and permeability of reinforced sand is investigated at low, medium, and high strain levels.

A soil layer mass that includes randomly distributed discrete components, i.e. fibres, can be described as a principle of reinforced soil with their fibre., i.e. fibres(bagasse fibres'), that contribute to the improvement of the soil matrix's engineering properties and mechanical behaviour Permeability and direct shear test conduction with improved fibre (bagasse fibre) percentages of 0.5%, 1% and 1.5%. Comparison of findings from river sand and fibre addition. The use of fibre inclusions to improve the mechanical properties of weak sands is a geotechnical engineering technique that has recently gained popularity.

Keywords: Index properties, Bagasse fiber, Shear strength, Permeability, Direct Shear test.

INTRODUCTION :

Sand has a number of drawbacks, including a lack of cohesion and a loose particle structure, as well as a high porosity. These sand limitations can trigger a number of engineering hazards if they are not strengthened (Helming et al., 2006; Wan and Fell, 2004; Xiao and Shwiyhat, 2012). The stability of a sandy slope, for example, was severely harmed by liquefaction caused by ground vibrations and erosion caused by seepage after heavy rains. Riverbank sandy slopes erode and eventually collapse due to landslides and other natural disasters, resulting in channel blockage.

(Sivakumar Babu, G.L., Vasudevan, A.K. (2008a). "Strength, stiffness response of coir reinforced tropical soils", ASCE Journal 20 (9), 571-577) Civil engineers are concerned about the existence of soft soils near infrastructure building projects because of their low shear strength and excessive deformations. Many engineering applications necessitate that polymers' strength and stiffness be increased in order to withstand stress.

Adding reinforcing fillers in the form of fibres to composites is one way to accomplish this with increased stiffness and strength Glass, bagasse, rice straw, and other synthetic fibres are commonly used as insulation for polymers.(Li, C.; and Zorn berg, J., "Mobilization of reinforcement in fibre-reinforced soil," Geoenvironmental Engineering ASCE, 2013, V. 139, pp.107-115.)

Hemp, wheat, corn, wood, bagasse, rice straw, and other natural fibres are used cheap, plentiful, organic, recyclable, and biodegradable obtainable capital Natural fibres and polymers are combined to create materials that are lighter in weight, less expensive, and have good properties biodegradable and recyclable, their strength-to-weight ratio is extremely high. Natural fibres, such as jute, coir, and grass, on the other hand, are biodegradable, environmentally friendly, and abundant in India.

They can be used as an additive if they are suitable sand and dirt in the sub base and sub grade as a product of a rise in strength and a decrease in strength the power to deform the cost of such an application would be reduced road building, (A. Ramesh, M. Kumar, experimental investigation on coir fibre and fly ash in stabilized pavements. Proc. Indian Geotech. Conf. 1, 201–204 (2009) by allowing for a thinner layer of asphalt paving stones the addition of fibres to constructions is required.

To create a more compact interlocking mechanism between the components natural fibres and the soil system were used. In this regard, preliminary research using fibre reinforced sand suggests that it may be possible to boost the sand's compatibility, develop a high California Bearing Ratio (CBR) value, and maintain compactness. Distinctive Glass fibre is the type of fibre used in this analysis.

OBJECTIVES :

The main objective of our experiment is as below.

- •To determine the effect of percentage of fibres on the strength on Bagasse Fibre reinforced sand.
- •To determine the effect of percentage of fibres on the Permeability on Bagasse fibre reinforced sand
- •To determine the effect of percentage of fibers on the strength and Permeability on Bagasse fibre reinforced sand.
- •To determine the effect of percentage of fibers on the Relative Density on Bagasse fibre reinforced sand.

METHODOLOGY:

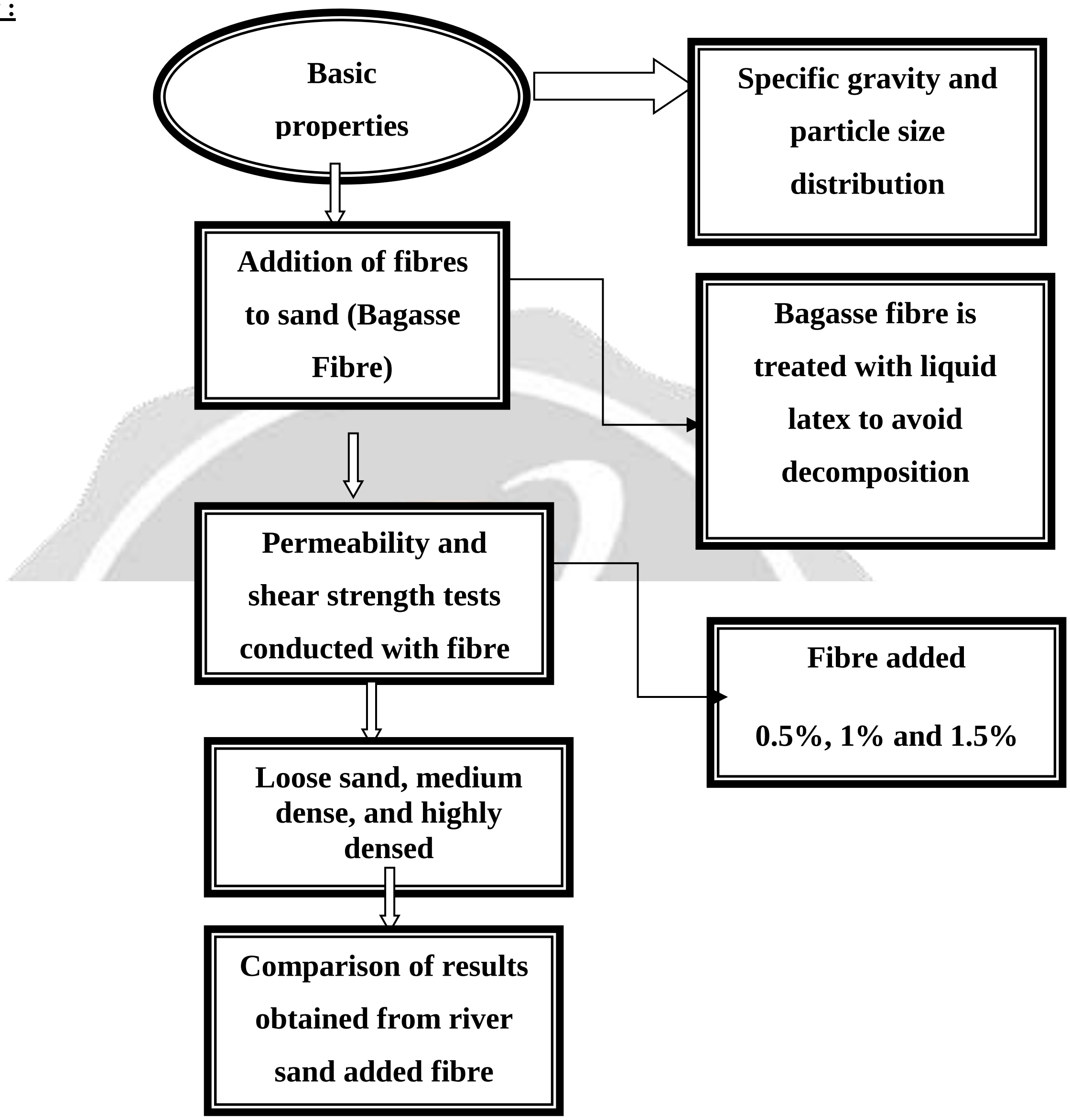
Basic tests performed on the River sand:
1) Specific gravity as per IS 2720: part 3:1985
2) Particle size distribution IS 2386: part 1:1963

Further tests conducted on the sample are:
1) Permeability test as per IS 2720-17:1986
2) Direct shear test as per IS 2720: part 15:1986

Preparation of Sample:

By studying the literature, stabilization of sand using Rice Straw looks to be economical and Effective. In this test we are going to stabilize the river sand by keeping the length of Rice Straw Fibers constant and varying the percentage of fibers. The length of rice straw is taken as 6mm and percentage of fibre to be added is 0.5%, 1%, 1.5%. In a similar way the length of Rice Straw is changed to 12mm and varying percentage of fibre is added 0, 5%,1%,1.5%. As the Rice Straw Fibres taken is an organic material it will decomposes in sand after few days so to overcome this Hurdle the Rice Straw is treated with liquid latex to prevent it from decaying after mixing with Sand. At the end we are going to compare the results obtained by various tests with the basic Properties of river sand.

Methodhology :



Here basic properties tests are done on the river sand such as specific gravity test, sieve analysis and specific gravity of sand is 2.67 after the initial tests on the sand further Emax and Emin are found out for the sand by considering relative density as 30%, 50%, 70% for loose sand, medium dense, highly dense state and fibre content in the sand is varied from 0% to 0.5%, 0.75%, 1% before the tests the rice straw fibre is treated with liquid latex to avoid the decomposition of the fibre (bagasse fibre) as it is a natural polymer.

And further shear strength and permeability tests are conducted on the sand with varying percentage of fibres. In shear strength test relative density is taken as 30%, 50%, 70% and the normal stresses are considered as 50kPa, 100kPa, 150kPa according to IS code the tests are conducted similarly in permeability fibre is added after the initial tests in varying content 0.5%, 0.75%, 1% and the results obtained are compared and the conclusions are drawn .

Materials Used.

1. River Sand:

River sand is fine-grained building sand that can be found between rivers and lakes. This sand is white-grey in nature and is one of the fine-graded sands. The sand was collected from Banashankari Bangalore the sand is classified as loose sand, Medium dense, highly dense sand and as per IS classification system the properties of sand are mentioned below in the table 1

2. Bagasse Fibres

Bagasse fibre is a sugar cane by-product that is retained over after the juice is collected, and it is an useful resource due to its high production and annual growth ability. Sugar cane bagasse fibre has only recently been recognized into Geotechnical Engineering fields, and there have been very few studies on bagasse fibres reinforced problematic soil. Bagasse has been known as a potential material for ground improvement in expansive soils. At the average fibre content of 2 percent (diameter 0.3–3.1 mm, length 0.3–13.8 mm), bagasse fibre reinforced clay soils retains better control in shrink-swell nature. Bagasse fibre, which was obtained from industry and had a diameter of 0.3 mm to 3.1 mm and a length of 0.313.8 mm, was used in this study. Bagasse fibre had a specific gravity of 1.25 to 1.55.

Table 1: Properties of Sand

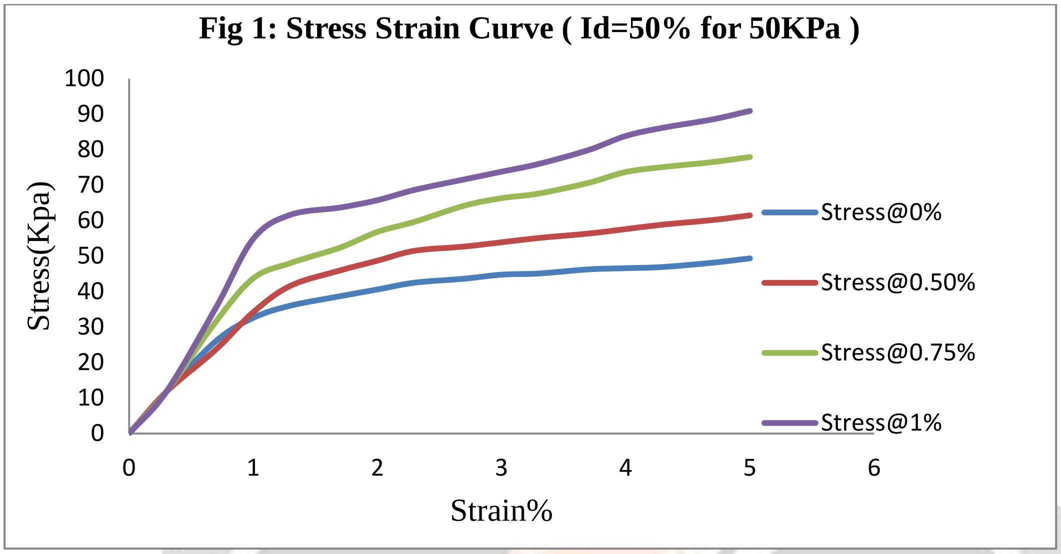
SAND PROPERTIES	VALUES
Specific gravity , Gs (mm)	2.67
Mean particle size , d10 (mm) Mean particle size , d60 (mm)	0.20 0.71
Uniform coefficient , Cu	3.55
Curvature coefficient , Cc	1.2
Maximum void ratio ,Emax	1.19
Minimum void ratio , Emin	0.81

RESULTS AND DISCUSSIONS

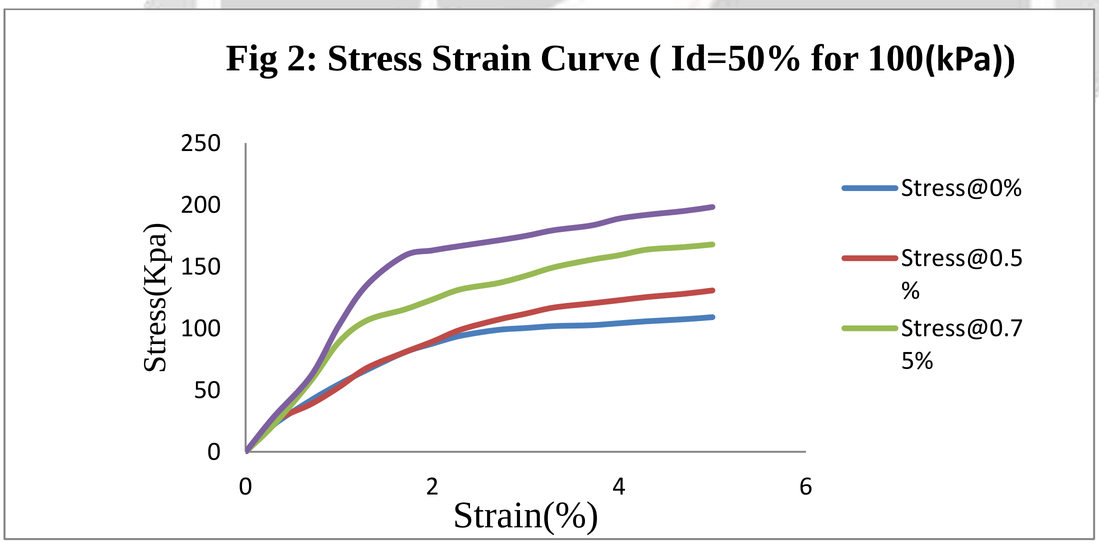
After the initial analysis of the sand according to the above mentioned methodology following our objective we found the following results.

I) Shear strength of sand with fiber content:

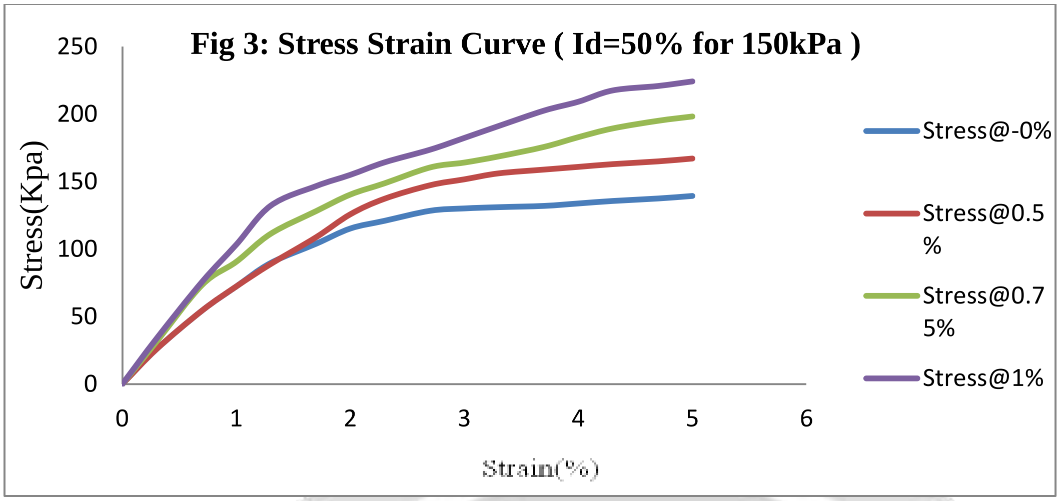
The shear strength parameter was calculated by varying the percentage of fibre content in the sand. The relative density of the sand was kept constant i.e. 30%, 50%, 70% and the length of the fibre is kept 5mm and fibre content was varied for each and every relative density fibre content is taken as 0% , 0.5%, 0,75%, 1% after conducting the shear strength test we got the following stress-strain graphs .



In the fig 1. graphs Id is constant 50% is constant and fibre percentage is varied to 0% - 49kpa, 0.5% -61kpa,0.75% - 77kpa,and 1% - 90kpa, and normal shear stress also varies to 50kpa,. Here the enhanced strength was mainly attributed to mobilization of friction between fibres' and sand from graph it is found that when normal stress increase there is enhancement in shear stress.



In the fig2, graphs Id is constant 50% is constant and fibre percentage is varied to 0% -109(kPa), 0.5% -130(kPa), 0.75% -167(kPa), and 1% -198(kPa), and normal shear stress also varies to 100(kPa). Here the enhanced strength was mainly attributed to mobilization of friction between fibres' and sand from graph it is found that when normal stress increase there is enhancement in shear stress.



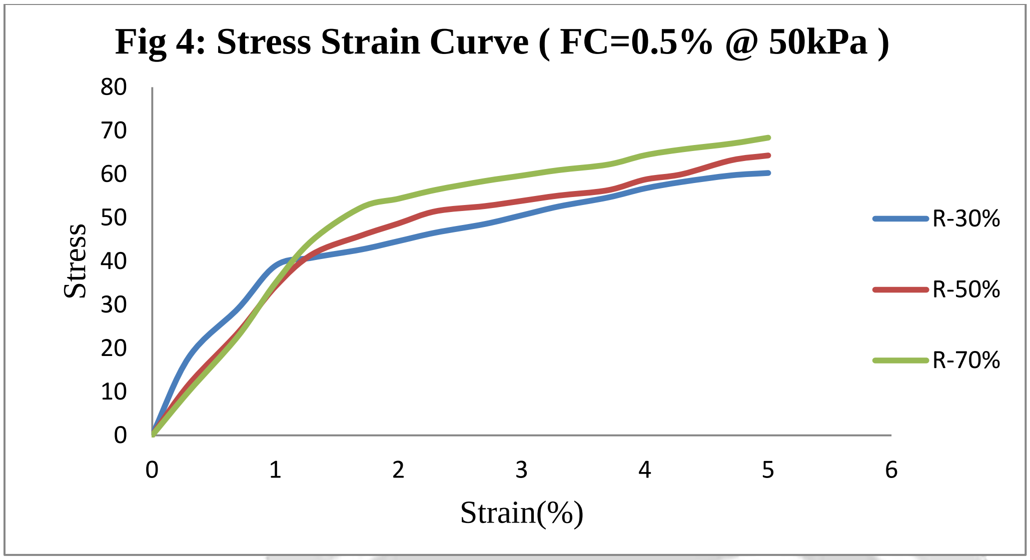
In the fig3, graphs Id is constant 50% is constant and fiber percentage is varied to 0% -139(kPa), 0.5% - 167(kPa), 0.75% -198(kPa), and 1% - 224(kPa) and normal shear stress also varies to 150(kPa). Here the enhanced strength was mainly attributed to mobilization of friction between fibres' and sand from graph it is found that when normal stress increase there is enhancement in shear stress.

Table 2: Summary of the shear strength for Id =50%

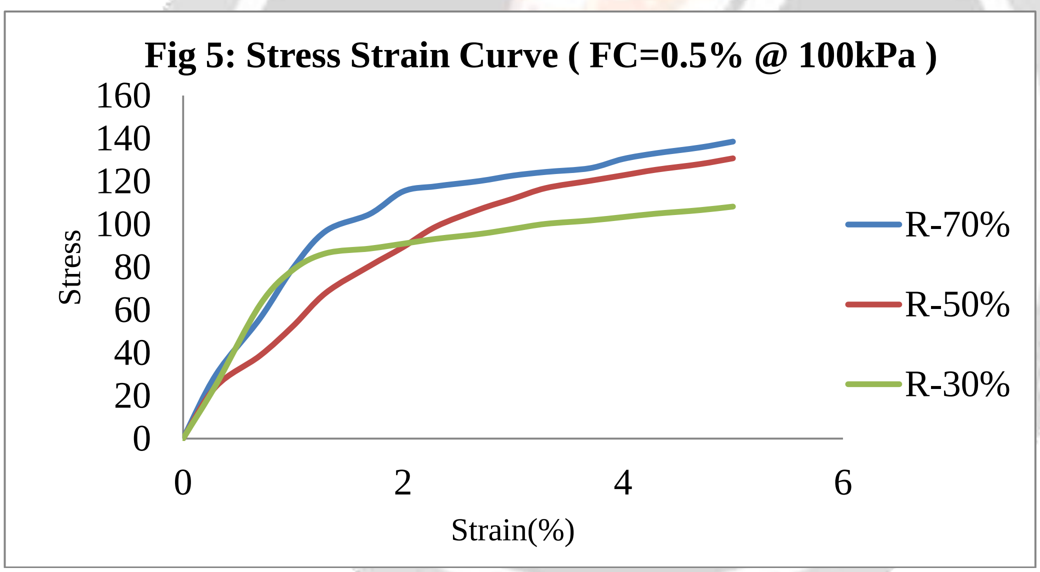
Fiber content	Normal stress 50(kPa)		Normal stress 100(kPa)		Normal stress 150(kPa)	
	shear stress (kPa)	Increase rate	shear stress (kPa)	Increase rate	shear stress (kPa)	Increase rate
0	49	1	109	1	139	1
0.5	61	1.24	130	1.19	167	1.20
0.75	77	1.57	167	1.53	198	1.42
1.0	90	1.84	198	1.82	224	1.61

II) <u>Effect of relative density on shear strength:</u>

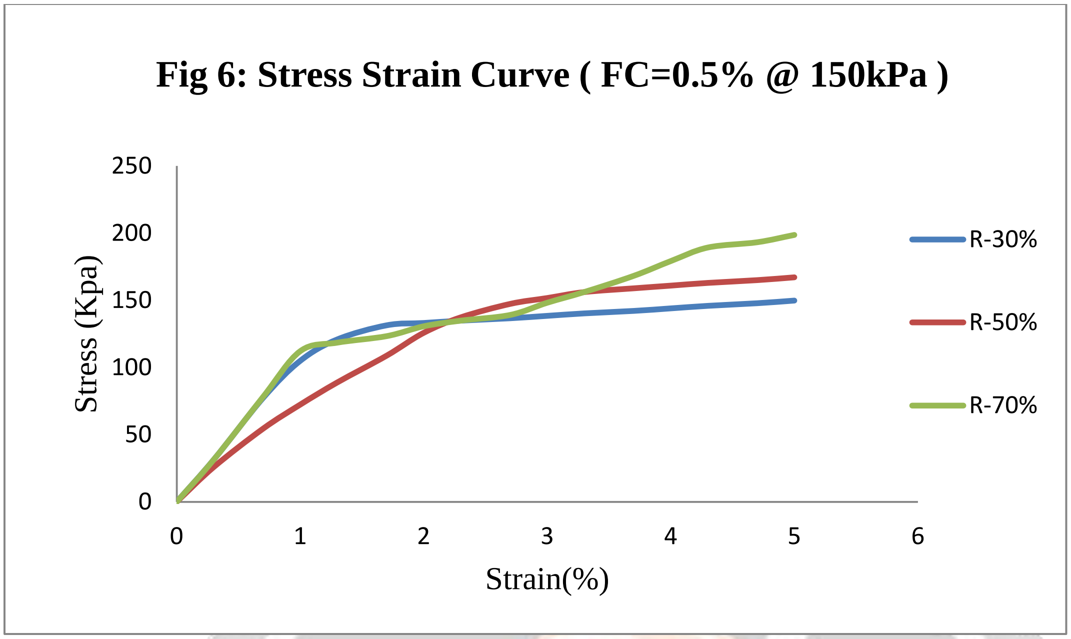
In the graph the fibre content is varied from 0%, 0,5%,0.75%.1% and relative density is taken as 30%, 50%, 70% and for normal stress @ 50, 100, 150kPa respectively graph is plotted.



In the fig 4 graphs fiber content is kept constant i.e. 0.5% and the relative density is varied 30% -63kPa, 50% -65kPa, 70% -68kPa and the enhancement in strength is attributed by mobilization of friction between fibers and sand and normal stress is also kept constant i.e. 50kPa.



In the fig 5 graphs fiber content is kept constant i.e. 0.5% and the relative density is varied 30% -108kPa, 50% -130kPa, 70% -138kPa and the enhancement in strength is attributed by mobilization of friction between fibers and sand and normal stress is also kept constant i.e. 100kPa.



In the Fig 6 graphs fiber content is kept constant i.e. 0.5% and the relative density is varied 30% -149kPa, 50% -158kPa, 70% -167kPa and the enhancement in strength is attributed by mobilization of friction between fibers and sand and normal stress is also kept constant i.e. 150kPa

Table 3: Summary of the shear strength for FC =0.5%

Relative density (Id)	Normal stress 50 (kPa)		Normal stress 100 (kPa)		Normal stress 150 (kPa)	
	shear stress (kPa)	Increase rate	shear stress (kPa)	Increase rate	shear stress (kPa)	Increase rate
30	63	1	108	1	149	1
50	65	1.03	130	1.20	158	1.06
70	68	1.11	138	1.30	167	1.12

III) <u>Effect of fiber content on permeability:</u>

In the graph the fiber content is varied from 0%, 0.5%, 0.75%.1% and relative density is taken as 30%, 50%, 70%

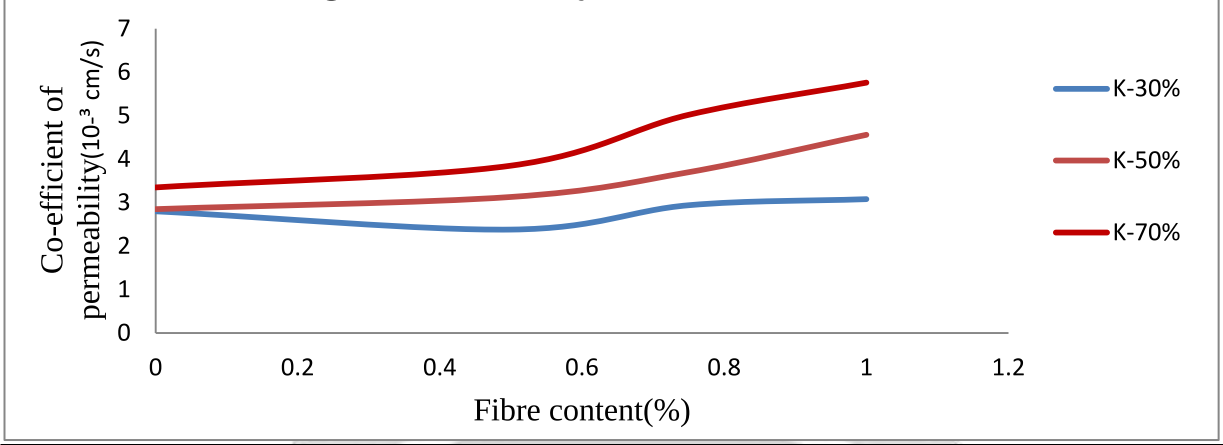


Fig 7: Permeability V/S Fiber Content%

At loose state i.e. relative density 30% initially as the voids were bigger, the inclusion of fibers resulted in a decrease in effective void ratio, As a result of permeability of the soil found to be decrease slightly when the fiber content was 0.5%. As we increased the fiber content, the fiber got in between soil particles and resulted in creating distance between them due to which effective pore size increased and led increase in permeability.

At medium state I.e. relative density Id @ 50% since soil is packed a little more tightly, the void space is less and inclusion of fibers led to these fibers setting in between soil particles there by increasing the permeability.

At dense state I.e. relative density Id @ 70% since soil is packed a more tightly, the void space is less and inclusion of fibers led to these fibers setting in between soil particles there by increasing the permeability.

Table 4: Summary of the Coefficient of permeability

Fiber content	Coefficient of permeability for 30% K (10^{-3} cm/s)		Coefficient of permeability for 50% K (10^{-3} cm/s)		Coefficient of permeability for 70% K (10^{-3} cm/s)	
	K for 30%	Increase rate	K for 50%	Increase rate	K for 70%	Increase rate
0	2.8	1	2.85	1	3.35	1
0.5	2.38	0.85	3.13	1.05	3.85	1.1
0.75	2.94	1.1	3.7	1.3	5.02	1.6
1.0	3.08	1.15	4.56	1.5	5.76	1.72

IV) <u>Effect of FC on relative density for permeability</u>

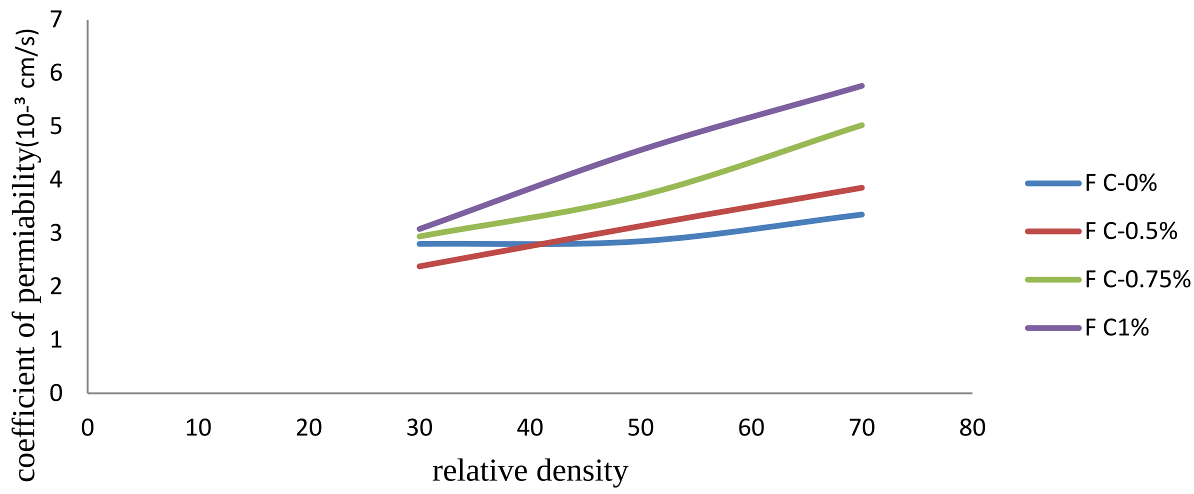


Fig 8:Permeability V/S Fiber Content%

In the figure 8 the relative density is kept constant and fibre content is varied for each relative density from graph it is observed that for 0% fibre content the permeability does not increase when there is inclusion of fibre and content of fibres' is varied such as 0.5%, 0.75%, 1% for same relative density the permeability increases. For relative density 30% coefficient of permeability for 0% fibre content is 2.8 for 0.5% fibre content K value is 2.38 and 0.75% K value is 2.94 for 1% fibre coefficient of permeability is 3.08. The permeability increases with quantity of fibre and when relative density is taken as 50% coefficient of permeability for 0% fibre content is 2.85 K for 0.5% K value is 3.135 and for 0.75% K value is 3.705 for 1% fibre K value is 4.56 similarly for 70% relative density the values are for 0% 3.35 and 0.5% 3.825 for 0.75 % value is 5.025 for 1% K value is 5.762 by inclusion of fibre void ratio is reduced (i.e., aspect ratio). The value of K increases for different relative density i.e. 30%, 50%, 70%

Table 5: Summary of the Coefficient of permeability

Relative density (Id)	Coefficient of permeability for 0% FC (10^{-3} cm/s)		Coefficient of permeability for 0.5% FC (10^{-3} cm/s)		Coefficient of permeability for 0.75% FC (10^{-3} cm/s)		Coefficient of permeability for 1% FC(10^{-3} cm/s)	
	K for 0% FC	Increase rate	K for 0.5%	Increase rate	K for 0.75% FC	Increase rate	K for 1% FC	Increase rate
30	2.8	1	2.38	1	2.94	1	3.08	1
50	2.85	1.02	3.135	1.32	3.705	1.26	4.56	1.48
70	3.35	1.21	3.8525	1.62	5.025	1.71	5.762	1.87

CONCLUSION:

The following conclusions are drawn from the results of this study

- Bagasse has Silica content which is about 87% (Cement Silica content : 22%) which help in increasing the strength and durability in construction

- Bagasse can potentially increase the inter-particle cohesion of sand leading to enhanced mechanical strength in the wet condition

- From the study the shear strength of sand increases as the fibre content increases when relative density is kept constant we observed that there is increase in shear stress

- The fibres inclusion increases the cohesion in the sand therefore there is increase in strength for 0% fibre shear stress was 48.49kpa at 50kpa when fibre was included for 0.5%shear stress was 63.74kpa and 0.75% shear stress was 82.43kpa and for 1% fibre shear stress was 102.19kpa so we can observe that stress is increasing

- When the relative density is varied and fibre content is kept constant i.e. 0.75% the values of shear strength are for 30% relative density 77.94kpa for 50% density 82.73kpa for 70% 90.33kpa and normal stress is taken as 50kpa

- When the normal stress is increased from 50kpa to 100kpa and 150kpa we observed increase in the strength

- For permeability at loose state relative density @30% for FC 0% value of K is 2.8 10^{-3} cm/s , 0.5% K is 2.38 10^{-3} cm/s ,0.75% K is 2.94 10^{-3} cm/s and 1% K is 3.08 10^{-3} cm/s voids are filled with inclusion of fibres leading to increase in permeability .

- The increase in strength is attributed by mobilization of friction between fibres and sand

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