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Experimental Study on Strength Characteristics of Fiber Reinforced Expansive Soil

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***Abstract*— The B.C soil utilized in this examination is gathered from KADIAL Dist. Bidar. Here in my research work used three materials they are black cotton soil, sisal fiber and jute fiber. The sisal fiber was collected from Go Green Products, Valasaravakkam (Tamilnadu); jute fiber has been bought from the merchandise of Bidar (Karnataka). Soil Stabilization is done with the addition of sisal fiber and jute fiber with varying percentages of sisal fiber and jute fiber are 0.2%, 0.4%, 0.6% and 0.8% with a length of sisal fiber and jute fiber as 1.0cm length. For knowing the properties of soil laboratory tests are to be done. They are Atterberg's limits, Light compaction test, unconfined compressive strength test, Specific gravity test, California bearing ratio test, Moisture content test and Sieve analysis test. The addition of sisal fiber, the optimum moisture content decreases and maximum dry density is increased at 6% and various % of jute fiber is blended with black cotton soil; it is noticed that highest dry density is obtained at 1.74gm/cc and moisture content at 24.22% at 6% of jute fiber. From CBR test is performed with expansive soil with varying % of sisal fiber and the result obtained are for unsoaked as 4.62% and soaked as 3.20% at 20% of sisal fiber. The varying % of fiber is added in BC soil which results in unsoaked value as 4.16% and soaked value as 2.99% at 20% of jute fiber.**

Keywords — Black cotton soil, Sisal fiber, Jute fibre, OMC, MDD, Soaked and Unsoaked CBR

I. INTRODUCTION

. Black cotton soil is available everywhere in India. These soils are looking dark in color. These soils are sticky and weak soil. For coming out from this problematic situation have chosen the sisal fiber and jute fiber. The sisal fiber gives good tensile strength and it is reusable material then easy to carry because it is light weight material. Sisal fiber is available in three types.Type1 lower type is used in paper industry, Type 2 is medium type is used in cordage industry and Type3 is higher type is used in carpet industry. Brazil is producing high amount of sisal fiber in the world. Sisal fiber comes under natural fibers as geotextiles. Generally, jute is believed to be one of the most affordable and economic fibers. Jute fibers are very strong. Jute fibers are also quite cheap and cost-effective. Sisal fibre is extremely long, having a length of 0.6-1.2m and has a shade of yellowish to white. Black cotton soil is mixed with sisal fiber and jute fiber with varying percentages and having 1cm length of sisal fiber and jute fiber then various laboratory tests have to be conducted.

SCOPE OF WORK

1. Eco-friendly and naturally available jute and sisal fibre used as soil stabilizing materials which give out two purpose at same time i.e.; soil stabilization and effective use of jute and sisal fibre.
2. To research the actual properties of expansive soil.
3. To examine the conduct of solidarity acquire by jute fibre and sisal fibre.
4. Investigation of index properties of expansive soil, when settled with jute and sisal fibre by varying percentages of jute fibre and sisal fibre from 0.4%,0.6%,0.8%,1.0% & keeping a length of 1cm

II. LITERATURE REVIEW

Asheesh Kumar and Anshuman Srivastava-2017

Had worked on arrangement and mechanical properties of jute fibre supported epoxy composites.Juteis environment friendly material and also bio-degradable and a piece of epoxy is used. Prepared by had lay-up technique, open shape comprised of gentle steel has been utilized. By this it has been inferred that blend of jute epoxy betray superior tensile and compressive strength. As number of fibre in bundle increases there is a decrease in bundle strength of fibers. Jute fibre reinforcement increases tensile and compressive strength. This type of combination is very useful in construction of wall, floor, and doorframes.

Bin Shi, Chaosheng Tang, Fengjun. Chen, Yi Cai, Wei Gao-March 2019

Analysis the conduct of short propylene fibre supported concrete settled clayey soil. In this investigation 5% and 8% of two different cement content are utilized and distinctive soil tests are arranged with three diverse polypropylene fibre content. Direct shear test and unconfined compressive tests are done. Determination of stiffness, strength parameter and ductility are done by UCS test.As fibre content increases peak axial strength increases, there is no post-peak strength and there is decrease in stifeness.From this study it results that the mix of separate fibre and cement goodness of both fibre supported soil and concrete settled soil can be effective for ground improvement.

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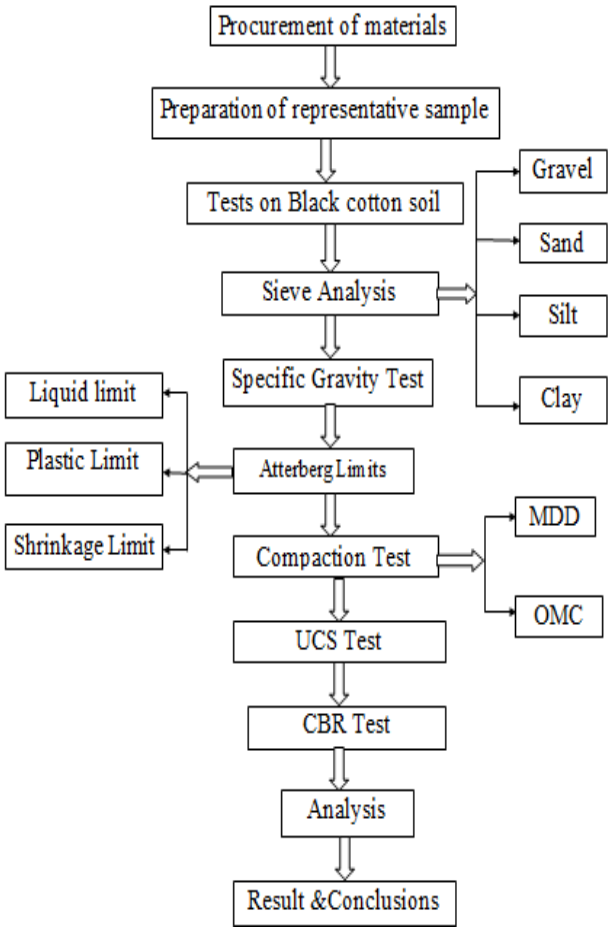
III. MATERIALS AND METHODS

1. Materials :
   - Black cotton soil:-Soil was collected from KADIAL Dist. Bidar (KA), at a depth of 5 feet from the ground level.
   - Sisal fiber:-Sisal fiber was collected from Go Green Products, Valasaravakkam (Tamilnadu). The fiber color is creamy white and average diameter of fiber is 0.2mm and average length of sisal fiber is 15-25mm.
   - Jute fiber: - Jute fiber has been bought from the local market of Bidar (Karnataka). The fiber is greyish to brown and average diameter of fiber is 2mm and average length of sisal fiber is 15-45mm.

2. Methodology :

The below flow chart shows methodology executed throughout the study.



IV. . RESULT & DISCUSSION

MDD & OMC Calculation for BC Soil After Adding Varying Amount of Sisal Fibre & Jute Fibre.

The compaction test has been conducted to get connection between dry thickness and dampness substance of soil. The concept used in test explains that any compactive effort i.e.; MDD depends upon the OMC in soil. The below data table is obtain from test conducted which helps in plotting the graph i.e.; OMC in x-axis and MDD in y-axis.

Table: 1 Compaction Properties of Black Soil and Sisal Fiber

Sl No.	Description	MDD (gm/cm^3)	OMC (%)
1.	Black cotton soil alone	1.60	19.22
2.	BC + 2% Of Sisal Fibre	1.61	20.28
3.	BC + 4% Of Sisal Fibre	1.70	21.78
4.	BC + 6% Of Sisal Fibre	1.85	23.78
5.	BC + 8% Of Sisal Fibre	1.66	20.95

Black cotton soil alone mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and Obtained MDD IS 1.60 gm/cc & OMC is 19.22%.

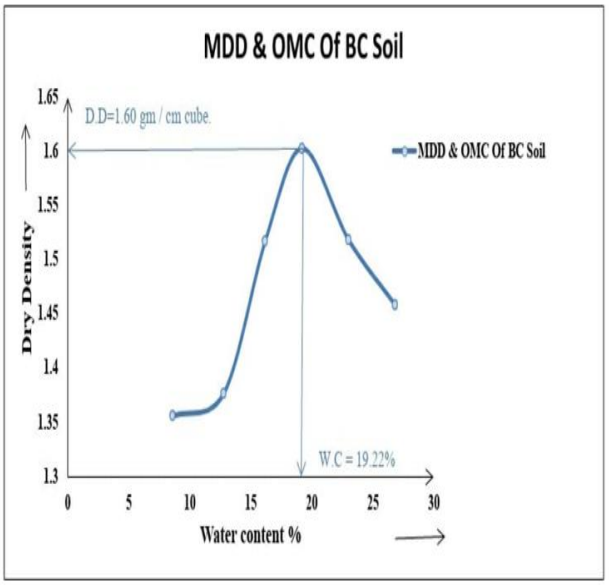


Fig 1: MDD & OMC of Only BC Soil

- Black cotton soil and 2% of sisal fibre with 1cm length is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained MDD is 1.61 gm/cc & OMC is 20.28%.

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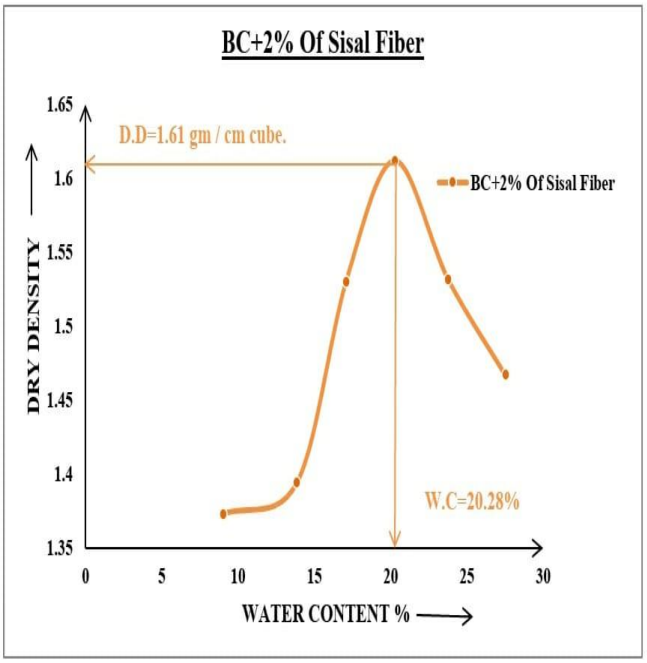

Fig 2: MDD & OMC of Expansive Soil With 2% of Sisal Fiber

- Black cotton soil and 4% of sisal fibre with 1cm length is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained value is 1.70 gm/cc & 21.78%.

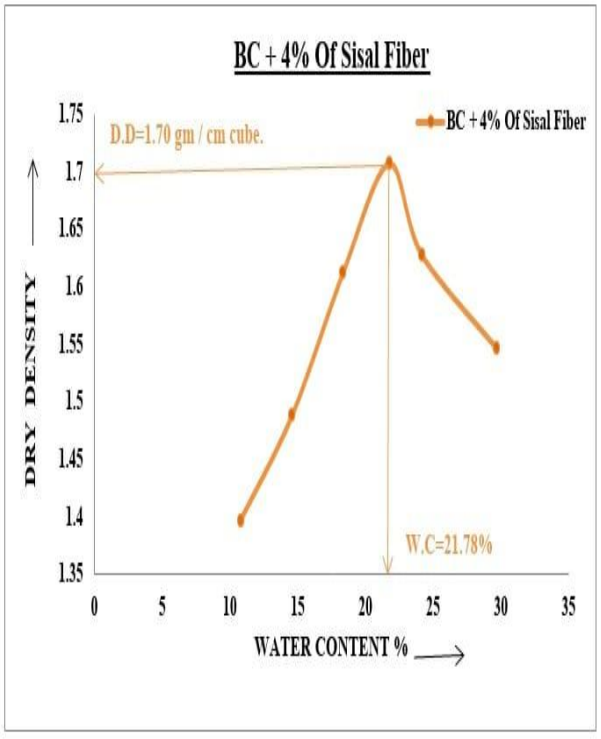

Fig 3: MDD & OMC of Black Cotton Soil With 4% of Sisal Fiber

- Black cotton soil and 6% of sisal fibre with 1cm length is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained result is 1.85 gm/cc & 23.78%.

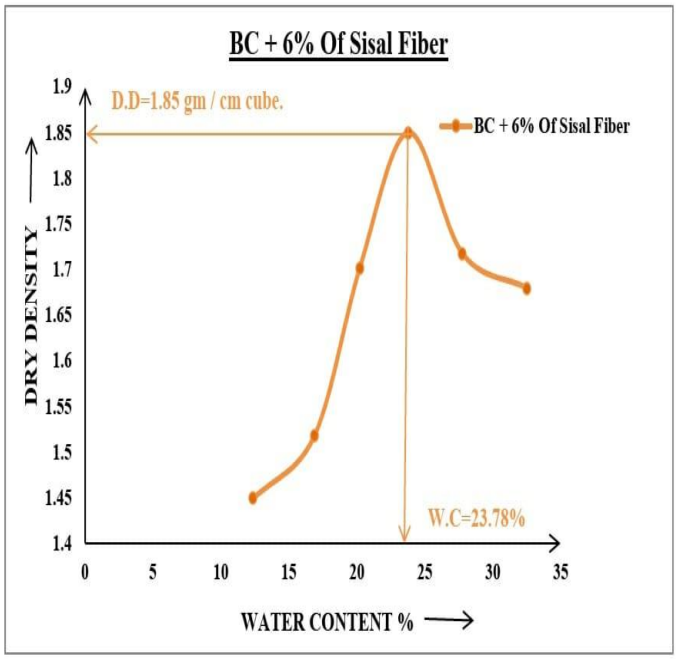

Fig 4: MDD & OMC of BC Soil With 6% of Sisal Fiber

- Black cotton soil and 8% of sisal fibre with 1cm length is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained result is 1.66 gm/cc are 20.95%.

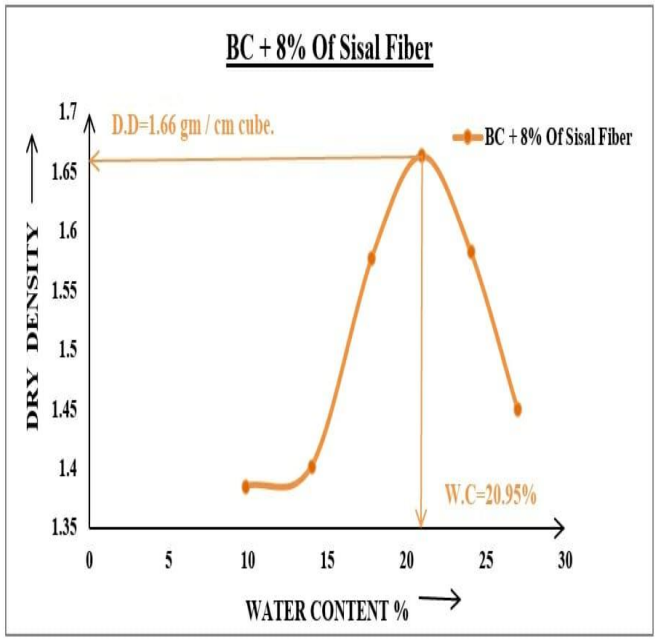

Fig 5: MDD & OMC of Expansive Soil With 8% of Sisal Fiber

Table: 2 Compaction Properties of Black Soil and Jute Fiber

Sl No.	Description	MDD (gm/cm^3)	OMC (%)
1.	Black cotton soil alone	1.60	19.22

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2.	BC + 2% Of Jute Fibre	1.59	19.50
3.	BC + 4% Of Jute Fibre	1.64	23.68
4.	BC + 6% Of Jute Fibre	1.74.	24.22
5.	BC + 8% Of Jute Fibre	1.62	20.28

- Black cotton soil and 2% of jute fibre having a length of 1cm is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained results are1.599 gm/cc & 19.5%.

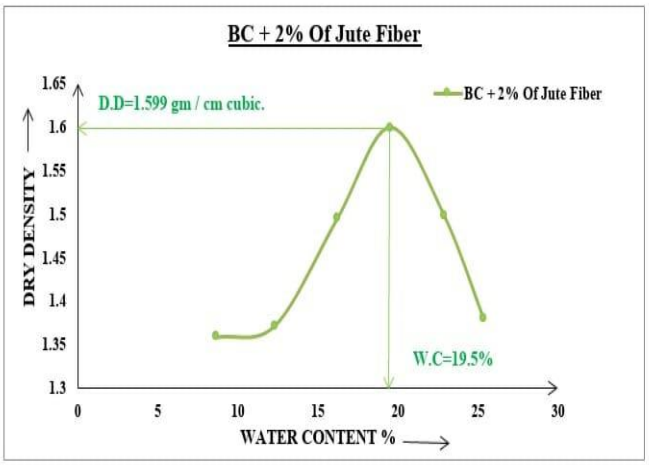

Fig 2: MDD & OMC of BC Soil With 2% of Jute Fiber

- Black cotton soil and 4% of jute fibre having a length of 1cm is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained results are 1.64 gm/cc & 23.68%.

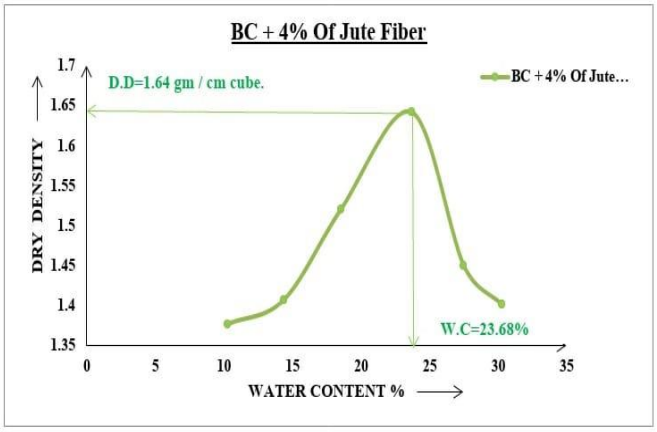

Fig 3: MDD & OMC of BC Soil With 4% of Jute Fiber

- Black cotton soil and 6% of jute fibre having a length of 1cm is mixed with 2%, 4%, 6%, 8%,10% & 12% of water and obtained results are 1.74 gm/cc & 24.22%.

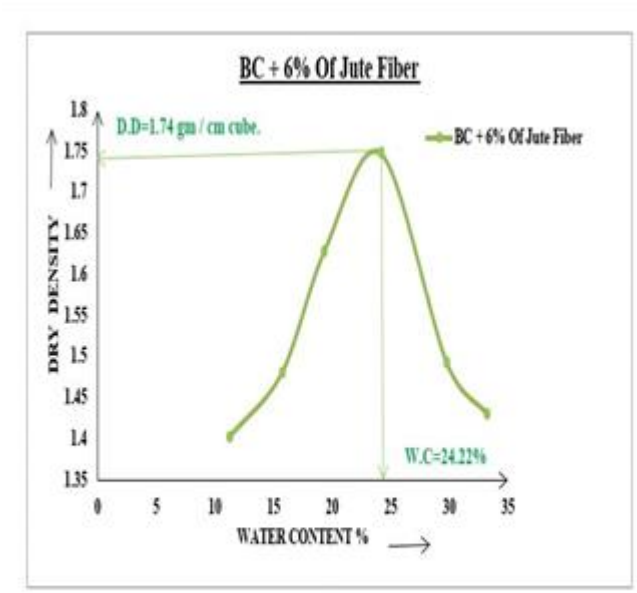

Fig 4: MDD & OMC of BC Soil With 6% of Jute Fiber

- Black cotton soil and 8% of jute fibre having a length of 1cm is mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and results obtained are 1.62 gm/cc & 20.28%.

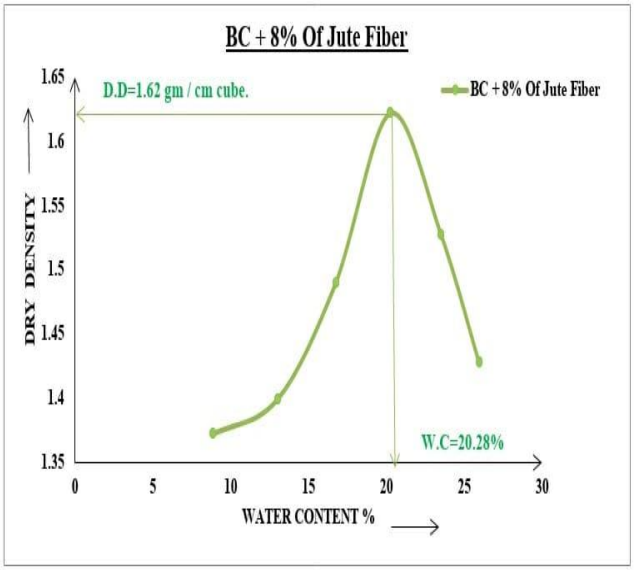

Fig 5: MDD & OMC of BC Soil With 8% of Jute Fiber

The below Graph is plotted for optimum values for sisal and jute fibre both fibre has a length of 10cm respectively..

→ Sisal Fiber: OMC = 23.78% & MDD = 1.85 gm/cc.

→ Jute Fibre: OMC =24.22% & MDD = 1.74 g/cc.

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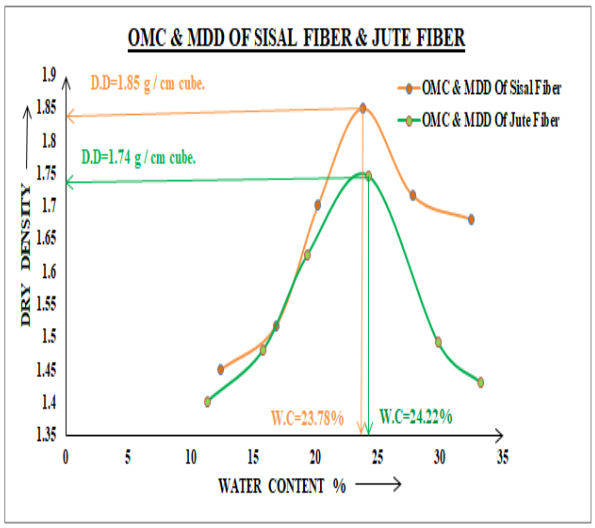

Fig 6: MDD & OMC of Sisal Fibre & Jute Fiber.

❖ Below figure represents graph of Black cotton soil + sisal fibre + jute fibre compacted together which gives MDD as 1.87 gm/cc and OMC as 24.33%.

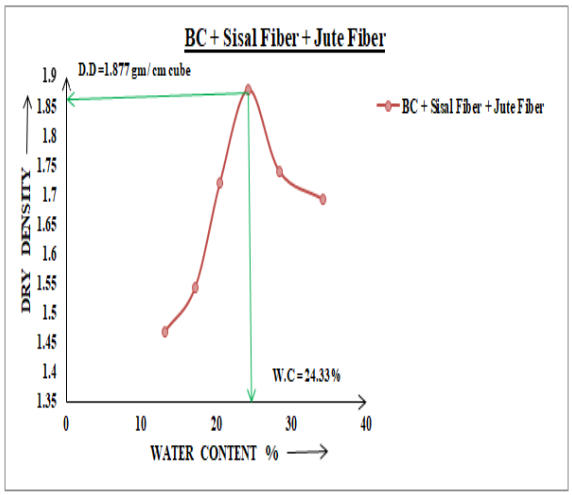

Fig 7: MDD & OMC of BC+Sisal Fibre + Jute Fiber

CBR Calculation For Expansive Soil After Adding Different Amount of Sisal Fibre and Jute Fibre.

CBR is a strength measure of soil and flexible pavement.CBR test was performed on BC soil by adding varying % of sisal fibre and jute fibre and length of fibers is 1cm. The below data table is obtain from test conducted which helps in plotting the curve i.e. on x-axis penetration and y-axis loading in (kg).

Table: 3 CBR Calculations of BC Soil and Sisal Fiber

Sl No.	Description	CBR %	
		Unsoaked	Soaked For 4 Days
1.	Black cotton soil alone	3.06	2.48
2.	BC + 5% Of Sisal Fibre	3.13	2.62
3.	BC + 10% Of Sisal Fibre	3.43	2.84
4.	BC + 15% Of Sisal Fibre	3.79	3.13
5.	BC + 20% Of Sisal Fibre	4.62	3.20

❖ BC soil alone mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil is 3.06% & BC soaked for 4 days is 2.48%.

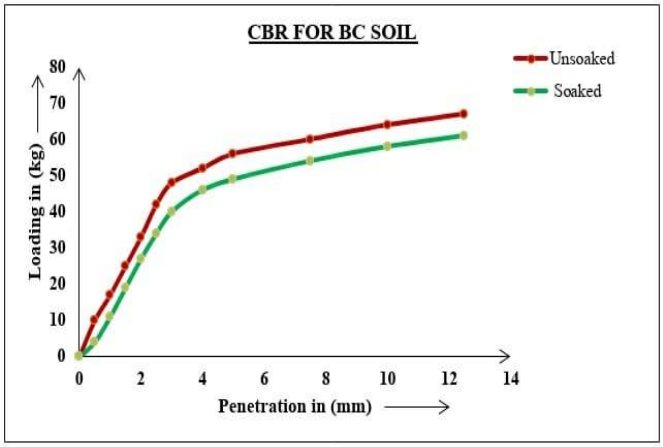

Fig 1: CBR for BC Soil

❖ BC soil and 5% of sisal fibre mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + sisal fibre whose values is 3.13% & BC soil + sisal fibre soaked for 4 days is 2.62%

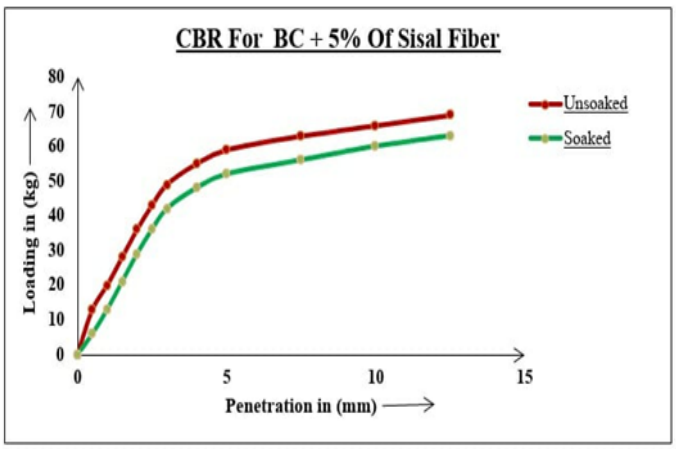

Fig 2: CBR for BC Soil With 5% of Sisal Fibre

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❖ Expansive soil and 10% of sisal fibre blended with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + sisal fibre whose values is 4.43% & BC soil + sisal fibre soaked for 4 days is 2.84%

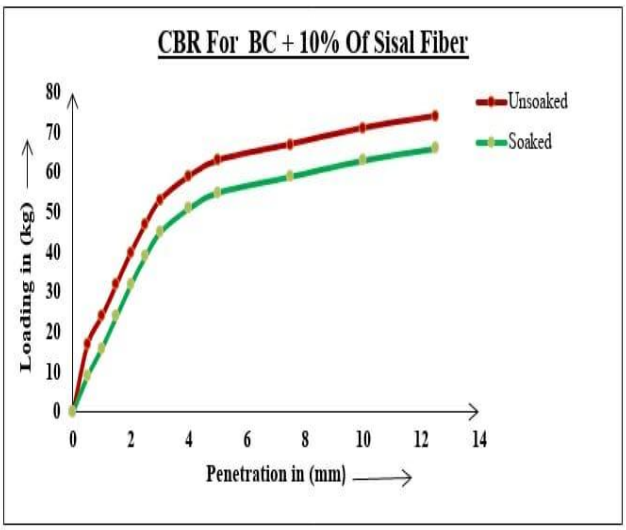

Fig 3: CBR for Black Cotton Soil With 10% Of Sisal Fibre

❖ BC soil and 15% of sisal fibre jumbled with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + sisal fibre whose values is 3.79% & BC soil + sisal fibre soaked for 4 days is 3.13%

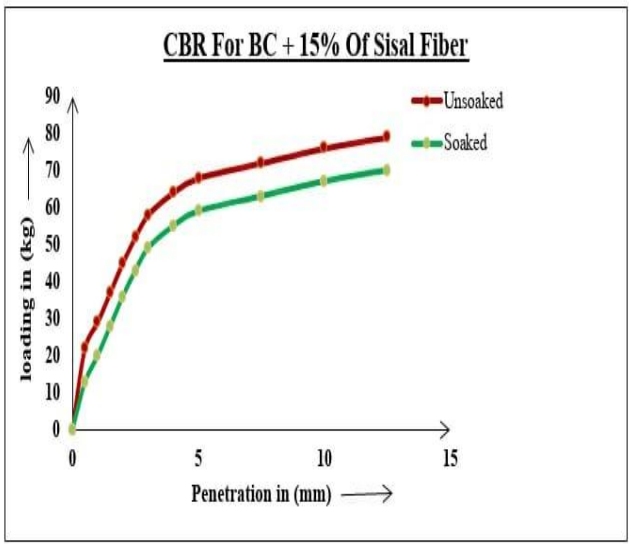

Fig 4: CBR for BC Soil With 15% of Sisal Fibre

❖ Expansive soil and 20% of sisal fibre combined with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + sisal fibre whose values is 4.62% & BC soil + sisal fibre soaked for 4 days is 3.20%.

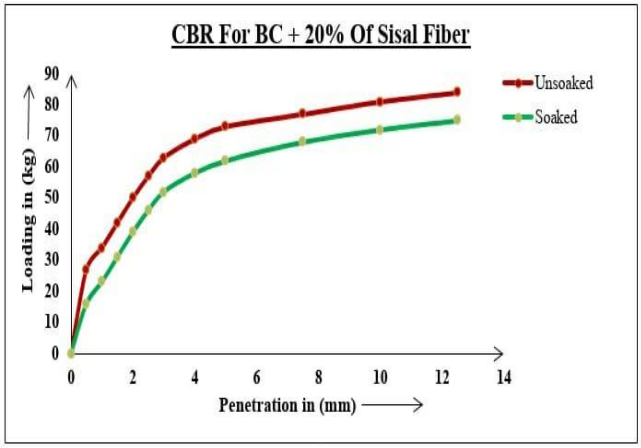

Fig 5: CBR For BC Soil With 20% Of Sisal Fiber

Table: 4 CBR Calculation of Black Cotton Soil & Jute Fiber

Sl No.	Description	CBR %	
		Unsoaked	Soaked For 4 Days
1.	BC + 5% Of Jute Fibre	2.99	1.89
2.	BC + 10% Of Jute Fibre	3.28	2.11
3.	BC + 15% Of Jute Fibre	3.57	2.33
4.	BC + 20% Of Jute Fibre	4.16	2.99

❖ Black cotton soil and 5% of jute fibre mixed with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + jute fibre whose values is 2.99% & BC soil + jute fibre soaked for 4 days is 1.89%

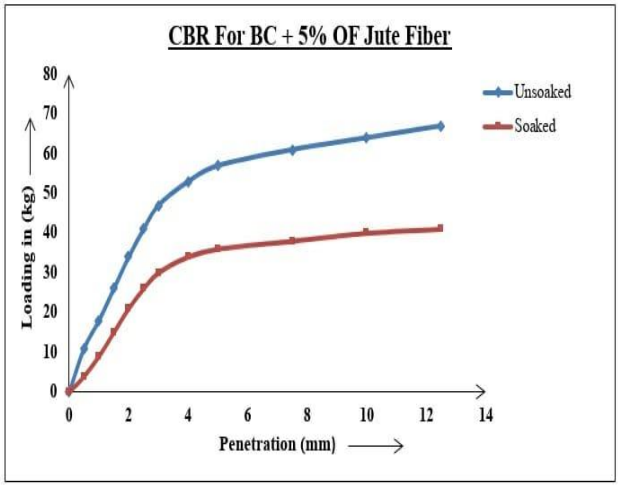

Fig 1: CBR of BC Soil With 5% of Jute Fibre

❖ BC soil and 10% of jute fibre blended with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph

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shows CBR % for unsoaked BC soil + jute fibre whose values is 3.28% & BC soil + jute fibre soaked for 4 days is 2.11%

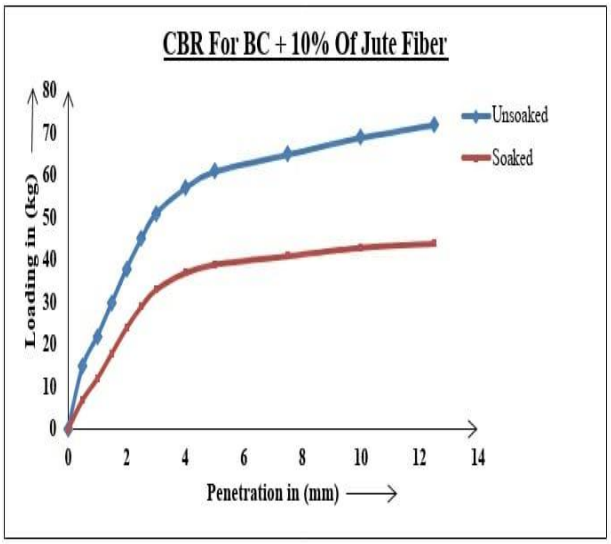

Fig 2: CBR of BC Soil With 10% of Jute Fibre

- Expansive soil and 15% of jute fibre combined with 2%, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + jute fibre whose values is 3.57% & BC soil + jute fibre soaked for 4 days is 2.33%.

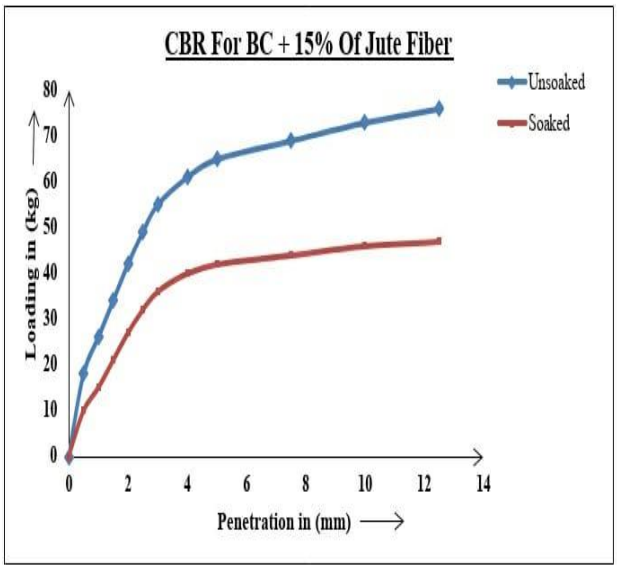

Fig 4: CBR For Black Cotton Soil With 15% Of Jute Fibre

- Soil sample and 20% of jute fibre together combined 2 %, 4%, 6%, 8%, 10% & 12% of water and obtained below graph shows CBR % for unsoaked BC soil + jute fibre whose values is 4.16% & BC soil + jute fibre soaked for 4 days is 2.99%.

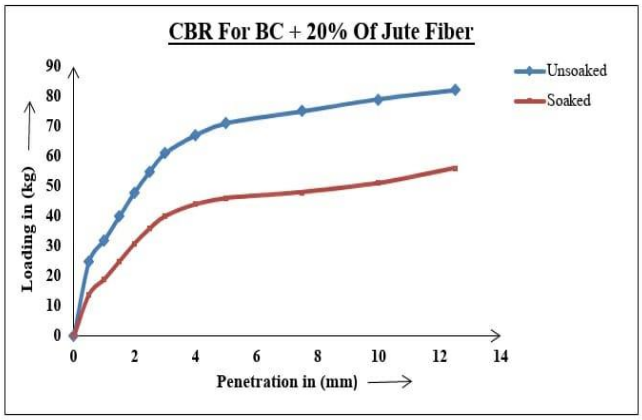

Fig 5: CBR for Black Cotton Soil With 20% of Jute Fibre

The below Graph is plotted for CBR optimum values for sisal and jute fibre.

- Sisal Fiber: Unsoaked = 4.62% & Soaked = 3.20%
- Jute Fibre: Unsoaked =4.16% & Soaked = 2.99%.

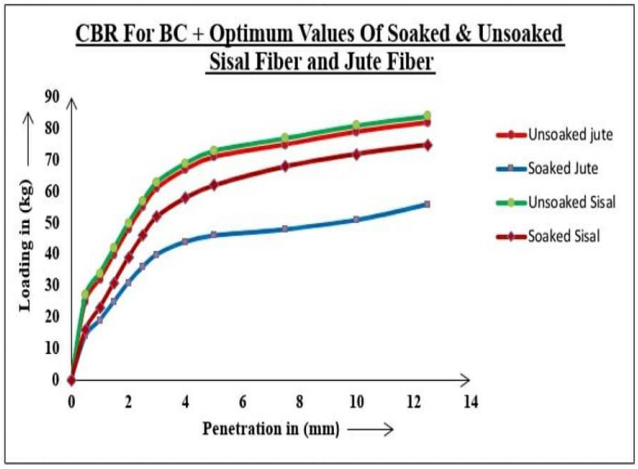

Fig 6: CBR % for Optimum Values for Sisal Fibre & Jute Fiber.

Below figure represents graph of Black cotton soil + sisal fibre + jute fibre compacted together which gives CBR % for unsoaked as 4.25% and soaked as 3.64%.

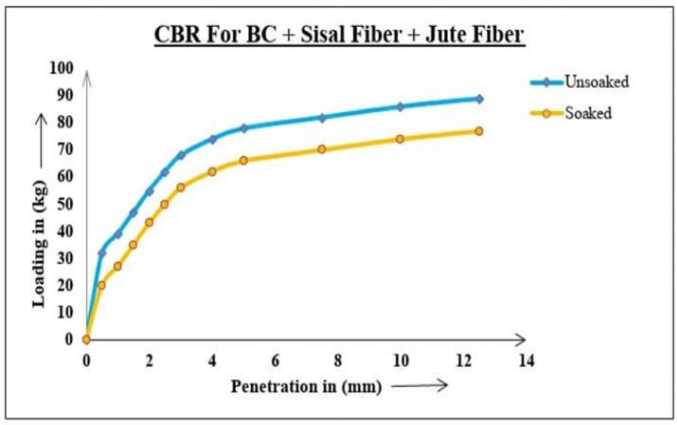

Fig 7: CBR% of BC+Sisal Fibre + Jute Fiber

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V. CONCLUSIONS

To improve the weak subgrade soil researchers have done many tests by using different fibers which are eco-friendly. In the present work sisal fibre and jute fibre are used as admixtures. In this current work we have made endeavor to know the joined impact of sisal fibre and jute fibre on strength of BC soil

The accompanying conclusion can be drawn based on the current work:

- The experiment is conducted on expansive soil which is brought from kadiyal village; the BC soil is replaced by with certain varying amount of sisal fibre and jute fibre in order to increase strength & characteristics of soil.
- From SPT (compaction), when various percentages of admixtures are mixed with BC soil, the obtained optimum dry density as 1.85gm/cc and optimum moisture content as 23.78% at 6% of sisal fibre.
- Various % of jute fibre is blended with black cotton soil; it is noticed that highest dry density is obtained at 1.74gm/cc and moisture content at 24.22% at 6% of jute fibre.
- Together compaction of sisal fibre, jute fibre and black cotton soil, the obtained MDD is 1.87g/cc and OMC as 24.33% at 6% of sisal fibre and jute fibre.
- Hence, from obtained results it is forth obvious that adding both the fibres to BC soil has improved the density on soil.
- From CBR test is performed with expansive soil with varying % of sisal fibre and the result obtained are for unsoaked as 4.62% and soaked as 3.20% at 20% of sisal fibre.
- The varying % of fibre is added in BC soil which results in unsoaked value as 4.16% and soaked value as 2.99% at 20% of jute fibre.
- By adding BC soil, sisal fibre and jute fibre compacted together the obtained CBR %, for unsoaked sample is 4.25% and soaked sample is 3.64% at 20%.
- From the results obtained it is concluded that by adding admixtures i.e.; sisal fibre and jute fibre the soil strength is increased as compared to alone BC soil.
- By improving the attributes of expansive soil by adding sisal fibre and jute fibre which helps in increasing load bearing capacity and soil shear strength without any hazardous effect to nature.

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