International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

"Enhancement of Bearing Properties of Black Cotton Soil by Optimal Blending Of Jute and Coir Fibres as a Reinforcement''

Shaikh Ashfak, Maneeth P D, Sharanabasappa Kori

Abstract: ***Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing with additives. The different types of method used for soil stabilization are: Soil stabilization with cement, Soil stabilization with lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of stabilization by Geo textiles and Geo synthetic fibres. In this study, we are making use of Jute and Coir fibre as geo synthetic material for stabilization of soil. With the introduction of Jute and Coir fibres to the soil the CBR values will improve and thickness of pavement layer also gets reduced. It also reduces the intensity of stress on subgrade. Jute and Coir fibres are such a geo synthetic material which is easily available, eco friendly and also cost effective. With the application of soil stabilization method in construction the overall cost gets reduced when compared to the ordinary method of construction. To determine the Liquid limit using Casagrande Method, Plastic limit by rolling the sample to 3mm diameter thread, Optimum Moisture Content and Maximum Dry Density using Standard Proctor Test, Unconfined compression test and also California Bearing Ratio by conducting CBR test.***

Keywords: OMC, MDD. UCS, CBR, Jute fibres, Coir fibres, Black cotton soil.

I. INTRODUCTION

Stabilization is a technique of increasing the strength of the soil. In other words we can say that improving the bearing capacity of the soil. In India there are many places were the soil is very weak. Many areas have affected by the water. Many regions have marshy areas were the area contains grossy vegetation. In these regions it is very difficult to construct the roads. Because due to the high water table the soil becomes weaker so that it is necessary to stabilize the soil. Subgrade is the lowest layer of the pavement.

Revised Manuscript Received on October 30, 2019.
***** Correspondence Author
Shaikh Ashfak*, Department of Highway Technology, VTU Regional centre for PG studies, Kalaburagi, India. Email: shaikhashfak948@gmail.com
Maneeth P D, Assistant Professor, Department of Civil Engineering, VTU Regional centre for PG studies, Kalaburagi, India. Email: maneeth.pd@gmail.com
Sharanabasappa Kori, Assistant Professor, Department of Civil Engineering, VTU Regional centre for PG studies, Kalaburagi, India. Email: sharanukori67@gmail.com

It takes all the loads of the pavement as well as the loads coming on the pavement. So, it should possess sufficient stability under adverse climatic and loading conditions. The defects in black top pavement surface like rutting, corrugation, etc. are generally attributed to poor subgrade. Thus the stability of the pavement depends upon the Stability of the subgrade. In this project I am using jute fibres and coir fibres for stabilization of soil. Jute fibres and coir fibres are easily available and eco friendly and also cost effective. Adding these fibres in the soil may increase the strength of soil and also helps to decrease the height of the subgrade soil. By stabilizing the soil may result economic cost of construction of subgrade.

II. OBJECTIVES

- The cost of replacing the weak soil with good quality of soil is more compared to stabilizing the weak soil.
- Jute fibres and coir fibres are natural product and easily available and also they cheaply available hence by using them in the stabilization helps to economic cost of construction.
- Stabilizing the soil with these fibres helps to reduce the overall thickness of the subgrade, and improves the soil bearing capacity.

III. LITERATURE REVIEW

Aamir Farooq, Prof (Dr) Rajesh Gayal: In this Research they have stabilized the soil by using jute fibre. They have carried some laboratory tests and come to a conclusion that adding jute fibre in the soil increases the optimum moisture content and decreases the maximum dry density, and it acts as a drainage layer and does not allow the water penetrate into the above layers.

Akhil Gayal, Ved Prakash, Vishal Kural: In this research they have experimented and stabilized clay soil using jute fibre and Gypsum. Based on the experiment they concluded that adding jute fibre into the soil increases the maximum dry density and decreases the optimum moisture content, but as we increases the fibre content the maximum dry density start to decreases and OMC get increases.

Shukla Devdatt, Rajan Shikha, Saxena A.K: They carried out experiment on stabilizing soil using coconut coir fibre. They have come to a conclusion that the adding coir fibres in the soil have increase the properties of the soil. The OMC has decreased and MDD has increased. Adding 1% coir fibre in the soil increase CBR value 3% to 6%.

T.Subramani, D.Udayakumar: They carried experiment on improving soil parameters by adding coir fibre. By carrying different methods they have come to conclusion that, coir fibre can be used to stabilizing the soil, strength will increase of soil-coir mix by increase in coir in the soil, the results of CBR, UCS will increase by increasing the percentage of coir in soil.

IV. MATERIALS

Black cotton soil:- Black cotton soil is also termed as Regur soil. Black cotton soil broadens and gluey during the rainy season. Black cotton soil contract in dry season lead to deep cracks within the soils. Black cotton soil contains chemicals like lime, alumina, and magnesium. Black cotton soil can hold the water and suitable for the forming of cotton hence known as Black cotton soil. Nearly 100 kg of locally available clayey soil was collected from Kalaburagi, and thoroughly hand-sorted to eliminate the vegetative matters and pebbles. Then the soil was sieved through 4.75 mm sieve to remove the gravel fraction. The oil was oven dried for 24 hours before the execution of geotechnical tests.

Table I. Physical Properties of Soil

S. No.	Parameters	Result
1	Light Compaction Test i. MDD (gm/cc) ii. OMC (%)	 1.645g/cc 18%
2	Liquid Limit (%)	54.40%
3	Plastic Limit (%)	21.46%
4	Plasticity Index (%)	32.94%
5	Specific Gravity	2.67

Jute fibres:- Jute is extended, flexible and bright vegetable fibre that can be twist into coarse, hard threads. It is formed from vegetation in genus co chorus. Jute is the economical vegetable fibre brought from skin of the plants and jute intern of usage is second most crucial vegetable fibre after cotton. Jute fibre is eco friendly and it can be recyclable. Jute fibre is all-round natural fibre. It has been consumed in raw materials for boxing, fabrication, cloths and forming sectors.

Jute fibres have been used. The fibres are cut into pieces of 15mm lengths and are mixed in constant percentage (0.5%) by the dry weight of soil, The jute fibre has been purchased from the market at Kalaburagi.

Table II. Physical Properties of Jute fibres

S. No.	Physical Properties	Range/Values
1	Fibre length, mm	15
2	Fibre Diameter, mm	0.3-0.45
3	Fibre type	Single
4	Ultimate tensile Strength, Mpa	350
5	Modulus of Elasticity, Gpa	28.43

Fig. 1.Jute fibres

Coir fibres:- Coir fibre is a ligno glucose fibre. Coir is a disposable, recyclable and eco friendly fibre. Coir fibre is hard, long lasting, all round and springy fibre. Coir fibre is obtained from coconut husk. The hairy mass coating coconut. The Coir fibres are cut into pieces of 15mm lengths and are mixed in constant percentage (0.5%) by the dry weight of soil, The Coir fibre has been purchased from the market at Kalaburagi.

Table III. Physical Properties of Coir fibres

S. No.	Physical Properties	Range/Values
1	Fibre length, mm	15
2	Fibre Diameter, mm	16 micron
3	Fibre type	Single
4	Ultimate tensile strength, MPa	175
5	Modulus of Elasticity, Gpa	4-6

Fig.2 Coir fibres

V. METHODOLOGY

The following tests were conducted in the soil by varying the percentage of Mixture of Jute fibres and coir fibres:

- Consistency limits or Atterberg's limits
- Standard Proctor Test
- Unconfined Compressive Strength using UCC testing machine
- California Bearing Ratio from CBR testing apparatus

VI. RESULTS AND DISCUSSION

A. LIQUID LIMIT TEST BY CASAGRANDE METHOD

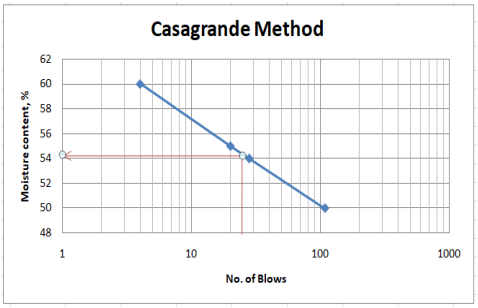

Fig.3. Liquid limit test on Black cotton soil

Liquid limit as obtained from graph = **54.40%** (Corresponding to 25 blows)

B. PLASTIC LIMIT TEST

Table IV. Plastic limit test on Black cotton soil added with 0.5%, 1.0%, 1.5% and 2%, fibres

Trial Number	1	2	3	4	5
Fiber added, %.	0	0.5	1	1.5	2

Container No.	1	2	3	4	5
Mass of empty container, M1 g	32.15	29.50	34.50	30.00	31.50
Mass of container + wet soil, M2 g	47.15	43.50	44.30	45.59	47.47
Mass of container +dry soil, M3 g	44.50	40.50	42.00	41.80	43.50
Mass of water, Mw= M2-M3	2.650	3.000	2.300	3.790	3.970
Mass of dry soil= Md= M3-M1 g	12.35	11.00	7.500	11.80	12.00
Plastic Limit,% Wp=(Mw/Md)*100	21.46	27.27	30.46	32.13	33.14
Liquid Limit WL	54.40	41.90	38.90	37.70	35.25
Plastic Limit,% Wp	21.46	27.27	30.46	32.13	33.14
Plasticity Index WL- Wp	32.94	14.63	8.440	5.570	2.110

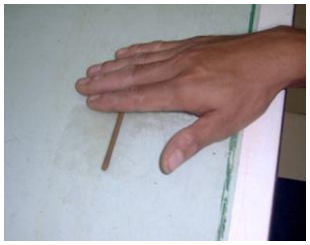

Fig.4. Plastic limit test

C. 1. STANDARD PROCTOR TEST ON BLACK COTTON SOIL

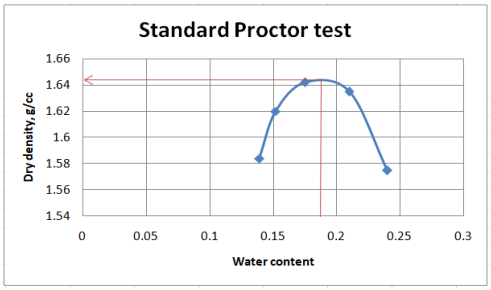

Fig.5. Standard Proctor Test on Black cotton soil

OMC as obtained from graph = **18%**
MDD as obtained from graph = **1.645 g/cc**

2. Standard Proctor Test on Black cotton soil added with 0.5% fibres

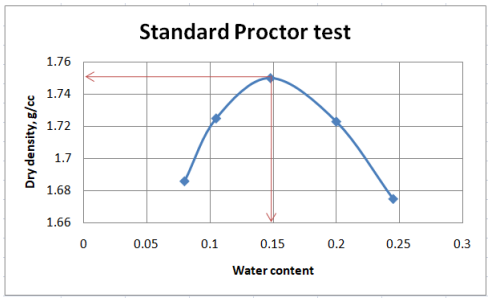

Fig.6 Standard Proctor Test on Black cotton soil added with 0.5% fibres

OMC as obtained from graph = **14.8%**
MDD as obtained from graph = **1.75 g/cc**

3. Standard Proctor Test on Black cotton soil added with 1% fibres

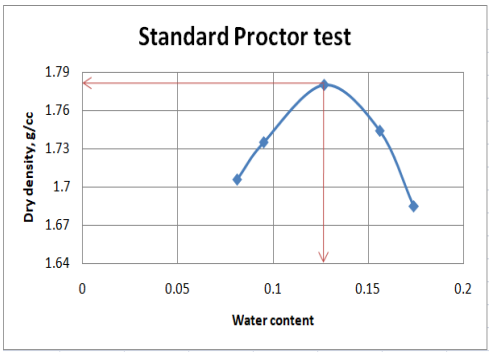

Fig.7 Standard Proctor Test on Black cotton soil added with 1% fibres

OMC as obtained from graph = **12.7%**
MDD as obtained from graph = **1.78 g/cc**

4. Standard Proctor Test on Black cotton soil added with 1.5% fibres

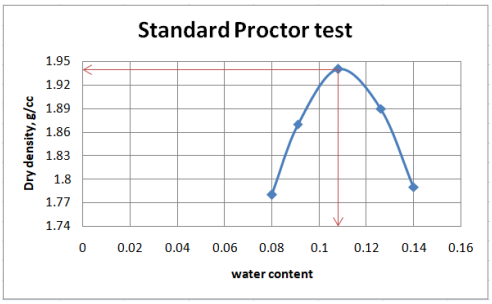

Fig.8 Standard Proctor Test on Black cotton soil added with 1.5% fibres

OMC as obtained from graph = **10.8%**
MDD as obtained from graph = **1.994 g/cc**

5. Standard Proctor Test on Black cotton soil added with 2 % fibres

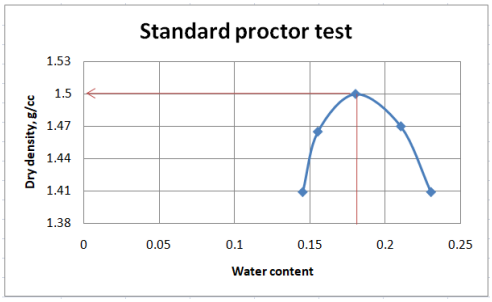

Fig.9 Standard Proctor Test on Black cotton soil added with 2 % fibres

OMC as obtained from graph = **18%**
MDD as obtained from graph = **1.5 g/cc**

D. 1. UNCONFINED COMPRESSION TEST ON BLACK COTTON SOIL

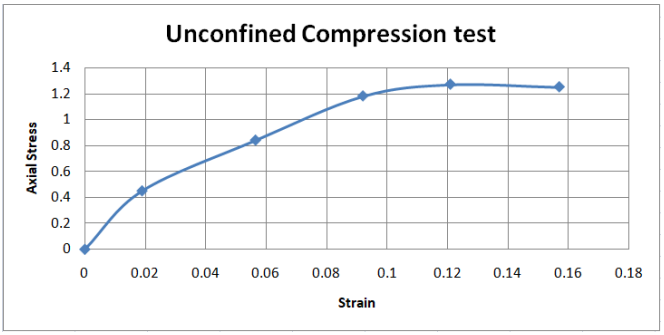

Fig.10 Unconfined Compression Test on Black cotton soil

2. Unconfined Compression Test on Black cotton soil added with 0.5% fibre

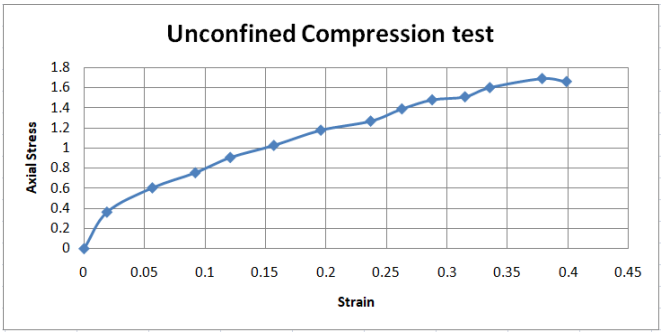

Fig.11 Unconfined Compression Test on Black cotton soil added with 0.5% fibre

3. Unconfined Compression Test on Black cotton soil added with 1% fibre

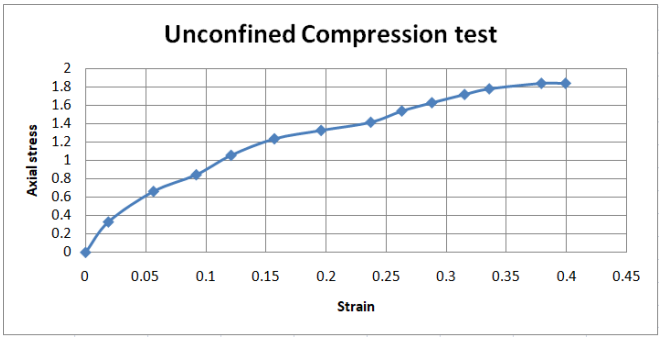

Fig.12 Unconfined Compression Test on Black cotton soil added with 1% fibre

4. Unconfined Compression Test on Black cotton soil added with 1.5% fibre

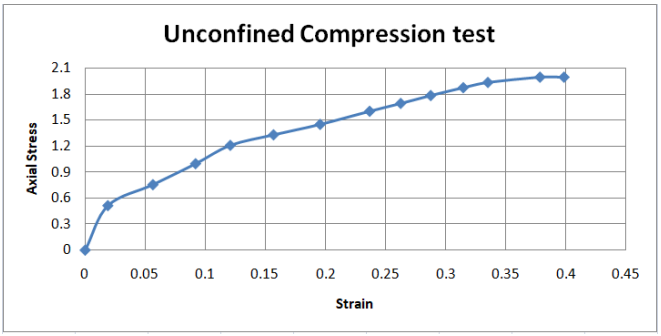

Fig.13 Unconfined Compression Test on Black cotton soil added with 1.5% fibre

5. Unconfined Compression Test on Black cotton soil added with 2% fibre

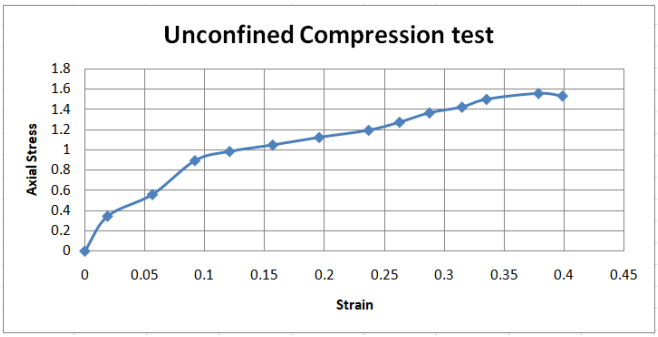

Fig.14 Unconfined Compression Test on Black cotton soil added with 2% fibre

E. 1. CALIFORNIA BEARING RATIO TEST ON BLACK COTTON SOIL

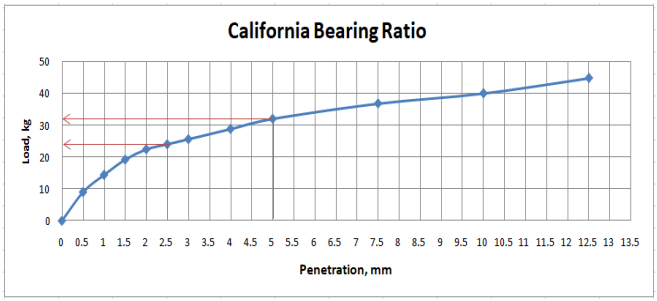

Fig.15 California Bearing Ratio Test on Black Cotton Soil

Load as obtained from graph at 2.5 mm penetration = 24 kg
CBR of Specimen = (24/1370) *100=1.75%
Load as obtained from graph at 5 mm penetration = 32 kg
CBR of Specimen = (32/2055) *100=1.55%

2. California Bearing Ratio Test on Black cotton soil added with 0.5% fibres

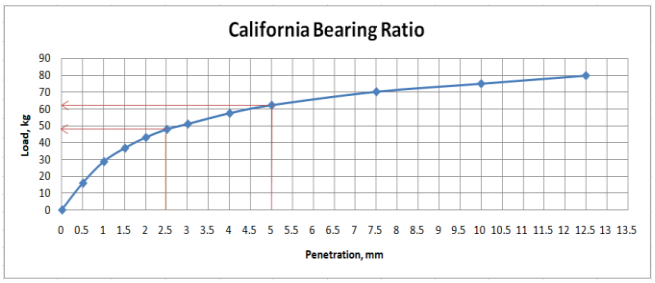

Fig.16 California Bearing Ratio Test on Black cotton soil added with 0.5% fibres

Load as obtained from graph at 2.5 mm penetration = 48 kg
CBR of Specimen = (48/1370) *100=3.49%
Load as obtained from graph at 5 mm penetration = 62.4 kg
CBR of Specimen = (62.4/2055) *100=3.02%

3. California Bearing Ratio Test on Black cotton soil added with 1% fibres

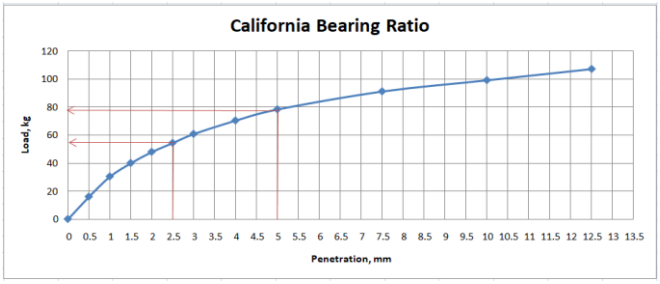

Fig.17 California Bearing Ratio Test on Black cotton soil added with 1% fibres

Load as obtained from graph at 2.5 mm penetration = 54.4 kg
CBR of Specimen = (54.4/1370) *100=3.96%
Load as obtained from graph at 5 mm penetration = 78.4 kg
CBR of Specimen = (78.4/2055) *100=3.80%

4. California Bearing Ratio Test on Black cotton soil added with 1.5% fibres

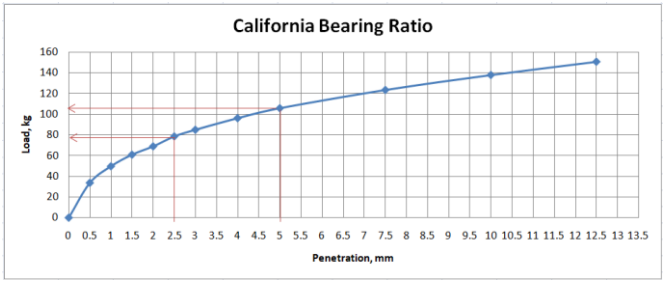

Fig.18 California Bearing Ratio Test on Black cotton soil added with 1.5% fibres

Load as obtained from graph at 2.5 mm penetration = 78.4 kg
CBR of Specimen = (78.4/1370) *100=5.41%
Load as obtained from graph at 5 mm penetration = 105.6 kg
CBR of Specimen = (105.6/2055) *100=5.12%

5. California Bearing Ratio Test on Black cotton soil added with 2% fibres

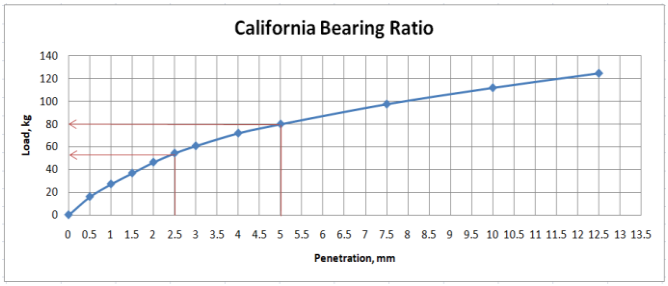

Fig.19 California Bearing Ratio Test on Black cotton soil added with 2% fibres

Load as obtained from graph at 2.5 mm penetration = 54.4 kg
CBR of Specimen = (54.4/1370) *100=3.96%
Load as obtained from graph at 5 mm penetration = 80 kg
CBR of Specimen = (80/2055) *100=3.88%

DISCUSSION

A. Liquid limit

• The liquid limit of the soil alone was found to be 54.40%
• The liquid limit of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 41.90%, 38.90%, 37.70% and 35.25% respectively.

B. Plastic limit

• The plastic limit of the soil alone was found to be 21.46%
• The plastic limit of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 27.27%, 30.46%, 32.13% and 33.14% respectively.

C. Plasticity Index

• The Plasticity index of the soil alone was found to be 32.94%.
• The Plasticity index of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 14.63%, 8.44%, 5.57% and 2.11% respectively.

D. Shrinkage limit

• The shrinkage limit of the soil alone was found to be 23.309%
• The shrinkage limit of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 16.471%, 15.876%, 8.043% and 5.826% respectively.

E. Standard Proctor Test

• The optimum moisture content (OMC) and maximum dry density (MDD) of soil alone was found to be 18.0% and 1.645 g/cc respectively.
• The MDD of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 1.750g/cc, 1.780g/cc, 1.940g/cc and 1.5g/cc respectively and the corresponding OMC is found to be 14.8%, 12.7%, 10.8% and 18% respectively.

F. Unconfined Compression Test

• The shear strength of the soil alone was found to be 1.27MPa.
• The shear strength of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 1.687, 1.838, 1.989 and 1.560 Mpa respectively.

G. California Bearing Ratio (CBR) Test

• The CBR value of the soil alone was found to be 1.75%
• The CBR value of the soil with addition of 0.5%, 1.0%, 1.5%, and 2% Jute and Coir fibres by weight of soil is found to be 3.49%, 3.96%, 5.41% and 3.96% respectively.

VII. CONCLUSION

On the basis of present experimental study, the following conclusions are drawn.

- The Jute-Coir stabilization is found to be very much effective for stabilizing the soil, the changes observed in the soil after stabilization is remarkable.
- Based on the observations and the results obtained, it can be concluded that there is substantial increase in maximum dry density (MDD) with increase in addition of fibres up to 1.5% by weight.
- There is substantial decrease in Optimum moisture content (OMC) with increase in addition of fibres.
- In unconfined compression test it was observed that the shear strength of the soil has increased with the increase in percentage of Jute and Coir fibres, when compared to that of shear strength of soil tested without fibres.

- The shear strength of the soil is maximum when 1.5% (by weight of soil) mixture of Jute and Coir fibres is added to it. Hence in order to obtain higher shear resistance 1.5% of fibres (by weight of soil) can be considered as the optimum fiber content.
- The California bearing ratio (CBR) of the soil alone is obtained as 1.82% and it increased to 5.41% after stabilizing it with optimum percentage of fibres, hence the fibres can be used for stabilization of different soil having low CBR value.
- From the above laboratory investigation it can be concluded that the industrial waste like Jute fibres and coir fibre has a potential to modify the engineering behavior of Black cotton soil and to make it suitable in many geotechnical application.

REFERENCES

1. Aamir Farooq, Prof (Dr) Rajesh Gayal "STABLIZATION OF SOIL BY USE OF GEO-JUTE AS SOIL STABILIZER" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 08 | Aug -2017
2. Akhil Gayal, Ved Prakash, Vishal Kural "SOIL STABILIZATION OF CLAYEY SOIL USING JUTE FIBRE AND GYPSUM" International Journal of Innovative Research in Science, Engineering and Technology Vol. 5, Issue 8, August 2016
3. Shukla Devdatt, Rajan Shikha, Saxena A.K "SOIL STABILIZATION USING COCONUT COIR FIBRE" International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 3 Issue 9, September 2015
4. T.Subramani, D.Udayakumar "EXPERIMENTAL STUDY ON STABILIZATION OF CLAY SOIL USING COIR FIBRE" International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 5, Issue 5, May 2016
5. Jeena Mathew, Karthika Ramesan "COMPARATIVE STUDY ON EFFECT OF SOFT SOIL STABILIZATION USING COIR FIBRES AND POLYPROPYLENE FIBRES" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X,
6. Pooja Upadhyay, Yatendra Singh "SOIL STABILIZATION USING NATURAL FIBER COIR" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 12 | Dec-2017
7. Amit Kumar Singh, R.K Yadav "IMPROVEMENT IN CBR OF EXPANSIVE SOIL WITH JUTE FIBER REINFORCEMENT" International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 11 | Nov -2016
8. Yogya sharma, Dr. D.G.M Purohit, Dr. Sunil Sharma "IMPROVEMENT OF SOIL PROPERTIES BY USING JUTE FIBRE AS SOIL STABILIZER" American Journal of Engineering Research (AJER) Volume-6, Issue-10, pp-123-129
9. Azar Hamid, Huda Shafiq "SUBGRADE SOIL STABILIZATION USING JUTE FIBRE AS A REINFORCING MATERIAL" International Journal of Engineering Development and Research (IJEDR) Volume 5, Issue 1
10. Aneesha Aseez, Firdousul Hakh CT "STRENGTHENING OF SUB-GRADE SOILUSING GEOSYNTHETICS" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03 | Mar-2018

AUTHORS PROFILE

Shaikh Ashfak, Department of Highway Technology, VTU Regional centre for PG studies, Kalaburagi, India.

Maneeth P D, Assistant Professor, Department of Civil Engineering, VTU Regional centre for PG studies, Kalaburagi, India.

Sharanabasappa Kori, Assistant Professor, Department of Civil Engineering, VTU Regional centre for PG studies, Kalaburagi, India.