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SUBGRADE BLACK COTTON SOIL REINFORCEMENT BY BITUMEN EMULSION WITH JUTE FIBRE

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ABSTRACT

Beginning from the base, soil is the one of the majority construction material. Maximum all type of construction built upon the soil. Subgrade is the sometimes stabilized or replaced by stronger soil material to progress the strength. The main objective of this experimental study is to improve the properties of the black cotton subgrade soil by adding bitumen emulsion with jute fibre. An attempt has made to use emulsion with jute fibre for improving the strength of expansive soil expressed in terms of CBR values which may confirm to be economical. Bitumen emulsion and jute fibre most easily available in our country. Bitumen Emulsion acts as good bonding agent with soil particles and jute fibre acts as best crack resisting agent. In this study, the entire laboratory work revolves around the fundamental properties of soil and it is strength in terms of CBR value. It observed that exceptional soil strength results by using bitumen emulsion (MS) with jute fibre as a reinforcement agent. The suitable mixing conditions for black cotton soil with MS Bitumen emulsion with jute fibre have attempted. This is followed to show the variation in dry density and CBR value to achieve the best possible strength properties of subgrade black cotton soil.

Key words:Bitumen Emulsion, Jute fibre, compaction test and CBR test.

1. INTRODUCTION

The Black Cotton Soil named as expansive soil which is deposited 20% surface area in the India. Black cotton soil made by volcanic rocks. soil has imperative material of montmorillonite material. The strength of soil is high when soil is dry state and once its contact with water leads deformation of soil by swelling and shrinkage characteristics of soil and which is much faster changes in character with environment. In the seasons watertable changes in behavior of wet substance by varying temperature. Black cotton soils lead to the major damages to the subgrade Pavement layer and structures. Subgrade is the lower part of pavement layer. It carries loads of pavement by pavement layers. To enhance engineering properties and soil strength of soil can be reinforced by jute fibre. Jute fibre can use as best reinforcing agent because which has permanence, high strength of tensile against rutting and which is suitable for fine drainage and filtration character. Jute easily and nearby available, low cost, ecological material. Reinforcing process of increases the soil strength, bearing capacity, reduce the settlement and lateral deformation of pavementlayers by heavy loads. Soil stabilization by the agents of Bitumen Emulsion, cement fly ash, quarry dust used for the increase the strength of Black cotton soil. In same way we have used Bitumen Emulsion and Jute Fibre are used as stabilizers and soil Reinforcement by combination of MS Bitumen Emulsion and Jute fibre.

2. LITERATURE REVIEW

1. **Ayininuola Gbenga Matthew main paper entitled in 2018:** This study was examined stabilizing the lateritic soil with bitumen emulsion and cement and Degree examination to check the impact of Bitumen Emulsion on the subgrade soil characteristics based on CBR value at different proportion of bitumen emulsion. The outcomes of the flexibility properties of soil were impressively changed upon the the variation of bitumen emulsion. The emulsion impact on UCS and CBR by mixtures of bitumen emulsion and increase in strength as proportion of the cement content increased and bitumen vice versa. The optimum combination bitumen emulsion and cement was 75% and25%.

2. **K Ashwini Chandh and S Akhila main paper entitled in April 2017:** They have done a research on strength improvement by using Bitumen as admixture.They have found OMC of expansive soil has increased by addition of Bitumen Emulsion and which has improved CBR value of the soil by Bitumen Emulsion then after tests carried out the bitumen emulsion addition minimizes the thickness of subgrade and the reduces the quantity of soil and coast of construction. This concluded that max. replacement of bitumen emulsion in the soil was 8% only because 9% of the BE reduces the value of CBR.

3. **Anzar Hamid main paper entitled in 2017:** Concentrated over stability of Black cotton subgrade soil by Jute fibre as a reinforcement material with different percentage. Which is enhanced the property of soil by jute fibre and CBR value found 200% over the plain soil, it has conducted by using Jute Geotextile in subgrade soil. when Jute fibre substance increases value of CBR and will be increases upto remarkable percentage he has used jute geo textile as reinforcement material which is shown as 0.75% is optimum fibre content with the lenth of 90mm and diameter of Fibre was 2mm.

4. Yagya Sharma main paper entitled in 2017: He focused on enhancement of the engineering properties of soil through JF treating by sand and he analyzed potential of sand with jute fibre and length was 20mm as an admixture and varying percentage of jute fibre pieces with different densities andimoisture content. Finished theprogression ofresearch trials independently and together of Jute fibre and fine sand in extensive soils area. He found that the geotechnical properties of far reaching soils enhanced with expansion of Jute fibre up to and fine sand. Unconfined compressive strength at varying compositions and this admixture improve the strength characteristics of soil.

5. M.Udaya sri main paper entitled in February 2017: Had utilized Bitumen emulsion is a soil stabilizer to increase the CBR strength value for the laterite soil by his laboratory tests at varying percentage of bitumen Emulsion. This research involved all laboratory tests revolve about the vital characteristics of that soil and strength term of CBR value. A small quantity of fly ash was usedas a filler additive and from the following through study it comprehensible that significant increasing of CBR strength, in particular laboratory cram of CBR value improved upto 50% on plain soil CBR.

6. Dharmendra kumar main paper entitled in 2015: He has also concentrated on the CBR strength value on Subgrade soil by admixer of Jute fibre as reinforcing materials. He was prepared five samples based on maximum dry density and OMC in CBR mould among and without Jute Fibre . He is investigated on the length of jute fibre was taken 20,40,60,80 and 100mm length and jute fibre taken 1 to 5% in increasing base. as per his tests increasing lenth and content of jute fibre of fibre increasing the CBR value. concluded that strength to be increased by using 1.5 to 2 % of fibre content and substantially reduces the depth of pavement layer and reduces cost of pavement construction.

7. Satyendra kumar verma main paper entitled in 2015: He has researched on bitumen emulsion as a soil stabilizer. To enhance the CBR of subgrade soil. He got best results on increasing CBR value by emulsion mix at different dosage of MS Bitumen emulsion. In that study of laboratory tests revolve on the essential characteristics of the soil and it is strength in term CBR value and small amount of cement was added to gain the strength of soil with bitumen emulsion. He was used ideal soil passing through 600 microns IS sieve. By bitumen emulsion the dry density was increased at various percentage of emulsion make soil strength and water proof.

8. Maheshawari G Bisanal main paper entitled in July 2015: They have concentrated on to improve the USC and CBR value for subgrade soil by using Sea shell powder and Bitumen Emulsion and tests carried out and which shows the USC of the Black cottonsoil has improved from adding sea shell powder and bitumen emulsion. This test of CBR the shown that the addition above the admixtures are improved the CBR value of expansive soil and they have concluded that UCS and CBR are increased up to certain limit then after beyond the limits reduces the strength

3. OBJECTIVES AND SCOPE OF THE PRESENT INVESTIGATION

On real issues representing with the Black cotton soil is the based on swelling and shrinkage qualities. TheExpansive soil to be swell when it interacts by water. This kind of soilscharacterize from natural change in volume by behavior of Montmorillonite mineral due to changes of wetness. In the point of dimensions alter on the formation made on that kind of soils can be manageddegree of difference settlement of the pavement subgrade. Adding MS Bitumen Emulsion as strength modifying cause.Attempt made for use BE and JF for escalating the strength and geotechnical actions on Black cotton soil. Bitumen emulsion is environmentally friendly material and Jute Fibre is increases the tensile strength and bearing capacity of soil if drydensity was less.

Hence, theObjectives of currentinvestigation as follows;

(i) To identifyindex and compactionproperties of BlackCotton soil on plain black cotton soil.
(ii) To study onindex &compaction behaviorof the Expansive soil with adding up various percentages of Bitumen Emulsionwith Jute Fibre to turn up the best percentage andalsoproposed to match up to the geotechnical properties of normal soils.
(iii) To study on the strengthbehavior of Black Cotton soil.
(iv) Tostudy the strengthbehavior of Expansivesoil atvariouspercentages of Bitumen MS Emulsion with Jute Fibre.
(v) Tostudy ofthe strength behaviorof Expansivesoiltreatedwith optimum percentage of Bitumen MSEmulsion with Jute Fibre.

4. MATERIAL

4.1 Black cotton soil

Black cotton soil is maximum available in the Deccan plateau or Basalt region, this kind of soil is spreadon the north-west Deccanplateau in the states of Maharashtra, NorthKarnataka, Malwa andsouthern Madhya Pradesh continue eastwardsin the south, along the Godavari and Krishna Valleys. It is well-known of ability to hold themaximum moisture in the soil. which are develops thick fissures in the field when hot season. These kind of soils developed under the semi-aridconditions specificallyin the areas that arecovered with basalt. For the investigation of Black cotton soil obtained from Near Aland Check post land Kalaburgi district, Karnataka state, India. It is collected by an open dug at a depth of 0.5 m below ground surface. The soil was air dried and pulverized and passed through 425 microns IS sieve has used for this investigation of soil.

4.2 Bitumen Emulsion

MS BitumenEmulsion was obtained by LASA plant karavar branch office Karnataka , India . It is one of the dispersion of small droplets by oneliquid in another liquid and most of the emulsion phase is water. Its produced batch oran in line process and bitumenemulsion classified as RS Emulsion, MS Emulsion and SS Emulsion.

4.3 Jute Fibre

After cotton, it is the secondmost important vegetable fibre, in the terms of production, and availability with low cost. Which has has high tensionstrength andlow extensibility characteristics. It is best suitable for Reinforcing the soil during the construction of roads and can be used as anti-erosion material at the place of slope in hill areas and high embankment some time jute fibre is used as geo textile in infrastructures to enhance the strength of soil and pavement layers.

Fig.4.1: Black cotton soil with Bitumen emulsion **Fig.4.2: Jute fibre sample**

5. METHODOLOGY

The methodology consists basic necessary tests as mentioned below for now the strength properties of soil. The study to be found variation in soil sample with additives such are MS Bitumen Emulsion with Jute fibre. MS Bitumen Emulsion used constant as per previous research papers and the dose of MS Bitumen Emulsion fixed 5% for every test samples. Jute Fibre is used as soil reinforcing agent which has high tensile strength and crack resisting property, the percentage of JF maintained as per research papers and which are shown the optimum JF at 0.75% to 1.2 % based on diameter and length of jute fibre. The percentage of JF varying from 0%,0.5%,1% and 1.5% by the weight of soil and the sample of soil is tested as listed below.

1. Sieve Analysis
2. specific gravity
3. Liquid limit test
4. Plastic Limit test
5. Shrinkage limit test
6. Modified Proctor TestCBR Test.

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6. RESULTS ANALYSIS

6.1 Compaction Characteristics

Compaction is the process of a mechanical strategy which the solidification I accomplished by the removal of air voids from the soil at OMC of substance of the soil mass. Which is most important factor to increase the dry density of soil and has different methods of compactions are considered and the consequences of the compaction tests territory unit normally communicated inside of the kind of dry thickness v/s water content relationship. The two basic compaction attributes the range unit ideal OMC and MDD. This variable that have impacted on these attributes territory unit and the compaction exercise. Increasing compaction effort, the MDD increases and the OMC decreases.

1. Compaction will be increased the DD of soil, along these lines increases its shear quality and bearingability.
2. Compaction is the declines the settlement of soil and
3. Compaction brings very low permeability of the soil.

Table 6.1: Compaction test on Black cotton soil without stabilizer

Trials		1	2	3	4
1.	Mass of Empty mould, m_1 (gms)	5310	5310	5310	5310
2.	Mass of mould + Compacted soil, m_2(gms)	6875	6950	7082	6985
3.	Mass of Compacted soil, M= m_2-m_1(gms.)	1565	1640	1770	1675
4.	Bulk density, γ_b=(M/V)g/cc	1.56	1.64	1.77	1.67
5.	Container number	18	24	17	13
6.	Mass of container, M(gms.)	10.15	10.40	11.20	12.01
7.	Mass of container+*Wet soil M_2(gms.)	35.12	35.80	36.23	38.42
8.	Mass of container+*Dry soil M_3(gms.)	32.24	32.40	32.15	34.28
9.	Water content, w=(M_w/M_d)	13.03	15.45	19.47	21.48
10.	Dry Density,γ_d= γ_b/(1+w) g/cc	1.38	1.42	1.48	1.37

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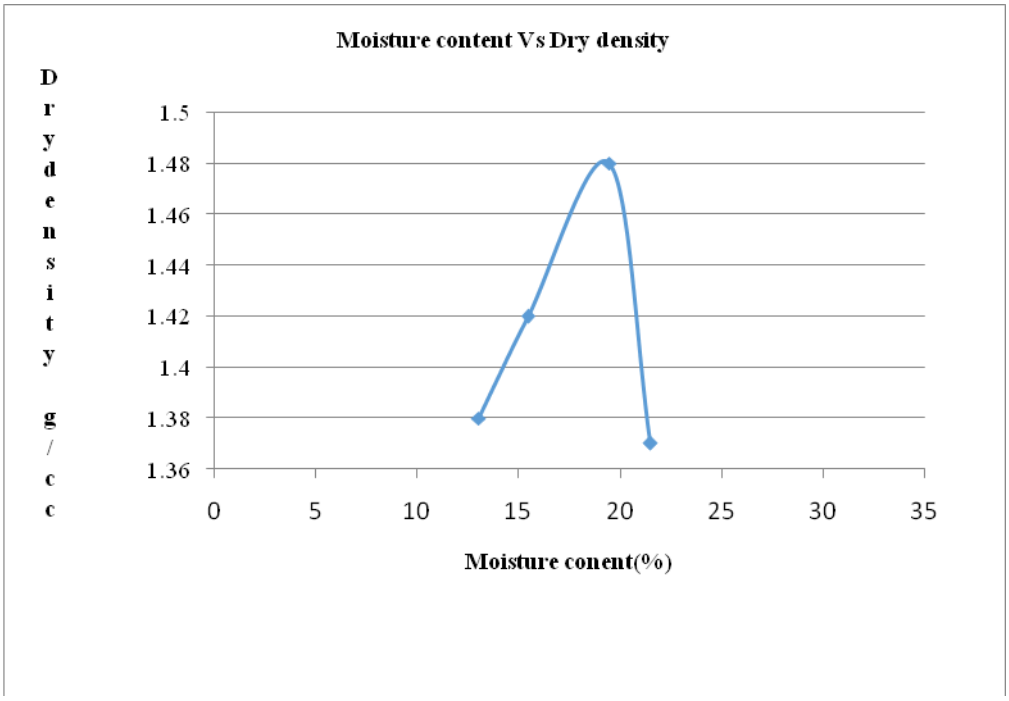

Graph 6.1: The above compaction of Black cotton soil graph shows that maximum dry density is 1.48g/cc and optimum moisture content is 19%.

Table 6.2: Compaction test on Black cotton soil with5% of MS BE and 0.5% of JF

Trils	1	2	3	4
Mass of Empty mold, m_1 (gms.)	5310	5310	5310	5310
Mass of mould + Compacted *soil, m_2(gms.)	7008	7100	7250	7210
Mass of Compacted soil, M= m_2-m_1(gms.)	1698	1790	1940	1900
Bulk density, γ_b=(M/V)g/cc	1.69	1.79	1.94	1.90
Container number	7	8	11	10
Mass of container, M(gms.)	10.24	11.34	1030	10.86
Mass of container+ Wet soil M_2(gms.)	35.30	36.23	36.20	35.31
Mass of container+Dry soil M_3(gms.)	32.56	32.82	31.80	31.02
Water content, w=(M_w/M_d)	12.27	15.80	19.29	21.27
Dry Density,γ_d= γ_b/(1+w) g/cc	1.50	1.54	1.62	1.56

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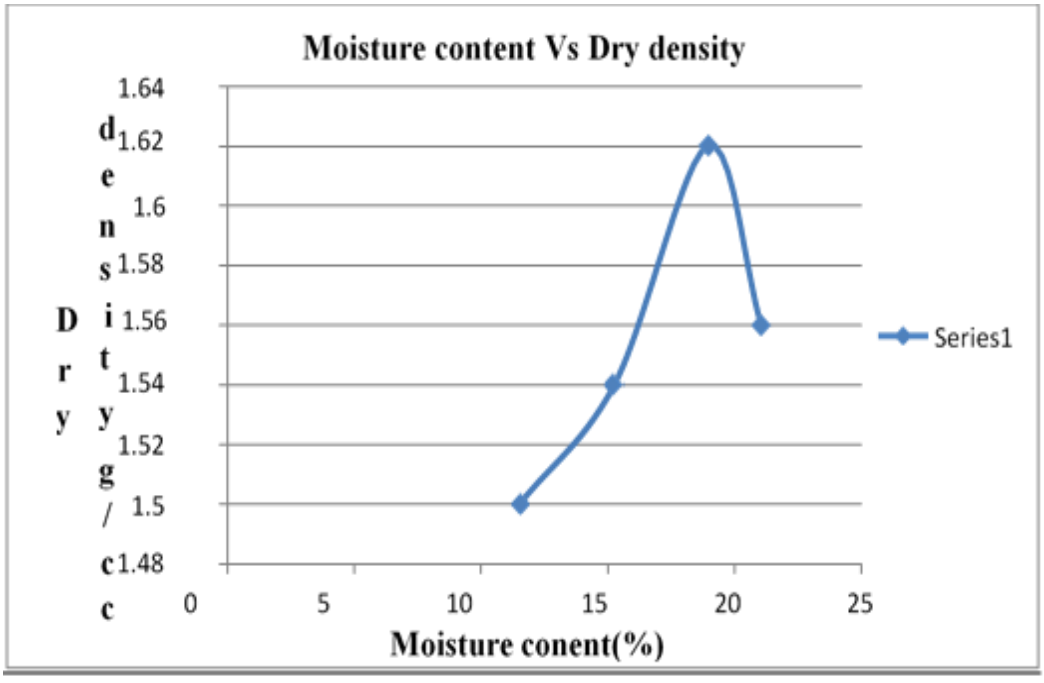

Graph 6.2: The above graph compaction of 5% of MS BE and 0.5% of JF shows that OMC is 18% and MDD is 1.62g/cc.

6.2 CALIFORNIA BEARING RATIO TEST

Fig.3 Preparation of CBR Mould

Table 6.2.3: CBR test on Plain Black cotton soil

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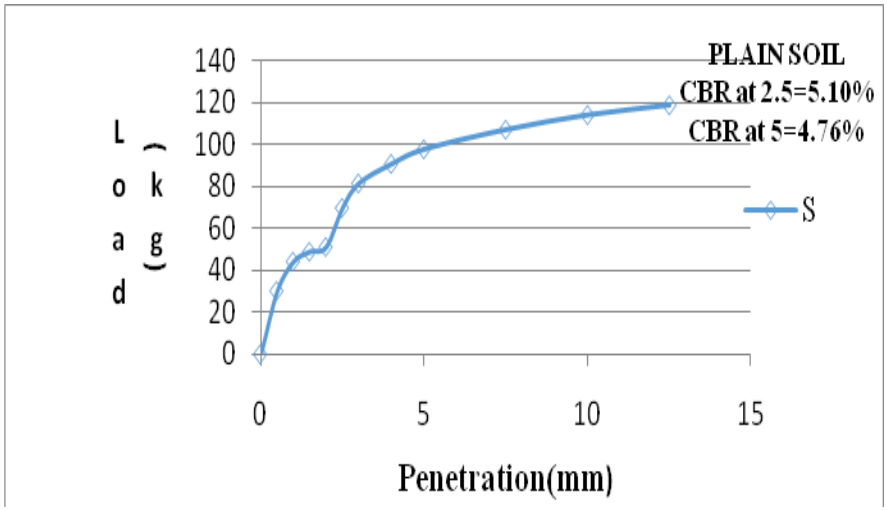
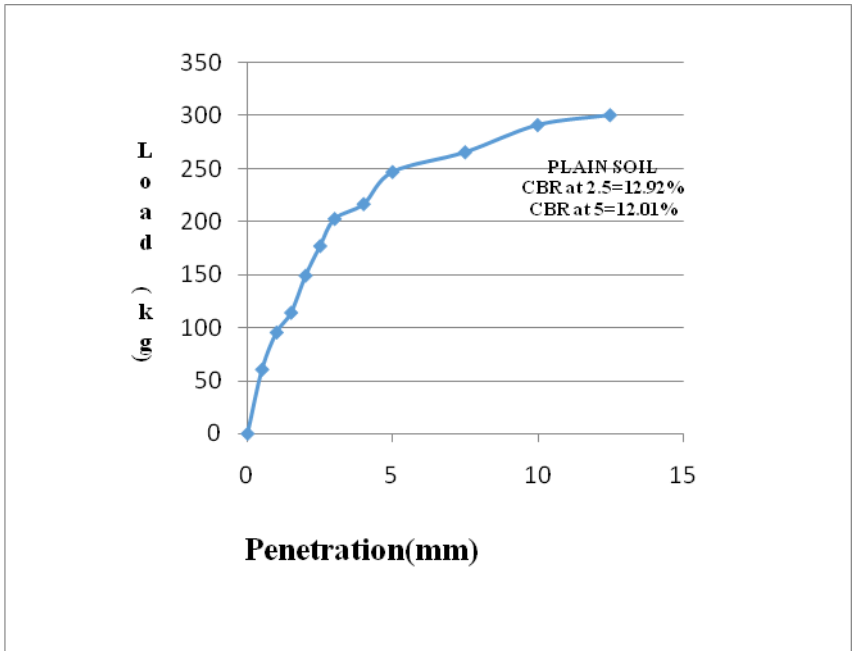
Penetration(mm)	PRR	Load(kg)
0	0	0
0.5	13	30.30
1	19	44.30
1.5	21	48.95
2	22	51.25
2.5	30	69.90
3	35	81.55
4	39	90.85
5	42	97.85
7.5	46	107.20
10	49	114.20
12.5	51	118.85



Graph6.2.3: The above graph for 0 % of Bitumen emulsion and Jute fibre shows that CBR value at 2.5 is 5.10%.

Table 6.2.4: CBR test on Black cotton soil Modified by MS BE 5% with 1% JF

Penetration (mm)	PRR	Load (kg)
0	0	0
0.5	26	60.60
1	41	95.55
1.5	49	114.20
2	64	149.10
2.5	76	177.15
3	87	202.70
4	93	216.70
5	106	247.05
7.5	114	265.60
10	125	291.25
12.5	129	300.55



Graph6.2.4: The above graph for 5% of MS BE with 1.0% of JF shows that CBR value at 2.5 is 12.92%.

7. RESULTS AND DISCUSSIONS

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Atterberg's limits

1 Liquid limit

i. The liquid limit of the soilalone found tobe54.33%
ii. The liquid limitof the soil with 5% of Bitumen Emulsion and 0% 0.5%, 1.0% and 1.5% Jute fibers by weightof soil is foundto be 54.33%, 39.2%, 39.7%, and 42.0% respectively.
iii. The liquidlimit of the soil withaddition of 0%, 0.5%, 1.0% and 1.5% Jute fibers is found to be decreased by 34.66%, 33.83%, 30.0% and 29.5% respectively, when compared to liquid limit of soilalone.

2. Plastic limit

i. The Plastic limit value of the soil alone found 21.46%
ii. The Plastic limit of the soil with addition of 0%, 0.5%, 1.0% and 1.5% Jute fibers by weight of soil is found 22.27%, 33.33%, 35.59% and 37.50% respectively.
iii. The plastic limit value of the soil with blended of 0%, 0.5%, 1.0% and 1.5% Jute fibers is found to be decreased by 21.3%, 43.5%, 51.8% and 58.8% respectively, when compared to plastic limit of soil alone.

3. PlasticityIndex

i. The Plasticityindex value of the soilalone found38.54%.
ii. The Plasticityindex value of the soil by addition of 0%, 0.5%, 1.0% and 1.5%Jute fibers by weightof soil is found to be 11.93%, 6.37%, 6.41% and 4.8%respectively.
iii. The Plasticityindex value of the soil by theaddition of 0%, 0.5%, 1.0% and 1.5% Jute fibers is found to be decreasedby 69%, 84.47%, 83.36% and87.54%.

4. Shrinkagelimit

i. The shrinkage limit value of the soilalone found 23.309%
ii. The shrinkage limit value of the soil by adding up of 0%, 0.5%, 1.0% and 1.5% Jute fibers by weightof soil isfound tobe 23.309,16.471%,15.876%,and8.043% respectively.
iii. The shrinkagelimit value of the soil by adding up of 0%, 0.5%, 1.0% and 1.5% Jute fibers is found to be decreasedby 29.33%,31.88% and 65.49%.

5. Modified proctor test

i. The OMC and MDD of soil alone was found 1.48 g/cc respectively
ii. The MDD of the soil with addition of 0%, 0.5%, 1.0% and 1.5% Jute fibers by weight of soil is found to be 1.48 g/cc, 1.62g/cc, 1.49 g/cc and 1.54 g/cc respectively and the corresponding OMC is found to be 19.47%, 19.29%, 19.80% and 20.03% respectively.

6. California Bearing Ratio (CBR) Test

i. The CBR value of soil alone was found to be 5.04%
ii. The CBR value of soil by adding up of 5% of MS Bitumen Emulsion to be constant and 0%, 0.5%, 1.0% and 1.5% Jute fibers by weight of soil respectively.
iii. The CBR value of soil by adding up of 0%,0.5%, 1.0% and 1.5% Jute fibers by weight of soil is found to be increased up to 1% then after decreases.
iv. The CBR value of soil adding up of 0%, 0.5%, 1.0% and 1.5% Jute fibers by weight of soil is found to be 5.04%, 12.18%, 12.75% and 10.05% respectively.
v. The CBR value of the soil by adding up of 0.5%,1.0% and 1.5% Jute fibers by weight of soil is found to be increased by 241.67%, 252.98% and 199.40% respectively.

7. CONCLUSIONS

The basis on present experimental study, conclusions are drawn:

1. There is substantial increase in MDD with increase in addition of fibers up to 0.50% by the weight of soil and beyond which is decreased.
2. There is substantial decrease in OMC with increase in addition of fibers.
3. Addition of Bitumen emulsion make a water resisting coat on Jute fibres against deterioration of jute fibre by decomposition by the water and soil.
4. When the percentage of jute fibreincreases, Shrinkage limit values decreases.
5. The California bearing ratio of the soil alone obtained as 5.04% and it increased to 12.75% after stabilizing it with optimum percentage of Bitumen Emulsion with Jute fibers.
6. The percentage increase in CBR value after stabilizing it with optimum percentage of Bitumen Emulsion is 5% and optimum percentage of fibers is 1.0%.
7. The California bearing ratio of the soil alone obtained and their substantial increase CBR value by adding of Bitumen emulsion and fibres till OMC of MS Bitumen Emulsion and OFC of Jute fibre and beyond which it decreased.
8. From above the investigation, can be concluded that the addition of jute fibres to Black cotton soil decreases the swelling behavior, decreases the shrinkage limits, increases the Plastic-limit, decreases plasticity index and improves the CBR value of soil.

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