International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 11 | Nov -2016 www.irjet.net p-ISSN: 2395-0072

Improvement in CBR of Expansive Soil with Jute Fiber Reinforcement

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ABSTRACT

Soil is a base of structure, which actually supports the structure from beneath and distributes the load effectively. If the stability of the soil is not adequate then failure of structure occurs in form of settlement, cracks etc. Expansive soil also known as black cotton soil is more responsible for such situations and this is due to presence of montmorillonite mineral in it, which has ability to undergo large swelling and shrinkage. To overcome this, properties of soil must be improved by artificial means. Soil reinforcement technique is one of the most popular techniques used for improvement of poor soils. Metal strips, synthetic geotextiles, geogrid sheets, natural geotextiles, randomly distributed, synthetic and natural fibers are being used as reinforcing materials to soil. Further, the soil reinforcement causes significant improvement in unconfined compressive strength, maximum dry density, bearing capacity as well as economy. Use of natural fiber in civil engineering for improving soil properties is advantageous because they are cheap, locally available and environmental friendly. In this project an attempt is made to study the influence of jute fiber reinforcement on CBR properties of expansive soil with reinforcement of jute layers between soil. It was observed that inclusion of Jute Geotextile layer into the soil increases the unconfined compressive strength and CBR value and this increase is maximum corresponding to 4 layers of Jute Geotextile layers.

Keywords: Jute Geotextile Sheet, Geotextile Reinforcement, Expansive soil, Stabilization, CBR, geo-synthetic reinforcement, Strength of soil.

1- Introduction

The road generally consists of Subgrade, Sub Base, Base And Wearing Course. The Subgrade, which is made of existing soil is an important part of road construction. The Economy of road construction depends on it. However, if the subgrade is made of weak and highly expansive soil, such as Black Cotton, It should be replaced by another soil having strength according to the requirement, to achieve economy in construction. If the appropriate soil is not available in the nearby areas and is to be transported from long distance, then there is an Increase in cost and time of construction. Hence, there is a need for soil improvement by using Jute Geotextile, in which we can use locally available weaker soil. Black cotton soil is clay of high plasticity. It has low bearing capacity and highly compressible nature. The expansive soil exerts upward swelling pressure in the structure. The primary purpose of reinforcing a soil mass is to improve its stability by increasing its bearing capacity, and by reducing settlement and lateral deformation. The fiber-reinforced soil behaves as a composite material. When loaded, the fibers mobilize tensile resistance, which in turn imparts greater strength to the soil. Use of natural or synthetic fibers in geotechnical engineering has been in the construction of pavement layers, road and railway

embankments, and retaining walls as well as in the protection of slopes.

2- Literature Review

Bairagi, (2014) studied the Effect of jute fibers on engineering characteristics of black cotton soil and gave result that CBR and UCS values of soil were increased significantly when mixed with jute fiber from 0% to 5%. **Choudhary et al, (2012)** studied the improvement in CBR of expansive soil with a single Jute reinforcement layer and gave results that reinforcement in layer controls swelling and enhances CBR value. **Singh, (2013)** conducted work on strength and stiffness of soil reinforced with jute geotextile sheets and concluded that there is increase in shear strength of soil with inclusion of jute in soil. **Pandit et al, (2016)** conducted experimental work on Effects of Jute Fiber on Compaction Test and concluded that OMC of soil increases upto 1.25% of jute fibres and then decreases for 1.50%. MDD decreases upto 1.25 % of jute fibre and then increases for 1.50%. **Das and Singh, (2014)** studied on Deformation and strength Characteristics of jute geotextile in reinforced soil concluded that jute layer reinforcement is very effective in stabilizing and protecting of weak soil. **Gill and singh**, (**2012)** studied CBR improvement of clayey soil and concluded that CBR was improved by 9.4% with different positions of layer. **Jagan, (2016)** conducted a case study on a critical review on applications of natural jute fibers and concluded that the cbr value of soil was increased after mixing the jute fiber in soil.

3- Objective

- To Study the effect of jute fiber layers on compaction characteristics of Black Cotton soil.
- To study the change in CBR value of soil due to jute layer reinforcement.

4- Materials

In this study, black cotton soil which is very much expansive in nature due to the montmorrilonite mineral present in it was used. Black cotton soil due to its swelling and shrinkage properties can cause deformation of subgrades, foundations etc and Jute fiber geotextile layer which is easily available in local market.

Soil

The soil sample is collected from Jasuja City, near Dhanwantri Nagar, Jabalpur (MP). The sample was collected and tested in lab and the following characteristics of soil were observed:

Table-1

Sno.	Property	Notation	Value
1	Specific Gravity	G	2.40
2	Soil classification	CH	-
3	Liquid Limit	LL	68.29%
4	Plastic Limit	PL	30.05%
5	Plasticity Index	PI	38.24
6	Differential free Swelling	DFS	60%
7	Optimum Moisture Content	OMC	19.54%
8	Maximum Dry Density	MDD	1.698 g/cc
9	Californnia Bearing Ratio	CBR	2.67%
10	% Passing 75 micron sieve	-	98.54%

Jute

Jute is economical and easily available in the market. Jute bags are locally available in the market. Jute bags were cut in desired shape with an average overall thickness of 2mm and about 0.4% and 0.8% by weight of soil for 2-layer and 4-layer jute reinforcement as shown below:

5- Methodology

The soil sample is tested for different tests listed below:

- Sieve Analysis
- Pycnometer test for Specific Gravity
- Liquid Limit
- Plastic Limit
- DFS
- Modified Proctor Test
- CBR test

The sample was tested as listed above and values obtained are shown in table-1. After the tests on Natural Soil Specimen Modified Proctor Test and CBR test were again conducted on soil specimen reinforced with 2-Layer and 4-Layer respectively

Figure 1- Compacted soil layers with no reinforcement

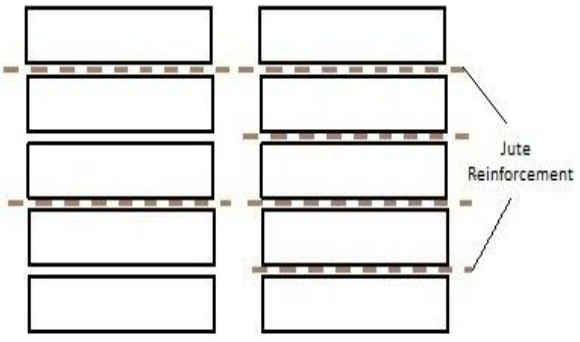


Figure 2- Compacted soil with 2-layer and 4-layer Jute reinforcement

Above shown figure-1 shows compacted soil layers with no reinforcement and Figure-2 shows the position of jute layers in soil specimen used in Modified Proctor Test and CBR test.

Modified Proctor Test

The soil sample is oven-dried at 105°C for 24 hours. Soil passing from 4.75mm sieve is taken and kept in the mould having volume 2250 cc. Weight of the hammer is 4.89 kg. Soil is reinforced in 5-layers with 56 blows on each layer. The MDD is determined and water content corresponding to MDD is taken as OMC. The test is again repeated on 2-layer and 4-layer reinforced sample to observe the change in corresponding values.

California Bearing Test

The California bearing ratio indicates the bearing resistance of soil. After knowing the OMC the optimum water quantity is mixed in oven-dried soil. The soil Is compacted in 5-layers with 56 blows on each layer. Sample is soaked in water for 96 hours for worst moisture condition. The soil is then tested on CBR machine in which load and penetration are recorded. The loads corresponding to 2.5mm and 5mm penetration is taken and CBR values are obtained. The same process is repeated on specimen reinforced with Jute reinforcement in 2-layers and 4-layers and corresponding change in values is noted.

6- Results and Discussion

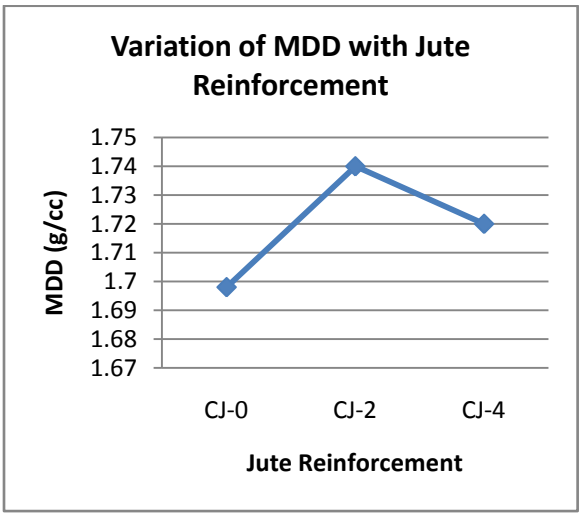
The dry density and CBR properties of soil are improved. The maximum improvement is seen in 4-layers of reinforcement. The results are tabulated below:

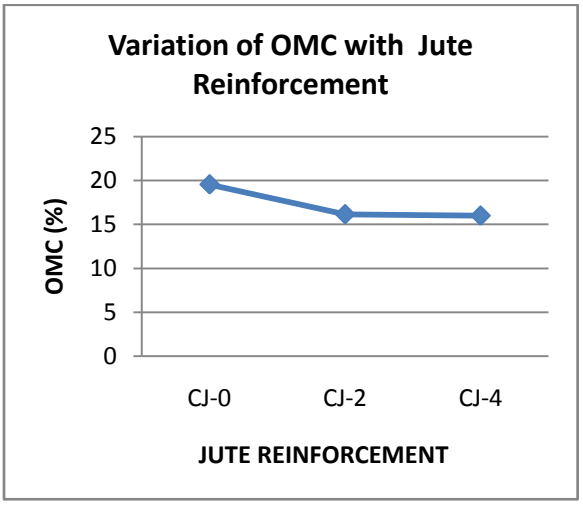
Sno.	Experiment	CJ-0	CJ-2	CJ-4
1	MDD (g/cc)	1.698	1.74	1.72
2	OMC (%)	19.54	16.14	15.98
3	CBR (%)	2.67	6.07	11.85

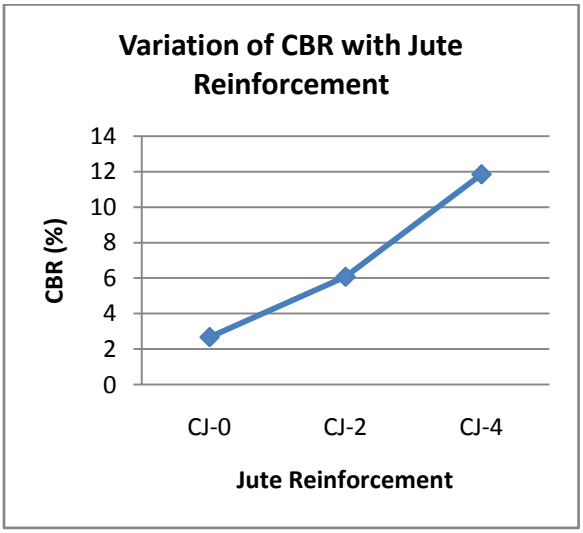
CJ-0 = Soil sample with no reinforcement

CJ-2= Soil sample with 2-layer reinforcement

CJ-4= Soil sample with 4-Layer reinforcement







The above results indicate that the MDD (Maximum Dry Density) of the soil is maximum in 2-Layer reinforcement and there is a slight decrease in 4-layer sample. The OMC (Optimum Moisture Content) is reduced from 19.54% to 15.98%. The CBR (California Bearing Ratio) is improved from 2.67% to 11.85%. The CBR value obtained is maximum in 4-Layer reinforcement in soil sample.

7- Conclusions

The jute reinforcement is found to be very much effective for stabilizing the expansive soil as the CBR values of the soil were improved. The changes observed in the soil after reinforcement is remarkable. The OMC of the soil was decreased from 19.54% to 15.98%. The MDD was increased at 2-layer reinforcement from 1.698 g/cc to 1.74 g/cc and after the 4-layer reinforcement of jute layer, the MDD was seen to be reduced to 1.72 g/cc. The CBR values were enhanced as the CBR value of natural sample was 2.67% and after 2-layer reinforcement of jute layer the improvement in CBR value was improved to 6.07% and when the jute layer reinforcement was increased to 4-layers the tremendous CBR value of 11.85% was obtained. Thus it can be concluded that maximum improvement was seen in 4-layer reinforcement of jute layer in soil.

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