STABILIZATION OF MOUNTAINOUS SUBGRADE USING JUTE FIBRE AND CEMENT

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Abstract:

Different soils behave differently to the loads subjected on them. To improve the strength parameters of soil, various additive materials have been suggested over the time. The main focus of this research was to enhance the strength of mountainous clayey subgrade & to get an optimum amount of Soil-Cement-Jute mix. For a fact Jute acts as a reinforcing material when added to subgrade. As mountainous clay shows high shrinkage, swell characteristics & low bearing capacity especially under sub-grade, therefore, there's a requirement to enhance the strength characteristics of soil. The main focus of this research was to improve the strength characteristics of subgrade. The tests performed in laboratory was Pycnometer test for relative density, Casagrande's test for liquid limit, plastic limit test, Standard proctor test for determination of OMC & MDD & modified proctor test. Proportion of the 6mm Jute used was 0.4, 0.7, 1.0, 2.0 & 4.0 % & proportion of cement was 1, 3, 5, and 7% by wright of sample. The optimum value of cement and 6mm jute fibre was found to be 5% and 0.4% respectively. The CBR value was found peak at 2% cement + 0.4% Jute fibre (6mm) combination. From the results it had been verified that 0.4% Jute content is more economical than 5% cement content.

Key Words: Jute fibre, Cement, Subgrade Stabilization, Specific gravity, CBR.

1. Introduction

Technically, soil is a mixture of rock or mineral particles, water and air. It is in the concept of these elements that the properties of the soil vary from one part to another. In addition, the development of different types of soil works differently. The type of soil for a construction site has a great influence on the design and cost of the building. Therefore, soil analysis helps to determine if further work is required to prepare the location of the construction.

In addition, different types of soil require different foundations to ensure a sustainable construction process. For example, the construction of walls for building foundations in sandy soils requires making sure that sand is present; Clay sand requires more material in the foundation because the clay can swell or shrink depending on the amount of water in the foundation, thus creating cracks in the walls and forming the foundation of the building.

1.1 METHODS OF SOIL STABILIZATION

Methods of stabilization can be broadly classified under two categories and these are as follows:

• Stabilization without additives

• Stabilization with additives

1.2 OBJECTIVES OF THE RESEARCH WORK

In the present study, "Stabilization of Mountainous Subgrade using Jute Fibre and Cement" an attempt is made to study how Cement, Jute fibres may be effectively utilized in combination with clayey soil, to get an improved quality of composite material which may be used as better sub-grade for highways.

The specific objectives of the research work include:

1) To collect clayey soil from land of City Mandi, State HIMACHAL PRADESH.

2) To determine the index properties of the clayey soil including LL, PL and PI.

3) To study the clayey sub-grade soil sample under proctor compaction test to determine the maximum dry density and optimum moisture content.

4) To study the CBR value of clayey sub-grade soil at optimum moisture content and maximum dry density.

5) Stabilizing agent cement is mixed with clay soil in varying percentages and optimal dose is obtained from proctor compaction and CBR tests.

6) Clayey soil mixed with Jute fibre (6 mm) in varying percentages and optimal dose is obtained from proctor compaction and CBR tests.

7) Combined effect of optimal dose of different stabilizers (cement, and Jute fibre) on CBR value of clayey soils also studied.

1.3 IMPORTANCE OF RESEARCH TOPIC

The topic "Stabilization of Mountainous Subgrade using Jute Fibre and Cement'' has been selected for the laboratory investigation, to work out the effect on California Bearing Ratio of sub-grade soil with some variation of soil stabilizing materials. Clayey soil losses their strength after attaining moisture content. This soil is taken into account poorest material from engineering point of view. Being volume-less in nature, replacement of soil is non engineered solution to tackle with the poor soil. Various techniques are used for improving the engineered properties of clayey soil, referred to as soil stabilization.

Improved sub-grade soil with higher CBR value reduces the pavement crust requirements. As an example for design traffic of 10 MSA pavement crust requirement reduces from 850 mm for sub-grade CBR of twenty-two to 540 mm for sub-grade CBR of 10%. Stabilization of clayey soils, being weakest with minimum CBR value, can bring economy in highway projects to an excellent extent.

2. Literature Review

2.1 **Mishra Ravi And Jawed S.M. Ali (2014)** Explained the potential of coal ash to be used in coal development methods in thermal power plants. During this study, samples were prepared from different compounds of different percentage of soil-fly ash, and they had to experience strength by adding geofibers.

2.2 **Pandey B. Et Al. (2013)** We have learned that many tons of posolanic products called ash are produced in our country. During this study, the properties of black cotton soil were improved using ash, hemp fiber and waterproof compounds. No projector tests or CPR testing were performed on the fiber-mixed soil of the fire, including Atterberg's range test. 2 - 8 mm and several% (0.2-1%) 0.5–2 mm in length, the most favorable sizes, with gray varying from 10%, 15%, 20%, 25%, and 1-5%. The simplest ratio after CPR testing is 1% hemp fiber + 5% lime + 20% ash. This study has several advantages over the stability of quality soils.

2.3 **J. Erik Loehr, Paul J. Axtell and John J. Bowders (2000**) He described a series of laboratory tests performed on fiber-reinforced and expanded clay samples to enable the possibility of using fiber reinforcement to prevent inflammation. The test program includes uniform independent swelling tests performed with reinforced and non-reinforced expanded clay expansion test equipment with a diameter of 10.2-cm and a diameter of 6.4 cm, and glued ring integration cells. The samples used for this test project were made using different fiber contents in different fiber dose ratios. The results of these experiments show that the addition of expanded fibers to the expanded clay significantly reduces the volume change when subjected to a uniform free swelling condition. As a result, there seems to be a great deal of potential mitigation of adverse effects on buildings, land-retaining structures, and dirt roads.

3. MATERIALS USED

Primary and secondary binders form cementitious composite material when they come in contact with the water or in the presence of pozzolanic material Reacts with water. The commonly used binders are;

- Cement
- Lime
- Gypsum
- Jute
- Fly ash
- Rice husk ash
- Blast furnace slag etc.

The above materials can be used alone or in combination. This work makes the use of Jute and Cement with clayey soil. A brief introduction to the materials and their behaviour is given below:

3.1 Jute Fibre

Jute may be a long, soft, shiny vegetable fiber which will be spun into coarse, strong threads. it's produced from plants within the Corchorus , which was once classified with the Tiliaceae more recently with Malvaceae, and has now been reclassified as belonging to the family Sparnnanniaceae. the first source of the fibre is Corchorusolitorius, but it's considered inferior to Corchoruscapsularis. "Jute" is that the name of the plant or fiber that's wont to make burlap, Hessian or gunny cloth. Jute is one among the foremost affordable natural fibers and is second only to cotton in amount produced and sort of uses of vegetable fibers. Jute fibers are composed primarily of the plant materials cellulose and lignin.

Properties of Jute Fibre

Type	
Shape	Elliptical
Diameter	5-25 micrometres
Tensile Strength	393-773 Mpa
Length of Fibre	0.8/6 mm
Specific Gravity	1.48
Elongation	>16%
Melting point (°C)	250-265

Loose 6mm polyster Jute Fibre

3.2 Cement

Ordinary hydraulic cement (43 grade); manufactured by Ambuja Cement is employed within the present study together of stabilizer. The cement bag of fifty kg was purchased from local market of Mandi @ of Rs.500 per bag. Properties of the cement tested in laboratory are given in Table 2.2

Table 2.2 Properties of Ordinary Portland Cement

Properties	**Result Obtained**	**As per IS:8112-1989 specifications**
Normal consistency	29%	25-35%
Initial setting time(min)	105	30(min)
Final setting time(min)	410	600(max)
Fineness retained on 90 µm	2.5%	10(max)
Specific gravity	3.17	…

3.3 Clayey Soil

In order to study the behaviour of clayey soil with different stabilizers a sample of Clayey sub – grade soil is collect from District Mandi, State HIMACHAL PRADESH. Following figure shows the map of HIMACHAL PRADESH state and shows the location of soil sample collection from District Mandi.

Figure 3.2 Map of Himachal Pradesh State

3.4 Water

Portable tap water is used for experimental work.

3.5 CHARACTERISTICS OF CLAYEY SOIL

The index properties of clayey soil include consistency limit, liquid limit, plastic limit and shrinkage limit.

Shrinkage Limit: Ws = $\frac{(M1-M2)(V1-V2)\rho w}{Ms}$ $\frac{(M1-M2)(V1-V2)\rho w}{Ms}$

Plasticity Index: IP = WL - WP

Flow Index: If = $\frac{w_1-w_2}{\log(N_2/N_1)} \times 100$ $\frac{w_1-w_2}{\log(N_2/N_1)} \times 100$

Where N1 and N2=number of blows required at water content of W1 and W2.

Liquidity Index: Liquidity Index (Il or LI) is defined as

$I\,I_1$ =w – wp/ IP x 100

Where w = water content of the soil in natural condition.

Consistency Index

Ic= WL –W/IP x 100

Consistency Index (Ic, CI) is defined as

Where w =water contents of the soil in natural condition.

2.4 CONSISTENCY OF SOIL

Consistency of a soil is its resistance to deformation. Consistency is conventionally described as very soft, soft medium, stiff, very stiff and hard. These terms are relative and should have different interpretation to different geo-technical engineers. For quantitative measurement of consistency, it's associated with the shear strength or compressive strength. Consistency is obtained through unconfined compressive strength (qu) or by the vane shear test. Table 3.3 gives the unconfined compressive strength of a soil of various consistency.

Table 3.3 Consistency **in term of consistency index and unconfined compressive strength (qu).**

S.No	Consistency	Consistency index (%)	Unconfined compressive strength (q_u) (KN/m^2)	Characteristics of soil
1.	Very soft	0-25	<25 KN/m^2	Fist can be pressed into soil
2.	Soft	25-50	25-50	Thumb can be pressed into soil

3.	Medium (Firm)	50-75	50-100	Thumb can be pressed with pressure
4.	Stiff	75- 100	100-200	Thumb can be pressed with great difficulty
5.	Very stiff	>100	200-400	The soil can be readily indented with thumb nail
6.	Hard	>100	>400	The soil can be indented with difficulty by thumb nail

4. EXPERIMENTAL INVESTIGATION

This is very important as part of the whole process. This includes the material collection sample method, so the tests performed on them produce different samples using different amounts of sludge and lime, and several experiments are carried out to find a suitable value for the mixed samples.

Table 4.1 Properties of Soil

S. NO.	Parameters	Results
1	Light compaction test i) MDD (gm/cc) ii) OMC (%)	 1.66 20.04
2	Liquid Limit	38.06%
3	Plastic Limit	26.12%
4	Plasticity Index	11.37%
5	Specific Gravity	2.63
6	Indian Soil Classification	MI

4.2.2 Jute:

Jute fibers were used. The fibers are cut into 6 mm long pieces and mixed with different percentages (0.4%. 1%, 2%, 0.7%, 4%) with the dry weight of the soil. Hamp fiber is procured from Mandi market.

4.2.2 Cement:

Ambuja Cement of 43 Grade has been purchased from the market at Mandi. The properties of the Cement have in Table 4.1

Table 4.2 Properties of Cement Used

Properties	Result Obtained	As per IS:8112-1989 specifications
Normal consistency	29%	25-35%
Initial setting time(min)	105	30(min)
Final setting time(min)	410	600(max)
Fineness retained on 90 µm	2.5%	10(max)
Specific gravity	3.17	…

4.3.3 Plastic Limit Test

The plastic limit is the minimum amount of water, in percentage, in the soil, and the 3-4 mm thick threads are often loosened without breaking. Tested in accordance with IS: 2720: Part 4 (1985). The soil in the thin threads on the glass plate is adjusted with non-stretching fingers (Figure 4.4). With a diameter of 3–4 mm, the threads are folded until they begin to break.

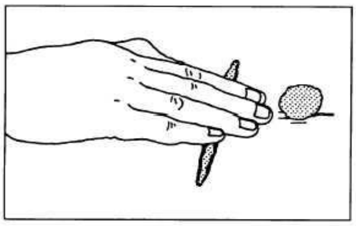

TABLE 4.3 RANGE OF OPTIMUM WATER CONTENT

Sand	Sand silt or silty sand	Silt	Clay
6 to 10 %	8 to 12 %	12 to 16 %	14 to 20 %

Table 4.4 Different types of moulds with desired compactive efforts

Types of compaction	Size of mould	Number of layers	Number of blows per layer
Light compaction	1000 ml	3	25
Light compaction	2250 ml	3	56
Heavy compaction	1000 ml	5	25
Heavy compaction	2250 ml	5	56

4.5 Comparison of Standard and Heavy Proctor Compaction Test

The dry density is obtained for different water contents, so the compression curve is drawn, showing the compression curve for the modified projector test. The curve and top are derived from a standard proctor test. Heavy shrinkage will increase the density of most dries, but will reduce moisture. The share of dry density is higher than that of sandy soils. Figure 4.7 also shows a zero air vacuum line. It should be noted that the very dry density that can be achieved even in the modified proctor test is less than the theoretical maximum dry density indicated by the zero-air vacuum line. The optimal path shown in the figure corresponds to the points indicating the driest density.

If the proportion of soil stored in a 4.75 mm filter is 20%, the largest mold of the inner layer of 150 mm, effectively using 127.3 mm and a capacity of 2250 mm. In this case, 56 feet is required for each layer. The rest of the procedure is similar to a normal projector

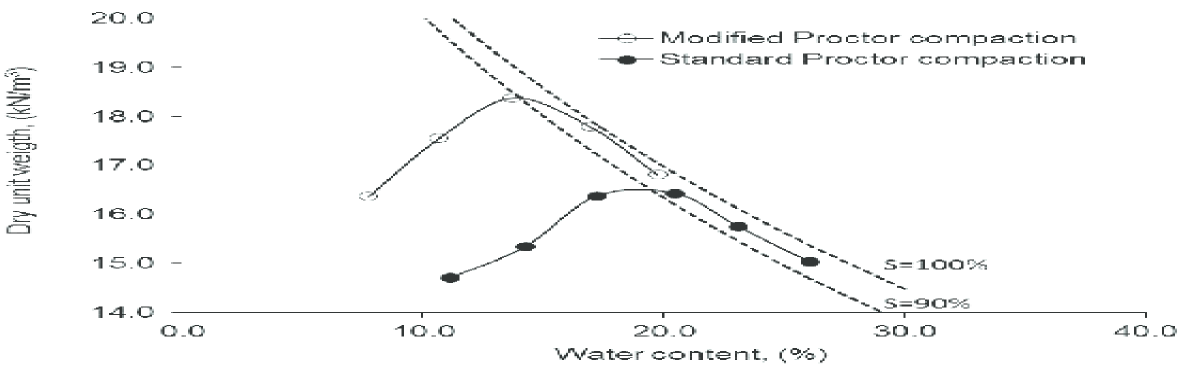

Table 4.5 Penetration under Standard Load

Penetration of plunger (mm)	Standard load (Kg)
2.5	1292
5.0	1987
7.5	2598
10.0	3098
12.5	3589

5.0 ANALYSIS OF RESULTS AND DISCUSSIONS

To achieve the objective of the study, three types of clay were tested using soil stabilization agents. The detailed process is explained within Chapter Four. This chapter presents the test results and their analysis according to the test plan. The results are obtained by comparing the results of different soil stabilizers in CPR value in the following order:

Clay Clay Sub Grade Soil Test Results C

Clay + Cement Test Results C Clay + 6mm Jute Fiber Test Results

Test results in clay in different ratios + 0.4% hemp fiber (6 mm), cement

Sub-grade testing is important for civil engineers, including Aterberg's limitations, filter analysis, projector compression tests, and CPR tests. Continuous standard projector compression tests and CPR tests (both uncooked and wet) are performed on clay soils, which are mixed with several stabilizers (cement and hemp fiber). Cement was mixed at a rate of 1, 2, 3, 5% by weight of dry soil, while hemp fiber (6 mm) was mixed at 0.4%, 0.7%, 1.0%, 2.0% and 4.0%. Weight of dry soil. None of the different stabilizers in clay soil (considering the optimal size of the individual) are evaluated for the best performance combination.

Table 5.1: Index Properties of Clayey Soil

Index Property	Experimental Value
Liquid limit	38.06%
Plastic limit	26.12%
Plasticity index	11.37%

Table 5.2: Index Properties of Clayey Soil

I.S. Sieve No.	Mass of SOIL Retained((gm)	Percentage of Soil Passing
4.75mm	0	100
2.0 mm	0	100
1.0 mm	0	100
425µ	4.13	(250-4.13)x 100/250=98.34
75µ	2.73	(250-(4.13+2.73)x 100/250=97.30

It is observed from table 5.2, that 100% of the soil mass passes through 1mm sieve, moreover, 98.34% and 97.30% of the clayey soil passes through 425 and 75 micron sieve respectively.

Table 5.3: Specific Gravity of Clayey Sub-grade Soil

Wt. of Pycnometer(W_1)	Wt. of Pycnometer bottle + Clay soil(W_2)	Wt. of Pycnometer bottle + half filled soil + distilled water (W_3)	Wt.of Pycnometer bottle+ distilled water(W_4)
706 gm	950 gm	1983 gm	1832 gm

Specific gravity = $(W_2\text{-}W_1)/(W_4\text{-}W_1)\text{-}(W_3\text{-}W_2)$ = (950- 706) / {(1832 – 706) - (1983-950)} = 2.63

5.2 Proctor Compaction Test

The relationship between soil moisture and dry density can be obtained by standard projector compression testing. The value of MDD and OMC for clay sub-grade soils mixed with different percentages of soil stabilizers (cement and hemp fiber) can be calculated from the following diagrams.

a) **Results for Clayey Sub-grade Soil**

Standard Proctor Test results Performed on clayey sub-grade soil are presented in Figure 5.1 below.

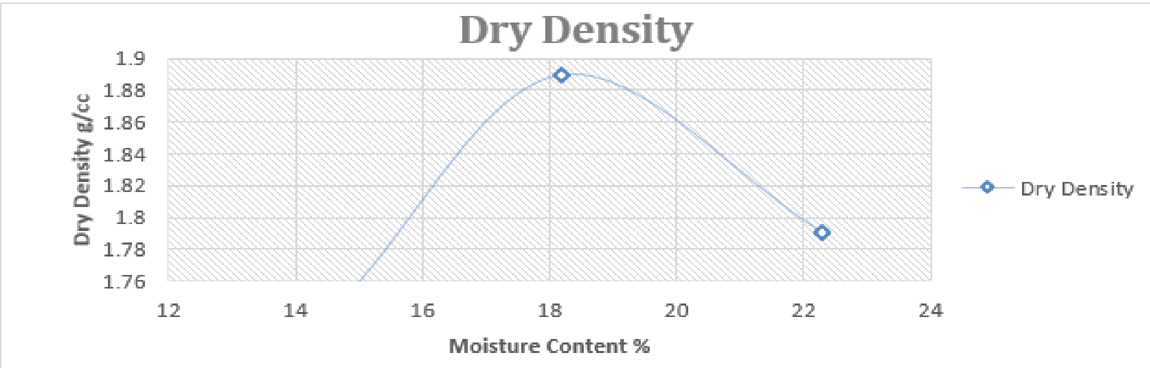

Figure – 5.1 Proctor compaction Test on clayey sub-grade soil

From the test MDD is obtained as 1.89 g/cc and corresponding OMC is 18.2 %.

(a) Results of clayey soil mixed with cement

Standard Proctor tests performed on clayey sub-grade soil mixed with cement are presented in Table 5.4

Table 5.4 MDD and OMC values of clayey soil + cement

Variation in MDD and OMC with Cement Stabilizers	Maximum Dry Density g/cc	Optimum Moisture Content(%)
Pure Clay	1.890	18.2
Clay + 3% Cement	1.873	16.3
Clay +5% Cement	1.866	15.8
Clay +7% Cement	1.859	16.1

The addition of 3%, 5% and 7% cement (depending on the weight of dry soil) to the clay reduces the maximum dry density from 1.890 g / cc to 1.859 g / cc as shown in Table 5.4. 18.2% without absolute trend.

c) Results of Clayey Soil mixed with 6mm Jute Fibre

Standard Procter test results performed on clayey sub-grade soil mixed with 6mm Jute Fibre are presented in Table 5.5

Table 5.5: MDD and OMC values of clayey soil + 6mm Jute Fibre

Variation in MDD and OMC with 6mm fibre	Maximum Dry Density (g/cc)	Optimum moisture Content (%)
Clay only	1.890	18.2
Clay + 0.4 % fibre	1.966	14.3
Clay + 0.7 % fibre	1.971	13.1
Clay + 1.0 % fibre	1.931	13.9
Clay + 2.0 % fibre	1.892	14.1
Clay + 4.0 % fibre	1.830	15.3

f) Results of Clayey Soil mixed with Cement and 0.4% Jute 6mm Fibre

Standard Proctor Test results performed on Clayey Sub-grade soil mixed with Cement, and 0.4% Jute Fibre 6mm are presented in table 5.6

Table 5.6: MDD and OMC values of Clayey Soil + Cement + 6 mm Jute Fibre

Variation in MDD and OMC with 6mm Fibre	Maximum Dry Density (g/cc)	Optimum Moisture Content (%)
Clay Only	1.89	18.2
Clay+1.0% Cement + 0.4% Fibre	1.992	13.7
Clay+3.0% Cement + 0.4% Fibre	1.823	16.9
Clay+5.0% Cement + 0.4% Fibre	1.821	17.8
Clay+7.0% Cement +0.4% Fibre	1.819	18.6

5.3 CBR TEST RESULTS UNDER UN-SOAKED CONDITION

a) Effect of Cement Stabilizer on CBR value of Clayey Soil under Un-Soaked condition

CBR Test results performed on clayey sub-grade soil and clay soil mixed with Cement are presented in Figure 5.2

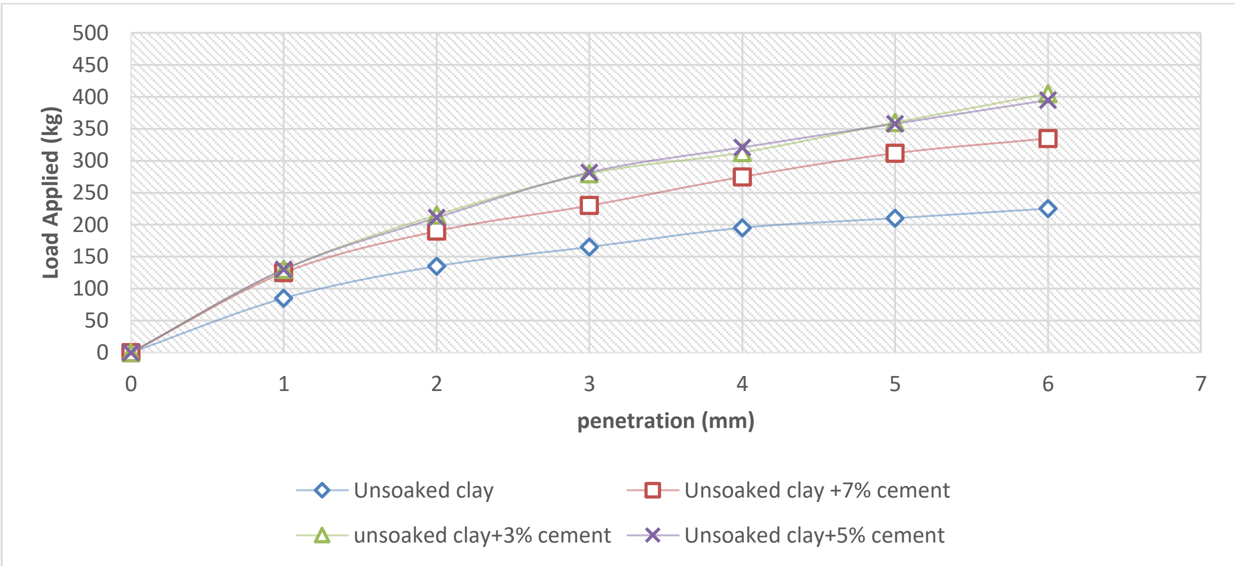

Figure 5.2 CBR value of Clayey Sub-grade Soil mixed with Cement under Un-soaked condition

From above graph, results were summarized in tabular form in table 5.7

Table 5.7 CBR value of Clayey Sub-grade soil mixed with Cement under un-soaked condition

Amount of Compaction on 2.5 and 5.0 mm penetration	Un-soaked Clay only	Clay + 3% Cement	Clay + 5% Cement	Clay + 7% Cement
CBR value at 2.5 mm Penetration	10.94	15.32	18.06	17.99
CBR value at 5.0 mm Penetration	10.21	15.18	17.51	17.42

b) Effect of 6mm Jute Fibre Stabilizer on CBR Value of Clayey Soil under Un-soaked condition

CBR test results performed on Clayey Sub-grade Soil mixed with 6mm Jute Fibre are presented in Figure 5.3

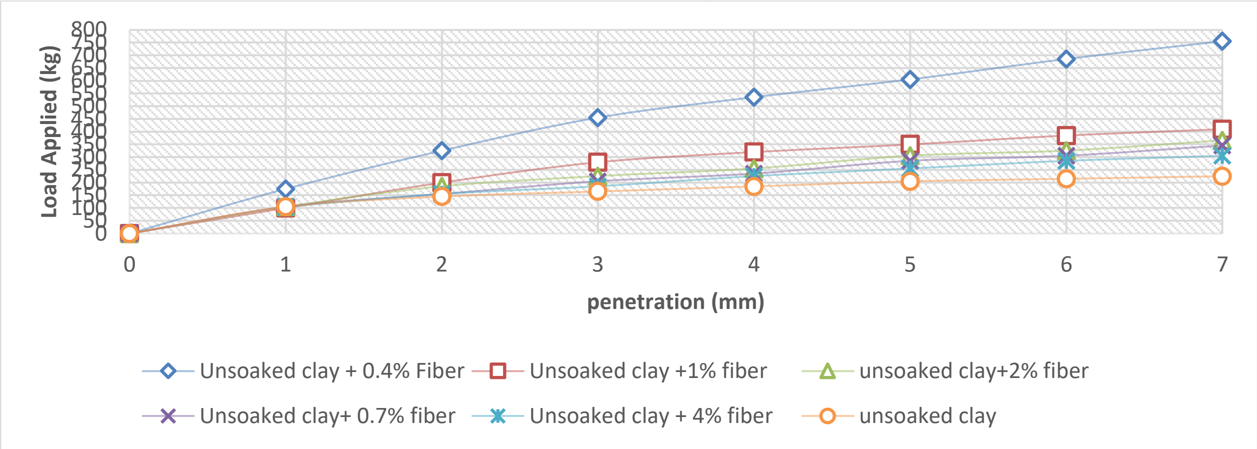

Figure 5.3 CBR value of Clayey Sub-grade Soil mixed with 6mm Jute Fibre under Un-Soaked condition

From the above graph, results were summarized in tabular form in Ta ble 5.8

Table 5.8 CBR value of Clayey Sub-grade Soil mixed with 6mm Jute Fibre under Un-Soaked condition

Amount of compaction on 2.5 and 5.0 mm penetration	Clay Only	Clay + 0.4% F	Clay + 0.7% F	Clay + 1.0% F	Clay + 2.0% F	Clay + 4.0 % F
CBR value at 2.5 mm penetration	11.31	28.46	17.52	14.96	13.13	12.40
CBR value at 5.0 mm penetration	9.98	29.44	17.03	14.84	13.86	12.04

d**) Effect of a Combination of Cement and 0.4% Jute Fibre (6mm) soil stabilizer on CBR value of Clayey Soil under Un-soaked condition;**

CBR test results performed on clayey sub-grade soil mixed with a combination of Cement, and 0.4 % Jute Fibre (6mm) are presented in Figure 5.4

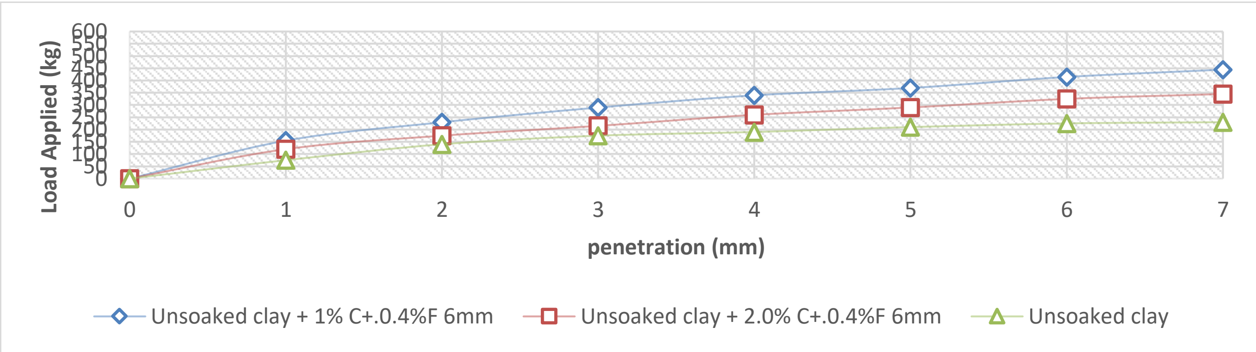

Figure 5.4 CBR value of Clayey Sub-grade Soil mixed with different proportion of Cement and 0.4 % 6mm Jute Fibre

CBR TEST RESULTS UNDER SOAKED CONDITION

a) Effect of Cement Stabilizer on CBR value of clayey soil under soaked condition

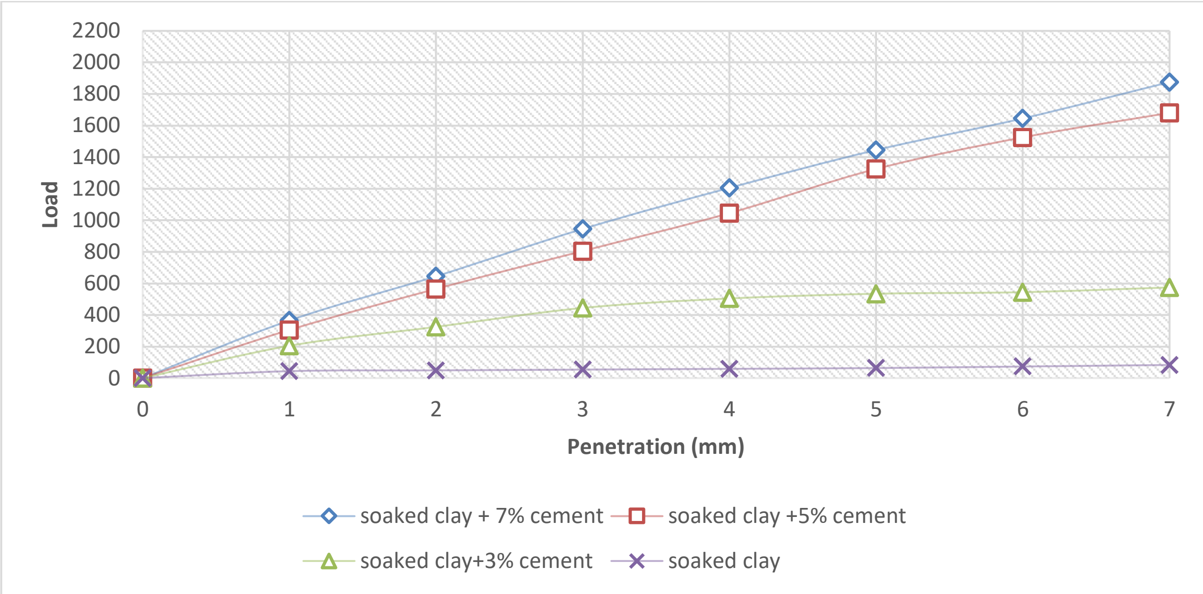

Figure 5.5 CBR value of clayey sub-grade soil mixed with cement under soaked condition

b) Effect of 6mm Jute Fibre Stabilizer on CBR value of Clayey Soil under Soaked condition

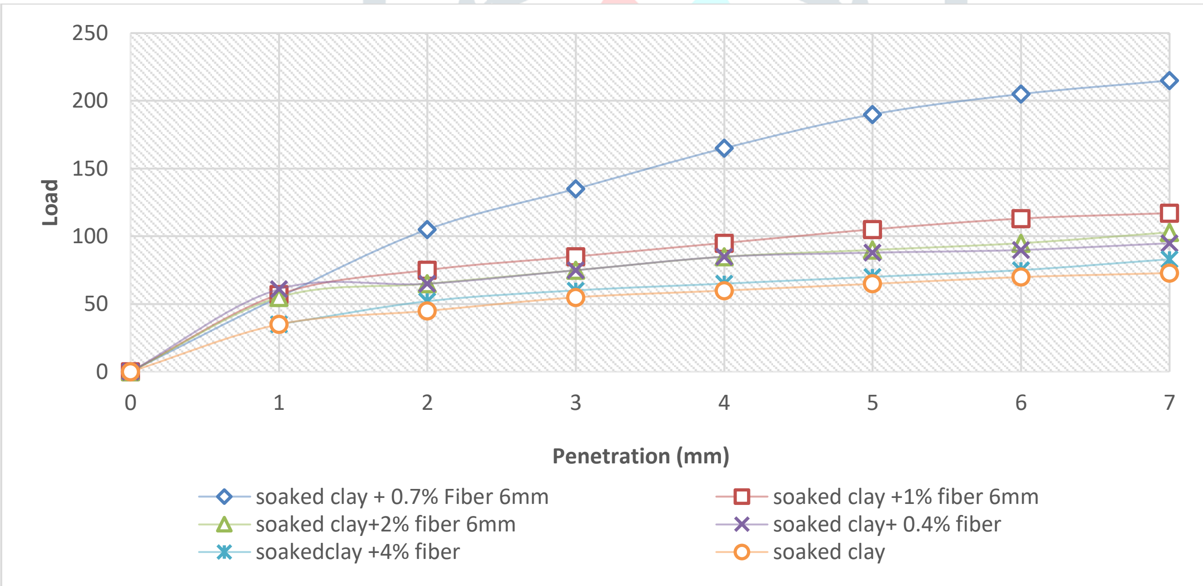

Figure 5.6 CBR value of Clayey Sub-grade Soil mixed with 6mm Jute Fibre under soaked condition

c) Effect of a combination of Cement and Jute Fibre (6mm) stabilizer on CBR value of Clayey Soil under Soaked condition

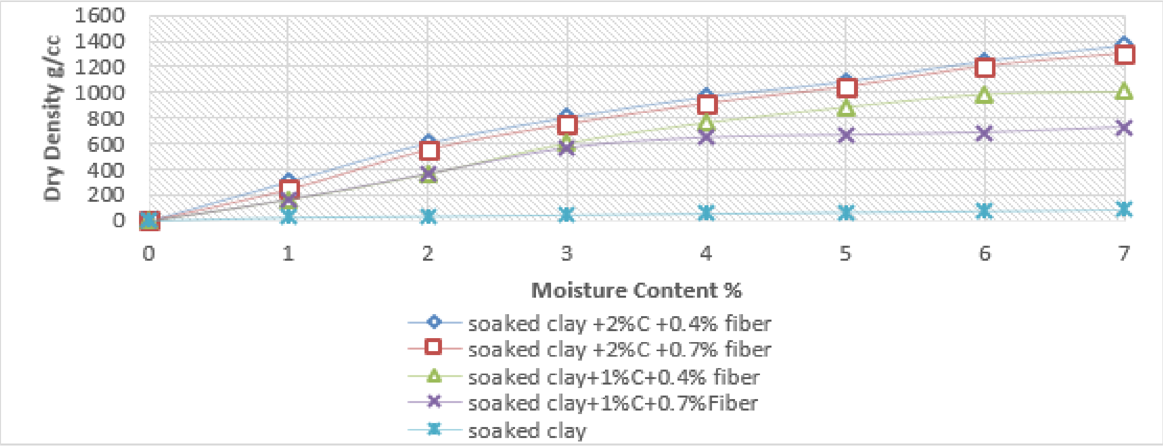

Figure 5.7 CBR value of Clayey Sub-grade Soil mixed with different proportion of Cement, and 6mm Jute Fibre under Soaked condition.

From above graph, results were summarized in tabular form in table 5.12

Table 5.12 CBR value of Clayey Sub-grade Soil mixed with different proportion of Cement, and 6mm Jute Fibre under Soaked condition.

Amount of compaction on 2.5 and 5.0 mm penetration	Clay Only	Clay + 2.0% C+ 0.4 %F	Clay +2.0%C+ 0.7 %F	Clay +1.0%C +0.4%F	Clay + 1.0%C +0.7%F
Soaking Period	17 days	21 days	21 days	21days	21 days
CBR value at 2.5mm penetration	2.91	51.45	47.81	35.40	33.94
CBR value at 5.0mm penetration	3.16	52.79	50.85	43.06	32.36

As shown in Figure 5.7 and Table 5.12, the increase in CPR value results in a constant 0.4% of the cement content with a penetration of 5.0 mm with 6 mm fiber.

6.0 CONCLUSION AND SCOPE OF FURTHER STUDY

This investigation was conducted to assess the behaviour of Jute fiber sheet on the performance of subgrade soil. The Stabilizers utilized in the study are Cement and Jute fibre with 6mm length. The clayey soil sample is collected from Mandi. The behaviour of unreinforced soil, and soil reinforced with Jute fiber and soil reinforced Jute fiber incorporated with cement were investigated in terms of CBR values, supported the results obtained from this investigation, the subsequent conclusions might be drawn:-

- The Liquid Limit, Plastic Limit and Plasticity Index were reported as 38.06%, 26.12%, and 11.37% respectively. From these results it is clear that soil used in the study is medium plastic clay. From Wet Sieve Analysis, it is observed that 100% soil passes through 1.0 mm sieve and 97.30% of the sub-grade soil passes through 75 micron sieve.
- Addition of cement reduces the maximum dry density (MDD). With the addition of cement OMC varies in the range of 16.1 % to 18.2%.
- The MDD of clay up to 0.4% Fibre increases with an addition of Jute Fibre (6mm) and thereafter MDD reduces with further increased percentage of Jute Fibre. With the addition of 6mm Fibre OMC varies in the range of 13.1% to 18.2%.

- While studying co-action of fiber and cement, I observed MDD increases up to 1% Cement + 0.4% Fibre, then decreases. OMC shows the opposite behaviour.
- In CBR test the optimum cement dosage (corresponding to maximum CBR) was noted as 5%. CBR value was observed as 19.8, increase by about 0.88 times as compared to untreated soil.
- In CBR test, the CBR increases up to 0.4% 6mm fiber, suggesting the optimum dosage of 6mm Jute fibre as 0.4% for both soaked as well as un-soaked condition.
- For un-soaked condition, in CBR test, the optimum cement dosage (corresponding to maximum CBR) was noted as 5%, for CBR increases up to 5% cement, and for soaked condition the optimum dosage is 7% respectively.
- For an un-soaked condition, the combination of 1% cement + 0.4% Fibre (6mm) increased the CBR value. CBR value was observed 18 % an increase by about 1.5 times as compared to untreated soil.
- For an soaked condition, the combination of 2% cement + 0.4% Fibre (6mm) increased the CBR value. CBR value was observed 52.79 % an increase by about 25 times as compared to untreated soil.
- The concentration and clay sample were soaked for 17 days. However, 5% and 7% cement did not complete the clay sample after 30 days
- The addition of 6 mm long hemp fibers increases the CPR value by 0.4% and spreads naturally in the higher percentage sample, resulting in a reduction in soaking time and a decrease in the saturated CPR value.
- The use of J hemp fibers economically results in a significant increase in the strength of the KE, which is required per hour.

REFERENCES

1. Arora K.R. (2008),Soil Mechanics and Foundation Engineering Standard Publishers Distribution, New Delhi, Seventh Edition
2. Behzad Kalantari[1], Arun Prasad[2,] and Vujang B.K. Haut[3](2012)"Use of cement, Polypropylene Fibres and Optimum Moisture Content value of Strengthen Peat ". International Journal of Physical Sciences Vol. 7(8), pp 1276-1285
3. Braja M. Das (2009),"Principles of Geotechnical Engineering" Fifth Edition.
4. Dallas N. Little, Eric H, Males, Jan R,Prusinski, Barry Stewan "cementitious Stabilization" A2101: Cmmittee on Cementitious Stabilization , Chairman Roger K Seals, Louisiana State University.
5. Gray, D.H and Ohashi,H. "Mechanics of fibre reinforcing in sand " Journal of Geotechnical Engineering ASCE, Vol. 109(3): pp. 335-353
6. Aziz, M.A. And Ramaswamy, S.D. (1984) [26], - Studies On Jute Fabric Upon Coir Grid Matting For Subgrade Strengthening, Revue Generate Das Routes Et Das Aerodromes, No.614, Paris, Pp. 56-58.
7. Ramaswamy, S. D. And Aziz, M.A. (1989) [25], Jute Geotextiles For Roads, Geotextiles Vol. 1, Tata Me. Graw Hill Publishing Co. Ltd., New Delhi, Pp. 159-166.
8. IS: 1498-1970, " Classification and Identification of Soils for General Engineering purposes"
9. Saxena, A.K. (2005) [22] "Behaviour Of Sand And Nylon Fiber Mixed Black Cotton Soil". An M.Tech Thesis Submitted To M.A.N.I.T. Bhopal
10. Tantway, V.K. (2007) [24] "Soil Improvement By Locally Available Material A Comparison", An M.Tech Thesis Submitted To M.A.N.I.T. Bhopal.
11. IS 2720: Part 3 : 1980 Methods of Tests for soils (Determination of Specific Gravity).
12. IS 2720: Part 4 : 1985 Methods of test for soils (grain size analysis)