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IN SOIL STONE COLUMN CONSTRUCTED BY USING JUTE GEOTEXTILEREINF OR CEMENT FOR GROUND IMPROVEMENT

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ABSTRACT

In this study, an attempt has been done to improve ground by developing Jute geotextile reinforced stone column of small size and tested, Stone column performance has determined with and without jute geotextile reinforcement. On reinforcing the stone column by jute geotextile improved the bearing capacity of Soil and stiffness of soft soil. Load verses settlement of soil has been determined. Result reveal that increasing the length of gute geotextile increased the load carrying capacity of soft soil. It is found that higher is length of the jute geotextile, higher is the load carrying capacity of soil.

Key words: Jute, Stone, column, numbers of geotextile, bearing **capacity** of soil, shear strength, settlement of clay soil.

1. INTRODUCTION

In order to construct a heavy Structure, LPG gas storage mounded bullet, oil drum storage area and aggregate stacking yard it is necessary to have desired load bearing soil. A number of methods are available to improve the load carrying capacity and decreased the settlement of soft soil. Stone column used in the past improved, slope stability reduced seismic subsidence also reduced liquefaction potential etc. Stone column achieve their Load carrying capacity by Bulging it furnished the primary function of reinforcement and drainage Jute geotextile reinforced stone column is used to improve the ground of soft soil properties. This technique has been used in the various road embankments, bridges, machine foundation, mounded bullet gas storage tank at [BPCL Patna] and foundation of Multi story buildings. To improve the bearing capacity of soft clay soil. Jute geotextile has water absorption capacity 500% so it better than other textile materials [3-21]. Jute geotextile reinforcement in lateral direction on single floating stone chips stone column in investigated through laboratory CBR test performed to enhanced bearing capacity, Strength of clay soil.

As jute geotextile reinforcement bridging layer over the column and soft soil foundation enhance the load transfer efficiency from the embankment to the deep foundation elements and reduced the required area replacement ratio of the column. The use of jute geotextile layer resist horizontal thrust at construction site. The jute geotextile reinforced stone column have the important role of transferring the surcharge and embankment loads from the ground surface to stiffer under laying layer. In soft clay soil, it is well established that the use of granular columns can be problematic due the lack of adequate lateral confining pressure.

Jute is abundantly grown in India (1,720,000 tons) & Bangladesh (1681939 tons) Jute fiber are extracted from the fibrous bark of jute plants jute geotextile is mainly economical and environmental friendly geotextile. Which is expected to improving the CBR value of the ordinary stone column. This paper gives the development of small size jute geotextile reinforced stone column Jute fibers in different percentage ranges from (0.2-1.0%) to reinforced soil. Has been added Jute fibre reduces the MDD and increased the OMC. Maximum CBR value observed with 60mm long and 8% weight of stone chips of jute fibre an increase of more than 2.5 times of soil CBR value. Jute geotextile different lengths from (5-60mm) and in different percentage of jute geotextile ranging from (0.31-8%) by weight of stone chips in stone column, enhance the load carrying capacity by improving the CBR value by 3.1times.

2. MATERIALS AND METHODS

A typical test arrangement for jute geotextile reinforced stone column (JGRSC) and ordinary stone column is shown in Fig 5. All the experiments are conducted on floating stone columns in homogeneous clay soil bed in CBR mold. The load settlement behaviour of stone column encased with and without using jute geotextile reinforced stone column has been studying by applying the vertical load over it with the help of proving ring in CBR testing machine as shown in Fig 2

The vertical load is applied through a CBR testing machine at constant displacement rate of 1.25mm/min and the vertical load is chosen so as to avoid any possibility of squeezing out of soil particle from the clay bed and to avoid the generation of extra pore pressure in the clay bed. And compact transfer the uniformly distributed load over stone column. The plate was directly rested over the stone column and uniform loading was applied over the surcharge.

Stone column is one of the of ground improvement method having a track history of experience. It is best for improving the clay soil, silts and also for loose silty sands. The concept was first applied in france in 1830 to enhance a native soil. Among all these methods, the stone column techniques is mostly adopted because they furnishes the primary function of reinforcement and drainage, stone column achieve their load carrying capacity by construction of jute geotextile stone column in surrounding clay soil.

Jute geotextile is the economical and environmental-friendly in nature that is used for producing porous textiles which are widely used for filtration drainage. Different diameter stone column at the centre of the clay.110mm length and 25mm and 30mm diameter stone column with varying 1%,3%,4%,5%,6% & 8% jute geotextile & 10mm,20mm, 30mm, 40mm and 60mm length its % by mass of stone chips use in jute geotextile reinforced stone column, to increase the CBR value with jute geotextile stone column (JGRSC) with increasing % of jute geotextile. The strength CBR value increase 3.1time after using jute geotextile in stone column. The soil improvement methods use to improve the soil properties by increasing the shear strength and reduce the settlement, and Also Increase the 25-30% of bearing capacity of soil after using 8% of Jute geotextile In reinforced stone column. Six nos of CBR test are perform CBR test of clay soil sample collected from, Work for C/O Multi Modal IWT Terminal at Haldia (W.B).

Aggregate of size passing from 4.75mm and retained from 0.600mm IS sieve use to prepare stone chips.

Figure 1. Gute geotextile

A typical test arrangement for jute geotextile reinforced stone column (JGRSC) & ordinary stone column shown in figure 6 and 9. All the experiments are conducted on single stone columns in centre of clay soil in CBR mold.

The load settlement behaviour of stone column encased with and without using jute geotextile reinforced stone column has been study by applying the vertical load over it with the help of proving ring in CBR testing machine as shown in figure 2.

Figure 2 CBR testing machine

The vertical load is applied through a CBR testing machine at constant displacement rate of 1.25mm/min and the vertical load is chosen so as to avoid any possibility of squeezing out of soil particle from the clay bed and to avoid the generation of extra pore pressure in the clay bed. The stainless steel pipe of 25mm and 30mm diameter and 110mm length of stone column was use to transfer the uniformly distributed load over stone column. The plate was directly rested over the stone column and uniform loading was applied over the surcharge.

2.1 Maximum Dry Density (MDD), Optimum Moisture Content (OMC) and California Bearing Ratio (CBR) Test.

Following steps are follow in the construction of nonwoven jute geotextile reinforced stone column.

This test was perform by dynamic compaction method.

Material should be use 19mm IS sieve passing and replace the material on 19mm sieve by equal amount of material passing 19mm sieve and retained on 4.75mm sieve.

Take the sample of soil weighting approximately 7kg and mix thoroughly at OMC. Record empty weighty weight of mold with base plate with extension collar removed (w1) and replace extension collar of the mold. Insert a spacer dish over the base plate & place a course filter paper on the top of spacer dish. Mould place on base plate and compact the weight soil in five layer and compact each layer 56 blow with 4.90kg hammer at a 450mm height. Soil leaving not more than 6mm to be struck off.

Remove the extension collar & carefully level the compacted soil top of mould by means of a straight edge. Remove the spacer disc by inverting the mould and weigh the mould with compacted soil (w2). Filter paper place b/w base plate and inverted mould.

Replace the extension collar and prepare two more specimen in the same procedure.In both cases of compaction, sample is to be soaked, take representative samples of the material at the beginning of compaction and another sample of remaining material after compaction for determination of moisture content. Each sample shall weight not less than 90gm.

Place the adjustable stem and perforated plate on the compacted soil specimen in the mould. Immerse the whole mould and weights in a tank of water allowing free access of water to the top and bottom of specimen for 96 hours

1. **Test for swelling.**

Determine the initial height of specimen (h).

Expansion measuring device along with the tripod on the edge of the moulid & record initial dial gauge reading (ds).

Keep to mainten 96 hours in undisturbed every day reading must be note down and maintane constant water level.

At the end of the soaking note final dial gage reading (df).

Expansion ratio = df-ds/h x 100

Penetration test. After 96 hours of soaking take out the specimen from water & remove the extension collar, perforated disc, surcharge weights and filter paper. Drain off the excess water by placing the mould inclined for about 15 minutes and weight the mould. Surcharge weight place 2.5kg annular weights on the soil surface prior to seating the penetration plunger after which place the reminder of the surcharge weights. Plunger set under a load of 4kg so that full contact is established b/w the surface of the specimen and the plunger. Stress and strain gauge set to zero. Consider the initial load applied to the plunger as zero. Load apply 1.25mm/min and take the reading 0-12.5mm Collect the soil sample approximately 25 to 60gm from top 30mm layer of specimen and determine the water content as per IS: 2720 (part 4) 1973.

Calculation

Select CBR values for penetration of 2.5mm and 5mm.

Calculate CBR value from the equation

California Bearing Ratio = pt x cf/ps x100.

Where pt = corrected unit test load corresponding to the chosen penetration from load penetration curve.

Ps = standard load for the same depth of penetration, Cf = Proving ring correction factor.

Take the average three test CBR value. If the CBR value of corresponding to penetration of 5.0mm exceed that of 2.5mm, then repeat the test. If the identical result follow, take 5.0mm as the CBR value.

A stainless steel pipe of 25mm and 30mm diameter and 110mm length of stone column and 105gm stone chips and 8.4gm of nonwoven jute geotextile fill 25mm stone with jute in each layer in the stone column in 4 layer compaction applying to 4.9kg of hammer and 450mm height and each layer 55 time compacted to achieve sufficient compaction in stone column.

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Table 1. Show MDD and OMC.

Maximum dry density			**1.87**
Mass of sample	**6.0 kg**	**Optimum moisture content**	**14.10**
Condition of test			**Soaked**
Type of compaction	**Dynamic**	**Surcharge load in soaked condition (kg).**	**5 kg**

Condition of sample	Before soaking	Before Soaking	Before soaking	Remark
Mass of mold +wet soil	11288	11198	13306	-
Mass of mold in gm	6605	6605	6605	-
Mass of wet soil in gm	4683	4593	4701	-
Volume of mold in cc	2250	2250	2250	-
Wet density of soil in gm/cc	2.081	2.041	2.084	-
Dry density in gm/cc	1.821	1.789	1.826	1.873
Compaction in %	97.17	95.46	97.51	-
Container no	A3	A7	A6	-
Mass of wet soil+can in gm	110.59	125.17	118.20	-
Mass of dry soil + can in gm	98.93	111.9	105.9	-
Mass of water in gm	11.66	13.27	12.30	-
Mass of can in gm	17.18	17.71	16.60	-
Mass of dry soil in gm	81.75	94.19	89.30	-
Water cant in %	14.26	14.09	13.77	14.10
Initial dial gauge Reading	0	0		
Final dial gauge Reading	0	0		
Swell Percentage	0	0		

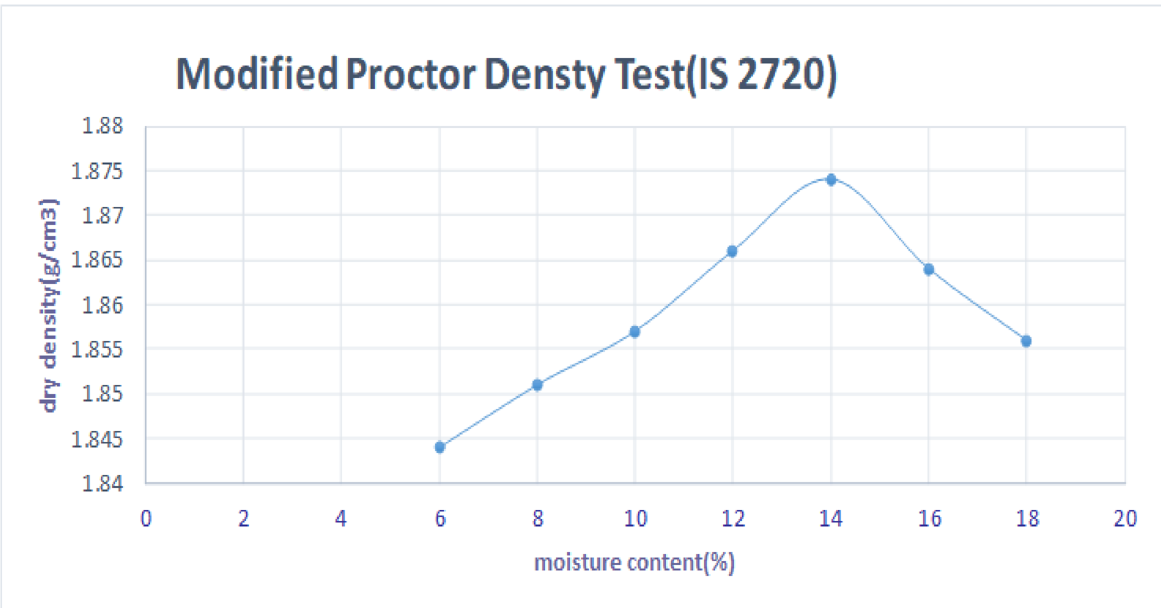

Figure 3 Shows Mximum dry density and Optimum moisture contant.

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Figure 4 Process of preparation of stone column by clay soil, jute geotextile and stone chips

2.2 Stone column construction procedure in CBR mould.

Stone column construction at centre of clay soil in design CBR mould, stainless steel of 25mm and 30mm internal diameter and 110mm length of casing or pile, when casing pipe is push or pulled out, then maintain no any lateral bulging in soil. The procedure was repeated until the column was completed in four layer of jute geotextile and stone chips feeding each layer 27.5mm column was compacted by 12mm diameter and 25mm length of tamping rod to achieve sufficient compaction up to the full length of jute geotextile reinforced stone column 25mm diameter stone column consumed 100gm stone chips and 8.0gm of jute geotextile use to complete (JGRSC) and 30mm diameter stone column consumed 110gm stone chips and 8.8gm of jute geotextile use to complete (JGRSC)

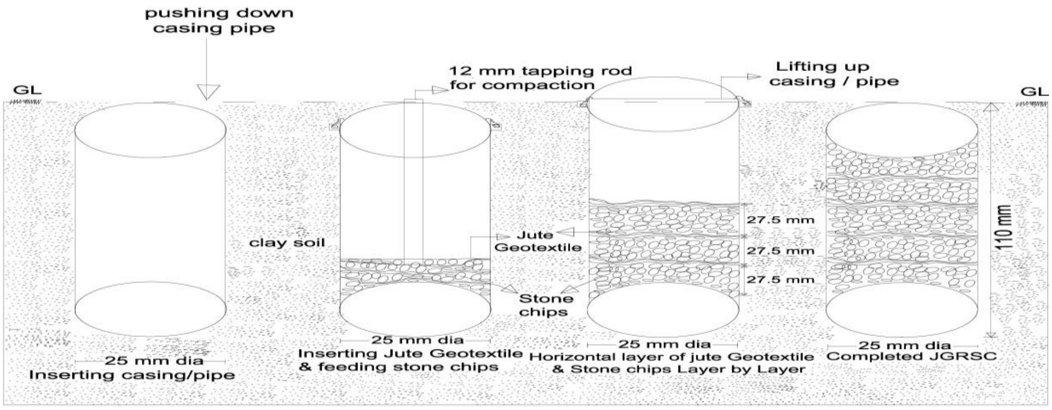

Figure5. Shows 25mm diameter and 110mm length in four layer jute and stone chips pour to construct Jute geotextile Reinforced Stone column**.**

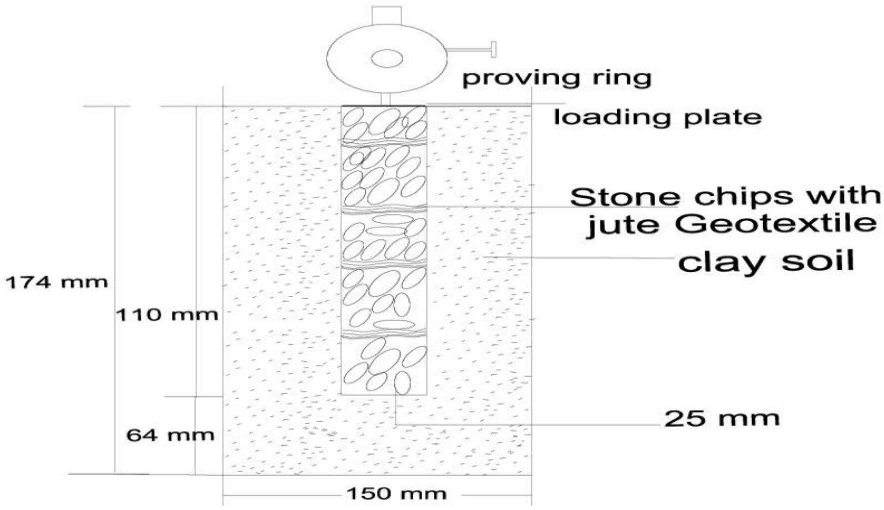

Figure 6 Shows 25mm diameter and 110mm length of Jute geotextile Reinforced Stone column

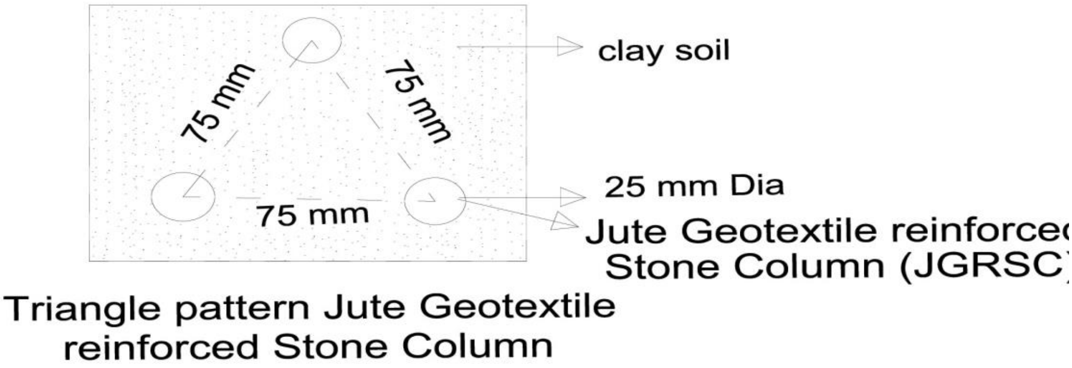

Figure 7 Shows 25mm diameter triangular pattern of Jute geotextile Reinforced StonecolumnDiagram.

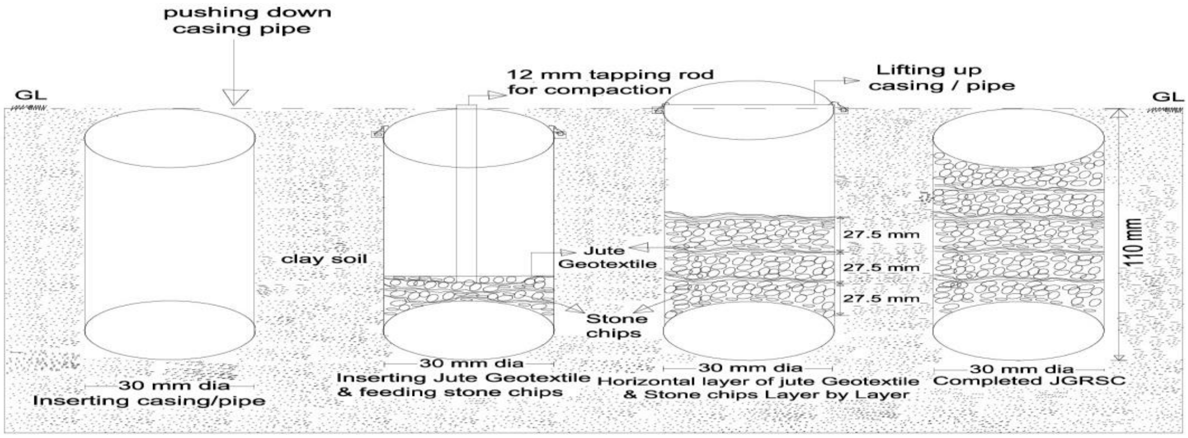

Figure 8 Shows 30mm diameter and 110mm length in four layer jute and stone chips pour to construct Jute geotextile Reinforced Stone column**.**

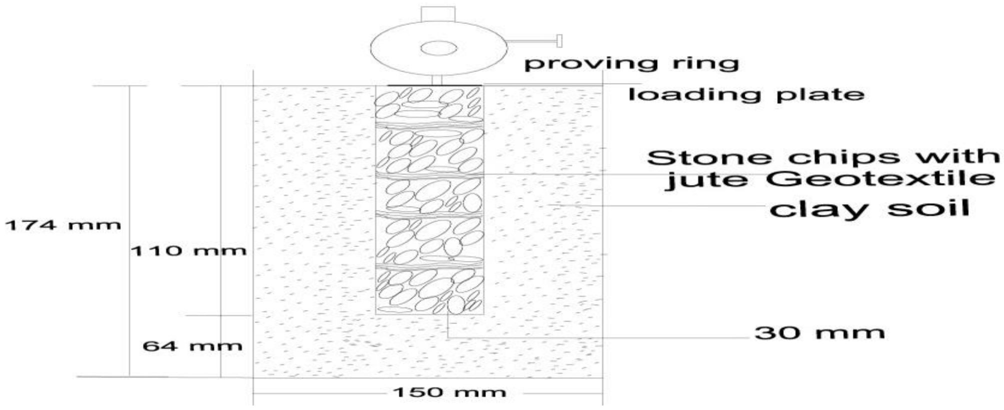

Figure 9 Shows 30mm diameter and 110mm length of Jute geotextile Reinforced Stone column

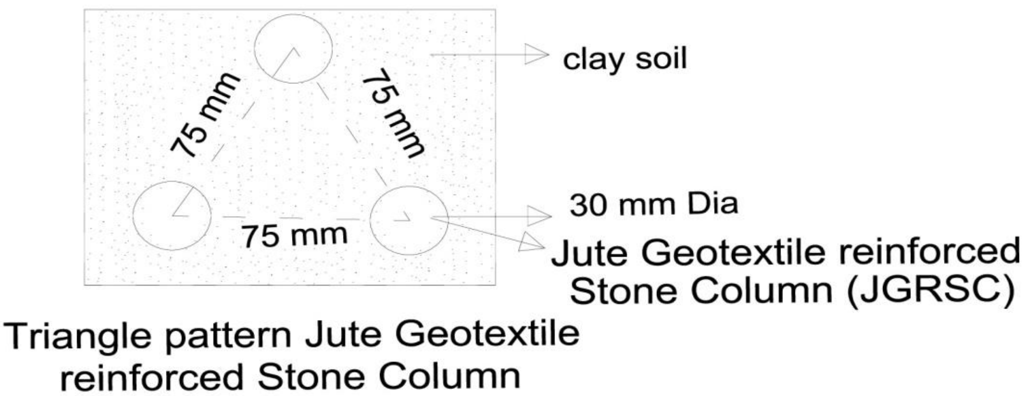

Figure 10 Shows 30mm diameter triangular pattern of Jute geotextile Reinforced StonecolumnDiagram

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Table .1. 2 CBR Test of clay soil at natural ground level**.**

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742						
TEST 1 (mould no. 1)		TEST 1 (mould no. 2)		TEST 1 (mould no. 3)		Remark
Penetration (mm)	Load (kgf)	Penetration (mm)	Load (kgf)	Penetration (mm)	Load (kgf)	-
0	0	0	0	0	0	-
0.5	22.45	0.5	18.71	0.5	22.45	-
1	37.42	1	33.67	1	29.93	-
1.5	56.13	1.5	52.38	1.5	48.64	-
2	63.61	2	63.61	2	61.35	-
2.5	71.09	2.5	67.35	2.5	67.35	-
4	100.77	4	97.84	4	89.8	-
5	108.51	5	104.77	5	101.03	Selected value
6	112.26	6	108.51	6	104.77	-
7.5	116	7.5	112.26	7.5	108.51	Peak value

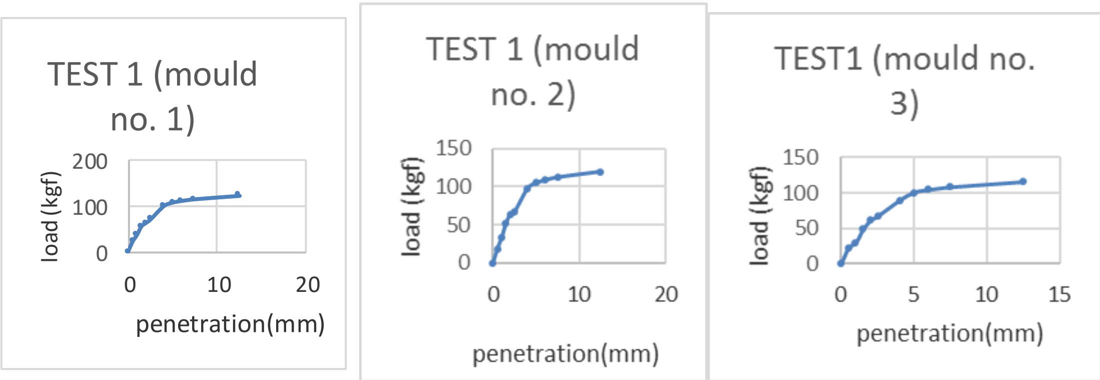

Figure 11 CBR variation graph

Table 3 CBR Test of clay soil at 400mm below natural ground level.

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742					
TEST 2 (mould no. 1)		TEST 2(mould no. 2)		TEST 2 (mould no. 3)	
penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	penetration(mm)	load (kgf)
0	0	0	0	0	0
0.5	26.19	0.5	18.71	0.5	26.19
1	41.16	1	29.93	1	37.42
1.5	56.13	1.5	56.13	1.5	52.38
2	69.22	2	67.35	2	63.61
2.5	82.32	2.5	74.84	2.5	78.58
4	120.48	4	111.3	4	115.8
5	127.22	5	123.48	5	130.97
6	130.97	6	130.97	6	135.98

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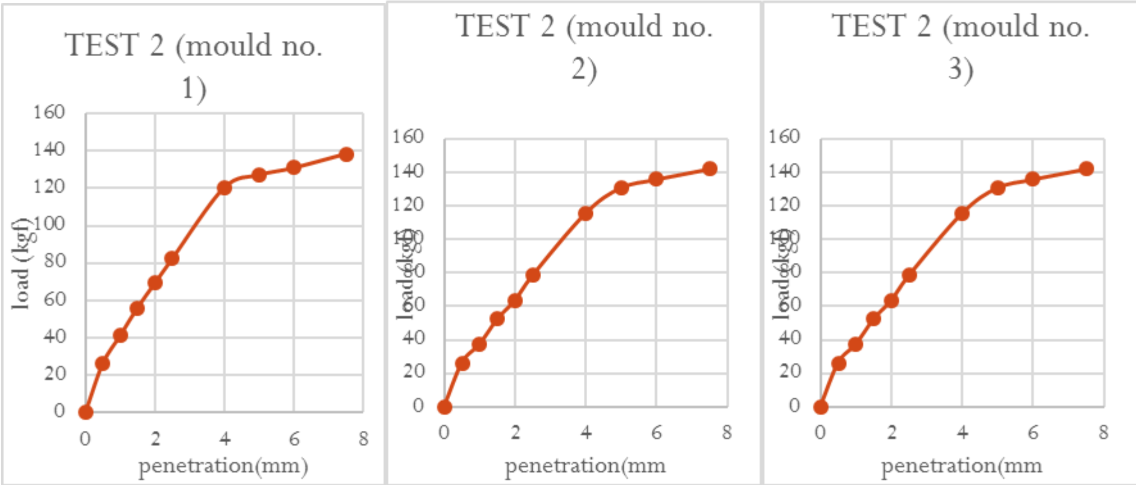

Figure 12 CBR variation graph

Table 4 CBR test of 25mm diameter and 110mm length stone column

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742						
TEST 3 (mould no. 1)		TEST 3(mould no. 2)		TEST 3(mould no. 3)		Remark
penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	-
0	0	0	0	0	0	-
0.5	41.16	0.5	37.42	0.5	33.67	-
1	78.58	1	63.61	1	71.09	-
1.5	119.8	1.5	101.03	1.5	112.26	-
2	130.97	2	130.97	2	123.48	-
2.5	145.93	2.5	138.45	2.5	142.2	-
4	202.06	4	198.9	4	183.39	-
5	220.8	5	217.03	5	213.3	Selected value
6	228.3	6	220.78	6	224.52	-
7.5	239.49	7.5	232	7.5	235.74	-
12.5	250.72	12.5	254.45	12.5	246.98	Peak value

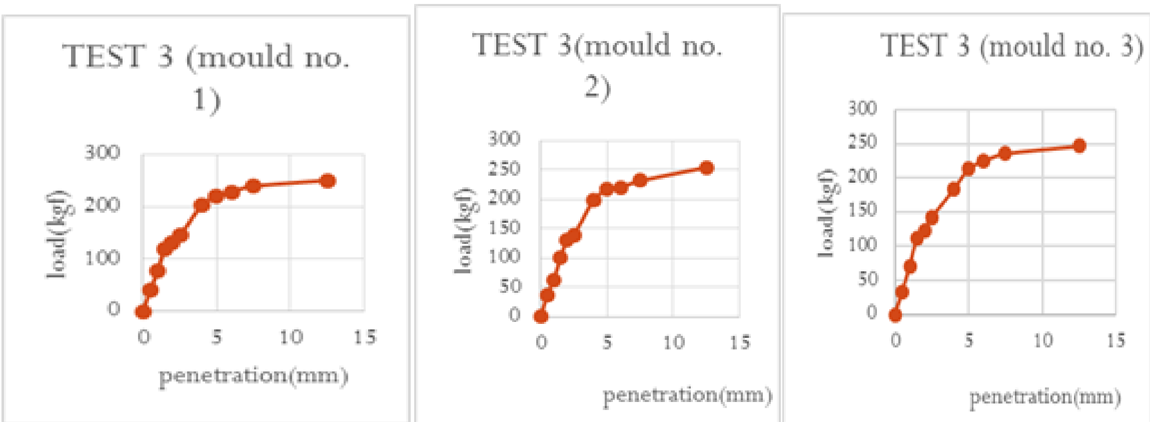

Figure 13 CBR variation graph

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Table 5 CBR test of 30mm diameter and 110mm length stone column

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742						
TEST 4(mould1)		TEST 4(mould 2)		TEST 4 (mould 3)		Remark
penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	-
0	0	0	0	0	0	-
0.5	56.13	0.5	52.38	0.5	59.87	-
1	97.3	1	86.06	1	82.32	-
1.5	145.93	1.5	130.97	1.5	130.97	-
2	164.64	2	160.9	2	157.16	-
2.5	183.35	2.5	175.87	2.5	179.61	-
4	264.42	4	224.3	4	225.6	-
5	280.65	5	259.42	5	261.9	Selected value
6	291.87	6	273.16	6	284.4	-
7.5	299.36	7.5	291.87	7.5	291.87	-
12.5	321.81	12.5	314.32	12.5	306.84	Peak value

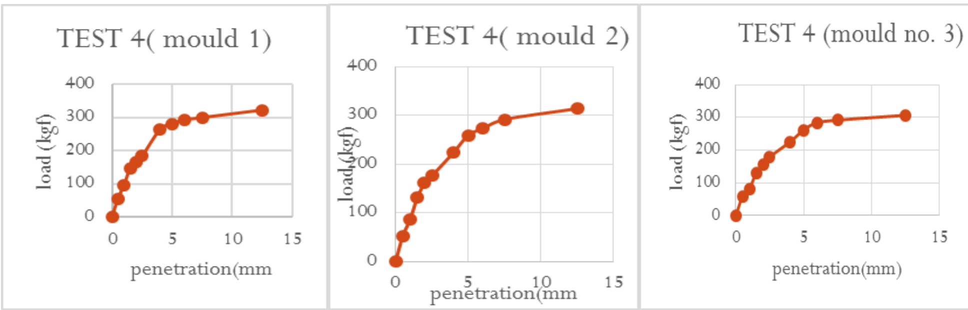

Figure 14 CBR variation graph

Table 6 CBR Test of 25mm Diameter & 110mm length of Stone Chips Jute geotextile Reinforced stone column.

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742						
TEST 5 (mould no. 1)		TEST 5(mould no. 2)		TEST 5(mould no. 3)		Remark
penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	-
0	0	0	0	0	0	-
0.5	56.13	0.5	52.38	0.5	52.38	-
1	89.8	1	89.8	1	86.06	-
1.5	130.97	1.5	127.22	1.5	123.48	-
2	153.42	2	149.68	2	145.93	-
2.5	175.87	2.5	168.39	2.5	164.64	-
4	256.7	4	250.71	4	246.97	-
5	265.68	5	258.1	5	254.45	Selected value
6	280.65	6	276.9	6	273.16	-
7.5	288.13	7.5	280.65	7.5	276.9	-
12.5	290.10	12.5	286.15	12.5	282.13	Peak value

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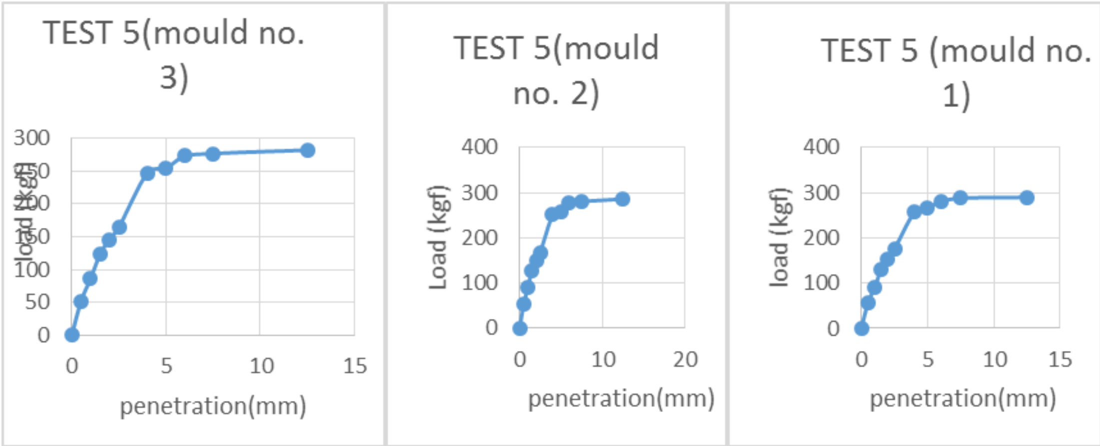

Figure 15 CBR variation graph

Table 7 CBR test of 30mm diameter and 110mm length of stone chips jute geotextile reinforced stone column.

Proving ring capacity in kg = 3059.15 & Proving ring least count 1 division= 3.742						
TEST 6 (mould no. 1)		TEST 6 (mould no. 2)		TEST 6 (mould no. 3)		Remark
penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	penetration(mm)	load (kgf)	-
0	0	0	0	0	0	-
0.5	56.13	0.5	63.61	0.5	59.87	-
1	97.3	1	108.51	1	108.51	-
1.5	157.16	1.5	164.64	1.5	168.4	-
2	187.1	2	194.58	2	190.84	-
2.5	205.81	2.5	209.6	2.5	213.3	-
4	264.77	4	265.8	4	265.03	-
5	310.6	5	311.07	5	310.07	Selected value
6	325.55	6	329.3	6	321.81	-
7.5	332.3	7.5	336.78	7.5	330.03	-
12.5	363	12.5	366.71	12.5	370.45	Peak value

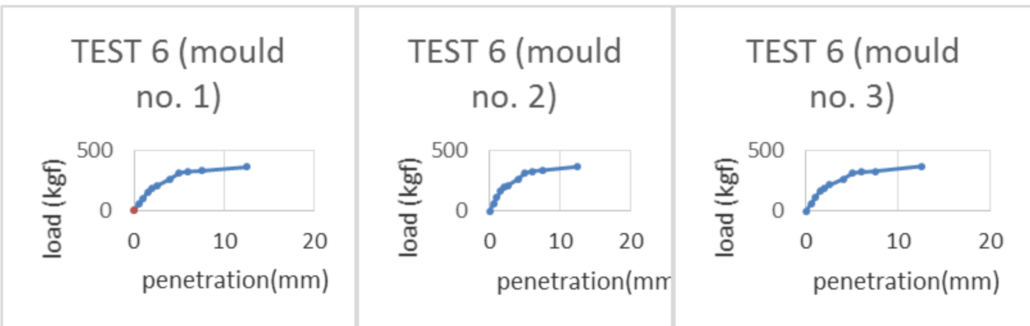

Figure 16 CBR variation graph

The area influencing the stress due to installation of stone column is considered as a unit-cell area. There is a no stress beyond the boundary of CBR mold. This concept is used to predict the load settlement behaviour of jute geotextile Reinforced stone column.

According to IS 15284 (part 1): 2003, the influence of load is within the equivalent diameter. The triangular pattern was considered to design the stone column. A cylindrical CBR mold of 25mm and 30mm diameter and 110mm length was used for load tests on single stone column. The L/d ratio in the model tests was adopted 3 to 8 for single stone column. The stone column diameters used in the present model tests is 25mm and 30mm.

2.2 Application of jute geotextile reinforced stone column

The geotextile encasement impact lateral confinement is used for footings isolated/ raft,

in storage foundations, increases the friction angle & shear modulus and improve the slope stability of embankments, increases the resistance to liquefaction, reduces the settlements in soils and increases the soil bearing capacity and CBR value of soil.

3. RESULT AND DISCUSSION

To know the effect of different type of geotextile material on the clay soil, the load vs penetration test results are compared with untreated soil. The results are as follows

Jute geotextile stone column technics reduces the settlement by function of horizontal and vertical permeability due to pore water pressure, the flow of water in upward direction to reduce water table in specified area thus by providing incasing layers of jute geotextile reinforced stone column to increase the bearing capacity of clay soil.

Jute Geotextile use 1% , 2% ,5% and 8% with varying length of jute 10mm, 20mm 30mm, 40mm and 60mm increases the jute % quantity, Length and Also increased the layer of Jute geotextile to increasing the bearing capacity (CBR) value of soil. 1/3, 2/3, 4/3 and 5/3 layer of jute geotextile use in stone column. geotextile encasement impact lateral confinement and avoids lateral squeezing of the stone in extremely soft soils.

Unit weight of stone columns was estimated with the quantity of stone chips and jute geotextile consumed for the construction of the stone column. The corresponding unit weight of jute geotextile reinforced stone column was found to be 18 kN/m^3. Stone column is triangular in pattern. To allow for axial symmetry conditions, into a circle (cylinder) of the same (cross-sectional) area. Therefore, the diameter of the unit cell is equal to d_e =1.05x75=78.75 for triangular pattern where s is the centre-to-centre spacing between column.

i. CBR value of clay soil at natural ground level without jute geotextile reinforced stone column, at penetration 0 mm to maximum 7.5mm found to be maximum failure load at 116 kg & CBR value be 5.1 %.

ii. CBR value of clay soil 400mm below natural ground level without jute geotextile reinforced stone column, at penetration 0 mm to maximum 6mm found to be maximum failure load at 135.98 kg & CBR value be 6.2 %.

iii. CBR test of 25mm Diameter & 110mm length of Stone Chips stone column in 4 layer of compaction using 12mm diameter tamping rod Achieve required compaction of clay soil with stone column, at penetration 0 mm to maximum 12.5mm found to be maximum failure load at 254.45kg & CBR value be 10.54%.

iv. CBR Test of 30mm Diameter & 110mm length of Stone Chips stone column in 4 layer of compaction using 12mm diameter tamping rod Achieve required compaction in clay soil with stone column, at penetration 0 mm to maximum 12.5mm found to be maximum failure load 280.65kg & CBR value found to be 12.97%.

v. CBR Test of 25mm Diameter & 110mm length of Stone Chips Jute geotextile Reinforced stone column laying of jute geotextile 4 layer of compaction, 12mm diameter tamping rod at jute of 20mm-50mm length up to 5% of jute geotextile use penetration at 0 mm to maximum 12.5mm found to be maximum failure load 290.1kg CBR value found to be 12.60%

vi. CBR Test of 30mm Diameter & 110mm length of Stone Chips Jute geotextile Reinforced stone column laying jute geotextile 4 layer of compaction, 12mm diameter tamping rod at 10mm-60mm length and 2%-8% of jute geotextile use penetration at 0 mm to maximum 12.5mm found to be maximum failure load 370.45kg CBR value found to be 15.10%.

4. CONCLUSION

In this investigation we have used jute geotextile pieces on different lengths to reinforced stone column and to effects on various jute geotextile on CBR of clay soil in a stone column. Stone column install in soft clay soil take less load carrying capacity as compared to jute geotextile layers reinforced stone column and sufficient bearing capacity. The jute geotextile stone column increases the bearing capacity due to increased the friction angle of granular materials and jute geotextile. Ultimate bearing capacity of jute geotextile stone column increased the stiffness.

By using Jute geotextile reinforcement in stone column to improved shear strength, reduce settlement, is achieved.

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