Application of Geo Synthetics For Soil Erosion Control

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Abstract - From the past history of soil failures, the conventional methods of strengthening of soils by replacing them with suitable soils or adopting deep foundations were limited, because of land scarcity, rate of demand of construction, realization of seismic hazards and tightened rules for environmental impacts. These forced for the evolution of number of ground improvement technique, one of the economical and eco friendly technique came into existence named geo synthetics.geo synthetics have proven to be among the most versatile and cost effective ground modification materials. Their use has expanded rapidly into nearly all areas of civil, geo technical, environmental, coastal, and hydraulic engineering.
Key words:Geo synthesis,coir fiber,jute fiber,mechanical stabilization of slope.

I.INTRODUCTION

Erosion of soil is the most important drawback and serious identified problem which needs an effective and economic solution.geo synthetics a new born technique started playing a vital role in stabilizing slopes and some of the techniques are biotechnical methods, making use of natural vegetation are becoming more popular mainly for environmental and economy reasons. Natural vegetation on slopes is able to self maintain, brake and dilute the kinetic energy of the rain and also provide surface roughness which slows the runoff velocity.

It is unable to resist severe scouring or high runoff and takes time to establish. Slopes can suffer from severe soil erosion and instability, which in turn makes vegetation establishment extremely difficult. Erosion of seeds and seedlings from unprotected sites by surface runoff and winds is costly since all previous attempts to establish vegetation on the slope have to be repeated (Rickson, 1995). Hence a protective covering on soil is required which resists soil erosion, retains runoff and facilitates establishment of vegetation on the surface.

In Geo synthetics woven and Non woven textiles applied in various fields for soil stabilization, turf reinforcement, erosion control, separation, filtration and drainage. depending on the application, they are available under various trade names such as rolled erosion control systems (RECSs), Geo synthetic matting, Geotextiles, erosion control blankets (ECBs),erosion control re-vegetation mats(ECRMs) and turf reinforcement mats. Despite the technological advances natural fibre application is less compare to the synthetic.

II.THEORY

The study of geo synthetics not limited to stabilize slopes it started playing vital role in all strength and stability gaining parameters.

The research include with following materials

1.0 SOIL

Soil used in this thesis is collected from ramayampet of medak district in telangana where embankment slopes of the lake are stabilized by application of geo synthetics. The Properties of soil is tabulated below.

1	Specific gravity (G)		2.59
2	Liquid limit (%)		26
3	Plastic limit (%)		NP
4	Particle size distribution curve	Gravel size (>4.75mm)	0
		Sand size(0.075-4.75mm)	44%
		Silt size(0.002-0.075mm)	52%
		Clay size(<0.002mm)	4%
5	Coefficient of uniformity(C_u)		7.8
6	Coefficient of curvature(C_c)		1.48
7	Maximum Dry Density , γ_d (kN/m3)		17.30
8	Optimum moisture content OMC (%)		16.2

2.0 JUTE FIBER

Jute fibre manufactured from bast or skin of the plants stem. It's a naturally procured fibre with golden colour and glossy appearance hence it has named as The Golden Fibre. After cotton it is the second most important vegetable fibre, acquiring high tensile strength, low extensibility, and ensures better breathability of fabrics.
Jute has the ability to be blended with other fibres, both synthetic and natural, and accepts cellulosic dye classes such as natural, basic, vat, sulphur, reactive, pigment dyes. The properties of jute tabulated below.

PHYSICAL PROPERTIES	CHEMICAL PROPERTIES
Fiber Length:1.0 - 4.0 meters	Cellulose:65%
Diameter:17-20 microns	Hemi cellulose:22.5%
Color: half white to brown	Lignin:11.0%
Strength:3.5-5.0gm/denier	Fat & Wax:0.3%
Specific Gravity:1.48	Water Soluble materials:1.2%
Moisture Regain:13.75%	

Fig1: physical appearence of jute

ADVANTAGES OF JUTE FIBER

- It has great antistatic properties.
- It works as insulating fiber
- Jute fiber can be blended with natural and synthetic fibers.

Disadvantages of jute fiber

- High moisture absorption leading to dimensional changes.
- Preparation of fiber is labour intensive and time consuming

Application of jute fibers

- Pavements
- Embankments

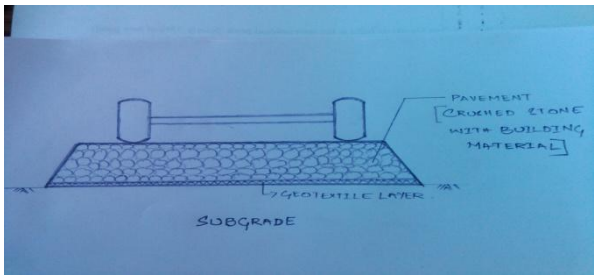


Fig2:application of jute in pavements

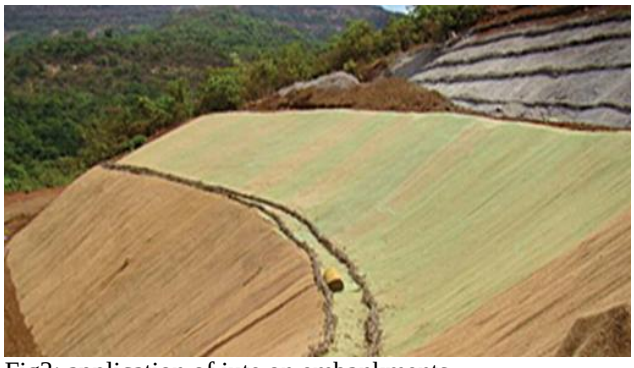


Fig3: application of jute on embankments

III.EXPERIMENTAL INVESTIGATIONS

3.1 **Brief steps involved in the experiments**

3.1Procedure for the determination of minimum & maximum dry density of soil and soil with fiber 10% and 20%

Sand containing particles smaller than 9.50 mm should be placed as loosely as possible in the mould by pouring the sand through the spout in a steady stream. The spout should be adjusted so that the height of free fall of the sand is always 25 mm. While pouring the sand the pouring device should be moved in a spiral motion from the outside towards the centre to form a sand layer of uniform thickness without segregation.

The mould should be filled approximately 25 mm above the top and levelled with top by. Making one continuous pass with the steel straight edge. If all excess matter is not removed, an additional continuous pass should be made. Great care shall be exercised to avoid jarring the mould during the entire pouring and trimming operation. The mould and the sand should be weighed and the mass recorded.

SL.NO	SAMPLES	OMC %	MDD (G/CC)
1	SOIL	11.75	1.9
2	SOIL+10%JUTE	7.2	2.03
3	SOIL+20%JUTE	10	2.50

3.2Procedure for the determination of shear stress by direct shear test method.

DIRECT SHEAR TESTIn many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are

required for the design. Direct shear test is used to predict these parameters quickly. The laboratory report covers the laboratory procedures for determining these values for cohesion less soils.

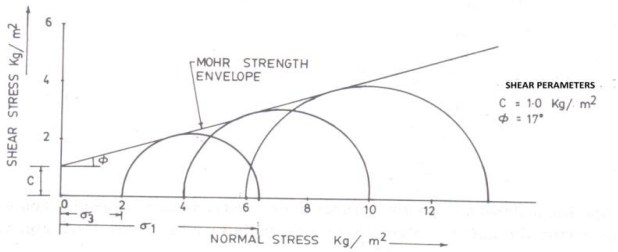
PROCEDURE

Strain controlled direct shear machine consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation and volume changes. A two piece square shear box is one type of soil container used.A proving ring is used to indicate the shear load taken by the soil initiated in the shearing plane. Check the inner dimension of the soil container. Put the parts of the soil container together. Calculate the volume of the container. Weigh the container. Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil. Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of soil. Make the surface of the soil plane. Put the upper grating on stone and loading block on top of soil. Measure the thickness of soil specimen. Apply the desired normal load. Remove the shear pin. Attach the dial gauge which measures the change of volume. Record the initial reading of the dial gauge and calibration values. Before proceeding to test check all adjustments to see that there is no connection between Two parts except sand/soil. Start the motor. Take the reading of the shear force and record the reading. Take volume change readings till failure. Add 5 kg normal stress 0.5 kg/cm^2 and continue the experiment till failure Record carefully all the readings. Set the dial gauges zero, before starting the experiment.

Test	Normal stress (kg/m$^{2)}$	Shear stress at failure (Mpa)	Shear stress (kg/m^2)
For sample-1	0.5	39.6	0.396
For sample-2	1	64.8	0.648
For sample-3	1.5	100.7	1.007

Table 11.0 : shear strength of unreinforced soil

Angle of shear resistance =17^O Cohesion =1.0kg/m^2



Graph 1: Mohr's circle for unreinforced soil

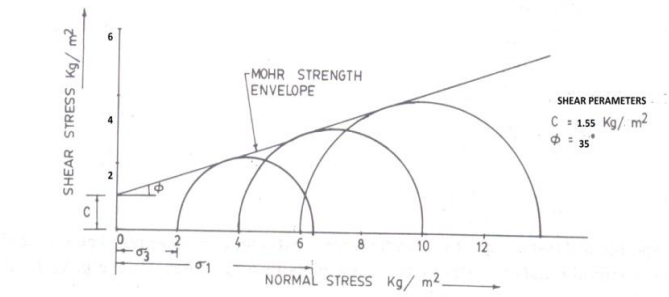
Shear strength of soil+10% Jute fiber of 1mm diameter of 30mm length

Test	Normal stress (kg/m^2)	Shear stress at failure (Mpa)	Shear stress (kg/m^2)
For sample-1	0.5	80.5	0.805
For sample-2	1	115.2	1.15
For sample-3	1.5	155.6	1.556

Table.11.2 Shear strength for soil+20% Jute fiber of 1mm diameter of 30mm length

Angle of shear resistance =35^O Cohesion =1.55 kg/m^2

Mohr's circle



Graph 3: Mohr's circle for soil+20% Jute fiber of 1mm diameter of 30mm length

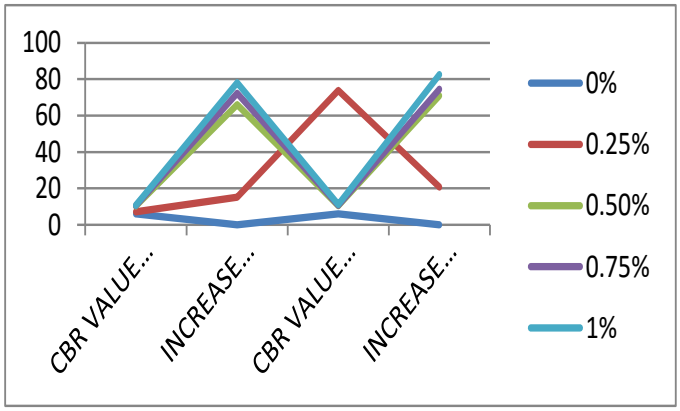
3.2Procedure for the determination of shear stress by direct shear test method. The california bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement. This instruction sheet covers the laboratory method for the determination of C.B.R. of undisturbed and remoulded /compacted soil specimens, both in soaked as well as unsoaked state.

Cylindrical mould with inside dia 150 mm and height 175 mm, provided with a detachable extension collar 50 mm height and a detachable perforated base plate 10 mm thick. Spacer disc 148 mm in dia and 47.7 mm in height along with handle. Metal rammers. Weight 2.6 kg with a drop of 310 mm (or) weight 4.89 kg a drop 450 mm. Weights. One annular metal weight and several slotted weights weighing 2.5 kg each, 147 mm in dia, with a central hole 53 mm in diameter. Loading machine. With a capacity of atleast 5000 kg and equipped with a movable head or base that travels at an uniform rate of 1.25 mm/min. Complete with load indicating device. Metal penetration piston 50 mm dia and minimum of 100 mm in length. Two dial gauges reading to 0.01 mm. Sieves. 4.75 mm and 20 mm I.S. Sieves..Miscellaneous apparatus, such as a mixing bowl, straight edge, scales soaking tank or pan, drying oven, filter paper and containers. It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard

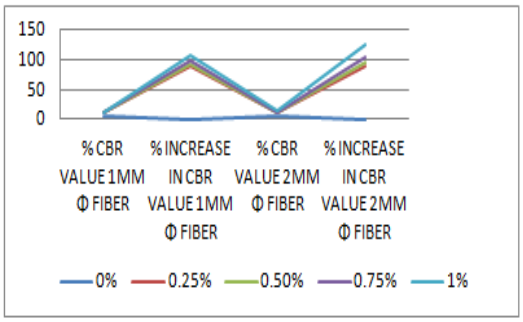
material. C.B.R. = Test load/Standard load * 100. The following table gives the standard loads adopted for different penetrations for the standard material with a C.B.R. value of 100%.

		Fiber Diameter 1mm		Fiber Diameter 2 mm.	
Length of Jute Fiber (mm)	Percentage of fiber by dry weight of soil	CBR Value (%)	%increase in CBR value	CBR Value (%)	%increase in CBR value
30	0%	6.08	-	6.08	-
	0.25%	7.03	15.62	7.33	20.55
	0.5%	10.16	67.10	10.35	70.23
	0.75%	10.50	72.69	10.58	74.13
	1%	10.89	79.11	11.12	82.89
60	0%	6.08	-	6.08	-
	0.25%	11.49	88.98	11.56	90.13
	0.5%	11.73	92.92	11.90	95.72
	0.75%	12.00	97.36	12.40	103.9
	1%	12.67	108.38	13.60	123.6
90	0%	6.08	-	6.08	-
	0.25%	13.21	117.26	13.53	122.5
	0.5%	13.70	125.32	13.70	125.3
	0.75%	14.66	141.11	15.22	150.3
	1%	17.04	180.26	18.27	200.4

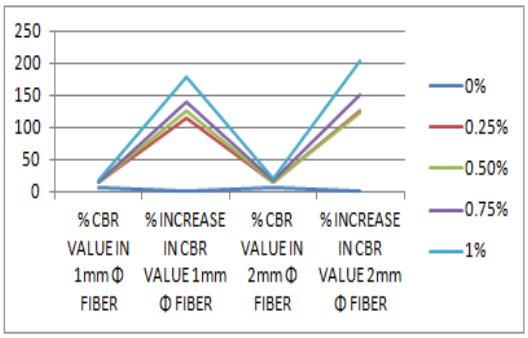
Table 8: showing CBR value



Graph 1: CBR Values Variation with 1mm & 2 mm fibreof,30mmlength



Graph 2: CBR Values Variation with 1mm Φ & 2mm fibre of 60 mm length



Graph 3: CBR Values Variation with 1mm & 2 mm Φ fibre of 90 mm length

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CONCLUSION

Geo jute or jute geo textile has many potential applications in civil construction works. The engineering properties of jute fabrics are suitable for separation, reinforcement, drainage and filtration functions and can be suitably used in overcoming geotechnical problems of weak soil. Applied research including performance evaluation of geo jute applications are needed to highlight the beneficial uses of geo jute in the field. The use of a thickly woven coir geo textile for construction of mud wall has been demonstrated in the area, which represents a typical peat soil. Besides it has been proved to act as good separator and drainage filter also. The strength of soil has been found to increase in course of time as the organic skeleton has remained in place in compressed form that acts as a filter cake providing sustainable protection to the stream bank. Local vegetation grown over the embankment has been providing extra protection against erosion of mud wall. This treatment opens up new avenues for the application of coir geo textiles that could be applied in low-lying areas all over the world. It is seen that even after 8 years the mud wall is intact and it is performing well. The tremendous strength and biodegradability of coir makes it suitable to various new areas of application in the soil bioengineering.

REFERENCES

[1] Lawton E.C, Khire, M.V. and Fox, N.S. (1993).”Reinforcement of soils Multi oriented geo synthetic inclusion.” Journal of Geo technical engineering ASCE, 119(2), 257-275.

[2] Maher, M.H. and Gray, D.H.(1990).”static response of sands reinforced with randomly distributed fibres.

[3] Saran, S. (2010). “Reinforced soil and its engineering applications”, I.K. International Publishing House Pvt . Ltd., New Delhi.

[4] Singh, H.P.(2011), “Strength Characteristics of Soil Reinforced With Geosynthetic ”. International Journal of Earth Sciences and Engineering ISSN 0974-5904,Vol 04,No 06 SPL, October 2011,pp 969-971,2011.

[5] Fourie, A.B.: Predicting rainfall-induced slope instability. Proceedings of the Institution of Civil Engineers –Geotechnical Engineering 119(4), 211–218 (1996).

[6] IS: 2720(Part 2), 1973 Methods of Test for Sands, Determination of water content.

[7] IS 2720(VII):1980 Methods of Test for Sands, Determination of water content dry density relation using light compaction.

[8] IS 2720(XIII):1986 Methods of Test for Sands, direct shear test.

[9] Zahid Hossain Prodhan (2008), Application of Jute Geotextile on rural roads of Bangladesh for slope protection, International workshop on Jute geotextiles, Kolkata.

[10] Zlatuska K., (2004) Utilization of Geo Textiles made from Natural materials in Civil Engineering, A.KTI, Int. Symposium on Jute, May, Liberec, Czech Republic.

[11] Majumdar.A.K, Bhattacharya.S.K., S.Ghatak, K.Goswami and D.Sanyal (2006), Case studies on field trials for road construction with jute based geotextiles, Proceedings of International Seminar on Geosynthetics in India – Present and Future, New Delhi.

[12] Rao.P.J., et al (1996) Report on evaluation of Jute Geotextiles in civil engineering applications, CRRI, New Delhi.

[13] Rao.P.J. et al (1996), Design and construction of drainage filter using jute geotextile at Hanuman Setu, Proceedings of national Seminar on Jute based Geotextiles, New Delhi.

[14] Ranganathan.S.R (1994), Development of potential jute geotextiles, Geotextiles and Geomembranes, Vol 13, Nos 6-7, Elsevier Applied Sciences, Oxford .