Jute Geotextiles as Revetment Filter for River Bank Protection

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ABSTRACT: Calcutta Port Trust authorities in their development work at Haldia, were suffering serious erosion problems to an island in the river. As part of their development programme they were investigating the use of geotextile filters, and had specified their requirement in terms of technical specification including strength and porosity which is critical in a filter application. A woven cost effective jute geotextile impregnated with rot proofing compound was fabricated and an area covering 30,000 sq.mts was laid on the erosive banks of Nayachor island during 1992. Revetment filter is quite a sophisticated application involving dynamic flow and is relatively an permanent application. Efficiency of such application is primarily measured by silt formation. A good amount of siltation up to a height of 600 mm was observed after a period of eight months. Jute geotextile has withstood without any signs of failure.

1.0 INTRODUCTION

Geotextiles are permeable textile fabrics used as filters to prevent soil from migrating, while maintaining the water flow. They are similarly used as filters below rip rap and other armour materials to prevent soil from washing out costal and stream bank protection systems. In the western countries, environment pollution is an major issue, of which planners are increasingly aware off. As the synthetic geotextile are prone to adverse environmental effects, the desirable ecological aspects of jute geotextiles come into play in erosion control applications.

Trials carried out by United States Department of Agriculture (USDA) for Road Bank Erosion and its control in the Piedmont upland of Georgia (3), show Jute to be superior to all the other conventional material like straw, paper, plastics, saw dust, water soluble latex and grass matts. Jute was best suited for use in flow channels and for protecting banks against erosion, water damage and floods.

In the opening paper to the IECA Conference in 1988, J.C.Thomson and T.S. Ingold, two noted authorities, reviewed the results of the entire erosion control scene in Europe in their presentation (1), to conclude "Overall, the best performance achieved by jute mesh and wood wool, with the jute mesh out performing the wood wool on the sandy loam and sandy loam with gravel.

2.0 RIVER BANK EROSION PROBLEMS AT HALDIA

The ports of Calcutta and Haldia in West Bengal, are located on the banks of the river Hoogli. The stretch of the river from its confluence with the Bay of Bengal to the ports has been posing persistant problems due to its depleting draft. The depleting draft of the river poses the biggest obstacle to induction of modern

heavy cargo ships to the port. Calcutta Port Trust in their development work at Haldia port were suffering serious erosion problems to an island in the river. A program of stone pitching was underway. As part of there development programme they were investigating the use of geotextile filters and had invited synthetic and jute manufacturers to provide with suitable material for trials.

The authorities had specified their requirements in terms of technical specification including the strength and porosity, which is critical in a filter layer. This paper highlights the work done with jute geotextiles for river bank protection at Nayachor Island, Haldia.

The river at Haldia is divided into two arms by a low lying island called Nayachor and because of siltation problems in the shipping channels a training arm has been installed on the northern end of the island. The objective being to divert an increased flow through the western shipping channel and reduce siltation. This training arm has been constructed using Dutch expertise. As a result of this work the western shore of the island was subjected to increased erosion forces causing severe erosion in the embankments. Photograph-1 shows typical erosion at Nayachor Island, Haldia.

1. Erosion of river bank in Nayachor Island under Calcutta Port Trust, Haldia.

3.0 APPLICATION OF JUTE GEOTEXTILES AS REVETMENT FILTER

River and sea shore bank erosion is counteracted by protection of the surface to resist the forces generated by the flow and waves. One method widely used is to install a layer of stone pitching on the shore line to stop the loss of soil. The rise and fall of the tide and wave action causes water to flow into the pitched bank and then drain away. This two way flow is know as dynamic flow. This flow is capable of dislodging and carrying away soil which lies below the stone protection and ultimately causing the revetment to fail. To protect against this section traditionally a granular filter is installed between the stone and the soil which theoritically allows the water to pass through freely but not the soil particles. The design and choice of suitable granular material for this filter is not an easy task. The use of geotextile filters in such cases has proven to be an attractive alternatives. A woven jute substrate coated with bitumen was developed for this application as per standards and requirements specifically laid down by Calcutta Port Trust authorities.

4.0 JUTE GEOTEXTILE

4.1 PROPERTIES OF JUTE FIBRES

PROPERTY	RANGE OF VALUES
Fibre length (mm)	50-300
Fibre diameter (mm)	0.035-0.14
Specific gravity	1.48
Bulk density (kg/mt^3)	120-140
Ultimate tensile Strength (N/mm^2)	250 - 350
Modulus of elasticity (kN/mm^2)	26-32
Moisture absorption(%)	13.8
Tenacity (g/tex)	2.7-5.3
Breaking elongation(%)	0.8-1.8
Refractive Index	0.8-1.8
Parallel	1.577
Perpendicular	1.536
Swelling in water(diameter)	20-21%
Stifness (Average)	185
Specific heat	0.324
Specific internal surface (mt^2/g)	10-200

(at standard conditions of temperature 21°C, Relative Humidity 65%)

4.2 SPECIFICATIONS

Construction	DOUBLE WARP TWILL 8X12
Weight gm/sq.mt	850
Weight gm/sq.mt	1500
Thickness at 100 gm/sq.mt	2.83
Breaking strenth(kgf)	
Warp	168.3
Weft	143.8
Puncture resistance (Kgf/sq.cm)	37.9
Air permeability ($M^3/m^2/min$)	16.2
Water permeability ($l/m^2/set$)	
10cm coloumn	20.4
Pore size (microns)	150

The fabric was treated with 5% HEDRAOL-LT solution in a bath followed by squeezing at padding mangle. Under the treatment the fabric weight in wet condition should be 100% on the weight of dry jute fabric. Liquour ratio between jute and chemical 1:10. After treatment the fabric is passed through the heated cylinder for drying. Then the fabric is treated with admixture of bitumen (IS-702-1961) in take of 100%. The machines used are similar to the machines being used for making roofing felts.

5.0 SITE & SOIL CHARACTERISTICS

The site & soil characteristics in an around the laid site are given below: (2)

Tides : Semidurnal with a period of 12.42 Hrs. Average flood period 5 hrs. Average ebb period 7.42 h

Range : Rise of Water Max. 7.26m, Min. 0.06m.

Current : Peak ebb velocity is 2.5m/Sec.

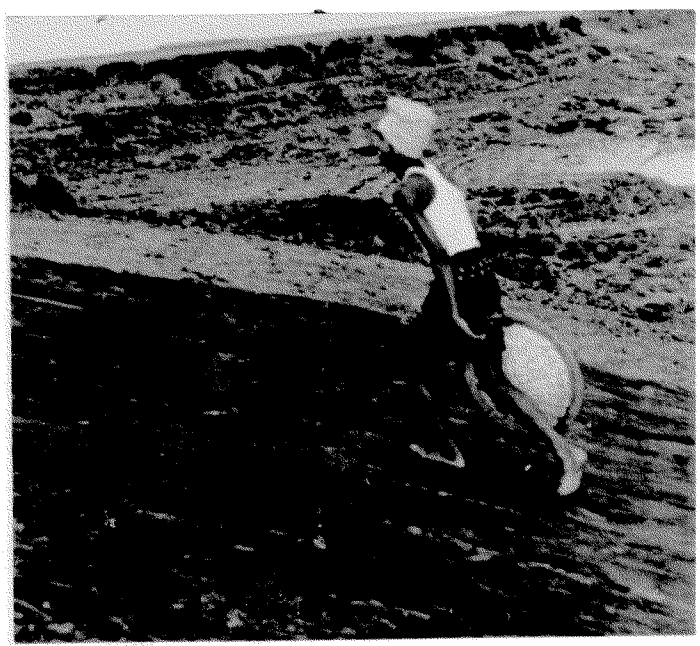
Wave : Rough river due to strong winds

Soil : Sand -33%, Silt -55%, Clay - 12%.

6.0 LAYING OF JUTE GEOTEXTILE

The jute geotextile manufactured to 48" width x 50 meter rolls was firt stitched together with an overlap of 4" firmly. The eroded site was first prepared to form a uniform slope 1:1. The bare fabric was unrolled over the slope of the embankment, starting from the top of the bank. The fabric was anchored at the top in a trench 1m x 1m and similarly at the sides. The over lappings were nailed with 10" long iron pegs at an interval of one meter.

The bottom portion of the jute geotextiles was fabricated in such a manner that it had multiple pockets to fill sand in it. This is done to anchor the jute geotextile in its place and protect eroding by reverse current and eddies. After the entire area was covered with the jute geotextile, small laterite boulders were placed over the jute geotextile. The small laterite boulders were laid to provide a cushion effect to the jute geotextile. On top of the small laterite boulders, big laterite boulders weighing approximately 15 to 20kg were pitched to a height of 1½ feet. The entire operation was carried out during low tide. The condition of the embankment and the method of laying are shown in Photographs 2 & 3 and figures 1 & 2.



2. Laying of Jute Geotextile along the prepared slope at Nayachor Island embankment. (+5 to -3 level).

3. 600mm Siltation over the laid Jute Geotextile after a period of 8 months.

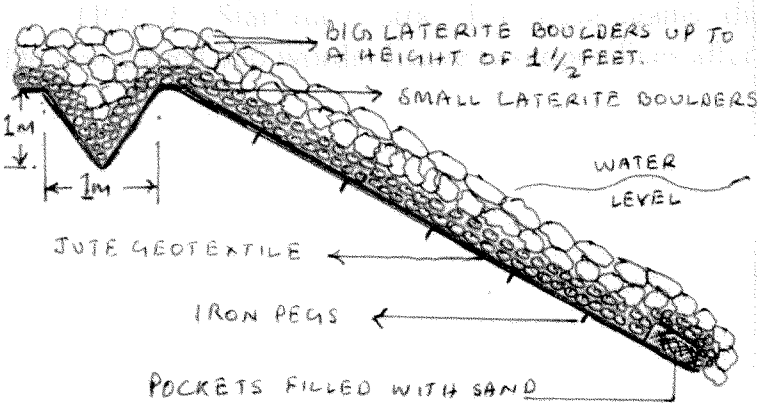


FIG - 1

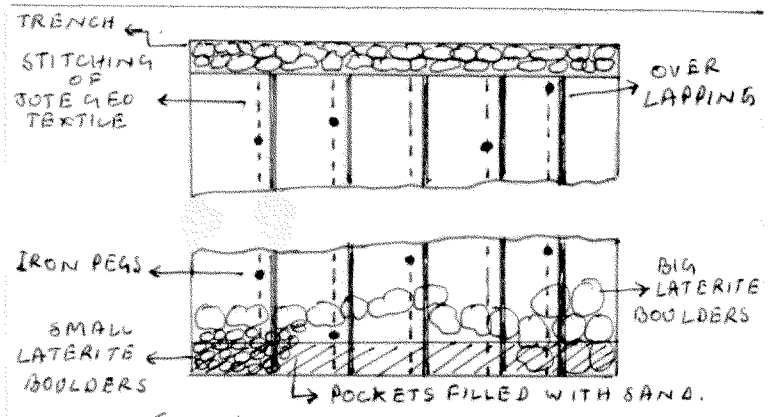


FIG - 2

7.0 RESULTS

The efficiency of such application is primarily measured by silt formation over the laid site. A good amount of siltation up to a height of 600 mm was observed after a peiod of 8 months. A revetment filter is quite a sophisticated application involving dynamic flow and is a relatively an permanent application, and jute geotextile has withstood without any signs of failure. After the maximum tides during the rainy season, when the whole island went under water, the revetment work appeared to be controlling the bank erosion.

In India there lies a vast potential for a wide range of geotextiles. To tap this demand it will be necessary to develop products which will meet the specific needs of the users. The role of jute geotextiles is determined by its characteristics, detailed analysis of applications. The most important role for jute lies in Erosion Control where the material qualities including degrading are an advantage when compared to synthetics. In India there is a very large and extensive soil erosion problem which includes:

* Road & Rail embankment and cutting slopes
* River, Canal and Stream bank erosion
* Forestry revegetation
* Mining waste revegetation
* 'Bad Land' rehabilitation

Although no investigation was undertaken into the demand it is possible to forecast an annual demand of several millions of square meters for erosion control in India alone.

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