Application of a coir geotextile reinforced mud wall in an area below sea level at Kuttanad, Kerala

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ABSTRACT
Kuttanad is situated in the Alleppey district of the state of Kerala that is known as the Venice of East. Kuttanad, a low lying area, about 1 meter below MSL is known as the rice bowl of the state of Kerala in the southern most part of India. The average rainfall is 316cm, therefore, during the rainy season the whole area gets submerged due to overflow of river/canal waters resulting in loss of its fertile soil and destroying the paddy fields due to water logging. The locally situated Rice Research Station [RRS] under Kerala Agricultural University had been constructing mud walls every year using bamboo stakes that used to give in during flooding conditions due to heavy rains submerging the nearby paddy fields. Therefore, the RRS had approached the Coir Board to undertake a project to construct a mud wall on the bank of a nearby flowing river. Natural geotextiles made up of fibers extracted from coconut husk are emerging products for erosion control of soil slopes. Coconut is abundantly available in tropical countries and generates large quantities of renewable resource in terms of coir fiber. This paper reports a case study on the application of thickly woven [basket weave] coir matting as a reinforcement of mud wall. The mud wall using this material has withstood the flooding conditions for last 8 years. Such reinforced mud walls using thickly woven coir geotextiles could find applications in the low lying areas in different countries so as to protect the valuable soil against erosion.

ABOUT AUTHORS
U. S. Sarma has been working in the area of different textiles including Jute, Pineapple, Sansevieria and Coir for more than 30 years. He got Ph.D. degree while working in the Indian Association for the Cultivation of Science, Kolkata, on “Studies of the Fiber Hemicelluloses”. He was awarded one-year postdoctoral fellowship by Ministry of Agriculture, Government of France, for his work on the Lignin-Carbohydrate Complexes of Rice Straw. Under his guidance and supervision 20 experiment-cum-demonstrations on application of coir geotextiles for soil erosion control have been conducted at various places in India.

A. C. Jose is Ex. Member of Parliament and at present Chairman of the Coir Board. The Coir Board is a statutory body of the Government of India for the promotion of R & D and marketing of coir. During his tenure as Chairman, owing to his leadership qualities, there has been a tremendous advance in the modernization of the Coir Industry in India. The export of coir has risen and crossed the set targets. He continues to encourage the R & D in coir for diversified end uses including geotechnical applications. He is the patron of Indian Chapter of International Erosion Control Association.

KEY WORDS: coir geotextiles, basket weave, stream bank, mud wall, soil erosion control.

INTRODUCTION

Coir is a 100% organic naturally occurring fiber, from a renewable source obtained from coconut [*cocos nucifera*] husk. Naturally resistant to rot, moulds and moisture, it is not treated with any chemicals during its spinning process for converting it into a yarn. Hard and strongest among all natural fibers, it can be spun and woven into different types of mattings and mats. Geotextiles made out of coir are ideally suited for low cost applications because coir is available in abundance. Only 36% of available coconut husks in India are used for extraction of coir. Therefore there is enough scope to enhance is application. Coir fibers resemble the wood fibres in terms of physical properties and chemical composition.

Coir geotextiles are found to provide protection against soil erosion to the various types of slopes that has been demonstrated and documented by the Coir Board[1]. The ability of coir fibres to absorb water and to degrade with time is its prime properties, which give it an edge over synthetic geotextiles for erosion control purposes. The present study was conducted to determine the suitability of coir geotextiles to increase the load bearing capacity of the mud wall constructed by the reinforcement of coir geotextiles.

Kuttanad bears strong resemblance to Holland in terms of geographical features. The deltaic formation of four major river systems, criss crossing this region are Pampa, Achencoil, Manimala and Meenachil, confluencing into the Vembanad Lake. The region extends from 9° 17′ to 9° 40′ N latitude and 76° 19′ to 76° 33′E longitude, comprising an area of 1100 sq. km.

Kuttanad, the traditional rice bowl of Kerala, covers 53, 777 hectares of low-lying reclaimed lands, from shallow stretches of the Vembanad Lake, exclusively under paddy cultivation[2]. This is perhaps the only region in the world where farming is done 1.5 to 2 m below sea level. Inland waterways, which flow above land level, are an amazing feature of this region.

BACKGROUND

For over two thousand years the mud walls have been made to protect the stream banks in India for preventing them from causing soil erosion. Mud sometimes made into mud bricks, sometimes rammed or placed into position, and nearly always covered with mud plaster (a mix of mud and straw) have been used in different places in India.

The latest technology provides artificial structures (terraces, rock riprap, gabions, and tire or sandbag barriers) to support and protect stream banks. These structures supplement plants by reinforcing steep banks and banks that are vulnerable to flood, swift currents, strong winds, and heavy wave action. However, concrete readily fractures and cracks and metal structures (steel beams and iron pipes) will rust, pollute stream water, and eventually collapse.

Earlier, Schurholz[3] had reported that when natural coir was exposed to water continuously for 167 days [in order to simulate the traction effect while flooding], it had almost no damage. Singh and Rao[4] subsequently carried out studies on change in tensile strength of woven coir geotextiles by immersion in water and embedding in saturated kaolinite clay. It was found that even after 6 months, the strength of woven coir geotextiles was not affected in both the cases except increase in elongation at failure, which was due to water absorption by coir yarn resulting in increased elasticity.

Considering the above difficulties, it was considered to utilize the coir geotextiles to provide protection to the streambanks and allow vegetation to become established for providing sustainable protection against soil erosion.

Coir Board in collaboration with Kerala Agricultural University had earlier demonstrated the application of coir geotextiles for riverbank protection using cocologs [coir fibres stuffed in the nets made out of coir] [5].

MATERIALS AND METHODS

Two Treadle Basket weave fabric [warp3xweft3] made from coir yarn was chosen for the construction of mud wall on a high velocity streambank near the Mancombu Rice Research Station. The Coir Board has established a testing laboratory for coir geotextiles at the Central Coir Research Institute, Kalavoor, Alleppey that is listed in the web site of ASTM [American Society for Testing and Materials] International Directory of Testing Laboratories. Rao and Dutta have discussed in details about testing of coir geotextiles[6].

TABLE-I CONSTRUCTIONAL DETAILS OF M2BV3-TWO TREADLE BASKET WEAVE COIR MATTING

Mass, Kg/cm^2	:	1.58
Thickness, mm	:	11.0
Puncture resistance, mm	:	2.0
CBR, (kN)	:	4.35
AOS (mm)	:	1.42
Permeability (litres/m^3/mm)	:	8484.40
Picks/dm	:	15
Ends/dm	:	24

TABLE-II STRENGTH PARAMETERS OF M2BV3-TWO TREADLE BASKET WEAVE COIR MATTING

Break Load	kN/m	Elongation at break
Warp direction	50.0	32.0
Weft direction	27.0	20.0

Scorage & Type of warp yarn : 12 Vycome
Scorage & Type of weft yarn : 12 Vycome

Vycome is the typical low twist yarn made in a particular region [Vycome] in the state of Kerala, India for making mats and mattings. Due to its good brush forming properties, it is also being used extensively for manufacture of PVC tufted mats.

Soil- Kuttanad soil resembles peat soil. It is acidic [pH4.5-6] and saline with medium in organic matter content. It is poor in available nutrients but rich in Calcium. River borne alluvial soil is found at 1-2 meter below the sea level, which is generally clay loam in texture, high acidity, fair amount of organic matter, but poor in available nutrients. Average temperature in the area ranges between 23.5-31.2^0 C. with a relative humidity of 89%.

RESULTS AND DISCUSSION

During the year 1997, Rice Research Station at Mancombu, Kuttanad, Kerala had contacted the Central Coir Research Institute for carrying out a study using coir geootextiles as reinforcement to the mud wall for a high velocity stream that was causing floods in the entire area of paddy cultivation despite putting up mud walls every year [Fig. 1]. The project was commenced in April; 1999 after conducting the study on the site. The coir geotextiles were applied on the stream bank for a stretch of 250meters, as illustrated in the Fig. 2. The basket weave fabrics were chosen, as those are the thickest woven coir geotextiles. The nearby Rice Research Station used to put mud wall on the stream bank in the area, every year, which used to give in during the monsoon season when extensive floods occurred almost every year causing damage to rice crops. Fig. 3 depicts the close up view of the mud wall erected using the coir geotextile and bamboo poles for providing support.

The lush green paddy field growing near the protected bank of stream is seen in Fig.4 [The rice Research Station is in the background]. Due to slow biodegradation of coir geotextile, the vegetation could sustain and provide extra support to the mud wall even after 8 years of its erection [Fig. 5].

Fig. 1. The broken mud wall near the Rice Research Station

Fig. 2. Application of coir geotextile using bamboo poles

Fig.3. Close up view of applied coir geotextile on the stream bank

Fig. 4. Mud wall using coir geotextile at Kuttanad

Fig. 5. Reinforced mud wall with grown vegetation after 8 years

CONCLUSION

The use of a thickly woven coir geotextile for construction of mud wall has been demonstrated in the Kuttanad 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 streambank. Local vegetation grown over the embankment has been providing extra protection against erosion of mud wall [Fig. 6].

This treatment opens up new avenues for the application of coir geotextiles 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[7].

Fig.6. Fully protected mud wall due to established vegetation

ACKNOWLEDGEMENTS

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APPLICATION OF A COIR GEOTEXTILE REINFORCED MUD WALL IN AN AREA BELOW SEA LEVEL AT KUTTANAD, KERALA

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KUTTANAD, THE RICE BOWL OF KERALA IS SITUATED IN ALLEPPEY, THE VENICE OF THE EAST

ACTIVITIES OF COIR BOARD



The Coir Board is a statutory body established by Govt. of India under the Coir Industry Act 1953 for promoting the overall development of coir industry and for promotion of domestic as well as export market of coir and coir products.

MAJOR SCHEMES OF COIR BOARD

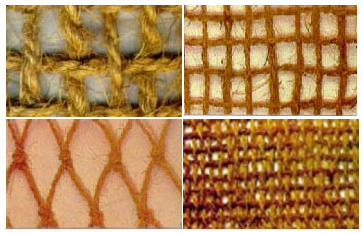
- Research and Development
- Training, Extension, Quality Improvement, and Welfare Measures
- Development of Production Infrastructure
- Domestic Market Promotion
- Export Market Promotion
- Trade Information Service, Information Technology and Strengthening of Organizational Structure
- Economic Market Research

R & D

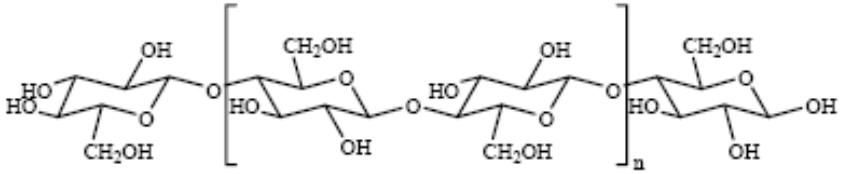
Research & Development activities are carried out through two Research Institutes:-

(i) Central Coir Research Institute [CCRI], Alleppey, Kerala.

(ii) Central Institute of Coir Technology [CICT], Bangalore, Karnataka.



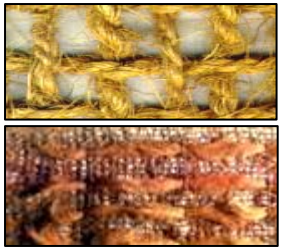
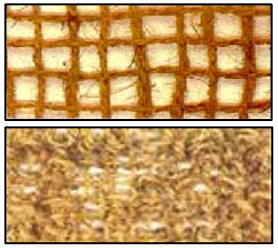
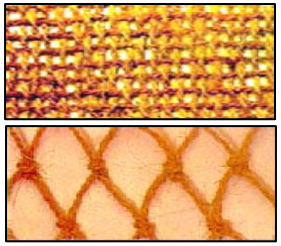
COIR- A LIGNOCELLULOSIC FIBRE



CELLULOSE

- A natural wrapping material along with coir pith for proper packing of nut
- It is thick in the middle and tapered at both the ends
- Thousands of cellulose micro fibrils are reinforced with hydrophobic lignin plastic to prepare this natural composite which is resistant to water logging having an extensibility of ~30%
- Lignin bestows the properties of resistance towards mould, mildew and moths
- Perforations on the surface to the extent of 40% provide it lightness and buoyancy

LIGNIN


COIR GEOTEXTILES [Woven & Non- Woven]..

FEATURES AT A GLANCE

- 100% NATURAL
- ECO-FRIENDLY
- STRONG & DURABLE
- BIO-DEGRADABLE
- EASY TO INSTALL
- COST EFFECTIVE

DAMAGED MUD WALL DURING THE RAINY SEASON

TWO TREADLE BASKET WEAVE COIR GOTEXTILE

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ERECTION OF MUD WALL REINFORCED WITH THICKLY WOVEN COIR GEOTEXTILES

CLOSE UP VIEW OF APPLIED COIR GEOTEXTILE

FULLY ESTABLISHED MUD WALL

MUD WALL AFTER 8 YEARS

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THANK YOU