RETTED (WHITE) COIR FIBRE NETTINGS - THE IDEAL CHOICE AS GEOTEXTILES FOR SOIL EROSION CONTROL

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BIOGRAPHICAL SKETCHES

K. George Joseph

K. George Joseph, with over 24 years in the Indian Administrative Service, is the Chairman of the Coir Board for the last four years. The Coir Board is a statutory body of the Government of India for promotion of R and 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 and D in coir for diversified end uses including geotechnical applications. Due to his initiative, Coir Board has become the member of the International Erosion Control Association. His present interest is to propagate the natural and environment friendly coir for its use for various geotechnical applications, for which he has taken certain steps which include the organization of a series of seminars in Europe and USA.

U. S. Sarma

U. S. Sarma has been working in the area of different textiles including Jute, Pineapple, Sansevieria and Coir for more than 20 years. He received his M.Sc. degree in organic chemistry in 1974. He got his Ph.D. degree while working in the Indian Association for the Cultivation of Science, Calcutta, on "Studies of the Fibre Hemicelluloses." He was awarded a one year post doctoral fellowship by Ministry of Agriculture, Government of France, to work on the Lignin-Carbohydrate Complexes of Rice Straw. His current interests are the research and development in the field of coir to develop coir based products for various purposes including geotechnical applications.

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ABSTRACT

India produces the best quality of coir fibre (*Cocos nucifera*) by retting the matured green coconut husks in waters for 6 to 10 months. It is mostly used for manufacture of mats, mattings and carpets. This fibre is free from the toxic phenolic materials which are usually present on the surface of brown fibre, extracted mechanically from dry husk. The retted fibre is also comparatively less sensitive to UV light due to leaching out of photo-sensitive materials from its surface during retting process. Yarn made out of retted fibre has superior strength compared to the yarn made out of brown fibre. Recently a unique process has been developed by Central Coir Research Institute of Coir Board by which green husk fibre can be retted by Coirret (a bacterial cocktail) within 72 hrs. A wide variety of geotextiles ranging in densities from 400 to 1400 grams/m^2 of coir nettings can be made for different applications. Experiments were conducted in 1995 at three different sites using coir nettings as erosion control material. A canal bank and road slopes at two different sites were chosen for this purpose.

It was observed that the area treated with coir geotextiles in the three locations was free from soil erosion when compared to other areas elsewhere thus establishing the fact that coir is an ideal geotextile. The lemon grass root slips were used for vegetating the soil on the canal bank of area 370 m^2 (Experiment I), a nearby road slope of area 800 m^2 (Experiment II) and vetiver grass slips were used at a different place on a very steep slope of area 600 m^2 (Experiment III). The study revealed that the nutrients of the soil increased due to degradation of coir nettings and substantial growth of grass was observed in the areas under experiment. It has been observed that the material maintains the pH balance of the soil and

becomes part of it after vegetation grows. The material due to its weight and capability to absorb water conforms closely to the contour of the soil surface. The hairiness of the yarn also contributes to holding soil particles in place. The woven construction of coir nettings allows intersecting strands to move independently of one another which reduces the risk of wild life entrapment also.

INTRODUCTION

India ranks first in the production of coir fibre and the state of Kerala in India produces about 57.1% of best quality of coir fibre viz. White coir fibre (Figures 1 and 2).

The World Bank–aided Moovattupuzha Valley Irrigation Project (MVIP) construction work commenced during the VIII Plan period. The first stage of the canal was commissioned on November 1, 1994. According to the Superintending Engineer on the project it was necessary to protect the slope of the

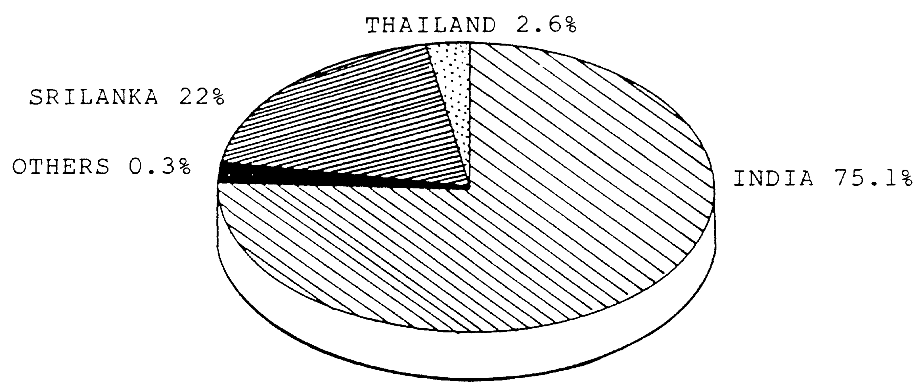

Figure 1. World production of coir fibre 1994. Source: Statistic on coir 1989–94. FAO, Coir Statistic CCP:HF 95/4, April, 1995, and Coir Board, India (White fibre).

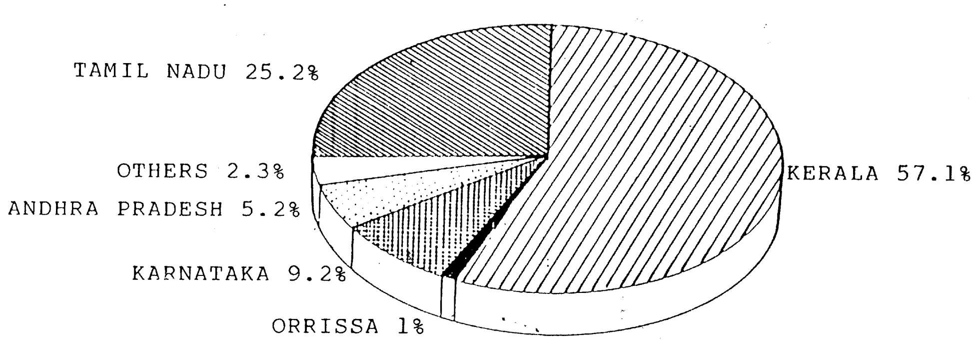

Figure 2. Production of coir fibre in India 1994–95. Source: Coir Board, India.

canal constructed for irrigation purpose. The other method viz. planting turfing grass on the banks of the canal proved to be costly and ineffective. It was suggested by Coir Board that the hundred percent biodegradable erosion control netting utilizing coir yarn in lieu of the above method will fit in perfectly with the total concept of the project to protect the environment and effective use of the project. Further it was stressed that besides working as erosion control media the material will also allow the vegetation to establish, as coir after biodegradation, enriches the soil. This paper reports the results of three field experiments carried out in the year 1995 with the strong, biodegradable and environment friendly coir fibres.

MATERIALS AND METHODS

White (retted) coir was used for the preparation of nettings of MMV_2 (H_2M_6) and MMV_1 (H_2M_5) quality for protecting the canal bank and road embankments respectively. The details about the specifications of the MMV_2 (H_2M_6) and MMV_1 (H_2M_5) qualities are as follows:

Coir Mesh Mattings	(1" Grids)	(1/2" Grids)
Code No.	MMV_2 (H_2M_6)	MMV_1 (H_2M_5)
Warp Yarn	Vycome (retted yarn)	Vycome (retted yarn)*
Weft Yarn	Vycome (retted yarn)	Vycome (retted yarn)
Ends per dm	4.6	9
Picks per dm	4	8
Weight per sq.mtr.	400 gms.	740 gms.

*Vycome: Denotes the area where this particular variety of yarn is produced in the state of Kerala in India.

The product was installed on the slope, after the slope was converted into a smooth and stable surface. The width of the coir netting was 2 meters. 300 to 300 mm (12" x 12") anchor trench was excavated at the top and a 300 to 300 mm (12" x 12") toe trench was established at the bottom of the slope. The geotextile was then unrolled down the slope, secured into the anchor trenches and onto the slope face. Wrought iron pegs (‘J’ clips) were used to fix the fabric to the slope. The anchor trenches were filled back and consolidated. After fixing the geotextiles firmly on the slope, the lemon grass (*Cymbopogon citratus*)/vetiver grass (*Vetiveria zizanioides*) slips were planted in the mesh holes at the distance of about 10 cm.

PRODUCT BENEFITS

The coir geotextiles are recommended on longer slopes where increased run off velocities necessitate greater durability and effectiveness (Langford and Coleman, 1996, p. 15). Channel bank stabilization of various slopes between 1V:2H and 1V:3H have been reported by the use of coir geotextiles (Rotar and Windell, 1996, p. 55).

The main advantage of the coir geotextile is its capability to absorb water and to conform to the soil surface. Coir is a low density (1.40 gms/c.c) fibre. About 40% of the coir fibre is porous. When soaked in water, coir swells to a minimum (5%) in the lateral directions in comparison to other common hard fibres like Sisal, Manila, Phormium and Aloe etc., which swell to almost 18–22% (Chakravarty, 1968, p. 381). This property of coir helps to weigh the netting down and conform the fibre matrix to the soil surface. Hairlike fibres tend to protrude from the strands and bind to the underlaying soil when moistened.

Out of three qualities of coir fibre viz., white, brown and green husk fibre, the best quality is the white coir obtained traditionally by retting the matured coconut husk in backwaters. This method has been now improved by the Central Coir Research Institute of Coir Board so that the husk is defibered by machine and the extracted fibre is treated with a bacterial mix known as Coirret. This yields white fibre which is now finding extensive use in the making of geotextiles. The white fibre produces the best quality of yarn spun on the modern spinning machines developed by the Institute.

The yarns are converted into geofabrics by the semi-automatic looms which are cost effective and produce the material of the power loom quality at high speed. The inventions of Coirret and the development of these machines have given a new dimension to the growing market of coir geotextiles. The woven construction allows the intersecting strands to move independently of one another which reduces the risk of wild life entrapment. The fineness and pliability of the white fibres in comparison to the other quality of coir fibres like brown and green husk fibres is much better. It produces the best quality of yarn having good strength and uniformity.

RESULTS AND DISCUSSION

Experiment I

23rd kilometer of left bank main canal of Moovattupuzha Valley Irrigation Project near M. C. Road crossing between Moovattupuzha and Kuthattukulam, Kerala.

The area selected was highly eroded due to the high stream velocity at this point of the canal (Figure 3) due to two major rainy seasons in a year.

Figure 3. Moovattupuzha left bank main canal before geotextile treatment.

The treatment with the vegetation turfing grass failed in this area because the seeds and the spriggings were getting washed away during the following monsoon since it takes a lot of time for the vegetation to take root. It was therefore felt necessary to protect the slope adequately till such time that the seeds broadcast over the slopes or the roots slips of grass dibbled into the slope take time to germinate, grow and take root. The coir geotextile helped to dampen the kinetic energy of the flowing water and kept both the soil and the root slips in their place. The technique is also cost effective in comparison to the vegetative turfing method. The fabric chosen for this purpose was having sufficient space for the proper dibbling of the grass. The strength of the coir netting was monitored at regular intervals so as to understand the longevity of the material under natural conditions in the region. It has been found that the strength of the yarn was reduced to its half after a period of 6 months which indicates that the netting will last for about 5 years under the normal conditions in that region. The method of such estimation was followed as per the half life method usually adopted. It was assumed that after 10 half lives the fabric will be completely degraded and will be the part of soil. Based on these, it has been derived that the fabric will be totally degraded after 5 years under the normal conditions in the region. In the process the degradation products of the coir helped the good growth of the plantation for permanent consolidation of the soil on the slope (Figure 4).

The pH of the soil at the time of laying the geotextile in the region was 4.3 and the organic carbon percentage was 0.18. After the laying of coir geotextile on the slope the organic carbon percentage increased to 0.46. The growth of lemon grass was abundant in the area where the geofabric was laid. The length of the roots was found to be more than 1.5 ft (Figure 5) and the leaves of the grass grew between 3 ft and 4 ft.

It was also found that the lemon grass did not grow so abundantly in the nearby area where it was planted without the aid of coir geotextiles. It was estimated that the growth in this area was 1/3 of the growth in the geotextile treated area. Even that growth was in patches, not homogeneous.

There was a marginal increase in the nitrogen and potassium content of the area where geotextiles were applied. However there was a substantive increase in the phosphorus content of the area which increased from 0.140 to 0.195%.

The above results indicate that coir geotextile has been successful in controlling erosion by establishing the vegetation in the erosion control area by protecting root slips of lemon grass as well as providing essential nutrients to the soil. Use of coir geotextile is economically viable and is an environmentally friendly method of protecting the slopes in the erosion prone areas.

Experiment II

24th kilometer of left bank canal bund road near second road crossing of Thodupuzha-Ramamangalam road, Kerala.

Figure 4. The left bank main canal after geotextile treatment.

Figure 5. The well grown lemon grass along with its root, extending more than 1.5 ft.

The work involved covered an area of 800 sq.mtr. (Figure 6(a)) and the idea was to protect the slope which was very much vertical and high (1V:1H). The coir geotextiles of MMV_1 (H_2M_5) quality were laid on the slope and the seeds of lemon grass as well as the root slips were planted on the geofabric applied surface. The area was treated with water in the beginning two times a day to keep the fabric moistened as at that time of the year there was no rainfall. Substantial growth of the lemon grass was observed in this area and the slope has been well protected by the application of coir netting (Figure 6(b)).

Experiment III

The site was selected as per the suggestion of a private contractor, namely, M/s. Elite Gardiena, Trichur, who was bringing up a housing complex above the road slope and there was a need to protect it against abundant soil erosion in the area (Figure 7).

It was a steep slope with sandy soil not supportive of vegetative growth so the fabric chosen for protecting the slope was of heavier construction i.e., MMV_1 (H_2M_5) quality. The gap in the nettings was about 1/2".

Figure 6(a). Laying of coir geotextile at the road slope at Moovattupuzha.

Figure 6(b). The road slope at Moovattupuzha after protection with the coir geotextile.

Figure 7. The road slope at Elite Gardenia, Trichur, Kerala, before geotextile application.

The root slips of vetiver grass were planted in the mesh openings considering their deep, strong fibrous root system. The effective erosion control has been observed on the slope due to the deep penetration of the roots of vetiver grass slips (Figure 8(a)).

Due to the nature of the soil (sandy) the growth of vegetation was slightly delayed, however, with the onset of monsoon the plants grew well and have established the slope (Figure 8(b)).

CONCLUSION

The projects have been completed and the abundant growth of vegetation is there in the areas treated with the coir geotextiles. The technique is cost effective as well as simple.

RECOMMENDATIONS

From the above study it is concluded that the coir geotextiles of comparatively lighter construction as for

Figure 8(a). Road slope protection at Elite Gardenia, Trichur, Kerala by coir geotextile.

Figure 8(b). A close up view of the protected slope with the coir geotextile.

example MMV_2 (H_2M_6) quality are most suitable for soil erosion control in the heavily rain fed areas of slopes (2V:1H). Further the 1" grids allow more space for the root slips to grow. On the road embankments which are of very steep nature (1V:1H and 0.25V:1H) the kinetic energy of the water is very high. Hence it is advisable to use the MMV_1 (H_2M_5) quality of fabric which is of comparatively heavier construction. In the sandy soil and steep slopes also the heavier construction like MMV_1 (H_2M_5) has proved to be successful for the effective soil erosion control.

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