Proceedings of the Peradeniya University Research Sessions, Sri Lanka, Vol. 15, 16th December 2010

ON THE DURABILITY OF BITUMEN COATED COIR FOR ITS USE AS GEO-REINFORCEMEN

S. Kawsihan, L.C. Kurukulasuriya, R. Suveenthan and R. Subhananthan

Department of Civil Engineering, University of Peradeniya

Introduction

Coir fibers are extracted from the fibrous outer shell of coconut. The individual fiber cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature but later become hardened and yellowed as a layer of lignin is deposited on their walls (Mwasha, 2009). In comparison to other natural fibers like sisal or tobacco, coir fiber is found to be resilient, strong, highly durable but less flexible. There are two varieties of coir: brown and white. Brown coir is harvested from fully ripened coconuts. It is thick, strong and has high abrasion resistance. White coir is extracted from the husks of coconuts harvested shortly before they are mature. These fibers are softer and much weaker than brown coir.

Geo-textiles made out of brown coir are ideally suited for low cost applications, because coir is available in abundance, and it is a biodegradable product. The tensile strength of geotextiles made of coir is reduced to 30% of their initial strength when subjected to natural field conditions for 7 months and to 19% after 9 months (Vishnudas *et al.*, 2006). Therefore, if the coir is to be used as a reinforcing material in an internally stabilised wall the durability of the coir should be improved. In this study, application of a bitumen coating on the improvement of durability of coir is investigated for its use in internally stabilized walls. For this purpose, 1M NaOH solution is used as the corrosive environment which the coir ropes will come into contact with.

Methodology

Initially, coir ropes of length 900 mm and having diameters of 3.88 mm (D1), 6.99 mm (D2), 9.46 mm (D3) and 18.58 mm (D4) were selected as samples for this study. A set of coir rope samples were then immersed in bitumen for a period of 60 s that has been heated up to 80° C. Then, coated and uncoated samples were placed in a 1M NaOH solution in order to expose the coir fiber to the corrosive environment. Every fortnight, up to eight weeks, a set of coated and uncoated coir rope samples were taken out from the NaOH solution to be tested in a Hounsfield Tensile Test apparatus following a method similar to that described in BS 6906. Samples were allowed to air dry for a period of one week before the tensile test. The degree of degradation the coir samples have been subjected to during the period of exposure in the NaOH solution was determined by evaluating the mass and the strength reduction. Mass reduction calculations and tensile tests were done only on 100 mm gauge length of the sample (Fig.1).

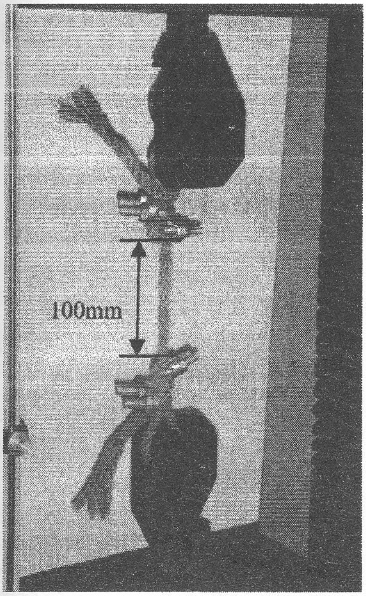

Fig. 1. Tensile Test Arrangement for an Uncoated Sample.

Results

Fig.2 shows the relationship between percentage mass reduction and the period of exposure for uncoated samples and Fig.3 shows the relationship between percentage mass reduction and period of exposure for coated samples.

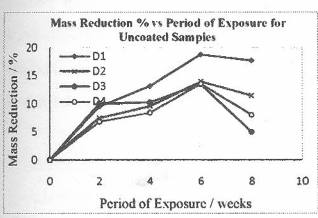

Fig. 2. Variation of Percentage Mass Reduction with Period of Exposure for Uncoated Samples

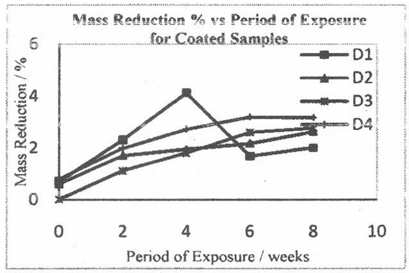

Fig. 3. Variation of Percentage Mass Reduction with Period of Exposure for Coated Samples

Fig. 4 shows the relationship between load at failure and period of exposure for coated samples and Fig.5 shows the relationship between load at failure and period of exposure for uncoated samples.

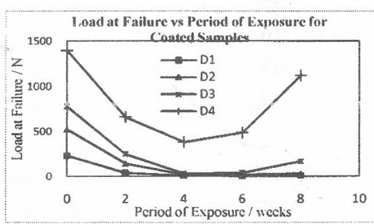

Fig. 4. Variation of Load at Failure with Period of Exposure for Coated Samples

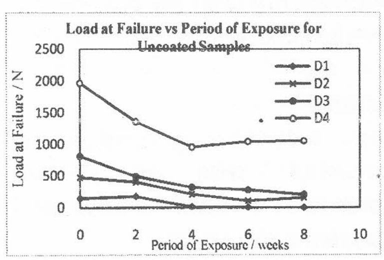

Fig. 5. Variation of Load at Failure with Period of Exposure for Uncoated Samples

Discussion

It should be emphasized that coir ropes cannot be considered as having a uniform diameter throughout its length. Further, it is unpreventable that a small percentage of coir fiber tends to fall out from the uncoated rope. However, with such characteristics being inherent in coir ropes, the results clearly show an increase in % mass reduction with the increase of the duration of exposure in NaOH solution but comparatively at a lower rate in coated samples. A close visual examination of the uncoated ropes exposed in the solution for a period of 8 weeks showed a deposition of NaOH thus explaining the apparent mass gain after 6 weeks. However, this study shows that the bitumen coating of the coir ropes has caused a greater loss of tensile strength than that for the uncoated coir ropes, though the causes leading to such a decrease in strength are not investigated. Therefore, the use of bitumen coated coir ropes as reinforcing material in internally stabilized earth retaining structures cannot be recommended especially in an alkaline environment due to the reduction in strength with duration of exposure. Hence, the possibility of the use of another material for coating the coir needs to be investigated.

Conclusions

(1) Mass reduction percentage is increasing with period of exposure for both coated and uncoated coir ropes.

(2) Mass reduction percentage of bitumen coated coir ropes is less than that of uncoated ropes.

(3) Load at failure of coated samples is less than that of uncoated samples under the same exposure conditions.

(4) Bitumen coated coir ropes have not shown improved durability to be considered as having the potential to be used as geo-reinforcement due to its reduction in tensile strength.

References

BS 6906 : Part 1 : 1987; British Standards Institution.

Mwasha A. P. (2009). Coir fibre: A sustainable engineering material for the Caribbean environment. The College of the Bahamas Research Journal, 15, 36-44.

Vishnudas S., Sanenije H.H.G., Van der Zaag P., Anil K.R. and Balan K. (2006). The Protective and Attractive Covering of a Vegetated Embankment Using Coir Geotextiles. Journal of Hydrology and Earth System Sciences, 10, 565-574.