DEVELOPMENT OF A BIO-COMPOSITE INTERLOCKING BLOCK SYSTEM FOR RIVER REVETMENT

By

NOR AZLINA BINTI ALIAS

Thesis Submitted to the School of Graduate Studies Universiti Putra Malaysia in Fulfilment of the Requirement for the Degree of Master of Science

September 2006

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DEVELOPMENT OF A BIO-COMPOSITE INTERLOCKING BLOCK SYSTEM FOR RIVER REVETMENT

By

NOR AZLINA BINTI ALIAS

September 2006

Chairman: Associate Professor Thamer Ahmed Mohamed, PhD

Faculty: Engineering

In Malaysia, many types of revetment systems are used in channel lining. These systems are mostly manufactured and patented overseas or designed using technologies transferred from foreign countries. Development of an interlocking block with environmental consideration is a new approach that may help in river protection and restoration. It is important to design and develop locally a new revetment block which is economical, durable and environmentally friendly.

In this study, a block has been developed to be used as river revetment. As it also incorporates a bio-material, it is called a bio-composite revetment block. The block has a dimension of 400 mm x 400 mm x 100 mm (length x width x thickness) and it is designed to resist forces developed after installation at site and it complies with the requirements of the design and theory of existing blocks. The bio-composite block is made of concrete and it consists of tongue and groove to provide self interlocking between the blocks. In the opening at the centre of the block, a 10 mm layer of coconut husk is held in its place by two layers of plastic meshes that are embedded in concrete.

Laboratory tests carried out were the flexural and tensile strength test on a single and multiple blocks. To conduct these tests, a special testing set-up was used. Direct tensile tests for single blocks indicate the failure was at 9.16 kN while for a group of blocks, the system failed at 5.81 kN. A finite element software called ANSYS was used to validate the failure pattern obtained from the laboratory tests and it was found to be in agreement with the predicted failure pattern by ANSYS. Laboratory experiment on biological materials showed that the coconut husk was the best medium for grass to grow compared to other media (oil palm husk and sugar cane husk).

Field tests were conducted in which a 15 m stretch of a stream inside Universiti Putra Malaysia with a top width of 7 m was selected to install the bio-composite block. The purpose of field test is to measure the flow velocity and Manning roughness coefficient for the bio-composite block after installation. The average value of Manning roughness coefficient was found to be 0.040. The stability of the block and the rate of grass growth were also monitored. There was no block failure observed and a rapid grass growth was noticed with a rate of growth of 1.4% to 15% per week.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PEMBANGUNAN SISTEM BLOK BIO-KOMPOSIT SALINGKUNCI UNTUK LAPIS LINDUNG SUNGAI

Oleh

NOR AZLINA BINTI ALIAS

September 2006

Pengerusi: **Profesor Madya Thamer Ahmed Mohamed, PhD**

Fakulti: **Kejuruteraan**

Di Malaysia, banyak jenis blok lapis lindung yang digunakan dalam projek-projek perlindungan saluran. Blok-blok ini dikilangkan serta diimport dari luar negara ataupun direkabentuk menggunakan teknologi-teknologi yang dibawa masuk dari negara luar. Merekabentuk blok lapis lindung yang baru dengan mengambilkira keadaaan alam sekitar adalah satu pendekatan baru dalam mengekalkan keadaan sungai yang sedia ada dan ia penting untuk membangunkan blok lapis lindung yang ekonomi, tahan lasak dan mesra alam.

Dalam kajian ini, blok mesra alam dicadangkan sebagai lapis lindung sungai dan dinamakan blok lapis lindung bio-komposit. Blok ini berdimensi 400 mm x 400 mm x 100 mm (panjang x lebar x tebal) dan direkabentuk untuk menahan daya terorak selepas pemasangan dengan mematuhi keperluan rekabentuk dan teori digunakan blok sedia ada. Blok lapis lindung bio-komposit ini mempunyai lidah dan alur yang menyediakan salingkunci diantara blok dan bukaan tengah blok. Di bukaan tengah blok, sabut kelapa setebal 10 mm dipegang oleh dua lapisan jejaring plastik dan dibenamkan dalam konkrit.

Ujian-ujian makmal dilakukan termasuk lenturan dan terikan keatas satu dan gabungan beberapa blok. Untuk mejalankan ujikaji, satu rangkaian khas untuk ujian dibuat. Ujian terikan keatas blok individu mencatatkan kegagalan adalah pada nilai terikan 9.16 kN manakala ujian keatas blok gabungan gagal pada nilai terikan 5.81 kN. Perisian Unsur Terhingga yang dikenali sebagai ANSYS digunakan untuk mengesahkan paten kegagalan dari ujian makmal dan paten kegagalan dari ujian makmal didapati sama dengan paten kegagalan yang diramal oleh ANSYS. Eksperimen di makmal ke atas bahan biologikal menunjukkan bahawa sabut kelapa merupakan penggalak terbaik sebagai media pertumbuhan berbanding media lain (sabut kelapa sawit dan sabut tebu)

Ujian di tapak dilakukan di mana sungai sepanjang 15 m dengan lebar permukaan 7 m di Universiti Putra Malysia digunakan untuk memasang sistem ini. Tujuannya adalah untuk mengukur halaju air dan pekali kekasaran Manning bagi blok bio-komposit selepas pemasangan. Nilai purata pekali kekasaran Manning adalah 0.040. Kestabilan blok dan kadar pertumbuhan rumput juga dicerap. Tiada kegagalan blok dicerap dan kepantasan pertumbuhan rumput dapat dikesan dengan kadar pertumbuhan sebanyak 1.4% hingga 15% dalam tempoh seminggu.

ACKNOWLEDGEMENTS

Thanks and gratitude to God for His Blessing and Grace, this thesis could be written successfully.

Special thanks and appreciation are due to my supportive supervisors; Assoc. Prof. Dr. Thamer Ahmed Mohammed, Assoc. Prof. Dr. Abdul Halim Ghazali and Assoc. Prof. Dr. Mohd Saleh Jaafar for their advice, guidance, ideas, their generous help and comments and encouragement during completing this project.

Special appreciation is extended to the technicians of Civil Engineering Department (UPM), especially to Mr. Mohd. Halim Othman for his help and cooperation during the development of this project. Deepest appreciation is also extended to the Department of Civil Engineering, Faculty of Engineering for providing all the facilities to complete the project successfully.

Greatest thanks are also extended to my beloved parents and friends for their encouragement through out my studies and their support in the making of the thesis.

Lastly, I would like to acknowledge all who have contributed towards the completion of this thesis.

I certify that an Examination Committee has met on 8 September 2006 to conduct the final examination of Nor Azlina Binti Alias on her Master of Science thesis entitled "Development of a Bio-composite Interlocking Block System for River Revetment" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Mohd. Razali Abdul Kadir, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Lee Teang Shui , PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Katayon Saed, PhD
Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Othman Abdul Karim, PhD
Associate Professor
Faculty of Engineering
Universiti Kebangsaan Malaysia
(External Examiner)

HASANAH MOHD. GHAZALI, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Thamer Ahmed Mohammed, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Abdul Halim Ghazali, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Mohd. Saleh Jaafar, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

_____
AINI IDERIS, PhD
Professor/ Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

NOR AZLINA BINTI ALIAS

Date:

TABLE OF CONTENTS