ASSESSMENT OF TSUNAMI AND STORM SURGE IMPACT MITIGATION BY COASTAL VEGETATION

By

R.B.C.D. Manawasekara

A thesis submitted to University of Moratuwa
for the Degree in Master of Science

Research Supervised

By

Prof. S. P. Samarawickrama

Mr. A. H. R. Ratnasooriya

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF MORATUWA
SRI LANKA

September 2010

ABSTRACT

The devastation caused by the Indian Ocean tsunami in 2004 and subsequent tsunami alerts in 2005 and 2007 as well as the historical records of possible tsunamis in the past have highlighted the vulnerability of the country to such major hazards. More than two third of the 1600 km long coastline in the Northern, Eastern, Southern as well as part of relatively sheltered Western regions suffered with a widespread damage in the event. The damage caused by the tsunami varied significantly with the local near shore wave height, topography and the resistance offered to the overland flow. In addition to the ground surface resistance the resistance offered by the various features in the coastal zone is among the factors contributing to such hydraulic resistance. These features include coastal infrastructure such as buildings as well as natural features such as coastal green belts. The study on the effect of such contributory features is important in identifying and planning possible tsunami impact mitigation measures. In this study, attention is focused on the resistance offered by coastal green belts to overland flow and their effectiveness as a possible tsunami impact mitigation measure. Such a measure would also have the dual advantages of being environmentally friendly and cost effective, which could be a more suitable method for developing countries like Sri Lanka.

In this study investigation conducted to assess the influence of coastal vegetation in resisting the overland flow. The resistance would depend on characteristics of individual plant structure and the vegetation as a whole, as well as the ability of plants to resist the flow without being damaged or destroyed. The factors affecting the drag force were related to the characteristics describing a vegetation, namely, plant type, size, extent, spacing & pattern. Experimental & numerical studies were conducted to assess the influence of these characteristics on energy dissipation of the flow under steady condition and reduction in inundation distance under unsteady flow. Small scale physical model tests were carried out in a hydraulic flume (length 10 m, width 30 cm and depth 30 cm). Coastal vegetation was represented by geometrically similar small scale models and energy dissipation characteristics were observed under different discharge conditions. Experiment results indicate up to about 48% of energy loss through the vegetation and it highlight the contribution of different patterns and densities of vegetation in effective impact mitigation.

ACKNOWLEDGEMENT

I wish to pay my heartiest gratitude to my supervisors Mr. A.H.R. Ratnasooriya and Prof S.P. Samarawickrama, who suggested this research problem and offered the most valuable guidance and encouragement throughout this study. At the same time, I have the pleasure in thanking Prof. S.S.L. Hettiarachchi and Prof. J.M.S.J. Bandara & Dr. Nimal Wijerathna, for having reviewed my research work and advising me in improving it. I also want to thank the Head of the Department of Civil Engineering for permitting me to make use of the resources of the department which indeed facilitated me to carry out my work unhindered.

I am grateful to Mr. Kithsiri Nandasena and Prof. Nario Tanaka for the fruitful guidance on vegetation modeling and for providing guidance and support for the research work.

I would like to acknowledge the staff members of the Hydraulic and Water Engineering Laboratory and also wish to record my appreciation to Ms. Harini Thalagala, Mr. P.K.C. De Silva, Mr. I.S.K. Wijewardena, Mr. R.M.J. Bamunawala, Mr.K.M.M. Ansaf, Mr. V.A.N. Soysa, Ms. A.V.A.U. Karunathilaka and Mr. Janitha Batagoda for the immense support and motivating me in carrying out the research work.

I convey my thanks to non-academic staff Mr. Lahiru Ariyarathna, Mr. Gunasekara, Mr. Wajira Kumarasinghe, Mr. K.T. Priyantha and Mr. Gamini for their kind support in conducting field studies, developing the physical model and conducting laboratory experiments.

I extend my gratitude to the University of Moratuwa Senate Research Fund for financial assistance provided for my research work.

I wish to thank my parents, sister and brother for the encouragement support given and standing by me throughout.

R.B.C.D. Manawasekara

DECLARATION

This thesis is a report of research carried out in the Department of Civil Engineering, University of Moratuwa, between July 2008 and August 2010. Except where references are made to other work, the contents of this thesis are original and have been carried out by the undersigned. The work has not been submitted in part or whole to any other university. This thesis contains 62 pages.

.....

R.B.C.D. Manawasekara,
Department of Civil Engineering,
University of Moratuwa.
Sri Lanka.

.....

Supervisor
Prof. S.P. Samarawickrama,
Department of Civil Engineering,
University of Moratuwa.
Sri Lanka.

.....

Supervisor
Mr. A. H. R. Ratnasooriya,
Department of Civil Engineering,
University of Moratuwa.
Sri Lanka.

CONTENTS

Chapter 2 : Overview of the Previous Investigations

Chapter 3 : Mechanism of Impact Mitigation

Annexes

LIST OF FIGURES

LIST OF TABLES