INVESTIGATING THE PERFORMANCE OF BERMS IN RUBBLE MOUND BREAKWATERS

MASTER OF PHILOSOPHY

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UNIVERSITY OF MORATUWA

SRI LANKA

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The work included in this Thesis in part or whole has not been submitted for any other academic qualification at any Institution

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Investigating the Performance of Berms in Rubble Mound Breakwaters

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ABSTRACT

The results of a comprehensive study on the hydraulic performance of rock armoured rubble mound breakwaters are presented. Based on an extensive literature review, results from selected previous investigations were re-analyzed following which, the scope of a major hydraulic model study of a large scale was developed and implemented.

The results from the hydraulic model study were compared with similar studies reviewed to arrive at conclusions on the hydraulic performance of rock armoured rubble mound structures with emphasis on the use of a berm for a greater efficiency with respect to energy dissipation.

In this study, a large scale model of a rock armoured rubble mound berm breakwater was tested to obtain a complete profile of energy transformation resulting from wave-structure interaction. Attention was focused on achieving reliable estimates of wave reflection and direct measurements of wave transmission as such information are essential for the evaluation of energy dissipation. In addition, two other structures were investigated to assess their hydraulic performance under extreme wave conditions.

In all the structures considered, the hydraulic performance was presented in relation to the wave conditions, structural geometry and water depth.

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The support extended by the Lanka Hydraulic Institute during model testing and by providing relevant information for this study is greatly appreciated.

I acknowledge with thanks the financial assistance given by the Institute of Technology, University of Moratuwa (ITUM) for my postgraduate studies. The encouragement and support given by Dr. T.A.G. Gunasekara, Director, ITUM and my colleagues during this study is greatly appreciated.

Special thanks are due to Prof. S.A.S. Kulathilaka and Prof. J.M.S.J. Bandara for their encouragement during the study period. My sincere thanks are also due to Premini and Saman for their encouragement and support.

Finally I am very grateful for my husband Harsha for the helping hand given and for the continuous encouragement.

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LIST OF SYMBOLS

The most important symbols used in the text are listed below. Variables which have been used locally are not listed but are defined in the text.

a	Steady laminar flow coefficient in the Forchheimer equation
b	Steady turbulent flow coefficient in the Forchheimer equation
B	Length of the berm
C_d	Coefficient of wave energy dissipation
C_{d1}	Coefficient of wave energy dissipation at probe 1
C_{d2}	Coefficient of wave energy dissipation at probe 2
C_{d3}	Coefficient of wave energy dissipation at probe 3
C_{de}	Coefficient of wave energy dissipation at external probe
C_r	Coefficient of wave energy reflection
C_t	Coefficient of wave energy transmission
C_{t1}	Coefficient of wave energy transmission at probe 1
C_{t2}	Coefficient of wave energy transmission at probe 2
C_{t3}	Coefficient of wave energy transmission at probe 3
C_{te}	Coefficient of wave energy transmission at external probe
E_k	Mean kinetic energy per unit surface area
E_p	Mean potential energy per unit surface area
E_T	Total energy per unit surface area
E_i	Incident wave energy
E_d	Dissipated wave energy
E_{d1}	Dissipated wave energy at probe 1
E_{d2}	Dissipated wave energy at probe 2
E_{d3}	Dissipated wave energy at probe 3
E_{de}	Dissipated wave energy at external probe
E_r	Reflected wave energy
E_t	Transmitted wave energy
E_{t1}	Transmitted wave energy at probe 1

E_{t2}	Transmitted wave energy at probe 2
E_{t3}	Transmitted wave energy at probe 3
E_{te}	Transmitted wave energy at external probe
f	Non-Darcy friction factor
g	Acceleration due to gravity
h	Constant water depth outside the structure
H	Wave height
H_i	Incident wave height
H_t	Transmitted wave height
H_r	Reflected wave height
H_s	Significant wave height
H/L	Wave steepness
H/L_o	Wave steepness in deep water
I	Hydraulic gradient
Ir	Surf similarity parameter/Iribarren Number
L	Wave length
L_o	Wave length in deep water
P	Porosity
Q	Overtopping discharge
R	Wave run-up
R/H	Relative run-up
T	Wave period
T_m	Mean wave period
T_p	Peak wave period
t	Time
u	Horizontal component of the macroscopic (bulk) velocity
u_p	Particle velocity
u_i	Particle velocity of the incident wave
u_r	Particle velocity of the reflected wave
u_t	Particle velocity of the transmitted wave
W_i	Energy flux of the incident wave

W_d	Energy flux of the dissipated wave
W_t	Energy flux of the transmitted wave
W_r	Energy flux of the reflected wave
α	Slope angle
η	Free surface elevation relative to still water level
η_i	Free surface elevation of the incident wave relative to still water level
η_r	Free surface elevation of the reflected wave relative to still water level
η_t	Free surface elevation of the transmitted wave relative to still water level
τ	Square root of tortuosity
γ	Unit weight of fluid