DEVELOPMENT OF AN ANALYTICAL MODEL TO STUDY WAVE MOTION THROUGH POROUS VERTICAL COASTAL STRUCTURES

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By

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This Thesis has not been previously presented in whole or part to any University or Institution for a Higher Degree.

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ABSTRACT

This study is concerned with the development of an analytical model to predict wave reflection and transmission characteristics of porous, vertical coastal structures. Because of the complexity of the problem the study was limited to non-breaking, small amplitude, long waves normally incident to the structure.

The input data for the model are the incident wave characteristics and the properties of the porous media. The wave climate is identified by the wave height, the wave period and still water depth. The porous structure is characterised by its length, overall porosity and the laminar and turbulent flow coefficients (determined under steady flow conditions). The Forchheimer equation was used for the hydraulic gradient-velocity relationship. Continuity and momentum equations are linearised for the inclusion in the model.

The model was verified with results obtained from hydraulic model investigations carried out at Imperial college, London and Lanka hydraulics institute, Sri Lanka. Satisfactory agreement was obtained between experimental and predicted values.

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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	back interface of the open block structure
B	length of the structure
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
f	front interface of the open block structure
g	acceleration due to gravity
h	constant water depth outside the structure
H_o	height of the wave at the front interface
H_i	incident wave height
H_t	transmitted wave height
H_r	reflected wave height
H_{if}	incident wave height at the front interface
H_{ib}	incident wave height at the back interface
H_{tf}	transmitted wave height at the front interface
H_{tb}	transmitted wave height at the back interface
H_{rf}	reflected wave height at the front interface
H_{rb}	reflected wave height at the back interface
I	hydraulic gradient
j	loss coefficient at the interface
j_f	loss coefficient at the front interface
j_b	loss coefficient at the back interface
k	coefficient of permeability
k^*	coefficient of effective permeability

K_T	coefficient of transmission
K_R	coefficient of reflection
K_{tf}	coefficient of transmission at the front interface
K_{tb}	coefficient of transmission at the back interface
K_{rf}	coefficient of reflection at the front interface
K_{rb}	coefficient of reflection at the back interface
P	porosity
P_1	porosity of medium 1
P_2	porosity of medium 2
T	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	phase difference with respect to the incident wave
δ	phase difference between η and u
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