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"Research Note"

EXPERIMENTAL INVESTIGATION ON RESPONSE AND EFFICIENCY OF MOORED PONTOON TYPE FLOATING BREAKWATERS[*]

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Abstract– This paper presents the experimental results of an investigation on the response and efficiency of floating pontoon type breakwaters. Random waves modeled by the Pierson Moskowits wave spectrum are used for various configurations of floating breakwaters. The experimental results are presented in graphs for the transmission coefficient as a function of incident wave length and height for breakwaters used in this study. The obtained results for the breakwaters of this study show that by increasing the wave period and length, the transmission coefficient increases, while increase in the mass and draft of the floating breakwater causes the transmission coefficient to reduce.

Keywords– Floating breakwater, model testing, irregular wave, transmission coefficient

1. INTRODUCTION

A floating breakwater may be defined as a structure or device which combines the ability to appreciably reduce the height of ocean waves with a degree of mobility sufficient to allow its ready transportation and fast installation when arriving at a site. Among different types of breakwaters the pontoon type include several different models such as the ladder type, catamaran type, sloping-float (inclined pontoon), and frame type. Wave energy reflection, transformation and dissipation are the main mechanism for wave height reduction by any floating breakwater. Based on a model test, Blumberg and Cox [1] presented design curves for both transmitted wave height and maximum horizontal loading as functions of incident wave height and period. Sannasiraji *et al.* [2] have also carried out investigations on the pontoon type floating breakwaters. They have calculated mooring forces and the motion response of pontoon type floating breakwaters.

Yao *et al.* [3] selected the optimal type of floating breakwaters by experimental study. They used regular waves and ten types of improved floating breakwaters for their study.

The present experimental investigation is the result of more than 700 experiments on five types of pontoon type floating breakwater with different drafts. The Pierosn-Moskowits wave spectrum has been selected for most of the experiments. Incident waves with different heights and periods are used in the study. The response and efficiency curves for each type of pontoon floating breakwater given in this paper may be applied for design purposes in the equivalent scaled sea conditions.

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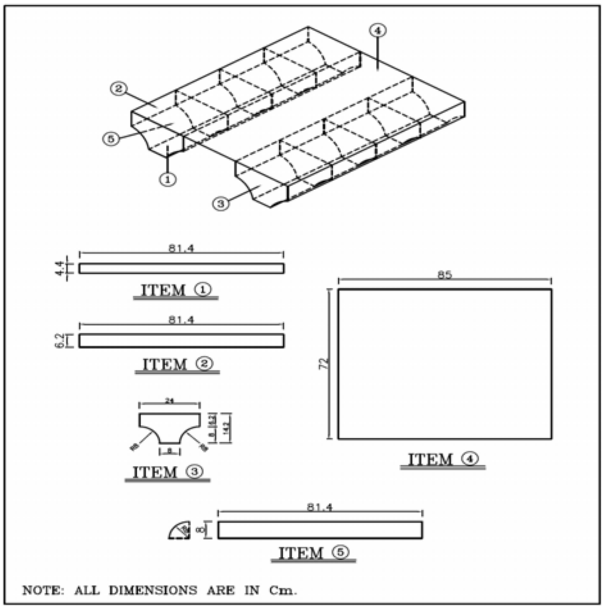
2. LABORATORY FACILITY, INSTRUMENTATION AND TEST MODELS

The wave flume at the hydraulic laboratory of soil conservation and watershed management research center (SCWMRC) has a 33m length, 5.5m width and a 1.5m depth. A computer controlled hydraulic drive piston type wave generator is positioned at one end of the flume and a 1 in 8-rock slop absorber for damping wave reflection at the other. For recording incidents and transmitted wave heights, a standard capacitance wave height meter with a 65cm length are used. Five wave height meters are used to measure the H_t, H_i and reflected wave height. The two on each side of the floating breakwater are used to measure the H_t and H_i, while the other three are used to give the reflected wave height. Figure 1 gives the dimensions for a catamaran with two-curved keel pontoons used in this study.



NOTE: ALL DIMENSIONS ARE IN Cm.

Fig. 1. Dimensions of the catamaran with two curved keel

3. MODEL TESTING

After constructing models, synthetic silk with a minimum-breaking load of 350N is used to moor them. The models are placed in the flume with a distance of 11m and 20m from paddle and spending beach, respectively.

For each experiment, the wave is generated by the wave synthesizer with given wave parameters. Apart from the first few experiments where regular wave has been implemented, a Pierson-Moskowitz wave spectrum is used for most cases. More than 700 experiments are carried out with different wave parameters and model configurations. Transmission coefficient (C_t) is calculated from the data recorded by these sensors using the Goda [4] method.

4. EXPERIMENTAL RESULTS

Each model has been tested with different configurations, and a variety of incident waves with a period of 3 seconds. The results for a floating pontoon breakwater are compared with those obtained by Blumberg and Cox [5] in Figs. 2 and 3. In these figures H_t vs. H_i is plotted. There is an excellent agreement between the results of the current study and the results given by Blumborg and Cox in most cases. In Fig. 2 the results of the current study demonstrate lower values for the transmitted waves compared with those given by Blumberg and Cox, although the trend is the same. This is mainly because of a 90cm draft in this study and a 40cm draft in the study by Blumberg and Cox. The results obtained for a catamaran with a 72cm width and 30cm draft is compared with the result of a catamaran with a 72cm width and 40cm draft in Fig. 3. Comparing higher values obtained for H_t, in this example by applying a lower draft with those obtained by a former researcher proves that draft is the main reason for the difference in the results of the two investigations.

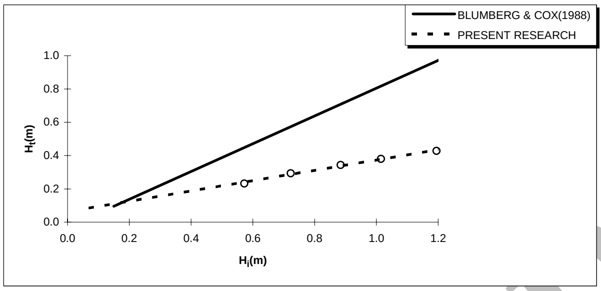


Fig. 2. H_t versus H_i for a pontoon type floating breakwater of width 72 cm

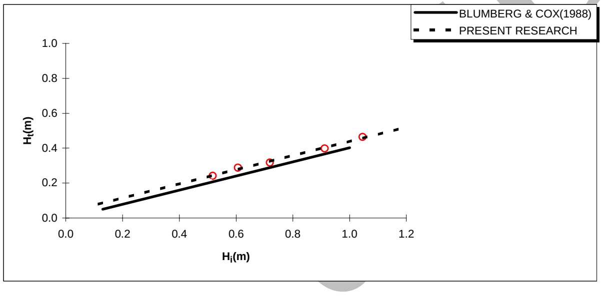


Fig. 3. H_t versus H_i for a catamaran floating breakwater of width 72 cm

5. IRREGULAR WAVES

The Pierson-Moskowits wave spectra are used for this part of the investigation. The effect of different model and wave parameters on the transmission coefficient has been investigated as follows:

Floating breakwaters experimented with three different drafts of 90, 110, and 130cm. Results for a catamaran of 72cm width and different wave periods are given in Fig. 4. For a given incident wave condition, increasing draft or (D/d) has been shown to result in reduced wave transmission, because of greater wave energy reflection.

Widths of 24, 48, and 72cm are considered for investigating the width effect. B/L is the parameter used for this purpose. Results are presented in Figs. 5-7. The results from these experiments show that the transmitted wave height decreases by increasing the values of B/L.

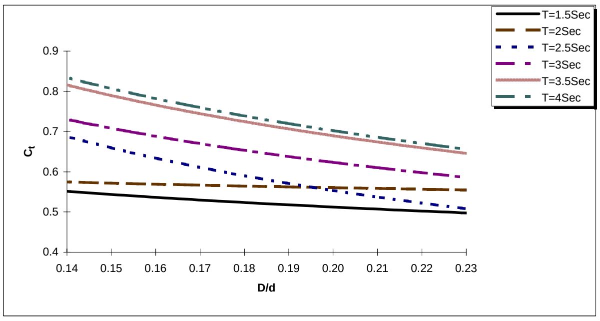


Fig. 4. C_t versus D/d for a catamaran floating breakwater of width 72 cm and different wave period

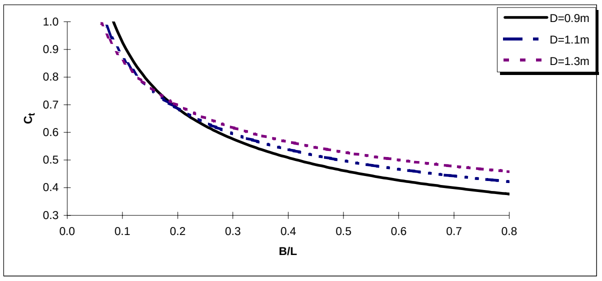


Fig. 5. C_t versus B/L for a floating pontoon breakwater of 24 cm width and different drafts

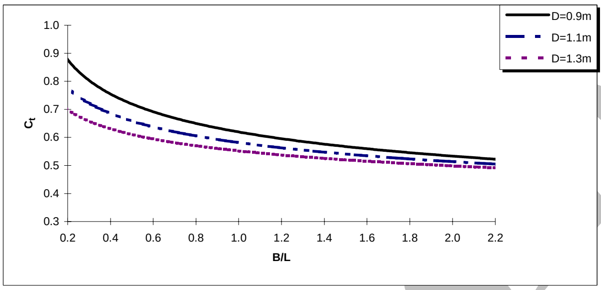


Fig. 6. C_t versus B/L for a catamaran floating breakwater of width 72 cm and different drafts

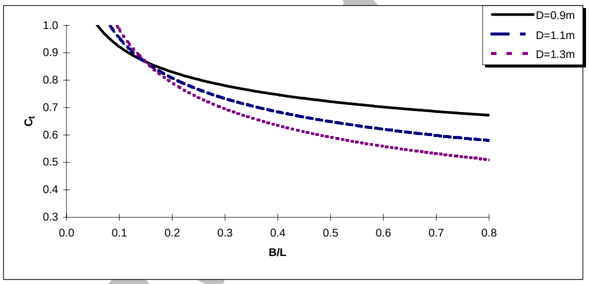


Fig. 7. C_t versus B/L for a curved keel pontoon of width 24 cm and different drafts

6. WAVE PERIOD

A comparison between the results of this research with those obtained by Wright *et al*. [5] is given in Figs. 8 and 9. In these figures transmission coefficient C_t is plotted versus wave period T. Variation in C_t as a function of T in these figures is similar to the results of the Wright study. The differences in C_t values for these two investigations are due to the different values of drafts used in these studies. Results of these experiments indicate that for wave periods of less than 4 seconds the transmission coefficient increases by increasing the period of the wave, however after that it remains almost the same by increasing the wave period.

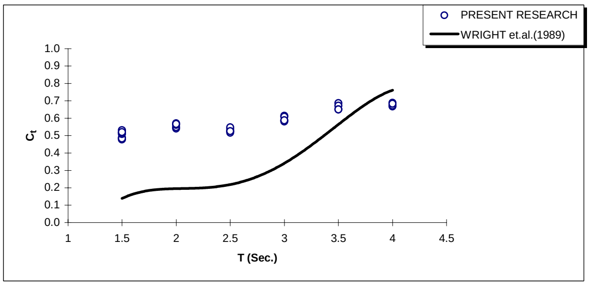


Fig. 8 C_t versus wave period for a catamaran floating breakwater of width 72 cm

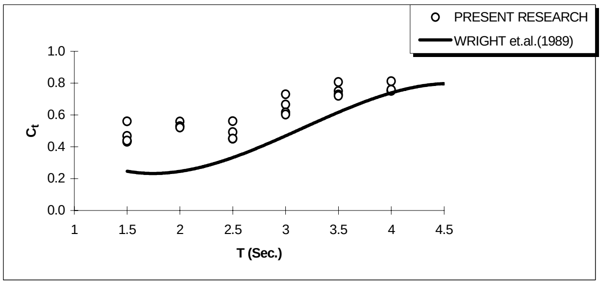


Fig. 9 C_t versus wave period for a curved keel catamaran breakwater of width 24 cm.

7. CONCLUSIONS

The results of approximately 700 experiments on the dynamic response and the efficiency of floating pontoon breakwaters of different configurations to random waves modeled by the Pierson Moskowits wave spectrum is presented.

For similar conditions there is an excellent agreement between the results of this study and those obtained by other researchers.

The results of experiments carried out on breakwaters of this study show that by increasing draft (D/d), the wave transmission reduces.

The effect of the breakwater width used in this study on the transmitted wave height is also evaluated. Although increasing the breakwater width results in a decrease in the transmitted wave height, after B/L=0.8 the transmission coefficient remains almost constant in this study.

The results of research on the breakwaters of this study show that the wave period significantly changes the transmission coefficient, however for wave periods of more than 4 seconds this change may be neglected.

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NOMENCLATURE

B	breakwater width	H_i	incident Wave Height
D	draft	H_t	transmitted Wave Height
d	water Depth	C_t	transmission Coefficient (H_t/H_i)
L	wave Length	D/d	dimensionless Parameter for Draft
T	wave Period	B/L	dimensionless Parameter for Width

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