IMPROVED HYDRODYNAMIC EFFICIENCY OF PONTOON - TYPE FLOATING BREAKWATERS

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Floating breakwaters (FBs) are among the environmentally friendly coastal structures which may be used for wave protection and restoration of semi-protected coastal regions with generally mild wave conditions. The purpose of this study is to investigate numerically the effect of the FB shape on the hydrodynamic characteristics, including wave overtopping. Such a study requires a detailed analysis of the flow near and over the FB, such as 2DV velocity field, turbulence effects, which have not been found in previous numerical studies. In this study, the COBRAS (COrnell Breaking Waves and Structures) model, developed by Liu and Lin (1997), is used. The model solves the 2D-V Reynolds Averaged Navier-Stokes (RANS) equations in conjunction with transport equations for k and ε for the calculation of the Reynolds stresses. The model uses the Volume of Fluid (VOF) method (Hirt and Nichols (1981) to "track" the free surface location and the partial cell treatment in order to represent solid objects of arbitrary shape. Details can be found in Liu and Lin (1997). The model considers wave reflection, transmission, overtopping and breaking due to waves, and 2DV hydrodynamics properties of the flow near the FB

A numerical wave tank with dimensions 60m x 2.5 m is used. The incident monochromatic waves with wave height H = 0.25 m and wave period T=2.04 sec and 3.16 sec, are generated at a distance of 1.5 L from the left side of the domain. A variable mesh, which is finer close to the FB, is used with 4 sub-meshes in the x-direction, with $0.04<\Delta x<0.02$ and 2 sub-meshes in the y-direction, with $0.02<\Delta y<0.01$. The FB examined in this study has a width W=2.0m and a height H_{br}=0.90 m, which correspond to the common used dimensions in prototype scale (W=4.0m, H_{br}=1.80 m) with a scale parameter of 0.5. The examined shapes are a rectangular, and a trapezoid with slope of 45°, both with draught dr=0.65 m against waves with T= 2.04 and 3.16 sec. The dimensions of the wave tank and the FB are those of available large-scale experiments (Koutandos et al, 2005).

Transmission, reflection and dissipation coefficients (C_T, C_R, and C_D respectively), for the two FB configurations are compared with the experimental results (Koutandos et al, 2005) for the case of the rectangular FB, as shown in Table 1. It is found that the performance of the FB is highly reduced for longer waves and that the FB acts generally in a reflective manner. For the case of the trapezoid FB better results are obtained since the transmission coefficient is reduced by about 50% for T= 2.04 sec and 30% for T= 3.16 sec. For both FB configurations the reflection is similar, while reduced transmission and increased dissipation are found for the trapezoid FB. This can be seen also from figure 1 where the envelopes of the reflective and transmitted waves are shown. In general the greater energy dissipation that occurs in the sloping face of the FB is responsible for the reduced transmitted waves. This can also be seen by the detailed velocity field where, in the seaward side of the trapezoid FB much bigger eddies are formed caused by the complicated flow conditions on the sloping face (figure 2). In conclusion, the trapezoid FB shows reduced wave transmission and increased energy dissipation in its inclined front face for the conditions examined.

Table 1. Numerical and Experimental C_T ,C_R ,C_D coefficients

	Rectangular T=2.04 s	Exp. Data T=2.04 s	Trapezoid T=2.04 s	Rectangular T=3.16 s	Exp. Data T=3.16 s	Trapezoid T=3.16 s
C_T	0.21	0.25	0.11	0.53	0.60	0.38
C_R	0.85	0.88	0.78	0.67	0.62	0.52
C_D	0.48	0.41	0.62	0.52	0.51	0.76

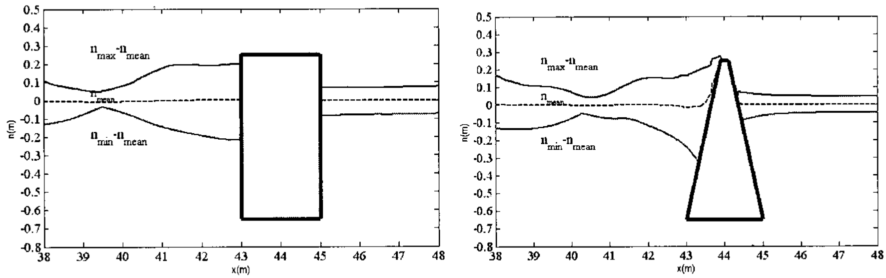

Fig. 1 Wave height envelopes and mean water level for the two FB configurations (T=3.16sec)

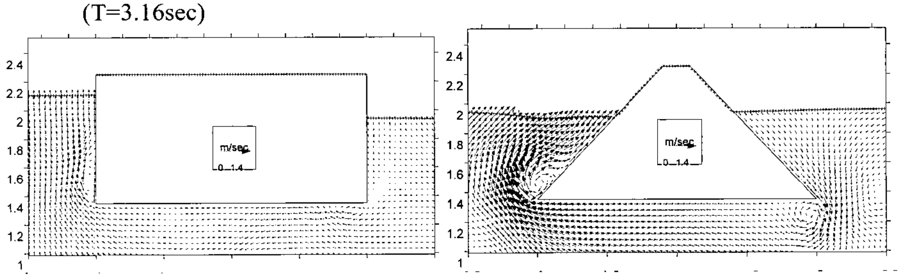

Fig. 2. Mean velocity field at t/T=18.75 (T=3.16sec)

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