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AN EXPERIMENTAL STUDY ON THE CUMULATIVE DAMAGE DEVELOPMENT OF RUBBLE MOUND STRUCTURES

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For the purpose of investigating two-dimensional (2D) performance of the designed cross-sections of rubble mound coastal defense structures planned to be constructed at different coastal regions of Turkey, several physical model experiments were carried out in the Ocean Engineering Research Center, Department of Civil Engineering, Middle East Technical University, Ankara, Turkey. This study presents the comparisons of results of cumulative damage performance of five different cross-sections of rubble mound coastal defense structures (Model 1-5). The cross-sections of different sizes of armor stones (6-10 tones in prototype) and front slopes (1:2-1:5) were designed using Van der Meer's approach (1988; modified by Van Gent et al., 2004, for shallow water conditions). The model scale for all experiments was 1:33.485. The cumulative damage development at the armor layers of the cross-sections were measured by the stone-count method. The percent damage values were converted to the damage parameters (S) by Burcharth et al.'s (2006) method. In the experiments, Bretschneider-Mitsuyasu spectrum was used for the generation of irregular plunging type wave trains. For Model 1, Model 2, Model 3, the structure slope is 1:5. For Model 4 and Model 5, the structure slopes are 1:3 and 1:2 respectively. The cumulative damage values observed in the experiments are compared with the theoretical formulations given in the literature (Van der Meer - shallow water; Van Gent et al., 2004; Melby, 2001). In Figure 1a, the results of experiments are plotted in terms of $[S_d/\sqrt{N}]$ vs. $[H_s/\Delta D_{n50}\cdot\xi^{0.5}\cdot p^{-0.18}\cdot H_{2\%}/H_s]$ together with the equation of Van der Meer - shallow water for plunging waves and the 90% confidence limit curves. The trend lines obtained from the experimental data and the available theoretical formulae are plotted in terms of $[S_d]$ and $[H_s/\Delta D_{n50}]$ in Figure 1b.

As shown in Figure 1a, the results of the experiments for Model 4 and Model 5 with the structure slopes of 1:3 and 1:2 respectively are in good agreement with the Van der Meer - shallow water method, as expected. In this respect, it can be said that the conversion formula of Burcharth et al. (2006), which converts the number of displaced stones in active zone to the damage parameters (S_d), gives reliable results. Although, the results of Model 1, Model 2 and Model 3 experiments with a structure slope of 1:5 slightly deviate from Van der Meer - shallow water formulation, overall data lies within the 90% confidence limits of the equation. In Figure 1b, the experimental data of cumulative damage values are compared with the available methods. As it can be seen from Figure 1b that the Van der Meer – shallow water formula provide a better representation of cumulative damage levels for the cross-sections and wave conditions used in the experiments compared to Van Gent et al.'s (2004) and Melby's (2001) methods.

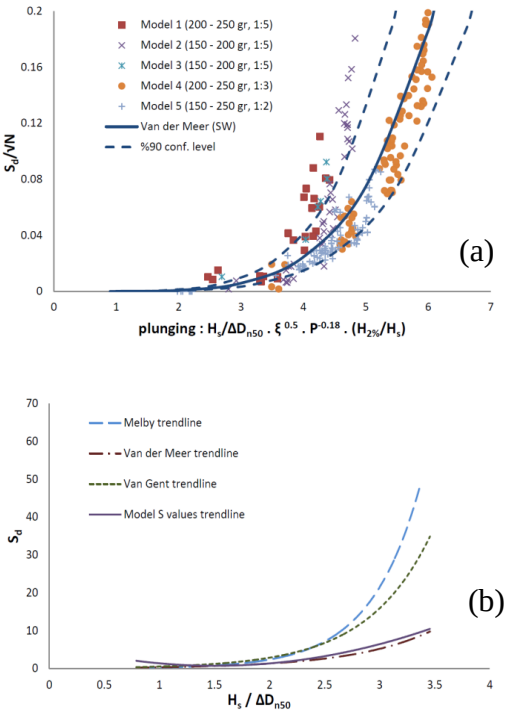

Figure 1 - The comparison of experimental data with Van der Meer formula for shallow water conditions (a), trend lines obtained from the experimental data and the available theoretical formulae (b). this instruction.

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