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# Hydrodynamic Characteristics of Single and Twin Offshore Rubble Mound Breakwaters under Regular and Random Waves

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**Abstract :** This paper investigates the interaction of single and twin offshore rubble mound breakwaters with regular and random water waves through physical modeling to assess their reflection, transmission and energy dissipation characteristics. Various combinations of wave heights and wave periods were utilized in a series of experiments, along with three different water depths. The single and twin permeable breakwater models were both constructed with one layer of rubbles. Both models had the same total volume; however, the single breakwater was of trapezoidal type while the twin breakwaters were of triangular type. Physical modeling experiments were carried out in the wave flume of the coastal engineering laboratory of Kuwait Institute for Scientific Research (KISR). Measurements of the six wave probes which were fixed in the two-dimensional wave flume were collected and used to determine the generated incident wave heights, as well as the reflected and transmitted wave heights resulting from the wave-breakwater interaction. The possible factors affecting the wave attenuation efficiency of the breakwater models are the relative water depth (d/L), wave steepness (H/L), relative wave height ((h-d)/Hi), relative height of the breakwater (h/d), and relative clear spacing between the twin breakwaters (S/h). The results indicated that the single and double breakwaters show different responds to the change in their relative height as well as the relative wave height which demonstrates that the effect of the relative water depth on wave reflection, transmission, and energy dissipation is highly influenced by the change in the relative breakwater height, the relative wave height and the relative breakwater spacing. In general, within the range of the relative water depth tested in this study, and under both regular and random waves, it is found that the single breakwater allows for lower wave transmission and shows higher energy dissipation effect than both of the tested twin breakwaters, and hence has the best overall performance.

**Keywords :** random waves, regular waves, relative water depth, relative wave height, single breakwater, twin breakwater, wave steepness
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