MODELLING OF WAVE OVERTOPPING LOADS ON A BUILDING BEHIND A RUBBLE MOUND BREAKWATER USING A 2DV NUMERICAL MODEL AND THEIR APPLICATION IN BUILDING DESIGN

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INTRODUCTION

This study considers the wave overtopping loads on a building behind a rubble mound breakwater using 2D numerical modelling. The building will be used as Coast Guard station in Greystones Marina, which is located on the Irish Sea. Similar studies, using physical modelling, were carried out recently by Watson et al. (2018) and Park et al. (2017). The applicability of the numerical model in predicting wave overtopping forces is discussed. Appropriate design wave conditions are considered and the resultant loads are assessed to determine their impact on the design of the proposed building.

DESCRIPTION OF THE NUMERICAL MODEL

In order to simulate wave-structure interaction, the two-dimensional (2DV) CFD numerical model IH2VOF was used. The validation of this model for the numerical analysis of wave overtopping of rubble mound breakwaters is described in Losada et al. (2008). The numerical model was constructed at a 1:1 scale. The most onerous cross-section of the breakwater was modelled, while the building was located 11m behind the front face of the recurved crown wall. Design storm events were selected based on the design life of the building and the design storm events for which the breakwater was designed. Simulations were carried out for a set of 3 sea states, considering irregular Jonswap type wave with 4 random time series of irregular waves generated and simulated per sea state. This involved 12 numerical simulations in total, each with a 3600 seconds duration. Wave overtopping pressures on the seaward face and roof of the building were calculated using the model. The effect of air entrainment was not considered in the water mass, providing slightly conservative results for a safer design.

NUMERICAL RESULTS

The pressure distribution over the face of the building, derived from the model, was converted to a total wave overtopping force over time with an application point calculated for the equivalent point load of the pressure distribution, as shown in Figure 1. High impulsive loads from discrete wave overtopping events were identified. The impact of impulsive wave loading was then assessed, as discussed in Cuomo et al. (2010).

APPLICATION IN BUILDING DESIGN

The integrated total force was used to identify wave overtopping events which had a significant impact on the face of the building. The pressure time series of these events were extracted for further analysis.

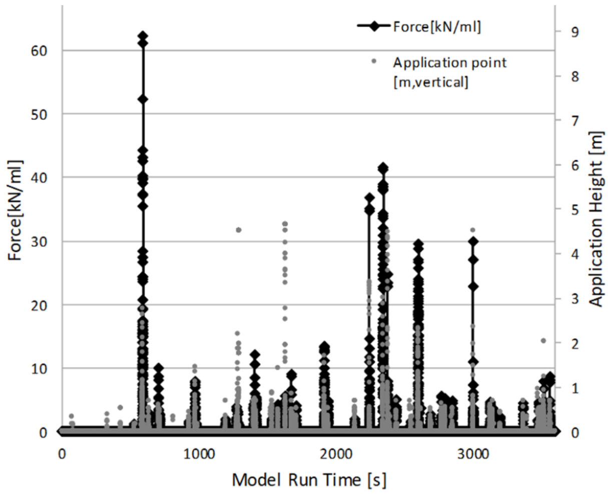

Figure 1 - Wave Overtopping Force with application height distribution for the 1 in 100 year storm event

The duration of impact loads was compared to the natural frequency of a cantilever wall and load magnitudes converted to a maximum envelope of quasi-static loads. This was further simplified for application in the structural model of the building by defining banded heights for the load application. The analysis allowed for significant optimization of the detailed design when compared with the conceptual design, which had been based on empirical methods for breakwater crown walls.

ACKNOWLEGDEMENTS

We would like to thank the Office of Public Works in Ireland for permitting us to present this project.

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