TSUNAMI WAVE LOADING ON A STRUCTURAL ARRAY PARTIALLY SHELTERED BY A SEAWALL

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INTRODUCTION

In recent years tsunamis have been recognized as one of the most catastrophic natural disasters in the world, highlighted by the 2004 Indian Ocean tsunami and the 2011 Tohoku earthquake and tsunami. These countries affected by tsunamis like Indonesia, Thailand and Japan usually arm their coast with sea walls to provide protection for coastal urban regions; however, surveys have found during both tsunami events, several sections of breached sea walls had led to extensive damage in those coastal regions (Dalrymple and Kriebel, 2005; Sato, 2015). Previous studies have examined the sheltering effect by macroroughness to individual structures, but limited knowledge is available on the sheltering and flow concentration effect by a partially standing wall to a field of structural array. The result from this experiment will serve to provide a better understanding on the tsunami loading variation induced by different length of partial seawalls, and help prepare more accurate hazard maps for tsunami events.

EXPERIMENTAL SETUP

The experiment was conducted at the Oregon State University Directional Wave Basin (DWB). A 10 × 10 array of cubic macro-roughness structures was placed at the beach section to represent a developed coastal region. Among the structures, five of them had built-in load cells to record inline (in the direction of wave propagation) wave loading (Moris et al., 2021). A partial wall with seven varying wall lengths was placed in front of the first row of structures. A no-wall condition was also conducted for comparison. Two different wave types were generated by the wavemaker: tsunami-like waves generated using an error function and solitary waves. The error function waves were non-breaking while solitary waves had intense wave breaking. A pump was used to create a current in the test section for several cases, and both high water level with current conditions (inundation cases) and low water level without current conditions (run-up cases) were studied.

RESULTS

Experiment results show that the highest loading occurs in the first row of structures when the partial wall ends just before the structure, leaving it barely exposed. This appears to be due to flow concentration around the end of the wall which focuses waves and currents towards the structure. On the other hand, wave loading on structures that are completely shielded by the seawall is significantly smaller. These results suggest that in most situations the location of coastal structures relative to the partial seawall determines their sustained load. However, for solitary wave inundating cases, where a breaking wave arrives at a already inundated region, the magnitude of wave loading is found mainly decided by the location of the wave breaking. In this experimental setting, when the partial wall is longer, the wave breaking point shifts closer to the structural array. In the meantime, the wave loading decreases as the wave breaking point gets closer to the structural array. Also, regardless of cases, those structures located at the second row and behind sustain significantly lower loading due to shielding from the rows in front.

Time-averaged loading analysis indicates that although the largest short-duration loads occur when breaking occurs at or near the structures, these decrease rapidly with increasing averaging time. In contrast, flow concentration near the end of the wall unrelated to breaking may generate larger loads for longer averaging periods.

Those results will be useful to analyze the risk on the costal structures behind a seawall in case of a seawall breaching under a tsunami. Ongoing study includes a numerical study to examine the inundation level and flow patterns within the structural array, to better understand the hydrodynamic impact of the partial wall within coastal structural arrays.

Figure 1 – Photo of the experimental setting with partial wall in front of the structural array.

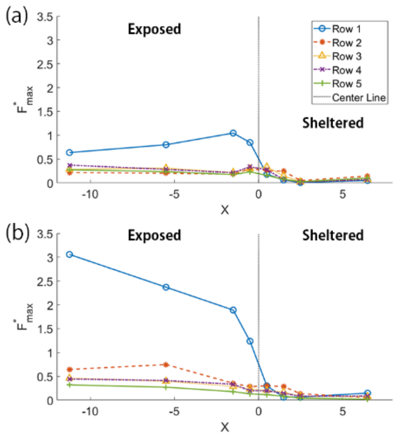

Figure 2 – Maximum dimensionless quasi-static loads for (a) error function waves with inundation and (b) solitary waves with inundation.

REFERENCES

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