STRUCTURAL RESPONSE OF WOOD STRUCTURES UNDER HYDRAULIC LOADING

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INTRODUCTION

Damage to coastal structures as a result of major flooding events is on the rise due to sea level rise as well as changes to the intensity and duration of storm events (Friedland et al. 2014). Under this new paradigm, predictive tools will increasingly need to address and accurately extrapolate future design conditions.

To improve the accuracy of these predictive tools, a realistic physical representation of structures is necessary. One of the current limitations in modelling coastal structures is the capacity to simulate the dynamic response of structures under flood-induced loading. Within both numerical and physical models, the structures are often represented as fixed, solid, rigid obstacles: this fails to capture dynamic behavior and existing flexural strength of the structure.

One of the primary reasons for this is that limited data exists to evaluate the response of common coastal structures under extreme hydraulic loading. This is due to the challenges in reproducing these behaviors at an economical scale. Linton et al. (2013) examined wave loading on a full-scale wooden wall. However, the full-scale representation of entire coastal structures is challenging due to limitations in current experimental facilities. Van de Lindt et al. (2009) modelled a 1:6 scaled wooden residential structure under tsunami loading to approximate behavior of a full-scaled version.

The problem of modelling the dynamic behavior of structures under extreme hydraulic loading requires a comprehensive examination at a range of scales to develop analytical relationships in the development of scaling methodologies. The experimental program outlined here begins this process by examining the structural response of idealized wooden structures under solitary wave loading. This program will be the **first comprehensive set of experiments merging structural and hydraulic modelling techniques to capture dynamic behaviour of idealized structural elements**.

EXPERIMENTAL SETUP

An experimental program was performed at the Large-Wave Flume (GWK, 307 m × 5 m × 7 m) at the Coastal Research Center in Hannover, Germany. The program examined wave loading due to broken solitary waves on idealized wooden structures (0.20 m × 0.20 m × 0.70 m). The construction of the structures was varied to investigate the influence of the moment of inertia and nail configuration on the response of the structure. A rigid-body version of the structure was also used to provide a baseline case and to determine the pressures acting on the face of the structure. The structures (*9 different structural configurations*) were subjected to various hydrodynamic forcing conditions to develop a detailed understanding of their behavior (Figure 1). Their structural response was monitored using several wireless accelerometers (+/- 400 g) and a stereo-camera system.

RESULTS AND DISCUSSION

Three wave-loading conditions were identified for a broken solitary wave acting on the wooden structure: (1) surge; (2) quasi-steady; (3) tail. The results showed that the response of the structure as well as the magnitude of the loading was generally dependent on the type of wave loading conditions.

Figure 1 - Solitary wave impact on an idealized wooden structure.

Dependent on the type of wave loading acting on the structure, the natural modes of the system were excited differently. This could have significant ramification in how researchers need to address the scaling of structures under transient wave loading.

CONCLUSIONS

The experimental program outlined herein is a first step in a comprehensive research program investigating the accurate representation of dynamic structures under hydrodynamic loading. It allowed, for the first time, to derive procedures for testing, in a holistic way, the structural response and hydraulic loading in a unique experiment while providing researchers with a sense for potential pitfalls of such novel experimentation. The program will use the insights and developed analytical models to further develop the program to model structures at a wide range of scales with the final objective to develop scaling methodologies for the accurate representation of the behavior of structures in coastal models.

REFERENCES

Due to space limitations, the reference list was omitted here.