COASTAL FLOODING-INDUCED DEBRIS MOTION

Ioan Nistor, University of Ottawa, inistor@uottawa.ca
Nils Goseberg, Leibniz University of Hannover, contact@nilsgoseberg.de
Jacob Stolle, University of Ottawa, jstol065@uottawa.ca
Tomoya Shibayama, Waseda University, shibayama@waseda.jp
Takahito Mikami, Tokyo City University, tmikami@tcu.ac.jp

INTRODUCTION

Extreme coastal events such as the 2004 Indian Ocean Tsunami, the 2011 Tohoku Tsunami as well as the 2005 Katrina and 2012 Sandy hurricanes demonstrated that, hydrodynamic loading aside, debris loading represents a major factor in the extreme loading conditions experienced by inland infrastructure. While extreme hydrodynamic loading due to coastal flooding events has been the object of intense research over the past decade, few studies dealing with debris impact due to coastal flooding have been conducted. Post-tsunami forensic engineering field investigations conducted by the authors (Nistor et al. 2005; Shibayama et al., 2006; Nistor et al. 2010) or other researchers (Chock et al. 2012, Sato et al. 2014;) revealed that debris loading and debris damming have a significant effect on the structural integrity of buildings and infrastructure in general, especially in high-density urban areas. Current design guidelines (FEMA P-55, 2011; FEMA P-646, 2012) and the new ASCE-7 Chapter 6 - Tsunami Effects and Loads suggest conservative estimations of the debris spatial spreading based on limited sets of field data to assess debris impact potential (Chock et al., 2012; Naito et al., 2014). The primary objective of this study was to *investigate the spatial and temporal displacement of floating debris due to rapid coastal flooding in a built-in port environment* using **two novel different measuring techniques: (1) high-accuracy video debris detection and tracking system and (2) a real-time locating "smart" sensor-tracking system. Results are compared with prescriptions of the ASCE7 Chapter 6 pertaining to debris motion.**

EXPERIMENTAL SETUP

The experimental program was conducted in the Tsunami Wave Basin at Waseda University, Tokyo, Japan. The experiments consisted of 48 experimental runs and examined the motion of 1:40 scaled 20' shipping container. Tests were run with one and up to 18 containers in different stacking configurations. Each container was equipped with a novel "Smart" debris system, consisting of a wireless Bluetooth Low Energy tracking device and a motion sensor, to track the spatial and temporal motion of the containers (Goseberg et al., 2016). The combination of the two sensors allowed the debris to be tracked with 6 degrees-of-freedom (6-DOF). A video camera-based object detection and tracking system (based on the Hungarian algorithm) was used in parallel to validate the accuracy of the "smart" debris system.

RESULTS

The spreading angle and longitudinal displacement of the debris was measured for single and multiple (up to 18) container model configurations. Fixed obstacles were additionally placed in the propagation path of the containers to examine the effect of the obstacles on the displacement of the containers.

Figure 1 shows the spatial distribution of the containers, as determined by the "Smart" debris system, with and without the presence of the fixed obstacles. For all experimental runs, the container trajectories remained well within the ±22.5 angle bound suggested by the ASCE-7 (Chock et al., 2015). Results showed that an increase in the number of containers or the presence of the fixed obstacles on the apron resulted in a decrease

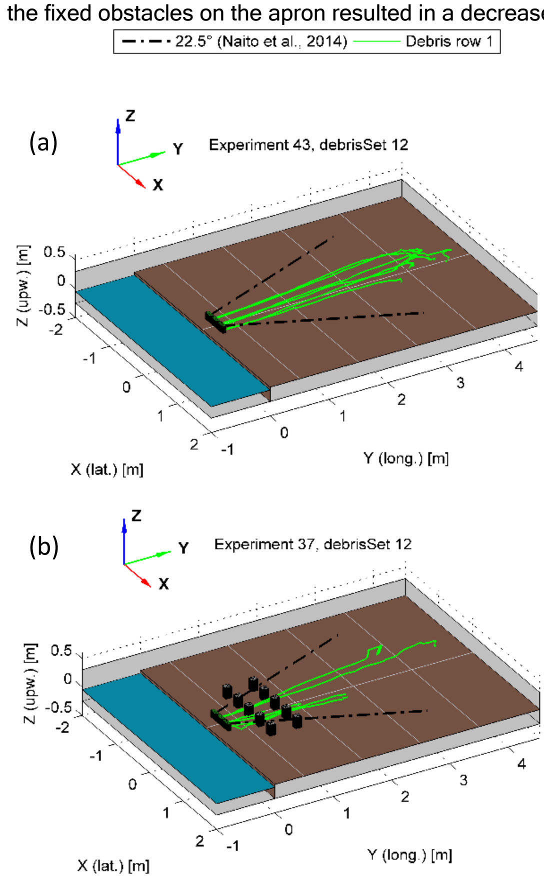

Figure 1- "Smart" debris trajectories in the presence of (a) no obstacles; (b) two rows of fixed obstacles

in the longitudinal displacement of the containers, similar to the results of Reuben et al. (2015).

CONCLUSIONS

This experimental study presents novel results related to the time-history of the spatial motion of multiple "smart" debris displaced by a hydraulic bore similar to a tsunami-generated coastal inundation. This work was conducted with the goal of assessing the validity of prescriptions made by the ASCE-7 Chapter 6-Tsunami Loads and Effects regarding debris motion. This study allowed the development of a laboratory measurement system capable of simultaneously recording the 6-DOF motion of multiple debris and of a high-accuracy video debris detection and tracking system.

REFERENCES

Due to space limitations, references mentioned herein are not listed.