TURBULENT BORES-INDUCED SCOUR AND PORE PRESSURE VARIATIONS AROUND A VERTICAL STRUCTURE

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INTRODUCTION

Tsunami waves can significantly modify nearshore coastal morphology [Larsen et al., 2017]. Past tsunami events such as the 2004 Indian Ocean Tsunami and the 2011 Tohoku Tsunami have shown the need to investigate the interaction of inundation hydrodynamics and the overland sediment transport in such disastrous events ((Saatcioglu et al. 2005; Chock et al. 2013). The scour due to the highly turbulent tsunami inundation is also a major threat to nearshore infrastructure [Nakamura, et al., 2008]. Research on local sediment erosion during tsunami events has shown a correlation between scour formation, pore pressure variations, and soil liquefaction [Mioduszewski and Maeno, 2003].
To understand the structures' capacity to withstand the tsunami bores, it is critical to assess scour formation and pore pressure variations around their foundations [Macabuag et al., 2018, Nicholas et al., 2020; Mehrzad et at. 2021]. Young et al. (2008) conducted laboratory experiments to study tsunami induced liquefaction failure on a sand bed with two different slopes of 1V:5H and 1V:15H. The correlation between soil liquefaction and scour showed a direct link with bed slope and pore pressure and the peak pressure increased as the bed slope increased. Concerning the hydrodynamic forcing factor, research conducted by [Chanson, 2006] showed that the hydrodynamic characteristics of tsunami inundation can be adequately modeled using dam-break waves.

OBJECTIVES AND NOVELTY

The prime objective of this study was to *comprehensively investigate the interaction of a wide range of hydrodynamic conditions and beach slopes on the variation of the pore pressure and associated scour.* **This present study examined (1) the effect of the transient bore depths on scour and pore pressure variations around a structural model installed onto horizontal and inclined beds, (2) the effect of bed slope on the scour and pore pressure development, and (3) the interaction between pore pressure development and scour formation around a square-shaped structure.**

EXPERIMENTAL SETUP

Experiments were conducted in the Dam-Break Flume (30 m long, 1.5 m wide, and 0.8 m deep) at the University of Ottawa, Canada. Two false floors were installed in the flume to provide a sediment bed section: one right after the rapidly opening swing gate (used to generate dam break waves) and the other one in downstream of the structure. Four dam-break bores were generated with impoundment depths of 0.4 m, 0.35 m, 0.3 m, and 0.25 m. The effects of the wet bed condition on scour was also investigated.
The sediment section was filled with uniform sand with a mean grain size D_{50} = 0.5 mm. Two sand beds, one with a horizontal slope and the other with an upward slope of 5% were examined in this study. As the bore front travelled over the sand section, the bore propagation over the flume and the scour evolution were recorded with four video-cameras.

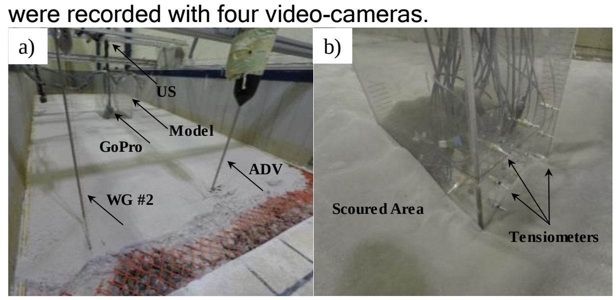

Figure 1- Experimental setup and instrumentation: a) ADV probe and wave gage (WG#2); b) tensiometers for measuring pore pressure.

RESULTS

Pore pressure measurements exhibited higher magnitude in bores over inclined bed compared to horizontal one, whereas the maximum scour depth took place in horizontal bed. Sediment erosion due to the turbulent bore front reached its maximum depth faster for the case of the inclined bed compared to that of horizontal one. A comparison of the pore pressure variations and scour evolution in the front and side faces of the structural model indicated that, unlike the pore pressure, scour depths were larger at the side face of the model than at the front face.

CONCLUSIONS

The results of this study were used to update the ASCE-7 Chapter 6-Tsunami Loads and Effects regarding scour. Main conclusions indicate that:

- The presence of the wet bed around the structure reduced scour depth.
- For the identical bore depths propagating over the sloped beach, scour depth and pore pressure showed strong correlation.

REFERENCES (selected)

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