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

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INTRODUCTION

Effects of the devastating tsunami events such as the 2004 Indian Ocean Tsunami and the 2011 Tohoku Tsunami demonstrated the importance of studying the hydrodynamics and bed sediment transport during such disasters. The scour due to highly turbulent tsunami inundation is a major threat to nearshore infrastructure [Nakamura, et al., 2008]. Analysis conducted by [Chanson, 2006] showed that hydrodynamic characteristics of tsunami wave can be adequately modeled using dam-break waves. Scour of sediment during tsunami events was shown to have a close link with pore pressure and soil liquefaction.

Pore pressure and scour formation around coastal structures have been investigated in the past which led to a relationship between the hydrodynamics of tsunami waves and sediment erosion around coastal structures. [Young et al. 2008] conducted laboratory experiments to study tsunami induced liquefaction failure on a sand bed with two different slopes: 1/5 and 1/15. The correlation between soil liquefaction and scour showed that as the bed slope increased, the peak pressure increased as well. Despite research studies in this field, further investigations are needed to better understand the combined and synchronous effects of the influential variables.

OBJECTIVES AND NOVELTY

With the objective of developing a comprehensive model to assess the interaction of hydrodynamic conditions, induced scour, soil pore pressure, and beach slopes, **this novel study aims to examine (1) the effect of hydrodynamic forcing factors such as bore depth on scour and pore pressure generation on both horizontal and inclined bed conditions and (2) the effect of bed slope on the scour and pore pressure development and (3) the influence of the soil pore pressure on scour around a square shaped structure.**

EXPERIMENTAL SETUP

The experimental setup was performed in the Dam-break Flume (30 m long, 1.5 m wide, and 0.8 m deep) at the University of Ottawa, Canada. Dam-break waves were generated using a rapidly opening swing gate, which released an impounded volume of water. Two false floors with a height of 0.20 m were installed downstream of the gate, in front and after the sand bed section, to provide a section for the sediment bed. The latter consisted of uniform sand with a mean diameter (D_{50}) of 0.5 mm. Two sand beds with a horizontal slope and a positive slope of 5% were tested in this study as the bore front propagation over the false floor and the sandy section. The bore propagation over the bed and the scour evolution were recorded with four video-cameras (GoPro Hero5). The dam-break waves were generated with four different impoundment depths of 0.4 m, 0.35 m, 0.3 m, and 0.25 m and two still water depths of 0.1 m and 0.03 m.

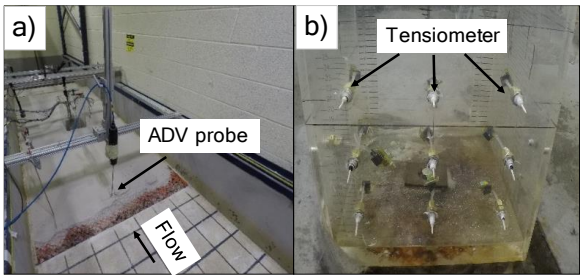

Figure 1- Experimental setup and instrumentation; a) ADV probe in sand bed; b) locations of tensiometers.

RESULTS

Effects of the dam beak wave characteristics and bed slope on the pore pressure variations and scour formation around the structure were investigated. It was found that the maximum pore pressure due to the bore front occurred over inclined beds, whereas the maximum scour took place on horizontal beds. The sediment erosion due to the motion of the turbulent bore front reached the equilibrium over a shorter time span on inclined beds compared to that on horizontal beds. Comparison of the front and side of the structure indicated that the pore pressures and scour depths were larger in the side of the vertical structure and they were independent of the bore to still water depths ratio.

CONCLUSIONS

The present study provide results of transient flow-induced scour and pore pressure variation around a vertical structure. It can be concluded that:

- The maximum scour depth increased with increasing the impoundment to still water depths ratio. Similarly, greater pore pressure variations were found around the structure foundation and this was correlated with the bore to still water depth ratios.
- For the same hydrodynamic conditions, positive bed slope generated shallower scour depths while larger pore pressures were observed within these beds in comparison with horizontal beds.

REFERENCES

Due to space limitations, references were not mentioned here.