

Hydro-dynamic Impact of Bore Waves on Structures (2014-2017)

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Introduction

In the past the impacts of bore waves against structures were considered extremely rare events and wave induced forces were often neglected in the design process. Recently catastrophic events with large amount of damages and casualties have shown that measures have to be taken to guarantee human safety and reduce reconstruction costs. In nature the sudden release of a large amount of water can be found in Impulse waves and Tsunamis. Dam-breaks have similar behaviors.

Impulse waves are caused by a landslides falling inside a body of water, producing a wave on the opposite direction. Examples of such natural disasters can be found in Lituya Bay, Alaska, in 1958 where a 60 m wave was produced. In Switzerland similar events occurred in Lucerne Lake in 2007 and in Grindelwald Lake in 2009 (Figure 1).



Figure 1 : Impulse wave, Grindelwald (H.R. Burgener)

Tsunamis are water waves caused by an earthquake offshore; they are characterized by long wave lengths and due to their low energy dissipation they can create flooding and destruction far away from the site of formation. Recent examples can be found in the Indian Ocean in 2004, Chile 2010 and Japan 2011 (Figure 2).



Figure 2 : Japan Tsunami 2011 (Keystone)

The phenomenon of the wave impact against a structure is poorly understood and the estimation of wave-induced forces is rough and subject to high incertitude. In addition most construction codes don't include design guidelines for waves-induced forces.

Objective

The objective of this research project is to evaluate and analyze damage potential of buildings hit by bore-waves. Through the reproduction in a laboratory environment of different types of bore waves, their impact against structures with various degrees of porosity is analyzed. The purpose is to identify which types of buildings are less vulnerable under wave impact, resulting into recommendations for a safe construction and design-code guidelines.

Research procedure

The project is based on an experimental approach. A schematic representation of the set-up is presented in Figure 3. To obtain a full understanding of the processes the main parameters identified will be varied, namely:

- Wave type (dry bed surge and wet bed bore)
- Permeability of the structure
- Impact angle

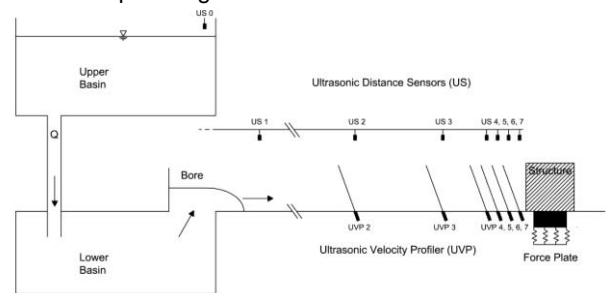


Figure 3 : Experimental Set-Up

Bore formation is achieved through sudden release of a known volume of water from an upper basin into a lower tank and therefore into the channel. Different volumes result into waves with various heights and velocities. The wave is followed during the displacement along the channel, where speed and height are measured using UVP and US respectively. The structure is installed on a Dynamometric plate providing impact forces on the structure. The porosity of the structure (Figure 4) and the impact angle are supposed to be determinant parameters in the evaluation of the wave-induced forces.

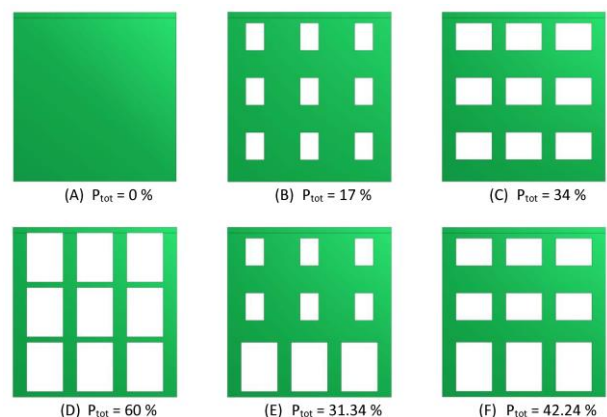


Figure 4 : Structures with various permeability