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Tsunami Simulators in Physical Modelling – Concept to Practical Solutions

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Whilst many researchers have conducted simple 'tsunami impact' studies, few engineering tools are available to assess the onshore impacts of tsunami, with no agreed methods available to predict loadings on coastal defences, buildings or related infrastructure. Most previous impact studies have relied upon unrealistic waveforms (solitary or dam-break waves and bores) rather than full-duration tsunami waves, or have used simplified models of nearshore and over-land flows.

Over the last 10+ years, pneumatic Tsunami Simulators for the hydraulic laboratory have been developed into an exciting and versatile technology, allowing the forces of real-world tsunami to be reproduced and measured in a laboratory environment for the first time. These devices have been used to model generic elevated and N-wave tsunamis up to and over simple shorelines, and at example coastal defences and infrastructure. They have also reproduced full-duration tsunamis including Mercator 2004 and Tohoku 2011, both at 1:50 scale.

Engineering scale models of these tsunamis have measured wave run-up on simple slopes, forces on idealised sea defences, pressures / forces on buildings, and scour at idealised buildings. This presentation will describe how these Tsunami Simulators work, demonstrate how they have generated tsunami waves longer than the facilities within which they operate, and will present research results from three generations of Tsunami Simulators. Highlights of direct importance to natural hazard modellers and coastal engineers include measurements of wave run-up levels, forces on single and multiple buildings and comparison with previous theoretical predictions.

Multiple buildings have two malign effects. The density of buildings to flow area (blockage ratio) increases water depths and flow velocities in the 'streets'. But the increased building densities themselves also increase the cost of flow per unit area (both personal and monetary). The most recent study with the Tsunami Simulators therefore focussed on the influence of multiple buildings (up to 4 rows) which showed (for instance) that the greatest forces can act on the landward (not seaward) rows of buildings.

Studies in the 70m long, 4m wide main channel of the Fast Flow Facility on tsunami defence structures have also measured forces on buildings in the lee of a failed defence wall and tsunami induced scour. Supporting presentations at this conference: McGovern et al on tsunami induced scour at coastal structures and Foster et al on building loads.