ANALYSIS OF TSUNAMI SCOUR AROUND SQUARE STRUCUTRES USING A PUMP-DRIVEN FLOW METHOD

Rafael Aranguiz, Universidad Catolica Santisima Concepcion, raranguiz@ucsc.cl
Oscar Link, University of Concepcion, olink@udec.cl
José Aliaga, Oscar Briones, Rubén Alarcón, Nicolás Gatica, University of Concepción.

INTRODUCTION

Estimation of the maximum scour depth is important for defining the size and depth of building foundations in order to avoid failure during a tsunami event (Jayaratne, et al 2016). Traditionally, tsunami scour has been studied in laboratory experiments that use solitary waves. However, it has been demonstrated that this type of wave does not represent well a real tsunami (Madsen et al, 2008). In addition, results from field surveys are based on the scour depth after the tsunami event, studying only the maximum flow depth, and ignoring other hydrodynamic features such as velocity and wave period, as well as sediment deposition.

The main objective of this research is to estimate maximum tsunami scour around rectangular structures as a function of realistic tsunami variables.

METHOD

The tsunami scour is studied by means of laboratory experiments in a flume that is 6 m long by 0.4 m wide. This flume has already been used to run experiments on scour around bridge piers (Link et al 2019). The flume is implemented with a 0.6 m long sediment recess located 4 m downstream of the flume entrance with a column installed in the middle. The scour is monitored with a snake video camera that is 7mm in diameter, with a resolution of 640 by 480 pixels. The images will be captured at a 0.2Hz frequency. The pump capacity is 25 l/s with a variable frequency driven by a logic programmable controller, so that any desired hydrograph shape can be generated. The flow depth is controlled by an automatized tailgate at the end of the flume and measured with a precision of ±0.1 mm using an ultrasonic distance sensor. The scale of the experiment is set to be 1:70. The experiments will analyze the inundation stage only.

The realistic tsunami hydrodynamic variables were defined by means of numerical simulations of 2015 Chile tsunami using NEOWAVE (Non-hydrostatic Evolution of Ocean Wave) model (Yamazaki et al 2011).

In addition, a numerical model using DualSPHysics will be implemented in a laboratory scale to study the hydrodynamic variables around the square structure. To do this, the inlet/oulet option with variable discharge will be implemented. In a first stage, numerical simulations with DualSPHysics will consider only water particles, thus future work may include both water and soil particles.

PRELIMINARY RESULTS

Figure 1 shows preliminary results of laboratory experiments. The blue line represents the scaled realistic tsunami variables. Since only the inundation stage is simulated, it is possible to observe that the discharge (Q) and velocity (V) increase and then decrease, while the flow depth (H) increases constantly until reaching maximum inundation.

In general, it is possible to observe a good agreement between the experiment (black dots) and the realistic tsunami features (blue line). Therefore, the pump-driven flow method with variable discharge showed to be a suitable method for experimental studies of tsunami scour.

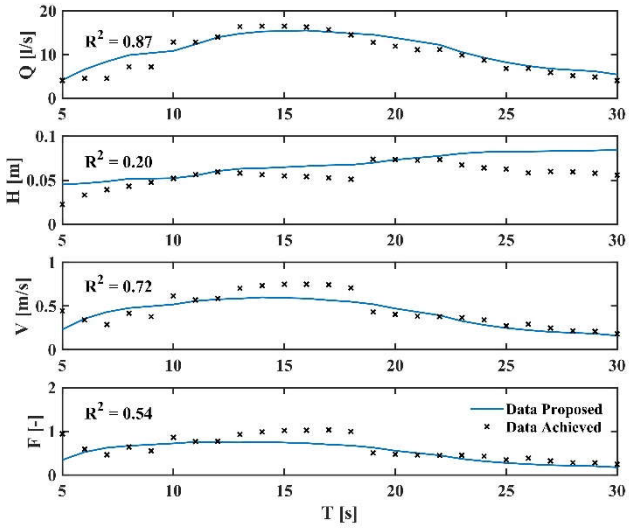

Figure 1.- Comparison of laboratory experiment and realistic tsunami variables such as Discharge (Q), Flow depth (H), Flow Velocity (V) and Froude number (F).

REFERENCES

Jayaratne, et al (2016). Failure Mechanisms and Local Scour at Coastal Structures Induced by Tsunami. Coastal Engineering Journal, 58(4), 1640017-1-1640017-38. http://doi.org/10.1142/s0578563416400179

Link et al (2019). Physical scale modelling of scour around bridge piers. Journal of Hydraulic Research, 57(2), 227-237. http://doi.org/10.1080/00221686.2018.1475428

Madsen et al (2008). On the solitary wave paradigm for tsunamis. Journal of Geophysical Research: Oceans, 113(12). http://doi.org/10.1029/2008JC004932

Yamazaki, Y., Cheung, K. F., & Kowalik, Z. (2011). Depth-integrated, non-hydrostatic model with grid nesting for tsunami generation, propagation, and run-up. International Journal for Numerical Methods in Fluids, 67(12), 2081-2107. http://doi.org/10.1002/fld.2485