Structures impacted by tsunami bores

Engineering

Hydraulic-structural engineering is quite essential for several aspects of the society, particularly in relation to the effects of extreme hydrodynamics to the structural elements like roads, dams, and residential areas. In this study by St-Germain, Nistor, Townsend, & Shibayama (2013), the primary concern is in understanding the way the coastal zones can be able to prepare themselves to withstand dangerous hydrodynamic forces associated with large tsunami waves that are progressing to the mainland. This is aimed at significantly preventing the loss of life when damage occurs to the low-lying coastal developments. As such, the study employs " a single-phase three-dimensional (3D) weakly compressible smoothed-particle hydrodynamics (WCSPH) model" in investigating the hydrodynamic forces caused by the swiftly advancing hydraulic bores of the tsunami (St-Germain et al., 2013, p. 66). This critical review shall be focused on the objectives, context, results, and conclusion aspects of the study.

Objective

Largely, this study's primary aim was the development of new guidelines and recommendations that can be applied to various hydraulic, structural elements in areas that are prone to tsunami flooding. As a result, the new guidelines are targeted at making the onshore structures have sound designs that will make them resistant to tsunami flooding. Consequently, the study seeks to offer understanding into the ways by which the coastal areas can be able to prepare themselves to withstand dangerous hydrodynamic forces associated with large tsunami waves that are progressing to the mainland (St-Germain et al., 2013).

Study's Context

The conduct of this study is based on the recent occurrences of tsunamis

that have majorly hit parts of the world such as Japan, Philippines, and Chile. As a result, many human lives have been endangered out of the tsunami waves that have extended into the mainland, hence causing severe destruction of buildings. The economic loss attributed to these tsunami attacks are also enormous with the 2011 attack costing US$319 billion worth of damages (St-Germain et al., 2013). Furthermore, during the destruction, even the building that had been engineered are affected; thus, calling for the erection of hydraulic bores as shown in the figure below.

Figure 1: Hydraulic bore induced by 2011 Tohoku Tsunami, Iwanuma City, Japan

Source: St-Germain et al., 2013

Therefore, the current study aimed at showing that the design of buildings needs to be done in consideration of the hydrodynamic forces, especially in the tsunami prone areas. By developing new guidelines and recommendations, it is aimed that the same will be applied in hydrodynamic constructions.

Results

In testing for the interaction between the bore and the structure, it is determined that a zero level of water momentum results in an impulsive force being exerted in the upstream (St-Germain et al., 2013). Consequently, the study established that for narrow channel conditions, the run-up power can strongly be affected by the channels. These channels can be built through SPH method as shown in the figure 2 below. Therefore, the study recommends taking special care in interpreting the hydrodynamic forces following initial impacts from the bore.

Figure 2: SPH Method used for making narrow hydraulic channels

Source: St-Germain et al., 2013

Consequently, there is a need for developing numerical models and engineering tools that can simulate the extremity of the impacts of the hydrodynamic forces on the infrastructural buildings as elaborated in figure 3 below.

Figure 3: Numerical plan view of the velocity field around the column 2. 50 s after gate opening

Source: St-Germain et al., 2013

Conclusion

Through the experimental studies conducted by the study, the results of the physical and numerical tests conducted indicate that the hydrodynamic forces can influence the dry and wet-bed conditions and cause impulse movements. The study's result also established the essence of incorporating natural flow characteristics of the inundation of incoming tsunamis. Thus, it will be possible for more elaborate and authentic design relationships to be established between the features of inbound bores of the tsunami and the hydrodynamic loads that results out of it.

Reference

St-Germain, P., Nistor, I., Townsend, R., & Shibayama, T. (2013). Smoothed-particle hydrodynamics numerical modeling of structures impacted by tsunami bores. Journal of Waterway, Port, Coastal, and Ocean Engineering.