A New Physical Flume of Tsunami-Inundation Flow

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ABSTRACT

A new physical flume of the tsunami-inundation flow, the Large-scale Tsunami Physical Simulator, was installed in CRIEPI, Japan. In the flume, high and long tsunami inundation flow, with height of over 2 m and duration of over 100 s, can be reproduced. This flume is composed of a head tank, a control unit, a test section, and a water storage. In order to control the tsunami-inundation flow in the test section, aperture of valves, and the heights of a radial gate and a weir are computer-controlled simultaneously.

KEY WORDS: Tsunami; experimental flume; tsunami fragility assessment; large-scale experiment

INTRODUCTION

The 2011 Tohoku earthquake tsunami struck widely the northeastern coastal area in Japan. The earthquake and tsunami caused more than 15,000 deaths, 2,000 missing people, and destructive damages of so many infrastructures. For disaster prevention and mitigation against tsunami at coastal areas in Japan, it is necessary to assess fragilities of structures against the tsunamis.

In the fragility assessment of a structure in an inundation area, both loads due to probable tsunamis and the responses of the structure against the loads must be predicted. For these predictions, numerical approaches are in general used. On the other hand, for the investigation of the predominant failure mode of the structure and the development/verification of the numerical approaches, large-scale experiments for the fragility of the structure against tsunami are helpful.

Tsunami fragility experiments have been carried out by using hydraulic flumes. In these experiments, tsunamis have been in general generated by piston wave generators, but the limitation of the stroke length makes generation of long and high tsunamis difficult. On the other hand, some of the experiments, dam-break flows have been used as tsunamis, based on the analogy between the tsunami bore and the dam-break flow. However, velocities and heights of the dam-break flow in the test section strongly depend on the initial depth of the head tank, leading to low degree of freedom of controlling the flow in the test section.

A new physical flume of the tsunami-inundation flow, the Large-scale Tsunami Physical Simulator, was installed in the Central Research Institute of Electric Power Industry (CRIEPI), Japan. Fig. 1 is the diagram showing phases of evolution of a typical tsunami from source to shore, which was described in Rossetto et al. (2011). As shown in Fig. 1, main research targets of experiments using our new flume is the fragility assessment in inundation areas. In this proceeding, we present the specifications and functions of the new flume.

CONVENTIONAL TSUNAMI FLUME

Laboratory experiments on tsunami propagation, overtopping, run up, and inundation have been carried out by using flumes with four types of conventional wave generator; the piston-type wave generator, the pump wave generator, the pneumatic wave generator, and the gate-rapid-opening generator, i.e., dam break flow.

Figure 1  Diagram showing phases of evolution of a typical earthquake-generated tsunami from source to shore. Fig.1 in Rossetto et al. (2011) is modified.