WAVE GENERATION DUE TO DEBRIS FLOW INTO A SMALL AREA OF WATER

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INTRODUCTION

It is known that the tsunami is generated by the debris flow due to slope collapse into the sea. The huge waves may cause damage to coastal structures and residents. Because of heavy rain in northern parts of Kyushu Island, Japan, in July 2017, many reservoirs were damaged and were destroyed. It has been reported that the huge waves may have been caused by debris flow due to the heavy rain. Many laboratory experiments and numerical simulations of the landslide-generated tsunami into the sea have been carried out to clarify the process of wave generation. However, there are a few studies of wave generation by debris flow into a small area of water such as a reservoir. In this study, model experiments of debris flow were conducted in a two-dimensional flume and numerical models based on the depth-averaged shallow water equations have been per-formed in order to clarify the hydraulic characteristics of the waves.

METHODOLOGY AND RESULTS

Figure 1 shows an experiment equipment. Experimental tests consist in removing the gate quickly and measuring wave propagation with a capacitance-type wave gage at a frequency of 100 Hz. A digital video camera recorded the flow at 30 frames per second from the side at the location of the shoreline. Table 1 shows experimental conditions. Figure 2 shows measured profiles of water surface and debris flow surface of Case-M-M-H. When a head of debris flow was submerged under the water surface, a trough of water waves is created behind the head of debris flow and a crest of water waves is created over the head. Figure 3 shows spatial and temporal distributions of horizontal velocity of debris flow by PIV analysis. The head of debris flow moves at a constant speed, but a tail of debris flow moves at an acceleration. The experimental study has demonstrated that flowing forms of debris flow and distributions of flow velocity are not spatially uniform. In numerical analysis, we propose algorithms to calculate motions of both debris flow and water waves. Figure 4 shows computational water surfaces and debris flow surfaces. It is found that numerical results agree with experimental results by considering interface resistance between the inflow sediments layer and the water layer.

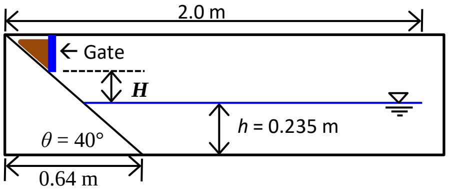

Figure 1 - Sketch of experiment equipment.

Table 1 - Experimental conditions

Case-	D_{50} (mm)	H (mm)	Weight of debris (kg)
M-H-H	8.2	65.0	0.440
M-H-M			0.293
M-H-L			0.146
S-H-H	4.1		0.470
S-H-M			0.313
S-H-L			0.156
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M-M-M			0.293
M-M-L			0.146
S-M-H	4.1		0.470
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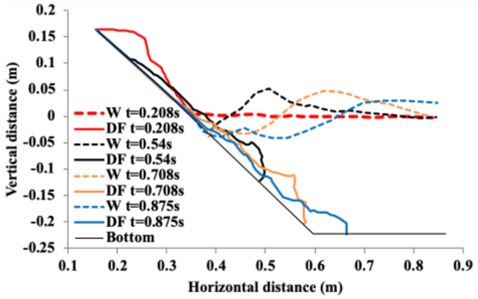

Figure 2 - Measured profiles of water surface (W) and debris flow surface (DF) of Case-M-H-H.

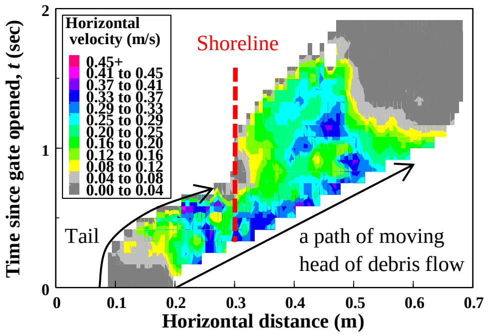

Figure 3 - Spatial and temporal distributions of horizontal velocity of debris flow by PIV analysis (Case-M-H-H).

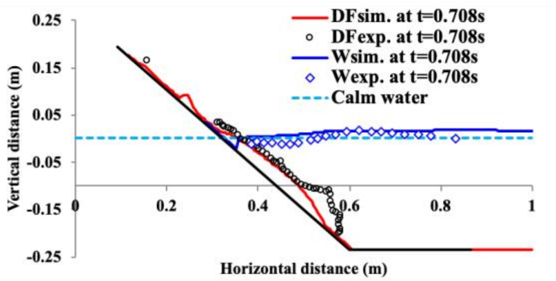

Figure 4 - Computational water surfaces ($W_{sim.}$) and debris flow surfaces ($DF_{sim.}$) of Case-M-H-H.