Propagation Characteristics of Surge Produced by Landslides

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INTRODUCTION

Propagation characteristics of surges in a straight channel with mild slope have been researched under small water discharge conditions by many researchers, because tsunami and tidal bores are observed near the coastal area. On the other hand, surges are produced in mountainous area. It is considered that surges are produced by landslides in the Totsu River, Uguhara, Japan on Sep. 2011. The horizontal shape of the Totsu River in Uguhara is the meandering with high slope. Additionally, it is considered that the surges are propagated in upstream direction under large water discharge. In this study, propagation characteristics of surges produced by landslides in the mountainous river have discussed by use of flume tests and horizontal two dimensional numerical analysis.

EXPERIMENT AND NUMERICAL ANALYSIS

Table 1 shows the hydraulic conditions of flume tests and numerical analysis. Figure 1 shows the experimental flume. The horizontal shape of the fume is the meandering channel with sine-generated curve. The channel width is 20cm. The longitudinal slope along the channel is 1/100. The maximum meandering angle is 61degree. The location of the production of surges (location of the landslide) is shown in Figure 1. Furthermore, one more landslide is considered under Cases 2 and 4 and produces landslide dam in the downstream area of upstream landslide. In Cases 2 and 4, water deposited in the upstream area of the landslide dam and the upstream landslide sediment flows into the

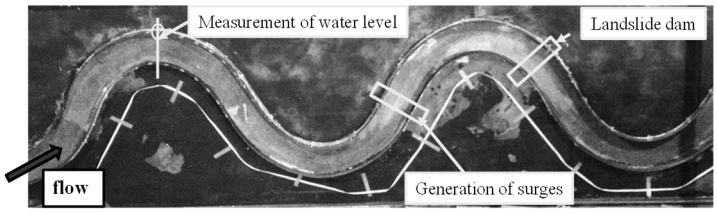

Fig. 1 experimental flume (Case 1- Case4)

Tab.1 Hydraulic conditions

	Discharge (m^3/s)	Landslide dam	Channel shape
Case 1	0.00096	No	Meandering
Case 2	0.00096	Yes	Meandering
Case 3	0.00092	No	Meandering
Case 4	0.00092	Yes	Meandering
Case 5	2500	No	Meandering
Case 6	2500	Yes	Meandering

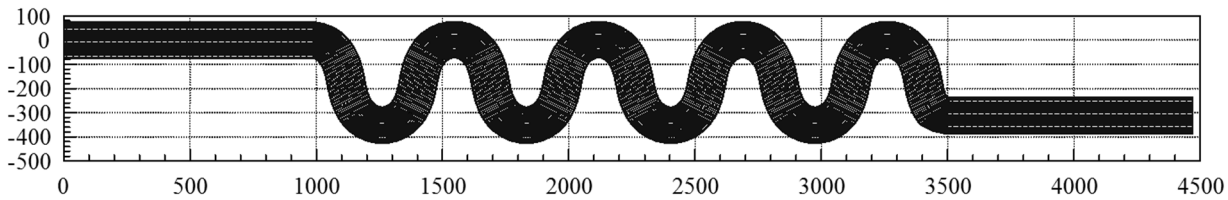

Fig. 2 Grids of numerical analysis (Cases 7 and 8)

deposited water. The distance between the landslide dam and the upstream landslide is 1.2m and the distance between the upstream landslide to the measurement instrument of water surface level is 2m. The hydraulic conditions of Cases 5 and 6 are decided in reference to the hydraulic conditions of the Totsu River. Figure 2 shows the grids of numerical analysis of Cases 5 and 6. The horizontal shape of the calculation domain is the meandering channel with sine-generated curve. The channel width is 150m, the bed slope along the channel is 1/100, and the maximum meandering angle is 80 degree.

RESULTS AND DISCUSSION

Figure 3 shows the temporal change of water surface elevation obtained by the flume tests. When the water deposition due to the landslide dam is considered (Case 2), the propagation velocity of the surge in upstream direction is 6s and faster than that without landslide dam (Case 1). The propagation velocity is affected by the water depth and the water velocity. When the water depth is deep and the water velocity in downstream direction is small, the propagation velocity of surge in upstream direction becomes faster.

There is no difference of the propagation velocity of the first surge between Case 2 and Case 4. However, the dispersion characteristics of the surges are difference. The surge in Case 4 has one large peak. On the other hand, the surges are dispersed in Case 2 and the first surge in Case 1 has smaller value. In a straight channel the transverse distribution of the water velocity and the reflection of the surges from the walls are small. On the other hand, as shown in Figure 4, the transverse distribution of the water velocity is large in the meandering channel. Additionally, the reflection of the surges from the walls is large, because the propagation direction of the surge is not parallel to the walls. As a result, the surges are dispersed in Case 2. This is the important characteristics of the propagation characteristics of surges in meandering channels.

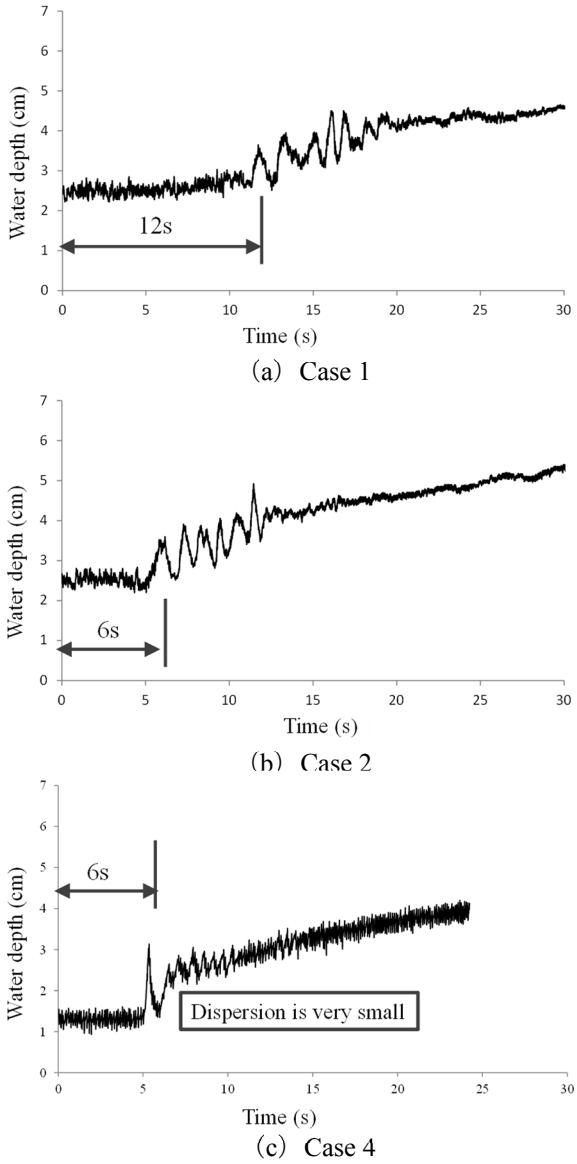

Fig. 3 Temporal change of water level

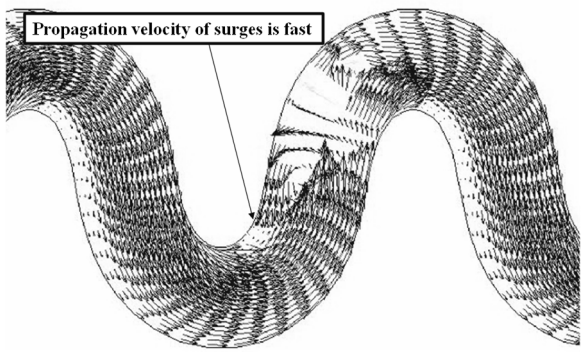

Fig. 4 Horizontal distribution of depth averaged water velocity (Case 5)

Keywords: Surge, landslide dam, experiment