Study on the Influence of Sabo Dam Type on Sediment and Water Behavior

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INTRODUCTION

Numerous studies on the sediment capture function of the sabo dam have been carried out by waterway experiment and numerical analysis. As a result, much knowledge about it has been obtained. Now, they are reflected in the planning and design of the debris flow countermeasure facility. However, it is difficult to decide the shape of the sabo dam which is most suitable for measures of the difference in shape of hydrograph or the various sediment discharge phenomena such as low sediment concentration. Here we conducted a waterway experiment to clarify how the sediment deposition process and the water outflow process around the sabo dam differ depending on the sabo dam type. In addition, we prepare a one-dimensional calculation program of river bed variation and verified the reproducibility of experimental result.

WATERWAY EXPERIMENT AND ONE-DIMENSIONAL CALCULATION OF RIBERBED VARIATION

The dam we studied in the experiment was three kinds (closed-type, two types of open-type with different open widths). We used a rectangular experimental flume with a length of 10m and a width of 30cm. We set the slope to 5degrees. We used mixed sand of 50% particle diameter 8mm. We supplied water and sediment from the upstream of the flume on fixed bed. We measured the time series change of the water depth and discharge amount of water and sediment at the end of waterway. We set the hydrograph to three patterns shown in **Fig.1**.

In carrying out the reproduction calculation, we used a numerical calculation program for mixed particle sizes. The numerical calculation program can continuously analyze from debris flow to bedload and suspended load. Also, it can calculate flowing, depositing and erosion of bedload and suspended load. Further, it can perform non-equilibrium calculation of suspended load. We newly created a numerical calculation program combining (1) to (3) in order to evaluate the behavior of water and sediment around the dam.

(1) Calculation of runoff amount combining weir formula and equation of motion

(2) Calculation of captured sediment volume in spillway and transmission part considering particle diameter and lattice interval

(3) Calculation of sediment volume of deposition area by method of Satofuka and Mizuyama [2005] (Numerical simulation on debris flow control by a grid dam, Journal of the Japan Society of Erosion Control Engineering, 57(6). 21-27).

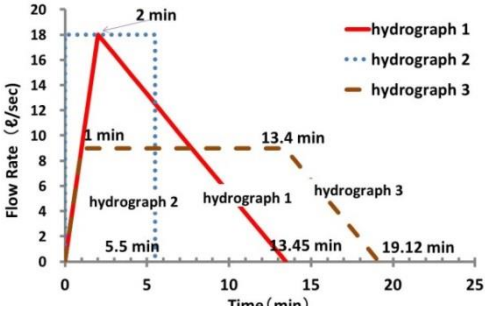

Fig. 1 Hydrograph

RESULTS AND CONSIDERATION

Table1 shows the amount of sediment trapped by sabo dam after input of water and sediment. In addition, **Table1** shows the ratio of the amount of sediment discharged per unit time around peak discharged at the time of no facilities. In each case of hydrographs 1 to 3, the trapping rate (the ratio of the trapped sediment volume to the dam volume) was over 90%. The amount of sediment discharged per unit time around peak supply flow rate, in the case of hydrograph 1, was 10% different from the amount of sediment discharged when case7 and case 10 are compared. As shown in **Fig.2**, when the transmission part is narrow, the backwater caused on the upstream side of the dam. And sediment accumulated while forming sediment shoulder, and accumulated sediment did not reach the dam at peak supply flow rate. As a result, we thought that the sediment discharge was less in the case where the transmission part is narrow than the case where the transmission part is wide. The outflow amount to the downstream side from the dam resulted in the following results. (1)In case of the closed-type dam, there was no significant difference in peak flow rate and peak arrival time compared with that no facility.(2)In case of the open-type dam, regardless of the transmission width, the peak flow rate was about 20% less than when no facilities and closed-type dam in the case of hydrograph1. It is thought that the outflow to the downstream slowed down as a result of accumulating water in the upstream area of the sabo dam due to weir up and penetrating a part of surface water into the deposited sediment.

Subsequently, the result of reproduction calculation the case of Hydrograph1 is shown in **Fig.3** and **Fig.4**. In any type of sabo dam, sediment deposition process could be reproduced roughly.

Table1 Result

CASE	SABO DAM TYPE	HYDRO-GRAPH	TRAPPING RATE	OUTFLOW RATIO TO NON-FACILITIES
4	Closed-type	1	0.94	0
5		2	0.98	0.39
6		3	0.99	0
7	Open-type (transmission part is wide)	1	0.94	0.15
8		2	0.91	0.11
9		3	0.97	0.04
10	Open-type (transmission part is narrow)	1	0.96	0.03
11		2	0.92	0.09
12		3	0.98	0.04

Fig. 2 Deposition Process

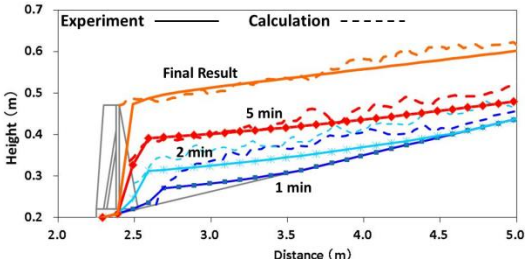

Fig. 3 Calculation Result

(the transmission part is narrow)

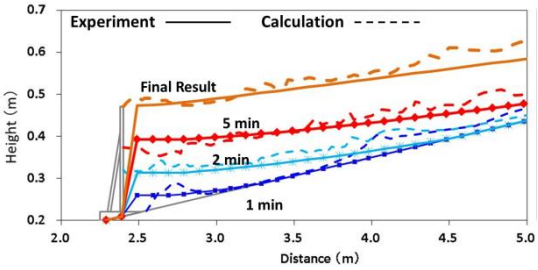

Fig. 4 Calculation Result

(the transmission part is wide)

CONCLUSIONS

Depending on the sabo dam type, we found that sediment and water behaviors differed greatly. For example, if the transmission part is narrowed, the backwater caused by the open widths or the sediment accumulates while forming sediment shoulder. As a result, It is suggested that peak flow reduction effect can be expected. Also, we confirmed that the obtained experimental results can be reproduced by numerical calculation when adding the evaluation method of the sabo dam.

Keywords: Waterway experiment, Sabo dam type, Hydrograph, Numerical simulation, sediment and water behavior