Experimental Study of Countermeasures Against the Successive Debris Flow

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INTRODUCTION

Although debris flow still occurs and makes a loss of lives and properties, many people are living in the debris flow prone areas. There is not only damage from the main body of debris flow but also a successive debris flow. For example, disaster occurred in Hiroshima city on August 20, 2014. It was confirmed that many houses and humans were damaged by not only the main body of debris flow but also the successive debris flow. To mitigate successive debris flow hazard in the debris flow prone areas, channel works should be constructed. However, such measures requires extensive area therefore it is difficult to apply it to urbanized areas. Many structures and high population density residential areas could interrupt to provide an extensive area for channel works construction. For the reason above, other physical measures must be required which is efficient for urbanized debris flow prone areas. Arai *et al*. (1997) and Kurihara *et al*. (1989) examined flume experiments using polymer. Their experiments have successfully demonstrated the decreasing in flow speed of the main body of debris flow. In this study, the main body of debris flow is controlled by Sabo dam, and the effect of countermeasures on the change in the hydrograph and total discharge volume of the successive debris flow were studied.

METHOD

The experimental flume consist of two parts (Upper part : 140 cm long, 6.5 cm wide, 10 cm high and 18˚ gradient; lower part : 25 cm long, 8 cm wide, 10 cm high and 8˚ gradient). Basically, install one Sabo dam(hereafter "SD") to catch the main body of debris flow was installed at the point of gradient change. Debris flow is produced by supplying a constant water supply 250 cm^3/s for 2.5 s and sand supply 625 cm^3 (d_m = 1.5 mm) from upstream of the flume. In here, when the experimental scale is 1/200 with assuming the Froude Law, the height of Sabo dam(5cm) is 10m and amount of sediment in debris flow(625cm^3) is 5000m^3. Also carried out absorption ability test(hereafter "AAT") to determine the suitable amount of polymer for experiment (**Fig. 1**). ATT was conducted in static condition. And sub dam was installed in experimental flume to make a pool for increasing absorption ability of polymer. The height and distance from SD of sub dam are calculated from equations used by the Japanese Ministry of Land, Infrastructure, Transport and Tourism Technical Criteria for River Works. Additionally, screen was installed in the just lower of the SD to capture debris of successive debris flow and reduce the velocity of successive debris flow. Experiment was conducted in 8 cases (**Table 1**).

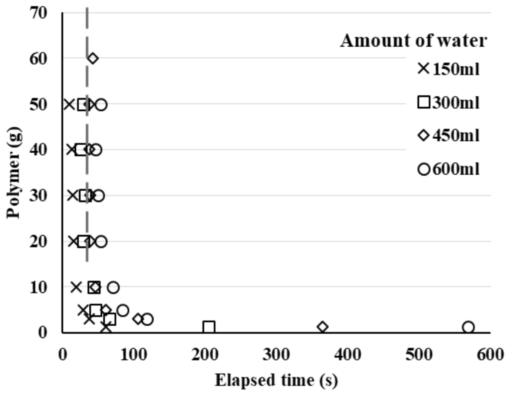

Fig. 1 Absorption ability of polymer

RESULT

Fig 1. shows the relation between elapsed time of polymer water absorption and amount of polymer. There is not a remarkable elapsed time difference over 20 g of polymer, this is the reason why 20 g was determined to be used in the experiment. **Fig 2**. shows the result of hydrograph of successive debris flow. There is a definite change in peak discharge in successive debris flow. Peak discharge decreased approximately 70% (SD+Sub dam+Screen +P(20)). In this experiment, water volume of successive debris flow is approximately 600 cm^3 and flowing duration of successive debris flow takes almost 10 s. Through ATT, the square in **Fig. 2** represents an elapsed time to water gelation by polymer. When a polymer absorbs 1/4, 1/2 and 3/4 water of successive debris flow, it needs 15, 29, 38 and 53 s. Therefore experiment was conducted to expect decrease 1/4 water of successive debris flow.

CONCLUSION

Cases including polymer, show higher concentration and lower water volume than cases without polymer. It means polymer could decrease flooding prone area of successive debris flow and it is helpful to successive debris flow hazard mitigation.

Of course, in this experiment, the flowing duration of the successive debris flow is short to absorb large amount of water by using polymer, so sub dam is effective to promote polymer water absorption. Combination of SD, Screen, Sub dam and P(20) is more effective as measure against successive debris flow.

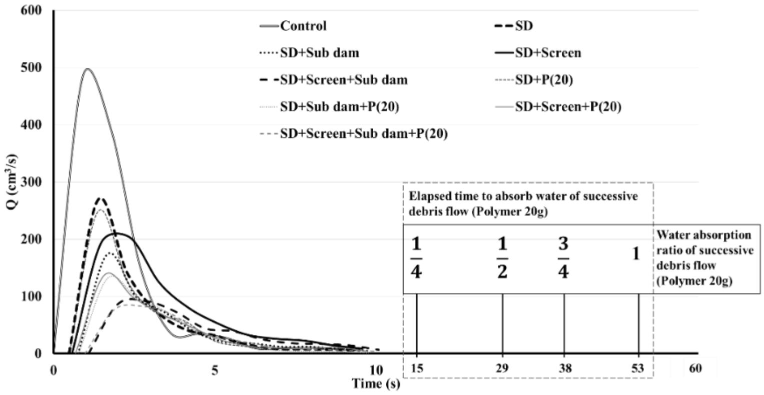

Fig.2 Hydrograph of debris flow

Tab.1 Each value of Concentration, Ratio of water volume and Peak discharge

Cases	Concentration	Ratio of water volume	Peak Discharge(cm^3/s)
SD	0.1434	1.00	269.0
SD+P(20)	0.1852	0.79	249.0
SD+Sub dam	0.0588	0.79	173.5
SD+Sub dam+P(20)	0.0659	0.67	131.6
SD+Screen	0.1364	0.92	202.9
SD+Screen+P(20)	0.0808	0.80	137.2
SD+Screen+Sub dam	0.0048	0.65	91.8
SD+Screen+Sub dam+P(20)	0.0095	0.62	82.7

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