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The effect of polymer on the change in the hydrograph of 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. 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 effect of polymer on the change in the hydrograph and total discharge volume of the successive debris flow were studied.

Methodology

The experimental flume is shown in Fig. 1 (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). 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 = 0.75 mm) from upstream of the flume. Basically, install One Sabo dam(hereafter “SD”) to catch the main body of debris flow was installed at the point of gradient change. Also carried out absorption ability test(hereafter “AAT”) to determine the suitable amount of polymer for experiment (Fig. 2). 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(T) and distance from SD(L) 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 5 cases (Table 1).

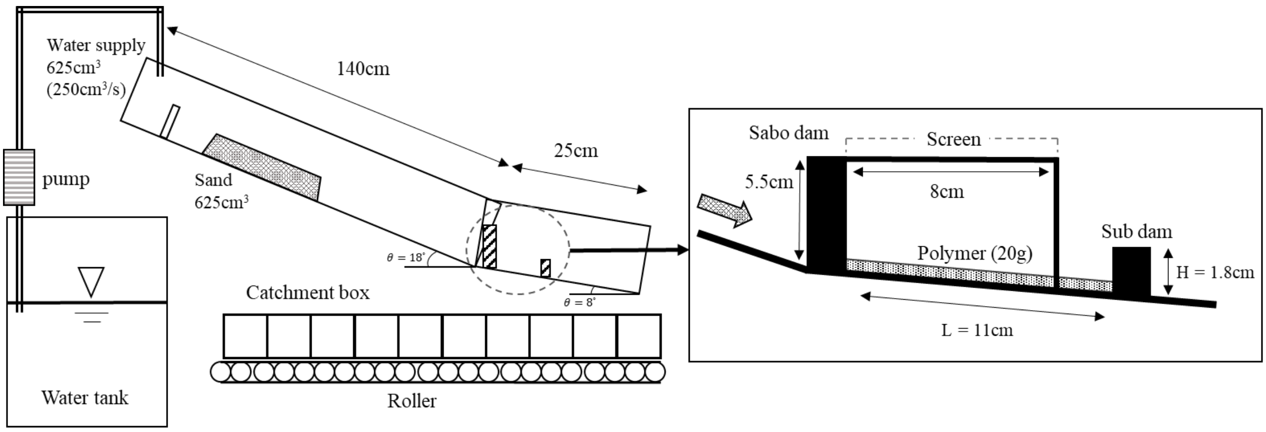

Figure 1. Experimental flume

Result and Discussion

Fig 2. 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 3. shows the result of hydrograph of successive debris flow. There is a definite change in peak discharge in successive debris flow. From the case-1 to 5, peak discharge decreased approximately 75%. 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. 3 represents an elapsed time to water gelation by polymer. If a polymer absorbs 1/4, 1/2 and 3/4 water of successive debris flow, it needs 15 s, 29 s, 38 s and 53 s. Therefore experiment was conducted to expect decrease 1/4 water of successive debris flow. Table 1 shows a concentration and water volume of successive debris flow. Case-2, including polymer, shows higher concentration and lower water volume than case-1. Case-3 and 4 show the same result, as well. It means polymer could decrease flooding boundary 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.

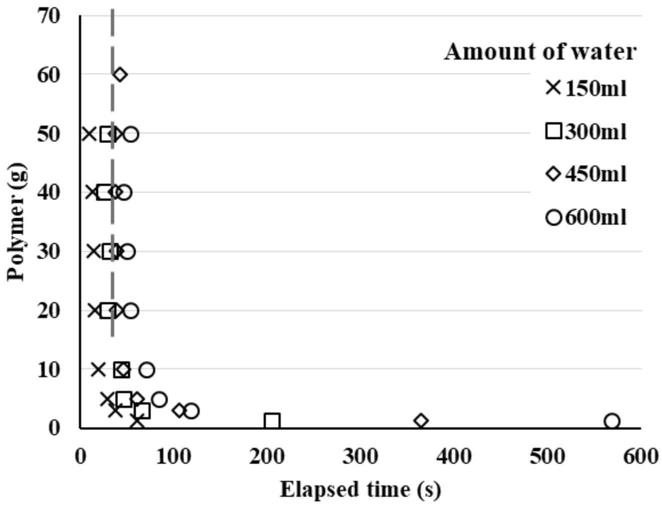

Figure 2. Absorption ability

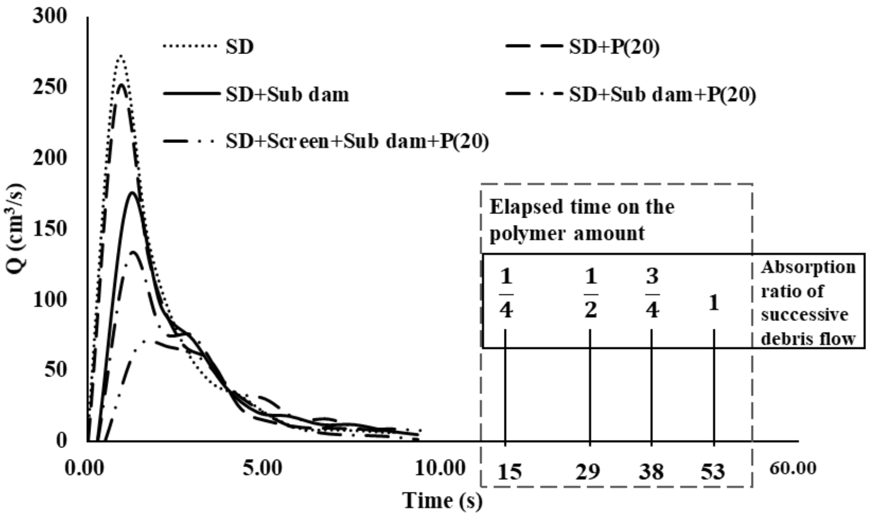

Figure 3. Hydrograph of successive debris flow

Table 1. Concentration and Water volume in each experiment case

Case	Concentration	Water Volume
1 - SD	0.143	1.00
2 - SD+P(20)	0.185	0.79
3 - SD+Sub dam	0.060	0.81
4 - SD+Sub dam+P(20)	0.066	0.67
5 - SD+Screen+Sub dam+P(20)	0.005	0.69

*SD : Sabo dam, P(20) : Polymer 20g

References

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2) J. Kurihara, T. Mizuyama, H. Suzuki: 高分子吸水剤の土石流流動阻止効果．第38回砂防学会研究発表会概要集, 161-164, 1989