Flume experiment of debris flow mitigation applying water absorbent and screen dam model

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1. Introduction

Debris flow was defined as "a flow in which sediment particles are dispersed in water or clay slurry at a concentration slightly lower than that needed for stable sediment accumulation (Takahashi, 1977). However the debris flow occur in mountain torrential streams often pick up the material along river bed or drop off the material including the flow unit. Then debris flow could change in flow speed with changes in concentration. Because the concentration of debris flow was expected to decrease by separating water (liquid) and sediment. Therefore we can result theoretically that if the water including debris flow would be taken away along the pathway, the debris flow speed will quickly decrease with increase in concentration.

To understand the relation between concentration and flow speed of debris flow, Arai *et al.*(1997) and Kurihara *et al.*(1989) have examined flume experiments using absorbent. Their experiments have successfully demonstrated the decreasing in flow speed with increasing in concentration of debris flow. Authors assumed that flow speed as well impulsive force of debris flow could relate with the reaching distance of debris flow unit downstream. The reaching distance of debris flow is significantly related to the setting methods of hazard area such as yellow and red zones. In this study, therefore, the relation between both flow speed (velocity) of debris flow and impulsive force downstream, and the concentration of debris flow were examined by experimental flume. We also examined the effect of screen dam as one of the actual separating system of water and sediment. Additionally the sediment area of debris flow at the downstream fluvial fan with the difference in concentration was measured.

2. Method

2.1. Outline of experiment

The debris flow experimental flume consists of a 500 cm long horizontal acrylic flume with a square section 18 cm wide and 18 cm high. The absorbent for setting on the experimental flume is 9 cm long and 14 cm wide, and the screen dam is made of wood, and the parameter is 27 cm long and 18 cm wide which have an opening (0.3 mm) and blocking (0.5 mm) size. It is a reduced to 1/100 scale of screen dam which was constructed in 1980 at Nojiri river in Sakurajima. To generate the debris flow, mixing sediment with clay to sand and water was used each 3 liters. Through in the experiment, measure the impulsive force by load cell also figure area of progress in sediment and velocity out by using a high-speed camera. At last weight of absorption is calculated measure the weight before and after generating a debris flow. To obtain result, experiment should be repeat 3 times each condition.

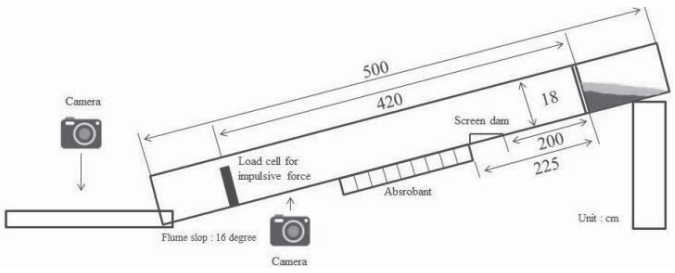

Figure 1. Sketch of experimental flume

2.2. Condition of experiment

2.2.1. Experiment with absorbent

Set up the absorbent on the middle part of experiment flume as five conditions: Control, 3 absorbents(A-3), 5 absorbents(A-5), 7 absorbents(A-7) and 9 absorbent(A-9).

2.2.2. Experiment with absorbent and screen dam

Conduct an experiment by adding a screen dam to experiment of 1.2.1.. Screen dam is located above the absorbent.

3. Result

3.1. In experiment with absorbent (Fig. 2), the condition of A-9(1.6 kg) was absorbed water approximately 2.3 times more than the condition of A-3(0.7 kg). And therefore velocity and impulsive force was decreased. The velocity was decreased approximately 2.2 times in the condition of A-9(0.4 m/s) more than Control(0.9 m/s), and impulsive force was decreased approximately 8.2 times in the condition of A-9(0.5 N) more than Control(4.1 N).

3.2. In experiment with absorbent and screen dam (Fig. 2), the condition of A-9(1.6 kg) was absorbed water approximately 2.7 times more than the condition of A-3(0.6 kg). And therefore velocity and impulsive force was decreased. The velocity was decreased 1.8 times in the condition of A-9(0.5 m/s) more than Control(0.9 m/s), and impulsive force was decreased approximately 5.8 times in the condition of A-9(0.6 N) more than Control(3.5 N).

3.3. As the velocity and the impulsive force decreasing, the sediment area of debris flow to downstream was also decreased. It means the distance of debris flow unit attaining to downstream also decreasing (Fig. 3).

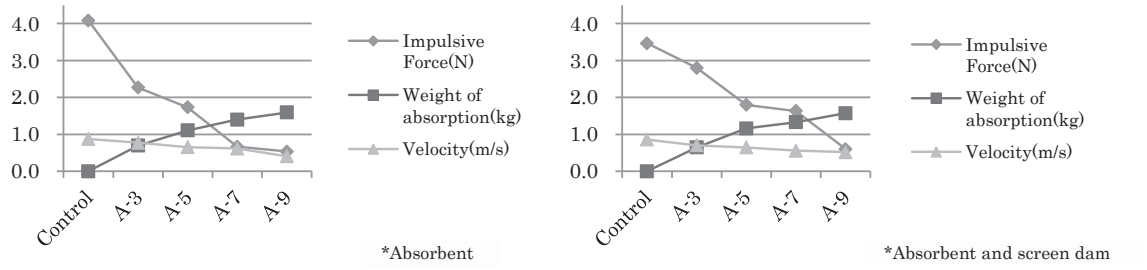

Figure 2. Relationship of impulsive force, weight of absorption and velocity with absorbent and screen dam

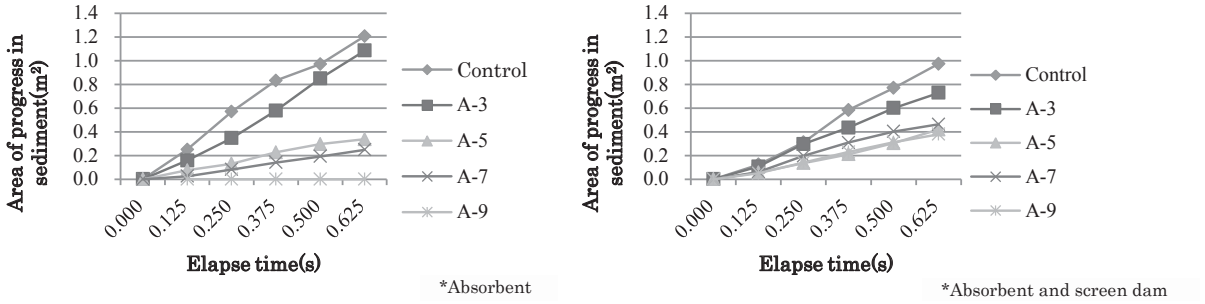

Figure 3. Changes area of progress in sediment with the flow of time

4. Discussion

In this study, we figured out the absorbent and the screen dam is effective to separation of water and sediment from debris flow through the flume experiment. Generally in all condition, the velocity and impulsive force was decreased with increase in weight of absorption. From these results, the relation between the distance of debris flow unit attaining to downstream and the changes in concentration is s uggested. But in experiment with absorbent and screen dam, the results showed less effect to decrease in the velocity and impulsive force than in experiment with absorbent. Proceeding from this experiment, one could logically assume that soils make a jump pad on screen dam as deposition. As shown in Fig. 1, absorbent is close to screen dam, so it should be hard to absorb water in front part of absorbent and beginning of debris flow. I tentatively conclude that this phenomenon had an effect on results.

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