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# Study on impact force of debris flow due to variable of check dam shape

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**Abstract.** Impact often causes structural destruction and is the key element in engineering design and risk assessment. Nature of the debris flow characteristics are the front part of the flow, where big boulders accumulate, lasts only a few seconds and the following part that lasts long looks like a mud flow with gradually decreasing discharge. Besides, boulder impact force is much greater than fluid dynamic pressure. Therefore, it is necessary to make sure that the structure is affordable of boulder impact force. In this study, an attempt has been made to clarify the impact of grain size distribution on check dam and variable of check dam type with experimental methods.

Keywords: *Debris flow, Impact force, check dam type*

## 1. INTRODUCTION

Debris flows are common in mountainous areas throughout the world, which contain varying amounts of mud, sand, gravel, boulders, and water. In addition to causing significant morphological changes along riverbeds and mountain slopes, these flows are frequently reported to have brought about extensive property damage and loss of life (Takahashi, 1991; Hunt, 1994; Huang and Garcia, 1997). Debris flow cause damage mainly in three ways: deposition, erosion and direct impact. Impact often causes structural destruction and is the key element in engineering design and risk assessment. Nature of the debris flow characteristics are the front part of the flow, where big boulders accumulate, lasts only a few seconds and the following part that lasts long looks like a mud flow with gradually decreasing discharge. Besides, boulder impact force is much greater than fluid dynamic pressure. Especially, Sabo dam would be designed with the necessary function and stability based on the Sabo master plan. In this time, we should be take impact force of debris flow levels into consideration when designing a Sabo dam. However, we are only considering as hydrostatic conditions about external forces. So far, impact force is calculated by an empirical formula according to experiments and observations, but the phenomenon can be analyzed by three-dimensional model is necessary. In this study, it is part of an ongoing study. It is conducting an experiment to test the maximum impact force of debris flow for other point of vertical with variable bed sediments. Especially, it would be utilized the verification of 3D debris flow model with experimental methods.

## 2. LABORATORY EXPERIMENTS

A rectangular flume of 5m long, 10cm width and 14cm deep is used for the experiments. The slopes of flume are set at upstream with 18°. The details of experiment setup are shown in **Fig. 1**. The bed sediment with 1.9m long and 7cm deep is positioned 2.8m upstream from the outlet of the flume by installing a partition of 7cm in height to retain the sediment. The bed sediments are used 3 kind of different mean diameters. Debris flow is produced by supplying a constant water discharge of 300cm$^3$/sec for 10sec from upstream end of the flume. Debris flow produced in the experiments is the fully stony type debris flow and the largest particles are accumulated in the forefront. The impact force measurement system (as showed in **Fig. 2**) is used four load cells, interface and adaptor with 4 channels. The

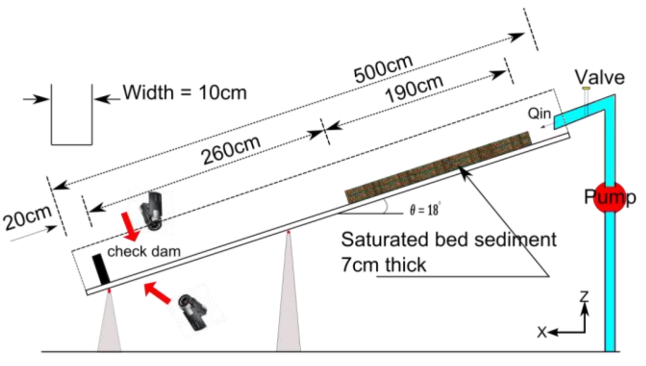


**Fig. 1** Sketch of the Experimental Flume


**Fig. 2** Measurement of the Impact Force

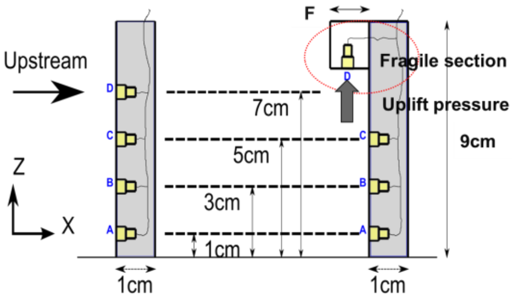


**Fig. 3** Sensors fixed on the dam

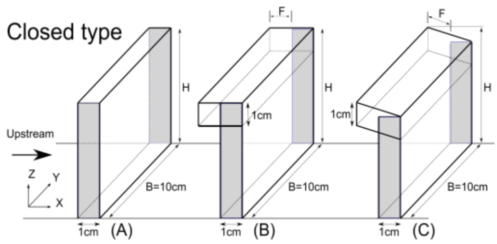


**Fig. 4** Type of check dam

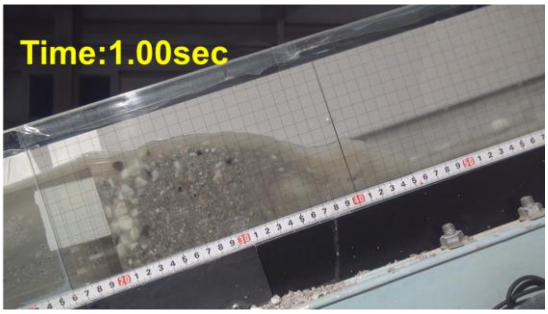


**Fig. 5** Deposit of debris flow: Type A

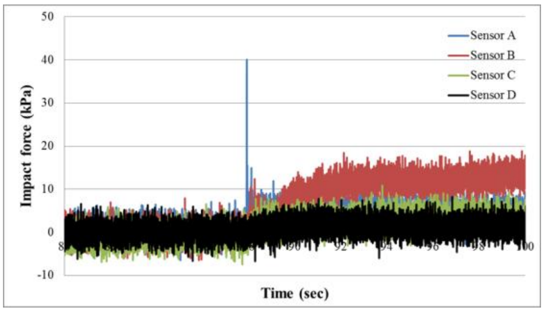


**Fig. 6** Impact force of debris flow

closed dam of this study is made of acrylic board. The measurement system is composed of dam type with load cells (as showed in **Fig. 3 and Fig. 4**).

## 3. Results and Discussions

The experiments are carried out to predict impact force of debris flow characteristics. Firstly, the 4 sensors were calibrated by hydrostatic pressure conditions. Debris flow produced in the experiments is the fully stony type debris flow and the largest particles are accumulated in the forefront (**As** shown in **Fig. 5**). For we have to measure the transient impulse of boulder impact force and fluid dynamic pressure transmission, the sampling frequency must not be too low (Zanuttigh and Lamberti, 2006). This study's sampling frequency is 500Hz. **Fig. 6** shows the temporal variations of impact force between sensor A, B, C and D. Impact force of Debris flow on check dam produces in general a very abrupt occur of the force to the maximum value $F_{max}$ that is related to a height of debris flow approaching. The approaching depth of debris flow is about 1~2cm. Therefore sensor A was recorded the maximum impact force about 40kPa.

## 4. Conclusions

In this study, it is part of an ongoing study. It is conducting an experiment to test the effectiveness of the new shape of dam and discovery the maximum impact force of debris flow with variable bed sediments. Experiments are carried out to predict impact force of debris flow characteristic with various depths and the impact force of debris flow on the front of check dam and deposit pattern due to variable dam shape were presented. These predicted characteristics can be used for debris flow mitigation and countermeasures in downstream. Especially, it would be utilized the verification of 3D debris flow model with experiment results.


**References:**

[1] Huang, X., and Garcia, M.H. (1997): *A perturbation solution for Bingham-plastic mudflows*, Journal of Hydraulic Engineering, ASCE, Vol.123, No.11, 986-994.

[2] Hunt, B. (1994): *Newtonian fluid mechanics treatment of debris flows and avalanches*, Journal of Hydraulic Engineering, ASCE, Vol.120, No.12, 1350-1363.

[3] Takahashi, T., Nakagawa, H., Harada, T., and Yamashiki, Y. (1992): *Routing debris flows with particle segregation*, Journal of Hydraulic Engineering, ASCE, Vol.118, No.11, pp.1490-1507.

[4] Zanuttigh, B. and Lamberti, A., (2006) : *Experiment analysis of the impact of dry avalanches on structures and implication for debris flows*, Journal of Hydraulic Research, Vol.44, No.4, pp.522-534.