# STUDY ON DEBRIS-FLOW DEPOSITION AND EROSION PROCESSES UPSTREAM OF A CHECK DAM

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Debris flows are common in mountainous areas throughout the world. It destroys houses, bridges and claim people's lives. Sometimes it flows over even high ridge of mountain. A check dam is commonly used for preventing the sediment disaster due to debris flow by storing the harmful sediment discharge. Experimental works have been carried out to investigate the mechanism of debris flow deposition process upstream of a check dam and transported of deposited sediment due to erosion process by a normal flow discharge. The experiments are carried out on closed type and grid type check dams. From the results, it is shown that the grid type check dam can keep their debris flow trapping capacity more effectively than the closed type check dam.

***Key Words*** **:** *Debris flow, check dams, deposition, erosion, laboratory experiment*

## 1.0 INTRODUCTION

Debris flows are common in mountainous areas throughout the world. Often triggered as mudflows by torrential rains, debris flows 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; Huang and Garcia, 1997; Hunt, 1994). **Fig. 1** shows the annual loss of life and property from the debris flow, landslide and floods in Nepal.

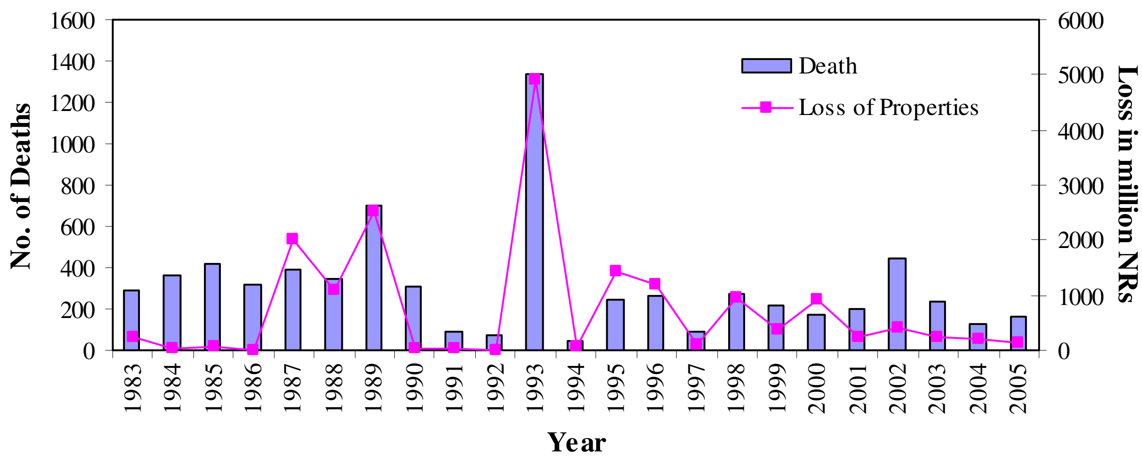



**Fig.1** Annual loss of life and property from the debris flow, landslide and floods in Nepal.

Check dams are one of the effective structural measures for debris flow control. It can be classified as a closed type and an open type check dam. In the context of Nepal, a closed type check dam is mostly used. Debris flow stops by the closed-type check dam until the retention space behind the dam is full of sediment and consequently could not have controlled debris flow successfully if they lose their storage capacity. It becomes impossible for fish to move upstream and downstream freely or that not enough sediment is supplied downstream. Accordingly, degradation of the riverbed and the retrogression of shoreline occur. In recent years, a open type check dam has become popular. Their dams have the merits that the debris flow is captured and the sediment discharge is small and medium floods pass through (Miyazawa et al., 2003).

The objective of this paper is to experimental study and to investigate the debris flow deposition and erosion of deposited debris flow upstream of closed type and grid type check dams. The effectiveness of check dam to control debris flow is presented.

## 2.0 LABORATORY EXPERIMENTS

The experimental works are carried out on a 5m long, 10cm wide and 13cm deep flume. The slope of flume is set at 18 degrees. The details of experiment setup are shown in **Fig. 2**. Silica sand and gravel mixtures 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. Sediment materials with mean diameter $d_m = 2.53$mm, maximum diameter $d_{\max} = 15$mm, maximum sediment concentration at bed $C_* = 0.65$, angle of repose $\tan\phi = 0.7$ and sediment density $\sigma = 2.65$ g/cm$^3$ are used. The particle size distribution of sediment mixture is shown in **Fig. 3**. Check dams are set at the 20cm upstream from end of the flume. The experiment works are carried out using one closed dam of 8cm in high and two open type grid dams with various spacing of grid. The details of the check dam types are shown in **Fig. 4**. Debris flow is produced by supplying a constant water supply 260cm$^3$/sec for 10sec from upstream end of the flume. Debris flow deposition pattern upstream of check dams and erosion of deposited debris flow are captured by two standard video cameras located at side and above the flume end.

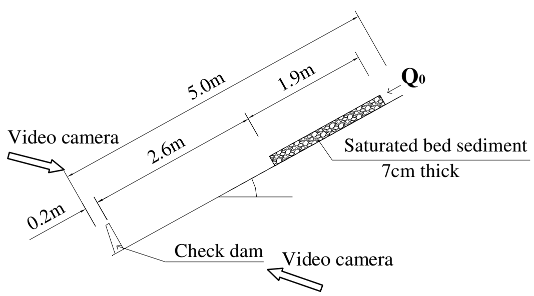



**Fig.2** Experimental laboratory flume setup

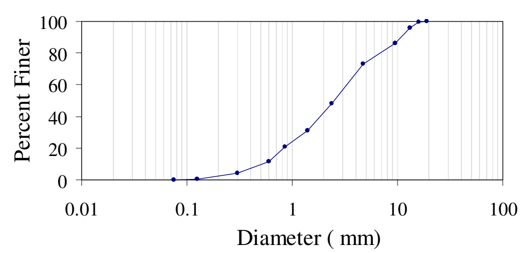



**Fig.3** Particle size distribution of bed sediment

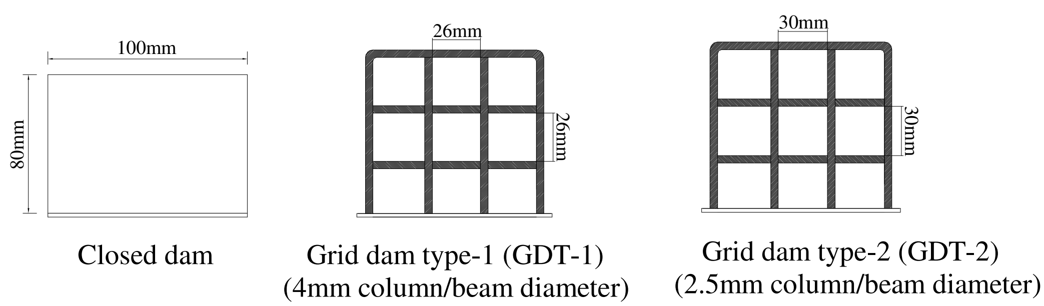



**Fig.4** Check dam types

## 3.0 RESULTS AND DISCUSSIONS

### (1) Deposition process upstream of a check dam

**Fig. 5** shows the experimental results of the debris flow deposition upstream of a closed type or a grid type check dam. From the results, it is found that the closed dam traps all the sediments until the dam is filled up with sediment, and their sediment storage capacities are decreased soon. In the case of grid dams harmless sediment discharge is transported to downstream before the blockade of grid opening and keeps the sediment storage capacities. The opening of a grid dam is blockaded by large sediment particles in debris flow. This blockade phenomenon is influenced by the width of dam opening, the maximum particle diameter of sediment, and the sediment concentration of debris flow. After blockade of grid dam opening, it is found that the debris flow deposition pattern upstream of a grid dam similar as that type of a closed dam. However, the

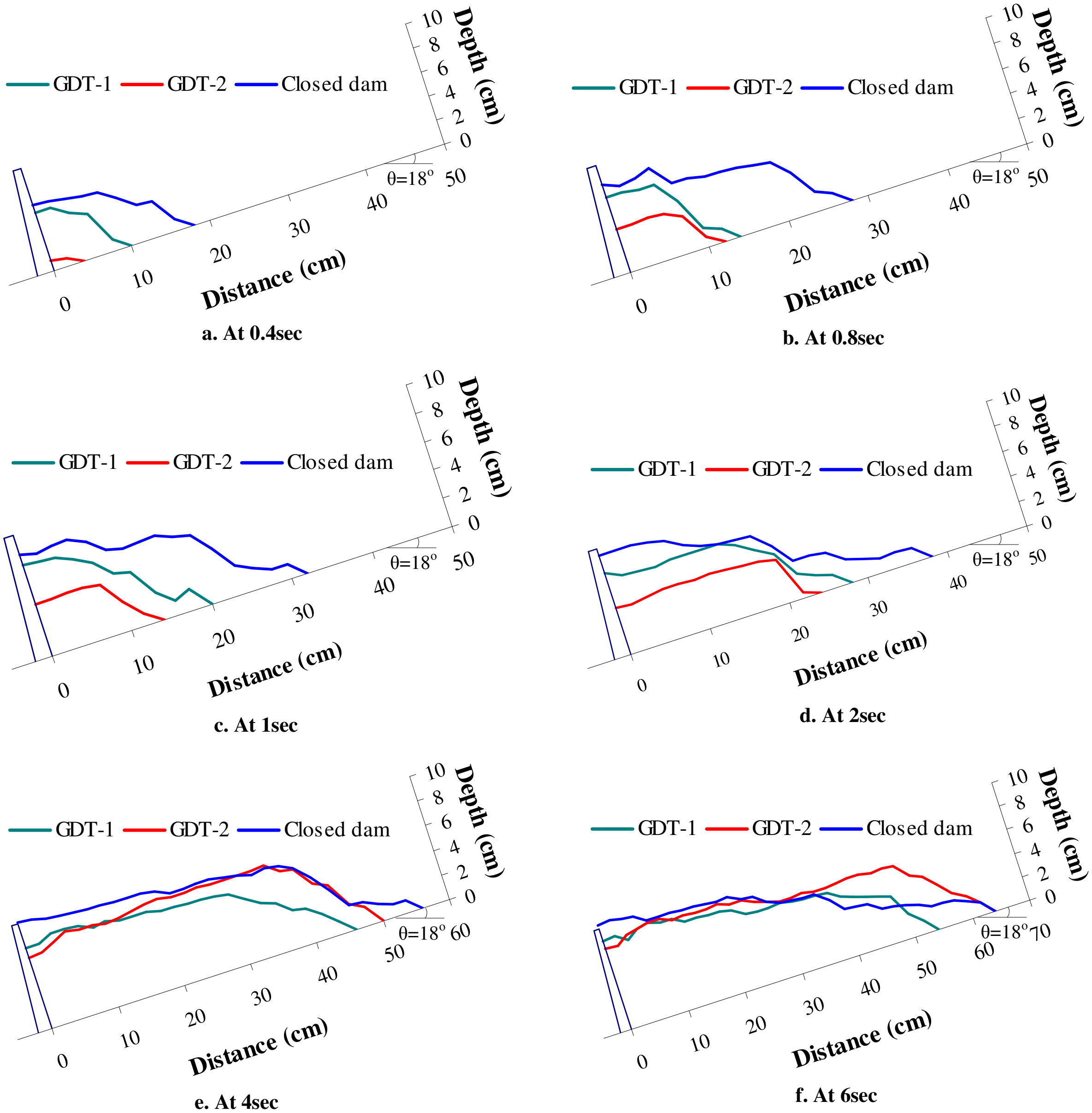



**Fig.5** Experimental results of debris flow deposition upstream of a check dam.

grid type check dam can store debris flow more effectively than the closed dam.

### (2) Erosion of deposited debris flow upstream of a check dam.

The large boulders deposited upstream of a check dam can not be transported by a normal scale flood flow. If we remove large boulders deposited upstream of a grid dam or blockaded large boulders at open spaces of grid, deposited sediment upstream of a grid dam may be transported by a normal scale of flood flow. Hence, the experiments on flushing out of deposited sediment upstream of a check dam due

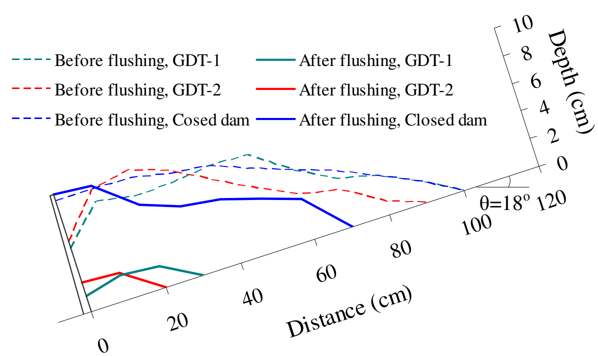
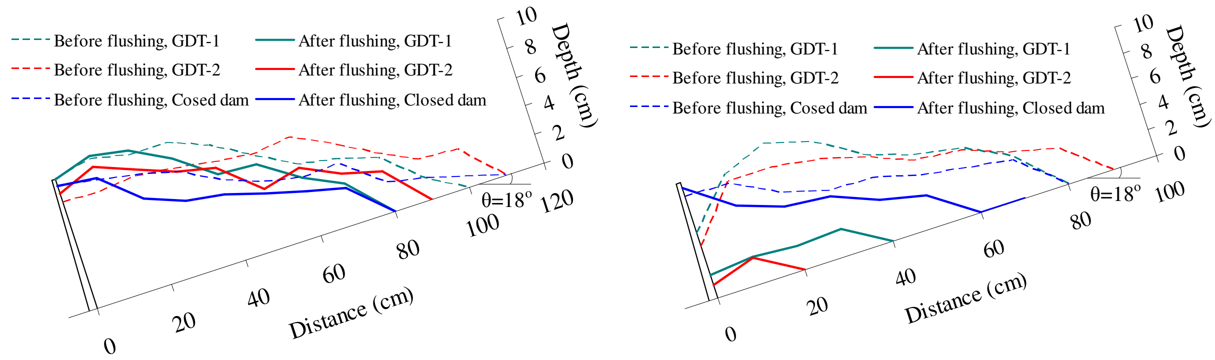



**Fig.6** Experimental results of flushing out deposited sediment due to erosion and variations in depth, CASE-I




**a. Experimental results of flushing out deposited sediment before removing large boulders**

**b. Experimental results of flushing out deposited sediment after removing large boulders**

**Fig. 7** Experimental results of flushing out deposited sediment upstream of check dam and variations in depth, CASE-II

to erosion process are carried out in two cases. In CASE-I: some large boulders deposited upstream of the check dam are removed and supplying discharge at a rate of 260cm$^3$/sec for 15sec. **Fig. 6** shows the variation in depth after flushing out of deposited sediment upstream of check dams due to erosion process by normal flow.

In CASE-II: firstly flow discharge at a rate of 260cm$^3$/sec is supplied for 15sec, and after that some deposited large boulders are removed, then again flow discharge at a rate of 260cm$^3$/sec is supplied for 15sec. **Fig. 7** shows the experimental results of flushing out of deposited sediment in the case II. The deposited sediment could not be flushed out effectively by erosion of water supplying before removing large boulders. It is found that deposited sediment upstream of grid dam can be flushed out more effectively by a normal scale flood if we remove deposited large boulders.

## 4.0 CONSLUSIONS

Debris flow deposition and erosion upstream of a check dam are investigated through several laboratory experiments. The deposited sediment upstream of grid dam can be flushed out due to erosion process by a normal scale flood flow if deposited large boulders are removed. From the results, it is shown that the grid type check dam can keep their debris flow trapping capacity more effectively than the closed type check dam.

In the further study, the numerical model will be developed to investigate debris flow deposition and erosion process upstream of a check dam.

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