BED AND BANK EROSION RATE EQUATIONS FOR A STEEP MOUNTAIN RIVER

HIROKI TAKAOKA[1], HARUYUKI HASHIMOTO[2],
KICHAN PARK[3] and NATSUKI HISAOKA[4]

[1]Department of Civil Engineering, Kyushu University, Fukuoka, 812-8581, Japan.
(Tel: +81-92-642-3289, Fax: +81-92-642-3290, e-mail: river4@civil.kyushu-u.ac.jp)
[2]Associate Professor, Department of Civil Engineering,
Kyushu University, Fukuoka, 812-8581, Japan.
(Tel: +81-92-642-3288, Fax: +81-92-642-3290, e-mail: hasimoto@civil.kyushu-u.ac.jp)
[3]Reseach Associate, Department of Civil Engineering,
Kyushu University, Fukuoka, 812-8581, Japan.
(Tel: +81-92-642-3289, Fax: +81-92-642-3290, e-mail: kpaku@civil.kyushu-u.ac.jp)
[4]Department of Civil Engineering, Kyushu University, Fukuoka, 812-8581, Japan.
(Tel: +81-92-642-3290, Fax: +81-92-642-3290, e-mail: river19@civil.kyushu-u.ac.jp)

Landslides sometimes occur on mountain slopes during heavy rains. Some of the landslides change into debris flows and move down a steep mountain river. During the movements they significantly erode river bed and bank, and increase the discharge of debris flows.

In the downstream reach with mild slope, the sediment deposition occurs and causes an increase in bed level. The debris flows move over the river bank and sometimes kill some people of residents along the river.

When we consider their countermeasures, it becomes necessary to predict the outflow discharge from a steep river. The prediction of the discharge requires the knowledge of erosion rate in mountain rivers.

There are some studies on bed and bank erosions in mountain rivers.

Ashida et al. [1988] introduced a concept of equilibrium bed slope into the discussion of bed erosion by debris flows. They defined the equilibrium bed slope as that without erosion and deposition, and derived a bed erosion rate equation depending on the difference between bed slope and its equilibrium slope.

Takahashi et al. [1991] proposed an idea that erosion rate becomes zero as sediment concentration approaches equilibrium concentration. Under the idea they obtained a bed erosion rate equation and verified the equation with the experiments using coarse sands and gravels as bed materials. Takahashi [1993] also obtained a bank erosion rate equation by estimating shear stress on banks as a half of bed shear stress. However the bank erosion rate equation was not verified with the experiments.

Hashimoto et al. [2002] and Takaoka et al. [2004] investigated flow characteristics in a steep open channel with erodible bank of fine sand. Using fine sand as the bed and bank materials, they found the channel cross sections almost rectangular and distinguished bed and bank erosions clearly.

The present study is an extension of the works of Hashimoto et al. [2002] and Takaoka et al. [2004]. First, we make experiments of bed and bank erosion rate in a steep open channel with erodible bed and bank. Second, using the erosion rate measurements, we estimate hydraulic quantities of flow velocity and sand concentration at any positions of

the channel. From the result, we obtain the equations of relationship between bed and bank erosions and the hydraulic quantities. Finally, we apply the erosion rate equations to the erosion problem by the debris flow in Atsumari River on July 20, 2003 (Photo 1)

Photo 1. Bed and bank erosion in Atsumari River, Minamata City

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