Experimental Studies for Monitoring of Bedload using Various Sensors

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INTRODUCTION

Considerable efforts have been made to continuously monitor bedload discharge in mountainous torrents. It is found several characteristics such as discontinuity between water discharge and bedload runoff in the flood stage through monitoring in mountainous basin.

In the Hodaka Sedimentation Observatory of the Disaster Prevention Research Institute of Kyoto University, which is abbreviated as Hodaka Obs. DPRI, bedload monitoring with pipe hydrophone started in the supercritical flume of the Ashi-arai-dani River in the 1990s and Reid-type bedload slot was installed in the 2000s, and data of sediment runoff due to rainfall has been collected in event to event (Fig. 1).

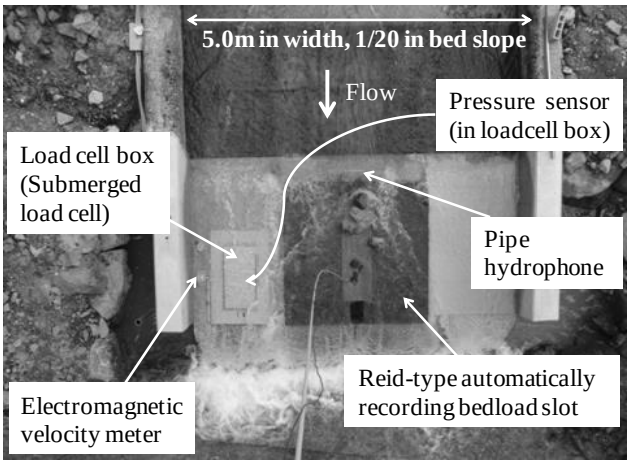

Fig. 1 Several instruments for bedload monitoring in the flume of Ashi-arai-dani river

VARIOUS SENSORS FOR BED LOAD MONITORING

Sensors based on acoustic method, which is one of passive sensor, is called as hydrophone or geophone system, and there are several names such as Japanese pipe hydrophone, piezoelectric plate in Swiss and plate-type hydrophone in Japan. Bedload monitoring using hydrophone can easily collect data for the numbers of sediment particles, however it becomes difficult to capture those data, when a lot of sediment particles move in high shear stress. We need to choose proper specific sensor in several equipments for each monitoring usage, taking into account the magnitude of bed shear stress and the size of sediment particles.

As seen in debris flow monitoring, the measurement with load cells can be useful for large bedload particles. A small, automatically recording submerged loadcell system with four pin-type load cells, a pressure sensor and electromagnetic velocity meter were developed and

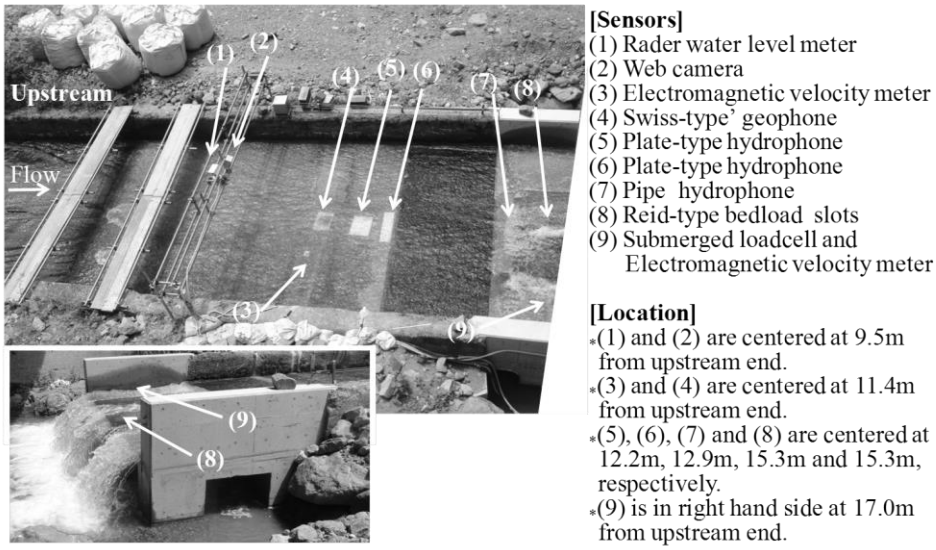

Fig. 2 Several instruments for water discharge and bedload monitoring in the supercritical flume of Ashi-arai-dani river (Hodaka Obs. DPRI)

installed for bedload measurements. The temporal variation of submerged bedload particle weight is measured and recorded by the submerged load cell system. The system was installed on November 8, 2012 in the Ashi-arai-dani River in the supercritical flume installation of the Hodaka Obs. DPRI of Kyoto University (Fig. 1). In this location watershed area is 6.5 km^2. Bed slope is 1/20 and flow width is 5 m in the flume. This well instrumented site also has installed several kinds of hydrophone systems (Japanese pipe hydrophone, a Swiss piezoelectric plate and Japanese plate-type hydrophone), Reid-type bedload slots and other hydrometric equipments (Fig. 2). Bedload discharge obtained by the submerged load cell system is confirmed through flume tests in Hodaka Obs. DPRI. Comparison with data obtained by those sensors in several floods and flume experiment, and applicability of each sensor will be presented in the paper.

CONCLUSIONS

The results obtained in present data analyses are summarized as follows:

(1) In comparison of various sensors, the peak of sediment movements can watch by vibration sensor and geophone, and two peaks are clearly measured through the flood events on June 19th to 23rd, 2013.

(2) Hydrophone can observe continuous time of sediment, and especially, the plate-type hydrophone (800 mm in width and 200 mm in length) seems to watch both peak and continuous time of sediment movements, through the flood events on June 19th, 2013. It seems that it can be easy to capture the signal due to sediment movements if the width of sensor is wide.

(3) Data of flume tests are shown in present study because data could not be obtained due to electric trouble for data accumulations. The estimated sediment discharge rate using submerged loadcell system has about 4 to 5 % errors in flume tests, though more data collections are needed. There are almost two ways to estimate velocity of sediment moving layer. One is the method using cross-correlation of loadcells, and the other is the method using electromagnetic velocity meter.

Keywords: Bedload monitoring, hydrophone, geophone, Hodaka Sedimentation Observatory