Monitoring for sediment control by a shutter sabo dam in Yokawa River in Kiso River basin

Satoru Matsuda, MS agri.[1]; Shin'ichi Kusano[2]; Takahiko Nagayama[3]; Tsuyoshi Ikeshima[3]; Ken GOTO[3]; Yotaro Nishi[3]; Takahiro Itoh[3]; Jun'ichi Kanbara[4]; Taro Uchida[4]

INTRODUCTION

A sabo dam with slit of 2m in width and shutters consisted of six iron bars in a slit was modified in Kamiyama-sawa, a branch of Yokawa River, in Kiso River basin. In order to evaluate sediment control by a slit sabo dam with shutters, monitoring started since June in 2013 concerning to sediment and water runoff. Data such as flow depth, images from camera, turbidity and pulses form Japanese hydrophone were obtained for two flood events after installed those sensors. Typical water and sediment runoff through the slit were observed on July 9th in 2014 for the first time in Japan.

WATER AND SEDIMENT MONITORING AROUND A SHUTTER SABO DAM

Kamiyama-sawa is watershed area of 13 km^2, bed slope is 1/9.7. Kamiyama-sawa No. 1 sabo dam is 13 m in height, with 25 m in spillway width, a slit of 2 m in width and 7 m in height, and the ratio of slit for spillway width is 1/12.5. Shutters in a slit consisted of six iron bars, which are 508 mm in diameter and 19 mm in thickness, and the clearance between iron bars is set as 700 mm. The sabo dam has a secondary dam and log booms, and close type sabo dams are located in around 300 m upstream reach and around 400 m downstream reach form the slit dam, respectively. The mean diameter of bed material including granite sand is 40 mm around the sabo dam. As shown in Fig. 1, monitoring systems for water and sediment movements were installed in June in 2013, such as two pressure sensors for flow depth, turbidity meter for wash load, a pipe-hydrophone for bed load, an electromagnetic velocity mater for bed shear stress, three interval cameras for flow condition and flow patterns, and LED light, which turns on at intervals of 10 minutes, for night photography by interval camera. Pressure sensor has a data logger and a battery, and data from sensors expect the pressure sensor are recorded in the logger: CR1000 (Campbell Scientific, Inc.). Interval camera is powered by dry battery and the image data are recorded on the SD memory card. Sensors and logger are powered by solar panels, and those monitoring data are recorded in every 5 minutes.

FLOOD EVENTS ON JULY 9TH IN 2014

After installation of sensors, there were two flood events on September 16th in 2013 (Accumulated rainfall depth: 95.5 mm, duration of rainfall: 14 hours, maximum rainfall intensity: 16.5 mm/h at Nagiso rainfall observation station) and on July 9th in 2014 (Accumulated rainfall depth: 93.5 mm, duration of rainfall: 6 hours, maximum rainfall intensity: 70.0 mm/h).

Figure 2 shows temporal changes of rainfall intensity, flow depth in a storage area of the slit dam, flow depth near the secondary dam, pulses of hydrophone and turbidity, which were obtained on July 9th in 2014. The dash and dotted lines in Fig.2 represent the bottom and top limits of the lower iron bar.

In the flood events, there were three rainfall events. In rainfall (1), as shown in Picture (A), maximum flow depth is 1.3 m at upstream of the slit, and peak of turbidity appears before peak of flow depth. Bed load runoff from river bed between the slit dam and the secondary dam is observed until peak flow depth, and the runoff stops after peak flow depth due to inactive sediment movements from the slit dam.

In rainfall (2) and (3), typical bed load runoff in a narrow slit with shutters is observed as follows.

In the stage [B1] to [B3], maximum flow depth is 2.7 m at upstream of the slit, and turbidity has a peak at same time of flow depth. In the stage [B1], bed load runoff from river bed between slit dam and secondary dam and from the slit is observed until the time (B). Bed load runoff stops in the stage [B2] because the flow depth is in the bottom iron bar. In the stage [B3], bed load runoff restart through the slit because the bed load reaches the slit part due to flow depth decreasing in the storage area. Bed load discharge rate controlled to be constant by bottom iron bar, except 9:00 to 14:00 in July 10th, 2014, in which flow depth in the storage area of slit dam increases due to rainfall event (3). In addition, at 15:00 to 18:00 on July 10th in 2014, bed load runoff stops because the flow depth increases due to small rainfall during 12:00 to 18:00, and the free surface is located at the bottom iron bar (flow depth is around 0.9 to 1.0 m). The value of flow depth is same as the flow in (B) to (C) in the stage [B2]. In the stage [B4], the flow depth decreases from the lower level of the bottom iron bar. After the time (D), at 17:00 on July 11st in Fig. 2, the bed load runoff is almost constant due to open channel flow in a slit.

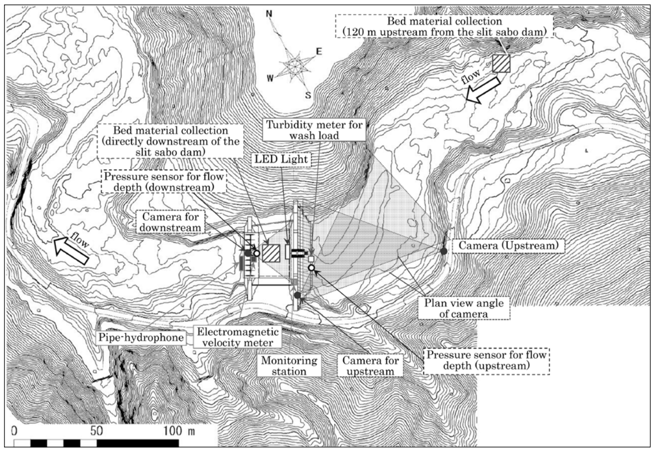

Figure 1. Plan view of sediment and water monitoring equipments installed in Kamiyama-sawa basin

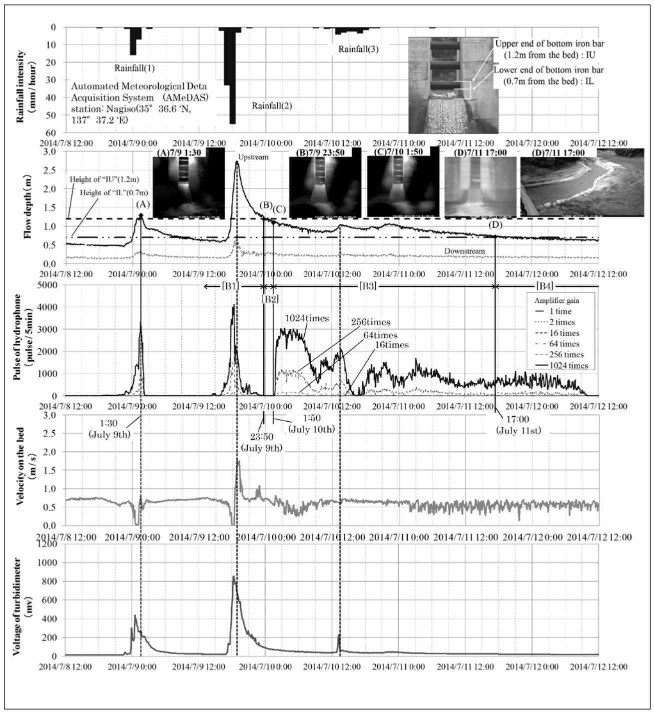

Figure 2. Temporal changes of water flow and sediment movements observed on July 9th in 2014

CONCLUSIONS

Water- and sediment- monitoring started since June in 2013 to evaluate sediment runoff control by the slit sabo dam with shutters. After installed several sensors for monitoring, typical water and sediment runoff through the slit with shutters were observed for the first time on July 9th in 2014. In the flood, it was confirmed that sediment runoff was controlled by both a narrow slit and shutters, and especially was controlled by a bottom iron bar in decreasing stage of the flood. If the free surface in the slit is located at between top and bottom of height the iron bar, sediment runoff from the slit is controlled well because the flow in the slit became as pipe flow surrounded by the slit and shutter. The water runoff controlled by shutters results in delaying and smoothing of sediment runoff, especially in decreasing stage of the flood. Data need to clarify the sediment control function by shutters and narrow slit, respectively, in future every flood, because there are only two floods events for discussions of sediment control function in present study.

KEYWORDS

Sabo dam with shutters; Granite sand; Bed load; monitoring

1 Nippon Koei Co., Ltd., Nagoya, JAPAN, a7148@n-koei.co.jp
2 Tajimi Office of Sabo and National Highway, Chubu Regional Development Bureau, Ministry of Land, Infrastructure and Transport (MLIT), JAPAN
3 Nippon Koei Co., Ltd., JAPAN
4 National Institute for Land and Infrastructure Management (MLIT), JAPAN