Experimental Study on Sediment Deposition Using Bandal Like Structure with Different Ratio of Permeable and Impermeable Part

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INTRODUCTION

Generally, impermeable type spur dikes have a large effect on controlling sediment deposition comparing to permeable type. However, local erosion occurs around impermeable type and cause problem. On the other hand, many spur dikes of Bandal like structure have applied and seemed to work effectively (Rahman et al., 2003; Alauddin et al., 2011). Bandal like structure (hereafter, described as Bandal) is consist of upper and lower part; upper is impermeable type and lower is permeable type. When flow surface with high velocity hit the Bandal impermeable part, water splash effect lead the flow to main-stream direction. Flow around riverbed with high concentration of suspended flow pass the Bandal permeable part and deposition occur due to the slow velocity at Bandal downstream. Because the flow characteristics are different in permeable part and impermeable part even with in same landform or hydraulic condition, the ratio of permeable and impermeable part seems to influence on the controlling function. However, Bandal effects are considered only qualitatively and how deposition effect change due to different ratio of permeable and impermeable part is even not considered. In this study, we conducted channel experiment to examine the deposition function of Bandal with different ratio of permeable and impermeable part on same hydraulic condition.

EXPERIMENT OUTLINE

We conducted experiments using 2,000 cm long, 30 cm height and 100 cm width rectangular straight open channel and set the slope as 1/1,000 with fixed bed condition. From upstream, we supplied 31.6 l/s water in steady state. We caused 0.6 cm dam-up at downstream end, and confirmed the steady flow conditions. We used uniform sediment with diameter 0.093 mm. In experiment condition, u_*/w_0 (u_*: friction velocity, w_0: setting velocity) ratio is 4.1 and indicates suspended load condition. We supplied sediment 1.92 cm^3/s in steady state using sand feeder. Ripple cause in this condition but we confirmed that sediment deposition did not become higher than ripple in cases without setting dikes. We used non-overflow type Bandal model with 15cm height, and permeable part consist with 1.2 cm interval of 0.7 cm diameter brass columns. On the upper part of Bandal model, we set impermeable part with stemless steel plate and adjust the permeable part height as 1.5 cm, 3.5 cm, and 5.5 cm. We installed 4 Bandal models with 30 cm interval from 1,000 cm to 1,090 cm from downstream end on left bank. Flow depth was measured from ultrasonic sensor in time series, and we measured deposition and surface flow velocity from 4.5 hours after achieving equilibrium condition. When measuring flow surface velocity with PIV software, we used PCV powder (average diameter 0.113 mm, density $0.59 g/cm^3$). We used laser displacement sensor and measured the sediment thickness before and after the experiment. **Table 1** shows the experimental cases hydraulic and Bandal model conditions.

Table 1 Experimental cases

Case	Discharge (l/s)	Channel width(cm)	Slope	Sediment diameter(mm)	Permeable height/Water depth
1	31.6	100	1/1,000	0.093	0.22
2					0.51
3					0.80

EXPERIMENT RESULTS

Fig.1 shows the bed level counter and **Fig.2** shows the surface flow velocity to longitudinal direction distribution. The results showed two characteristics on Bandal deposition function. First, upward flow occurs due to shearing between the fast flow passing through the lower permeable part and the slow flow around the Bandal, and the sediment deposits along the upward flow. Second, flow collided with the upper impermeable part of the Bandal causes retention and deposition occurs due to settling. Suspended load volume passing through the permeable part and that moving from the main stream to the Bandal installation section affect the total sediment deposition volume. Furthermore, the most upstream Bandal controls the moving sediment volume from both. When the ratio of the Bandal permeable/impermeable part is different, it leads to change of suspended flow discharge in both part. Discharge passing the permeable part changes due to the slow velocity at Bandal downstream and discharge from main-stream direction to Bandal changes due to the impermeable part splash effect. In our experiment conditions, largest ratio of permeable/impermeable Case3 showed largest sediment deposition volume.

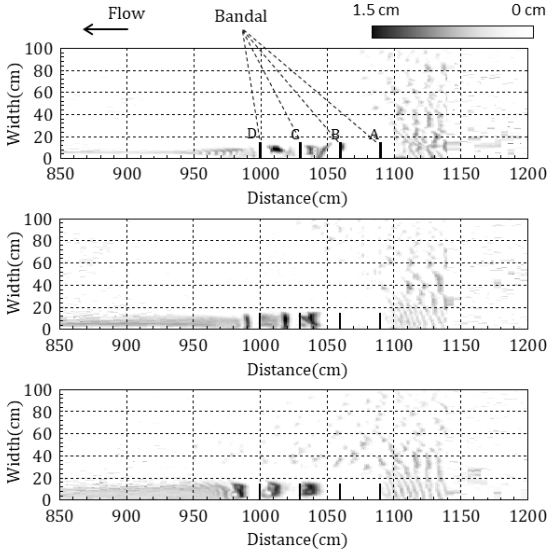

Fig.1 Bed level contour

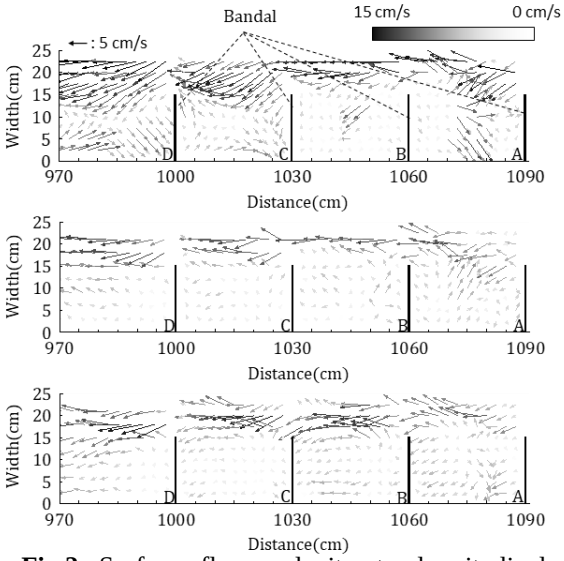

Fig.2 Surface flow velocity to longitudinal direction distribution

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