THE APPLICATION OF CONCREATE BLOCKS AS SLOPING ENERGY DISSIPATOR WITH LARGE ROUGH ELEMENTS

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INTRODUCTION

Generally, a plunging flow is formed below drop hydraulic structure as a stability of jump position. The hydraulic jump is a phenomenon well known as useful method of energy dissipation. If the toe of jump is not plunging, it must be required to keep jump length and approach length of supercritical flow on concrete apron. In this case, the total length of energy dissipator might be longer, and the total cost might not be economically adequate. Further, concrete blocks were installed below concrete apron as river-bed protection work, but concrete blocks might be flushed away by the formation of local scour. After floods, flushed blocksmust be used as recycle resources. In order to stabilize the jump position, a plunging flow is formed. But, a high velocity near the bottomcontinues far downstream, and the formation of plunging flow might cause local scouring and degradation of river bed.

The application of concrete blocks with protrusion type to the sloping energy dissipator. The experimental investigation yields that the formation of plunging flow can be disappeared by installing the concrete blocks with protrusion type on 1/15 slope for plunging flow. different discharges. Also, it has beenconfirmed that the surface jet flow is formed without the formation of The velocity fields at the downstream of concrete blocks were measured, and the velocity measurement supported that the velocity near the bottom could be reduced by the formation of the surface jet flow.

EXPERIMENTAL SETUP

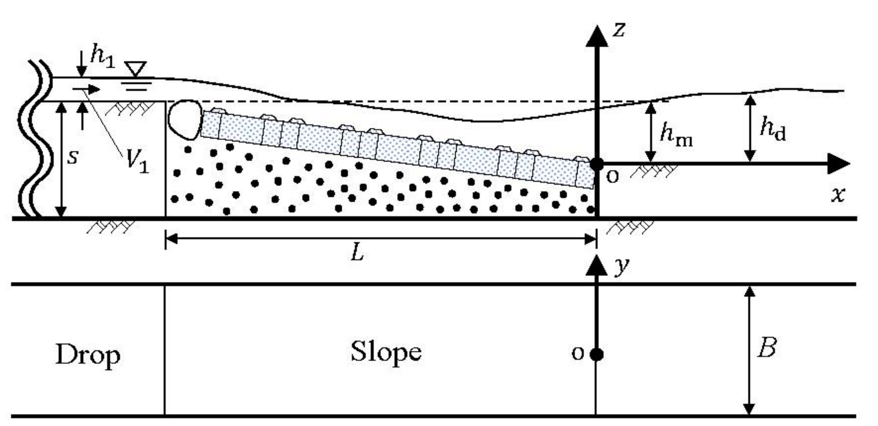

Figure 1. Definition sketch of sloping energy dissipator with concrete blocks below low drops

Photo 1. Installations of drop model, concrete blocks, and boards for abrupt rise in rectangular channel.

Photo 2. Concrete block model with protrusion type.

Table 1. Experimental conditions.

	h_m/h_1	F_1	$i\ (=h_m/L)$	$Re\times 10^4$	h_d/h_1
Concrete Blocks with protrusion type	0.79	1.00	1/15	8.65-9.56	1.44,1.81,2.17
	1.32	2.16	1/15	10.7	2.78,3.33,3.96

The experimental condition is shown in Table 1. Then, i is slope of installed concrete block defined as hm/L(hm= Height difference, L= horizontal installation length of installed concrete blocks). The inflow condition above the drop was settled by Froude number F1 and relative drop height hm/h1. Here, h1 is the inflow depth defined in the flow passing over the drop (located in 3.5 times of h1 upstream from drop), s is the drop model height, and F1 is the inflow Froude number defined as V1/(gh1)1/2; V1 is average velocity.

If the inflow Froude number is unity, a free overflow type was assumed. The relative drop height hm/h1 (=hm/dc; dc is critical depth) was settled as 0.79. If the flow above the drop is supercritical(F1 > 1.00), the relative drop height hm/h1 was settled as 1.32. In addition, the downstream depth is expressed as averaged depth measured in gradually varied flow region (200 cm < x < 300 cm)

Results

The mean velocity below concrete blocks was measured, and the velocity profile at each vertical section was arranged by equation (1).

$$\frac{u}{V_1}=f\left(\frac{x}{h_1},\frac{z}{h_1},F_1,\frac{h_m}{h_1},i,\frac{h_d}{h_1}\right) \quad (1)$$

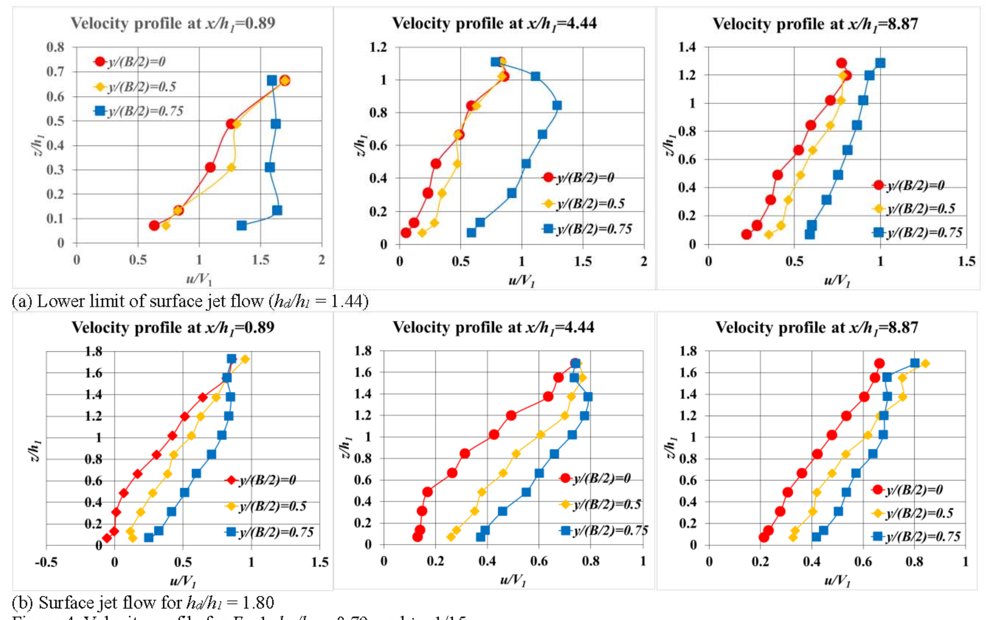

Figure 4. Velocity profile for F_1=1, h_m/h_1 = 0.79, and i = 1/15.

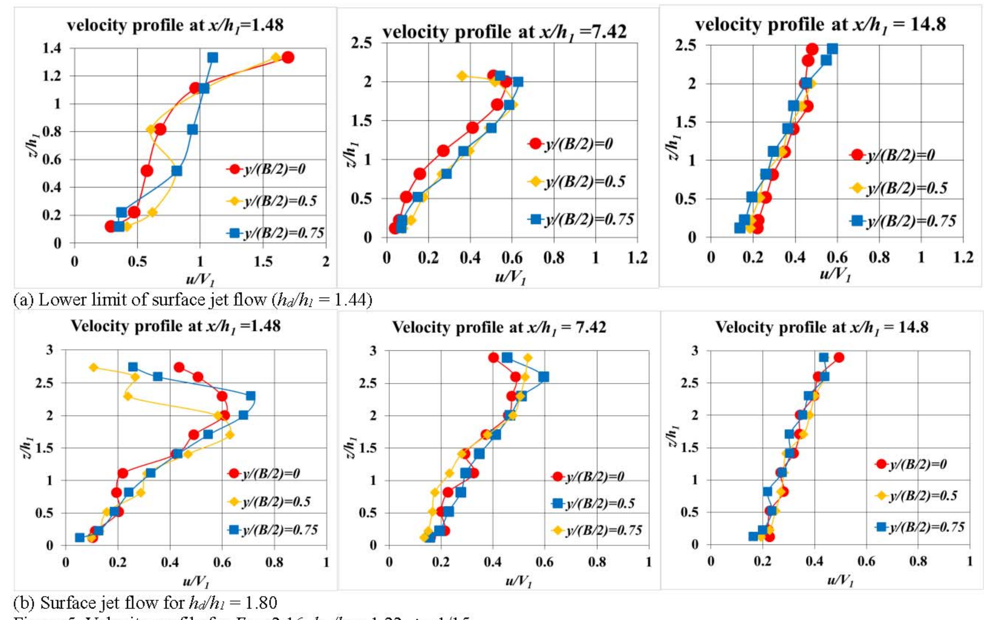

Figure 5. Velocity profile for F_1 = 2.16, h_m/h_1 = 1.32, i = 1/15.

Figure 4 shows the velocity profiles at downstream of the stacked boulders for F1 = 1.00, hm/h1 = 0.79, and i = 1/15. For the formation of the surface jet flow, as shown in Figure 4, it has been confirmed that the main flow lifts into the water surface. Also, the velocity near the bottom is smaller than that near the water surface.But,This might be caused by a high velocity flow along the side wall on the slope. As the concrete block was installed as staggered arrangement, a local flow resistance due to the protrusion of concrete block might be small near the side wall. At y = 0 cm, a reverse flow is formed near the bottom by the formation of stational wave.

Figure 5 shows the velocity profiles at downstream of the stacked boulders for F1 = 2.16, hm/h1 = 1.32, and i = 1/15. At x/h1 = 1.48, the velocity distribution at y/(B/2) = 0.75 is slightly different from that at y/(B/2) = 0 and 0.5. In this case, the effect of staggered arrangement on the flow along the side wall might be small.

In order to investigate the maximum mean velocity decay below the installation of concrete blocks for both free over flow type and supercritical flow type, the maximum mean velocity Umax was determined from the mean velocity profile profile at each vertical section, and the maximum mean velocity was arranged by equation(2).

$$\frac{U_{max}}{V_1}=f\left(\frac{x}{h_1},F_1,i,\frac{h_m}{h_1},\frac{h_d}{h_1}\right)$$

equation(2)

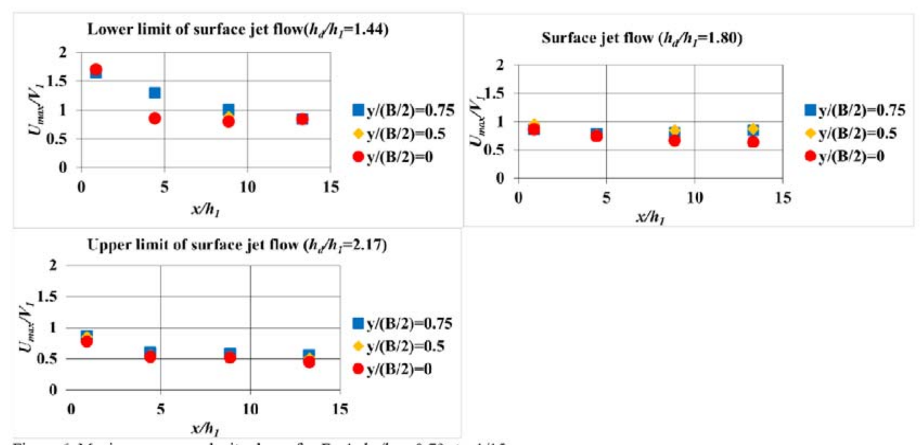

Figure 6. Maximum mean velocity decay for F_1=1, h_m/h_1 = 0.79, i = 1/15.

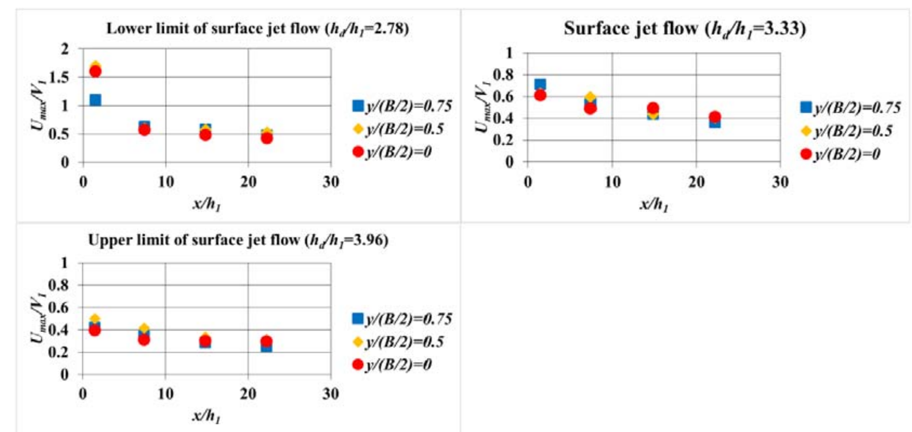

Figure 7. Maximum mean velocity decay for F_1 = 2.16, h_m/h_1 = 1.32, i = 1/15.

Figure 6 shows the maximum mean velocity decay of the surface jet flow under free over flow type. As the flow passing over the drop transits from critical to supercritical flows, and the velocity on the slope is accelerated. As shown in this figure, for the lower limit of surface jet flow, the maximum mean velocity decays within the range of 0 < x/h1 < 8. If the tailwater elevation is increased, the transition flow moves upstream, and the maximum mean velocity decays slightly at the downstream of the downstream of the installation of concrete blocks.

In the case of supercritical flow type, as shown in Figure 7, the maximum mean velocity is more dissipated comparing with the case of free over type. Because, a strong turbulent flow is formed.

CONCLUSIONS

- ✓ The application of concrete blocks with protrusion type to the sloping energy dissipator was presented. The installation of the sloping apron with concrete blocks below low drop structure is effective for the protection of river bed during flood stages if the slope of the installation is settled as 1/15 slope. The concrete block was installed as staggered arrangement. It might be easy to form surface jet flow by the flow resistance due to protrusion of concrete block for different discharges and tailwater elevations.
- ✓ The method for the installation of concrete blocks with protrusion type is the most important, because the flow resistance due to the protrusion of concrete block is necessary to reduce the approaching high velocity. For the formation of the surface jet flow, it has been confirmed that the main flow lifts into the water surface.Also, the velocity near the bottom is smaller than that near the water surface.The velocity distribution below the installation of concrete block for supercritical flow type differs from that for free over type.
- ✓ For the lower limit of surface jet flow, the maximum mean velocity decays in a short distance. In the case of supercritical flow type, the maximum mean velocity is more dissipated comparing with the case of free over type. Because, a strong turbulent flow is formed. If the tailwater elevation is increased, the transition flow move upstream, and the maximum mean velocity decays slightly at the downstream of the installation of concrete blocks.

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