CONTROL OF HYDRAULIC JUMP IN STILLING BASIN WITH USBR-TYPE III

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There are a lot of high mountains in Japan, nevertheless the size of land is small, so that the rivers are very steep. The vertical concrete drops were constructed in rivers to prevent degradation of river bed up to the present. In such a situation, aquatic lives, such as fish and shrimp, cannot migrate there. Recently, the construction method by making use of a steep channel and pool has attracted a great deal of public attention. The slope of the steep channel is usually 1/10 to give a helping of migration for the fish. On the other hand, hydraulic jump may occur in the pool when the river is flooded.

The relationship between toe and tail depths of hydraulic jump with abrupt rise is derived semi-theoretically. Forster & Skrinde(1949) pointed out that the this relationship is not valid when the ratio between the inlet flow depth and height of abrupt rise is large, due to the hydrostatic pressure distribution is not valid. The hydraulic jump with abrupt rise is classified into A-jump, B-jump, aerated wave and non-aerated wave by Forster & Skrinde(1949). In the A-type, the tail of the hydraulic jump is located at the front of abrupt rise. In the B-type, the tail is located at the back of abrupt rise. In the aerated and non-aerated types, the flow jumps after colliding on abrupt rise and falls on the bed. The aerated and non-aerated types are also called spray condition. Hager & Bretz(1987) and Onitsuka et al.(2004) suggested a formula which predicts the length of hydraulic jump of A- and B-types.

Although, there are a lot of researchers' efforts, the location of toe of hydraulic jump can not be predicted at present. If the location of the toe can be controlled, the cost of construction decreases, due to the length of the pool can be reduced. The energy dissipaters such as USBR type I, II and III can control the location of toe at the lower reach of the spillway of dam. USBR type-III is the most useful in USA. The geometry of USBR type-III is given by the inlet Froude number.

In this study, the USBR type-III is adapted in the steep open-channel flows and it is investigated whether the location of the toe of hydraulic jump can be controlled or not.

USBR type-III consists of chute block, baffle block and end sill. The geometry of USBR type-III is given by the inlet Froude number Fr_1. It is difficult to apply the USBR type-III to steep open-channel flows, due to the slope of the inlet flow is about 1/10 so that the construction of chute block is difficult and control of the inlet Froude number is not possible. Therefore, the geometry of USBR type-III can not be determined. In this study, the slope of chute block was set to -0.2 and the inlet Froude number Fr_1 for design is set to 4. This Froude number is little larger than that when the river is flooded (see Akiyama et al., 2004). All geometry except for the slope of the chute block is used of that of USBR type-III as shown in Fig. 1.

It was found that when the end sill height is higher than the inlet flow depth, the flow type belongs to A- or B-jumps, not spray condition and also that the length of hydraulic jump is reduced about 50% in comparison with that in the flow without blocks.

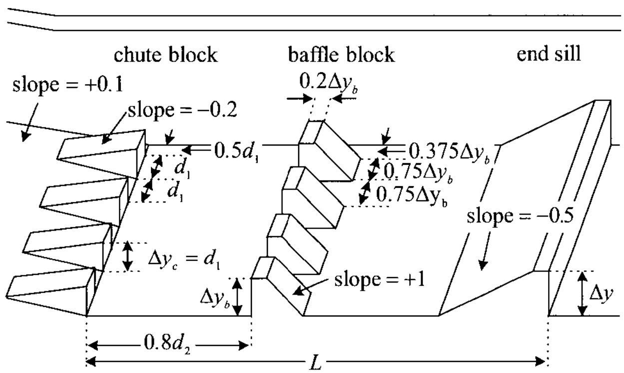

Fig. 1 Improved USBR type-III for steep open-channel flows.

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