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REDUCTION OF STILLING BASIN LENGTH WITH TALL END SILL*

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Abstract: Experiments were conducted to characterize forced hydraulic jumps in stilling basins for enforced cases due to tail water level or dam site arrangement and construction. The case with a single tall sill was simulated in a horizontal flume downstream of a sluice gate. Results of experiments are compared with the classical hydraulic jump, and significant effect of tall sill on dissipation of energy in shorter distance was confirmed. Furthermore, the generated jumps were classified based on the ratio of sill height to basin length, and a simple design criterion was proposed to estimate the basin length for a desired jump and particular inflow.

Key words: forced hydraulic jump, energy dissipater, sill, stilling basin length

Introduction

Kinetic energy of water over large spillways must be dissipated in the stilling basin through generation of a jump in order to prevent severe scouring of riverbed and failure of downstream structures as a result of the jump being wept out of the basin. The chute block and sills with different configurations are used in standard stilling basins to disturb water and dissipate water energy through forming a forced hydraulic jump. In basins with ordinary sill height, the type of generated jump (A- to D-type jumps as were described in Hager and Li[1]) is totally controlled by the water surface downstream of the basin. Unfavorable D-type jumps are likely to be generated when tail water is low, while A-, B-, and C-type jumps appear for higher tail water levels.

In most practical cases, the basins with a positive step end or slope end are constructed below the natural ground level to grant a forced jump inside of the basin. However, when hydraulic jump should be controlled in a shorter distance, or limitations associated with site arrangement and construction do not allow the lowering of the basin, a tall sill at the smallest possible distance from the jump toe is a novel alternative in practice. The tall sill should be high enough to dissipate considerable amount of energy, and the well being positioned to prevent extreme flow conditions (submergence of jump or splashing flow).

Review of the literature has drawn considerable attention to the effects of tail water on generation of forced hydraulic jumps. Based on tail water relative to inflow depth, and approaching Froude number, an extensive classification of forced hydraulic jump has been provided. Hager and Li[1] have presented extensive relationships for sill control jumps and classified jumps into five classes, namely A, B, minimum B, C, and D-jump. In their studies, the A-jump is the classical hydraulic jump which is characterized by the maximum sequent depth ratio for the Classical Hydraulic Jump (CHJ, where sill is far away to affect the jump). By decreasing the tail water depth, the jump toe moves toward the sill and a B-jump occurs in which the flow is considerably modified by the sill and the streamline pattern becomes curved over the sill. As the tail water depth decreases further and the

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