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Study of Effect of Number of Tri-angular Deflectors on Energy Dissipation and Jet Length at Ski-Jump Spillway

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Extended Abstract

Introduction

In reservoir dams, high kinetic energy at downstream of their spillways can cause destruction of the spillway and its surrounding areas which results significant loss of life and financial loss, so it is necessary to investigate the performance of energy dissipation structures during its operation. In this regard, the effects of the number of deflectors located just donsream of its chute on energy dissipation and its projectile length were investigated experimentally. Deflectors separate the incoming jet to few smaller jets, which pass through the slut between the deflectors or overflow above the deflectors. Therefore, more air mix with the jet flow and the separated jets hit each other, the results of which are increase in the amount of energy dissipation. On the other hand, the existence of deflectors reduces projectile length, makes smaller submerged ponds easier to maintain, and reduces costs.

Methodology

At the beginning of flume, a ski jump structure, with a height of 100 cm, a length of 90 cm and a radius of 14 cm was made by the galvanized sheet. Adjustment of the alignment and location of the hydraulic jump occurred by a slide gate located at the downstream of the flume. At each stage, the number of deflectors was deployed at the starting point of the jumper launcher such that the bottom side of the deflector was aligned to the horizon and the distance of the first deflector from the wall of the flume was halfway between the deflectors. Experiments were performed at four different ratios of critical depth to the total head (= 0.02, 0.035, 0.03 and 0.049) and three different tailwater depths. In these conditions, the deflector-free jumper launcher was tested using two, three and four deflectors. Relative energy dissipation was calculated by measuring the total energy in the upstream reservoir and downstream of the jetty overflow immediately after the ski jump, and projectile length was determined using projectile shooting and Get Data Graph Digitizer softwar.

Results and Discussion

Data analysis showed that for both cases, with deflector and without deflector, the relative energy dissipation rate decreased with increasing ratio of (Yc)/H , critical depth to the head, in each of the three adjoining depths. Because with increasing (Yc)/H as the discharge increases, the jet flows more rapidly mix with the air, which is less effective in resisting the jet launcher, mixing air and water. At a constant number of deflectors and at a constant (Yc) /H, the relative energy dissipation rate in the free hydraulic jump is greater than that int semi submerged jump and in the semi submerged jump more than that in full submerged jump, because by decreasing the projectile path, the air contact surface as a resisting agent of motion decreases. Also, at each of the three tailwater water depths, the relative energy dissipation rate increases as the number of deflectors at (Yc)/H increases. This is due to the mixing of jets with each other and the ambient air around the projectiles.

In examining the effects of deflectors on the projectile length, the results showed that in both cases, without deflector and with deflector, the projectile length increased with (Yc)/H because with increasing (Yc)/H the flow rate increased, The greater depth of flow on steep slope, the greater slab thickness, the lower slab impact on slip velocity profile, and shear stress as a fluid impedance factor, and hence the more jet flows into the air and larger projectile lengths. At a constant (Yc)/H, the projectile length in the free jump was greater than that of the semi submerged hydraulic jump, and in the semi submerged jump was greater than that in full submerged jump because of increased depth of passage due to submerged hydraulic jump and failure to max. The possible path for the jet outlet from the jumper launcher was to shorten the projectile length. At each of the three steady depths at constant (Yc)/H, as the number of deflectors increased, the projectile length decreased because the path-based deflectors acted as bumpers and decreased the jet launch length and elongation.

Conclusions

The highest relative energy dissipation in four deflectors at (Yc)/H was 0.027 in free hydraulic jump, 65.87%, and the lowest in two deflectors at (Yc)/H of 0.049 in submerged full hydraulic jump of 6 52 /% and maximum projectile length in two deflectors, (Yc)/H = 0.049 was obtained to be 66.84 cm in free hydraulic jump for the caes of complete submerged was equal to 25.62cm. Based on triangular cross section deflector launcher performance in increasing energy dissipation and decreasing projectile length and saving running and maintenance costs, it is recomended, in terms of hydraulic and economical issues, to use deflector on the ski-jump with structural component.

Keywords: Dams, Hydraulic Jump, Ski-Jump, Tailwater Depth