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Hydraulics of 3D Aerators with Lateral Enlargements

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Abstract : The construction of high dams has led to significant challenges in managing flow rates discharging over spillways, resulting in cavitation damages on hydraulic surfaces. To address this, aerator devices were designed and installed to promote fore aeration, thereby controlling and mitigating damages caused by cavitation. Consequently, these aerator types, three-dimensional aerators (3DAEs), have demonstrated superior efficiency in introducing forced air into the flow.This research focuses on the installation and evaluation of three-dimensional aerator devices at the high discharge spillway surface. In the laboratory, the air concentration downstream of the hydraulic structures was extensively measured, and the data were analyzed in details.Multiple flow scenarios and structural arrangements of the aerators were adopted for the study. The outcomes of these experiments are listed as In terms of air concentration value, the comparison between 3 DAE (three-dimensional aerator) with offset only and offset with ramp reveals significant differences. The concentration value on the side wall was justified. The side cavity length was found to increase with higher approach Froude numbers and lateral enlargement widths. Furthermore, 3DAE exhibited shorter side cavity lengths compared to three-dimensional aerator devices without ramps (3DAD), a beneficial features for controlling water fins. An empirical formula to express the side cavity length was derived from the measured data. Also, the comparison were made on the basis of water fin formation between the different arrangements of 3D aerators. In conclusion, this research provides valuable insights into the performance of three-dimensional aerators in mitigating cavitation damages and controlling water fins in high dam spillways. The findings offer practical implications for designers and engineers seeking to enhance the efficiency and safety of hydraulic structures subjected to high flow rates.

Keywords : three-dimension aerator, cavity, water fin, air entrainment
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