



## **Characteristics of Hydraulic Shock Waves in an Inclined Chute Contraction by Using Three Dimensional Numerical Model**

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The inclined rectangular chute construction is a common structure used in hydraulic engineering for typical reasons such as the increase of bottom slope, the transition from side channel intakes to tunnel spillways, the drainage construction, and the reduction of chute width due to bridges, flood diversion structures or irrigation systems. The converging vertical sidewalls of a chute contraction deflect the supercritical flow to form hydraulic shock waves. Hydraulic shock waves have narrow and locally extreme wavy surfaces, which commonly results in the requirement of higher height of sidewalls. Therefore, predicting the possible height and position of maximum hydraulic shock wave are necessary to design the required height of sidewalls to prevent flow overtopping. In this study, we used a three-dimensional computation fluid dynamics model (i.e. FLOW-3D) to simulate the characteristics of hydraulic shock waves in an inclined chute contraction. For this purpose, the parameters of simulated hydraulic shock wave, such as the shock angle, maximum shock wave height and maximum shock wave position in various conditions are compared with those calculated by the empirical relations obtained from literatures. We showed that the simulated results are extremely close to the experimental results. The numerical results validated the applicability of these empirical relations and extend their applicability to higher approach Froude numbers from 3.51 to 7.27. Furthermore, we also applied the Yuan-Shan-Tsu flood diversion channel under 200-year peak flow condition to FLOW-3D model to simulate the hydraulic shock waves and validate the effect of the installation of a diversion pier in the channel on promoting the stability of flow fluid. The results revealed that a diversion pier installed in the Yuan-Shan-Tsu flood diversion channel is helpful for improving the stability of flow field. In summary, this study demonstrates that FLOW-3D model can be used to simulate the characteristics of hydraulic shock waves in an inclined chute contraction.