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Research Article

Numerical investigation of flow hydraulics in the side weir of a sharp edge with variable crown height

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Extended Abstract

Introduction
Side weirs are hydraulic structures commonly utilized in various water management systems, including sewage, irrigation, and flood control. They function to divert a portion of the flow from a main channel, ensuring that downstream flow does not exceed the channel's capacity. The flow over side weirs is characterized by spatially variable flow rates, and the governing equations for such flows often lack analytical solutions, necessitating extensive experimental studies. Side weirs can be designed in various shapes, including rectangular, triangular, and trapezoidal forms. The performance of these weirs is influenced by several factors, including the weir height, which affects the flow characteristics such as pressure, shear velocity, and free surface levels. The primary goal of this study is to numerically evaluate the hydraulic behavior of flow over sharp-edged side weirs in trapezoidal channels, focusing on the impact of weir height on flow parameters.

Materials and Method
In this investigation, a trapezoidal channel model measuring 12 meters in length, 2.5 meters in width, and 1.25 meters in height was utilized to assess the hydraulic flow over sharp-edged side weirs. Various weir shapes, including semicircular, rectangular, and triangular, were implemented along the channel's side. To analyze the influence of water level behind the weir on flow modeling, two different water levels of 1.9 meters and 2.0 meters were tested. The numerical simulations were performed using the Flow3D software, which allows for detailed analysis of hydraulic conditions. The boundary conditions were set to reflect realistic flow scenarios, including volume flow rates at the inlet and pressure conditions at the outlet.

Results and Discussion
The numerical results indicated that increasing the height of the sharp-edged weir significantly affected the hydraulic parameters. For instance, when the weir height increased from 60 cm to 80 cm, the pressure at the weir increased by 3.5%, while the shear velocity decreased by 7%. Conversely, the horizontal velocity increased by 13.5%. Additionally, as the height was raised from 80 cm to 100 cm, pressure increased by 4.5%, shear velocity decreased by 2.5%, and horizontal velocity increased by 11.24%. The Froude number, which is a

critical parameter in hydraulic flow analysis, demonstrated a reduction of 23% and 8.8% for the respective height increases.
The pressure distribution showed that the semicircular weir provided the highest-pressure output, reaching 7.54 kPa, while the triangular weir exhibited the lowest pressure at 6.75 kPa. The shear velocity results indicated that the maximum shear velocity occurred at the 60 cm weir height, while the minimum was recorded at the 100 cm height. Furthermore, the analysis of free surface levels revealed that the highest free surface was associated with the 100 cm weir height, measuring 1.76 meters, compared to 1.75 meters for the 60 cm height.

Conclusion
The findings of this study highlight the significant impact of weir height on the hydraulic performance of sharp-edged side weirs in trapezoidal channels. The increase in weir height correlates with variations in pressure, shear velocity, horizontal velocity, and free surface levels. Specifically, higher weir heights result in increased pressure and horizontal flow velocities, while shear velocities tend to decrease. The study provides valuable insights into the design and optimization of side weirs, emphasizing the need for careful consideration of height and shape to enhance hydraulic efficiency. Future research is recommended to explore additional shapes and configurations of side weirs to further understand their hydraulic behavior under varying flow conditions.

Keywords: Lateral weir, Flow modeling, Crown height