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Research on Shape Optimization of Spillway Tunnel

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Abstract: Over the past decades, with the massive construction of high-head hydropower stations, issues associated with the shape optimization and discharge capacity of the spillway tunnel are becoming increasingly significant. In the context of practical hydraulic engineering, this study investigates the hydraulic characteristics within the transition section of the spillway tunnel (behind the WES practical overflow weir) with the aid of numerical simulation tests and physical modeling experiments. The three-dimensional flow field has been simulated numerically by employing the unsteady RNG k∼epsilon turbulence model and the VOF interface-tracking method, and several design schemes of the transition section have been analyzed and compared. This study presents the hydraulic factors such as flow velocity, hydro-dynamic pressure and water-surface profile, and further investigates the distribution characteristies of the flow regime, the velocity field and the pressure field. It should be emphasized that the numerical model adopted in this study has been validated by the results of the physical modeling experiment. This study shows that the reasonable design of the intersection angle between the transition-section wall and the vertical axis of the spillway tunnel is the key to the optimization and safe operation of the spillway tunnel. Concretely, when the aforementioned intersection angle get smaller [U+FF0C] the mainstream will attach to the side walls more tightly and it will be more beneficial to the elimination of the water-wing phenomenon. Consequently, several unfavorable phenomena, such as the turbulent flow regimes and the aerated flow flapping the roof, could be effectively improved. Through the optimal design and comparative analysis of the transition section, this study points out that setting the transition-section length to 60 meters and the turning angle to 1.9 ° is the most economical and rational optimization scheme. The results are of reference value to similar projects.

Keywords: Spillway Tunnel; Shape Optimization; Numerical Simulation; Turbulence Model; Physical Modelling Experiment;

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