FLOW CHARACTERISTICS IN CHAMBER WITH FLARING GATE PIERS

LI FUTIAN

Doctor student, Institute of Fluid Mechanics, Beijing University of Aeronautics &. Astronautics, 37, Xueyuan Road, Beijing 100083, China,
(Tel: +86-10-68786221, Fax: +86-10-68711905, e-mail: hqlft@163.com)

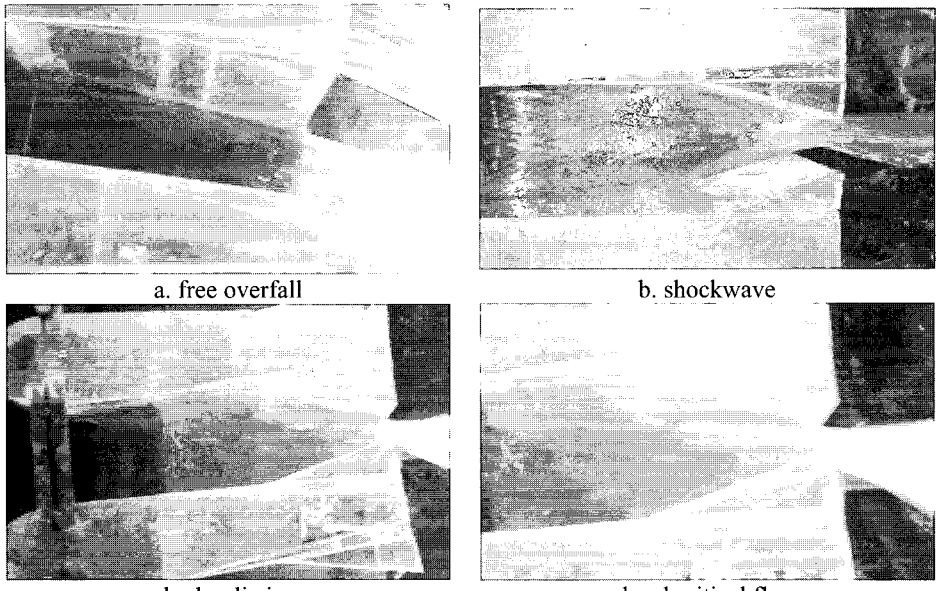
The flaring gate piers (FGP) combined dissipator is a new type dissipator that has successfully been applied on many projects with high water head and large discharges in China. But it is first research for water jet from a spillway with flaring gate piers on high arch dams. The flaring gate piers contract the overflow in transverse direction to suit a narrow valley, and disperse the flow both in longitudinal and vertical directions. The shockwaves caused by the vertical boundaries deflecting inward the course of the flow promote air entrainment and energy dissipation. Fig. 1 shows flow pattern of the FGP combined dissipator on the high arch dam.

A series of experimental studies on the flow patterns and the discharge capacities of spillways with flaring gate piers have been carried out. The flow patterns depend on the Froude number Fr at the spillway outlet and the discharge over the spillway with flaring gate piers is closely related to the flow patterns in the gate chamber. With the total energy head on the crest and the contraction rate of flaring gate piers varying, the flow patterns occur: free overfall, shockwave, jump and subcritical flow, and only subcritical flow pattern will reduce the discharge.

In the past years, the approaches to solution shockwaves due to the boundaries deflection used in the past mainly were proximate analytic or graphic methods. Li Guifen and Liu Qingchao carried out a series of 2D numerical simulations of the hydraulic properties of the contracted flow and attained excellent results (Li Guifen, Liu Qingchao, 1988). Because they reduce the 3-dimensional problem into 2-dimensional one and ignore the air entrainment (use a single phase model), the computational water levels of water in gate chamber are less than the experimental values. Besides, experimental investigation shows that the dispersion of the nappe of the discharge depends on its exit velocity distribution (Li Futian, Liu Peiqinq, Xu Weilin, Tian Zhong. (2003). The dispersion of the contracted jet from a spillway with flaring gate piers for high arch dams depends on the distribution of the velocity at the exit section of the jet.

In this research, a 3D numerical simulation of spillway with flaring gate piers was presented using the volume of fluid (VOF) method for the free surface flow in order to find out the hydraulic features. The results show that four kinds of flow patterns emerge depending on the water heads over the weir and the geometrical meters of the flaring gate piers. The discharges and water surface profiles from the numerical modeling agree with experimental results for different flow patterns including free overflow, shockwave, hydraulic jump and sub critical flow, which verifies that the model is suitable for this situation. the 2D plane numerical model cannot compute the depth velocity distribution however. In this paper, author applies RNG k-ε two phases turbulent model to simulate the flow properties in the chamber with flaring gate piers, and compare the computational results with experimental results. Fig. 2 shows the Distributions of pressure on spillway

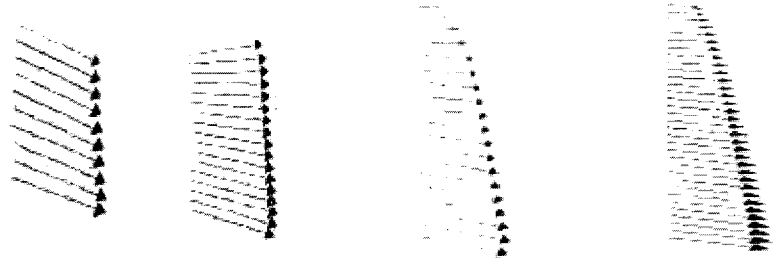
face and side wall in different pattern.



a. free overfall b. shockwave

c. hydraulic jump d. subcritical flow

Fig. 1 The flow pattern of the FGP combined dissipator on the high arch dam



a. Free overfall b. Shockwave c. Hydraulic jump d. Subcritical flow

Fig. 2 Vertical velocity curves at the bucket-lip in various patterns

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