PREVENTION OF CAVITATION AND WATER-WING FOR MIDDLE-PIERS OF DISCHARGE TUNNELS

WU JIANHUA[1], CAI CHANGGUANG[2], JI WEI[1] and RUAN SHIPING[1]

[1]College of Water Conservancy and Hydro-power Engineering,
Hohai University, 210098, Nanjing, China
(Tel: +86-25-83703738, Fax: +86-25-85829977, e-mail: jhwu@hhu.edu.cn)
[2]Mid-South Design & Research Institute for Hydro-electric
Projects of China, 410014, Changsha, China,
(Tel: +86-731-5075214, Fax: +86-731-5073384, e-mail: cgcai@sina.com)

In the construction of high dams, discharge tunnel, specially, deep-water one, is a sort of usual flood discharge structures with pressure flows in the inlet section, followed pressure flows or open flows, and is used in flood discharge or emptying reservoir, and/or washing sand (Zhang et al, 1994). For the reasons of the design and collocation of the engineering projects the section size of the single tunnel is sometimes on the large side, and then the design of middle-pier, placed in a discharge tunnel to divide it into two parts, is a better choice that could breakthrough the limits of the manufacture and operation of the gate due to the high head to the gate, such as the tunnel of the Sanbanxi Hydropower Station (MSDRI, 2001). However, cavitation and water-wing, a sort of flows striking the top and side walls of the tunnel, induced by the middle-pier, may take place and bring about bad effects of operation of the discharge tunnel, such as production of damage and vibration of the tunnel because of high head and velocity in it.

The experimental models, manufactured with plexiglass material, its geometrical scale $\lambda_l = 40$, of the discharge tunnel with middle-pier in the Sanbanxi Hydropower Station, were designed according to the criteria of gravity and cavitation similarities (IWHR, 1995; Zuo, 1984; Huang, 1991; Wu et al, 1995; Wu, 2004), and the inlet, pressure flow section, working-gate chamber and partial open flow section of the tunnel were simulated. The six comparing plans were arranged, such as a triangle curve plan, a round curve plan and two ellipse curve ones as well as two primary plans of short convergent section and shallow weir. The model experiments were conducted in Hohai University, consisting of atmospheric and vacuum tank models (Wang, 2002; Wu et al; 1992). The interesting experimental areas included relationships between discharges and reservoir levels, measurement of side wall pressures, comparisons of water-wing states for middle-piers, estimations of the incipient cavitation numbers and the flow cavitation number and analyses of cavitation characteristics for the tunnel. A kind of new bodily form of middle-pier was developed which had inclined tail with the gradual decrease of height along the flow direction. The experimental results shown that discharges for the various plans met the needs of design, that the side walls of the present middle-pier had better pressure states and that non-cavitation conditions were satisfied of incipient cavitation number less than flow cavitation number. Especially, the present bodily form of the middle-pier could obviously improve water-wing states since it could separate the concentrated forces produced by two flows in the same section of the traditional vertical tail pier.

Keywords: Discharge tunnel; Middle-pier; Cavitation; Water-wing

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