XVIII World Water Congress
International Water Resources Association (IWRA)

Experimental Study on Hydraulic Model of the Inlet and Outlet Hydraulic Characteristics of Xiazhuang Inverted Siphon

Zhou Yonglin, Yang Qingyuan, Cheng Zibing

Objectives

The Xiazhuang inverted siphon inlet of the Dianzhong Water Diversion Project is arranged with a combination of water diversion and drainage, which will have a certain impact on the flow pattern inside the inverted siphon pipe during water diversion, and even induce some unfavorable flow patterns, thereby affecting the safety of the project. Secondly, the Xiazhuang inverted siphon pipe is a three pipe cast-in-place concrete pipe with complex operating conditions. Under the condition of open discharge of the three pipes, there is an alternating oscillation of the water surface in the two sides of the outlet chamber and the middle pipe outlet gate well, and the maximum lifting amplitude is up to 1.4m, which is not conducive to the safety of the engineering structure. So it is necessary to optimize the inverted siphon inlet, improve the operating flow pattern, and analyze the oscillation process to identify the causes of oscillation, and take engineering measures to ensure the safety of engineering operation.

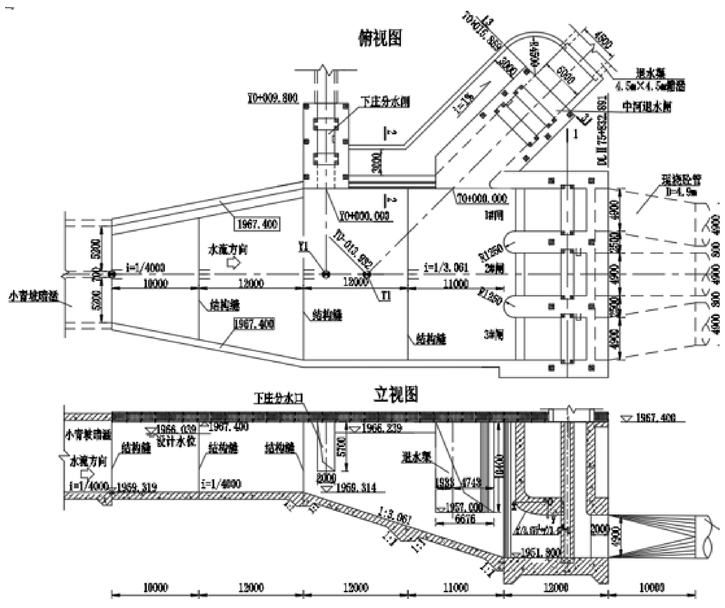

Fig. 1 Structural Diagram of Xiazhuang Inverted Siphon Inlet

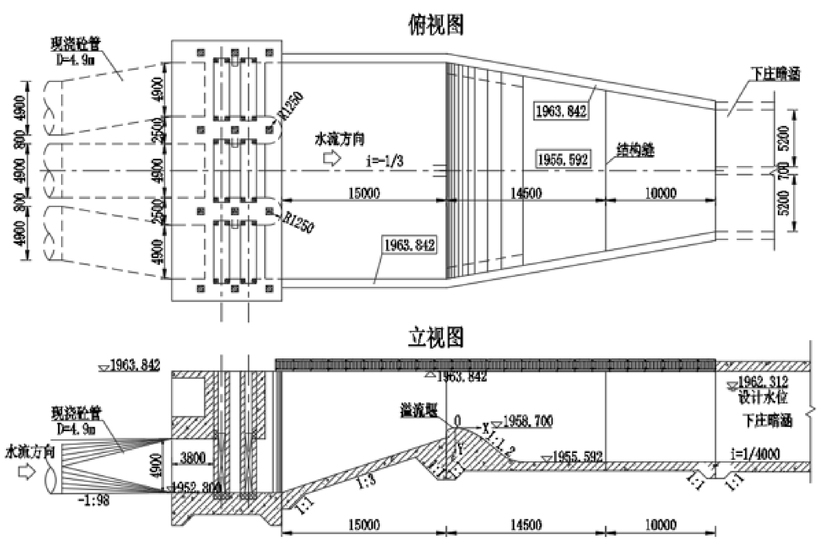

Figure 2 Structure Diagram of Xiazhuang Inverted Siphon Outlet

Methods

(1) After analysis, it was found that the poor flow pattern at the inlet of the Xiazhuang inverted siphon was caused by the water diversion at the water outlet. Therefore, reducing the elevation of the water outlet and changing the open flow diversion to pressure diversion can effectively improve the water flow pattern. That is, reducing the elevation of the bottom plate at the inlet of the water outlet by 2.9m to 1958.80m, using a pressure short pipe layout, and adjusting the size of the working gate orifice to 2m × 2m (width × High), connected to the diversion channel behind the gate.

(2) In order to explore the phenomenon of alternating water surface oscillation, three schemes were studied. After analysis and comparison, a partition beam was arranged at the top of the flow channel between the outlet maintenance gate shaft and the working gate shaft. Although the upper water bodies of the two gate shafts remained connected, the vertical diffusion of water along the gate shaft was effectively suppressed, and the disturbance of the water body in the gate shaft was very weak. The amplitude of water surface fluctuation was reduced to 0.10m, It can effectively solve the problem of alternating water surface oscillation in the outlet gate shaft.

Results

(1) The Xiazhuang inverted siphon inlet reduces the impact of water diversion on the inlet flow pattern by lowering the elevation of the water diversion outlet and changing the open flow water diversion to pressurized water diversion. At the same time, the pressurized water diversion outlet is lowered, increasing the overflow capacity of the water diversion gate.

(2) By arranging a partition beam at the top of the flow passage between the outlet maintenance gate shaft and the working gate shaft, the vertical diffusion of water flow along the gate shaft is effectively suppressed. The water disturbance in the gate shaft is weak, and the fluctuation amplitude of the water surface in the outlet gate shaft is reduced from 1.4m to 0.10m, effectively solving the problem of alternating oscillation of the water surface in the outlet gate shaft.

Conclusions

(1) The setting of the water outlet near the inverted siphon inlet can easily induce adverse flow patterns such as mainstream deflection and suction vortices. The optimization plan reduces the elevation of the water outlet and changes it from non pressure water distribution to pressure water distribution, which is beneficial for reducing the impact of water distribution on flow patterns. At the same time, reducing the bottom elevation of the water outlet also increases the flow capacity of the water outlet.

(2) The vertical diffusion of water flow in the gate chamber can induce water level oscillation under certain working conditions, and continuous low-frequency and large amplitude oscillation is not conducive to structural safety. Setting a partition beam or partition between the maintenance gate well and the working gate well can simulate vertical diffusion of water flow, thereby reducing water surface oscillation. However, the installation of a partition beam scheme has a relatively small engineering quantity and is more economical. Therefore, this scheme will be adopted in the subsequent optimization plan layout.

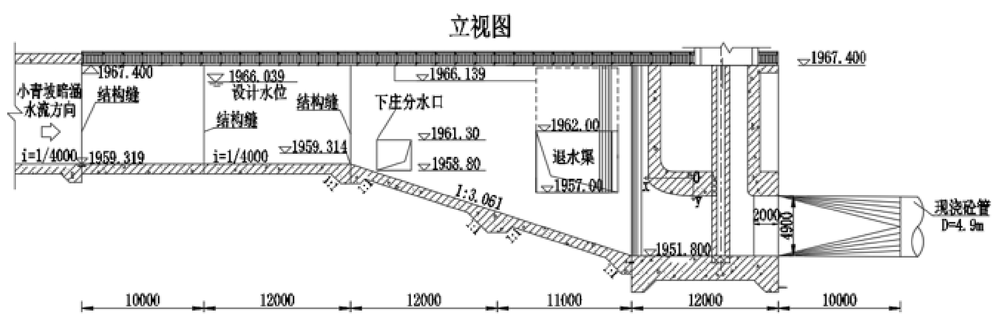

Figure 3 Schematic Diagram of Xiazhuang Inverted Siphon Inlet Optimization Scheme

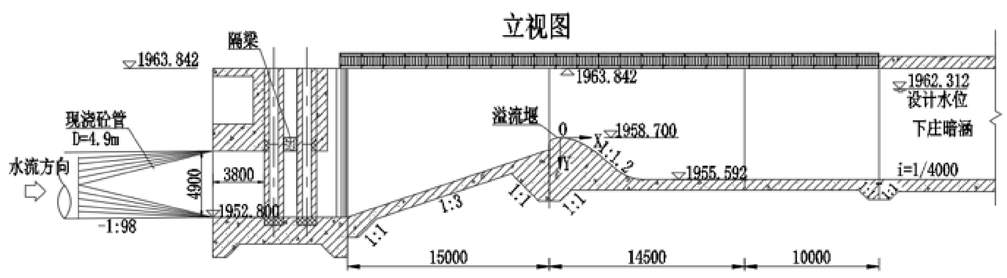

Figure 4 Schematic Diagram of Xiazhuang Inverted Siphon Outlet Optimization Scheme

XVIII WORLD WATER CONGRESS
Water for All
Harmony between Humans and Nature
第18届 世界水资源大会
水与万物：人与自然和谐共生