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Local Scouring Characteristics Downstream of Arched Cross-Vane Structures

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Groundsill is one of the hydraulic structures used to stabilize the riverbed and prevent the erosion of riverbank. Therefore, groundsill may have the negative effects on the ecological environment. Comparing with a traditional groundsill, a Cross-Vane concentrates the water flow and create a downstream pool. This may improve the diversity of the aquatic habitats. The aim of this research is to analyze the scour phenomena and morphologies downstream of an arched Cross-Vane with different geometrical dimensions in a straight channel by using the numerical model. The riverbed slopes of 0%, 2%, 4% and 6% were tested. Among them, the ratio (L/B) between the arc length of the structure (L) and the channel width (B) represents the camber of structures, including 13 kinds of arches. For each arch structure, Densimetric Froude numbers (F_d) , approach flow depths (h_0) and drop heights (Δy) were tested in different flow rate, and the flow rate was between 0.01cms and 0.04cms.The results showed the downstream scour pattern of the arched Cross-Vane had a significant correlation with F_d and Δy, and could be classified according to the scour length (l_m) and the ridge length (l_n). Scour typology included five types of scour. Type 1 : $l_m/B > 2.5$ and $l_n/B < 1$. Type 2: l_m/B was located about 2.0 to 2.5 and $l_n/B > 1$. Type 3: l_m/B=2.0 and $l_n/B < 1$. Type 4: l_m/B was located about 1.5 to 2.0 and $l_n/B > 1$. Type 5 : $l_m/B < 1.5$ and $l_n/B > 1$. L/B was one of the most important parameters affecting the maximum scour depth and its position. When L/B was less than 1.4, the scour holes were similar to the traditional groundsill. When the L/B ranged between 1.4 and 2.3, the maximum scour depth was located at about 0.5 to 0.65 times of scour length downstream the Cross-Vane. When L/B was greater than 2.3, the maximum scour depth was located adjacent to the Cross-Vane.

Keyword : Cross-vane, Scour morphology, Numerical model