Sediment control at lateral water intakes through submerged vane-fields

Summary

Bifurcations of river channels constitute the entrance: (i) into diversion channels used as by-passes for flood alleviation, navigation or irrigation, or (ii) lateral water intakes. Very frequently it is necessary to control the sediment entrainment into the bifurcation. The use of submerged vane-fields in front of a mobile-bed bifurcation is investigated as a solution for such control. To fill the gap of knowledge regarding the three-dimensional flow features near the diversion entrance and around the vane-field, and the associated bed morphology, four laboratory experiments were performed: (i) with no vanes, (ii) with a vane-field, (iii)–(iv) with a second vane-field for two different alignments (angle β) of the vanes. Additionally, numerical simulations of the flow field in the absence of vanes and in the presence of a vane-field for the equilibrium bed were performed using SSIIM 1.

Two unit diverted water discharge ratios were used: ≈ 0.5 in experiments (i)–(ii), and ≈ 0.2 in experiments (iii)–(iv). The equilibrium bed morphology and the water surface, and the associated three-dimensional flow field were measured. Average point velocities, vorticity, turbulence variables, and Reynolds stresses were calculated. Each vane-field prevented the formation of the diversion vortex in the main channel, and created tip vortices and a trail vortex along the vanes, which contributed to a decrease in the amount of sediments entering the diversion. Larger values of β led to greater scouring upstream and in front of the diversion entrance, and enhanced the strength of the vortical structures. For β = 30° a horseshoe vortex seems to have formed around the bed of the downstream diversion corner.

The main flow features without and with vanes were reproduced by numerical approximation.

Keywords

Diversion channel, sediment transport, submerged vane-field, three-dimensional flow, diversion vortex.

Vane-field in front of the diversion channel.

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