SPATIAL AND TEMPORAL SCOUR FEATURES OF CIRCULAR BRIDGE PIERS

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The internal flow features in a scour hole due to pier scour are explored using Particle-Image-Velocimetry PIV. In contrast to present experimentation with either the Hydrogen-Bubble Method or the Acoustic-Doppler Velocimeter (Graf and Istiarto 2002, Julien 2002), PIV records instantaneous plane velocity fields. The spatial appreciation of such a flow pattern may be obtained by successive PIV application both in the horizontal and in the vertical directions. The present preliminary results introduce the experimental set-up used and the results obtained for one test case. Page limitations do not allow a full appreciation of the results, such as the temporal advance of scour hole geometry along with the complex sediment deposition pattern further downstream.

The observations were conducted in the VAW scour channel 1 m wide and of 6 m test length. Figure 1 shows the schematic set-up involving 1 a Flashlight stroboscope, 2 a CCD camera of 60 Hz shutter speed, 3 the Programmable Timing Unit PTU, 4 a Fiber-optic light guide, 5a Line converter of 40 cm length, 6 the Particle reservoir, 7 the Particle hose pump, and 8 the Particle injector.

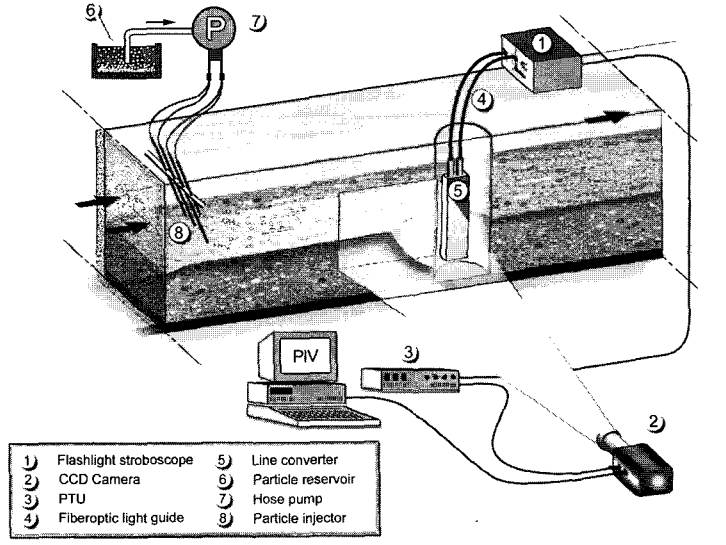

Fig. 1 Schematic experimental Set-up including PIV-Application

To successfully apply PIV, the flow fields in various plan and in vertical sections parallel to the channel axis were recorded. For the plan view observations, the flow was covered to inhibit optical problems with free surface waves (Unger et al. 2004). The test was made with the following conditions: Sediment size d_{50}=0.0011 m, Discharge Q=0.070 m^3/s, Approach flow depth h_o=0.182 m, Approach velocity V_o=0.38 m/s, Densimetric Froude number $F_{do}=V_o/(g'd_{50})^{1/2}$=2.83, Threshold Froude number F_{to}=0.83, and pier diameter D=0.26 m.

Fig. 2 (a) shows the streamlines as obtained from velocity fields at 4, 7 and 24 hours after test initiation. The horseshoe vortex in the channel axis is initiated at time $t\cong$1200 s. From then, its diameter expands along with the generation of a secondary vorticity between the horizontal approach bed and the primary vortex. These images show the significant 'downflow' along the pier occupying a larger extent than the surface recirculation. Fig. 2 (b) shows the corresponding flow fields in plan. Close to the water surface, the pier deflects the approach flow only around a radius of influence of roughly up to 2D, whereas the deflection of the flow more towards the sediment bed is much larger. In parallel, recirculating flow close to the free surface is much larger than close to the scour hole.

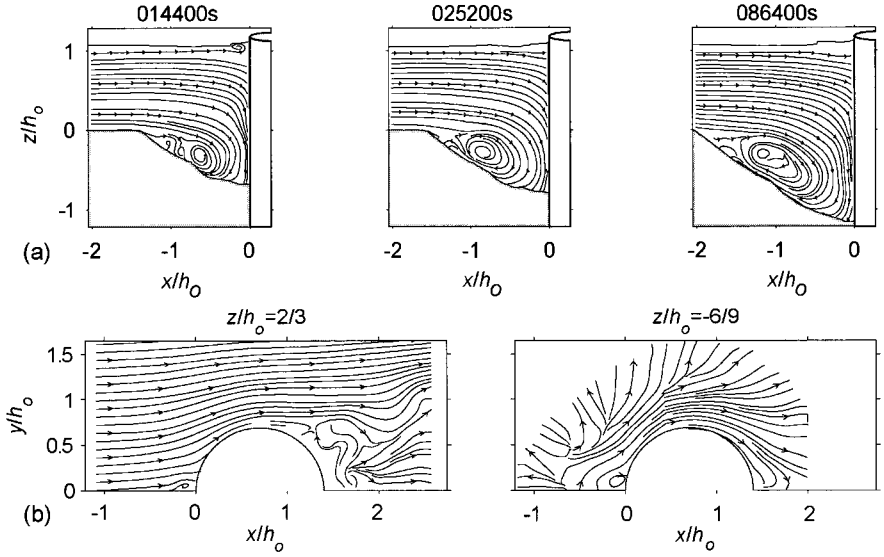

Fig. 2 Streamline Plots, in (a) Channel Axis, (b) in Plans

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