HORIZONTAL ACOUSTIC DOPPLER CURRENT PROFILER (H-ADCP) FOR REAL-TIME OPEN CHANNEL FLOW MEASUREMENT: FLOW CALCULATION MODEL AND FIELD VALIDATION

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A new horizontal acoustic Doppler current profiler (H-ADCP) is introduced recently for real-time open channel flow measurement. The H-ADCP is a side-mounting, horizontally-looking system. It has up-to 128 user selectable cells. It measures velocity profile at a horizontal line across channel as well as water level. Data for velocity profile and water level can be used to calculate open channel flow rates.

A flow calculation model was developed for H-ADCP flow measurement. The model is based on a power law for velocity distribution (Chen 1991). It uses H-ADCP velocity profile data and water level data to create the velocity distribution in the whole cross-section. Flow rate can then be calculated from the integration of the cross-section velocity distribution. Generally speaking, the flow calculation model does not require calibration.

A numerical scheme was developed to implement the flow calculation model. The channel cross-section was first divided into a grid with square or rectangular elements. The width of a element was at least one tenth of the maximum depth at the channel. The velocity at each element was then calculated from the power law. Finally, a Gaussian numerical integration was employed to calculate flow rate.

The flow calculation model with the numerical scheme was incorporated into a Windows-based software named Q-Monitor (written in C^{++}). The software can be used in real-time flow measurement as well as in data playback.

The flow calculation model for H-ADCP flow measurement was validated at two open channels. One was the Westside Main Canal in the Imperial Irrigation District in California, USA. The other was an irrigation canal in Angoori Barrage, India. During a field test, concurrent with the H-ADCP flow measurement, flow rates were independently measured using a down-looking mini ADCP mounted on a small float (a standard moving-boat ADCP flow measurement method (Simpson 2001; USGS 2001)).

Figures 1 and 2 show time series data for flow rates measured by H-ADCP (line) and the moving-float ADCP measured flow rates (dots) at the California site and Angoori Barrage site, respectively. It can be seen from Figures 1 and 2 that the flow rates measured from the H-ADCP and the moving-float ADCP agree well. It is important to note that the two instruments are different in operation, purely independent, and without any calibration. The results indicate that the H-ADCP with the flow calculation model provides an effective tool for real-time open channel flow measurement.

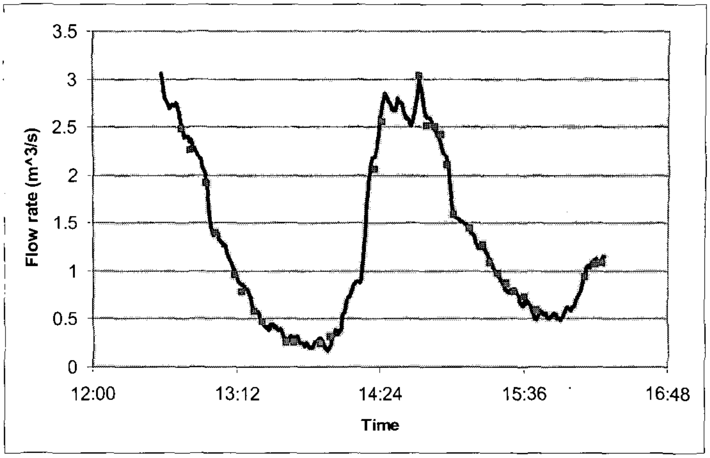

Fig. 1 Time series data for flow rate measured by H-ADCP (line) and the moving-float ADCP measured flow rates (dots) at the California site

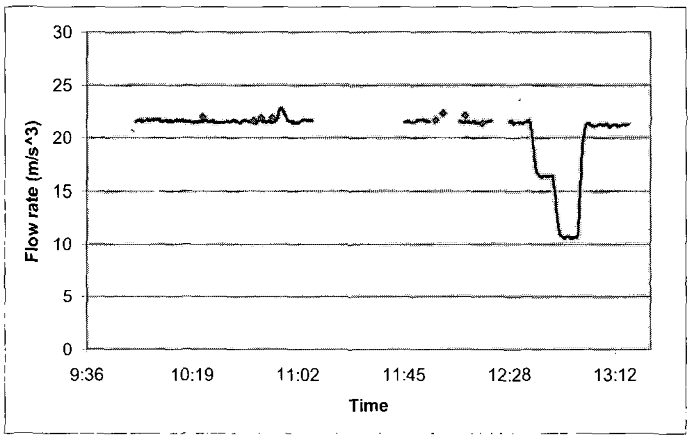

Fig. 2 Time series data for flow rate measured by H-ADCP (lines) and the moving-float ADCP measured flow rates (dots) at the Angoori Barrage site

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