Comparing LIDAR with common free-surface measurement methods in aerated hydraulic jumps

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Abstract To assess the comparative performance of LIDAR against traditional instruments in recordings of time-varying air-water free-surface motions, free-surface data of hydraulic jumps were simultaneously recorded with acoustic displacement meters, wire gauges and a LIDAR. All instruments showed close agreement in distributions of free-surface properties. LIDAR had the advantage of being able to simultaneously track the jump toe which provided more precise mean jump toe positions than visual observations. The LIDAR appears to be well suited for free-surface measurement of air-water flows where a high-spatial resolution and the time-variation in free-surface is important.

Keywords: Acoustic displacement meter, air-water flows, free-surface, physical modelling, remote sensing.

Methods

Simultaneous measurements of aerated hydraulic jumps for 30 minutes using LIDAR, acoustic displacement meters (ADMs) and wire gauges (WGs).

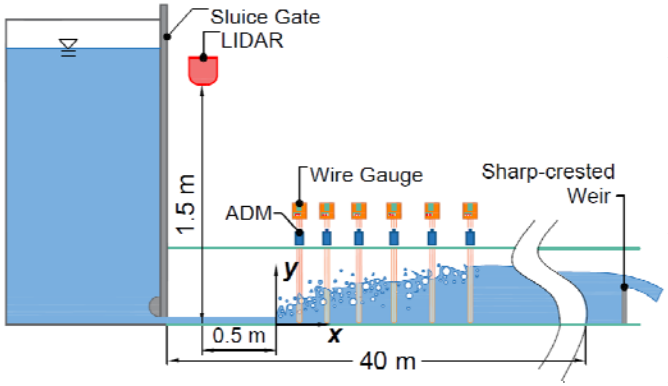

Figure 1: Experimental setup with 0.6 m wide flume

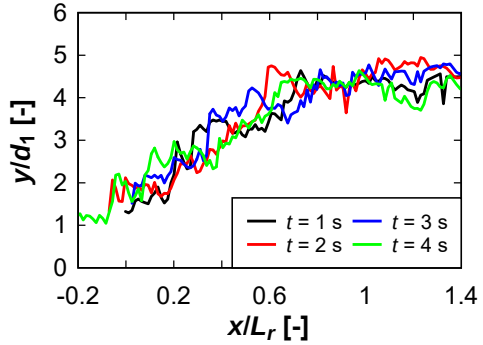

Figure 2: Dimensionless instantaneous free-surface profiles y/d_1 (Inflow Froude number Fr_1 = 3.5);

Results

- Strong agreement was observed between instruments with respect to basic free-surface properties.
- Average difference in mean free-surface elevations and fluctuations of LIDAR compared to ADMs and WGs less than 17 mm (13%) and 2.7 mm (12%)
- Relative differences in free-surface properties are related to different measurement principles.
- LIDAR is also able to track the jump toe instantaneously providing more precise mean jump toe location compared to visual observations.
- Difference between visual observations and LIDAR measurements of mean jump toe location is up to 70 mm.

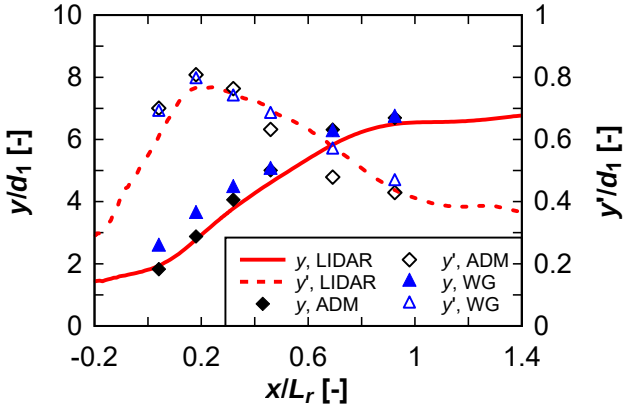

Figure 3. Free-surface profile and fluctuations measured with LIDAR, ADMs and WGs (Fr_1 = 5).

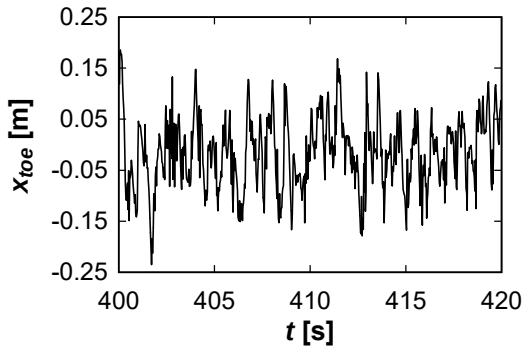

Figure 4: Instantaneous jump toe position x_{toe} (Fr_1 = 8).

Conclusions

- All instruments can be used for free-surface measurements of air-water flows.
- LIDAR provides new opportunities for air-water flow measurements where the free-surface needs to be recorded with high-spatial resolution including the jump toe motion.
- LIDAR may provide new opportunities to also measure air-water free-surface flows at prototype scale

Bibliography

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