Velocity profiles on a grass-lined spillway in supercritical flow

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Abstract

Grass-lined spillways represent an environmentally friendly solution for flow conveyance in mildly-sloped water ways. Velocity profiles of grass-lined open channel flows have been extensively studied under subcritical flow conditions, whereas experiments in supercritical flows are limited. Herein, velocity profiles and flow resistance on a mildly sloped chute with artificial grass were experimentally investigated using a Prandtl Pitot tube, which exhibited the development of the boundary layer along the chute achieving uniform flow conditions towards the chute's end. The results revealed similarities of the velocity profiles to a previously proposed velocity decomposition and provided insights into point flow resistance

Research objective:

Experimental modelling of velocity profiles on a grassed spillway in supercritical flows.

Keywords: Boundary layer, Eco-friendly hydraulic structures, Flow resistance, High-velocity flows.

Methods

- Facility: 0.8 m wide, 8 m long flume with θ=10.8°
- Artificial grass with 25 mm undeflected height
- Investigated flow rates: 25 l/s to 250 l/s
- Froude number: 1.46 to 3.42 (uniform region)
- Instrumentation: Pitot tube, phase-detection conductivity probe
- Measurements conducted every meter

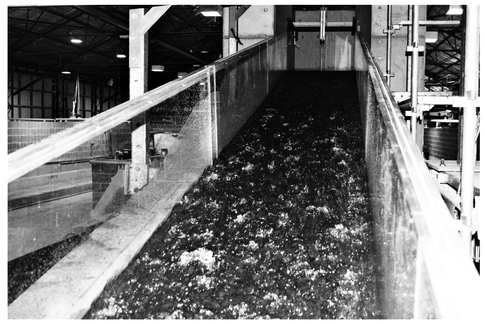

Figure 1: Grassed spillway with an example of self-aerated flows at 125 l/s. UNSW Water Research Laboratory

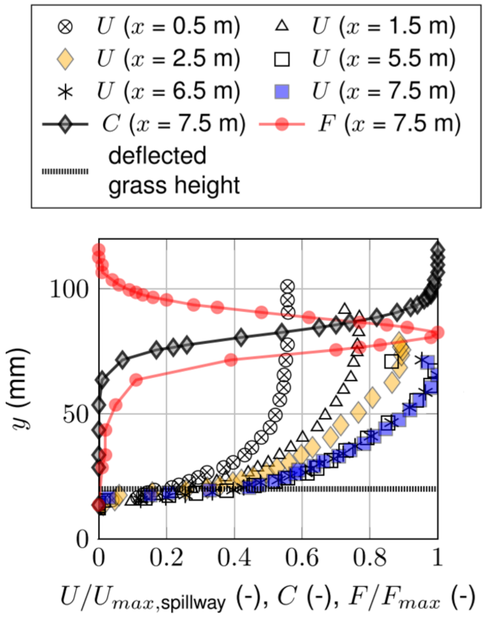

Figure 2: Velocity profiles along the channel, void fraction (*C*) and bubble count rate (*F*) at *Q*= 150 l/s

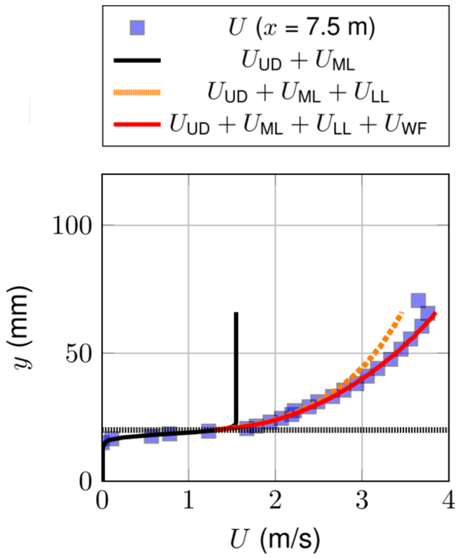

Figure 3: Velocity profile fitting example at *x* = 7.5 m for Q= 150 l/s

Results

- **Systematic experimental modelling of velocity profiles in supercritical flows.**
- **Boundary layer development and convergence in the uniform region.**
- **Self-aeration mainly present in the upper flow region (C_{mean}= 0.13 at *x* = 7.5 m).**
- **Velocity profiles were fitted to the velocity distribution model of Nikora et al (2013).**

Conclusions

- Velocity profiles comparable to subcritical flows.
- Results demonstrated velocity decomposition, including inflection point, mixing layer, log layer and wake region.
- Pitot tube retains credibility in log layer
- Provided valuable insights into the velocity profile and flow resistance.

Bibliography

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