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NEGATIVE SURGES IN OPEN CHANNELS: PHYSICAL AND NUMERICAL MODELLING - CLOSURE

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We thank the discussers for their pertinent comment. Indeed a negative surge is observed in the upstream reservoir during a dam break wave and there is an abundant literature on the topic. The complete solution of dam break wave is commonly treated in modern textbooks (Henderson 1966, Montes 1998, Sturrn 2001, Chanson 2004a,b). The analytical solution of dam break wave advancing over some water was first solved by Barré de Saint-Venant (1871) for a rising tide in a channel with initial water depth. Relevant experimental evidences included Bazin (1865, pp. 536-553) (see also Darcy and Bazin 1865), Schoklitsch (1917), Cavaillé (1965), Estrade (1967) among a few. Interestingly, Bazin (1865) repeated experiments in a large canal with different initial conditions to check his findings, while Cavaillé (1965) repeated identical experiments on smooth and rough inverts for three initial water depth to reservoir height ratios. Hager and Chervet (1996) reviewed the historical developments.

Experimental studies of negative surges included the free-surface measurements of Favre (1935), and the unsteady velocity data of Reichstetter and Chanson (2013) and Leng and Chanson (2013). Numerical studies of negative surges are more numerous (Tan and Chu 2009, Reichstetter and Chanson 2013), albeit restricted by the limited amount of detailed validation data sets.

In relation to the original data at x = 10.8 m (Fig. 4, Reichstetter and Chanson 2013), the water depth data were recorded 0.35 m upstream of the tainter gate, itself located 0.85 m of a free overfall (Fig. 1). Figure 1 presents an undistorted dimensioned sketch of the channel downstream end. The longitudinal flow profile was substantially determined by the hydraulic control mechanism operating within the system (Henderson 1966, Chanson 2004). Prior to gate opening, the channel flow was controlled by the undershoot tainter gate. The flow was subcritical upstream of the gate and supercritical between the tainter gate and free overfall (Fig. 1, solid black line). During the rapid complete gate opening, a transient flow took place during which the channel flow was controlled briefly by critical flow conditions at the gate location. This was followed by a gradually-varied flow motion in the flume which became controlled by the critical flow conditions at the overfall (Fig. 1, dashed red line). The channel flow experienced a shift in downstream control location which was responsible for a slight increase in water depth at x = 10.8 m beyond a certain time, as recorded by the acoustic displacement meter (Fig. 4, Reichstetter and Chanson 2013) and observed with video camera and digital photography.

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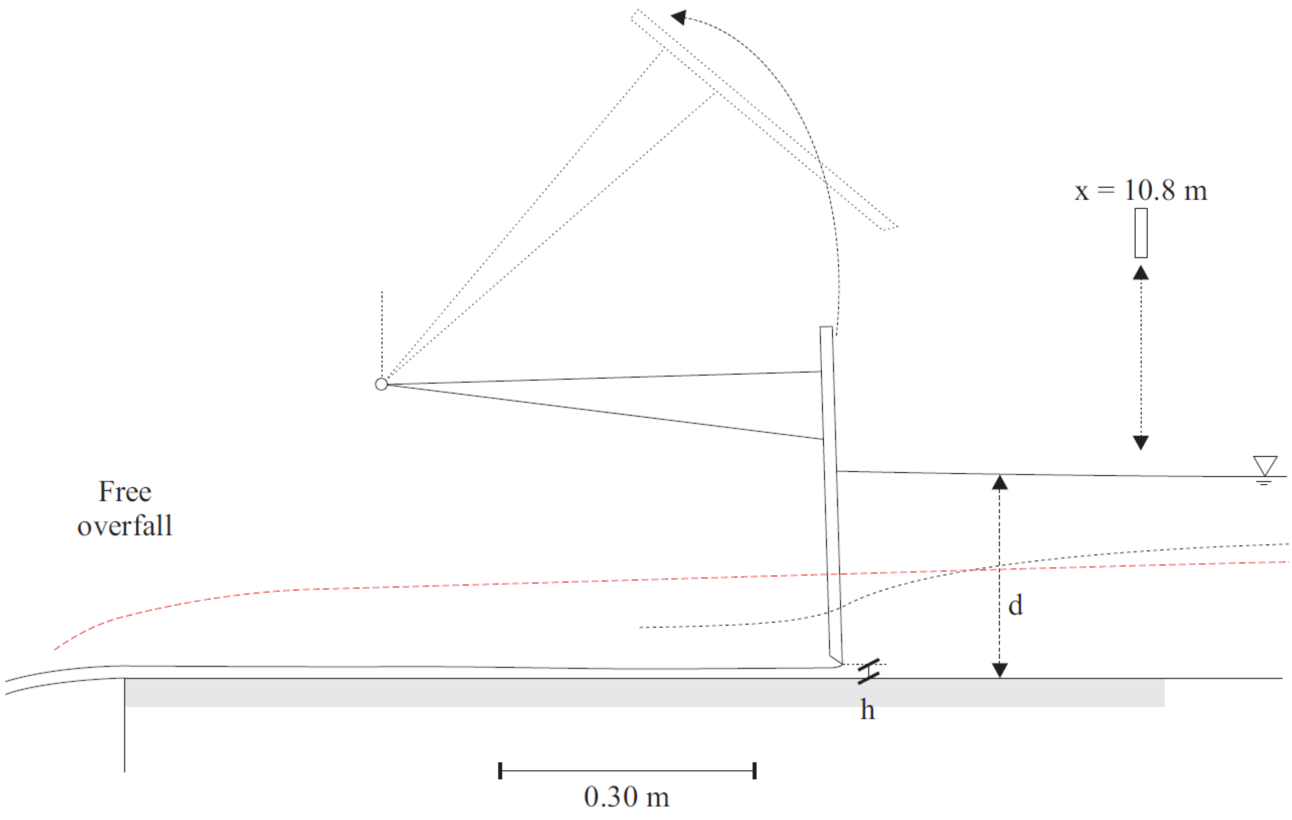
Fig. 1 - Sketch of the negative surge generated by the rapid tainter gate opening



NOTATION

d	water depth (m) measured above the invert;
h	initial undershoot gate opening (m);
x	longitudinal distance (m) positive downstream, with x = 0 at test section upstream end;

x_{Gate} longitudinal co-ordinate (m) of the tainter gate (x_{Gate} = 11.15 m herein);

Subscript

Gate flow properties at tainter gate;

x longitudinal direction positive downstream.