FLOW OVER A SUBMERGED THIN PLATE WEIR WITH DIFFERRING BED LEVELS

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The available formulas for discharge over a submerged thin plate weirs have been based on studies in flumes with the same upstream and downstream bed levels (equal beds). In practice, thin plate weirs that have been placed in natural channels would be expected to have downstream bed which have been eroded away by the impact of the modular (un-submerged) flow. This is the *unequal bed* case.

Downstream of a submerged weir, the flow divides into a distinct turbulent region with an ogee shaped upper boundary. Discharge is by a horizontal jet above the turbulent region Rajaratnam and Muralidhar (1969) found that the jet consists of a constant velocity core with a shear layer below it. With a lower downstream bed, the turbulent region would be physically lower. As there is no reason for the shear layer to thicken, the extra depth will be taken up in a thicker constant velocity core. Consequently, it will be easier for the downstream tailwater to influence and force up the upstream level. A given downstream water level would result in a higher upstream water level for the unequal bed case than for the equal bed case.

This is expected to have the following effects

- The plot of upstream head H_u against downstream head H_d will change shape. For most of its length the unequal bed graph would be steeper and would 'meet' the asymptote (which represents a submergence of 1.0) at lower values of H_u and H_d than the equal bed case. i.e. the two graphs would intersect.
- The approach Froude Number for an unevenly bedded weir would be higher than that for an evenly bedded weir with the same submergence and the upstream depth is smaller.
- As H_u is smaller for a given submergence in the unequal case, applying a conventional formula based on the equal bed case would lead to an underestimate of the discharge. However, as all graphs for the same discharge tend to the same asymptotes the error would be greatest at approximately mid submergence.

Two sets of laboratory measurements were made. These were a short series of measurements on a full scale weir 0.12 m high and 0.6 m wide. and a much larger series of measurements on a half scale model 0.13 m high and 0.1 m wide . The ratio downstream bed depth: upstream bed depth (Ł) ranged in vale from 0.33 to 1.0 and the discharges from 0.005 to 0.029 cumecs. For each combination of upstream and downstream beds and discharge, the model was systematically submerged and measurements taken of upstream and downstream water levels.

When the approach Froude numbers were calculated, there was a noticeable difference between the equal and unequal bed cases with the unequal case showing (as expected) a higher Fr number for a given submergence than for the equal bed case.

The expected change in the shape of the H_u vs H_d graph was found, but showed as a fine distinction on the graphs.. (It is interesting to note that such a small difference has such a marked effect on the approach Froude number.) Hence the effect of unequal beds on the discharge calculation would probably be small. In this study, the effect of the unequal bed has been swamped by the errors inherent in the equal bed formula.

From a practical engineering point of view this suggests that no further substantial errors are incurred when a standard discharge formula is applied to a weir with a lower downstream bed.

Keywords: Submerged weirs, Drowned weirs, Thin plate weirs

REFERENCE

Rajaratnam N., Muralidhar D.,(1969) *Flow Below Deeply Submerged Rectangular Weirs*, Journal of Hydraulic Research, 7, (1969), No.3 pp355 –373