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Discussion: Oblique rectangular sharp-crested weir

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1. INTRODUCTION

Professor Borghei and his co-authors are to be congratulated on providing a fresh look at rectangular weirs. As her current field of interest is submerged weirs, the discusser is interested in comparing their results with existing discharge formulas, particularly for rectangular weirs with differing upstream and downstream beds.

The discusser modified Borghei *et. al.*'s equation (11) to give the special case of a normal submerged weir and compared the resulting equation with the older formulas of Villemonte[15] and Abou-Seida and Quraishi.[16] The Borghei formula proved to be more useful than the two established ones.

2. BORGHEI *ET AL.*'S MODIFIED FORMULA

For the normal weir, equation (11) becomes

$$\boldsymbol{Q} = \left[0{\cdot}993 - 0{\cdot}318\left(\frac{H_d}{H_u}\right)^3\right]^2 \boldsymbol{Q}_m \tag{12}$$

where H_u is the upstream head measured relative to the weir crest, H_d is the downstream head measured relative to the weir crest, and Q_m is the modular flow discharge under head H_u.

3. LABORATORY STUDY

The data used in this discussion were obtained from a full-sized laboratory study conducted in a large flume 30 m long. The full-width Perspex weir was 600 mm wide. Upstream and downstream bed levels were modelled by wooden formers. Different bed configurations were described in terms of P_d/P_u, where P_d and P_u are the weir heights measured relative to the downstream and upstream beds respectively. The values of P_d/P_u ranged from 0·33 to 1·0. Each weir was tested with flows of 10, 15, 20 and 25 l/s.

For each model/flow combination, the weir was initially operated under modular conditions to establish the actual flow and then slowly submerged by closing a downstream sluice gate. The upstream and downstream water levels were measured at each submergence.

4. RESULTS

For each pair of data points the discharge was calculated by each of the three formulas. These discharges were plotted against submergence.

All three formulas were reasonably accurate at low submergences. However, as both Villemonte and Abou-Seid and Quraishi formulas contain a (1-submergence) factor, it is to be expected that these formulas would badly underestimate the discharge when submergence is high. This was shown to be true with both formulas reaching a 5% error (and often a 10% error) before reaching the accepted application limit of 70% submergence for Villemonte's formula.

In contrast, equation (12) was accurate up to much higher submergences. In some cases the calculation reached the 5% error boundary at approximately 90% submergence. However, beyond a submergence of approximately 95% the formula becomes markedly unstable.

This pattern was shown to be true both with constant bed factor and varying discharge and with constant discharge and varying bed factor. Engineers are therefore recommended to use the modified Borghei formula to calculate discharge over deeply submerged (i.e. up to 95%) weirs.

Authors' reply

The main objective of the research was to introduce the coefficient of discharge for oblique rectangular sharp-crested weirs. The results showed that the oblique weir can be used as a precise discharge measurement device when a plain (or normal) weir has limitations of water depth above the weir crest. Although general equations are presented in the paper, the main focus was the oblique weir. This was because for free and submerged plain weirs, standard formulas exist as outlined in the paper and the discussion.

However, equation (12) in the discussion presented by Dr Nalder does not include P_u/P_d as one of the main variables of the tests. Also the limitations to previous equations are not mentioned in the discussion and it is not known to what value of H_d/H_u each formula fits. If Dr Nalder could add a graph showing her data with the mentioned equations as well as equation (12) in the discussion, it would help other investigators to check the proposed formula for submerged rectangular plain sharp-crested weirs.

REFERENCES

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16. Abou-Seida M. M. and Quraishi A. A. A flow equation for submerged rectangular weirs. *Proceedings of the Institution of Civil Engineers*, 1976, **61**, Part 2, Dec., 685–696.