($387\ m^3/s$), whereas the predicted discharge is $369\ m^3/s$ at $H_t/P = 0.5$ for the labyrinth weir at Boardman, which possesses almost the same geometric characteristics. This prediction contradicts the nature of curves shown in the authors' Fig. 3, in which the value of the coefficient of discharge decreases with increasing H_t/P value beyond 0.3. On the other hand, the prediction by the proposed Eq. (3) for the labyrinth weir at Carty conforms to the nature of curves shown in the authors' Fig. 3, because C_L decreases with increasing H_t/P values beyond the value of 0.3.

Conclusions

To conclude, this discussion provides unified equations for the coefficient of discharge of labyrinth weirs, which can be applied across a spectrum of side wall angles ($\alpha = 8$–$30°$) for the prediction of discharge. The proposed equations render the authors' work more valuable and complete from a practitioner's perspective. Thus, they can be directly used for the predictions of discharge by real prototype dams. The discussion also reveals that a labyrinth weir with a smaller side wall angle achieves its maximum flow capacity at a relatively lower water head above the crest than a labyrinth weir with a higher side wall angle. Because the occurrences of nappe interference and local submergence (Crookston and Tullis 2012) in labyrinth weirs with low side wall angles cause a reduction in the discharge capacity, it can be inferred that labyrinth weirs are suitable for the low water head conditions above the crest; hence, they need to be designed for the same condition to achieve economy. However, it is suggested to find a suitable modification in the upstream apex of the labyrinth weirs that can avoid or delay the occurrence of the nappe interference phenomenon to preserve the ability of delivering increased discharge with increasing H_t/P value over a relatively wider range of water head above the weir crest.

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Introduction

The discussers would like to thank the authors for evaluating various hydraulic characteristics of the labyrinth weir. The authors have presented experimental data for trapezoidal labyrinth weirs with quarter round crest shapes and side wall angles of 8, 10, 20, 30, and 90°. Two sets of weir models with weir height $P = 0.10$ m and $P = 0.075$ m are studied. The work by the authors in accomplishing the regression equations applicable to discharge coefficients is really appreciated. These accurate equations have an average percentage error of 1% compared with the experimental data, and are applicable to trapezoidal labyrinth weirs that have side wall angles of 8, 10, 20, 30, and 90° (linear weirs). For other wall angles between 8 and 90°, an interpolation procedure should be employed to obtain the discharge coefficient. However, in practice, it is very suitable to have a single equation applicable to any side wall angle. Thus, the discussers would like to introduce single regression-based equations for discharge coefficients (based on experimental data presented in original paper), which are valid for any side wall angles between 8 and 90°. For this, the head to weir height ratio (H_t/P) and side wall angle (α) are considered to be independent variables in the proposed equations for discharge coefficients, that is, C_L and C_W. This investigation attempts to find a generalized equation for the discharge coefficient of the labyrinth weir. The proposed equation will be accurate and easy to use in practical situations.

General Regression Model for Discharge Coefficients

In this study, the following general model is considered for the discharge coefficient, C:

$$C = (k_0 + k_1\eta^{k_2} + k_3\eta^{k_4} + k_5\eta^{k_6} + k_7\eta^{k_8})[k_9 + k_{10}(\sin\alpha)^{k_{11}}] + (k_{12} + k_{13}\eta^{k_{14}} + k_{15}\eta^{k_{16}})[k_{17} + k_{18}(\sin\alpha)^{k_{19}}]^{k_{20}} \quad (1)$$

where $\eta = H_t/P$ and constant coefficients k_i ($i = 0, 1, \ldots, 20$) are determined via the optimization procedure. This general form is obtained by using regression analysis based on the practical ranges of the corresponding experimental variables ($0.12 \le \eta \le 0.7$ and $\alpha = 8$, 10, 20, 30, and 90°). To determine k_i, the maximum absolute percentage error ($\text{Max}|\text{PE}| = 100 \times |1 - C/C_{\text{experimental}}|$) is

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