



DISCUSSION

Discussions on 'Effect of downstream apron elevation and downstream submergence in discharge coefficient of ogee weir' Author: Farzin Salmasi

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ARTICLE HISTORY Received 1 January 2019; Accepted 2 January 2019

Multiple regression equations and GEP were used by the author to predict non-dimensional values of C_s/C_f . A total of 108 experimental data of Tullis from nine physical models of ogee spillways were used to predict C_s/C_f -values. These data relate to different values for P , P_d and Q . For training phase, 75% of these data points and for testing phase 25% of the total data points are used. Functional relation of C_s/C_f is expressed as

$$C_s/C_f = f(S, H_o/P, H_o/P_d) \quad (1)$$

Performance of the regression and MEP models were determined in terms of RMSE, R^2 and MAE. Performance of MEP model was found to be the best. In all the cases, the design head and the operating head of the spillway were the same. The equation derived by GEP is given by equation (9) in the paper:

$$C_s/C_f = (S^{3.588 \times 10^{-7}}) / [(0.046 - 2S) + [(S^3 - S - H_o/P_d)] / [(S - 6.332)(H_o/P + H_o/P_d)] + 1.008] \quad (2)$$

Submergence, S of crest is the major parameter affecting C_s . As illustrated in Figures 2 and 3 in the paper, author has defined submergence in terms of h_d/h - both of them measured above the crest of the spillway. USBR (1968), however, defined h_d as the difference between u/s energy level and downstream tail water level. Author's definition of h_d implies that submergence of spillway crest occurs only when the tail water level is above the crest level which may not be always correct.

Discusser (Mazumder 1966, 1981) defined submergence of flow meters in terms of critical submergence limit (S_{cr}) or often called modular limit. If submergence (S) is greater than S_{cr} , the meter is submerged and it is free when $S < S_{cr}$. Author has mentioned in the paper the threshold value (same as S_{cr}) of submergence as 0.8 (Figure 9 in the paper). It may be alright for the given spillway profile where design head is the same as operating head. However, a spillway operates for heads other than design head also depending upon incoming flow. S_{cr} may not be same at all the operating heads. From dimensional analysis, discusser (Mazumder and Joshi 1981) derived S_{cr} as a function of C_i , C_o , r and R where, C_i and C_o are the inlet and outlet head loss coefficient, respectively; r is the horizontal fluming ratio ($r = B_0/B_1$) and R is the vertical constriction ratio ($R = \Delta/y_1 = P/(P+h)$); Here B_1 and B_0 are the widths of original channel section and control section respectively; Δ

(= P) and y_1 are the height of crest and depth of the flow above upstream bed. Figure 1 illustrates the variation of S_{cr} with C_i , C_o and r for a given value of $R = 0.8$.

As regards C_f -value given by equation (10), it is valid only for the given spillway where operating and design head are the same and the u/s face is vertical. USBR (1968) results show that C_f is a function not only of P/H_o but also of H_e/H_o and a slope of upstream face. Thus, the author's expression is not a universal one but valid for the given spillway alone. USBR (1968) also gives the limiting values of $P/H_o = 3$ above which C_f -value remains the same. Here, H_o is the design head for finding spillway profile. It has also given the flow regime diagram by plotting h_d/H_e against $(h_d+d)/H_e$ indicating the tail water effect and floor effect, respectively. The curve indicates that for h_d/H_e greater than 0.7 there is no tail water effect on C_f . Similarly, for $H_e/(h_d+d) > 1.7$, $C_s/C_f = 1.0$, i.e., there is no floor effect. In the case $h_d/H_e < 0.7$ and $H_e/(h_d+d) < 1.7$ there is both floor and tail water effect on C_f/C_s . Here, d is tail water depth.

Flow measurement in open channel and canals is extremely important for water management. Apart from spillways in dams, hydraulic structures like weirs and barrages, drops, venture meters, etc., are devices by which the flow is measured. For free flow conditions, discharge can be measured by using single gauge upstream of these structures since there is no tail water effect. The Coefficient of discharge C_f under free flow condition, depending on the geometry of the device used, remains more or less constant. In submerged flow conditions; however, flow depths both upstream and downstream of the structure are to be measured for finding discharge. C_s under submerged flow is highly sensitive to submergence (S) as apparent from Figure 4 in the paper. Any small error in determining S will cause substantial error in discharge. Under submerged flow, the downstream flow surface is wavy resulting in difficulty in finding S very accurately. Thus, flow metering device should be so designed that it works under free flow conditions for the given range of discharges to be measured. For free flow, a control section must exist. Control can be achieved by constricting the channel either vertically or by fluming the channel laterally or by both. In vertical constriction (introducing a smooth hump like ogee weir), critical height of the hump (at its summit) is determined by the maximum discharge (Q_{max}). In that case, control will exist for all flows smaller than Q_{max} . In the case of lateral fluming (bed remaining horizontal) on the other hand, critical width of flume at the control section (B_0) has to be determined by the minimum flow (Q_{min}) so that control exists for all flows greater than Q_{min} . Using specific energy principles, discusser

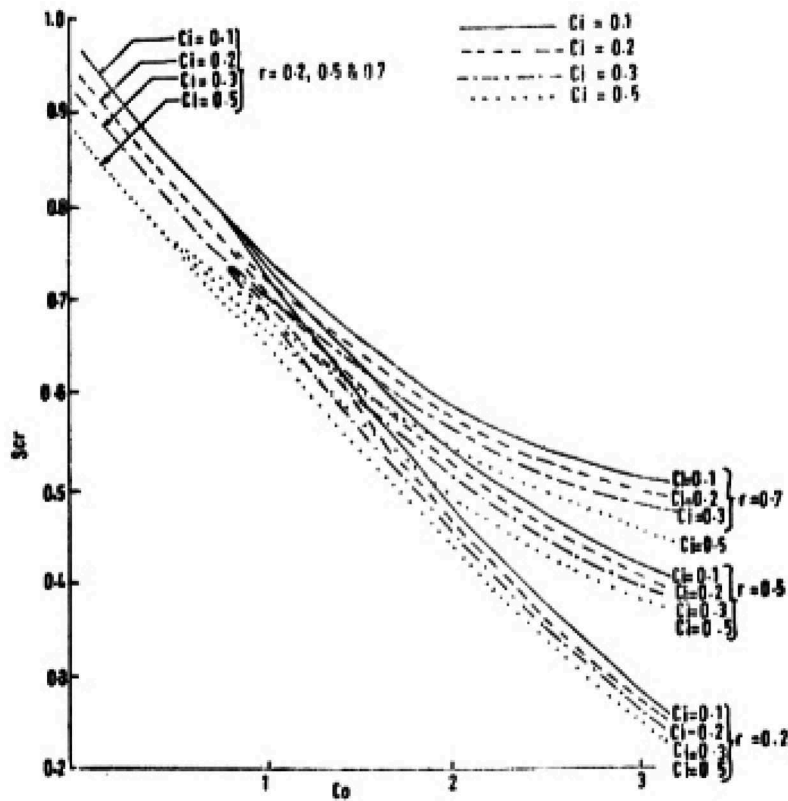


Figure 1. Showing variation of modular limit (S_{cr}) with C_i , C_o and r .

developed a unique kind of proportional flow meter by simultaneously raising the bed and fluming laterally. The critical height (Δ) of the hump at the flumed section of width B_0 is given by the equations (3) and (4) below:

$$\Delta = E_{1\max} - 3/2 [(Q_{\max}/B_0)^2/g]^{1/3} \quad (3)$$

$$B_0 = \left[0.7 (Q_{\max}^{2/3} - Q_{\min}^{2/3}) / (E_{1\max} - E_{1\min}) \right]^{3/2} \quad (4)$$

where $E_{1\max}$ and $E_{1\min}$ are the specific energy heads upstream corresponding to Q_{\max} and Q_{\min} , respectively. Further details about the flow meter with experimental results are available in the paper by Mazumder and Deb Roy (1999). It may be mentioned that C_f was almost the same in the flow range Q_{\max} and Q_{\min} for which the flow meter was designed. It is superior to the Parshall (1950) type flow meter used for measuring flow in irrigation canals.

Disclosure statement

No potential conflict of interest was reported by the author.

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