DISCHARGE OVER A RECTANGULAR SIDE WEIR WITH SUPERCRITICAL FLOW IN THE APPROACH CHANNEL

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Due to the transverse variation of flow profile and velocity distribution, the hydraulic behaviour over a side weir is completely different from that over a weir normal to the approach channel. Although many studies have been carried out in the past to investigate the discharge over side weirs under subcritical flows, only a limited number of studies are reported on side weir flow with supercritical flow. In this study, supercritical flow over a rectangular, sharp-crested side weir is examined with experimental data.

The experiments were carried out in a 13.5 m long, 0.3 m wide, 0.3 m deep rectangular, re-circulating flume. The sharp-crested weir was framed to a wall of the main channel at a height of 0.06 m leading to a side channel of rectangular cross section. Flow depths at upstream, mid point and downstream locations of the side weir were measured along the centerline of the main channel. The flow rates in the main channel passing the weir section as well over the side weir were accurately measured. The experiments were repeated for six different weir lengths, and for each weir length, tests were carried out for five different discharges.

Three different methods were used to analyse the experimental data. At first, the data was analysed using multiple regression to correlate discharge coefficient (C_m) with several non-dimensional quantities, namely, upstream Froude number (Fr_1), and the ratios of upstream water depth to weir height (y_1/w) and weir length to main channel width (L/B). In the second method, the governing equation for discharge through a channel with side weir was solved numerically using a *fourth-order Runge -Kutta method* treating this as an initial value problem, the coefficient C_m was related to the same non-dimensional parameters.

The variation of discharge in the main channel across the side weir is found to be quadratic and hence, the following relationship was obtained. $Q/Q_1 = \alpha X^2 + \beta X + 1$; where, $X = x/L$, L = length of side weir, Q = discharge in the main channel at a distance of x, α and β are coefficients. Hence, the discharge over the side weir is given by; $Q_w = Q_1 - Q_2 = -(\alpha + \beta)Q_1$, where, Q_1 and Q_2 = main channel discharges at upstream and downstream of side weir, respectively. The coefficients α and β are then, related to three non-dimensional quantities used in this study. The functional relationships developed in this method appear to give much improved results for estimating weir discharge in supercritical flows, as indicated in Table 1.

Table 1: Average percentage errors between measured and computed discharges using different methods.

Non-dimensional parameters used to express C_m (or Q_w)	% error
(i) $C_m = f(Fr_1)$	8.0
$C_m = f(w/y_1)$	8.3
$C_m = f(L/B)^2$	7.8
$C_m = f[Fr_1, w/y_1, (L/B)^2]$	5.5
(ii) C_m using numerical method	5.7
(iii) Q_w using quadratic function	4.6