Supplementary Material

Illustrative Example- A conical obstruction of diameter 0.36 m and apex angle 27° is inserted axially at the center of a trapezoidal channel having a bed width of 0.4 m and side slope of 1:1. The flow depth measured at the face of the cone is 0.32 m. Calculate the rate of flow through the channel.

Solution: For the given data, contraction ratio ($r = D/B$) is 0.9, side slope of cone [$m_2 = tan(\alpha/2)$] is 0.24 and width at throat section ($B_o = B - D$) is 0.04 m. From Eq. (14), the energy-critical depth (E/y_c) ratio of the flume is found to be 1.274. With known energy-critical depth ratio and upstream energy (E = 0.32 m), the critical depth of flow y_c is found to be 0.25 m. Now, the contracted width at critical section is calculated using Eq. (11), B_c = 0.0689 m. Since, the value of $B_c \geq B_o$ (i.e., 0.0689 m ≥ 0.04 m), the flow is found to create choking condition. Finally, using Eq. (12), the discharge over the channel is calculated as Q = 0.111 m^3/s.

Additionally, the location of critical section can also be calculated in terms of fraction (f) of the cone diameter using Eq. (7) in conjunction with Eq. (8), corresponding to the critical contracted width (B_c). Here, the critical section was obtained at f = 0.313 (i.e., P_2).