26.1 Standard Step Method

In the standard step method, flow depth at a specified location, y_d is determined, given the flow depth, Y_u at another specified location. Consider the channel shown in Figure 26.1. In this channel, say Y_u occurs at a distance X_u from the reference point. Discharge, Q, Channel bottom slope, S_0, the roughness coefficient, n and cross-sectional shape parameters (which relate A, P and R to y) are also known. The problem now is to determine the flow depth, Y_d at the specified location X_d (figure 26.1).

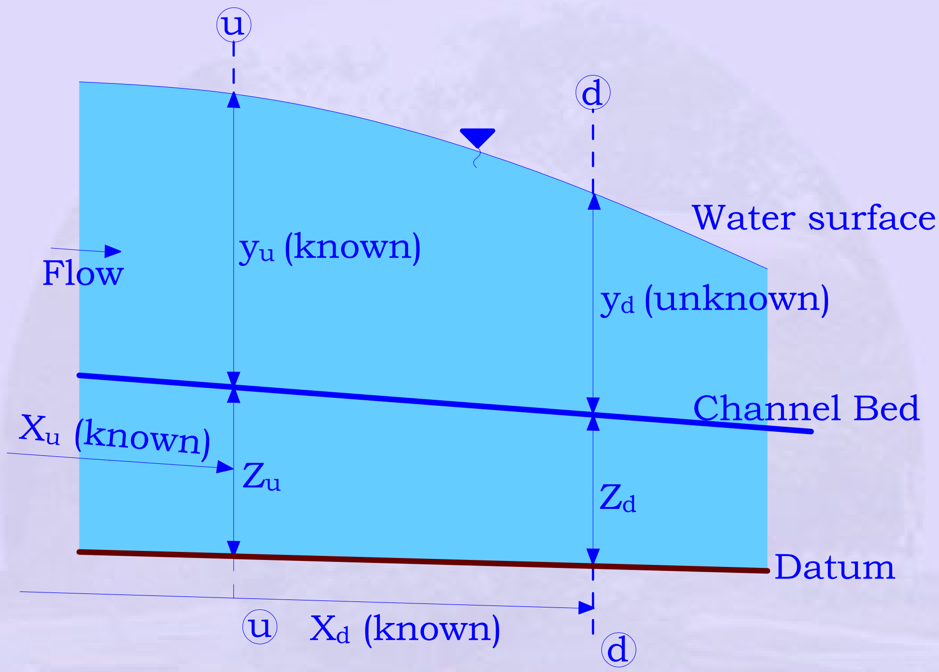

Fig. 26.1: Definition sketch for standard step method

Equation (25.3) $$-\left(y_d+\alpha_d\frac{V_d^2}{2g}\right)+\left(y_u+\alpha_u\frac{V_u^2}{2g}\right)=\bar{S}_f\left(x_d-x_u\right)-S_0\left(x_d-x_u\right) \qquad (25.3)$$

can be rewritten as

$$y_d+\frac{\alpha_d Q^2}{2gA_d^2}+\frac{S_{f_d}\left(x_d-x_u\right)}{2.0}=y_u+\frac{\alpha_u Q^2}{2gA_u^2}-\frac{S_{f_u}}{2}\left(x_d-x_u\right)+S_0\left(x_d-x_u\right) \qquad (26.1)$$

In Equation 26.1, the flow rate (Q), the roughness coefficient (n), distances X_d and X_u, the channel slope (S_0), the flow conditions at section u (y_u, α_u and A_u) are known. Therefore the right hand side of Eq. (26.1) can be determined. On the left hand side, the area, A_d and the friction slope, S_{f_d} are functions of the flow depth Y_d. Thus we have one equation (Eq. 26.1) in one unknown Y_d. Therefore, Y_d can be determined by solving

Equation (26.1). Equation (26.1) is a non-linear equation. Either trial and error or numerical techniques such as bisection, Newton -Raphson techniques etc. can be used for solving Eq. (26.1).

For example, for a wide rectangular channel (assuming $\alpha_u = \alpha_d = 1.0$), Eq. (26.1) becomes

$$y_d + \frac{q^2}{2gy_d^2} + \frac{n^2q^2\left(x_d - x_u\right)}{2y_d^{10/3}} = y_u + \frac{q^2}{2gy_u^2} - \frac{n^2q^2}{2y_u^{10/3}}\left(x_d - x_u\right) + S_0\left(x_d - x_u\right) \qquad 26.2$$

In Eq. (26.2), $q,\ n,\ y_u,\ x_d,\ x_u,\ S_0$ and g are known, and so Y_d can be determined by solving this equation. Note that Eq. (26.2) is non-linear.