3.11 Water flows at $20 m^3/sec$ in a trapezoidal channel that has a bottom width of 2.8m side slope of 2:1 H/V, longitudinal slope 0.01 and a Manning n of 0.015. Flow is fully turbulent

Given

a) Find normal depth of flow using the Manning Eq.

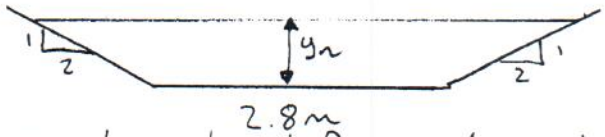
b) Determine the equivalent sand roughness

Reqd

Soln

a) $Q = \frac{1}{n} A_n R_n^{2/3} S_o^{1/2}$ where $R = \frac{A_n}{P_n}$ therefore

$$Q = \frac{1}{n} \frac{A_n^{5/3}}{P_n^{2/3}} S_o^{1/2}$$



Use channel geometry to define A_n and P_n as functions of y_n

$$A_n = [b + m y_n] y_n = [2.8m + 2 y_n] y_n$$

$$P_n = b + 2\sqrt{1+m^2}\, y_n = 2.8 + 2\sqrt{5}\, y_n = 2.8 + 4.472 y_n$$

Substitute in Manning Equation:

$$20 m^3/s = \frac{1}{0.015} \frac{[(2.8m + 2y_n) y_n]^{5/3}}{(2.8 + 4.472 y_n)^{2/3}} (0.01)^{1/2}$$

Simplify

$$3.0 m^3/s = \frac{[(2.8m + 2y_n) y_n]^{5/3}}{(2.8m + 4.472 y_n)^{2/3}}$$

Using Ti-85 Solver $\underline{\underline{y_n = .91m.}}$

b) See Next Page