PROBLEM 15.10

Given → A concrete sewer pipe 2.5 ft in diameter is laid so it has a drop in elevation of 1.0 ft per 800 length. If sewage flows at a depth of 1.25 ft in the pipe, what will be the discharge?

Find → Discharge

Assumptions → Properties of sewer are the same as clean water.
→ Assume concrete pipe ⇒ Manning's $n = .013$

Solution → slope $= \frac{1\text{ ft}}{800}$ $D = 2.5$ ft, $y = 1.25$ ft

→ Find flow area of sewer for manning's equation given that the diameter is half full

$$A = \frac{\pi D^2}{8} = \frac{\pi (2.5)^2}{8} = 2.45 \text{ ft}^2$$

→ Find hydraulic radius for manning Equation, given that the pipe is half full.

$$R_h = \frac{A_c}{P_{wet}} = \frac{\pi D^2/8}{\pi D/2} = \frac{D}{4}$$

$$\Rightarrow R_h = \frac{2.5\text{ ft}}{4} = .625 \text{ ft}$$

→ Use manning's equation to find Q

$$Q = \frac{1.4859}{n} (A)(R_h)^{2/3} (S_o)^{1/2}$$

$$= \frac{1.4859}{.013} (2.45)(.625)^{2/3} \left(\frac{1}{800}\right)^{1/2}$$

$$\boxed{Q = 7.24 \text{ cfs.}}$$

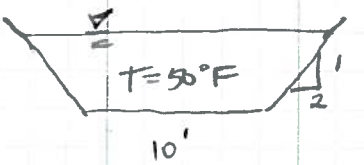
PROBLEM 15.12 →

Given → Water flows at a depth of 8ft in the trapezoidal, concrete-lined channel shown. If the channel slope is 1 ft in 1500 ft, what is the Vang and Q?

Find → Average velocity and discharge

Assumptions → $K_s = .066$ or $n = .015$

$\nu = 1.407\ e{-5}\ ft^2/s$



Solution →

Darcy-Weisbach equation →

$$R_h = \frac{A}{P} \quad \frac{100}{10 + 2(\sqrt{4}+1)} = 6.91$$

$$\frac{K_s}{4R_h} = \frac{.066}{4(6.91)} = .0024$$

$$Re f^{1/2} = \frac{(4R_h)^{3/2}}{\nu}(2gS_0)^{1/2} =$$

$$= \frac{[4(6.91)]^{3/2}}{1.40e-5}\left[(32.2)\left(\frac{1}{1500}\right)\right]^{1/2}$$

$$= 1.51e-6$$

$\Rightarrow f = .013$ (Figure 10.14)

$$V = \sqrt{\frac{8gR_hS_0}{f}} = \sqrt{\frac{8(32.2)(6.91)\left(\frac{1}{1500}\right)}{.013}}$$

$\Rightarrow V = 9.55\ ft/s$

$$Q = VA = \frac{9.55\ ft}{s} \Big| 100 = 955.42\ ft^3/s$$

Manning's Equation → $V = \frac{1.4859}{n}(R_h)^{2/3}(S_0)^{1/2}$

$$V = \frac{1.4859}{.015}(6.91)^{2/3}\left(\frac{1}{1500}\right)^{1/2}$$

$$\boxed{V = 9.28\ ft/s}$$

$$Q = VA = 9.28(100) = \boxed{927.91\ ft^3/s}$$

PROBLEM 15-23

Given → The water discharge in a rectangular channel 16ft wide is 900 cfs. If the depth of the water is 3ft, is the flow subcritical or supercritical?

Find → If flow is subcritical or supercritical

Solution →

Flow rate equation → $Q = VA$

$\Rightarrow 900 \text{ cfs} = (V)(16)(3)$

$\Rightarrow V = 18.75$

Froude number →

$$Fr = \frac{V}{\sqrt{gy}} = \frac{18.75}{\sqrt{(32.2)(3)}} = 1.908$$

Since Froude # is > 1, the flow is supercritical