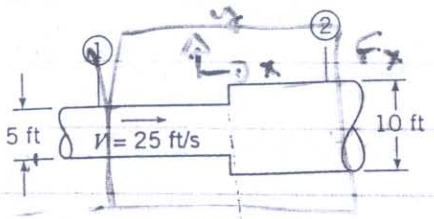
7.45 This abrupt expansion is to be used to dissipate the high-energy flow of water in the 5-ft- diameter penstock.
a. What power (in horsepower) is lost through the expansion?
b. If the pressure at section 1 is 5 psig, what is the pressure at section 2?
c. What force is needed to hold the expansion in place?



PROBLEM 7.45

$$h_L = \frac{1}{2g}(V_1 - V_2)^2 \qquad V_2 = V_1 A_1/A_2 = 6.25 \text{ ft/sec}$$

$$= \frac{1}{2\times 32.2}(25-6.25)^2 = 5.46 \text{ ft}$$

a $HP = \gamma Q h/550 = 304 \text{ hp}$

b $$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$\frac{5\times 144}{62.4} + \frac{25^2}{64.4} = \frac{p_2}{\gamma} + \frac{6.25^2}{64.4} + 5.46$$

$$\frac{p_2}{\gamma} = 15.17 \text{ ft} \qquad p_2 = 946.6 \text{ psf} \quad (6.52 \text{ psi})$$

$\frac{\#}{ft^2} \times \frac{ft^2}{12^2 in^2}$

c $$\Sigma F_x = \Sigma \rho Q V \cdot A$$

$$p_1 A_1 - p_2 A_2 + F_x = \rho Q (V_2 - V_1) \qquad Q = V_1 A_1 = 25 \times \frac{\pi 5^2}{4}$$

$$5\times 144 \times \frac{\pi 5^2}{4} - 946.6 \times \frac{\pi 10^2}{4} + F_x = 1.94 \times 491 (6.25 - 25)$$

$$F_x = 42{,}340 \#$$