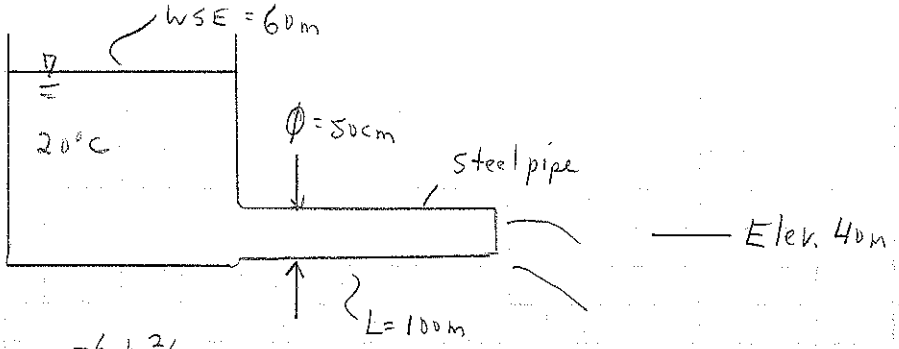
Determine the discharge of water through to 50-cm steel pipe show below



$\nu = 1 \times 10^{-6}\ m^2/sec$

$k_s = 4.6 \times 10^{-5}\ m$ (Fig 10.8)

$k_s/D = \frac{4.6 \times 10^{-5}\ m}{0.50\ m} = 9.2 \times 10^{-5}$

Energy Equation Reservoir / outlet

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

0 0 0

$$60 = \frac{V_2^2}{2g} + 40m + f\left(\frac{L}{D}\right)\left(\frac{V_2^2}{2g}\right)$$

$$\frac{V_2^2}{2g}\left(1 + f\frac{L}{D}\right) = 20m$$

$$V_2^2 = \frac{(20)(2g)}{\left(1 + f\left(\frac{L}{D}\right)\right)} = \frac{(40)(9.81)}{1 + f\left(\frac{100}{0.5}\right)} = \frac{392.4}{1 + 200f}$$

$$V_2 = \sqrt{\frac{392.4}{1+200f}}$$

Don't know h_L in this example

First trial $f = 0.020$

$$V_2 = \sqrt{\frac{392.4}{1+200(0.020)}} = 8.86 \text{ m/sec}$$

$$R_e = \frac{VD}{\nu} = \frac{(8.86)(0.5\text{m})}{1\times10^{-6}} = 4.43\times10^6$$

$f = 0.012$ (Fig 10.8 knowing k_s/D & R_e)

$0.012 \neq 0.020$

2nd trial $f = 0.012$

$$V_2 = \sqrt{\frac{392.4}{1+200(0.012)}} = 10.7 \text{ m/sec}$$

$$R_e = \frac{VD}{\nu} = \frac{(10.7)(0.5\text{m})}{1\times10^{-6}} = 5.35\times10^6$$

$f = 0.012$ = Assumption was 0.012 ; ok

$$Q = VA = (10.7 \text{ m/sec})(\pi)(0.25\text{m})^2 = 2.1 \text{ m}^3/\text{sec}$$

$$\boxed{Q = 2.1 \text{ m}^3/\text{sec}}$$