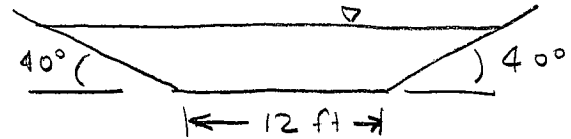


EXAMPLE 10.3

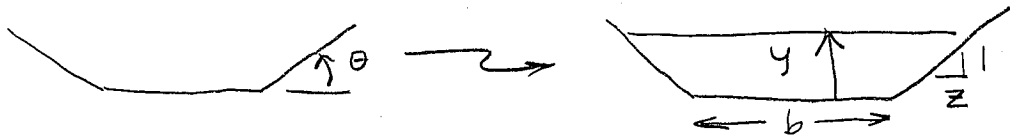
GIVEN: $Q = 10 \text{ m}^3/\text{s}$
weedy canal
lining, $S_o = 0.0014$



FIND: UNIFORM FLOW
DEPTH

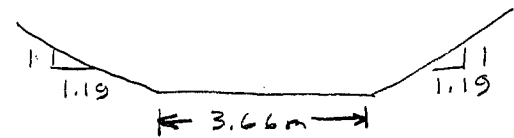
SOLUTION:

1. Use meters: $12 \text{ ft} \times \frac{1 \text{ m}}{3.28 \text{ ft}} = 3.66 \text{ m}$
2. convert cross section to standard engineering nomenclature:



from above, $\tan \theta = \frac{1}{z}$ or $z = \cot \theta$

in our problem, $\theta = 40^\circ \Rightarrow z = 1.19$



3. write Manning Equation as a $f(y)$ only:

$$Q = \frac{K}{n} A R^{2/3} S_o^{1/2} \quad \text{but } R = \frac{A}{P} \quad \text{so}$$

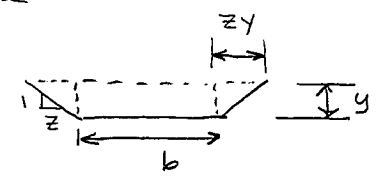
$$Q = \frac{K}{n} A^{5/3} P^{-2/3} S_o^{1/2} \quad \text{where}$$

$$A = by + 2\left(\frac{1}{2}zy \cdot y\right)$$

$$= y(b + zy)$$

$$P = b + 2\sqrt{y^2 + (zy)^2}$$

$$= b + 2y\sqrt{1 + z^2}$$



$$\Rightarrow Q = \frac{K}{n} [y(b + zy)]^{5/3} [b + 2y\sqrt{1 + z^2}]^{-2/3} S_o^{1/2}$$

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4. use all known values and simplify as much as possible:

$$Q = 10 \text{ m}^3/\text{s}$$

$$K = 1.0 \quad (\text{SI})$$

$$n = 0.03 \quad (\text{Table 10.1})$$

$$b = 3.66 \text{ m}$$

$$Z = 1.19$$

$$S_0 = 0.0014$$

$$\Rightarrow 10 = \frac{1}{0.03} \left[y (3.66 + 1.19y) \right]^{5/3} \left[3.66 + 2y \sqrt{1 + (1.19)^2} \right]^{-2/3} (0.0014)^{1/2}$$

$$8.02 = \left[y (3.66 + 1.19y) \right]^{5/3} \left[3.66 + 3.10y \right]^{-2/3}$$

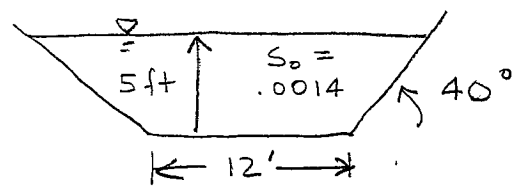
5. solve by trial-and-error or some solver:

y, m	1	2	1.5	1.49
right-hand side	3.88	13.83	8.07	7.97

↑
OK

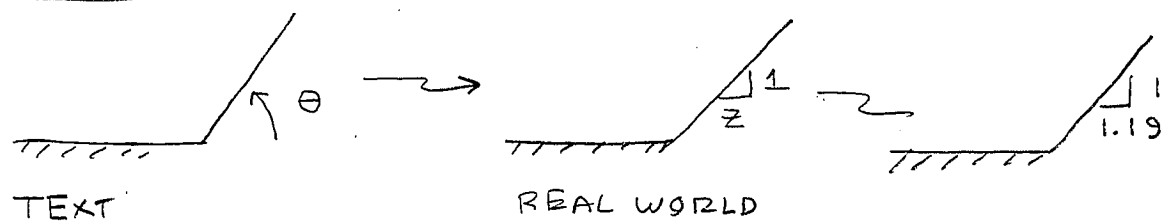
EXAMPLE 10.2 and more

GIVEN: canal as shown with
 (a) smooth concrete
 (b) weeds on perimeter



FIND: Q and Fr for each case

SOLUTION:

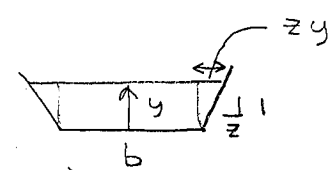


$$\tan \theta = \frac{1}{z} \Rightarrow \tan^{-1} \frac{1}{z} = \theta \Rightarrow z = \frac{1}{\tan \theta} = 1.19$$

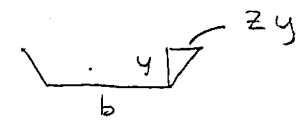
Table 10.1: $z_{con} = 0.012$; $n_{weeds} = 0.030$

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \quad \text{where}$$

$$A = by + \frac{1}{2} (2zy^2) = y(b + zy) = 5(12 + 1.19 \cdot 5) = 89.8 \text{ ft}^2$$



$$P = b + 2\sqrt{y^2 + (zy)^2} = b + 2y\sqrt{1 + z^2} = 12 + 2(5)\sqrt{1 + 1.19^2} = 27.5 \text{ ft}$$



$$R = A/P = 89.8 \text{ ft}^2 / 27.5 \text{ ft} = 3.26 \text{ ft}$$

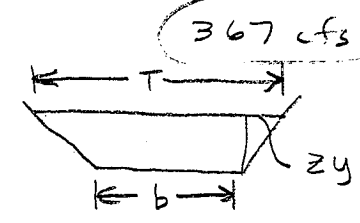
$$Q_{con} = \frac{1.49}{0.012} (89.8 \text{ ft}^2) (3.26 \text{ ft})^{2/3} (0.0014)^{1/2} = 917 \text{ cfs}$$

$$Q_{weed} = 917 \text{ cfs} \times \left(\frac{0.012}{0.03} \right) = 367 \text{ cfs}$$

$$Fr = \frac{V}{\sqrt{gD}}$$

where $D = A/T$,

$$T = b + 2zy = 12 \text{ ft} + (2)(1.19)(5 \text{ ft}) = 23.9 \text{ ft}$$



$$D = 89.8 \text{ ft}^2 / 23.9 \text{ ft} = 3.75 \text{ ft}$$

note: text incorrectly uses y

$$V_{\text{concrete}} = \frac{Q_{\text{concrete}}}{A} = \frac{917 \text{ ft}^3/\text{s}}{89.8 \text{ ft}^2} = 10.2 \text{ ft/s}$$

$$V_{\text{weed}} = \frac{Q_{\text{weed}}}{A} = \frac{367 \text{ ft}^3/\text{s}}{89.8 \text{ ft}^2} = 4.09 \text{ ft/s}$$

$$Fr_{\text{concrete}} = \frac{V_{\text{concrete}}}{\sqrt{gD}} = \frac{10.2 \text{ ft/s}}{\sqrt{32.2 \frac{\text{ft}}{\text{s}^2} \times 3.75 \text{ ft}}} = 0.93$$

$$Fr_{\text{weeds}} = \frac{V_{\text{weeds}}}{\sqrt{gD}} = \frac{4.09 \text{ ft/s}}{\sqrt{32.2 \frac{\text{ft}}{\text{s}^2} \times 3.75 \text{ ft}}} = 0.37$$