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For the exclusive use of adopters of the book Water-Resources Engineering, Second Edition,
3.31. Flow in a rectangular open channel is choked when

$$
\begin{aligned}
E_{1} & =E_{2}+\Delta z_{c} \\
y_{1}+\frac{V_{1}^{2}}{2 g} & =\frac{3}{2} y_{c}+\Delta z_{c} \\
y_{1}+\frac{V_{1}^{2}}{2 g} & =\frac{3}{2}\left(\frac{q^{2}}{g}\right)^{1 / 3}+\Delta z_{c} \\
y_{1}+\frac{V_{1}^{2}}{2 g} & =\frac{3}{2}\left(\frac{Q^{2}}{g b^{2}}\right)^{1 / 3}+\Delta z_{c} \\
y_{1}+\frac{V_{1}^{2}}{2 g} & =\frac{3}{2}\left[\frac{\left(V_{1} b y_{1}\right)^{2}}{g b^{2}}\right]^{1 / 3}+\Delta z_{c} \\
y_{1}+\frac{V_{1}^{2}}{2 g} & =\frac{3}{2} \frac{\left(V_{1}^{2 / 3} y_{1}^{2 / 3}\right)}{g^{1 / 3}}+\Delta z_{c}
\end{aligned}
$$

Dividing by $y_{1}$ yields

$$
\begin{equation*}
1+\frac{V_{1}^{2}}{2 g y_{1}}=\frac{3}{2}\left(\frac{V_{1}^{2}}{g y_{1}}\right)^{1 / 3}+\frac{\Delta z_{c}}{y_{1}} \tag{1}
\end{equation*}
$$

and defining

$$
\operatorname{Fr}_{1}=\frac{V_{1}}{\sqrt{g y_{1}}}
$$

then Equation 1 can be written as

$$
\frac{\Delta z_{c}}{y_{1}}=1+\frac{\mathrm{Fr}_{1}^{2}}{2}-\frac{3}{2} \mathrm{Fr}_{1}^{2 / 3}
$$

From Problem 3.30: $b=3 \mathrm{~m}, Q=4 \mathrm{~m}^{3} / \mathrm{s}, y_{1}=1.5 \mathrm{~m}$, and $\Delta z_{c}=0.15 \mathrm{~m}$. Therefore

$$
\begin{aligned}
V_{1} & =\frac{Q}{b y_{1}}=\frac{4}{(3)(1.5)}=0.889 \mathrm{~m} / \mathrm{s} \\
\operatorname{Fr}_{1} & =\frac{V_{1}}{\sqrt{g y_{1}}}=\frac{0.889}{\sqrt{(9.81)(1.5)}}=0.232
\end{aligned}
$$

which yields

$$
\begin{aligned}
\frac{\Delta z_{c}}{y_{1}} & =1+\frac{\operatorname{Fr}_{1}^{2}}{2}-\frac{3}{2} \operatorname{Fr}_{1}^{2 / 3} \\
\frac{\Delta z_{c}}{1.5} & =1+\frac{(0.232)^{2}}{2}-\frac{3}{2}(0.232)^{2 / 3}
\end{aligned}
$$

and solving for $\Delta z_{c}$ gives

$$
\Delta z_{c}=0.69 \mathrm{~m}
$$

