A tidal estuary is to be modeled at 1/300 scale. In the actual estuary, the maximum water velocity is expected to be 4 m/s and the tidal period is approximately 12.5h. What corresponding velocity and period would be observed in the model?

Solution: Fr similarity

$$F_{rm} = F_{rp}$$

$$\left(\frac{V}{\sqrt{gL}}\right)_m = \left(\frac{V}{\sqrt{gL}}\right)_p \quad \text{since } g_m = g_p$$

$$\frac{V_m}{V_p} = \left(\frac{L_m}{L_p}\right)^{1/2}$$

$$\frac{(L_m/t_m)}{(L_p/t_p)} = \left(\frac{L_m}{L_p}\right)^{1/2} \quad \text{or} \quad \frac{t_m}{t_p} = \left(\frac{L_m}{L_p}\right)^{1/2}$$

$$V_m = V_p\left(\frac{L_m}{L_p}\right)^{1/2} = 4 \times (1/300)^{1/2} = 0.231 \text{ m/s}$$

$$t_m = 12.5 \times (1/300)^{1/2} = 0.722 \text{ hr} = 43.3 \text{ min}$$

8.65 **Information and Assumptions**

provided in problem statement

Find

velocity and period observed in the model

Solution

Froude number applies:

$$F_m = F_p$$

or

$$\begin{aligned} (V/\sqrt{gL})_m &= (V/\sqrt{gL})_p \\ V_m/V_p &= (L_m/L_p)^{1/2} \end{aligned} \tag{1}$$

because $g_m = g_p$. Then

$$(L_m/t_m)/(L_p/t_p) = (L_m/L_p)^{1/2}$$

or

$$t_m/t_p = (L_m/L_p)^{1/2} \tag{2}$$

Then from Eq. (1)

$$V_m = V_p(L_m/L_p)^{1/2} = 4.0 \times (1/300)^{1/2} = \underline{\underline{0.231 \text{ m/s}}}$$

From Eq. (2)

$$t_m = 12.5hr(1/300)^{1/2} = 0.722\,\text{hr} = \underline{\underline{43.3 \text{ min}}}$$