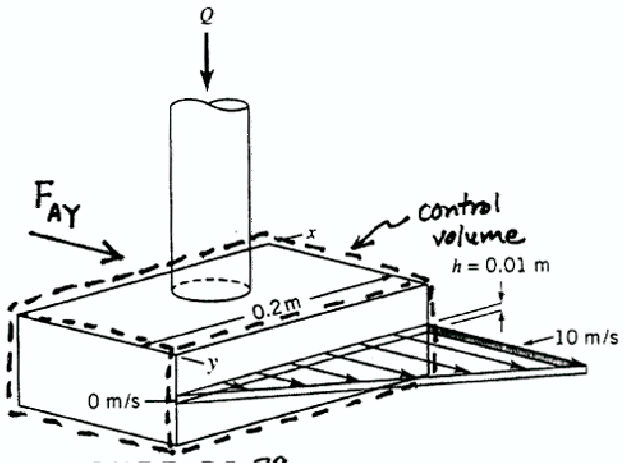
5.39

5.39 A sheet of water of uniform thickness (h = 0.01 m) flows from the device shown in Fig. P5.39. The water enters vertically through the inlet pipe and exits horizontally with a speed that varies linearly from 0 to 10 m/s along the 0.2 m length of the slit. Determine the y component of anchoring force necessary to hold this device stationary.



■ FIGURE P5.39

A control volume that contains the box portion of the device and the water in the box as shown in the sketch above is used. Application of the y-direction component of the linear momentum equation yields

$$F_{AY} = \int_{A_{slit}} v\,\rho\,\vec{V}\cdot\hat{n}\,dA = \rho\int_0^{0.2} v^2\,h\,dx$$

The variation of v with x is linear or

$$v = 50x \ \frac{m}{s}$$

Thus

$$F_{AY} = \rho\int_0^{0.2}(50x)^2 h\,dx = \rho\,(50)^2\,h\,\frac{x^3}{3}\Big|_0^{0.2}$$

or

$$F_{AY} = \left(999\ \frac{kg}{m^3}\right)\left(50\ \frac{1}{s}\right)^2(0.01m)\ \frac{(0.2\,m)^3}{3}\left(1\ \frac{N.s^2}{kg.m}\right)$$

and

$$F_{AY} = \underline{\underline{66.6\,N}}$$