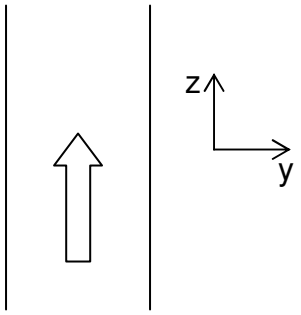
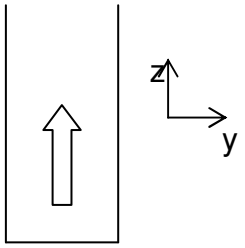
Comp Exam, Example 2
CE200A

Consider flow in an urban street canyon that is driven by heating from below. We will model the canyon as a uniform width, vertical slot (i.e. flow is two-dimensional with vertical velocity varying in only one lateral direction, $w = w(y)$).



(1) Suppose that the vertical forcing of the flow can be described by a uniform vertical pressure gradient, $dp/dz = -1.5\,\rho\, g$. For this case, simplify the govern equations and justify your assumptions.
(2) If flow is turbulent, describe how you would specify a turbulent viscosity and, using an average value, calculate the flow variability, $w(y)$.
(3) Obviously, the assumption of a uniform pressure gradient will not hold since the bottom of the canyon is closed (figure below). Considering mass conservation, describe the implications for the variation of the vertical flow.



General form of governing equations (fixed reference frame, index notation):

$$\frac{\partial \rho}{\partial t} + \rho \frac{\partial u_j}{\partial x_j} = 0$$

$$\frac{\partial u_i}{\partial t} + u_j \frac{\partial u_i}{\partial x_j} = -\frac{1}{\rho}\frac{\partial p}{\partial x_i} - g_i + \nu \frac{\partial^2 u_i}{\partial x_j \partial x_j}$$