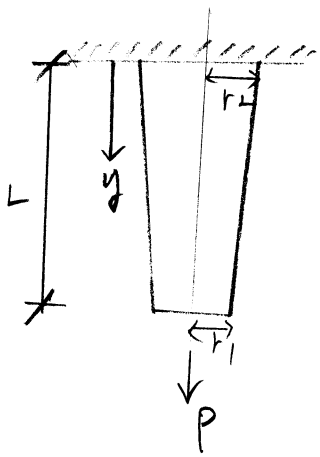
4-28



$$r(y) = r_1 + \frac{r_2 - r_1}{L} \cdot y = \frac{L r_1 + (r_2 - r_1) y}{L}$$

$$A(y) = \pi r(y)^2 = \frac{\pi}{L^2}\left[L r_1 + (r_2 - r_1) y\right]^2$$

$$\delta = \int_0^L \frac{P(y)\,dy}{A(y)\,E} = \frac{PL^2}{\pi E} \int_0^L \frac{dy}{\left[L r_1 + (r_2 - r_1) y\right]^2}$$

$$= -\frac{PL^2}{\pi E}\left[\frac{1}{(r_2 - r_1)\left[r_1 L + (r_2 - r_1) y\right]}\right]_0^L$$

$$= \frac{-PL^2}{\pi E (r_2 - r_1)}\left[\frac{1}{r_2 \cdot L} - \frac{1}{r_1 L}\right]$$

$$= \frac{-PL^2}{\pi E (r_2 - r_1)} \cdot \frac{(r_1 - r_2)}{r_1 \cdot r_2 L}$$

$$= \frac{PL}{\pi E\, r_1 \cdot r_2}$$

4-32

$$A(x) = \pi\left(\frac{0.1}{x+1}\right)^2$$

$$\delta = \int_0^L \frac{P\,dx}{A(x) \cdot E(x)}$$

$$= P \int_0^L \frac{dx}{\pi\left(\frac{0.1}{x+1}\right)^2 (125)(10^6)(x+1)}$$

$$= \frac{4 \times 10^3}{\pi (0.1^2)(125)(10^6)} \int_0^3 (x+1)\,dx$$

$$= 0.001639 \text{ (m)}$$

$$= 1.64 \text{ (mm)}$$