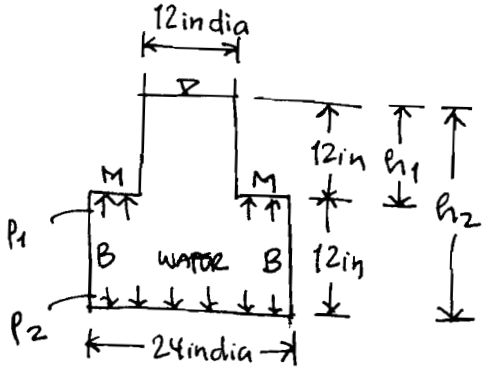
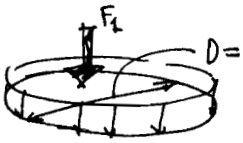
3.7.16. Figure X3.7.16 shows a cylindrical tank with 0.25-in-thick walls, containing water.



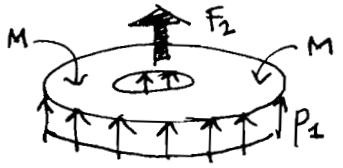
(a) What is the force on the bottom? SOL: For a horizontal plate, $F = pA_2 = \gamma h_2 A_2$. With $\gamma = 62.4\ lb/ft^3$, $h_2 = 24in = 2ft$ and $A_2 = \pi D^2/4$,



The force is $F = \gamma h_2 \pi D^2/4$,

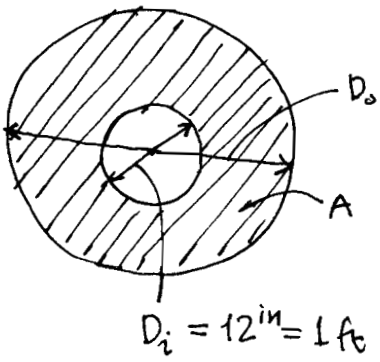
i.e., $F_2 = (62.4\frac{lb}{ft^3})(2\,ft)\cdot\pi\cdot(2\,ft)^2/4 = 392.07\ lb.$

(b) What is the force on the annular surface MM? $h_1 = 12^{in} = 1\,ft$



Since MM is a horizontal surface, the pressure on it is constant $p_1 = \gamma h_1$. The area of the annular surface is:

$$A_1 = \frac{\pi D_o^2}{4} - \frac{\pi D_i^2}{4} = \frac{\pi}{4}(D_o^2 - D_i^2)$$



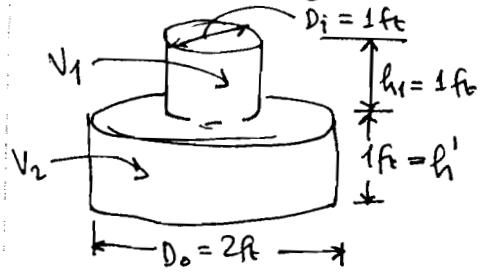
Thus, the force on MM is

$$F_1 = p_1 A_1 = \gamma h_1 \frac{\pi}{4}(D_o^2 - D_i^2)$$

$$= (62.4\frac{lb}{ft^3})(1\,ft)\cdot\frac{\pi}{4}\cdot((2ft)^2 - (1ft)^2)$$

$$= 147.03\ lb$$

(c) What is the weight of the water?



$$V = \frac{\pi D_i^2}{4} h_1 + \frac{\pi D_o^2}{4} h' = \frac{\pi}{4}(h_1 D_i^2 + h' D_o^2)$$

$$W = \gamma V = \frac{\pi\gamma}{4}(h_1 D_i^2 + h' D_o^2)$$

$$W = \frac{\pi}{4} \times (62.4\frac{lb}{ft^3})((1ft)(1ft)^2 + (1ft)(2ft)^2)$$

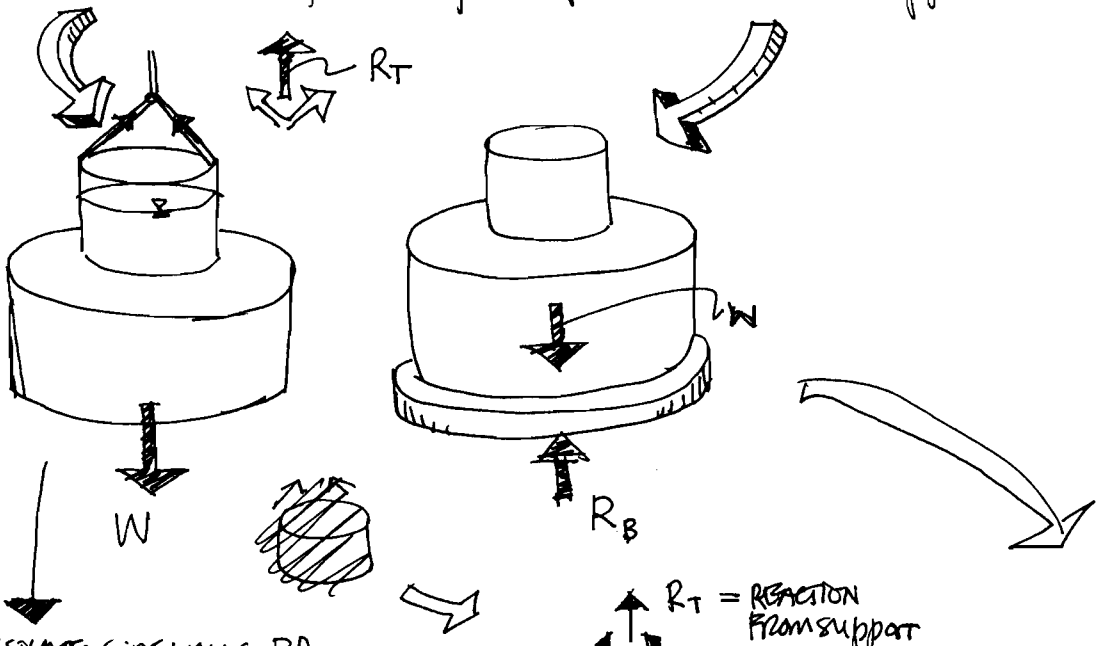
$$W = 245.04\ lb$$

NOTE: $W = F_1 - F_2$

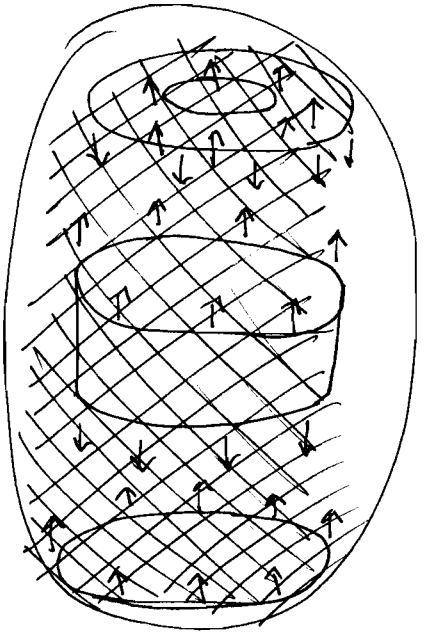
NOTE: NEGLECT WEIGHT OF TANK

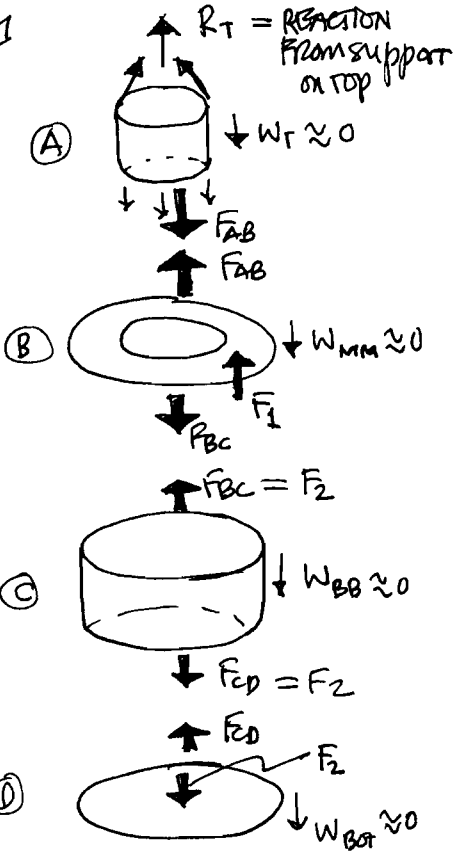
(d) Find the longitudinal (vertical) tensile stress in the sidewalls BB if

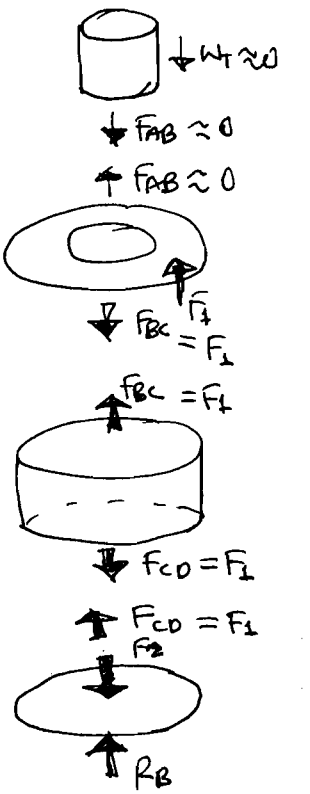
(d-a) the tank is suspended by the top (d-b) it is supported on the bottom.



ISOLATE SIDE WALLS BB







$F_{CD} = F_2$

$F_{BC} = F_{CD} = F_2$

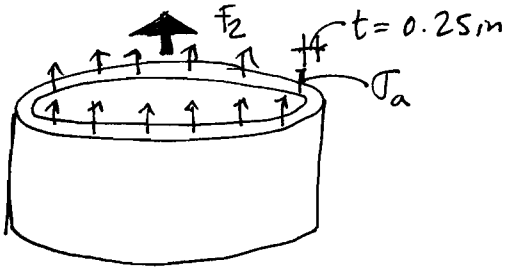
$-F_{BC} + F_1 + F_{AB} = 0 \Rightarrow F_{AB} = F_{BC} - F_1 = F_2 - F_1$

$R_T = F_{AB} = F_2 - F_1 = W$

$R_B = F_2 - F_1 = W$

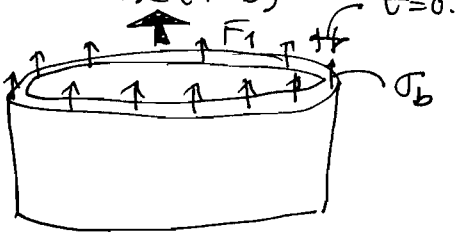
↑ REACTION from support at bottom

case (d-a)

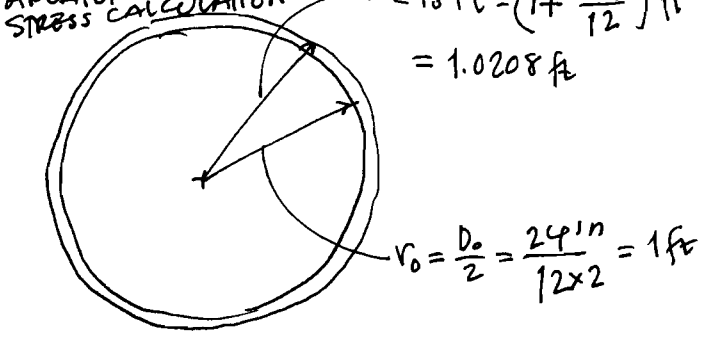


$F_2 = 392.07\,lb$

case (d-b)



$F_1 = 147.03\,lb$



$A' = \pi r'^2 - \pi r_o^2$

$= \pi(r'^2 - r_o^2)$

~~$= \pi(1.0208$~~

$= \pi(1.0208^2 - 1^2)$

$= 0.056784\,ft^2$

$$\sigma_a = \frac{F_2}{A'} = \frac{392.07\,lb}{0.056784\,ft^2} = 6904.6\,\frac{lb}{ft^2} = \frac{6904.6}{144}\,\frac{lb}{in^2} = 47.95\,psi$$

$$\sigma_b = \frac{F_1}{A'} = \frac{147.03\,lb}{0.056784\,ft^2} = 2589.28\,\frac{lb}{ft^2} = \frac{2589.28}{144}\,\frac{lb}{in^2} = 17.98\,psi$$