

Loads

Weight of the shell:

$$\sim (1.346 + 1.209 + 1.071 + 0.937 + 0.800 + 0.661 + 0.524 + 0.390 + 0.350 + 0.350)$$

$$\frac{1}{12} \cdot \frac{92.88}{12} \cdot \pi \cdot 174 \cdot 500 = 1,345,824 \text{ lb}$$

Roof weight: (see 4.1)

$$866 + 823 + 25 + 167 + 883 = 2764 \text{ kN} = 621,400 \text{ lb}$$

Live Loads: (see 4.1)

pressure: $+1126 \text{ kN} = 253,150 \text{ lb}$

$-15,235 \text{ kN} = 3,425,150 \text{ lb}$

Live Load: $2650 \text{ kN} = 596,000 \text{ lb}$

2.2 Design Condition

2.2.1 First Course

$$T_1 = \left(\frac{Rc}{2} \right) \left(P + \frac{W + F}{A_t} \right)$$

$$T_2 = P \cdot Rc$$

$$P = \text{total pressure} \\ = P_1 + P_g$$

$$P_1 = \text{pressure from the liquid} = 88 \cdot 42.56 = 3,745 \text{ lb/ft}^2 \\ = 26.0 \text{ lb/in}^2$$

$$P_g = \text{gas pressure} = 1.0 \text{ lb/in}^2$$

$$P = 26.0 + 1.0 = 27.0 \text{ lb/in}^2$$

$$Rc = \text{Radius of the tank} = 1,044 \text{ in}$$

$$W = \text{total weight of tank} = W_s + W_r + W_{\text{live loads}}$$

$$W_s = 1,346,000$$

$$W_r = 621,400$$

$$\text{max } W_l = 253,150 + 596,000 = +849,150 \text{ lb}$$

$$\text{min } W_l = -3,425,150 \text{ lb}$$

$$\text{max } W_{\text{compr}} = 1,346,000 + 621,400 + 849,150 = 2,816,550 \text{ lb}$$

$$\text{min } W_{\text{tension}} = 1,346,000 + 621,400 - 3,425,150 = -1,457,750 \text{ lb}$$

$$F = \text{summation, in pounds, of the vertical components of the forces} = 0$$

$$A_T = \text{cross sectional of the interia of the tank}$$

$$= \pi \cdot \left(\frac{174.12}{4} \right)^2 = 3,422,400 \text{ in}^2$$

$$T_1 = \frac{1044}{2} \cdot \left(27.0 + \frac{1,457,750}{3,422,400} \right) = 14,316 \text{ lb/in}$$

$$T_2 = P \cdot R_c \\ = 27 \cdot 1044 = 28,188 \text{ lb/in}$$

$$t_1 = \frac{I_1}{S_{xx} \cdot E} + c = \frac{14,316}{21,000 \cdot 1.0} = 0.682 \text{ [in]}$$

$$t_2 = \frac{I_2}{S_{xx} \cdot E} + c = \frac{28,188}{21,000 \cdot 1.0} = 1.343 \text{ [in]}$$

Selected : $t = 34.2 \text{ mm} = 1.346 \text{ in}$

Course 2:

T_2 is determined

$$T_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 9.288) \cdot 42.58$$

$$= 3352 \text{ lb/ft}^2 = 23.27 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 23.27 + 1.0 = 24.27 \text{ lb/in}^2$$

$$T_2 = 24.27 \cdot 1044 = 25,343 \text{ lb/in}$$

$$t_2 = \frac{T_2}{S_u \cdot t} + c$$

$$= \frac{25,343}{21,000 \cdot 10} + 0 = 1.207 \text{ in}$$

Selected: $t_2 = 30.7 \text{ mm} = 1.209 \text{ in}$

Course 3:

T_2 is determined

$$T_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 2 \cdot 9.288) \cdot 42.58$$

$$= 2956 \text{ lb/ft}^2 = 20.53 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 20.53 + 1.0 = 21.53 \text{ lb/in}^2$$

$$T_2 = 21.53 \cdot 1044 = 22,477 \text{ lb/in}$$

$$t_2 = \frac{T_2}{S_u \cdot t} + c$$

$$= \frac{22,477}{21,000 \cdot 10} + 0 = 1.07 \text{ in}$$

Selected: $t_2 = 27.2 \text{ mm} = 1.071 \text{ in}$

Course 4:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 3 \cdot 9.288) \cdot 42.58$$

$$= 2560.59 \text{ lb/ft}^2 = 17.78 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 17.78 + 1.0 = 18.78 \text{ lb/in}^2$$

$$I_2 = 18.78 \cdot 1044 = 19,608 \text{ lb/in}$$

$$t_2 = \frac{I_2}{S_{ts} \cdot t} + c$$

$$= \frac{19,608}{21,000 \cdot 1.0} + 0 = 0.934 \text{ in}$$

Selected: $t_2 = 23.8 \text{ mm} = 0.934 \text{ in}$

Course 5:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 4 \cdot 9.288) \cdot 42.58$$

$$= 2165 \text{ lb/ft}^2 = 15.035 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 15.035 + 1.0 = 16.035 \text{ lb/in}^2$$

$$I_2 = 16.035 \cdot 1044 = 16,741.032 \text{ lb/in}$$

$$t_2 = \frac{I_2}{S_{ts} \cdot t} + c$$

$$= \frac{16,741.032}{21,000 \cdot 1.0} + 0 = 0.799 \text{ in}$$

Selected: $t_2 = 20.3 \text{ mm} = 0.799 \text{ in}$

Course 6:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 5 \cdot 9.288) \cdot 42.58$$

$$= 1769.62 \text{ lb/ft}^2 = 12.29 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 12.29 + 1.0 = 13.29 \text{ lb/in}^2$$

$$I_2 = 13.29 \cdot 1044 = 13.873 \text{ lb/in}$$

$$t_2 = \frac{I_2}{S_{xx} \cdot t} + c$$

$$= \frac{13.873}{21,000 \cdot 1.0} + 0 = 0.661 \text{ in}$$

Selected: $t_2 = 16.8 \text{ mm} = 0.661 \text{ in}$

Course 7:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$P_1 = (88 - 6 \cdot 9.288) \cdot 42.58$$

$$= 1374 \text{ lb/ft}^2 = 9.543 \text{ lb/in}^2$$

$$P_g = 1.0 \text{ lb/in}^2$$

$$P = 9.543 + 1.0 = 10.543 \text{ lb/in}^2$$

$$I_2 = 10.543 \cdot 1044 = 11,006 \text{ lb/in}$$

$$t_2 = \frac{I_2}{S_{xx} \cdot t} + c$$

$$= \frac{11,006}{21,000 \cdot 1.0} + 0 = 0.524 \text{ in}$$

Selected: $t_2 = 13.3 \text{ mm} = 0.523 \text{ in}$

Course 8:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$\begin{aligned} P_1 &= (88 - 7 \cdot 9.288) \cdot 42.58 \\ &= 978 \text{ lb/ft}^2 = 6.796 \text{ lb/in}^2 \\ P_g &= 1.0 \text{ lb/in}^2 \end{aligned}$$

$$P = 6.796 + 1.0 = 7.796 \text{ lb/in}^2$$

$$I_2 = 7.796 \cdot 1044 = 8.139 \text{ lb/in}$$

$$\begin{aligned} t_2 &= \frac{I_2}{S_{rx} \cdot t} + c \\ &= \frac{8.139}{21,000 \cdot 1.0} + 0 = 0.388 \text{ in} \end{aligned}$$

Selected: $t_2 = 9.9 \text{ mm} = 0.390 \text{ in}$

Course 9 / 10:

I_2 is determined

$$I_2 = P \cdot R_c$$

$$P = P_1 + P_g$$

$$\begin{aligned} P_1 &= (88 - 9 \cdot 9.288) \cdot 42.58 \\ &= 583 \text{ lb/ft}^2 = 4.05 \text{ lb/in}^2 \\ P_g &= 1.0 \text{ lb/in}^2 \end{aligned}$$

$$P = 4.05 + 1.0 = 5.05 \text{ lb/in}^2$$

$$I_2 = 5.05 \cdot 1044 = 5.272 \text{ lb/in}$$

$$\begin{aligned} t_2 &= \frac{I_2}{S_{rx} \cdot t} + c \\ &= \frac{5.272}{21,000 \cdot 1.0} + 0 = 0.251 \text{ in} \end{aligned}$$

min $t = 350 \text{ [in]}$

Selected: $t_2 = 8.9 \text{ mm} = 0.350 \text{ in}$

2.3 Test Condition

First Course

$$t_{pt} = \frac{2.6 \cdot D \cdot (H-1) \cdot G}{S_t}$$

$$S_t = 30,000 \text{ lb/in}^2$$

$$G = 1.0$$

$$H = 88 \text{ ft}$$

$$D = 174 \text{ ft}$$

$$t_{pt} = \frac{2.6 \cdot 174 \cdot (88-1) \cdot 1.0}{30,000}$$

$$= 1.312 \text{ [in]}$$

$$< t_t = 1.346 \text{ [in]}$$

⇒ Design conditions are determined
Also for course 2 to 10