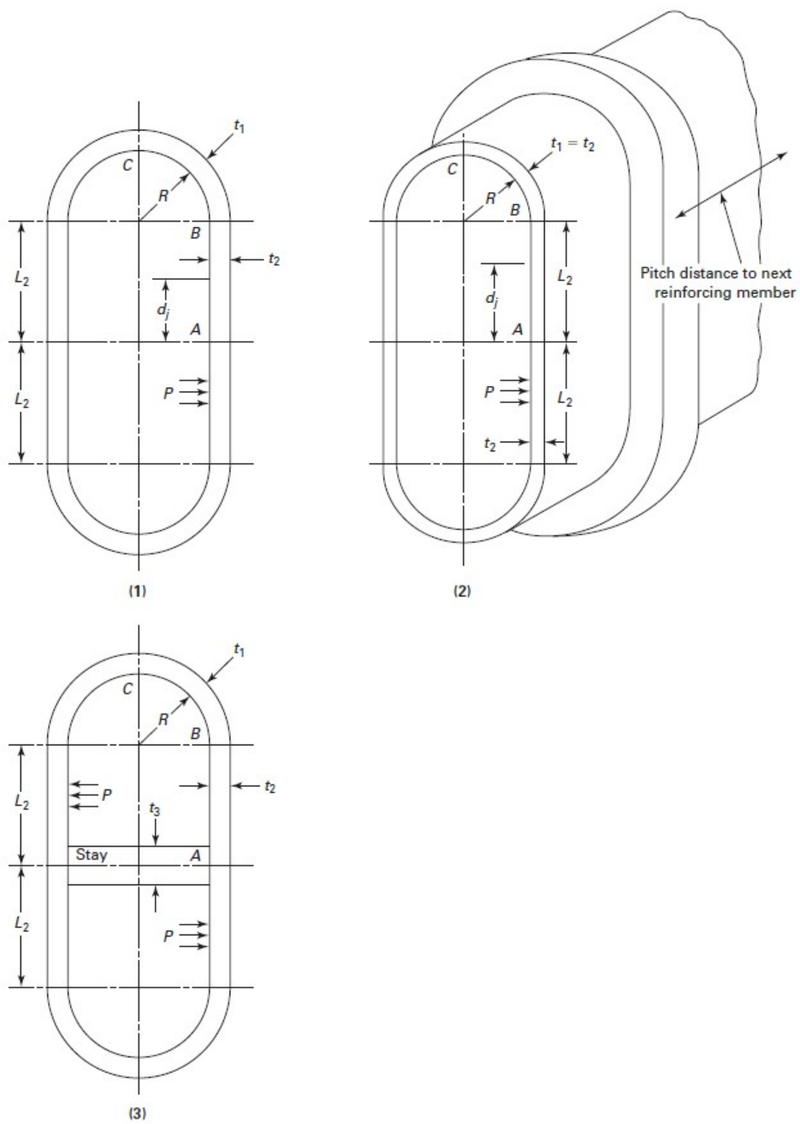
Figure 13-2(b)
Vessels of Obround Cross Section



GENERAL NOTES:

(a) See UW-13 for corner joints.

(b) See UG-47, UG-48, UG-49, and UW-19 for stay bars.

(c) See 13-8 for weld efficiency calculations.

13-10 UNREINFORCED VESSELS HAVING AN OBROUND CROSS SECTION [FIGURE 13-2(B), SKETCH (1)]

For the equations in these paragraphs, the moments of inertia are calculated on a per-unit-width basis. That is, $I = bt^3/12$, where $b = 1.0$. See 13-4(k).

(a) Membrane Stress

Semicylindrical sections:

$$(S_m)_B = PR/t_1 \tag{1}$$

$$(S_m)_C = P(R + L_2)/t_1 \tag{2}$$

Side plates:

$$S_m = PR/t_2 \tag{3}$$

(b) Bending Stress

Semicylindrical sections:

$$(S_b)_B = \frac{PL_2c}{6I_1}\left[3L_2 - C_1/A\right] \tag{4}$$

$$(S_b)_C = \frac{PL_2c}{6I_1}\left[3(L_2 + 2R) - C_1/A\right] \tag{5}$$

Side plates:

$$(S_b)_A = PL_2C_1c/6AI_2 \tag{6}$$

$$(S_b)_B = \frac{PL_2c}{6I_2}\left[3L_2 - C_1/A\right] \tag{7}$$

(c) Total Stress

Semicylindrical sections:

$$(S_T)_B = \text{eq.}(1) + \text{eq.}(4) \tag{8}$$

$$(S_T)_C = \text{eq.}(2) + \text{eq.}(5) \tag{9}$$

Side plates:

$$(S_T)_A = \text{eq.}(3) + \text{eq.}(6) \tag{10}$$

$$(S_T)_B = \text{eq.}(3) + \text{eq.}(7) \tag{11}$$

For the equations in these paragraphs, the moments of inertia are calculated on a per-unit-width basis. That is, $I = bt^3/12$, where $b = 1.0$. See 13-4(k).

(a) Membrane Stress

Semicylindrical sections:

$$(S_m)_B = PR/t_1 \quad (1)$$

$$(S_m)_C = P(R + L_2)/t_1 \quad (2)$$

Side plates:

$$S_m = PR/t_2 \quad (3)$$

Figure 3-2(b) Sketch 1
Section 13-10

P = internal design pressure (see UG-21) $P := 250\ psi$

t_1 = thickness of short-side plates of vessel $t_1 := 1.375\ in$

R = inside radius $R := 9.625\ in$

<u>Semicylindrical Sections</u>

$$S_{mb} := \frac{(P \cdot R)}{t_1} = 1750\ psi \qquad (1)$$

$L_2 := 10.25\ in$

$$S_{mc} := \frac{P \cdot (R + L_2)}{t_1} = 3613.636\ psi \qquad (2)$$

<u>Side Plates</u>

$t_2 := 1.375\ in$

$$S_m := \frac{(P \cdot R)}{t_2} = 1750\ psi \qquad (3)$$

S_m = membrane stress

(b) Bending Stress

Semicylindrical sections:

$$[S_b]_B = \frac{PL_2c}{6I_1}(3L_2 - C_1/A) \quad (4)$$

$$[S_b]_C = \frac{PL_2c}{6I_1}[3(L_2 + 2R) - C_1/A] \quad (5)$$

Side plates:

$$[S_b]_A = PL_2C_1c/6AI_2 \quad (6)$$

$$[S_b]_B = \frac{PL_2c}{6I_2}(3L_2 - C_1/A) \quad (7)$$

c_i = distance from neutral axis of cross section of plate, composite section, or section with multidiameter holes (see 2-12) to the inside surface of the vessel. Sign is always positive (+).

c_o = distance from neutral axis of cross section of plate, composite section, or section with multidiameter holes (see 2-12) to the extreme outside surface of the section. Sign is always negative (−).

c = distance from neutral axis of cross section to extreme fibers (see c_i and c_o). The appropriate c_i or c_o value shall be substituted for the c term in the stress equations.

$$c_i := \frac{t_1}{2} = 0.688\ in \qquad c_o := -\frac{t_2}{2} = -0.688\ in$$

$$b := 1.0$$

$$I_1 := \frac{(b \cdot t_1^{3})}{12} = 0.217\ in^3 \qquad I_2 := \frac{(b \cdot t_2^{3})}{12} = 0.217\ in^3$$

$\gamma = L_2/R$ $\qquad \gamma := \frac{L_2}{R} = 1.065$

$\alpha_2 = I_2/I_1$ $\qquad \alpha_2 := \frac{I_2}{I_1} = 1$

$C_1 = R^2(2\gamma^2 + 3\gamma\pi\alpha_2 + 12\alpha_2)$ $\qquad C_1 := R^2 \cdot (2\ \gamma^2 + 3\ \gamma \cdot \pi \cdot \alpha_2 + 12\ \alpha_2) = 2251.626\ in^2$

$A = R(2\gamma + \pi\alpha_2)$ $\qquad A := R \cdot (2\ \gamma + \pi \cdot \alpha_2) = 50.738\ in$

$$S_{bB} := \frac{P \cdot L_2 \cdot c_i}{6 \cdot I_1} \cdot \left(3 \cdot L_2 - \frac{C_1}{A}\right) = -18470.537 \ psi \quad (4)$$

$$S_{bC} := \frac{P \cdot L_2 \cdot c_i}{6 \cdot I_1} \cdot \left(3 \cdot \left(L_2 + 2\ R\right) - \frac{C_1}{A}\right) = 59802.19 \ psi \quad (5)$$

Side Plates:

$$S_{bA} := \frac{P \cdot L_2 \cdot C_1 \cdot c_i}{6\ A \cdot I_2} = 60148.223 \ psi \quad (6)$$

$$S_{bB2} := \frac{P \cdot L_2 \cdot c_i}{6 \cdot I_2} \cdot \left(3 \cdot L_2 - \frac{C_1}{A}\right) = -18470.537 \ psi \quad (7)$$

(c) Total Stress

Semicylindrical sections:

$$(S_T)_B = \text{eq.}(1) + \text{eq.}(4) \quad (8)$$

$$(S_T)_C = \text{eq.}(2) + \text{eq.}(5) \quad (9)$$

Side plates:

$$(S_T)_A = \text{eq.}(3) + \text{eq.}(6) \quad (10)$$

$$(S_T)_B = \text{eq.}(3) + \text{eq.}(7) \quad (11)$$

$$S_{TB} := S_{mb} + S_{bB} = -16720.537 \ psi \quad (8)$$

$$S_{TC} := S_{mc} + S_{bC} = 63415.827 \ psi \quad (9)$$

$$S_{TA} := S_m + S_{bA} = 61898.223 \ psi \quad (10)$$

$$S_{TB2} := S_m + S_{bB2} = -16720.537 \ psi \quad (11)$$

Maximum Allowable Stress for SA516G70 = 20000 psi