\[ S_{\text{shot}} = \text{total stress in tank shell at bottom} = S_{\text{mbot}} + S_{\text{sho}} \]
\[ S_{\text{sise}} = \text{total stress in tank shell at side} = S_{\text{mside}} + S_{\text{sside}} \]
\[ t_b = \text{baffle thickness less corrosion allowance} \]
\[ t_h = \text{head thickness less corrosion allowance} \]
\[ t_s = \text{tank shell thickness less corrosion allowance} \]
\[ X = \text{neutral axis distance from shell where shell is in tension} \]
\[ x = \text{neutral axis distance from shell where shell is in compression} \]
\[ Z_{1b} = \text{section modulus of baffle where shell is in tension} \]
\[ Z_{1s} = \text{section modulus of shell where shell is in tension} \]
\[ Z_{2b} = \text{section modulus of baffle where shell is in compression} \]
\[ Z_{2s} = \text{section modulus of shell where shell is in compression} \]

(c) **Design Pressure.** For cylindrical tanks and heads for cylindrical transport tanks, the internal pressure design equations shall be those of such tanks subject to pressures over 15 psi as noted in Articles TD-3 and TD-5. For noncylindrical transport tanks, the pressure design equations shall be as specified in Figures VIII-2-1, VIII-2-2, and VIII-2-3 of this Appendix and will apply to loads tributary to the heads, bulkheads, stiffeners, or internal baffles installed in the tanks. The membrane stresses due to pressure are taken by the tank shell, and the bending moments are taken by a portion of the shell acting in conjunction with baffles, bulkheads, heads, and internal or external stiffeners to form a girder [see (d) below]. The longitudinal stresses due to internal pressure and bending between supports in noncylindrical tanks are assumed to be membrane stresses alone. The design pressure for the tank shall be the MAWP plus the static head at the bottom of the tank. The hydrostatic test pressure for the tank shall be 1.50 times the design pressure. The maximum spacing of heads, bulkheads, stiffeners, and baffles for any noncylindrical tank shall not exceed 1,500 mm (60 in.). The following weld joint efficiencies shall be permitted:

(1) For longitudinal shell welds within 6 times the shell thickness of calculated circumferential bending moment points, use 70% of the allowable weld design stress. For aluminum, the allowable design stress at welds is for the 0 temper.

(2) For circumferential welds, the lower of 70% or the 0 temper allowable stress shall be used. For noncylindrical vessels, the head stresses are as follows: in the short direction, \[ S_a = P/[t_h (1/L_a + L_a/L_{a2})] \], and in the long direction, \[ S_b = S_a L_a/L_{a2} \].

For heads of low pressure tanks, the knuckle radius shall be the greater of 12.7 mm (0.5 in.) or 3 times the nominal thickness of the plate from which the head was formed. Stuffed (inserted) heads and baffles are allowed and may be attached to shells with a suitable fillet weld. Notwithstanding the rules and procedures outlined above, the thicknesses of tank shells, heads, bulkheads, and baffles shall not be lower than indicated in the applicable modal appendix for the particular tank specification.

(d) **Shell and Stiffener Properties.** Shell and stiffener properties shall be determined by the following procedures and are illustrated in Figure VIII-2-4:

(1) A shell/baffle combination acts as a girder in effective tee section using an effective breadth beyond the stiffener of 20\(t_s\) on each side where the shell is in compression and 50\(t_s\) on each side where the shell is in tension. The effective baffle depth is given in Figure VIII-2-4 for where the baffle is in compression of tension.

(3) For membrane stresses use \(P_a t_s\) for top and bottom and \(P_m t_i\) for sides, both in tension.

(e) **Openings.** Openings in low pressure cylindrical transport tanks shall be reinforced as required for pressure tanks taking into consideration the lower pressures. Noncylindrical transport tanks shall have openings located preferably outside the effective shell width on each side of baffles, bulkheads, or stiffeners (stiffening elements) used in determining the section properties for circumferential tank wall stresses. The openings need not be reinforced unless the tributary membrane stress calculated by deducting the shell cut away by the opening from the shell tributary to the stiffening element exceeds the allowable stress for the shell material.

(f) **Special Design Details.** Pressure-retaining heads and bulkeads in low pressure transport tanks can be inserted into the tank shell and fillet welded from one side, and each such pressure-retaining part may have a formed flange providing a faying surface to the shell. The single fillet weld shall be made on the end of the formed flange. Heads, bulkheads, baffles, and non-pressure-retaining elements can be installed without formed flanges but such tanks shall require an annual inspection of the shell welds to them to verify their integrity if made from one side only. Circumferential shell welds in noncircular tanks with shell plates running longitudinally shall be staggered so that no more than one-third of the circumference of the tank contains a circumferential weld seam located within 8 times the thickness longitudinally of another circumferential weld seam. The one-third circumference containing a weld seam need not be continuous but may be made up of several sections spaced at least 100 times the shell thickness apart circumferentially.
located in areas where shell bending stresses are less than 50% of maximum, and welds made from one side shall be made so that side is the one subject to compressive flexural stresses. Forming of materials shall be done to avoid sharp blows, peening type deformations, and excessive work hardening of local areas. Knuckle inside radii shall be more than 3 times the original plate thickness before forming. Where heat-treated material is fabricated into tanks, the forming, assembly, and welding processes used shall be as required elsewhere in this Code for the particular materials used.

(c) Inspection Requirements. Low pressure transport tanks shall be considered as Class 3 vessels per TG-430 and are subject to inspection by manufacturers, tank owners, and inspection agencies to a level commensurate with the service expected of the tank and the public danger associated with the tank contents escaping or reacting with the outside atmosphere.

(d) Safety Devices. All low pressure transport tanks shall have relief devices to ensure that design pressures are not exceeded in the transport condition as well as in the loading and unloading conditions.