Agenda Item: 620-263

Title: **Joint Eff. Of Lap Welded Plates in Compression**

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Purpose: To clarify that the allowable compressive stresses of lap-welded joints loaded in compression are to include the joint efficiencies listed in Table 5-2.

Source: INQUIRY 620-I-10-02 (#11) Section 3.5, API Standard 620, 9th edition Feb. 1996 with addendum 1, December 1996, add. 2, December 1997, add. 3, December 1998

Revision: 0

Impact: The business impact is neutral

Rationale: The need to use weld joint efficiency for lap-welded plates in compression is already covered in para. 5.5.4.7 of the tenth edition of API Standard 620, but minor clarification of the paragraph would be helpful.

Proposal: see Attachment for details

Use of Joint efficiency with lap-welded joints in compression in various stress states is not clear. Unfortunately all examples in appendix F are for butt-welded cases except example F.3 which has not specified type of joint. Paragraphs 3.5.4.7 and note 2 of table 3-2 say that Joint efficiency should be applied to lap welded joints but the procedure is not clear through other parts of code.

Question 1: Should '(including note 3)' in paragraph 3.5.4.7 be read as '(including note 2)'?

RESPONSE: Yes

Question 2: To consider note 2 of table 3-2 on joint efficiency of lap-welded joints is it correct to read this sentence of paragraph 3.5.4.7
'… but the minimum compressive stress shall be subject to …'
as
'… but all compressive stresses shall be subject to …'?

Question 3: To consider note 2 of table 3-2 on joint efficiency of lap welded joints in paragraph 3.5.3.3 is it necessary to find N from fig. 3-1 based on Scc/E, and not Scc alone, where E is joint efficiency of lap welded joint in compression? If not, then please give the correct procedure of considering E for compression.

Question 4: To consider note 2 of table 3-2 on joint efficiency of lap welded joints in paragraphs 3.5.4.2 & 3.5.4.3 is it correct to multiply all formulas specified therein by joint efficiency of lap-welded joint in compression?

Question 5: To consider note 2 of table 3-2 on joint efficiency of lap welded joints in paragraph 3.5.4.4 is it necessary to multiply Scs by joint efficiency of lap-welded joint in compression?

Question 6: To consider note 2 of table 3-2 on joint efficiency of lap welded joints in paragraph 3.5.4.5 is it correct to multiply Sca by joint efficiency of lap-welded joint in compression?

For values of $(t - c)/R$ between 0.00667 and 0.0175,

$$S_{cs} = 10{,}150 + 277{,}400[(t - c)/R]$$

For values of $(t - c)/R$ greater than 0.0175,

$$S_{cs} = 15{,}000$$

5.5.4.3 If both the meridional and latitudinal unit forces, T_1 and T_2, are compressive and of equal magnitude, the computed compressive stress, s_{cc}, shall not exceed a value, s_{ca}, established for the applicable thickness-to-radius ratio as follows:

For values of $(t - c)/R$ less than 0.00667,

$$S_{ca} \quad ,000{,}000[(t - c)/R]$$

For values of $(t - c)/R$ between 0.00667 and 0.0175,

$$S_{ca} = 5650 + 154{,}200[(t - c)/R]$$

For values of $(t - c)/R$ greater than 0.0175,

$$S_{ca} = 8340$$

5.5.4.4 If both the meridional and latitudinal unit forces, T_1 and T_2, are compressive but of unequal magnitude, both the larger and smaller computed compressive stresses shall be limited to values that satisfy the following requirements:

$$(S_1 + 0.8S_s)/S_{cs} \le 1.0$$

$$.8S_s/S_{cs} \le 1.0$$

where

S_l = larger stress, in lbf/in.^{2},

S_s = small stress, in lbf/in.^{2},

S_{cs} = maximum allowable longitudinal compressive stress, in lbf/in.^{2}, determined as in 5.5.4.2 using R for the larger unit force in the first equation and for the smaller unit force in the second equation.

Note: In the previous expressions, if the unit force involved is latitudinal, R shall be equal to R_1; if the force is meridional, R shall be equal to R_2.

5.5.4.5 If the meridional unit force, T_1, is compressive and the coexistent unit force T_2, is tensile, except as otherwise provided in 5.5.4.6, or if T_2 is compressive and T_1 is tensile the computed compressive stress, s_{cc}, shall not exceed a value of the allowable compressive stress, s_{ca}, determined from Figure 5-1 by entering the computed value of N and the value of t/R associated with the compressive unit stress and reading the value of s_c that corresponds to that point. The value of s_c will be the limiting value of s_{ca} for the given conditions. (See F-1 for examples illustrating the determination of allowable compressive stress values in accordance with this paragraph.)

5.5.4.6 When a local axial compressive buckling stress in a cylindrical shell is primarily due to a moment in the cylinder, then the allowable longitudinal compressive stress S_{cs} or S_{ca}, as specified in 5.5.4.2 or 5.5.4.3, may be increased by 20%. If the shell bending is due to wind (tank full or empty) or due to earthquake (tank empty), then in addition to the above allowed 20% increase, the allowable buckling stress due to a moment can be increased an additional 1/3. For tanks full or partially full of liquid and for an earthquake induced longitudinal compressive stress, the allowable compression stress need not be limited for biaxial stress as otherwise may be required by Figure 5-1.

For seismic design, the tank full is usually the worst case. For wind loading, the tank empty and with internal pressure is usually the worst case for local, bending induced compressive stress.

5.5.4.7 The allowable compressive stresses previously specified in 5.5.4 are predicted on butt-welded construction. If one or more of the main joints across which the compressive force acts are of the lap-welded type, the allowable compressive stress will be determined according to 5.5.4, ~~but the minimum compressive stress shall be~~ BUT subject to the limitations of 5.12.2 and Table 5-2 (including Note ~~1~~ 2).

5.5.4.8 Cylindrical shells can be checked for wind buckling to determine if there is the need for intermediate wind girders using the rules of 5.10.6. If the transition between the roof or bottom is a curved knuckle section (5.12.3) then 1/3 of the knuckle height shall be included as part of the unstiffened shell height.

5.5.5 Maximum Shearing Stresses

The maximum shearing stresses in welds used for attaching manways and nozzles and their reinforcements or other attachments to the walls of a tank and in sections of manway or nozzle necks that serve as reinforcement attachment shall not exceed 80% of the value of the applicable maximum allowable tensile stress, S_{ts}, given in Table 5-1 for the kind of material involved. Such maximum shearing stresses are permissible only where the loading is applied in a direction perpendicular to the length of the weld and must be reduced where the loading is applied differently (see 5.16.8.3).

5.5.6 Maximum Allowable Stresses for Wind or Earthquake Loadings

The maximum allowable stresses for design loadings combined with wind or earthquake loadings shall not exceed 133% of the stress permitted for the design loading condition;