Figure NC-3922.1-1
Biaxial Stress Chart for Combined Tension and Compression, 30,000 psi to 38,000 psi (205 MPa to 260 MPa) Yield Strength Steels

GENERAL NOTES:
(a) At no time can a compressive stress for a particular value of \( \frac{t - c}{R} \) exceed \( S_{ca} \) represented by curve OABC. No values of compressive stress or \( N \) are permitted to fall to the left or above this curve. (see Fig. NC-3822.1-2) for relationships between factors \( M \) and \( N \).
(b) If compressive stress is meridional, use \( R = R_1 \).
(c) If compressive stress is latitudinal, use \( R = R_2 \).

Established for the applicable thickness-radius ratio as follows:

For \( \frac{t - c}{R} \) values less than 0.00667

\[
S_{ca} = 1,000,000 \left( \frac{t - c}{R} \right)
\]

(U.S. Customary Units)

\[
S_{ca} = 69,000 \left( \frac{t - c}{R} \right)
\]

(SI Units)

For \( \frac{t - c}{R} \) values between 0.00667 and 0.0175

\[
S_{ca} = 5,650 + 154,200 \left( \frac{t - c}{R} \right)
\]

(U.S. Customary Units)

\[
S_{ca} = 8,340 \text{ psi}[575 \text{ MPa}]
\]

(SI Units)

For \( \frac{t - c}{R} \) values greater than 0.0175

\[
S_{ca} = \frac{390 + 10,600 \left( \frac{t - c}{R} \right)}{\bar{h}}
\]

(c) If both the meridional and latitudinal unit forces \( T_1 \) and \( T_2 \) are compressive but of unequal magnitude, both the larger and the smaller computed compressive stresses shall be limited to values which satisfy the following requirements.

\[
\frac{\text{larger stress}}{S_{ca}\text{ determined using } R \text{ for the larger unit force}} + 0.8 \frac{\text{smaller stress}}{S_{ca}} \leq 1.0
\]
For \( \frac{(t - c)}{R} \) values between 0.00667 and 0.0175

\[
S_{ca} = 5,650 + 154,200 \left( \frac{t - c}{R} \right)
\]

(U.S. Customary Units)

\[
S_{ca} = 390 + 10,600 \left( \frac{t - c}{R} \right)
\]

(SI Units)

For \( \frac{(t - c)}{R} \) values greater than 0.0175

\[
S_{ca} = 8,340 \text{ psi} \left[ 575 \text{ MPa} \right]
\]

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

\[
\frac{\text{larger stress}}{S_{ca} \text{ determined using } R \text{ for the larger unit force}} + 0.8 \left( \frac{\text{smaller stress}}{S_{ca} \text{ determined using } R \text{ for the smaller unit force}} \right) \leq 1.0
\]

\[
\frac{1.0 \left( \frac{\text{smaller stress}}{S_{ca} \text{ determined using } R \text{ for the smaller unit force}} \right)}{S_{ca} \text{ determined using } R \text{ for the larger unit force}} \leq 1.0
\]

(d) If the meridional unit force \( T_1 \) is compressive and the coexistent unit force \( T_2 \) is tensile or if \( T_2 \) is compressive and \( T_1 \) is tensile, the computed compressive stress \( S_{cc} \) shall not exceed a value of \( S_{ca} \) determined from **Figure ND-3922.1-1** by entering the computed value of \( N \) and the value of \( \frac{(t - c)}{R} \) associated with the compressive unit stress and by reading the value of \( S_c \) that corresponds to that point. Such value of \( S_c \) will be the limiting value of \( S_{cc} \) for the given conditions. Section F.1 of Appendix F of API 620, Feb. 1970 Ed. gives examples illustrating the determination of allowable compressive stress values \( S_{ca} \).
Add point C back to Figures NC-3922.1-1 and ND-3922.1-1

Add Lines and arrowheads back to Figures NC-3922.1-1 and ND-3922.1-1

FIG. NC-3922.1-1 BIAXIAL STRESS CHART FOR COMBINED TENSION AND COMPRESSION, 30,000 psi TO 38,000 psi YIELD STRENGTH STEELS

Add point C back to Figures NC-3922.1-1 and ND-3922.1-1

(t-c)/R Ratio

<table>
<thead>
<tr>
<th>Value of Tensile Stress Factor N = S_c - S_c</th>
<th>0.10</th>
<th>0.20</th>
<th>0.30</th>
<th>0.40</th>
<th>0.50</th>
<th>0.60</th>
<th>0.70</th>
<th>0.80</th>
<th>0.90</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_c = MS_c = 1,800,000 (t-c)/R</td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>S_c = 10,150 + 277,400 (t-c)/R</td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>S_c = 15,000 psf</td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
</tr>
</tbody>
</table>

NC-3922.3 Maximum Compressive Stresses. Except as provided in NC-3933.3(b), the maximum compressive stresses in the outside walls of a tank, as determined for the loadings, shall not exceed the applicable stress values determined in accordance with (a) through (d) below.

(a) If a cylindrical wall, or portion thereof, is acted upon by a longitudinal compressive force with neither a tensile nor a compressive force acting concurrently in a circumferential direction, the computed compressive stress S_c shall not exceed a value S_c established for the applicable thickness–radius ratio as follows:

\[ S_c = \frac{1,800,000 \cdot (t-c)}{R} \]

for \((t-c)/R\) values less than 0.00667:

\[ S_c = \frac{1,800,000 \cdot (t-c)}{R} \]

for \((t-c)/R\) values between 0.00667 and 0.0175:

\[ S_c = \frac{1,800,000 \cdot (t-c)}{R} \]

\[ S_c = \frac{1,800,000 \cdot (t-c)}{R} \]

43 These rules do not apply when the circumferential stress on a cylindrical wall is compressive as in a cylinder acted upon by external pressure.

For \( \frac{t-c}{R} \) values between 0.00667 and 0.0175,

\[
s_{eq} = 5,650 + 154,200 \left( \frac{t-c}{R} \right)
\]

For \( \frac{t-c}{R} \) values greater than 0.0175,

\[
s_{eq} = 8,340
\]

c. If both the meridional and latitudinal unit forces, \( T_1 \) and \( T_2 \), are compressive but of unequal magnitude, both the larger and the smaller computed compressive stresses shall be limited to values which satisfy the following requirements:

\[
\frac{(\text{larger stress}) + 0.8 \times (\text{smaller stress})}{\text{stress determined as in Par. 3.05.3(a)}} \leq 1.0
\]

using \( R \) for the larger unit force

\[
\frac{1.8 \times (\text{smaller stress})}{\text{stress determined as in Par. 3.05.3(a)}} \leq 1.0
\]

using \( R \) for the smaller unit force

**Note:** In these expressions, if the unit force involved is latitudinal, \( R \) shall be considered as equal to \( R_2 \) and, if such force is meridional, \( R \) shall be considered as equal to \( R_1 \).

d. If the meridional unit force, \( T_1 \), is compressive and the coaxial unit force, \( T_2 \), is tensile or, vice versa, if \( T_2 \) is compressive and \( T_1 \) is tensile, the com-

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**FIG. 3.05—Biaxial Stress Chart for Combined Tension and Compression, 30,000 psi to 38,000 psi Yield Strength Steels.**

**Notes to Table 3.05:**

1. All pertinent modifications and limitations of specifications required by Par. 2.02 through 2.06 shall be complied with.

2. Except for those cases where additional factors or limitations are applied as indicated by references to Notes 5, 6, 10, or 11 in the facing table, the allowable tension stress values given in this table for materials other than bolting steel are the lesser of: a. 30 percent of the specified minimum ultimate tensile strength for the material; or b. 60 percent of the specified minimum yield point.

3. Except where a joint efficiency factor is already reflected in the specified allowable stress value, as indicated by the references to Note 10, or where the value of \( N \) determined in accordance with Par. 3.05.3(b) is less than the applicable joint efficiency factor given in Table 3.23 (and therefore affects a greater reduction in allowable stress than the pertinent joint efficiency factor would effect, if applied), the specified stress values for welds in tension shall be multiplied by the applicable joint efficiency factor, \( E \), given in Table 3.23.

4. Plates and pipe of the specifications designated by references to this note shall not be used in thicknesses greater than \( \frac{5}{4} \) in.

5. Stress values for structural quality steels include a quality factor of 0.92.

6. Stress values for the steels designated by references to this note are limited to those for a steel having an ultimate tensile strength of only 55,000 psi.

7. See Par. 2.02.2 for a full description of this material.

8. To \( \frac{5}{8} \) in. thickness, inclusive.

9. Over \( \frac{5}{8} \) in. to 2 in. thickness, inclusive.

10. Stress values for fusion-welded pipe include a welded-joint efficiency factor of 0.80. (See Note in Par. 3.23.) Only straight-seam pipe shall be used; the use of spiral-seam pipe is prohibited.

11. Stress values for castings include a quality factor of 0.80.

12. Allowable stress based on Sec. VIII of the 1965 ASME Boiler and Pressure Vessel Code, multiplied by the ratio of the design stress factors in API Standard 620 and ASME Sect. VIII, namely 0.30.