

PIPE Combined Stress (Tresca's failure theory):

$$2 \left[\left(\frac{S_L - S_H}{2} \right)^2 + S_T^2 \right]^{1/2} \leq F_3 S$$

WHERE:

→ S_L = LONGITUDINAL STRESS = $S_A + S_B$ OR $S_A - S_B$

S_A = AXIAL STRESS
= F_x / A

S_B = BENDING STRESS
= $\frac{\left[(i_L M_i)^2 + (i_o M_o)^2 \right]^{1/2}}{Z}$

M = MOMENT

WHERE i = IN-PLANE
o = OUT-OF-PLANE

S_H = HOOP STRESS = $\frac{P \times OD}{2t}$

S_T = TORSIONAL STRESS = $M_{\text{TORSION}} / 2Z$

F_3 = COMBINED STRESS DESIGN FACTOR FROM B31 CODE.

S = MINIMUM YIELD STRENGTH

→ S_L IS ALSO = $S_P + S_T + S_x + S_B$

WHERE S_P = PRESSURE STRESS = $0.5 S_H$

S_T = $E \alpha (T_{\text{INSTALLED}} - T_{\text{OPERATING}})$

$S_x = F_x / A$

S_B = BENDING STRESS

FOR UNRESTRAINED