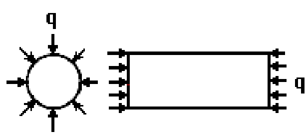
Case 20a

Thin tube with closed ends under uniform external pressure, lateral and longitudinal; ends held circular

Thin tube with closed ends under uniform external pressure, lateral and longitudinal



Enter dimensions and properties:

radius: $r := \frac{8.625}{2} \cdot in - \frac{.322}{2} \cdot in$ $\qquad r = ?\ in$

length: $L := 34 \cdot in$

wall thickness: $t := 0.250 \cdot in$

Modulus of elasticity: $E := 10 \cdot 10^6 \cdot \frac{lbf}{in^2}$

Poisson's ratio: $v := 0.33$

For the expressions in the case to be valid, the following condition must be true (i.e., condition = 1):

Conditions:

$\frac{r}{t} = 16.606 \qquad condition := \frac{r}{t} > 10 \qquad condition = 1$

Critical pressure: The general expression for q' as a function of n (the number of lobes formed by the tube in buckling) is as follows:

$$q'(n) := \frac{E \cdot \frac{t}{r}}{1 + \frac{1}{2} \cdot \left(\frac{\pi \cdot r}{n \cdot L}\right)^2} \cdot \left(\frac{1}{n^2 \cdot \left(1 + \left(\frac{n \cdot L}{\pi \cdot r}\right)^2\right)^2} + \frac{n^2 \cdot t^2}{12 \cdot r^2 \cdot \left(1 - v^2\right)} \cdot \left(1 + \left(\frac{\pi \cdot r}{n \cdot L}\right)^2\right)^2 \right)$$

To determine q', it is necessa
greater than 2 provides the s
To do this, the following is d

Input the number of nodes you wish to examine: Define the n's to be examined:

$nn := 10$ $i := 0..nn-1$ $n_i := i + 2$

Find the value of n that corresponds to the smallest computed value of q':

$qq'_i := q'\left(n_i\right)$

$qq'_i = ?\ \frac{lbf}{in^2}$

$index_i := \mathbf{if}\left(qq'_i = min\left(qq'\right), i, 0\right)$ $m := max\left(index\right)$ $m = 0$

Compute q' using the correct value of n:

$m := 2$

$q'(m) = ?\ psi$

Values of experimentally determined critical pressure range 20% above and below the theoretical value given by the expression above. A recommended probable minimum critical pressure is

$q' := q'(m) \cdot 0.8$ $q' = ?\ psi$

End of Section

Von Mises Formula (Ross; 2nd edition page 101)

$a := r \qquad l := L$

$$PVonMisescr(n) := \frac{E \cdot \frac{t}{a}}{n^2 - 1 + 0.5 \cdot \left(\frac{\pi \cdot a}{l}\right)^2} \cdot \left(\frac{1}{\left(n^2 \cdot \left(\frac{l}{\pi \cdot a}\right)^2 + 1\right)^2} + \frac{t^2}{12 \cdot a^2 \cdot (1 - \nu^2)} \cdot \left(n^2 - 1 + \left(\frac{\pi \cdot a}{l}\right)^2\right)^2 \right)$$

$PPVonMisescr_i := PVonMisescr(n_i)$

$PPVonMisescr_i = ?\ \frac{lb}{in}$

$0.8 \cdot PVonMisescr(m) = ?\ \frac{lbf}{in^2}$

Windenburg and Trilling Formula aka David Taylor Model Basin formula (Ross; 2nd edition page 102)

$$PWandTcr := \frac{2.42 \cdot E \cdot \left(\frac{t}{2 \cdot a}\right)^{\frac{5}{2}}}{(1 - \nu^2)^{0.75} \cdot \left(\left(\frac{l}{2 \cdot a}\right) - 0.447 \cdot \left(\frac{t}{2 \cdot a}\right)^{\frac{1}{2}}\right)}$$

$PWandTcr = ?\ \frac{lbf}{in^2}$

$0.8 \cdot PWandTcr = ?\ \frac{lbf}{in^2}$

Windenburg and Trilling Thinness Ratio (Ross; 2nd edition page 105)

$d := 2 \cdot a \qquad \sigma yp := 40000 \cdot \frac{lbf}{in^2}$

in^2

$$\lambda := \left(\frac{\left(\frac{l}{d} \right)^2}{\left(\frac{t}{d} \right)^3} \right)^{0.25} \cdot \left(\frac{\sigma yp}{E} \right)^{.5} \qquad \lambda = 1.771 \qquad \frac{1}{\lambda} = 0.565$$