Design Study of a Ring Stiffened Cylinder for use as a Manned Submersible

Shell Buckling using Widenberg's Formula - Comstock, John Paul, "Principles of Naval Architecture", 1967, Page 209, Equation [19]

SafetyFactor := 2.0

DesignGoal := 2000·ft·SafetyFactor

Design Variables:

Outside Diameter	OD := 42.0·in
Shell Thickness	t := .375·in, .4375·in .. .625·in
Shell Length	Len := 104.25·in
Number of Rings	num := 2

Constants:

$$SeaWaterDensity := 64 \cdot \frac{lbf}{ft^3}$$

Material Properties:

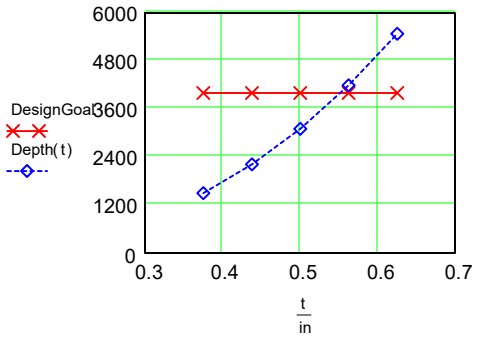
Poissons Ratio	$\mu := .3$
Yield Strength	$\sigma := 38000 \cdot \frac{lbf}{in^2}$
Youngs Modulus	$E := 30 \cdot 10^6 \cdot \frac{lbf}{in^2}$

Equations:

$$L := \frac{\frac{1}{3}\cdot\frac{OD}{2} + Len + \frac{1}{3}\cdot\frac{OD}{2}}{num + 1}$$

Mean Diameter $D(t) := OD - t$

$$Depth(t) := \frac{2.42 \cdot E \cdot \left(\frac{t}{D(t)}\right)^{\frac{5}{2}}}{\left(1-\mu^2\right)^{\frac{3}{4}} \cdot \left[\left(\frac{L}{D(t)}\right) - .45 \cdot \left(\frac{t}{D(t)}\right)^{\frac{1}{2}}\right] \cdot SeaWaterDensity}$$



$\frac{t}{in} =$

0.375
0.438
0.5
0.563
0.625

$$\frac{Depth(t)}{ft} = \begin{pmatrix} 1494 \\ 2209 \\ 3102 \\ 4188 \\ 5479 \end{pmatrix}$$

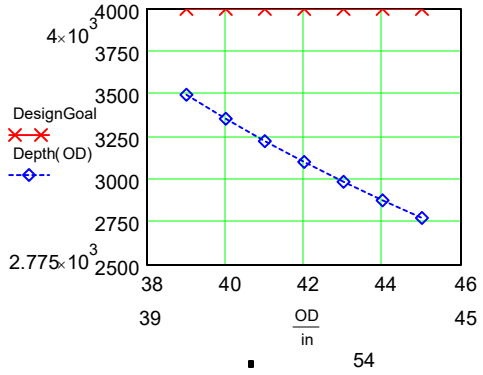
$OD := 39 \cdot in, 40 \cdot in .. 45 \cdot in$

$t := .5 \cdot in$

$$L(OD) := \frac{\frac{1}{3} \cdot \frac{OD}{2} + Len + \frac{1}{3} \cdot \frac{OD}{2}}{1}$$

Mean Diameter $D(OD) := OD - t$

$$Depth(OD) := \frac{2.42 \cdot E \cdot \left(\frac{t}{D(OD)}\right)^{\frac{5}{2}}}{\left(1 - \mu^2\right)^{\frac{3}{4}} \cdot \left[\left(\frac{L(OD)}{D(OD)}\right) - .45 \cdot \left(\frac{t}{D(OD)}\right)^{\frac{1}{2}}\right] \cdot SeaWaterDensity}$$



$$\frac{OD}{in} = \begin{pmatrix} 39 \\ 40 \\ 41 \\ 42 \\ 43 \\ 44 \\ 45 \end{pmatrix}$$

$$\frac{Depth(OD)}{ft} = \begin{pmatrix} 3496 \\ 3357 \\ 3226 \\ 3102 \\ 2987 \\ 2878 \\ 2775 \end{pmatrix}$$