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

Ring Yield using Frame Hoop Stress - Comstock, John Paul
"Principles of Naval Architecture", 1967, p. 211, Equation [27]

$SafetyFactor := 2.0$

$DesignGoal := 1320 \cdot ft \cdot SafetyFactor$ $\qquad DesignGoal = 2640\,ft$

Design Variables:

Outside Diameter	$OD := 42 \cdot in$
Shell Thickness	$t := .5 \cdot in$
Shell Length	$Len := 104.25 \cdot in$
Number of Rings	$num := 2$
Ring Depth	$RD := 2.5 \cdot in$
Ring Width	$RW := 2 \cdot in$
Ring Web Thickness	$b := .375 \cdot in, .4375 \cdot in .. .625 \cdot in$
Ring Flange Thickness	$RFT(b) := b$

Constants:

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

Material Properties:

Poissons Ratio	$\mu := .3$
Yield Strength	$\sigma := 38000 \cdot \frac{lbf}{in^2}$

Equations:

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

Mean Diameter $\quad D := OD - t$

Mean Radius $\quad R := \frac{D}{2}$

$$\theta := L \cdot \left[\frac{3 \cdot \left(1 - \mu^2\right)}{R^2 \cdot t^2}\right]^{\frac{1}{4}} \qquad N := \frac{\cosh(\theta) - \cos(\theta)}{\sinh(\theta) - \sin(\theta)}$$

$$A(b) := RFT(b) \cdot RW + (RD - RFT(b)) \cdot b$$

$$B(b) := \frac{b \cdot t}{A(b) + b \cdot t}$$

$$\beta(b) := \frac{2 \cdot N}{A(b) + b \cdot t} \cdot \left[\frac{1}{3 \cdot \left(1 - \mu^2\right)}\right]^{\frac{1}{4}} \cdot \left(R \cdot t^3\right)^{\frac{1}{2}}$$

$$A1(b) := RW \cdot RFT(b) \qquad I1(b) := \frac{RFT(b)^3 \cdot RW}{12}$$

$$A2(b) := (RD - RFT(b)) \cdot b \qquad I2(b) := \frac{(RD - RFT(b))^3 \cdot b}{12}$$

$$A3(b) := t \cdot b \qquad I3(b) := \frac{t^3 \cdot b}{12}$$

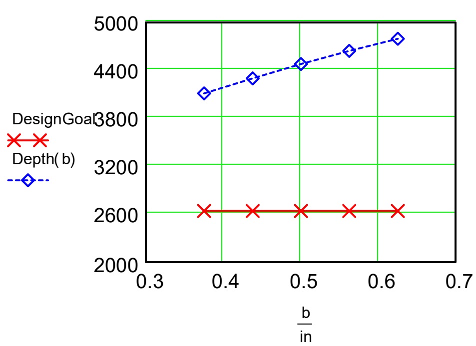
$$y(b) := \frac{\left(\frac{RFT(b)}{2}\right) \cdot A1(b) + \left(\frac{RD - RFT(b)}{2} + RFT(b)\right) \cdot A2(b) + \left(RD + \frac{t}{2}\right) \cdot A3(b)}{A1(b) + A2(b) + A3(b)}$$

$$Itemp(b) := I1(b) + I2(b) + I3(b) + \left(y(b) - \frac{RFT(b)}{2}\right)^2 \cdot A1(b) + \left[y(b) - \frac{(RD - RFT(b))}{2} - RFT(b)\right]^2 \cdot A2(b)$$

$$I(b) := Itemp(b) + \left(RD + \frac{t}{2} - y(b)\right)^2 \cdot A3(b)$$

$$F(b) := \frac{1}{(1 + \beta(b))} \cdot \left[\left(1 - \frac{1}{2} \cdot \mu\right) \cdot \beta(b) \cdot \left(\frac{A(b)}{t} + b\right) + b\right] \qquad Df(b) := OD - 2 \cdot (RD + t - y(b))$$

$$Depth(b) := \frac{\sigma \cdot (A(b) + b \cdot t) \cdot 2}{Df(b) \cdot F(b) \cdot SeaWaterDensity}$$



$\frac{b}{in} =$

0.375
0.438
0.5
0.563
0.625

$\frac{Depth(b)}{ft} =$

4108
4299
4477
4642
4795