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

Shell Yield using Von Sanden and Gunther's Equation - Comstock, John Paul "Principles of Naval Architecture", 1967, p. 210, Equation [21]

$SafetyFactor := 2.0$

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

Design Variables:

Outside Diameter	$OD := 42.0 \cdot in$
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	$\sigma := 38000 \cdot \frac{lbf}{in^2}$
Youngs Modulus	$E := 30 \cdot 10^6 \cdot \frac{lbf}{in^2}$

Equations:

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

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

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

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

$$N(b) := \frac{\cosh(\theta(b)) - \cos(\theta(b))}{\sinh(\theta(b)) - \sin(\theta(b))}$$

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

$$K(b) := \frac{\sinh(\theta(b)) - \sin(\theta(b))}{\sinh(\theta(b)) + \sin(\theta(b))}$$

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

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

$$Hm(b) := -2 \cdot \frac{\sinh\left(\frac{\theta(b)}{2}\right) \cdot \cos\left(\frac{\theta(b)}{2}\right) + \cosh\left(\frac{\theta(b)}{2}\right) \cdot \sin\left(\frac{\theta(b)}{2}\right)}{\sinh(\theta(b)) + \sin(\theta(b))}$$

$$He(b) := -2 \cdot \left(\frac{3}{1-\mu^2}\right)^{\frac{1}{2}} \cdot \left(\frac{\sinh\left(\frac{\theta(b)}{2}\right)\cdot\cos\left(\frac{\theta(b)}{2}\right) + \cosh\left(\frac{\theta(b)}{2}\right)\cdot\sin\left(\frac{\theta(b)}{2}\right)}{\sinh(\theta(b)) + \sin(\theta(b))}\right)$$

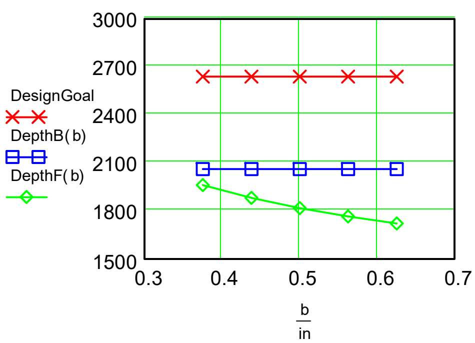
$$H(b) := Hm(b) + \mu \cdot He(b)$$

Yielding at Frame

$$DepthF(b) := \frac{\frac{2\cdot\sigma\cdot t}{D}}{\left[.5 + 1.815\cdot K(b)\cdot\left(\frac{.85 - B(b)}{1+\beta(b)}\right)\right]\cdot SeaWaterDensity}$$

Yielding at Mid-Bay

$$DepthB(b) := \frac{\frac{2\cdot\sigma\cdot t}{D}}{\left[1 + H(b)\cdot\left(\frac{.85 - B(b)}{1+\beta(b)}\right)\right]\cdot SeaWaterDensity}$$



$\frac{b}{in} =$	$\frac{DepthB(b)}{ft} =$	$\frac{DepthF(b)}{ft} =$
0.375	2061	1961
0.438	2061	1880
0.5	2061	1816
0.563	2061	1764
0.625	2061	1721