Buckling Limit State(Ship Rule)

Loading Condition $\eta := 1.0$

Material Information

$E := 206000$ $\nu := 0.3$ $fy := 355$ $Pr := 0.6$

Panel Information

$l := 3628$ $s := 1340$ $t := 19.0$ $C1 := 1.1$ $C2 := 1.2$

$fL := 12.7$ $fT := 70.6$ $fLT := 103.0$

$$\left(\frac{fL}{fcL}\right)^2+\left(\frac{fT}{fcT}\right)^2+\left(\frac{fLT}{fcLT}\right)^2 \le 1.0$$

Critical Buckling Stress : fcL

$$kix := 4 \cdot C1$$

$$fEL := kix \cdot \frac{\pi^2 \cdot E}{12 \cdot \left(1-\nu^2\right)} \cdot \left(\frac{t}{s}\right)^2$$

$$fcL := \text{if } fEL \le Pr \cdot fy \; fEL \text{ else } fy \cdot \left(1 - Pr \cdot (1-Pr) \cdot \frac{fy}{fEL}\right)$$

$kix = 4.4$

$fEL = 164.7$

$fcL = 164.7$

Critical Buckling Stress : fcT

$$kiy := C2 \cdot \left(1+\left(\frac{s}{l}\right)^2\right)^2$$

$$fET := kiy \cdot \frac{\pi^2 \cdot E}{12 \cdot \left(1-\nu^2\right)} \cdot \left(\frac{t}{s}\right)^2$$

$$fcT := \text{if } fET \le Pr \cdot fy \; fET \text{ else } fy \cdot \left(1 - Pr \cdot (1-Pr) \cdot \frac{fy}{fET}\right)$$

$kiy = 1.55$

$fET = 58.01$

$fcT = 58.01$

Critical Buckling Stress : fcLT

$$ft := \frac{1}{\sqrt{3}} \cdot fy$$

$$ks := \left(4.0 \cdot \left(\frac{s}{l}\right)^2 + 5.34\right) \cdot C1$$

$$fELT := ks \cdot \frac{\pi^2 \cdot E}{12 \cdot \left(1-\nu^2\right)} \cdot \left(\frac{t}{s}\right)^2$$

$$fcLT := \text{if } fELT \le Pr \cdot ft \; fELT \text{ else } ft \cdot \left(1 - Pr \cdot (1-Pr) \cdot \frac{ft}{fELT}\right)$$

$ks = 6.474$

$fELT = 242.343$

$fcLT = 163.357$

$$\left(\frac{fL}{fcL}\right)^2+\left(\frac{fT}{fcT}\right)^2+\left(\frac{fLT}{fcLT}\right)^2 = 1.885$$

Ultimate Strength under Combined in-Plane Stresses

Material Information

$E := 206000$ $\nu := 0.3$ $fy := 355$ $Pr := 0.6$ $Sm := 0.908$

Panel Information

$l := 3628$ $s := 1340$ $t := 19.0$ $C1 := 1.1$ $C2 := 1.2$

$fL := 12.7$ $fT := 70.6$ $fLT := 103.0$

$$\left(\frac{fL}{fuL}\right)^2+\left(\frac{fT}{fuT}\right)^2-\eta\left(\frac{fL}{fuL}\right)\cdot\left(\frac{fT}{fuT}\right)+\left(\frac{fLT}{fuLT}\right)^2\le Sm$$

slenderness ratio $\beta := \frac{s}{t}\cdot\sqrt{\frac{fy}{E}} = 2.928$

coefficient to reflect interaction between longitudinal and transverse stresses $\eta := 1.5-\frac{\beta}{2} = 0.036$

$$C := \text{if } \beta \ge 1.25 \quad \frac{2.25}{\beta}-\frac{1.25}{\beta^2} \quad \text{else} \quad 1.0$$

$bwLs := C$

$bwTl := C\cdot\frac{s}{l}+0.115\cdot\left(1-\frac{s}{l}\right)\cdot\left(1+\frac{1}{\beta^2}\right)^2$

$fuL := fy\cdot bwLs$ $fuT := fy\cdot bwTl$

$\alpha := \frac{l}{s}$

$$fuLT := fcLT+0.5\cdot\frac{\left(fy-\sqrt{3}\cdot fcLT\right)}{\sqrt{1+\alpha+\alpha^2}}$$

$fuL = 221.052$ $fuT = 113.75$ $fuLT = 174.202$

$$\left(\frac{fL}{fuL}\right)^2+\left(\frac{fLT}{fuLT}\right)^2 = 0.353$$

$$\left(\frac{fT}{fuT}\right)^2+\left(\frac{fLT}{fuLT}\right)^2 = 0.735$$

$$\left(\frac{fL}{fuL}\right)^2+\left(\frac{fT}{fuT}\right)^2-\eta\cdot\left(\frac{fL}{fuL}\right)\cdot\left(\frac{fT}{fuT}\right)+\left(\frac{fLT}{fuLT}\right)^2 = 0.737$$