3.3.1 Buckling Limit State

Loading Condition $\eta := 0.6$

Material Information

$E := 206000$ $\nu := 0.3$ $\sigma o := 355$

Panel Information

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

$\sigma x := 12.7$ $\sigma y := 70.6$ $\tau := 103.0$

$$\left(\frac{\sigma x}{\eta \cdot \sigma cx}\right)^2 + \left(\frac{\sigma y}{\eta \cdot \sigma cy}\right)^2 + \left(\frac{\tau}{\eta \cdot \tau c}\right)^2 \leq 1.0$$

Critical Buckling Stress : σcx

$\kappa := 1.0$

$Pr := 0.6$

$ksx := C1 \cdot \text{if } (\kappa \geq 0) \wedge (\kappa \leq 1)$
$\quad \frac{8.4}{\kappa + 1.1}$
$\quad \text{else}$
$\quad\quad \text{if } (\kappa \geq -1) \wedge (\kappa < 0)$
$\quad\quad\quad 7.6 - 6.4 \cdot \kappa + 10 \cdot \kappa^2$
$\quad\quad \text{else}$
$\quad\quad\quad -1$

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

$\sigma cx := \text{if } \sigma Ex \leq Pr \cdot \sigma o$
$\quad \sigma Ex$
$\quad \text{else}$
$\quad\quad \sigma o \cdot \left(1 - Pr \cdot (1 - Pr) \cdot \frac{\sigma o}{\sigma Ex}\right)$

$ksx = 4.4$

$\sigma Ex = 164.7$

$\sigma cx = 164.7$

Critical Buckling Stress : σcx

$\kappa := 1.0$

$Pr := 0.6$

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

$ksy := C2 \cdot \text{if } \left(\left(\kappa < \frac{1}{3}\right) \wedge (\alpha \geq 1)\right) \wedge (\alpha \leq 2)$
$\quad \left(1.0875 \cdot \left(1 + \frac{1}{\alpha^2}\right)^2 - 18 \cdot \frac{1}{\alpha^2}\right) \cdot (1 + \kappa) + 24 \cdot \frac{1}{\alpha^2}$
$\quad \text{else}$
$\quad\quad \text{if } \left(\left(\kappa < \frac{1}{3}\right) \wedge (\alpha > 2)\right)$
$\quad\quad\quad \left(1.0875 \cdot \left(1 + \frac{1}{\alpha^2}\right)^2 - 9 \cdot \frac{1}{\alpha}\right) \cdot (1 + \kappa) + 12 \cdot \frac{1}{\alpha}$
$\quad\quad \text{else}$
$\quad\quad\quad \left(1 + \frac{1}{\alpha^2}\right)^2 \cdot (1.675 - 0.675 \cdot \kappa)$

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

$\sigma cy := \text{if } \sigma Ey \leq Pr \cdot \sigma o$
$\quad \sigma Ey$
$\quad \text{else}$
$\quad\quad \sigma o \cdot \left(1 - Pr \cdot (1 - Pr) \cdot \frac{\sigma o}{\sigma Ey}\right)$

$ksy = 1.55$

$\sigma Ey = 58.01$

$\sigma cy = 58.01$

Critical Buckling Stress : τ

$$\tau o := \frac{1}{\sqrt{3}} \cdot \sigma o$$

$$Pr := 0.6$$

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

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

$$\tau c := \text{if } \tau E \leq Pr \cdot \tau o \quad \tau E \quad \text{else} \quad \tau o \cdot \left(1 - Pr \cdot (1 - Pr) \cdot \frac{\tau o}{\tau E}\right)$$

$$ks = 6.474$$

$$\tau E = 242.343$$

$$\tau c = 163.357$$

$$\left(\frac{\sigma x}{\eta \cdot \sigma c x}\right)^2 + \left(\frac{\sigma y}{\eta \cdot \sigma c y}\right)^2 + \left(\frac{\tau}{\eta \cdot \tau c}\right)^2 = 5.235$$

3.3.3 Ultimate Strength under Combined in-Plane Stresses

$$\left(\frac{\sigma x}{\eta \cdot \sigma Ux}\right)^2 - \left(\varphi\left(\frac{\sigma x}{\eta \sigma Ux}\right)\cdot\left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right) + \left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right)^2\right) + \left(\frac{\tau}{\eta \cdot \tau U}\right)^2 \leq 1.0$$

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

coefficient to reflect interaction between longitudinal and transverse stresses $\varphi := \left(1.0 - \frac{\beta}{2}\right) = -0.464$

$$Cx := \text{if } \beta > 1 \quad \frac{2}{\beta} - \frac{1}{\beta^2} \quad \text{else} \quad 1.0$$

$$\sigma Ux := \text{if } Cx \cdot \sigma o \geq \sigma cx \quad Cx \cdot \sigma o \quad \text{else} \quad \sigma cx$$

$$Cy := Cx \cdot \left(\frac{s}{l}\right) + 0.1 \cdot \left(1 - \frac{s}{l}\right)\cdot\left(1 + \frac{1}{\beta^2}\right)^2$$

$$Cy := \text{if } Cy > 1.0 \quad 1.0 \quad \text{else} \quad Cy$$

$$\sigma Uy := \text{if } Cy \cdot \sigma o \geq \sigma cy \quad Cy \cdot \sigma o \quad \text{else} \quad \sigma cy$$

$$\tau U := \tau c + \frac{0.5\cdot\left(\sigma o - \sqrt{3}\cdot\tau c\right)}{\sqrt{1 + \alpha + \alpha^2}}$$

$$\tau U := \text{if } \tau U < \tau c \quad \tau c \quad \text{else} \quad \tau U$$

$Cx = 0.566$ $Cy = 0.288$

$\sigma Ux = 201.093$ $\sigma Uy = 102.19$ $\tau U = 174.202$

$$\left(\frac{\sigma x}{\eta \cdot \sigma Ux}\right)^2 - \varphi \cdot \left(\frac{\sigma x}{\eta \cdot \sigma Ux}\right)\cdot\left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right) + \left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right)^2 + \left(\frac{\tau}{\eta \cdot \tau U}\right)^2 = 2.364$$