3.3.1 Buckling Limit State

Loading Condition $\eta := 1.0$

Material Information

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

Panel Information

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

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

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

Critical Buckling Stress : σcx

$\kappa := 1.0$

$Pr := 0.6$

$$ksx := C1 \cdot \begin{cases} \dfrac{8.4}{\kappa + 1.1} & \text{if } (\kappa \ge 0) \wedge (\kappa \le 1) \\ 7.6 - 6.4 \cdot \kappa + 10 \cdot \kappa^2 & \text{else if } (\kappa \ge -1) \wedge (\kappa < 0) \\ -1 & \text{else} \end{cases}$$

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

$$\sigma cx := \begin{cases} \sigma Ex & \text{if } \sigma Ex \le Pr \cdot \sigma o \\ \sigma o \cdot \left(1 - Pr \cdot (1 - Pr) \cdot \dfrac{\sigma o}{\sigma Ex}\right) & \text{else} \end{cases}$$

$ksx = 4.4$

$\sigma Ex = 164.7$

$\sigma cx = 164.7$

Critical Buckling Stress : σcx

$\kappa := 1.0$

$Pr := 0.6$

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

$$ksy := C2 \cdot \begin{cases} \left(1.0875 \cdot \left(1 + \dfrac{1}{\alpha^2}\right)^2 - 18 \cdot \dfrac{1}{\alpha^2}\right) \cdot (1 + \kappa) + 24 \cdot \dfrac{1}{\alpha^2} & \text{if } \left(\left(\kappa < \dfrac{1}{3}\right) \wedge (\alpha \ge 1)\right) \wedge (\alpha \le 2) \\ \left(1.0875 \cdot \left(1 + \dfrac{1}{\alpha^2}\right)^2 - 9 \cdot \dfrac{1}{\alpha}\right) \cdot (1 + \kappa) + 12 \cdot \dfrac{1}{\alpha} & \text{else if } \left(\left(\kappa < \dfrac{1}{3}\right) \wedge (\alpha > 2)\right) \\ \left(1 + \dfrac{1}{\alpha^2}\right)^2 \cdot (1.675 - 0.675 \cdot \kappa) & \text{else} \end{cases}$$

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

$$\sigma cy := \begin{cases} \sigma Ey & \text{if } \sigma Ey \le Pr \cdot \sigma o \\ \sigma o \cdot \left(1 - Pr \cdot (1 - Pr) \cdot \dfrac{\sigma o}{\sigma Ey}\right) & \text{else} \end{cases}$$

$ksy = 1.55$

$\sigma Ey = 58.01$

$\sigma cy = 58.01$

Critical Buckling Stress : τ

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

$$Pr := 0.6$$

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

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

```
τc := if  τE ≤ Pr · τo
        τE
     else
        τo · (1 − Pr · (1 − Pr) · τo/τE)
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$$ks = 6.474$$

$$\tau E = 242.343$$

$$\tau c = 163.357$$

$$\left(\frac{\sigma x}{\eta \cdot \sigma cx} \right)^2 + \left(\frac{\sigma y}{\eta \cdot \sigma cy} \right)^2 + \left(\frac{\tau}{\eta \cdot \tau c} \right)^2 = 1.885$$

3.3.3 Ultimate Strength under Combined in-Plane Stresses

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

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

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

```
Cx := if  β > 1
            2/β − 1/β²
      else
            1.0
σUx := if  Cx·σo ≥ σcx
            Cx·σo
       else
            σcx
```

```
Cy := Cx·(s/l) + 0.1·(1 − s/l)·(1 + 1/β²)²
Cy := if  Cy > 1.0
            1.0
      else
            Cy
σUy := if  Cy·σo ≥ σcy
            Cy·σo
       else
            σcy
```

```
τU := τc + 0.5·(σo − √3·τc) / √(1 + α + α²)
τU := if  τU < τc
            τc
      else
            τU
```

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

$$\left(\frac{\sigma x}{\eta \cdot \sigma Ux}\right)^2 + \varphi \cdot \left(\frac{\sigma x}{\eta \cdot \sigma Ux}\right) \cdot \left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right) + \left(\frac{\sigma y}{\eta \cdot \sigma Uy}\right)^2 + \left(\frac{\tau}{\eta \cdot \tau U}\right)^2 = 0.811$$