Column 1+2 Existing Conditions

Member Properties: 14WF90 w/ Cover Plates

$F_y := 36ksi$

$d := 14in$

$b_f := 14.5in$

$t_w := 0.44in$

$t_f := 0.71in$

$A := 26.5in^2$

$I_x := 999in^4$

$I_y := 362in^4$

$r_x := 6.14in$

$r_y := 3.70in$

$K := 1$

$L_{b.x.0} := 11ft$

$L_{b.y.0} := 11ft$

$L_{b.x} := 11ft$

$L_{b.y} := 11ft$

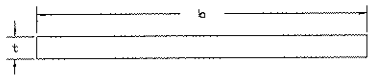
$E := 29000ksi$

Cover Plate:

$t_p := 0.5in$

$b_p := 6in$

$A_{plate} := t_p \cdot b_p$



Place Cover Plate on Flanges:

Solve for Ix Modified:

$$I_{plate.x.1} := \frac{b_p \cdot t_p^3}{12} \qquad I_{plate.x.1} = 0.063 \cdot in^4$$

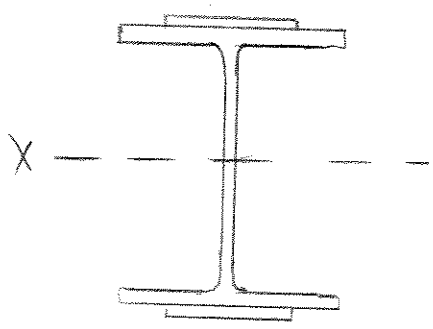
Use Parallel Axis Theorm:

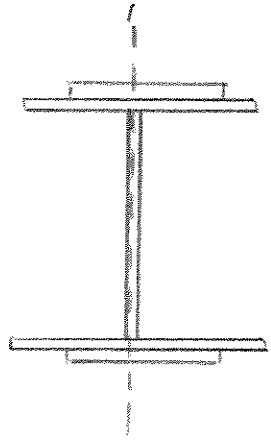
$$I_{plate.x.2} := I_{plate.x.1} + A_{plate} \cdot \left(\frac{d}{2} + \frac{t_p}{2}\right)^2$$

$I_{plate.x.2} = 157.75 \cdot in^4$

$I_{x.modified} := I_{plate.x.2} \cdot 2 + I_x$

$I_{x.modified} = 1314.5 \cdot in^4$



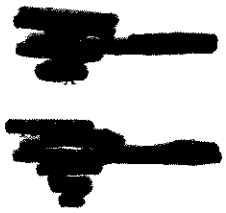


Solve for Iy Modified:

$$I_{plate.y.1} := \frac{(b_p)^3 \cdot t_p}{12} \qquad I_{plate.y.1} = 9 \cdot in^4$$

$$I_{y.modified} := I_y + 2 \cdot I_{plate.y.1} \qquad I_{y.modified} = 380 \cdot in^4$$

Radius of Gyration:



$$r_{x.modified} := \sqrt{\frac{I_{x.modified}}{A + 2A_{plate}}}$$

$$r_{x.modified} = 6.36 \cdot in$$

$$r_{y.modified} := \sqrt{\frac{I_{y.modified}}{A + 2A_{plate}}}$$

$$r_{y.modified} = 3.419 \cdot in$$

$$Modified_{klr.x} := \frac{K \cdot L_{b.x}}{r_{x.modified}} \qquad Modified_{klr.x} = 20.756$$

$$Modified_{klr.y} := \frac{K \cdot L_{b.y}}{r_{y.modified}} \qquad Modified_{klr.y} = 38.603$$

$$Modified_{klr.max} := \max\left(Modified_{klr.x}, Modified_{klr.y}\right)$$

$$Modified_{klr.max} = 38.603$$

Compute Compressive Strength: AISC E3

$\phi := 0.9$

$$F_e := \frac{\pi^2 \cdot E}{Modified_{klr.max}^2}$$

$F_e = 192.066 \cdot ksi$

$$F_{cr} := \left(0.658^{\frac{F_y}{F_e}}\right) \cdot F_y$$

$F_{cr} = 33.284 \cdot ksi$

$\phi P_n := \phi \cdot F_{cr} \cdot \left(A + 2 \cdot A_{plate}\right)$

$\phi P_n = 973.55 \cdot kip$

Column 1 w/ New Cover Plates

Member Properties:

$F_y := 36ksi$

$d := 14in$

$b_f := 14.5in$

$t_w := 0.44in$

$t_f := 0.71in$

$A := 26.5in^2$

$I_x := 999in^4$

$I_y := 362in^4$

$r_x := 6.14in$

$r_y := 3.70in$

$K := 1$

$L_{b.x.0} := 11ft$

$L_{b.y.0} := 11ft$

$L_{b.x} := 11ft$

$L_{b.y} := 22ft$

$E := 29000ksi$

Cover Plate:

$t_{p.s} := .5in$

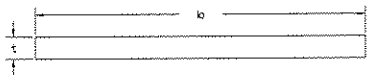
$b_{p.s} := 6in$

$A_{plate.s} := t_{p.s} \cdot b_{p.s} = 3 \cdot in^2$

$t_p := .5in$

$b_p := 14.5in$

$A_{plate} := t_p \cdot b_p = 7.25 \cdot in^2$



Place Cover Plate on Weak Axis:

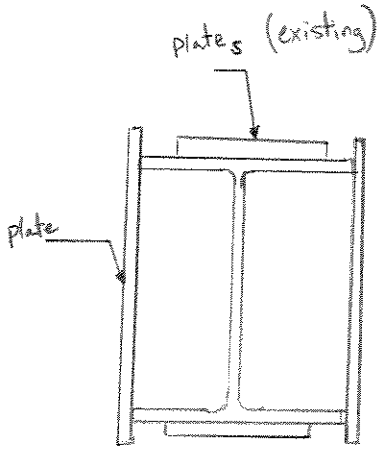
Solve for Ix Modified:

First find I of Existing Plate on Strong Axis:

$$I_{plate.x.s} := \frac{b_{p.s} \cdot t_{p.s}^3}{12} \qquad I_{plate.x.s} = 0.063 \cdot in^4$$

Use Parallel Axis Theorm:

$$I_{plate.x.s.1} := I_{plate.x.s} + A_{plate.s} \cdot \left(\frac{d}{2} + \frac{t_{p.s}}{2} \right)^2$$



Find I of Plate on Weak Axis:

$$I_{plate.x.1} := \frac{(b_p)^3 \cdot t_p}{12} \qquad I_{plate.x.1} = 127.026 \cdot in^4$$

$$I_{x.modified} := 2I_{plate.x.1} + 2 \cdot I_{plate.x.s.1} + I_x$$

$$I_{x.modified} = 1568.55 \cdot in^4$$

Solve for Iy Modified:

First Find I of Existing Plate on Strong Axis:

$$I_{plate.y.s} := \frac{(b_{p.s})^3 \cdot t_{p.s}}{12} \qquad I_{plate.y.s} = 9 \cdot in^4$$

Find I of Plate on Weak Axis

$$I_{plate.y.1} := \frac{b_p \cdot t_p^{\,3}}{12} \qquad I_{plate.y.1} = 0.151 \cdot in^4$$

Use Parallel Axis Theorm:

$$I_{plate.y.2} := I_{plate.y.1} + A_{plate} \cdot \left(\frac{b_f}{2} + \frac{t_p}{2}\right)^2 \qquad I_{plate.y.2} = 407.964 \cdot in^4$$

$$I_{y.modified} := 2 \cdot I_{plate.y.s} + 2 \cdot I_{plate.y.2} + I_y$$

$$I_{y.modified} = 1195.93 \cdot in^4$$

Radius of Gyration:

$$r_{x.modified} := \sqrt{\frac{I_{x.modified}}{A + 2A_{plate} + 2 \cdot A_{plate.s}}} \qquad r_{x.modified} = 5.777 \cdot in$$

$$r_{y.modified} := \sqrt{\frac{I_{y.modified}}{A + 2A_{plate} + 2 \cdot A_{plate.s}}} \qquad r_{y.modified} = 5.044 \cdot in$$

$$\frac{K \cdot L_{b.x}}{r_{x.modified}} = 22.849$$

$$\frac{K \cdot L_{b.y}}{r_{y.modified}} = 52.336$$

Compressive Strength:

Find Modified Column Slenderness AISC E6.1 (Can Be Ignored)

X-Axis:

$a := 14.5in$

$r_{ib.x} := r_{y.modified}$

$h_x := 12in$

$$\alpha_x := \frac{h_x}{2 \cdot r_{ib.x}} \qquad \alpha_x = 1.189$$

$$Modified_{klr.x} := \sqrt{\left(\frac{K \cdot L_{b.x}}{r_{x.modified}}\right)^2 + 0.82 \cdot \frac{\alpha_x^2}{\left(1 + \alpha_x^2\right)} \left(\frac{a}{r_{ib.x}}\right)^2}$$

$Modified_{klr.x} = 22.936$

Y-Axis:

$r_{ib.y} := r_{y.modified}$

$h_y := 14.75in$

$\alpha_y := \frac{h_y}{2 \cdot r_{ib.y}}$ $\alpha_y = 1.462$

$$Modified_{klr.y} := \sqrt{\left(\frac{K \cdot L_{b.y}}{r_{y.modified}}\right)^2 + 0.82 \cdot \frac{\alpha_y^{\,2}}{\left(1 + \alpha_y^{\,2}\right)} \left(\frac{a}{r_{ib.y}}\right)^2}$$

$Modified_{klr.y} = 52.38$

$Modified_{klr.max} := \max\left(Modified_{klr.x}, Modified_{klr.y}\right)$

$Modified_{klr.max} = 52.38$

Compute Compressive Strength: AISC E3

$\phi := 0.9$

$$F_e := \frac{\pi^2 \cdot E}{Modified_{klr.max}^{\,2}}$$

$F_e = 104.319 \cdot ksi$

$$F_{cr} := if\left[Modified_{klr.max} \le 4.71 \cdot \sqrt{\frac{E}{F_y}}, \left(0.658^{\frac{F_y}{F_e}}\right) \cdot F_y, 0.877 \cdot F_e\right]$$

$F_{cr} = 31.158 \cdot ksi$

$\phi P_n := \phi \cdot F_{cr} \cdot \left(A + 2 \cdot A_{plate} + 2 \cdot A_{plate.s}\right)$

$\phi P_n = 1318 \cdot kip$