Interaction diagram for concrete columns

General Information

$b := 24\ in$

$h := 24\ in$

$f'_c := 5000\ psi$

$f_y := 60\ ksi$

$E_s := 29000\ ksi$

$type := 1$ "$1 - \text{ties}, 2 - \text{spiral}$"

Solution:

$$Bars := \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

$c_{cover} := 2.0 \cdot in$

$d_b := 1.27 \cdot in$

$d_{btie} := \frac{3}{8} \cdot in$

$\varepsilon_u := 0.003$

$A_g := b \cdot h = 576\ in^2$

$A_s := \frac{\pi \cdot (d_b)^2}{4} = 1.267\ in^2$

$n_s := \text{cols}(Bars) = 4$

$i := 1 .. n_s$

$$n_i := \sum Bars^{\langle i \rangle} = \begin{bmatrix} 4 \\ 2 \\ 2 \\ 4 \end{bmatrix}$$

$$cover := c_{cover} + d_{btie} + \frac{d_b}{2} = 3.01 \ in$$

$$delta := \frac{h - cover \cdot 2}{n_s - 1} = 5.993 \ in$$

$$d_i := cover + (delta \cdot (i-1)) = \begin{bmatrix} 3.01 \\ 9.003 \\ 14.997 \\ 20.99 \end{bmatrix} in$$

$$d_t := \max(d) = 20.99 \ in$$

$$\beta_1 := \text{if}\left(\langle f'_c \geq 4 \ ksi\rangle \cdot \langle f'_c \leq 8 \ ksi\rangle, 0.85 - 0.05 \cdot \frac{f'_c - 4 \ ksi}{ksi}, \text{if}\left(\langle f'_c \leq 4 \ ksi\rangle, 0.85, 0.65\right)\right) = 0.8$$

$$c_t(a) := \frac{a}{\beta_1}$$

$$f_s(i,a) := \left\| \begin{array}{l} \varepsilon_s \leftarrow \varepsilon_u \cdot \dfrac{d_i - c_t(a)}{c_t(a)} \\ \text{sign}\left(\varepsilon_s\right) \ min\left(\left|E_s \cdot \varepsilon_s\right|, f_y\right) \end{array} \right.$$

$$A_{st} := A_s \cdot \sum n = 15.201 \ in^2$$

$$\theta := \text{if}((type \geq 1), 0.8, 0.85) = 0.8$$

$$\phi_{max} := 0.65$$

$$\phi P_{n.max} := \theta \ \phi_{max} \cdot \left[0.85 \cdot f'_c \cdot \left(A_g - A_{st}\right) + f_y \cdot A_{st}\right] = [1713.643] \ kip$$

$$\phi(a) := \left\| \begin{array}{l} \varepsilon_t \leftarrow \varepsilon_u \cdot \dfrac{d_t - c_t(a)}{c_t(a)} \\ \phi \leftarrow \text{if}\left(\langle \varepsilon_t > 0.002 \rangle \ \langle \varepsilon_t < 0.005 \rangle, \dfrac{1.45 + 200 \cdot \varepsilon_t}{3}, \text{if}\left(\langle \varepsilon_t < 0.002 \rangle, 0.65, 0.9 \right) \right) \end{array} \right.$$

$$\phi P_n(a) := min\left(\phi(a) \cdot 0.85 \ f'_c \cdot a \cdot b - \sum_{i=1}^{n_s} \left(A_s \cdot n_i \cdot f_s(i,a) \right), \phi P_{n.max} \right)$$

$$\phi M_n(a) := \phi(a) \cdot \left(0.85 \cdot f'_c \cdot a \cdot b \cdot \left(\frac{h}{2} - \frac{a}{2} \right) + \sum_{i=1}^{n_s} \left(A_s \cdot n_i \cdot f_s(i,a) \cdot \left(d_i - \frac{h}{2} \right) \right) \right)$$

$$a := 0 \ \textit{in}, \frac{h}{40} .. h$$

Interaction diagram

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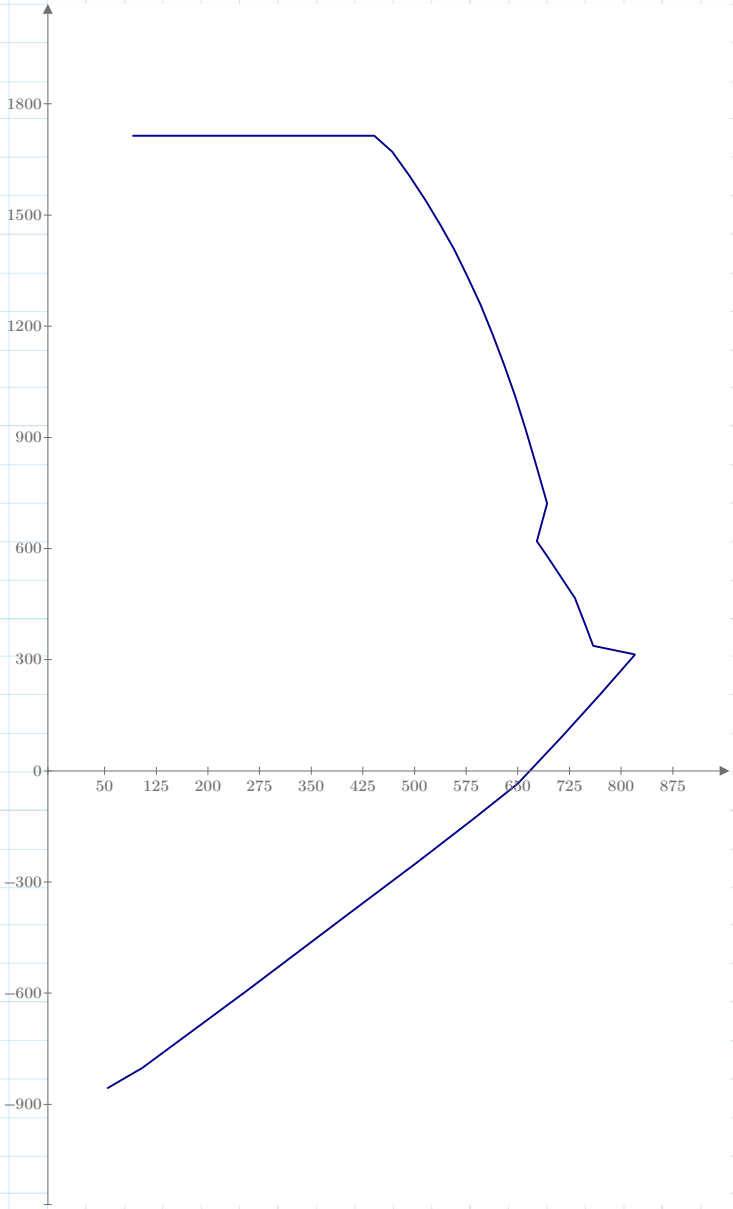

$\phi P_n(a)$ $(\boldsymbol{kip})$

$\phi M_n(a)$ $(\boldsymbol{kip \cdot ft})$