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Sample calculation for confined concrete

***Strength of concrete** $f'_c := 6\ ksi$

Calculate effective confining stress

Clear Spacing between hoops $s' := 6\ in - 2 \cdot 0.625\ in = 4.75\ in$

Hoop diameter $D_s := 44\ in - 0.625\ in = 43.375\ in$

Longitudinal bar yield strength $f_y := 60.4\ ksi$

Area of Long. bars $A_b := 2 \cdot 0.31\ in^2$

Spacing of hoops $s := 6\ in$

Passive confining stress $f'_i := 2 \cdot \dfrac{f_y \cdot A_b}{s \cdot D_s} = 287.78482\ psi$

Confinement efficiency coefficient $K_e := \left(1 - \dfrac{s'}{2 \cdot D_s}\right)^2 = 0.89349$

Effective confining stress $f'_{ie} := K_e \cdot f'_i = 257.13229\ psi$

***Ratio** $\dfrac{f'_{ie}}{f'_c} = 0.04286$

added it for clarity

Calculate confined concrete compressive strength and strain

Confinement coefficient $K_c := 4.1$

Confined concrete compressive strength $f'_{cc} := f'_c + K_c \cdot f'_{ie} = 7.05424\ ksi$

***Ratio** $\dfrac{f'_{cc}}{f'_c} = 1.17571$

added it for clarity

Strain at unconfined compressive strength $\varepsilon'_c := -0.0027$

Strain at f'_{cc} $\varepsilon'_{cc} := \varepsilon'_c \cdot \left(1 + 20 \cdot \dfrac{f'_{ie}}{f'_c}\right) = -0.00501$

Calculate normalization term

Longitudinal bar yield strength $f_y := 74.3\ ksi$

***Column length** $L := 24\ ft$

***Column spread of plasticity** $l_{p1} := 0.08 \cdot L = 23.04\ in$

Gage length ratio for unconfine conc. $\lambda_c := \dfrac{16\ in}{l_{p1}} = 0.69444$

Calculate terms for Modified Mander's model

***Confined concrete secant modulus** $E_{secc} := \dfrac{-f'_{cc}}{\varepsilon'_{cc}} = 1407\ ksi$

formatted output

***Concrete elastic modulus** $E_c := 3250\ ksi$

you had Ec in psi!

***Ratio** added it for clarity - $\dfrac{E_{secc}}{E_c} = 0.43288$

Power term $r_{cc} := \dfrac{1}{1 - \dfrac{E_{secc}}{E_c}} = 1.76329$

*** lambda_c = 1 from zero to the peak, ie no gage length dependence in this part of the curve. See Eq. 11**

Modified Mander's Model

$$f_c(\varepsilon) := \begin{cases} \lambda_c \leftarrow 1 \\ -\dfrac{\left(1+\dfrac{1}{\lambda_c}\cdot\left(\dfrac{\varepsilon}{\varepsilon'_{cc}}-1\right)\right)}{\left(r_{cc}-1+\left(1+\left(\dfrac{1}{\lambda_c}\right)\cdot\left(\dfrac{\varepsilon}{\varepsilon'_{cc}}-1\right)\right)^{r_{cc}}\right)}\cdot r_{cc}\cdot f'_{cc} & \text{if } \varepsilon \le 0 \wedge \varepsilon \ge \varepsilon'_{cc} \\ -\dfrac{\left(1+\dfrac{1}{\lambda_c}\cdot\left(\dfrac{\varepsilon}{\varepsilon'_{cc}}-1\right)\right)}{\left(r_{cc}-1+\left(1+\left(\dfrac{1}{\lambda_c}\right)\cdot\left(\dfrac{\varepsilon}{\varepsilon'_{cc}}-1\right)\right)^{r_{cc}}\right)}\cdot r_{cc}\cdot f'_{cc} & \text{else if } \varepsilon \le \varepsilon'_{cc} \wedge \varepsilon \ge -0.02 \\ 0 & \text{else} \end{cases}$$

$$\varepsilon := 0, -0.00001 .. -0.03$$

$\mathbf{Y} := f_c(\varepsilon)$

$\mathbf{X} := \varepsilon$