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ARCH 324 - Structures 2, Winter 2009

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(1) Determine Neutral Axis of the Effective Section:

\[ A_c \bar{x}_c = A_t \bar{x}_t \]

\[ (18" \times 3\text{"})(x + 1.5\text{"}) + (8" \times x)(x/2) = 24\text{in}^2 (15-x) \]

\[ 54x + 81 + 4x^2 = 360 - 24x \]

\[ 4x^2 + 78x - 279 = 0 \]

Solve using quadratic formula:

\[ x = \frac{-78 \pm \sqrt{78^2 - (4)(4)(-279)}}{2(4)} \]

\[ x = 3.088" \]

(2) Transformed Moment of Inertia:

\[ bd^3/12 = \frac{18(3)^3}{12} = 40.5\text{in}^4 \]

\[ Ax^2 = (18)(5)(3.088 + 1.5)^2 = 1136.7\text{in}^4 \]

\[ bd^3/3 = 8(3.088)^3 = 78.52\text{in}^4 \]

\[ A_{x^2} = \frac{3}{(24\text{in}^2)(11.912\text{in}^2)} = 3405\text{in}^4 \]

\[ I_{TR} = 4661.2\text{in}^4 \]

(3) Resisting Capacity of Concrete & Steel:

Concrete \( f' = 1.8 \text{ksi} \)

\[ M = \frac{F'I_{TR}}{C} = \frac{(1.8\text{ksi})(4661\text{in}^4)}{6.088"} = 1378''\text{k} \]

Steel \( f' = 20 \text{ksi} \)

\[ M = \frac{F'I_{TR}}{CN} = \frac{(20\text{ksi})(4661\text{in}^4)}{(11.912')(8)} = 978''\text{k} \]

Steel governs.

(4) Actual Stress in Concrete:

\[ f = \frac{Mc}{I_{TR}} = \frac{(978''\text{k})(6.088")}{4661\text{in}^4} = 1.28 \text{ksi} \]