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ARCH 324 - Structures 2, Winter 2009

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(1) Determine Neutral Axis of the Effective Section:

\[ A_e \bar{x}_e = A_t \bar{x}_t \]

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

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

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

Solve using quadratic formula:

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

\[ x = 3.088'' \]

(2) Transformed Moment of Inertia:

\[ bd^{3/2} = \frac{18(3)^3}{12} = 40.5 \text{in}^4 \]

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

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

\[ Ay^2 = \frac{24 \text{in}^2}{11.912 \text{in}^2} = 3405 \text{in}^4 \]

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

(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:

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