ARCH 324 - Structures 2, Winter 2009

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(1) Determine Neutral Axis of the Effective Section:

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

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

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

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

Solve using quadratic formula:

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

\[ x = 3.088" \]

(2) Transformed Moment of Inertia:

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

\[ bd^3/6 = 8(3.088)^3 = 78.52 \text{in}^4 \]

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

\[ I_{TR} = 466.12 \text{in}^4 \]

(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:

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