ARCH 324 - Structures 2, Winter 2009

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(1) Determine Neutral Axis of the Effective Section:

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

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

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

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

Solve using quadratic formula:

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

\[ x = 3.088" \]

(2) Transformed Moment of Inertia:

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

\[ Ay^2 = (24 \text{ in}^2) (11.91 \text{ in}^2) = 279 \text{ in}^4 \]

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

(3) Resisting Capacity of Concrete & Steel:

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

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

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

\[ M = \frac{F' I_{TR}}{CN} = \frac{(20 \text{ ksi})(4661 \text{ in}^4)}{(11.91\text{ in}) (8)} = 978 \text{ k in} \]

Steel governs.

(4) Actual Stress in Concrete:

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