ARCH 324 - Structures 2, Winter 2009

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Determine Neutral Axis of the Effective Section:

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

\[ (12'' \times x)(\frac{x}{2}) = 24in^2 \times (18'' - x) \]

\[ 6x^2 = 432 - 24x \]

\[ x^2 + 4x - 72 = 0 \]

Use quadratic equation to solve:

\[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]

\[ x = \frac{-4 \pm \sqrt{(4)^2 - 4(1)(72)}}{2(1)} = \frac{6.7''}{(2)(1)} \]

(Note: ignore negative answer, because we are only interested in a positive value)

Transformed Moment of Inertia

\[ I = \frac{bd^3}{3} = \frac{(12'')(6.7'')^3}{3} = 1203in^4 \]

\[ I = A \bar{x}^2 = (24in^2)(11.3'')^2 = 3064.56in^4 \]

\[ I_{TR} = \frac{4267.6in^4}{4268in^4} \]

Resisting Capacity of Concrete & Steel

Concrete: \( f = 1.8ksi \)

\[ M = \frac{fI_{TR}}{c} = \frac{(1.8ksi)(4268in^4)}{6.7''} = 1146.6in.k = 95.5''k \]

Steel: \( f = 20ksi \)

\[ M = \frac{fI_{TR}}{CN} = \frac{(20ksi)(4268in^4)}{(11.3'')(8)} = 944.2''k = \boxed{78.08''k} \]

Steel governs.

Actual stress in concrete:

\[ f = \frac{Mc}{I_{TR}} = \frac{(944.2''k)(6.7'')}{4268in^4} = 1.48ksi \]

Need Modular Ratio!