ARCH 324 - Structures 2, Winter 2009

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\[ A_0 = 3 \text{in}^2 \]

First transform section:
(Converting steel into equivalent area of concrete.)

\[ A_{te} = 3 \text{in}^2 \times 8 = 24 \text{in}^2 \]

\[ \text{(1) Determine Neutral Axis of the Effective Section:} \]

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

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

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

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

Use quadratic equation to solve:

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

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

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

\[ \text{(2) Transform Moment of Inertia} \]

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

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

\[ I_{te} = \frac{4267.6 \text{in}^4}{ \boxed{4267.6 \text{in}^4} } \]

\[ \text{(3) Resisting Capacity of Concrete & Steel} \]

Concrete: \[ f = 1.8 \text{ksi} \]

\[ M = \frac{f_{te}}{c} = \frac{(1.8\text{ksi})(4268 \text{in}^4)}{6.7''} = 1146.4 \text{in} \cdot \text{lb ft'' k} = 95.5' \text{k} \]

Steel: \[ f = 20 \text{ksi} \]

\[ M = \frac{f_{te}}{cN} = \frac{(20\text{ksi})(4268 \text{in}^4)}{11.3''(8)} = 944.2 \text{in} \cdot \text{lb ft'' k} = 78.08' \text{k} \]

\[ \text{Steel governs.} \]

\[ \text{(4) Actual stress in concrete:} \]

\[ f = \frac{M_c}{I_{te}} = \frac{(944.2' \text{ksi})(6.7'')}{4268 \text{in}^4} = 1.48 \text{ksi} \]

\[ \text{Need Modulus Ratio!} \]