ARCH 324 - Structures 2, Winter 2009

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13 - 1 (A)

First transform section:

- Convert steel into equivalent area of concrete.

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

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

1. Determine Neutral Axis of the Effective Section:

\[
a_c \bar{x}_c = a_t \bar{x}_t
\]

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

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

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

Use quadratic equation to solve:

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

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

(2) Transformed Moment of Inertia:

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

\[
I_{cr} = \frac{Ax^2}{4} = \frac{24 \text{in}^2 (11.3'')^2}{4} = 3064.56 \text{ in}^4
\]

\[
I_{cr} = \frac{4267.6 \text{ in}^4}{2a}
\]

(3) Resisting Capacity of Concrete & Steel

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

\[
M = \frac{f I_{cr}}{c} = \frac{(1.8 \text{ksi})(4268 \text{ in}^4)}{6.7''} = 1146.6''k = 95.5''k
\]

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

\[
M = \frac{f I_{cr}}{cN} = \frac{(20 \text{ksi})(4268 \text{ in}^4)}{(11.3'')(8)} = 944.2''k = 78.08''k
\]

Steel governs.

Lower Moment Governs

(4) Actual stress in concrete:

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

Need Modular Ratio!