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ARCH 324 - Structures 2, Winter 2009

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EXAMPLE: CONCRETE BEAM DESIGN
WORKING STRESS METHOD

GIVEN:

M = 200 k\text{-}ft

\(E_s = 29,000 \text{k}	ext{-}psi \quad f_s = 24 \text{ksi}\)

\(E_c = 3,625 \text{k}	ext{-}psi \quad f_c = 1.8 \text{ksi}\)

DESIGN THE SECTION SO THAT IT IS EXACTLY BALANCED.

1. MODULUS RATIO: \( n = \frac{E_s}{E_c} = 29,000 \quad 3,625 = 8 \)

2. FIND DEPTH, D SO THAT BOTH MATERIALS ARE STRESSED TO ALLOWABLE:

\[
\frac{f_c}{x} = \frac{1.8}{D-x} \Rightarrow 1.8D - 1.8x = 3x
\]

\[D = 2.67x\]

CONSIDERING THE INTERNAL COUPLE: \(M = R_c (D - \frac{x}{3})\)

\[R_c = \frac{f_c (B)(x)}{2} = \frac{(1.8 \text{ksi})(14')(x)}{2} = 12.6x\]

\[M = R_c (D - \frac{x}{3})\]

\[200 \text{k}\text{-}ft \times 12''/\text{ft} = 12.6x \left( 2.67x - \frac{x}{3} \right)\]

\[2400 \text{in} \times \text{k} = 33.64x^2 - 4.20x^2\]

\[= 29.44x^2\]

\[\Rightarrow x = 9.0''\]

\[D = 2.67x = 2.67(9'') = 24.1''\]
3. Find area of steel:

\[ R_c = \frac{f_c (8) (x)}{2} = 12.6 x \]

\[ = 12.6 (9.0') \]

\[ = 113.4 k \]

\[ R_t = R_c \]

\[ R_t = A_s f_s \]

\[ 113.4 k = A_s (24 ksi) \rightarrow A_s = 4.73 \text{ in}^2 \]