ARCH 324 - Structures 2, Winter 2009

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Example: 15.3. A

Given:

\[ \bar{M} = 712 \text{ k-ft} \]
\[ f'_c = 4000 \text{ psi} \]
\[ f_y = 60,000 \text{ psi} \]

Find \( A_s \)

\[ M_{des.} = \bar{M} = \frac{M_u}{\phi} = 712 \text{ k-ft} \] \text{ SEE ENGEL p. 2240 }

1. Non-Rectangular Section - Must check the moment carrying capacity of the section by parts:

\[ M_1 = 0.85 f'_c A_c \frac{2}{1} \]
\[ M_2 = 0.85(4000)(24)(24-2) \]
\[ M_1 = 7181 \times 10^6 \text{ in-lbs} \]
\[ M_1 = 598.4 \text{ k-ft} \]
\[ M_2 = 113.6 \text{ k-ft} \]
\[ M_2 = 1.363 \times 10^6 \text{ in-lbs} \]

We now have a two-part system of rectangular components which we can use to solve for the total area of steel.

\[ A_{s1} = \frac{M_1}{f_y(d_1 - a_1/2)} = \frac{7.181 \times 10^6}{(60,000)(24-2)} \]
\[ A_{s1} = 5.44 \text{ in}^2 \]
EXAMPLE 15.3. A cont

Use the iterative process to find $A_{s_2}$ and $\alpha$.

For the initial estimate of $A_{s_2}$, guess $\alpha = 0.9d_2$ for good behavior.

1. $A_{s_2} = \frac{M_2}{f_y(0.9d_2)} = \frac{1.363 \times 10^6}{(60,000)(0.9)(20)} = 1.26 \text{ in}^2$

$A_{s_2} = 1.26 \text{ in}^2$

$\alpha = \frac{A_s f_y}{0.85 f_c' b} = \frac{(1.26)(60,000)}{(0.85)(4000)(8)} = 2.18 \text{ in}$

2. $\alpha' = \frac{A_{s_2} f_y}{0.85 f_c' b} = 1.22 \text{ in}^2$

$\alpha' = \frac{1.22 f_y}{0.85 f_c' b} = 2.69 \text{ in}$

3. $A_{s_2}'' = \frac{M_2}{f_y(20 - \frac{2.69}{2})} = 1.2179 \text{ in}^2 \cong 1.22 \text{ in}^2$ (done)

Total Steel Area

$A_{\text{total}} = A_{s_1} + A_{s_2}'' = 5.44 + 1.22 = 6.66 \text{ in}^2$

$A_{\text{total}} = 6.66 \text{ in}^2$