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 \( A_s \)

\[ M_{des.} = \bar{M} = \frac{Mu}{\phi} = 712 \text{ k-ft} \quad \text{SEE ENGEL p. 2260} \]

1. Non-rectangular section - must check the moment carrying capacity of the section by parts:

\[ M_1 = 0.85 f'_c A_c \cdot 2 \]
\[ M_2 = 0.85(4000)(24/2)(24-2) \]
\[ M_3 = 7181 \times 10^6 \text{ in-lbs} \]
\[ M_4 = 5984 \text{ k-ft} \]
\[ M_5 = 1183.6 \text{ k-ft} \]
\[ M_6 = 1.363 \times 10^6 \text{ in-lbs} \]

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

Part 1

\[ A_{s1} = \frac{M_1}{f_y(d_1 - a_1/2)} = \frac{7.181 \times 10^6}{(60,000)(24-2)} \]

\[ A_{s1} = 5.44 \text{ in}^2 \]
Example 15.3. A cont

Use the iterative process to find \( A_{s2} \) and \( a \). For the initial estimate of \( A_{s2} \), guess \( 2_d = 0.9d_2 \) for good behavior.

1. \[ A_{s2} = \frac{M_2}{f_y(0.9d_2)} = \frac{1.363 \times 10^6}{(60,000)(0.9)(20)} \]

2. \[ A_{s2} = 1.26 \text{ in}^2 \]

3. \[ a = \frac{A_s f_y}{0.85 f'_{c} \cdot b} = \frac{(1.26)(60,000)}{(0.85)(4000)(8)} = 2.18 \text{ in} \]

4. \[ a' = 1.22 \frac{f_y}{0.85 f'_{c} \cdot b} = 2.69 \text{ in} \]

5. \[ A_{s2}'' = \frac{M_2}{f_y(20-2.69/2)} = 1.2179 \text{ in}^2 \approx 1.22 \text{ in}^2 \text{ done} \]

Total steel area

\[ A_{\text{total}} = A_{s1} + A_{s2}'' = 5.44 + 1.22 = 6.66 \text{ in}^2 \]

\[ A_{\text{total}} = 6.66 \text{ in}^2 \]