ARCH 324 - Structures 2, Winter 2009

von Buelow, Peter

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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 \( A_s \)

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

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

\[ M_1 = 0.85 f'_c A_c 2t \]
\[ M_1 = 0.85(4000)(24)(16)(2) \]
\[ M_1 = 598.4 \text{ k-ft} \]
\[ M_2 = 712 - 598.4 \]
\[ M_2 = 113.6 \text{ k-ft} \]

\[ M_{des} - M_1 = M_2 \]

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

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

\[ A_s = 5.44 \text{ in}^2 \]
EXAMPLE 15.3. A cont

USE THE ITERATIVE PROCESS TO FIND $A'_{s2}$ AND $a$: FOR THE INITIAL ESTIMATE OF $A'_{s2}$, GUESS $2'_{s} = 0.9d_{2}$ FOR GOOD BEHAVIOR

1. $A_{s2} = \frac{M_{o}}{f_{y}(0.9d_{2})} = \frac{1.363 \times 10^{6}}{(60,000)(0.9)(20)}$

$A_{s2} = 1.26 \text{ in}^2$

$A_{s2} = \frac{1.26}{0.85f'_{c} \cdot b}$

$\frac{1.26}{(60,000)(0.85)(4000)(8)} = 2.18 \text{ in}$

$\alpha = A_{s}f_{y}$

2. $A'_{s2} = \frac{M_{2}}{f_{y}(20 - 2.18)} = 1.22 \text{ in}^2$

$A'_{s2} = \frac{1.22}{0.85f'_{c} \cdot b}$

$\frac{1.22}{(60,000)(0.85)(4000)(8)} = 2.69 \text{ in}$

$\alpha' = 1.22f_{y}$

3. $A''_{s2} = \frac{M_{2}}{f_{y}(20 - 2.69)} = 1.2179 \text{ in}^2 \approx 1.22 \text{ in}^2 \text{ DONE}$

Total Steel Area

$A_{\text{total}} = A_{s1} + A'_{s2} = 5.44 + 1.22 = 6.66 \text{ in}^2$

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