ARCH 324 - Structures 2, Winter 2009

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Example: IS. 3. A

Given:
- $\overline{W} = 712\, \text{k}-\text{ft}$
- $f_c' = 4000\, \text{psi}$
- $f_y = 60,000\, \text{psi}$

Find $A_s$

$$M_{des.} = \overline{W} = \frac{M_u}{\phi} = 712\, \text{k}-\text{ft}$$

See Engel p. 2240

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

- $M_1 = 0.85 f_c' A_{c1} 2_1$
- $M_1 = 0.85 \times 4000 \times 24 \times 4 \times (24-2)$
- $M_1 = 718 \times 10^6\, \text{in.-lb}$
- $M_1 = 598.4\, \text{k}-\text{ft}$

- $M_2 = 712 - 598.4$
- $M_2 = 113.6\, \text{k}-\text{ft}$

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

For Part 1:

- $A_{s1} = \frac{M_1}{f_y (d_1 - a_1/2)} = \frac{7.18 \times 10^6}{(60,000)(24-2)}$
- $A_{s1} = 5.44\, \text{in}^2$
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. $A_{s2} = \frac{M_2}{f_y(0.9d_2)} = \frac{1.363 \times 10^4}{(60,000)(0.9)(20)}$

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

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

2. $A'_{s2} = \frac{M_2}{f_y(20 - 2d_2)} = 1.22 \text{ in}^2$

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

3. $A''_{s2} = \frac{M_2}{f_y(20 - 2.69)} = 1.2179 \text{ in}^2 \approx 1.22 \text{ in}^2$ done

Total Steel Area

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

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