ARCH 324 - Structures 2, Winter 2009

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GIVEN:

\[ 6.5' \quad 6.5' \]

13' 13'

5'' SLAB

BEAMS

FRAMING PLAN

D.L + L.L = 200 psf

EFFECTIVE WIDTH = 90''

5''

W = 36 x 135

SECTION

\[ n = \frac{1}{9} \left[ \frac{E_c}{E_s} \right] \]

\[ f_{steel} = 24 \text{ ksi} \]

\[ f_{concrete} = 1.35 \text{ ksi} \]

1. LOADING DIAGRAM.

\[ W = 156_k \]

\[ 2 \times \text{load} = 200 \text{ psf} \times 13' = 2600 \text{ psf} \]

\[ l = 60' \]

\[ W = \omega l = 2600 \text{ psf} \times 60' \]

\[ W = 156_k \]
2. Determine most economical section (W shape) to carry load without composite action.

For a simply supported uniformly loaded beam,

Max. bending moment,

\[ M = \frac{WL}{8} = \frac{156^k \times 60'}{8} \]

\[ \therefore M = 1170^k \]

Thus,

\[ S = \frac{M}{f} = \frac{1170^k \times 12''}{24 \text{ ksi}} \]

\[ \therefore S = 585 \text{ in}^3 \]

From Table D-35, for \( S_x = 585 \text{ in}^3 \), sections appropriate are,

- W 30 x 191  598 in\(^3\)
- W 33 x 201  684 in\(^3\)
- W 36 x 182  623 in\(^3\)

Thus 'W 36 x 182' is used.

3. Transformed section

\[ h = \frac{1}{q} = \frac{E_c}{E_s} \]

\[ \therefore \text{ Transforming the concrete to an equivalent area of steel by reducing the width we get,} \]
(4) Location of Neutral Axis (using D-28)

\[ \bar{x} \text{ (using top as base line)} \]

\[ \begin{array}{c|c|c}
A & \bar{x} = \frac{Ax}{A} & x = 2.5'' = 12.5 \text{ in}^3 \\
50 \text{ in}^2 & 2.5'' & 12.5 \text{ in}^3 \\
I & 39.7 \text{ in}^4 & 22.775' = 904.1675 \text{ in}^4 \\
\end{array} \]

\[ \bar{x} = \frac{\Sigma Ax}{\Sigma A} = \frac{1029.1675}{89.7} \]

\[ \therefore \bar{x} = 11.47'' \text{ (from top)} \]

(5) Transformed Moment of Inertia (By Parallel Axis Theorem)

\[ I_{TR} = \frac{I_G}{A} + \frac{Ad^2}{12} \]

\[ \begin{array}{c|c|c}
I & \frac{I_G}{A} & \frac{Ad^2}{12} \\
10 & \frac{bd^3}{12} (10.5)^3 & 50(11.47-2.5)^2 \]

\[ = 104.17 \]

\[ = 4023 \]

\[ I = 7800 \]

\[ 39.7(11.3)^2 \]

\[ = 5073.78 \]

\[ \therefore I_{a} = I_{G} + Ad^2 \]

\[ I_{a} = 104.17 + 4023 = 4127.17 \]

\[ + I = 7800 + 5073.78 = 12873.78 \]

\[ \therefore I_{TR} = 17000.99 \]

\[ \text{in}^4 \]
\[ M_c = \frac{f_c I_{TR}}{C_n} \]

\[ M_c = \frac{1.35 \times (17001)}{11.47(\frac{1}{19})} = 1800.89 \text{ k-ft} \]

\[ M_s = \frac{f_s I_{TR}}{C} \]

\[ M_s = \frac{24(17001)}{29.08} = 14031.08 \text{ k-ft} \]

\[ f_s = 24 \text{ ksi} \]

\[ f_c = \frac{M_{cn}}{I_{TR}} = \frac{14031.08(11.47)^{\frac{1}{9}}}{17001} \]

\[ f_c = 1.052 \text{ ksi} \]