ARCH 324 - Structures 2, Winter 2009

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**Given:**

- 6.5' x 6.5'

**Framing Plan**

- D.L + L.L = 200 psf

**Effective Width:** 90''

- W = 36 x 135

**Section**

- \( n = \frac{1}{9} \left[ \frac{E_c}{E_s} \right] \)
- \( f_{steel} = 24 \text{ ksi} \)
- \( f_{concrete} = 1.35 \text{ ksi} \)

**Loading Diagram**

- \( W = 156 \) k
- \( W = 200 \text{ psf} \times 13' = 2600 \text{ psf} \)
- \( l = 60' \)
- \( W = \omega l = 2600 \text{ psf} \times 60' \)
- \( W = 156 \) k
2. Determine most economical section (W shape) to carry load without composite action.

For a simply supported uniformly loaded beam,

Max. Bending moment,

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

\[ M = \frac{1170}{k} \]

Thus,

\[ S = \frac{M}{f} = \frac{1170}{24\text{ ksi}} \times 12\text{ in}^3 \]

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

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

- \( W\ 30 \times 191 \ 598\text{ in}^3 \)
- \( W\ 33 \times 201 \ 684\text{ in}^3 \)
- \( W\ 36 \times 182 \ 623\text{ in}^3 \)

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)  
\[ \frac{2Ax}{3A} \]  
using top as base line  

\[
\begin{align*}
A &= 50 \text{ in}^2 \\
2.5" &= 12.5 \text{ in}^3 \\
I &= 391.7 \text{ in}^4 \\
22.75" &= 9041675 \text{ in}^4 \\
\Rightarrow \frac{x}{2} &= \frac{2Ax}{3A} = \frac{1029.1675}{89.7} \\
\Rightarrow x &= 11.47" \text{ (from top)}
\end{align*}
\]

5) TRANSFORMED MOMENT OF INERTIA  
(By Parallel Axis Theorem)  

\[
\begin{align*}
I_{TR} &= I_g + Ad^2 \\
10 &= \frac{bd^3}{12} = \frac{[10(5)]^3}{12} = 104.17 \\
50[(11.47-2.5)^2] &= 4023 \\
I &= 7800 \text{ in}^4 \\
39.7(11.3)^2 &= 5073.78 \\
\Rightarrow I_a &= I_g + Ad^2 \\
I_a &= 104.17 + 4023 = 4127.17 \\
+ I &= 7800 + 5073.78 = 12873.78 \\
\Rightarrow I_{TR} &= 17000.99 \text{ in}^4
\end{align*}
\]
Now, $M_c = \frac{f_c I_{TR}}{C n}$

$M_c = 1.35 \frac{17001}{11.47 \frac{1}{19}} = 1800.89 \text{ k-in}$

$M_s = \frac{f_s I_{TR}}{C}$

$\therefore M_s = \frac{24(17001)}{29.08} = 14031.08 \text{ k-in}$

$\frac{f_s}{f_s} = 24 \text{ ksi}$

$f_c = \frac{M_c n}{I_{TR}} = \frac{14031.08(11.47)\frac{1}{19}}{17001}$

$\therefore f_c = 1.052 \text{ ksi}$