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ARCH 324 - Structures 2, Winter 2009

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GIVEN:

\[ 6.5' \quad 6.5' \]

FRAMING PLAN

\[ D' L + L' L = 200 \text{ psf} \]

EFFECTIVE WIDTH = 90''

\[ \begin{array}{c}
\text{SECTION} \\
W = 36 \times 135 \\
\end{array} \]

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

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

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

\[ W = 156^k \]

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

\[ W = 156^k \]
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,

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

**THUS \( W \ 36 \times 182^* \) IS USED.**

3) **TRANSFORMED SECTION**

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

**TRANSFORMING THE CONCRETE TO AN EQUIVALENT AREA OF STEEL BY REDUCING THE WIDTH WE GET,**
4. LOCATION OF NEUTRAL AXIS
   (USING D-28)

\[ \bar{x} = \frac{\sum A \bar{x}}{\sum A} \]

<table>
<thead>
<tr>
<th>A</th>
<th>\bar{x} = \frac{Ax}{A}</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 in²</td>
<td>2.5&quot; = 12.5 in³</td>
</tr>
</tbody>
</table>

\[ \bar{x} = \frac{\sum A \bar{x}}{\sum A} = \frac{1029 \cdot 1675}{89.7} \]

\[ \bar{x} = 11.47" \] (from top)

5. TRANSFORMED MOMENT OF INERTIA
   (BY PARALLEL AXIS THEOREM)

\[ I_{TR} = I + Ad^2 \]

<table>
<thead>
<tr>
<th>d</th>
<th>\frac{bd^3}{12}</th>
<th>\frac{50(11.47 - 2.5)^2}{12}</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>104.17</td>
<td>402.3</td>
</tr>
</tbody>
</table>

\[ I = 7800 \]

\[ I_a = I + Ad^2 \]

\[ I_a = 104.17 + 402.3 = 1427.17 \]

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

\[ I_{TR} = 17000.99 \]
6. **STRESSES**

Now, \( M_c = \frac{f_c I_{TR}}{C_n} \)

\[
M_c = 1.35 \left( \frac{17001}{1147} \right) = 1808.9 \text{ kips}
\]

\( M_s = \frac{f_s I_{TR}}{C} \)

\[
M_s = 24 \left( \frac{17001}{29.08} \right) = 14031.08 \text{ kips}
\]

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

\[ f_c = \frac{M_c C_n}{I_{TR}} = \frac{14031.08 (11.47)^{1/9}}{17001} \]

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