### Examples: Load Tracing and Factored Loads

**EXAMPLE (pg. 129 with corrections and additions)**

Assume that the average dead plus live load on the structure shown in Figure 3.15 is 60 lbs/ft². Determine the reactions for Beam D. This is the same structure as shown in Figure 3.1. Assuming all beams are weightless!

*Solution:*

Note carefully the directions of the decking span. Beam D carries floor loads from the decking to the left (see the contributory area and load strip), but not to the right, since the center decking runs parallel to Beam D and is not carried by it. Beam D also picks up the end of Beam G and thus also “carries” the reactive force from Beam G. It is therefore necessary to analyze Beam G first to determine the magnitude of this force. The analysis appears in Figure 3.15. The reactive force from Beam G of 2160 lbs is then treated as a downward force acting on Beam D. The load model for Beam D thus consists of distributed forces from the decking plus the 2160-lb force. It is then analyzed by means of the equations of statics to obtain reactive forces of 4896 lbs and 4464 lbs at its ends.

**FIGURE 3.15** Load modeling and reaction determination.

**Beam A:**

\[ R_{D2} = 4896 \text{ lb} \]
\[ R_{E2} = 4896 \text{ lb} \]

**Beam B:**

\[ R_{D1} = 4464 \text{ lb} \]
\[ R_{E1} = 4464 \text{ lb} \]

By symmetry:

\[ R_{CC1} = R_{CC3} = \frac{4893 \text{ lb} + 4896 \text{ lb}}{2} = 4896 \text{ lb} \]

\[ R_{CC2} = R_{CC4} = \frac{4464 \text{ lb} + 4464 \text{ lb}}{2} + \frac{(6 \text{ ft})(60 \text{ lb/ft}^2)(20 \text{ ft})}{2} = 6624 \text{ lb} \]

Additional loads are transferred to the column from the reactions on Beams C and F:

\[ R_{C1} = R_{C2} = R_{F1} = R_{F2} = \frac{wL}{2} = \frac{(6 \text{ ft})(60 \text{ lb/ft}^2)(20 \text{ ft})}{2} = 3600 \text{ lb} \]

- C1 = 4896 lb + 3600 lb = 8,496 lb
- C2 = 6624 lb + 3600 lb = 10,224 lb
- C3 = 4896 lb + 3600 lb = 8,496 lb
- C4 = 6624 lb + 3600 lb = 10,224 lb
**Example 2**
Determine the controlling load combinations(s) using AISC-LRFD for a building column subject to the following service or nominal (unfactored) axial compressive loads: \( D = 30 \text{ kips}, L = 50 \text{ kips}, L_r = 10 \text{ kips}, W = 25 \text{ kips}, E = 40 \text{ kips} \)

Using a spreadsheet analysis:

<table>
<thead>
<tr>
<th>LRFD (ASCE-7)</th>
<th>FACTORED LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 1.4D )</td>
<td>( 42 \text{ kips} )</td>
</tr>
<tr>
<td>( 1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R) )</td>
<td>( 121 )</td>
</tr>
<tr>
<td>( 1.2D + 1.6L + L_r )</td>
<td>( 102 )</td>
</tr>
<tr>
<td>( 1.2D + 1.6L + 0.5W )</td>
<td>( 64.5 )</td>
</tr>
<tr>
<td>( 1.2D + 1.6L - 0.5W )</td>
<td>( 39.5 )</td>
</tr>
<tr>
<td>( 1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R) )</td>
<td>( 116 )</td>
</tr>
<tr>
<td>( 1.2D + 1.0W + L + 0.5L_r )</td>
<td>( 66 )</td>
</tr>
<tr>
<td>( 1.2D + 1.0E + L )</td>
<td>( 126 )</td>
</tr>
<tr>
<td>( 1.2D - 1.0E + L )</td>
<td>( 46 )</td>
</tr>
<tr>
<td>( 0.9D + 1.0W )</td>
<td>( 52 )</td>
</tr>
<tr>
<td>( 0.9D - 1.0W )</td>
<td>( 2 )</td>
</tr>
<tr>
<td>( 0.9D + 1.0E )</td>
<td>( 67 )</td>
</tr>
<tr>
<td>( 0.9D - 1.0E )</td>
<td>( -13 )</td>
</tr>
</tbody>
</table>

Critical Factored Load: 126 kips (C), -13 kips (T)

**Example 3**

**EXAMPLE 2-4**

Determine factored loads for the beam shown in Figure 2-16.

**Solution**

For the left half of the beam:

\[
\begin{align*}
\text{\( w_{u1} \)} &= 1.2w_D + 1.6w_L, \\
\text{\( w_{u1} \)} &= 1.2 \times 1.0 + 1.6 \times 2.0 = 4.4 \text{ kip/ft}
\end{align*}
\]

For the right half of the beam:

\[
\begin{align*}
\text{\( w_{u2} \)} &= 1.2w_D + 1.6w_L, \\
\text{\( w_{u2} \)} &= 1.2 \times 1.0 + 1.6 \times 0 = 1.2 \text{ kip/ft}
\end{align*}
\]

**FIGURE 2-16** Example 2-4 (service loads).

**FIGURE 2-17** Example 2-4 (factored loads).

The concentrated load is a live load only:

\[
\begin{align*}
\text{\( P_u \)} &= 1.2P_D + 1.6P_L, \\
\text{\( P_u \)} &= 1.2 \times 0 + 1.6 \times 10 = 16 \text{ kip}
\end{align*}
\]

The factored loads on the beam are shown in Figure 2-17.