Examples: Load Tracing and Factored Loads

**Example 1** (pg. 109 with 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

Live and dead load

Assume \( w_{DL+LL} = 60 \text{ lbs/ft}^2 \)

Beam G carries distributed loads only

Find reactions for Beam G

\[ W = 6 \text{ ft}(60 \text{ lbs/ft}^2) = 360 \text{ lb/ft} \]

Beam G

\[ R_{D_1} \quad R_{D_2} \]

\[ R_{G_1} = \frac{wL}{2} = (360 \text{ lb/ft})(12 \text{ ft})/2 = 2160 \text{ lbs} \]

\[ R_{G_2} = \frac{wL}{2} = (360 \text{ lb/ft})(12 \text{ ft})/2 = 2160 \text{ lbs} \]

Beam D carries both distributed loads and the reaction \( R_{D_1} \) from Beam G

\[ \Sigma M_D = 0 \]

\[-(12 \text{ ft})(2160 \text{ lb})(20 \text{ ft})/2 + 20 R_{D_2} = 0 \]

\[ R_{D_1} = 4896 \text{ lb} = R_{E_2} \]

\[ \Sigma F_y = 0 \]

\[ R_{D_1} + R_{D_2} = (360 \text{ lb/ft})(20 \text{ ft}) + 2160 \text{ lb} \]

\[ R_{D_1} = 4464 \text{ lb} = R_{E_1} \]

**FIGURE 3.15** Load modeling and reaction determination.
Example 1 (continued)

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.

Beam A:  \[ R_{D2} = 4896 \text{ lb} \quad R_{E2} = 4896 \text{ lb} \]

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

Beam B:  \[ R_{D1} = 4464 \text{ lb} \quad R_{E1} = 4464 \text{ lb} \]

By symmetry:  \[ R_{CC2} = R_{CC4} = \frac{4464 \text{ lb} + 4464 \text{ lb}}{2} + \frac{(6 \text{ ft})(60 \text{ lb/ft}^2)(12 \text{ ft})}{2} = 6624 \text{ lb} \]

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

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

Columns:

\[ C1 = 4896 \text{ lb} + 3600 \text{ lb} = 8,496 \text{ lb} \]

\[ C2 = 6624 \text{ lb} + 3600 \text{ lb} = 10,224 \text{ lb} \]

\[ C3 = 4896 \text{ lb} + 3600 \text{ lb} = 8,496 \text{ lb} \]

\[ C4 = 6624 \text{ lb} + 3600 \text{ lb} = 10,224 \text{ lb} \]
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: \( D = 30 \text{ k} \), \( L = 50 \text{ k} \), \( L_r = 10 \text{ k} \), \( W = 25 \text{ k} \), \( E = 40 \text{ k} \)

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></td>
</tr>
<tr>
<td>( 1.4D )</td>
<td>= 42 kips</td>
</tr>
</tbody>
</table>

\( 1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R) \)

\( 1.2D + 1.6L + 0.5L_r \)

\( = 121 \)

\( 1.2D + 1.6L + 0.5W \)

\( = 64.5 \)

\( 1.2D + 1.6L_r - 0.5W \)

\( = 39.5 \)

\( 1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R) \)

\( 1.2D + 1.0W + L + 0.5L_r \)

\( = 116 \)

\( 1.2D - 1.0W + L + 0.5L_r \)

\( = 66 \)

\( 1.2D + 1.0E + L + 0.2S \)

\( 1.2D + 1.0E + L \)

\( = 126 \)

\( 1.2D - 1.0E + L \)

\( = 46 \)

\( 0.9D + 1.0W \)

\( 0.9D + 1.0W \)

\( = 52 \)

\( 0.9D - 1.0W \)

\( = 2 \)

\( 0.9D + 1.0E \)

\( 0.9D + 1.0E \)

\( = 67 \)

\( 0.9D - 1.0E \)

\( = -13 \)

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:

\[ w_{u1} = 1.2w_D + 1.6w_L \]
\[ w_{u1} = 1.2 \times 1.0 + 1.6 \times 2.0 = 4.4 \text{ kip/ft} \]

For the right half of the beam:

\[ w_{u2} = 1.2w_D + 1.6w_L \]
\[ w_{u2} = 1.2 \times 1.0 + 1.6 \times 0 = 1.2 \text{ kip/ft} \]

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

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

The concentrated load is a live load only:

\[ P_u = 1.2P_D + 1.6P_L \]
\[ P_u = 1.2 \times 0 + 1.6 \times 10 = 16 \text{ kip} \]

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