ARCH 331. Assignment #7

Date: 6/22/15, due 6/25/15

Pass-fail work

Problems: supplemental problems (7A, etc.) and from Onouye Chapter 9

Notes: Problems marked with a * have been altered with respect to the problem stated in the text. Multiframe or other methods may be used for V & M diagrams and maximums. Selected problems not required to be worked will be announced in class.

(7%) 7A) A joint similar to that in Figure 7a is formed with outer members of 1-inch nominal thickness (3/4-in. actual thickness) and 10d common wire nails. If the compression force to be transferred to the two side members having 5 nails each board side is 1200 lb, is the connection adequate? (wood connection analysis)

Partial answers to check with: $F = 1050$ lb

(7%) 7B) A truss heel joint similar to that in Figure 7b is made with gusset plates of ½-in. plywood and 8d nails. Find the tension force limit for the bottom chord having 12 nails each plywood side. (wood connection analysis)

Partial answers to check with: $F = 1560$ lb.

<table>
<thead>
<tr>
<th>Side Member Thickness, $t_c$ (in.)</th>
<th>Nail Length, $L$ (in.)</th>
<th>Nail Diameter, $D$ (in.)</th>
<th>Load per Nail for Douglas Fir-Larch $G = 0.50$, Z (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Plywood Side Members</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.113</td>
<td>6d</td>
<td>48</td>
</tr>
<tr>
<td>3/4</td>
<td>0.131</td>
<td>8d</td>
<td>63</td>
</tr>
<tr>
<td>0.148</td>
<td>10d</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>3/2</td>
<td>0.162</td>
<td>16d</td>
<td>92</td>
</tr>
<tr>
<td>3/4</td>
<td>0.113</td>
<td>6d</td>
<td>58</td>
</tr>
<tr>
<td>2/3</td>
<td>0.131</td>
<td>8d</td>
<td>73</td>
</tr>
<tr>
<td>3/3</td>
<td>0.148</td>
<td>10d</td>
<td>86</td>
</tr>
<tr>
<td>3/2</td>
<td>0.162</td>
<td>16d</td>
<td>100</td>
</tr>
</tbody>
</table>

Solid-Sawn Lumber Side Members

<table>
<thead>
<tr>
<th>Side Member Thickness, $t_c$ (in.)</th>
<th>Nail Length, $L$ (in.)</th>
<th>Nail Diameter, $D$ (in.)</th>
<th>Load per Nail for Douglas Fir-Larch $G = 0.50$, Z (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/3</td>
<td>0.131</td>
<td>8d</td>
<td>90</td>
</tr>
<tr>
<td>3/3</td>
<td>0.148</td>
<td>10d</td>
<td>105</td>
</tr>
<tr>
<td>3/2</td>
<td>0.162</td>
<td>16d</td>
<td>121</td>
</tr>
<tr>
<td>4/3</td>
<td>0.192</td>
<td>20d</td>
<td>138</td>
</tr>
<tr>
<td>1 7/8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.148</td>
<td>10d</td>
<td>118</td>
</tr>
<tr>
<td>3/2</td>
<td>0.162</td>
<td>16d</td>
<td>141</td>
</tr>
<tr>
<td>4</td>
<td>0.192</td>
<td>20d</td>
<td>170</td>
</tr>
<tr>
<td>4/2</td>
<td>0.207</td>
<td>30d</td>
<td>186</td>
</tr>
<tr>
<td>5</td>
<td>0.225</td>
<td>40d</td>
<td>205</td>
</tr>
<tr>
<td>5/2</td>
<td>0.244</td>
<td>50d</td>
<td>211</td>
</tr>
</tbody>
</table>


MORE NEXT PAGE
(8%) 7C) A nominal 3 x 8 in redwood beam is to be supported by two 2 x 8 in. members acting as a spaced column. The minimum spacing and edge distances for the 5/8 inch bolts are shown. How many 5/8 in. bolts will be required to safely carry a load of 3200 lb? Use the chart provided.

(wood connection design)

*Partial answer to check with: min \( n = 3.95 \).*

<table>
<thead>
<tr>
<th>Table 7.1</th>
<th>Holding Power of Bolts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Bolt in Main Wood Member (in Inches)</td>
<td>( p )</td>
</tr>
<tr>
<td>( p = ) Safe loads parallel to grain in pounds</td>
<td></td>
</tr>
<tr>
<td>( q = ) Safe loads perpendicular to grain in pounds</td>
<td></td>
</tr>
<tr>
<td>( p ) &amp; ( q )</td>
<td>( 3/8 )</td>
</tr>
<tr>
<td>Single ( p )</td>
<td>325</td>
</tr>
<tr>
<td>Single ( q )</td>
<td>185</td>
</tr>
<tr>
<td>Single ( q )</td>
<td>650</td>
</tr>
<tr>
<td>Single ( q )</td>
<td>370</td>
</tr>
<tr>
<td>Single ( q )</td>
<td>710</td>
</tr>
<tr>
<td>Double ( q )</td>
<td>620</td>
</tr>
<tr>
<td>Double ( q )</td>
<td>600</td>
</tr>
<tr>
<td>Double ( q )</td>
<td>620</td>
</tr>
<tr>
<td>Double ( q )</td>
<td>620</td>
</tr>
</tbody>
</table>

3) The length specified is the length of the bolt in the main member of double shear joints or the length of the bolt in the thinner member of single shear joints.

(24%) *9.1.21* Assuming A992 steel, select the most economical \( \frac{w}{h} \) section. Check the shear stress and determine the deflection at the free end. Assume the length is fully braced.

\[
F_b = \frac{2wL}{2h} \quad \text{(unified ASD design and deflection)}
\]

\[
F_b = 44.5 \text{ ksi} \quad F_y = 50 \text{ ksi}
\]

\[
E = 30 \times 10^3 \text{ ksi}
\]

\[
A_{LL} = L/260 \quad \text{and} \quad A_{L+DL} = L/200
\]

*Partial answers to check with: (for final section) \( Z \geq 66.4 \text{ in}^3 \), \( A_{web} \geq 0.928 \text{ in}^2 \), \( I \geq 674.7 \text{ in}^3 \).*

(10%) 7D) For the beam of problem 9.1.21, design the most economical beam for plastic flexure only (\( Z_e \)) for the dead and live load shown. Make certain to include self weight. The material has the following properties: \( F_y = 50 \text{ ksi} \), \( E = 30,000 \text{ ksi} \), \( \phi_b = 0.9 \). *(LRFD design)*

*Partial answer to check with: \( Z_e \geq 54.6 \text{ in}^3 \).*

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For the beam of problem 9.1.21, use the LRFD design method and the following available moment diagram to select the most economical beam with an unbraced length of 7.75 ft and the dead and live load shown. Assume $F_{yw} = 50$ ksi, and $\phi_b = 0.9$. The (unfactored) live load deflection and total load deflections are identical to those in the allowable stress design of problem 9.1.21.

\textit{(LRFD design)}

\textit{Partial answer to check with:} $M_u = 204.8\, k\cdot ft, V_u = 22.4\, k, (\text{when the final section has been chosen, it must have:} I_{req}^a \geq 675.8\, in^4, \phi M_n \geq 211.7\, k\cdot ft. \phi V_n \geq 23.9\, k.)$
A long span steel joist with a span of 80 feet is required to support a roof. The joists are spaced at 4 ft apart, the dead load is 12 lb/ft², the live load is 28 lb/ft² and the live load deflection is limited to L/360 (which is that used to determine the live load limit based on deflection in the Joist catalogue tables). Remembering to estimate a joist weight, use the table provided to select the most economical joist that can be used. \( \text{LRFD open web joist charts} \)

Partial answers to check with: 44LH likely
(12%) 7G) If a simply supported 36 ft parallel chord open-web joist has 12 panels at 3 ft for the top chord and the support reactions shown, use the method of sections to determine the member forces in the top chord, bottom chord, and the web for the section indicated in the figure at the section location shown for LRFD design. The joists are 2 ft. on center, the distributed load over the top of the truss is 25 lb/ft² dead load and 70 lb/ft² live load and the self weight is 12.2 lb/ft. NOTE: Remember that the tributary width for the end joints is only half what it is for the rest of the top joints.

Partial answers to check with:
top chord = 14.6 k (C)
bottom chord = 16.7 k (T)
web (diagonal) = 3.8 k (C)