Flooded Wooden I-Joists: How Do They Perform?

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Wood I-Joists

- Engineered Lumber Product
- “I” shaped member
- Flanges: Sawn Lumber or Structural Composite Lumber
- Web: OSB or Plywood
- Depths from 9 to 38 inches (9-16 inches typical)
- Lengths up to 50 feet (25 feet typical)

http://www.apawood.org/
Drawbacks

- Must be used in Dry-Service Condition (Moisture Content <16%)

https://upload.wikimedia.org/Nashville_Flood.jpg

http://www.awc.org/
Objective

• Begin to investigate the effects on strength and stiffness from submerging I-joists in water for extended periods of time

Boise Cascade BCI 6000s 1.8 series I-Joists:
16 inches deep – 12 feet long

<table>
<thead>
<tr>
<th>Time of Saturation</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (Dry Samples)</td>
<td>2</td>
</tr>
<tr>
<td>1-Day</td>
<td>2</td>
</tr>
<tr>
<td>2-Day</td>
<td>2</td>
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<tr>
<td>3-Day</td>
<td>2</td>
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<tr>
<td>5-Day</td>
<td>2</td>
</tr>
<tr>
<td>7-Day</td>
<td>2</td>
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</tbody>
</table>
Laboratory Testing

Load cell
Third point loading device
Load frame
Hydraulic bottle jack
Sample
Measuring device
Horizontal string
Laboratory Testing

Sample

Cut plywood attached to sample

Steel triangles

Steel I-beam

C-clamps
Failure Modes

- Lateral torsional buckling failure
- Shear at joint failure
- Flexural failure
- Crushing at support failure
<table>
<thead>
<tr>
<th>Specimens</th>
<th>Mode of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-A</td>
<td>Lateral Torsional Buckling</td>
</tr>
<tr>
<td>Dry-B</td>
<td>Lateral Torsional Buckling</td>
</tr>
<tr>
<td>1-Day-A</td>
<td>Lateral Torsional Buckling</td>
</tr>
<tr>
<td>1-Day-B</td>
<td>Shear Failure at Joint</td>
</tr>
<tr>
<td>2-Day-A</td>
<td>Flexural</td>
</tr>
<tr>
<td>2-Day-B</td>
<td>Lateral Torsional Buckling</td>
</tr>
<tr>
<td>3-Day-A</td>
<td>Lateral Torsional Buckling</td>
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<td>5-Day-A</td>
<td>Flexural</td>
</tr>
<tr>
<td>5-Day-B</td>
<td>Crushing at Support</td>
</tr>
<tr>
<td>7-Day-A</td>
<td>Crushing at Support</td>
</tr>
<tr>
<td>7-Day-B</td>
<td>Crushing at Support</td>
</tr>
</tbody>
</table>
Ultimate Load

Ultimate Load (pounds)

Allowable Load w/Cd of 1.6: 2530 lbs
Allowable Load: 1580 lbs

Specimens Saturation Period (Days)

Dry 1-Day 2-Day 3-Day 5-Day 7-Day

37.5% Decrease

954 lbs
Load-Deflection Behavior

Load (pounds)

Deflection (inches)

Allowable Load

Allowable Load with Load Duration Factor

Dry

1-day

3-days

2-days

7-days

5-days

L/360

L/240

L/180

Linear (Dry A)
Linear (Dry B)
Linear (1-Day A)
Linear (1-Day B)
Linear (2-Day A)
Linear (2-Day B)
Linear (3-Day A)
Linear (3-Day B)
Linear (5-Day A)
Linear (5-Day B)
Linear (7-Day A)
Linear (7-Day B)
Bending Stiffness

Number of Days Saturated (days)

Bending Stiffness (pounds per inch)

Dry  1-Day  2-Day  3-Day  5-Day  7-Day

31% Decrease
Conclusions

• Significant decrease in strength and stiffness
  – 37.5% for Strength
  – 31.0% for Bending Stiffness
• Time of submergence had little effect
• Strength and deflection were within published allowable limits
• Limitations – Need for future work
  – Samples (number and “variety”)
  – Effects of wetting and drying
  – Behavior between “dry” and 1-Day (actual moisture content)
  – Sustained loading (creep)
  – Other conditions?
Other Conditions?

http://www.yoderandsonsconstruction.com/

http://www.thehomeinspector.com/

http://washnewoldhouse.blogspot.com/

http://www.firehouse.com/
Questions

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– Bachelor of Science in Civil Engineering
– Master of Science in Civil Engineering
– Starting in 2017-18: Graduate Certificates in Civil Engineering (4 Courses)