Introduction

Cross Laminated Timber (CLT) has been manufactured in Europe for over a decade. CLT is a revolutionary building system that substitutes for concrete, masonry and steel in some applications. Ideal for floors, walls, and roofs, CLT has been described as the perfect structural solution.

Structurlam has created its own line of Cross Laminated Timber called CrossLam®. Using layers of locally sourced softwood stacked at right angles and glued together, CrossLam® provides load distribution and dimensional stability in all directions.

With its cross-layered construction, reduced carbon footprint, formaldehyde free adhesive and ready to assemble system, CrossLam® is the green choice for schools, health care facilities, public buildings, commercial buildings, and multi-family housing.

The contents of this guide provide technical information to allow architects and engineers to specify CrossLam®.

Carbon Footprint

The environmental benefits of CrossLam® speak for themselves. Because CrossLam® is made of wood, it possesses a number of inherent positive environmental characteristics common to all wood products.

According to life cycle assessment studies, these benefits include carbon storage, lower greenhouse gas emissions during the manufacturing process, and an overall lighter environmental footprint than non-wood materials.

Our Approach

CrossLam® has all the advantages of prefabricated buildings in addition to the Structurlam Advantage:

- Our state of the art manufacturing facility allows us to efficiently produce large volumes of world class, certified panels.
- Our planer can finish smooth all 4 sides to expose panel surfaces and ensure a perfect fit.
- Our Design Team can provide fully engineered design solutions for floors, roof, walls, and all connection details.
- Our Installation Partners can install any size of project.
- We manufacture panels using environmentally friendly resins that are free from formaldehyde and colour.
- The Structurlam Team is here to make your project a success.

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Benefits of CrossLam®

CrossLam® has many of the benefits that other building materials just don’t have.

- Up to 6 times lighter than concrete.
- Dimensional stability and static strength in all directions.
- Cost competitive against steel and concrete.
- Reduced construction time.
- Space creator, 1/3 thinner than concrete.
- Less demand for skilled workers on site.

Technical Approvals

CrossLam® is certified to meet the requirements of the Standard for Performance Rated CLT ANSI/ APA PRG 320 and the APA Product Report PR-L314, February 20, 2014.
Panel Properties

**The Allowable Bending Capacities**(a) for Structurlam’s CrossLam® CLT (for use in the US).

<table>
<thead>
<tr>
<th>CLT Grade (b)</th>
<th>Name</th>
<th>Layers</th>
<th>Depth (in)</th>
<th>Weight (lbs) per sq. ft</th>
<th>Major Strength Direction</th>
<th>Minor Strength Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$F_{u,0}^b$ (lbf/ft²)</td>
<td>$E_{0,0}$ (10⁶ psi)</td>
</tr>
<tr>
<td>V2M1</td>
<td>SLT3</td>
<td>3</td>
<td>3.90</td>
<td>10.5</td>
<td>1800</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>SLT5</td>
<td>5</td>
<td>6.66</td>
<td>17.0</td>
<td>4,275</td>
<td>321</td>
</tr>
<tr>
<td></td>
<td>SLT7</td>
<td>7</td>
<td>9.42</td>
<td>25.0</td>
<td>7,700</td>
<td>818</td>
</tr>
<tr>
<td></td>
<td>SLT9</td>
<td>9</td>
<td>12.18</td>
<td>32.0</td>
<td>12,075</td>
<td>1,662</td>
</tr>
</tbody>
</table>

(a) Tabulated values are allowable design values and not permitted to be increased for the lumber size adjustment factor in accordance with the NDS.

(b) The CLT grades are developed based on ANSI/APA PRG 320, as permitted by the standard using all visually graded No. 2 SPF lumber in both major and minor strength directions.

**Allowable Design Properties**(a) for Structurlam’s CrossLam® CLT (for use in the US).

<table>
<thead>
<tr>
<th>CLT Grade</th>
<th>Major Strength Direction</th>
<th>Minor Strength Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$f_{b,0}$ (psi)</td>
<td>$E_{0,0}$ (10⁶ psi)</td>
</tr>
<tr>
<td>V2M1</td>
<td>875</td>
<td>1.4</td>
</tr>
</tbody>
</table>

(a) Tabulated values are allowable design values and not permitted to be increased for the lumber size adjustment factor in accordance with the NDS. The design values shall be used in conjunction with the section properties provided by the CLT manufacturer based on the actual layup used in manufacturing the CLT panel (see Table above).
Panel Properties

Maximum Panel Size: 9’ 10.5” X 40’
Maximum Planed Panel Size: 7’ 10.5” x 40’
Maximum Thickness: 12.18”
Production Widths: 7’ 10.5” & 9’ 10.5”
Panel Edges: ¼” chamfer on long edges
Moisture Content: 12% (+/-2%) at time of production
Glue Specifications: Purbond polyurethane adhesive
Wood Species: SPF No.1/No. 2, other species available upon request
Squareness: Panel face diagonals shall not differ by more than 1/8”
Straightness: Deviation of edges from a straight line between adjacent panel corners shall not exceed 1/16”

Dimensional Tolerances

- **Thickness:** +/- 1/16” or 2% of the panel thickness whichever is greater
- **Width:** +/- 1/8” of the panel width
- **Length:** +/- 1/4” of the panel length (40ft panel)

Appearance Classification

**Visual**
- **Intended use:** A structural CLT panel that is used where one or both faces are left exposed.
- **Internal Fibre Layers:** SPF, NLGA Standard Grading Rules “No. 2 Structural” characteristics.
- **Face Layer:** SPF, “J” Grade (Japanese Grade), Douglas-fir (L3 Grade).

**Allowable Fibre Characteristics**
- **Shake and checks:** Several up to 2 feet long, none through.
- **Stain:** Up to a max of 5% blue stain, heart stain allowed.
- **Knots:** Firm & Tight (NLGA #2).
- **Pitch Streaks:** Not limited.
- **Wane on Face:** None.
- **Side Pressure on Visual Face:** Yes.

**Non-Visual**
- **Intended Use:** A structural CLT panel that is used where both faces are covered by another material.
- **Internal Fibre Layers:** SPF, NLGA Standard Grading Rules “No. 2 Structural” characteristics.
- **Face Layer:** SPF, NLGA Standard Grading Rules “No. 2 Structural” characteristics.

**Allowable Fibre Characteristics**
- **Shake and checks:** Allowed, shall not exceed 3’ or ¼ the length.
- **Stain:** Allowed, not limited.
- **Knots:** Firm & Tight (NLGA #2).
- **Pitch Streaks:** Not limited.
- **Wane on Face:** Minimal.
- **Side Pressure on Faces:** None.
Connection Details - Floor/Roof Panel Joints

1. **One row of self tapping screws on each side of joint inserted at an angle of 15 degrees.**

2. **Plywood spline is 1" thick x 5" wide.**

3. **One row of self tapping screws.**

4. **Standard overlap is 3 1/2".**

5. **Shear force transmission from panel to panel. Screw size and spacing as required for application.**

6. **CrossLam® panel.**

7. **Bent steel angle. Two rows of concrete screws for shear force transmission.**

8. **Concrete component (wall, ceiling, slab).**

9. **Moisture protection per project requirements.**

BASE POINT SOLE BRACKET
Connection Details - Panel to Panel

TYPICAL WALL TO FLOOR CONNECTIONS

1. CROSSLAM® PANEL
2. OPTION FOR WALL INTERSECTION
3. JOINT SEALANT TYP
5. MINIMUM 3” LENGTH OF PENETRATION INTO CONNECTED MEMBER.
6. BENT STEEL ANGLE. TWO ROWS OF SIMPSON STRONG TIE ANGULAR RINGED NAILS STAGGER EACH LEG.
7. FRAMING ANGLE. MINIMUM 1 AT EACH END OF WALL AND MINIMUM 1 AT EACH DOOR OPENING.
Connection Details - Panel to Panel

**ANGLE WALL JOINT**

1. SELF TAPPING SCREW.
2. MINIMUM 3” LENGTH OF PENETRATION INTO CONNECTED MEMBER.
3. EFFECTIVENESS OF SCREW CONNECTIONS DIMINISH FOR VERY SHALLOW ANGLES.
4. SCREWS ABSORB SHEAR FORCES PARALLEL TO BEARING OR WIND SUCTION FORCES.
5. FOR INCREASED FORCES TOWARDS THE INSIDE USE FULLY THREADED SCREWS.

**CORNER WALL JOINT**

**T-WALL JOINT**

**ROOF EXTERNAL WALL JOINT**
### CrossLam® Roof Panel Load Table

<table>
<thead>
<tr>
<th>PANEL TYPE</th>
<th>SIZE (in)</th>
<th>MAX. SPAN (ft)</th>
<th>NON-SNOW LOAD 125% (psf)</th>
<th>SNOW LOAD 115% (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>single span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT5</td>
<td>6.66</td>
<td>21.54</td>
<td>29.21</td>
<td>21.54</td>
</tr>
<tr>
<td>SLT7</td>
<td>9.42</td>
<td>26.95</td>
<td>37.36</td>
<td>26.95</td>
</tr>
<tr>
<td>SLT9</td>
<td>12.18</td>
<td>32.08</td>
<td>40.00*</td>
<td>32.08</td>
</tr>
<tr>
<td>double span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT3</td>
<td>3.90</td>
<td>20.00*</td>
<td>20.00*</td>
<td>20.00*</td>
</tr>
<tr>
<td>SLT5</td>
<td>6.66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT7</td>
<td>9.42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT9</td>
<td>12.18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*US CLT Handbook recommends L/300 for preliminary design.

**Span is governed by maximum panel length of 40ft - design as simple span using table values above.

### Notes:

1. For panel properties – see page 3. Span table assumes dry service conditions.
2. The following factors were used for calculations: \( C_D = 1.25 \) (non-snow) and \( C_D = 1.15 \) (snow); \( C_m = 1.0 \); \( C_t = 1.0 \); \( C_l = 1.0 \). (ref: Table 1 – Chapter 3 – 2013 US Edition of the CLT Handbook: cross-laminated timber).
3. Span table above includes panel self-weight plus 10psf miscellaneous dead load. [Ref: International Building Code 2012 - art. 1607.5]. Full deadloads were assumed.
4. Values in left column (green) correspond to a span governed by allowable bending stress, allowable shear stress or by time dependant deflection (creep - calculated using the following factor: \( K_{cr} = 2 \)) limit of L/300.
5. Values in right column correspond to maximum span governed by allowable bending stress, allowable shear stress or by dead plus live load deflection limit of L/180.
6. Spans shown represent distance between the centerlines of supports and are to be used for preliminary design only.
7. Spans are assumed to be equal for double span panels.
8. Engineer of Record to ensure that assumed deflection limit is appropriate for intended use.
9. CLT is NOT an isotropic material. Therefore the presented values must only be used for bending of panels in the longitudinal (major) axis.
10. Structurlam recommends considering long term deflection (creep) according to the proposed design method included in the 2013 US Edition of the CLT Handbook: cross-laminated timber.
11. For applications with deflection limits or loading different than what is included above, contact your Structurlam sales representative.
## CrossLam® Floor Panel Load Table

### MAX. SPAN (ft) FLOOR LIVE LOAD (psf)

<table>
<thead>
<tr>
<th>PANEL TYPE</th>
<th>SIZE (in)</th>
<th>MAX. SPAN-ft</th>
<th>FLOOR LIVE LOAD (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>40 Residential</td>
<td>50 Office/Classroom</td>
</tr>
<tr>
<td><strong>single span</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT3</td>
<td>3.90</td>
<td>11.50</td>
<td>13.60</td>
</tr>
<tr>
<td>SLT7</td>
<td>9.42</td>
<td>20.42</td>
<td>27.75</td>
</tr>
<tr>
<td><strong>double span</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT3</td>
<td>3.90</td>
<td>11.50</td>
<td>14.83</td>
</tr>
<tr>
<td>SLT5</td>
<td>6.66</td>
<td>16.22</td>
<td>20.00**</td>
</tr>
<tr>
<td>SLT7</td>
<td>9.42</td>
<td>20.41</td>
<td>24.82</td>
</tr>
<tr>
<td>SLT9</td>
<td>12.18</td>
<td>24.31</td>
<td>30.05</td>
</tr>
</tbody>
</table>

Notes:
1. For panel properties – see page 3. Span table assumes dry service conditions.
2. The following factors were used for calculations: $C_u=1.0, C_M=1.0, C_t=1.0, C_L=1.0$. (ref: Table 1 – Chapter 3 – 2013 US Edition of the CLT Handbook: cross-laminated timber).
3. Span table above includes panel self-weight, 20psf for the concrete topping plus 20psf miscellaneous dead load, and a 15psf partition load. (Ref: International Building Code 2012 – art. 1607.5.)
4. Values in left column (green) correspond to a span governed by allowable bending stress, allowable shear stress or by either allowable vibration (highlighted text - calculated according to chapter 7 of the 2013 US Edition of the CLT Handbook) or by time dependant deflection (creep - calculated using the following factor: $K_c=2$) limit of L/300.
5. Values in right column correspond to maximum span governed by either allowable bending stress, allowable shear stress or by dead plus live load deflection limit of L/240.
6. Spans shown represent distance between the centerlines of supports and are to be used for preliminary design only.
7. Spans are assumed to be equal for double span panels.
8. Engineer of Record to ensure that assumed deflection limit is appropriate for intended use.
9. CLT is NOT an isotropic material. Therefore the presented values must only be used for bending of panels in the longitudinal (major) axis.
10. Structurlam recommends considering vibration and long term deflection (creep) according to the proposed design method included in the 2013 US Edition of the CLT Handbook: cross-laminated timber.
11. For applications with deflection limits or loading different than what is included above, contact your Structurlam sales representative.
### CrossLam® Wall Panel Load Table (Axial Loading Only)

<table>
<thead>
<tr>
<th>Panel d (in)</th>
<th>SLT3</th>
<th>SLT5</th>
<th>SLT7</th>
<th>SLT9</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.90</td>
<td>6.66</td>
<td>9.42</td>
<td>12.18</td>
<td></td>
</tr>
<tr>
<td>L (ft)</td>
<td>Pr   (lbs/ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>31062</td>
<td>51778</td>
<td>71115</td>
<td>90263</td>
</tr>
<tr>
<td>8</td>
<td>26993</td>
<td>50462</td>
<td>70352</td>
<td>89724</td>
</tr>
<tr>
<td>10</td>
<td>21381</td>
<td>48275</td>
<td>69224</td>
<td>88968</td>
</tr>
<tr>
<td>12</td>
<td>16393</td>
<td>44782</td>
<td>67581</td>
<td>87938</td>
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<td>14</td>
<td>12688</td>
<td>39887</td>
<td>65209</td>
<td>86551</td>
</tr>
<tr>
<td>16</td>
<td>10021</td>
<td>34344</td>
<td>61864</td>
<td>84689</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>29124</td>
<td>57440</td>
<td>82206</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>24667</td>
<td>52187</td>
<td>78947</td>
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<td>22</td>
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<td>21005</td>
<td>46663</td>
<td>74823</td>
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<td>24</td>
<td></td>
<td>18028</td>
<td>41385</td>
<td>69917</td>
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<td>26</td>
<td></td>
<td>15603</td>
<td>36626</td>
<td>64514</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td>32464</td>
<td>58993</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td>28871</td>
<td>53670</td>
</tr>
</tbody>
</table>

**Notes:**
1. For panel properties – see page 3. Table assumes dry service conditions.
2. The following factors were used for calculations: C_d=1.0; C_m=1.0; C_t=1.0 (ref: Table 1- Chapter 3 - 2013 US Edition of the CLT Handbook: cross-laminated timber).
3. Panel ends condition are assumed as pinned (K_z=11.8, ref: Table 2 - Chapter 3 - 2013 US Edition of the CLT Handbook: cross-laminated timber).
4. Eccentricity of axial load and wind loading has not been included.
5. Pr = Φ Fcb A Kzc KC. Where the Pr values are not given, the slenderness ratio exceeds 50 (maximum permitted; AWC NDS 2012).
6. Engineer of Record to ensure that assumed compression resistance is appropriate for intended use.
7. CLT is NOT an isotropic material. Therefore the presented values must only be used for compression of panels in the longitudinal (major) axis.
8. For applications different than what is included above, contact your Structurlam sales representative.
Shear Wall and Diaphragm Applications

CrossLam® In-Plane Allowable Shear Capacity

<table>
<thead>
<tr>
<th>Panel d (in)</th>
<th>SLT3</th>
<th>SLT5</th>
<th>SLT7</th>
<th>SLT9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.90</td>
<td>6.66</td>
<td>9.42</td>
<td>12.18</td>
</tr>
<tr>
<td>Vr (lbs/ft)</td>
<td>2906</td>
<td>5812</td>
<td>8718</td>
<td>11624</td>
</tr>
</tbody>
</table>

Notes:
1. For panel properties – see page 3. Table assumes dry service conditions.
2. The following factors were used for calculations: $k_{mod} = 0.8; y_m = 1.25$.
3. Computed values based on “In-Plane Shear Capacity and Verification Methods” by Prof. G. Schickhofer, University of Graz.
4. Minimum width of wood used in lay-up is 3.5”.
5. Values are for CrossLam® panel only, not for shear connectors.
6. Table values are to be used for preliminary design only.
7. Engineer of Record to ensure that assumed shear capacity is appropriate for intended use.
8. For applications different than what is included above, contact your Structurlam sales representative.