Fasteners for Mass Timber

Max Closen

MyTiCon Timber Connectors
Auf der Baustelle gibt es große Fahrzeuge. Hast du schon den Betonmischer entdeckt?
Ein neuer Straßenabschnitt wird gebaut. Die Straßenwalze begradigt den Untergrund. Dann kommt der Asphalt auf die Straße. Was macht der Kran mit dem Betonträger?
Viele neue Häuser werden gebaut. Die Maurer bauen die Wände, die Zimmerer arbeiten am Dachstuhl. Und was macht der Schaufelbagger?
Where is Mass Timber?
So!

Understanding Mass Timber

Is also understanding

Fasteners for Mass Timber
Fasteners for Mass Timber today

• Self Tapping Wood Screws
• Beam Hangers
• Holdowns
• Reinforcements
• Panel Material Handling
Fastener - Performance

Capacity ➔ High or low

Stiffness ➔ Stiff or soft

Failure ➔ Brittle or ductile
Fasteners for Mass Timber

Self Tapping Screws
Basics - Performance
Basics - Performance
Basics - Performance

Relative displacement (inch)

Load per pair of STS (lbs)

Relative displacement (inch)

Load per pair of STS (lbs)
12.11 Wood screws

12.11.1 General
The design requirements specified in this Standard are based on the use of wood screws that meet the requirements of ASME B18.6.1. Nominal diameters and minimum design yield strengths shall be as specified in Table 12.11.1.

<table>
<thead>
<tr>
<th>Diameter, mm*</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.50</td>
<td>4.16</td>
<td>4.82</td>
<td>5.48</td>
</tr>
<tr>
<td>Minimum yield strength, MPa†</td>
<td>690</td>
<td>620</td>
<td>550</td>
<td>550</td>
</tr>
</tbody>
</table>

*For wood screw diameters greater than gauge 12, design in accordance with the lag screw requirements specified in Clause 12.6.
†Linear interpolation for yield strength may be used.
12.6.6 Lateral resistance

12.6.6.1 Side grain

Δ 12.6.6.1.1
The factored lateral strength resistance of a lag screw connection, \( P_r \), \( Q_r \), or \( N_r \), shall be greater than or equal to the effect of the factored loads, as follows:
(a) for parallel-to-grain loading:
\[
P_r = \phi P_u n_F L_G L_{PL}
\]
(b) for perpendicular-to-grain loading:
\[
Q_r = \phi Q_u n_F L_G L_{PL}
\]
(c) for loads at angle \( \theta \) to grain:
\[
N_r = \frac{P_r Q_r}{P_r \sin^2 \theta + Q_r \cos^2 \theta}
\]
where \( \phi = 0.6 \)

12.11.4 Lateral resistance

12.11.4.1
For two- or three-member connections, the factored lateral strength resistance of a wood screw connection shall be taken as follows:
\[
N_r = \phi N_u n_F n_s L_A L_E
\]
where \( \phi = 0.8 \)
\[N_u = n_u (K_D K_{SF} K_I)\]
where
\( n_u = \) unit lateral strength resistance, N (Clause 12.11.4.2)
\( n_F = \) number of fasteners in the connection
Design - Performance

![Graph showing lateral resistance vs screw length for different thread ratios. The graph compares two thread ratios, \( \phi = 0.8 \) and \( \phi = 0.6 \). The \( \phi = 0.8 \) line shows a significant increase in lateral resistance with screw length, while the \( \phi = 0.6 \) line remains relatively flat.]
Design - Performance

Evaluation Report CCMC 13677-R

ICC-ES Report
ESR-3179
DIVISION: 06 00 00—WOOD, PLASTICS, AND COMPOSITES
SECTION: 06 05 23—WOOD, PLASTIC, AND COMPOSITE FASTENINGS

ICC-ES Report
ESR-3178
DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
SECTION: 06 05 23—WOOD, PLASTIC, AND COMPOSITE FASTENINGS
Conversion - Performance
Conversion - Performance
Connection - Performance
Soft - Performance

![Graph showing load per pair of STS (lbs) vs. relative displacement (inch).]

Load per pair of STS (lbs)

Relative displacement (inch)
Soft - Performance

![Graph showing force per pair of screws (lb) vs. displacement (in) with labels for Quasi static load and Reverse cyclic load.](image-url)
Soft - Performance

Load per pair of STS (lbs) vs. Relative displacement (inch)
Soft - Performance

![Graph showing force per pair of screws (lb) vs. displacement (in) for quasi-static load and reverse cyclic load.]

- **Quasi static load**
- **Reverse cyclic load**
Stiff - Performance

![Graph showing load displacement relationship]

Relative displacement (inch)

Load per pair of STS (lbs)
Stiff - Performance

- Quasi static load
- Reverse cyclic load
Brittle - Performance
Ductile - Performance

![Graph showing force per pair of STS vs. relative displacement in inches]

- Force per pair of STS [lbf]
- Relative displacement [in]

January 9, 2019
Ductile - Performance

- Quasi static load
- Reverse cyclic load
Range - Performance
Opportunity - Performance
Opportunity - Performance
Opportunity - Performance

Load per pair of STS (lbs)

Relative displacement (inch)
Opportunity - Performance
Summary - Performance
Connection – Performance - Steel
Steel - Performance
Steel - Performance
Steel - Performance

![Load vs. Displacement Graph](chart)

- Relative displacement (inch) vs. Load per pair of STS (lbf)

![Wooden Structure](structure)

- Close-up of connection detail with red circle highlighting a component.
Steel - Performance
Steel - Performance

115,000 lbf

3/16”
Steel - Performance
Steel - Performance

9,000 lbf

Gutknecht 2017

3/16” Displacement (mm)
Summary – Performance - Steel

Gutknecht 2017
Fasteners for Mass Timber

Beam Hangers
Beam Hangers
Beam Hanger - Performance

- Pre Engineered and installed
- Failure mechanism
- Detailing requirements
- Fire resistance
- Adaptable
Pre manufacture - Performance
Pre manufacture - Performance
Failure - Performance
Failure - Performance
Failure - Performance
Failure - Performance
Failure - Performance
Failure - Performance
Failure - Performance
Detailing - Performance

Front View

Side View
Detailing - Performance

Front View

Side View
Detailing - Performance

Front View

Side View
Detailing - Performance
Detailing - Performance

Front View

Side View
Detailing - Performance

Front View

Side View
Detailing - Performance

Front View

Side View
Detailing - Performance

Girder Connection

Joist Connection

Girder Connection

Joist Connection
Fire - Performance

Fire Rating Achieved with Char Layer

Fire Rating with Char Layer
Adaptable - Performance

- Wood to concrete connections
- Wood to steel connections
- Skewed connections
Adaptable - Performance

• Double tilt connection
• Simple detailing
• Only needs parallel faces
Adaptable - Performance

Rafter to Ridge Beam Connection

$40^\circ \leq \theta \leq 90^\circ$
Adaptable - Performance

Joist to Beam Connection

Joist to Beam Connection
Summary - Performance
Fasteners for Mass Timber

Holdowns
Holdown - Performance
Holdown - Performance
Holdown - Performance
Holdown - Performance
Holdown - Performance
Holdown - Performance
Holdown - Performance

6 Fastener Tests

Load (kips) vs. Displacement (in)

- Test #1
- Test #2
- Test #3
- Test #4
- Test #5
- Test #6
Summary - Performance
Fasteners for Mass Timber Reinforcements
Think Concrete - Performance
Apply - Performance
Think Wood - Performance
Apply - Performance
Apply - Performance
Apply - Performance
Apply - Performance
Apply - Performance
Apply- Performance
Summary - Performance

Available technology not utilized yet
Fasteners for Mass Timber

Mass Timber Handling
Current state on a call:

Contractor: I am lifting wood things?
Me: What wood things?
Contractor: 20’ wide and 30’ tall formwork
Me: Wood formwork, framed?
Contractor: No, this wood is in panels
Me: Ah, CLT?
Contractor: Yes, those CLT things
Me: What is your estimated weight?
Contractor: Don’t know, I heard 12,000lbs
Me: Is 12,000lbs your gross weight?, You need to factor that up with a dynamic load

Contractor yelling: Hey Mike did you hear that, he's trying to tell me some scientific
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance

Figure 9 – Load-Deformation Curves:
Four 1/2-inch by 6.25-inch Screws in YOKE 8-0573-05
Device - Performance
Device - Performance

Shear Test 5T 10x160mm VG CSK

Non-retrofitted connections

Retrofitted connection

Load, P (k)

Displacement, Δ (in.)

Test 1, Pmax = 2.53 k
Test 2, Pmax = 3.88 k
Test 3, Pmax = 3.73 k
Test 3 Retrofit, Pmax = 7.41 k
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
Device - Performance
So!

Understanding Mass Timber

Is also understanding

Fasteners for Mass Timber
What have we looked at today?
Fastener - Performance
Fastener - Performance
Beam Hanger - Performance
Holdown- Performance
Apply - Performance
Material Handling - Performance
Outlook Future
Thank you!

Fasteners for Mass Timber

Max Closen

MyTiCon Timber Connectors