# Trus Joist® Coastal Construction Guide

Coastal construction requires special consideration of the potential for flooding due to temporary rises in sea level commonly associated with storms. Coastal construction requires compliance with National Flood Insurance Program (NFIP) regulations in addition to local building codes specifically developed for construction within a flood zone. Typical details of coastal residential buildings include elevating the habitable portions of the structure above the base flood elevation (BFE) as defined by NFIP or local codes. With few exceptions, building materials located below the BFE are required to be "Flood Damage-Resistant Materials" and may require special detailing to allow flood waters to pass through without displacing the structure. For wood construction, pile foundations are commonly used to elevate the structure above the BFE. This document provides some detailing and design guidance for connecting an elevated structure to a pile foundation. Design guidance contained within this guide is based on *Flood Resistant Design and Construction* (ASCE 24-24), and *Home Builder's Guide to Coastal Construction* (FEMA P-499) Technical Fact Sheet No. 3.3, Wood Pile-to-Beam Connections.

## Flood Damage-Resistant Materials

With the exception of Treated Parallam® Plus PSL, Weyerhaeuser engineered wood products (EWP) are not recommended or permitted for use below the BFE. For information on Flood Damage-Resistant Materials, refer to *Flood Damage-Resistant Material Considerations* (TB-213) and *Flood Damage-Resistant Materials Requirements* (FEMA Technical Bulletin 2). Treated Parallam® Plus PSL beams and columns are acceptable for use below the BFE when approved by the designer of record (DOR) and the governing jurisdiction. The DOR and the governing jurisdiction are ultimately responsible for determining suitability for the specific end use application and conditions. For additional design and installation guidance, reference *Trus Joist® Treated Parallam® Plus PSL Specifier's Guide* (TJ-7102).

## Available Widths and Depths of Treated Parallam® Plus PSL

**Treated Parallam® Plus PSL beams and headers are available in the following sizes:**
**Widths:** 3½" and 5¼"
**Depths:** 9¼", 11⅞", 14", and 16"

**Treated Parallam® Plus PSL columns and posts are available in the following sizes:**
3½" x 5¼" 5¼" x 5¼" 7" x 7"

## Moisture

Except for Treated Parallam® Plus PSL, Weyerhaeuser EWP are intended for dry-use applications. However, Treated Parallam® Plus PSL is permitted for use in wet conditions as defined by AWPA. Use Categories UC3B for beams or UC4B for columns. Design values for Treated Parallam® Plus PSL are dependent on the assumed Treated Parallam® Plus PSL Service Level (SL). For the design of connections, the fastener capacity for Parallam® PSL (untreated) is determined then adjusted for the appropriate Treated Parallam® Plus PSL Service Level (SL). Reference TJ-7102 for more information.



## Pile-to-Beam Connection

When placed above the BFE and fully protected from weather, any of Weyerhaeuser's engineered wood beam products (e.g. Microllam® LVL, TimberStrand® LSL, Parallam® PSL, or Treated Parallam® Plus PSL) may be used as beams supported by piles. Treated Parallam® Plus PSL is required when the beams are placed below the BFE or otherwise subject to wet-service conditions. Treated Parallam® Plus PSL beams are typically designed for SL1 or SL2 moisture conditions.

A design professional or engineer should confirm that the pile-to-beam connection has:

- Sufficient bearing capacity for the beam.
- Adequate uplift resistance.
- Capacity to resist lateral loads.

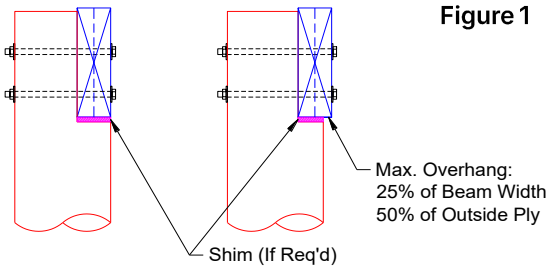



Figure 1

**General Notes:**

- Maintain beam in vertical position.
- Pile notch shall be limited to 50% of pile cross section.
- Each ply must be adequately supported. Maximum beam overhang is 25% of the beam width (single ply beam). For multi-ply beams, at least 50% of the outside ply must be supported (Figure 1).
- Shim between beam and pile as necessary; shim material must provide sufficient bearing capacity and not be prone to decay or corrosion.
- Two (2) ⅝" diameter bolts minimum. Use corrosion resistant connectors (refer to Hardware Recommendations section).

The reaction capacity of the beam is a function of the beam's bearing area, beam material, and moisture condition. The following table can be used to determine the allowable bearing capacity based on beam width, pile notch depth, beam material, and moisture condition. For additional reaction capacity information reference TJ-7102 and *Trus Joist® Beam, Header, and Column Specifier's Guide* (TJ-9000).

**BEAM BEARING CAPACITY [LB] (100% LOAD DURATION)[1]**

| Product | Service Moisture Condition | Pile Diameter [in.] | 3½" Beam | | 5¼" Beam | |
|---|---|---|---|---|---|---|
| | | | *Full Width[2] (3½ in.)* | *Partial Width[3] (2¼ in.)* | *Full Width[2] (5¼ in.)* | *Partial Width[3] (4 in.)* |
| TimberStrand® LSL | Dry Use above BFE | 8 | 19,030 | 10,435 | - | 22,620 |
| | | 10 | 22,050 | 11,905 | 35,345[5] | 26,405 |
| | | 12 | 24,695 | 13,210 | 42,815 | 29,700 |
| Microllam® LVL or Parallam® PSL[4] | Dry Use above BFE | 8 | 15,855 | 8,695 | - | 18,850 |
| | | 10 | 18,375 | 9,920 | 29,450[5] | 22,005 |
| | | 12 | 20,580 | 11,010 | 35,680 | 24,750 |
| Treated Parallam® Plus PSL | SL1[6] | 8 | 8,035 | 4,405 | - | 9,550 |
| | | 10 | 9,310 | 5,025 | 14,925[5] | 11,150 |
| | | 12 | 10,430 | 5,580 | 18,075 | 12,540 |
| Treated Parallam® Plus PSL | SL2[6] | 8 | 5,075 | 2,780 | - | 6,030 |
| | | 10 | 5,880 | 3,175 | 9,425[5] | 7,040 |
| | | 12 | 6,585 | 3,525 | 11,415 | 7,920 |

[1] May not be increased for duration of load.
[2] Full Width bearing (Figure 2a) is applicable if notch depth is greater than beam width (Figure 2b).
[3] Partial Width bearing (Figure 2c) is applicable when up to 25% of the beam width (or 50% of outside ply) is unsupported.
[4] Values representative of Eastern species Parallam® PSL manufactured at Buckhannon Plant No. 0579.
- For Western species Parallam® PSL, contact your Weyerhaeuser representative.

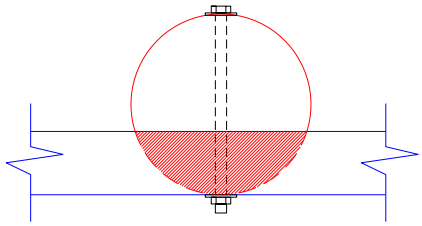


Figure 2a

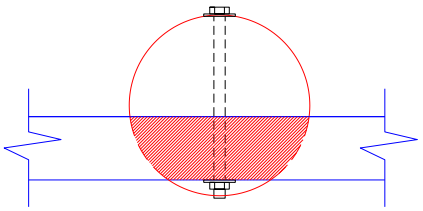


Figure 2b

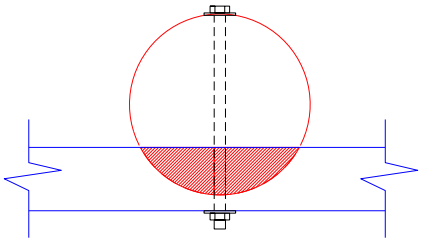


Figure 2c

[5] For 5¼″ beams supported on 10″ diameter piles, assumed bearing width is 5″.
[6] Treated Parallam® Plus PSL Service Levels take into account moisture content ranges that affect design properties. The equilibrium moisture content associated with each Service Level is as follows: SL0 ≤ 12%, 12% < SL1 ≤ 16%, 16% < SL2 ≤ 28%, and SL3 > 28%. See TJ-7102.

## Pile-to-Beam Uplift & Lateral Load Connection

The transfer of uplift and lateral loads from the beam to pile is normally accomplished by means of bolted connections. The *National Design Specification for Wood Construction* (NDS®) provides criteria for the design of these connections. The tables below provide material properties and minimum fastener spacing information. Figure 3 is a clip from FEMA P-499 Technical Fact Sheet No. 3.3 illustrating the minimum fastener spacing information.

### DESIGN PROPERTIES FOR CONNECTIONS[1]

| Product | Equivalent Specific Gravity | | Wet Service Factor ($C_M$) | | Modulus of Elasticity [x $10^6$ psi] | |
|---|---|---|---|---|---|---|
| | *Load Applied Parallel to Grain* | *Load Applied Perpendicular to Grain* | SL1 | SL2 | SL1 | SL2 |
| **Microllam® LVL** | 0.50 | 0.50 | 1.0 | NP[2] | 2.00 | NP[2] |
| **TimberStrand® LSL** | 0.50 | 0.58 | 1.0 | NP[2] | 1.55 | NP[2] |
| **Parallam® PSL** | 0.50 | 0.50 | 1.0 | NP[2] | 2.00 | NP[2] |
| **Treated Parallam® Plus PSL** | 0.50 | 0.50 | 0.69[3] | 0.50[3] | 1.65 | 1.49 |

[1] Connection design values must be calculated in accordance with NDS® Chapters 11 and 12 using the properties given above and adjusting by applicable factors specified in the NDS®.
[2] NP = Not Permitted; only Treated Parallam® Plus PSL can be used in wet-use conditions (Moisture Content > 16%).
[3] Connection design adjustment factor shall be 0.40 to avoid drying-induced splitting when a bolted connection is installed in wet material (SL2 or SL3) that is allowed to dry (SL0, SL1), subject to the exceptions noted in 2024 NDS® Table 11.3.3, footnote 2 (single fastener or row, separate side member for each row).

### BOLT FASTENER SPACING[1][2][3]

| Bolt Diameter | Member | Uplift Loading | | | Lateral Loading | | |
|---|---|---|---|---|---|---|---|
| | | *End Distance* | *Edge Distance* | *Bolt Spacing* | *End Distance* | *Edge Distance* | *Bolt Spacing* |
| **D** | **Beam** | 4D | 1.5D (Top)<br>4D (Bottom) | 4D | 7D (Tension)<br>4D (Compression) | 1.5D | 1.5D |
| | **Pile** | 7D | 1.5D | 4D | 4D | 4D (Loaded)<br>1.5D (Unloaded) | (5L + 10D)/8 |
| **⅝″** | **Beam** | 2½″ | 1″ (Top)<br>2½″ (Bottom) | 2½″ | 4⅜″ (Tension)<br>2½″ (Compression) | 1″ | 1″ |
| | **Pile** | 4⅜″ | 1″ | 2½″ | 2½″ | 2½″ (Loaded)<br>1″ (Unloaded) | 1⅞″ |

[1] Connection design values must be calculated in accordance with NDS® Chapters 11 and 12 using the properties given above and adjusting by applicable factors specified in the NDS®.
[2] Specified distances maintain $C_\Delta$ = 1.0. Refer to NDS® for $C_\Delta$ values when end or edge distances are less than shown.
[3] D = bolt diameter; L = beam width.

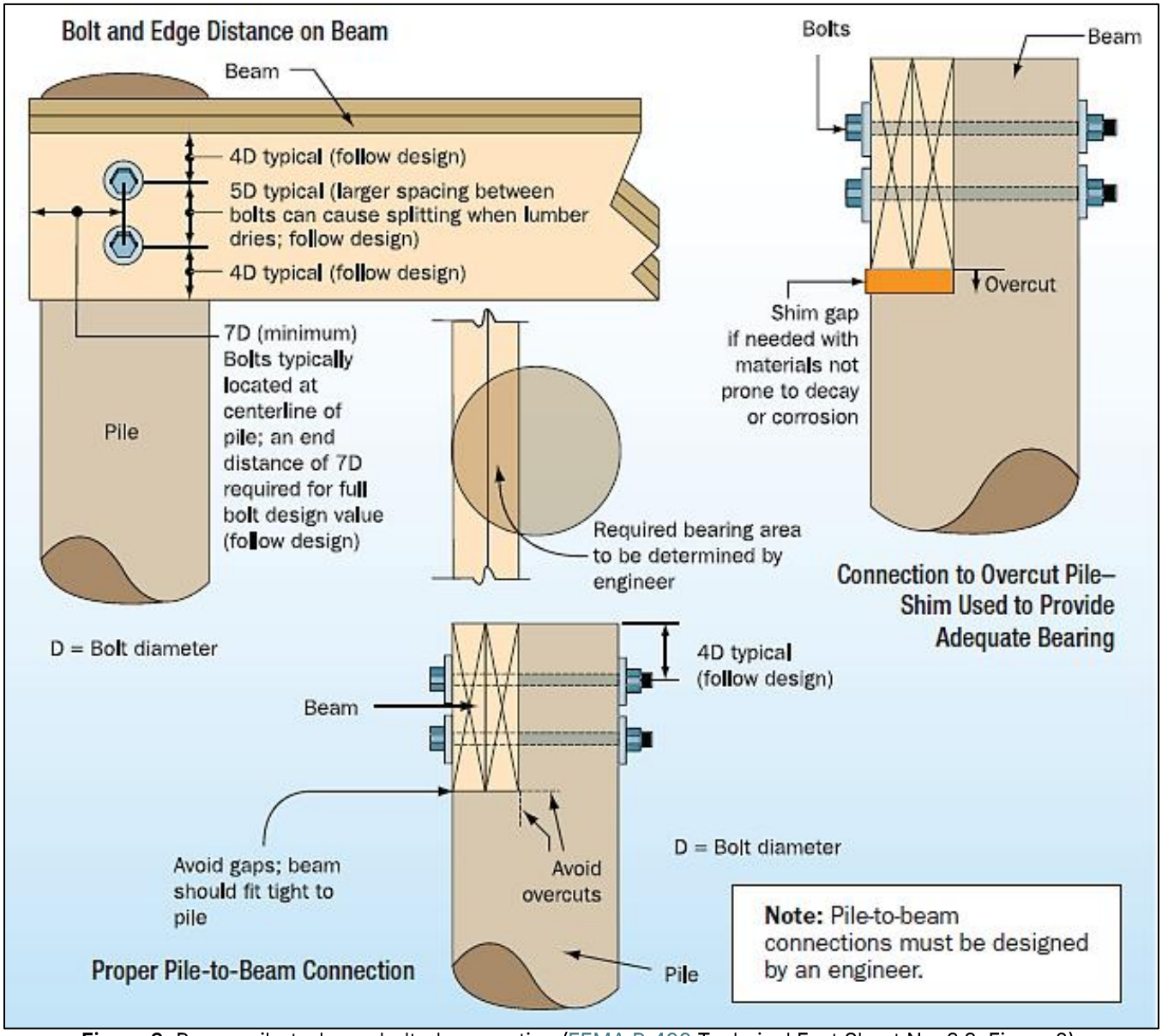



**Figure 3:** Proper pile-to-beam bolted connection (FEMA P-499 Technical Fact Sheet No. 3.3, Figure 2).

## Connection Design Example 1 (Uplift Design)

**Given:**

- 3½″ x 11⅞″ Treated Parallam® Plus PSL beam (MC<19%, as manufactured) place below the BFE.
- 10″ Southern Pine treated pile (SG = 0.55). For determining edge distances for bolts in the pile, the outer ½″ of the pile is neglected to account for the reduced thickness of cross section due to the round shape.
- ⅝″ bolts (refer to hardware manufacturer for corrosion protection requirements).
- Allowable Stress Design per NDS® Chapters 11 and 12.
- $C_t = C_g = C_{eg} = C_{tn} = 1.0$.
- Load duration factor ($C_D$) = 1.6.

**Requirement:**

Determine the capacity of the connection to resist uplift loads applied to the beam(s) for both SL1 and SL2 moisture conditions.

**Solution:**

Calculate the reference lateral design value ($Z$) per NDS®. Check all six (6) connection yield modes. Reference American Wood Council for a web-based connection calculator. Example 1 is based on 3½″ main and side member thicknesses, single shear loading with a wood side member (parallel loading of the pile and perpendicular loading of the beam). Use "Douglas Fir-Larch" side member to achieve the proper specific gravity for Parallam® PSL (SG = 0.50).

$$Z' = Z \times C_D \times C_M \times C_\Delta \ (see\ Design\ Example\ 1\ Summary\ table)$$

**Notes:**

- $C_\Delta$ = 1.0 based on maintaining all NDS® required end and edge distances for both the beam and pile. See Figures 4 and 5 for required distances based on this example.
- $C_M$ = 0.69 when Treated Parallam® Plus PSL is used for SL1.
- $C_M$ = 0.50 when Treated Parallam® Plus PSL is used for SL2 if the connection is fabricated in the dry condition.
- $C_M$ = 0.40 when Treated Parallam® Plus PSL is used for any SL if connection is fabricated in the wet condition.
- The shear capacity of the beam(s) must also be evaluated for notch effect at the connection (not shown) in accordance with NDS®.

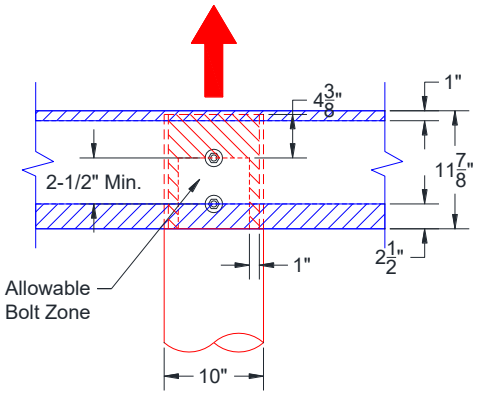



**Figure 4:** Uplift Design (Continuous Beam).

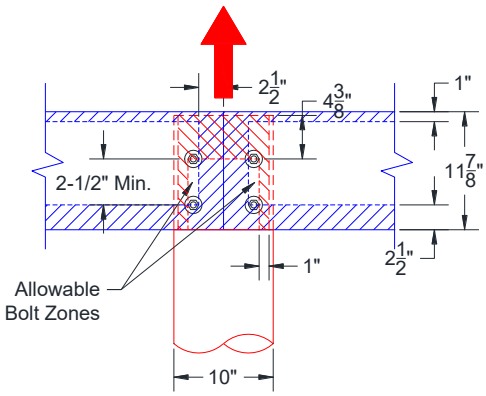



**Figure 5:** Uplift Design (Spliced Beam).

DESIGN EXAMPLE 1 SUMMARY

| Product (Moisture Condition) | Z [lb/bolt] | $C_M$ | $C_D$ | $C_\Delta$ | Z′ [lb/bolt] | Figure 4 Effective Bolts | Figure 4 Capacity [lb] | Figure 5 Effective Bolts | Figure 5 Capacity [lb] |
|---|---|---|---|---|---|---|---|---|---|
| Parallam® PSL (Dry Use) | 711 | 1.0 | 1.6 | 1.0 | 1138 | 2 | 2276 | 4 | 4552 |
| Treated Parallam® Plus PSL (SL1) | 711 | 0.69 | 1.6 | 1.0 | 785 | 2 | 1570 | 4 | 3140 |
| Treated Parallam® Plus PSL (SL2) | 711 | 0.50 | 1.6 | 1.0 | 569 | 2 | 1138 | 4 | 2276 |
| Treated Parallam® Plus PSL (Connections fabricated wet) | 711 | 0.40 | 1.6 | 1.0 | 455 | 2 | 910 | 4 | 1820 |

## Connection Design Example 2 (Lateral Design)

**Given:**

- 3½″ main and side member thicknesses (parallel loading of the beam and perpendicular loading of the pile).
- Required end and edge distances shown in Figures 6 and 7.
- All other assumptions same as for Design Example 1.

**Requirement:**

Determine the capacity of the connection to resist lateral loads applied to the beam for both SL1 and SL2 moisture conditions.

**Solution:**

Calculate the reference lateral design value ($Z$) per NDS®. Check all six (6) connection yield modes. Reference American Wood Council for a web-based connection calculator. Example 2 is based on 3½″ main and side member thicknesses, single shear loading with a wood side member (parallel loading of the pile and perpendicular loading of the beam). Use “Douglas Fir-Larch” side member to achieve the proper specific gravity for Parallam® PSL (SG = 0.50).

$$Z' = Z \times C_D \times C_M \times C_\Delta (See\ Design\ Example\ 2\ Summary\ table)$$

**Notes:**

- In Figure 7, the lateral compression load coming from the left cannot be assumed to bear equally on all four bolts, because the members may not be in tight contact. In addition, the end and edge distances for the two bolts on the right do not meet the NDS® requirements. Therefore, only the left two bolts are effective for this loading condition. If a tension load were applied to the beam, the loaded edge distance from the bolts to the edge of the pile would not meet the minimum NDS® requirement, so the connection should not be assigned a capacity for a tension load on the beam.
- $C_M$ = 0.69 when Treated Parallam® Plus PSL is used for SL1.
- $C_M$ = 0.50 when Treated Parallam® Plus PSL is used for SL2 if the connection is fabricated in the dry condition.
- $C_M$ = 0.40 when Treated Parallam® Plus PSL is used for any SL if connection is fabricated in the wet condition.
- The shear capacity of the pile must also be evaluated for notch effect at the connection (not shown) in accordance with NDS®.

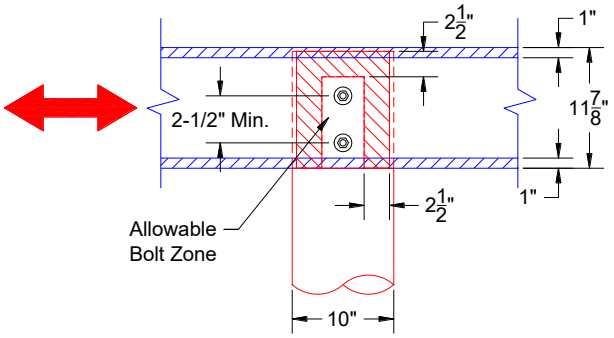



**Figure 6:** Lateral Design (Continuous Beam).

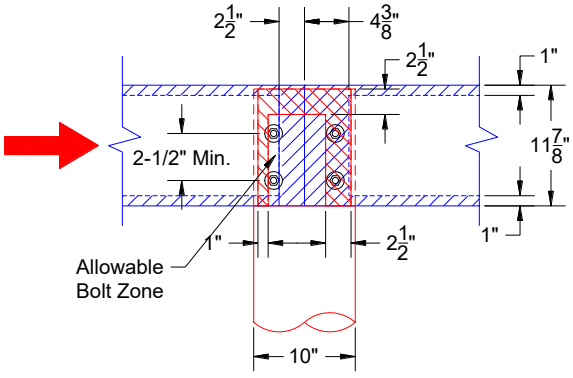



**Figure 7:** Lateral Design (Spliced Beam) (Load transfer hardware such as a strap across beams may be required by the DOR).

**DESIGN EXAMPLE 2 SUMMARY**

| Product (Moisture Condition) | Z [lb/bolt] | $C_M$ | $C_D$ | $C_\Delta$ | Z′ [lb/bolt] | Figure 6 Effective Bolts | Figure 6 Capacity [lb] | Figure 7 Effective Bolts | Figure 7 Capacity [lb] |
|---|---|---|---|---|---|---|---|---|---|
| Parallam® PSL (Dry Use) | 767 | 1.0 | 1.6 | 1.0 | 1227 | 2 | 2454 | 2 | 2454 |
| Treated Parallam® Plus PSL (SL1) | 767 | 0.69 | 1.6 | 1.0 | 847 | 2 | 1694 | 2 | 1694 |
| Treated Parallam® Plus PSL (SL2) | 767 | 0.50 | 1.6 | 1.0 | 614 | 2 | 1227 | 2 | 1227 |
| Treated Parallam® Plus PSL (Connections fabricated wet) | 767 | 0.40 | 1.6 | 1.0 | 491 | 2 | 982 | 2 | 982 |

## Joist to Beam Connection

Figure 8 illustrates a typical joist to beam connection when the floor framing does not cantilever beyond the support beam. In this condition, the TJI® joists are fastened to the beam and rim board per detail A3 in *Trus Joist® TJI® Joist Specifier's Guide* (TJ-4000). The DOR shall specify the appropriate fastening for the transfer of uplift and lateral loads from the structure above to the beam below. TimberStrand® LSL Rim Board can be utilized as part of this uplift and lateral load transfer system. Use appropriate corrosion resistant connectors (refer to Hardware Recommendations section).

***TJI® joists and TimberStrand® LSL are intended for dry-use applications***

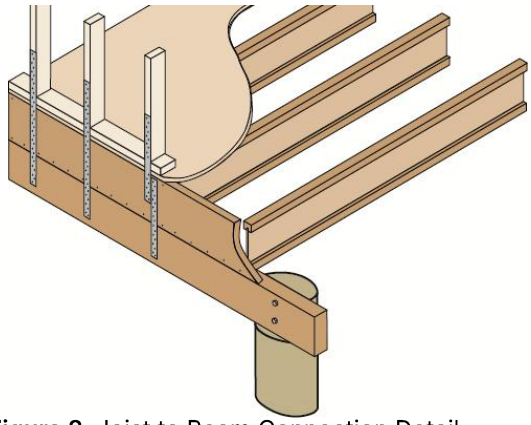


**Figure 8:** Joist to Beam Connection Detail.

## Joist to Beam Connection (Cantilever Condition)



Figure 9 illustrates a typical joist to beam connection when the floor framing cantilevers beyond the supporting beam. In this condition, the TJI® joists are fastened to the beam and blocking panel per the cantilever details in TJ-4000. The TJI® joists must also transfer the uplift load from the structure above to the beam below. The TJI® joists may also require reinforcement to provide sufficient capacity to transfer vertical gravity loads. Refer to TJ-4000 for cantilever reinforcement requirements. The DOR shall specify the appropriate fastening for the transfer of uplift and lateral loads from the structure above to the beam below. Uplift connectors should be fastened to the web of the TJI® joists (web stiffeners installed as required). Blocking panels may be used for lateral load transfer. Use appropriate corrosion resistant connectors (refer to Hardware Recommendations section).

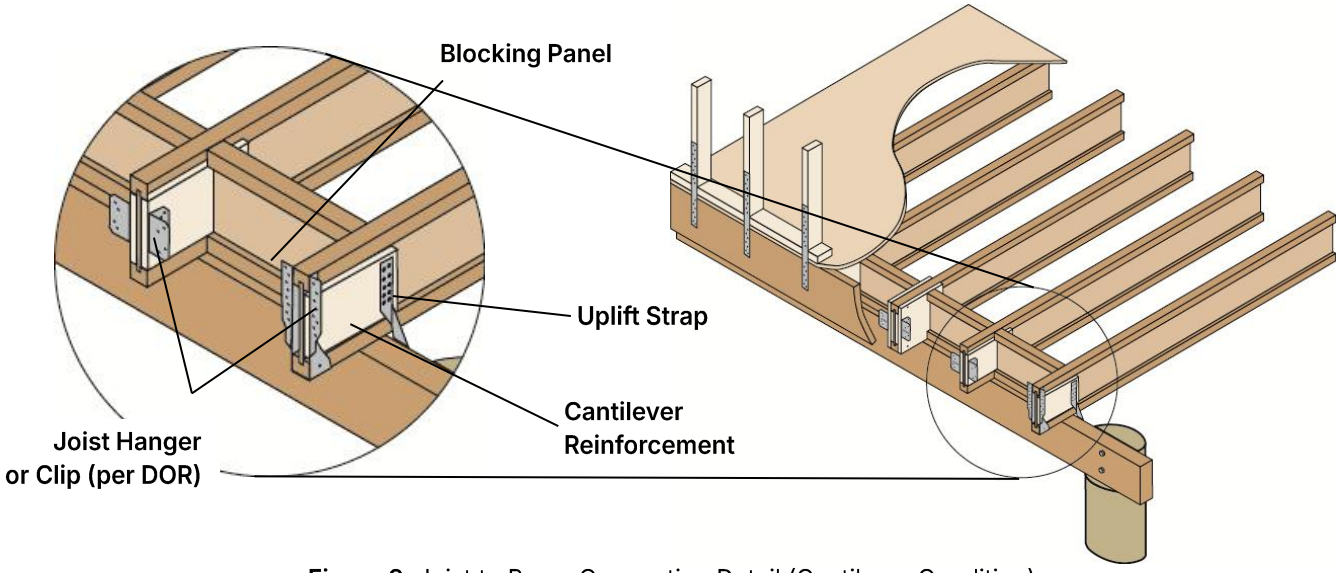



**Figure 9:** Joist to Beam Connection Detail (Cantilever Condition).

***TJI® joists are intended for dry-use applications***

## Perimeter Beam Cladding

Except for Treated Parallam® Plus PSL, Weyerhaeuser EWP must be placed above the BFE and fully protected from weather. Protecting Treated Parallam® Plus PSL may also be desirable to achieve higher design capacities (SL1 vs. SL2), and to improve serviceability. Figures 10 and 11 illustrate typical cladding protection of perimeter beams above the BFE. Figure 11 provides an example of an exterior bearing wall perpendicular to a dropped beam. Due to the lack of rim board below the bearing wall, a "Flush Beam" is required to transfer the wall load to the supporting structure.

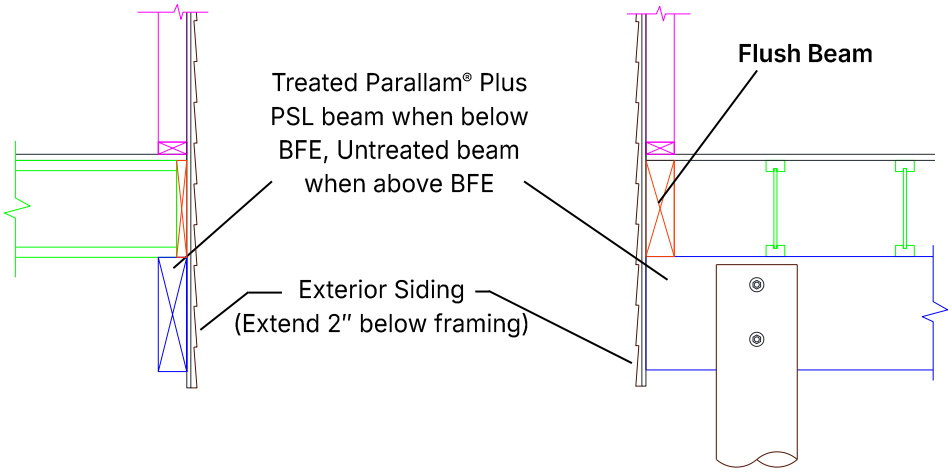



**Figure 10:** Siding Detail (Parallel to Beam).




**Figure 11:** Siding Detail (Perpendicular to Beam).

## Hardware Recommendations

Due to the high moisture content typically present where Treated Parallam® Plus PSL is used, it is very important to use building code approved, corrosion-resistant fasteners and connectors for all applications. Fasteners include nails, screws, and bolts. Connectors include straps, joist hangers, post bases, and hurricane or mudsill anchors.

Fasteners and connectors must have a coating that will provide the required level of corrosion resistance for the treatment types, retention levels, and end use conditions for Treated Parallam® Plus PSL. To ensure that you select the appropriate hardware, follow the hardware manufacturer's recommendation for AWPA Use Category UC4A for columns and beams in exposed above ground applications. For columns exposed to saltwater splash follow recommendations for greater than UC4A (UC4B).

***If you have any questions, please contact your Weyerhaeuser representative.***

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