

Attachment of Residential Deck Ledger to Metal Plate Connected Wood Truss Floor Systems

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Structural Building Components Association (SBCA)

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This research report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:

- [IBC Section 104.11.1](#) and [Section 1703.4.2](#) – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources*."
- [IBC Section 202](#) – "**APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

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Introduction:

This research report provides construction details for residential deck ledger attachment to metal plate connected wood truss floor systems. The applicable codes and standards follow the *2009, 2012 and 2015 International Building Code (IBC)* and the *2009, 2012 and 2015 International Residential Code (IRC)*. Proper attachment of the deck ledger to the house is critical for ensuring that an “attached” deck is safely and securely supported at this location. This report provides details for attaching a 2" nominal lumber deck ledger to residential floor systems constructed with metal plate connected wood (MPCW) floor trusses.

Key Definitions:

DECK LEDGER - A horizontal lumber beam attached to an existing wall and used to tie in construction elements such as porch roofs and decks. A deck ledger is installed as part of the deck frame construction and supports one end of the deck joists.

TRUSS - An engineered structural component, assembled from wood members, metal connector plates and other mechanical fasteners, designed to carry its own weight and superimposed design loads. The truss members form a semi-rigid structural framework and are assembled such that the members form triangles.

WOOD STRUCTURAL PANEL (WSP) - A panel manufactured from wood veneers, strands or wafers or a combination of veneer and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems. Examples include: plywood, Oriented Strand Board (OSB), waferboard and composite panels.

Background:

The *2009, 2012 and 2015 IRC* include prescriptive provisions for attaching a 2" nominal lumber deck ledger to a 2" nominal lumber band joist bearing directly on a sill plate or wall plate using ½"-diameter bolts or lag screws. AF&PA's American Wood Council, in cooperation with the International Code Council, has also developed *Design for Code Acceptance No. 6 (DCA6) – Prescriptive Residential Deck Construction Guide*, available at awc.org.

The prescriptive provisions for the deck ledger connection to the band joist in the *IRC* and *DCA6* are based on the results from a series of ultimate load tests conducted at Virginia Polytechnic Institute and State University (VT) Department of Wood Science and Forest Products, and Washington State University (WSU) Wood Materials and Engineering Laboratory. This testing evaluated the capacity 2" nominal pressure-preservative-treated (PPT) Hem-Fir (HF) and Southern Pine (SP) ledgers attached to either 2" nominal Spruce-Pine-Fir (SPF) or 1" net Douglas-Fir (DF) laminated veneer lumber (LVL) band joists, through 1⁵/₃₂"-thick oriented strand board (OSB) sheathing, with ½"-diameter hot-dipped galvanized (HDG) bolts or lag screws, meeting the requirements of *ANSI/ASME Standard B18.2.1*.

The deck ledger assemblies evaluated at VT and WSU were deemed to represent commonly accepted means of connecting deck ledgers to band joints that cannot be evaluated using the provisions of the *National Design Specification® for Wood Construction (NDS®)* because:

1. The ledger is not in direct contact with the band joist (i.e., separated by 1⁵/₃₂" OSB sheathing).
2. The minimum required penetration depth of four diameters (4D) is not met when using ½"-diameter lag screws into an 1¹/₂"-thick band joist.

Application:

The details and fastener spacing tables provided in this report for connecting a 2" nominal lumber deck ledger to a residential floor system constructed with MPCW trusses use a single shear reference lateral design value, Z, of 710 lbs. for a ½"-diameter bolt and 375 lbs. for a ½" x 6" lag screw. These lateral design values were developed from the VT and WSU testing, and assume the fasteners are installed in accordance with the *NDS* requirements for clearance holes, lead holes, edge distance and end distance.

Detail 1 includes construction information for attaching 2" nominal lumber deck ledgers to the ends of MPCW floor trusses spaced no more than 24" o.c.

Detail 2 includes construction information for attaching 2" nominal lumber deck ledgers to the side of a MPCW floor ladder frame with 4x4 vertical webs spaced no more than 16" o.c.

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[Detail 3](#) includes deck lateral load connection options capable of resisting the 1500 lbf lateral load requirement specified in 2009, [2012 and 2015 IRC Section 507](#).

[Table 1](#) provides the maximum on-center spacing for each ½"-diameter bolt or ½" x 6" lag screw used to attach the ledger to the floor truss system for deck joist spans up to 18', for design deck loads of 40 or 60 psf live load (or 40 or 60 psf snow load) and 10 psf dead load

Support of concentrated loads from deck beams of girders are beyond the scope of this report. Deck ledgers shall not be supported on stone or masonry veneer.

Installation:

The following is a summary of the minimum requirements and limitations for installing a 2" nominal lumber deck ledger with residential floor systems constructed with MPCW floor trusses.

1. Ledger must be 2x10 or 2x12 PPT or code-approved decay-resistant lumber with a specific gravity, $G \geq 0.43$. Ledger shall be identified by the grade mark of, or certificate of inspection issued by, an approved lumber grading or inspection bureau or agency. PPT material must be pressure-treated with an approved process in accordance with American Wood Protection Association standards
2. Install ledger directly over wood structural sheathing ($1\frac{5}{32}$ " maximum thickness) fastened to the wall per the building code.
3. Attach ledger through wood structural sheathing into 2-ply 2x4 truss end vertical, 4x4 vertical web or key-block with ½" x 6" lag screws or ½"-diameter bolts with washers and nuts.
 - 3.1 Only one (1) fastener into each truss member or key-block.
 - 3.2 Install each fastener through the centerline of the truss member or key-block and position so as not to interfere with bottom and top chord joints and connector plates. Refer to [Detail 1](#) and [Detail 2](#) for spacing requirements
 - 3.3 Lag screws and bolts shall be installed according to 2015 NDS requirements. A "test" installation is recommended before drilling the lead holes, to ensure that the lead holes are neither too small nor too large.
 - ½" x 6" lag screws:
 - Lead holes for the threaded portion shall be $\frac{5}{16}$ ".
 - Clearance holes shall be ½" and the same depth of penetration as the length of unthreaded shank.
 - ½"-diameter bolts:
 - Holes shall be a minimum of $1\frac{7}{32}$ " to a maximum of $\frac{9}{16}$ ".

All fasteners used with PPT wood shall be hot-dip zinc-coated galvanized steel, stainless steel, silicon bronze, or copper. Fasteners to be hot-dipped galvanized shall meet the requirements of *ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*, Class D, for fasteners $\frac{3}{8}$ " diameter and smaller or Class C for fasteners with diameters over $\frac{3}{8}$ ". Lag screws, bolts, nuts and washers are permitted to be mechanically deposited zinc-coated steel with coating weights in accordance with *ASTM B695*, Class 55, minimum.

All hardware (e.g., joist hangers, hold-down device, etc.) shall be galvanized or shall be stainless steel. Hardware to be hot-dipped prior to fabrication shall meet *ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*, G-185 coating. Hardware to be hot-dipped galvanized after fabrication shall meet *ASTM A123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.

- Fasteners and hardware exposed to saltwater or located within 300' of a salt water shoreline shall be stainless steel grade 304 or 316.
- Fasteners and hardware shall be of the same corrosion-resistant material.

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- Other coated or non-ferrous fasteners or hardware shall be as approved by the authority having jurisdiction.
4. Install flashing at top of ledger for water tightness. Flashing shall be corrosion-resistant metal of minimum nominal 0.019" thickness or an approved non-metallic material. Do not use aluminum flashing in direct contact with lumber treated with preservatives containing copper, such as ACQ, Copper Azole or ACZA.
 5. Two-ply 2x4 truss end verticals, 4x4 truss vertical webs and key-blocks connected to ledger with lag screws or bolts shall have a specific gravity, $G \geq 0.42$ (includes DF, HF, SP and SPF).
 - Construct key-blocks with minimum 2x4 No. 2 or better lumber.
 - Install key-blocks at required locations. Cut to fit tight.
 - Refer to [Detail 1](#) and [Detail 2](#) for additional information concerning key-block construction and attachment.
 6. Connect Joist to meet the Lateral Load Connection requirement of IRC 2015 for 1500 lbf.

Detail 3 is one option for meeting this requirement. Step by step instructions for this option are as follows:

For Ledger attached to end of truss (Figure 8):

- a.) Apply 24" long, full-height 7/16" 24/16 (minimum) span rated OSB or Plywood gusset to one side at end of truss. Carefully notch gusset for tight fit around ribbon board. Attach gusset to each 4x2 truss member with 1 row of 10d (0.131" x 3") nails spaced at 3" oc.
- b.) Apply Hold-Down capable of resisting 750 lbs minimum. Install hold-downs at four (4) locations, evenly distributed along ledger with one (1) hold-down within 2' of each end of ledger. Attach hold-down to 2-ply truss end vertical with 3/8" dia. fully threaded lag screw pre-drilled, with minimum 3" penetration into end vertical and to deck joist per manufacturer's specifications. Install Lag screw through center of 2-ply end vertical so as not to damage/disturb with/damage connector plates.

For Ledger attached to side of Floor Ladder Frame (Figure 9):

- a.) Apply minimum 2x_ SPF block of same depth as deck joists to one side of each 4x4 vertical web or key-block to which the hold-down is attached. Cut block to fit tight between exterior sheathing and side of first interior floor truss. Carefully notch block for tight fit around top chord of ladder frame. Attach block to side of 4x4 web or 2-ply key-block with 6-10d (0.131" x 3") nails and to floor sheathing with 1-row of 7-10d (0.131" x 3") nails spaced evenly along block.
- b.) Apply Hold-Down capable of resisting 750 lbs minimum. Install hold-downs at four (4) locations, evenly distributed along ledger with one (1) hold-down within 2' of each end of ledger. Attach hold-down to 4x4 vertical truss web or 2-ply key-blocks with 3/8" dia. fully threaded lag screw pre-drilled, with minimum 3-1/2" penetration into web/key-block and to deck joist per manufacturer's specifications. Install Lag screw through center of web or key-block so as not to damage/disturb with or damage connector plates.

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Truss Connection Condition	Deck Loading	Connection Details	Joist Span						
			≤ to 6'	6'-1" to 8'	8'-1" to 10'	10'-1" to 12'	12'-1" to 14'	14'-1" to 16'	16'-1" to 18'
			On-center Spacing of Fasteners (in.) ⁴						
End Connection	Live Load = 40 psf, Dead Load = 10 psf, Snow Load ≤ 40 psf	1/2" x 6" lag screw with 15/32", max., wood structural sheathing	24	12 ⁵	12 ⁵	12 ⁵	12 ⁵	8 ⁶	8 ⁶
		1/2" diameter bolt with 15/32", max., wood structural sheathing	24	24	24	24	24	12 ⁵	12 ⁵
	Live Load = 60 psf, Dead Load = 10 psf, Snow Load ≤ 60 psf	1/2" x 6" lag screw with 15/32", max., wood structural sheathing	12 ⁵	12 ⁵	12 ⁵	8 ⁶	8 ⁶	8 ⁶	Use bolted connection
		1/2" diameter bolt with 15/32", max., wood structural sheathing	24	24	24	12 ⁵	12 ⁵	12 ⁵	12 ⁵
Side Connection	Live Load = 40 psf, Dead Load = 10 psf, Snow Load ≤ 40 psf	1/2" x 6" lag screw with 15/32", max., wood structural sheathing	16	16	16	8 ⁷	8 ⁷	8 ⁷	8 ⁷
		1/2" diameter bolt with 15/32", max., wood structural sheathing	32	32	32	16	16	16	16
	Live Load = 60 psf, Dead Load = 10 psf, Snow Load ≤ 60 psf	1/2" x 6" lag screw with 15/32", max., wood structural sheathing	16	16	8 ⁷	8 ⁷	8 ⁷	8 ⁷	Use bolted connection
		1/2" diameter bolt with 15/32", max., wood structural sheathing	32	32	16	16	16	8 ⁷	8 ⁷

1. Ledgers shall be flashed in accordance with applicable building code requirements to prevent water from contacting the exposed wood structural sheathing and floor truss.
2. Snow load shall not be assumed to act concurrently with live load.
3. Ledgers must be 2x10 or 2x12 PPT or code-approved decay-resistant lumber with specific gravity, $G \geq 0.43$. Truss 2-ply 2x4 end verticals and key-blocks must have a $G \geq 0.42$.
4. Stagger lag screws and bolts as shown in [Detail 1](#) for End Connection and [Detail 2](#) for Side Connection.
5. If trusses are spaced greater than 12" o.c., install key blocks between the trusses to provide ledger attachment every 12". Attach ledger to 2-ply end vertical of each truss with one (1) fastener and to each key-block with one (1) fastener. Refer to [Detail 1](#) for key-block construction and installation information.
6. Install key blocks between the trusses, as required, to provide ledger attachment every 8". Attach ledger to 2-ply end vertical of each truss with one (1) fastener and to each key-block with one (1) fastener. Refer to [Detail 1](#) for key-block construction and installation information.
7. Install key blocks between the vertical webs of the floor ladder frame to provide ledger attachment every 8". Attach ledger to each 4x4 vertical web with one (1) fastener and to each key-block with one (1) fastener. Refer to [Detail 2](#) for key-block construction and installation information.

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Detail 1 (Figures 1, 2 & 3): Attachment of Deck Ledger to End of Floor System with MPCW Trusses

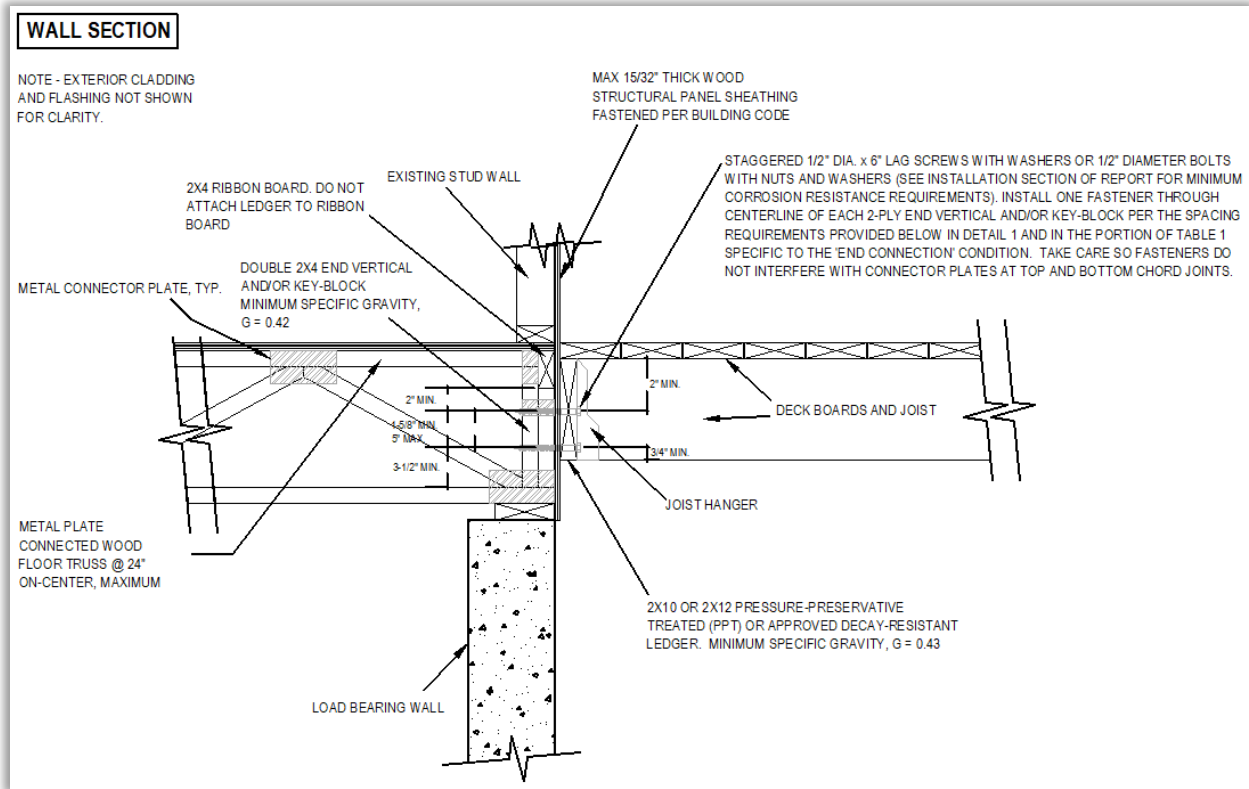


Figure 1

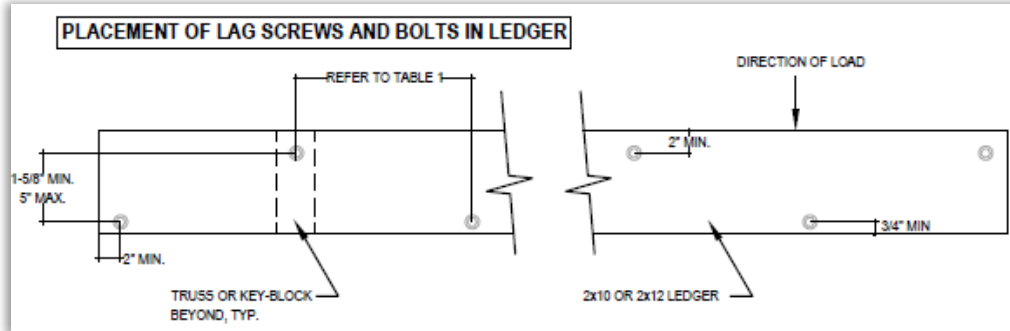


Figure 2

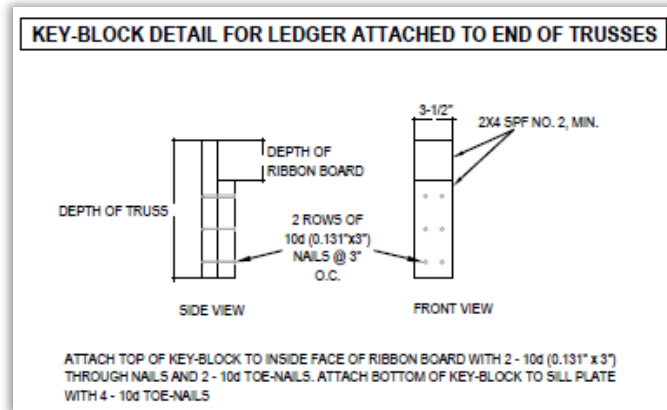


Figure 3

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Detail 2 (Figures 4, 5, 6 & 7): Attachment of Deck Ledger to Floor System with MPCW Trusses, When Ledger is Installed Parallel to Truss Span & Spacing of Screws is Less Than the Spacing of the Verticals

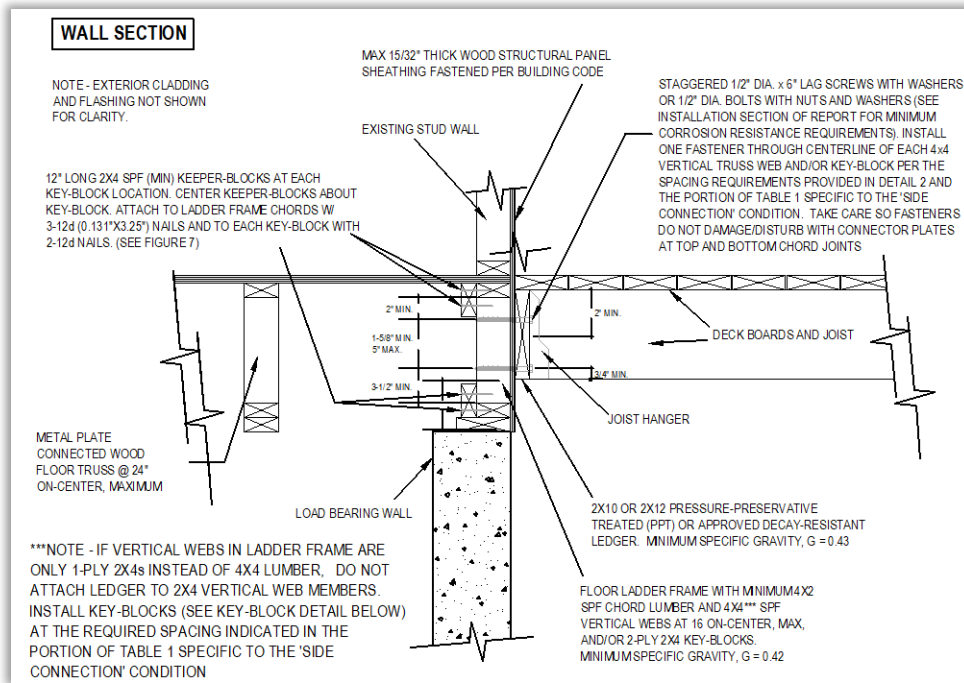


Figure 4

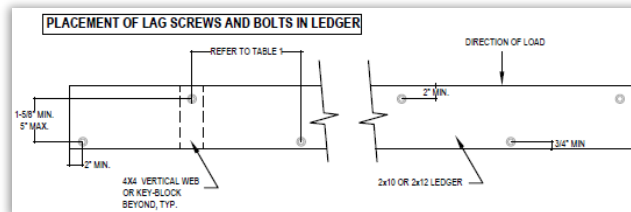


Figure 5

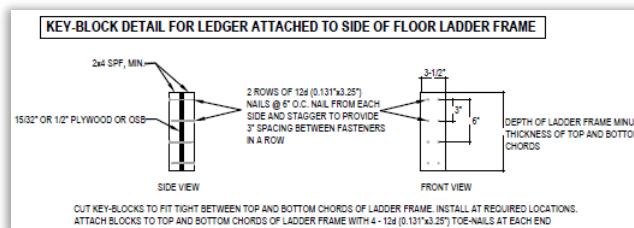


Figure 6

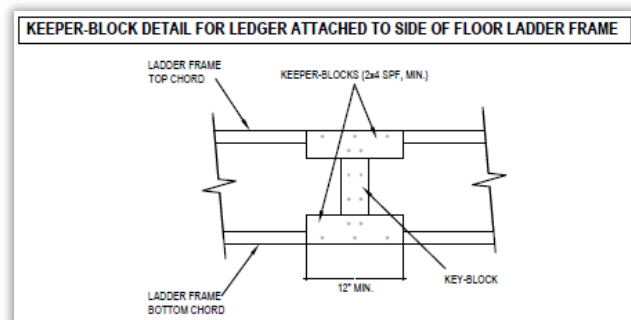


Figure 7

Detail 3 (Figures 8 & 9): Deck Lateral Load Connection Capable of Resisting the 1500 lbf Lateral Load Requirement Specified in 2009, [2012 and 2015 IRC Section 507](#)

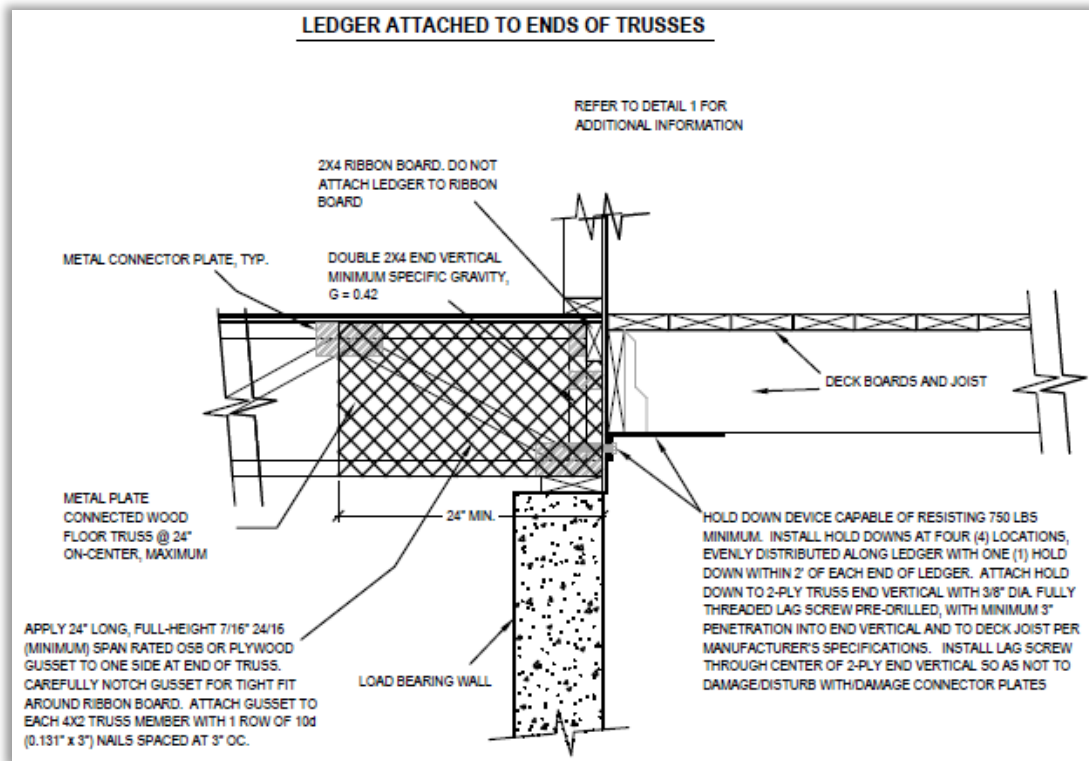


Figure 8

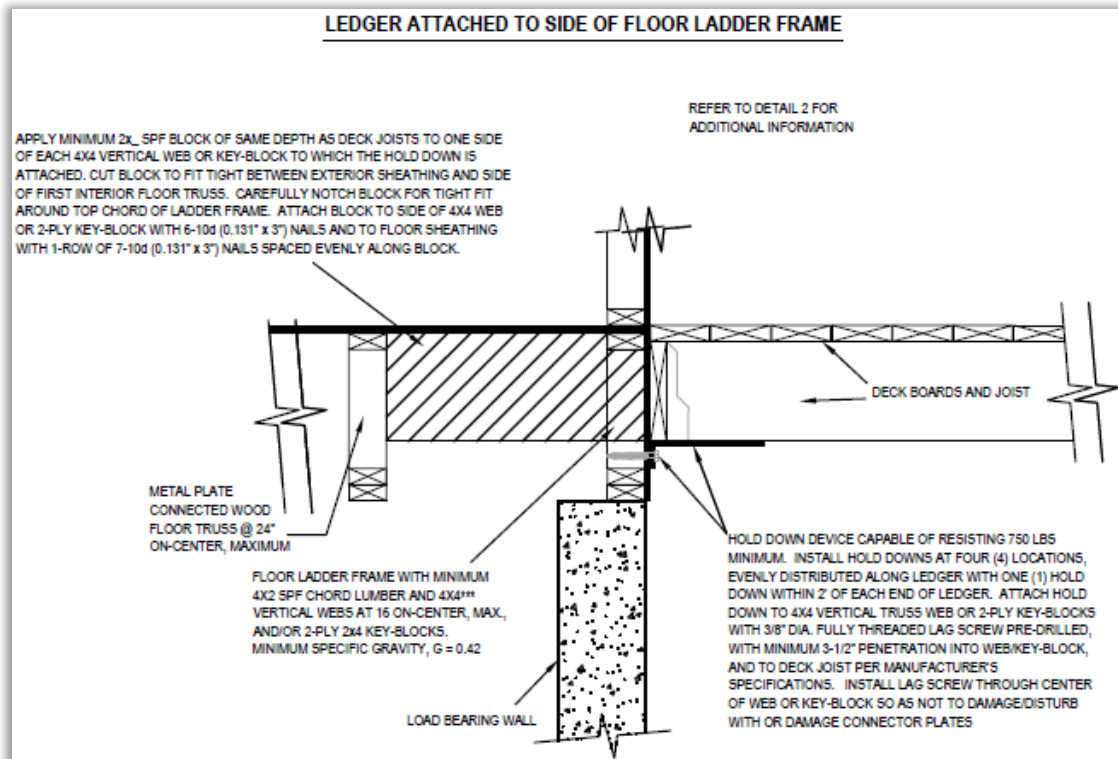


Figure 9

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Findings:

Nailing deck ledgers to metal plate connected wood truss floor systems is not sufficient. The deck ledger must be attached to the truss or key-block with lag screws or bolts. Various options and connection details for achieving the connection of the deck ledger to the metal plate connected wood truss floor system are provided in this report, which may be referred to by the building designer to achieve a code-conforming deck ledger connection.

[IBC Section 104.11](#) and [IRC Section R104.11](#) ([IFC Section 104.9](#) is similar) state:

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. ... Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.¹

This research report is subject to periodic review and revision. For the most recent version of this report, visit sbcindustry.com. For information on the current status of this report, contact SBCA.

References and Substantiating Data:

Anderson, C.A., Woeste, F.E. and Loferski, J.R. 2003; *Manual for the Inspection of Residential Wood Decks and Balconies*; Forest Products Society, 2801 Marshall Ct., Madison, WI 53705.

ANSI/AWC NDS-2015, *ASD/LRFD NDS®; National Design Specification for Wood Construction*. 2015; American Wood Council, 222 Catoctin Circle, SE, Suite 201, Leesburg, VA 20175.

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Carradine, D.M., Bender, D., Loferski, J.R. and Woeste, F.E. 2006; [Residential Deck Ledger Connection Testing and Design](#); *Structure Magazine*, May, 2008: (53-56).

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Loferski, J.R., Woeste, F.E., Caudill, R., Platt, T. and Smith, Q. 2004; [Load-Tested Deck Ledger Connections](#); *Journal of Light Construction*. 22(6):71-78.

Woeste, F.E. 2008; [Safe and Durable Coastal Decks](#); *Coastal Contractor*, March/April, 2008: (1-7).

¹ The last sentence is adopted language in the 2015 codes.