



CERTIFICATION



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Technical Evaluation Report

TER 1308-05

Use of TimberLOK® Fasteners to
Provide Top Plate Roll Resistance to
Trusses & Rafters Attached to the Tops
of Walls

**OMG®, Inc.
DBA FastenMaster®**

Product:

**FastenMaster® TimberLOK®
Heavy Duty Wood Screw**

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DIVISION: 06 00 00 - WOOD, PLASTICS AND COMPOSITES
SECTION: 06 00 90 - Wood and Plastic Fastenings

1 PRODUCT EVALUATED¹

- 1.1 FastenMaster® TimberLOK® Heavy Duty Wood Screw

2 APPLICABLE CODES AND STANDARDS^{2,3}

2.1 Codes

- 2.1.1 *IBC—12, 15, 18: International Building Code®*
- 2.1.2 *IRC—12, 15, 18: International Residential Code®*

2.2 Standards and Referenced Documents

- 2.2.1 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*
- 2.2.2 *ANSI/AWC SDPWS: Special Design Provisions for Wind and Seismic*
- 2.2.3 *ASTM A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*
- 2.2.4 *ASTM A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel*
- 2.2.5 *ICC 600: Standard for Residential Construction in High-wind Regions*

¹ Building codes require data from valid [research reports](#) be obtained from [approved sources](#). Agencies who are accredited through ISO/IEC 17065 have met the [code requirements](#) for approval by the [building official](#). DrJ is an ISO/IEC 17065 ANSI-Accredited Product Certification Body – Accreditation #1131.

Through ANSI accreditation and the [IAF MLA](#), DrJ certification can be used to obtain product approval in any [jurisdiction](#) or country that has [IAF MLA Members & Signatories](#) to meet the Purpose of the [MLA](#) – “certified once, accepted everywhere.”

Building official approval of a licensed [registered design professional](#) (RDP) is performed by verifying the RDP and/or their business entity complies with all professional engineering laws of the relevant [jurisdiction](#). Therefore, the work of licensed RDPs is accepted by [building officials](#), except when plan (i.e. peer) review finds an error with respect to a specific section of the code. Where this TER is not approved, the [building official](#) responds in writing stating the reasons for [disapproval](#).

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, visit drjcertification.org or call us at 608-310-6748.

² Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., *ASCE 7, NDS, ASTM*). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein.

³ All terms defined in the applicable building codes are italicized.

3 PERFORMANCE EVALUATION

- 3.1 TimberLOK® fasteners used in truss to top plate connections were evaluated to specifically assess the effect of “Top Plate Roll” (TPR).
 - 3.1.1 TPR is defined as the turning or “rolling” of the top plate of a wall assembly in relation to the truss assembly above and/or off the wall assembly below.
 - 3.1.2 TPR is caused by eccentric load path connections (i.e., the connections of the truss to top plate and the top plate to stud are not directly lined up vertically).
 - 3.1.3 This condition is shown in Figure 1.

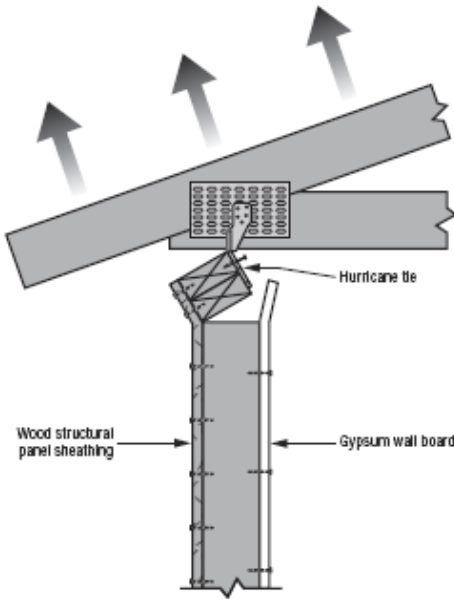


FIGURE 1. ILLUSTRATION OF TOP PLATE ROLL

- 3.2 The TPR condition is assessed with respect to existing building code requirements.
- 3.3 For general TimberLOK® truss to top plate connection design information, see [TER No. 1105-02: Use of FastenMaster® TimberLOK® Fasteners to Provide Uplift & Lateral Resistance to Trusses & Rafters Attached to the Tops of Walls.](#)
- 3.4 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.
- 3.5 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within DrJ’s professional scope of work.

4 PRODUCT DESCRIPTION AND MATERIALS

- 4.1 TimberLOK® fasteners (Figure 2) are manufactured with carbon steel wire conforming to *ASTM A510* with a minimum ultimate tensile strength of 60 ksi.

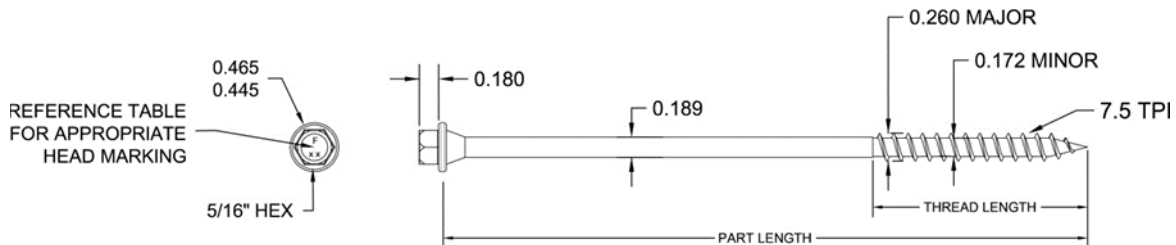


FIGURE 2. TIMBERLOK® FASTENER

- 4.2 TimberLOK® fasteners are manufactured using a standard cold-formed process followed by a heat-treating process.
- 4.3 Fasteners are approved for use in interior and exterior conditions and in pressure-treated wood.
 - 4.3.1 The proprietary coating has been tested and found to exceed the protection provided by code-approved hot-dipped galvanized coatings meeting *ASTM A153 (IBC Section 2304.10.5⁴ and IRC Section R317.3)*, which allows for its use in alkaline copper quaternary (ACQ) pressure-treated wood.
- 4.4 Fasteners are approved for use in fire retardant treated (FRT) lumber, provided the conditions set forth by the FRT lumber manufacturer are met, including appropriate strength reductions.
- 4.5 In-plant quality control procedures, under which the TimberLOK® fasteners are manufactured, are audited through an inspection process performed by an approved agency.
- 4.6 The TimberLOK® fasteners evaluated in this report are described in Table 1.

TABLE 1. FASTENER DESIGNATION FOR THE TIMBERLOK® FASTENERS EVALUATED IN THIS REPORT

Product Name	Fastener Designation ⁵	Head Marking	Overall Length (in)	Thread Length (in)
TimberLOK® 4"	TLOK04	F4.0	4	2
TimberLOK® 6"	TLOK06	F6.0	6	2

SI: 1 in = 25.4 mm

5 APPLICATIONS

5.1 General Code Requirements

- 5.1.1 Neither the *IBC* nor the *IRC* contain requirements that specifically address the potential for TPR due to an eccentric load path.
- 5.1.2 There are no code-defined deflection requirements for deformations caused by uplift.
- 5.1.3 The design for uplift is an allowable stress design load consideration. Uplift loads must be resisted by the fastening system used.
- 5.1.4 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience and technical judgment.

5.2 IRC Requirements

- 5.2.1 Table 2 defines the connection per *IRC Table R602.3(1)*.

TABLE 2. EXCERPT FROM *IRC TABLE R602.3(1)*⁵ FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

Item	Description of Building Elements	Number and Types of Fastener	Spacing of Fasteners
6	Rafter or roof truss to plate, toe nail	3-16d box nails (3 1/2" x 0.135"); or 3-10d common nails (3" x 0.148"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131" nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss ¹

1. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

⁴ 2012 *IBC Section 2304.9.5*

⁵ Fastener designations are found on the product packaging. Individual fasteners may be marked according to Table 1.

- 5.2.2 IRC Section R802.11 discusses the roof to wall uplift resistance in terms of resistance to load with no deflection criteria.

Where the uplift force does not exceed 200 pounds, rafters and trusses spaced not more than 24 inches (610 mm) on center shall be permitted to be attached to their supporting wall assemblies in accordance with Table R602.3(1).

- 5.2.3 IRC Section R802.11.1.1⁶ addresses truss to top plate connections for trusses.

R802.11.1.1 Truss uplift resistance. Trusses shall be attached to supporting wall assemblies by connections capable of resisting uplift forces as specified on the truss design drawings. Uplift forces shall be permitted to be determined as specified by Table R802.11, if applicable, or as determined by accepted engineering practice.

- 5.2.4 IRC Section R802.11.1.2⁷ then addresses the connection for rafters.

R802.11.1.2 Rafter uplift resistance. Individual rafters shall be attached to supporting wall assemblies by connections capable of resisting uplift forces as determined by Table R802.11 or as determined by accepted engineering practice. Connections for beams used in a roof system shall be designed in accordance with accepted engineering practice.

5.3 IBC Requirements

- 5.3.1 IBC Section 1604.8.1 contains the following requirements:

1604.8.1 General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads

- 5.3.2 There are a number of other requirements addressing specific conditions, all of which only address the resistance to applied load. There is no mention of deformation requirements.

- 5.4 There are two standards referenced by the *IRC* and *IBC* that contain provisions that could prescriptively address the potential for TPR.

- 5.4.1 *ICC 600* Section 304.1 states:

... Connectors resisting uplift of the roof framing shall be fastened to the top plate on the same side of the wall as the top plate to wall uplift connection.

- 5.4.2 *SDPWS* Section 4.4.1.5 states that, when using wood structural panels for top plate to stud uplift resistance:

Roof or upper level uplift connectors shall be on the same side of the wall as the sheathing unless other methods are used to prevent twisting of the top plate due to eccentric loading.

⁶ 2012 IRC Section R802.11.1.2

⁷ 2012 IRC Section R802.11.1.3

5.5 FastenMaster® commissioned testing conducted at the Structural Building Components Research Institute (SBCRI) to assess the occurrence of TPR.

5.5.1 Test assembly construction (Figure 3)



FIGURE 3. WALL CONSTRUCTION TEST SETUP

- 5.5.1.1 Double 2x4 top plates and trusses constructed from Spruce-Pine-Fir (SPF) #2.
 - 5.5.1.2 ½" gypsum wallboard installed to interior side of wall using #6 x 1¼" drywall screws. Fasteners along the top edge of the drywall were installed into the lower top plate at 7" o.c.
 - 5.5.1.3 Wood structural panel (WSP) sheathing was installed on the exterior wall in accordance with the code.
- 5.5.2 Three fasteners were tested and their performance compared as follows:
- 5.5.2.1 TimberLOK® TLOK06 fasteners installed at a 22.5° angle from vertical, beginning ½" from the inside edge of the lower top plate and driven up through both plates and into the truss.
 - 5.5.2.2 Simpson SDWC15600-KT fasteners installed at a 22.5° angle from vertical, beginning ½" from the inside edge of the lower top plate and driven up through both plates and into the truss.
 - 5.5.2.3 Simpson H2.5A connectors applied to the exterior side of the wall, over the oriented strand board (OSB), per the manufacturer's installation instructions.
 - 5.5.2.4 Simpson H2.5A connectors applied to the interior side of the wall, under the gypsum wallboard, per the manufacturer's installation instructions.

5.5.3 The published allowable design loads for the TimberLOK® fasteners is as shown in Table 3.

TABLE 3 ALLOWABLE LOADS FOR UPLIFT & LATERAL RESISTANCE FOR SELECTED LOAD DURATIONS & WOOD-SPECIFIC GRAVITIES USING TIMBERLOK® FASTENERS

Fastener Designation	Minimum Penetration into Truss/Rafter/Wood Structural Support (in)	Species Group (Specific Gravity)	Uplift (lbf)			Lateral (lbf)					
						F1 – Parallel to Wall			F2 – Perpendicular to Wall		
			1.0	1.33	1.60	1.0	1.33	1.60	1.0	1.33	1.60
TimberLOK® TLOK04 or TLOK06	2	Southern Pine (0.55)	390	520	620	255	340	410	280	375	450
		Douglas Fir-Larch (0.50)	340	450	540	240	320	385	265	350	425
		Spruce-Pine-Fir/Hem-Fir (0.42)	260	350	420	210	280	340	230	305	370

SI: 1 in = 25.4 mm, 1 lb/ft = 0.0146 kN/m

1. Wood truss and rafter members shall be a minimum of 2" nominal thickness. Design of truss and rafter members by others.
2. Equivalent specific gravity of structural composite lumber (SCL) shall be equal to or greater than the specific gravities provided in this table. Refer to product information from SCL manufacturer.
3. Uplift and F2 lateral load values have been adjusted using Hankinson's equation per *NDS*®.
4. For applications involving members with different specific gravities, use the allowable load corresponding to the lowest specific gravity.
5. Allowable uplift and lateral loads for applications in which the controlling load duration is two months (i.e., 115%) or seven days (i.e., 125%) may be obtained by multiplying the corresponding tabular value in the column marked "1.0" by 1.33 or 1.60, respectively.

5.5.4 Where it is anticipated that loads will be applied to a single fastener simultaneously in more than one direction, additional evaluation is required to account for the combined effect of these loads using accepted engineering practice.

5.5.4.1 Consult a professional engineer as needed for complex design conditions.

5.5.5 The following conditions were monitored throughout the tests:

5.5.5.1 Constant measurement and recording of load vs. displacement.

5.5.5.2 Separation measured between the stud and top plate at both the interior (B) and exterior (A) faces of the wall (Figure 4).

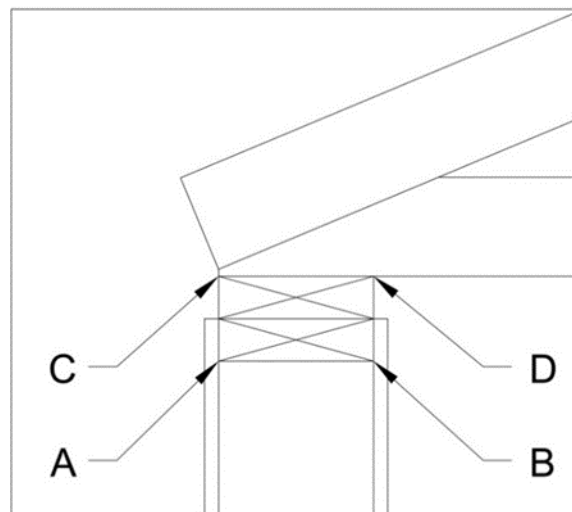


FIGURE 4: LOCATIONS OF DEFORMATION MEASUREMENTS

5.5.5.3 Separation measured between the truss and top plate at the interior (D) and exterior (C) faces of the wall (Figure 4).

5.5.5.4 Ultimate load at failure.

5.5.6 Test results:

- 5.5.6.1 Ultimate loads for each fastener type correlated to their respective published design loads.
- 5.5.6.2 The TimberLOK® fasteners experienced no significant TPR at allowable design loads.
- 5.5.6.3 Only the H2.5A connectors experienced significant TPR at their respective design loads (Table 4), when defined per this section, due to the higher eccentricity of the connection.

TABLE 4: DEFORMATIONS RECORDED AT AN ALLOWABLE LOAD OF 450 LBS

Fastener	Install Location	Design Load (lbs)	Deflection/Separation at 450 lbs (in)			
			Plate to Stud		Truss to Plate	
			Exterior (A)	Interior (B)	Exterior (C)	Interior (D)
H2.5A	Exterior	480	0.007	0.002	0.098	0.111
H2.5A	Interior	480	0.005	0.014	0.043	0.035
TimberLOK®	Interior	420	0.011	0.008	0.004	0.013
Serviceability Limit			0.125	0.031	0.125	0.031
SI: 1 in = 25.4mm, 1 lb = 0.45 kg						

- 5.5.6.3.1 Significant TPR is defined as follows:
- 5.5.6.3.2 1/8" (0.125") deformation at exterior joints (A and C) – the gap at which exterior materials assumed to cause potential serviceability issues.
- 5.5.6.3.3 1/32" (0.031") at interior joints (B and D) – the gap at which drywall or drywall joints assumed to start cracking.

6 INSTALLATION

- 6.1 Installation shall comply with the manufacturer's installation instructions and this TER. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.
- 6.2 Double Top Plate Installation
 - 6.2.1 Upward from below truss or rafter:
 - 6.2.1.1 Select a TimberLOK® fastener with a length sufficient to fully embed the 2" threaded portion of the fastener into the truss or rafter, see Table 1.
 - 6.2.1.2 Install one (1) TimberLOK® fastener upward through the wall top plate(s) or wood structural framing member and into the center of the truss, rafter or structural composite lumber (SCL), as shown in Figure 5.

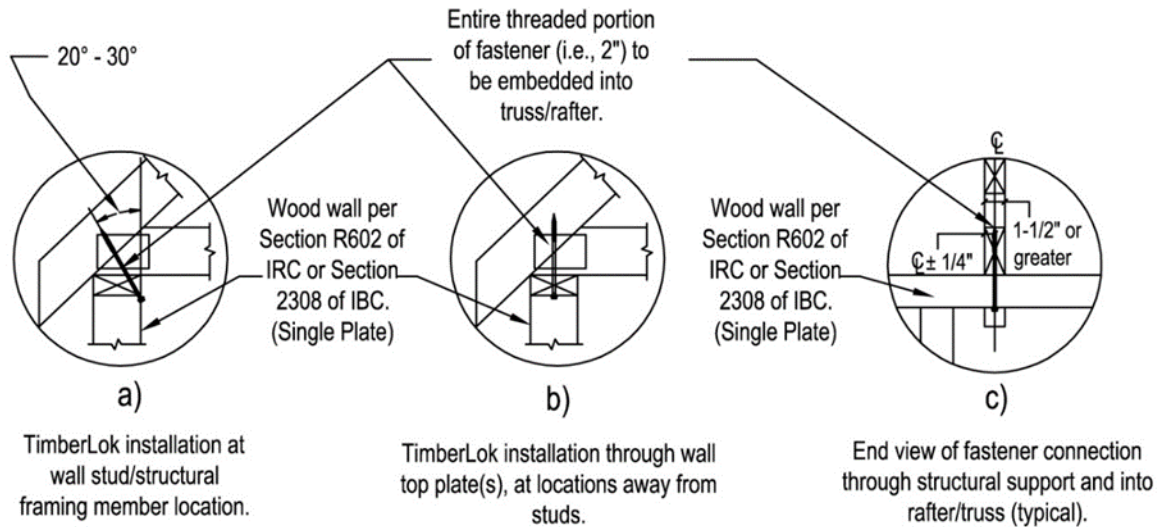


FIGURE 5: FASTENER ORIENTATION REQUIREMENTS FOR ATTACHING WOOD TRUSSES, RAFTERS OR SCL

FROM BELOW TO THE TOP OF A WOOD WALL OR STRUCTURAL FRAMING MEMBER

- 6.2.1.2.1 If the truss, rafter or SCL is located directly over a wall stud, insert the fastener at the joint between the inside top edge of the stud and the inside bottom edge of the bottom top plate at an upward angle from vertical of 20° to 30°, as shown in Figure 5a.
- 6.2.1.2.2 If the truss, rafter or SCL is located between the wall studs (double top plate application only), insert the fastener near the middle of the bottom face of the bottom top plate(s) straight upward into the truss, rafter or SCL, as shown in Figure 5b.
- 6.2.1.2.3 If the truss, rafter or SCL is located on top of a wood beam or header, insert the fastener approximately 3" below the top edge of the beam or header at an upward angle from vertical of 20° to 30°, as shown in Figure 5a.
- 6.2.1.3 Locate the fastener in line with the truss, rafter or SCL above so that it penetrates within $\pm 1/4$ " of the centerline of the narrow edge of the truss, rafter or SCL, as shown in Figure 5c.
- 6.2.1.4 Use a 1/2" low RPM/high torque drill to drive the fastener head flush with the surface of the wall framing.
- 6.2.2 Downward from top of the truss, rafter or SCL:
 - 6.2.2.1 Select a TimberLOK® fastener with a length sufficient to fully embed the 2" threaded portion of the fastener into the wall top plates or wood structural framing member, see Table 1.
 - 6.2.2.2 Install one (1) TimberLOK® fastener at a downward angle from vertical of 20° to 30° through the center of the truss, rafter or SCL and into the wall top plate(s), or wood structural framing member, as shown in Figure 6.

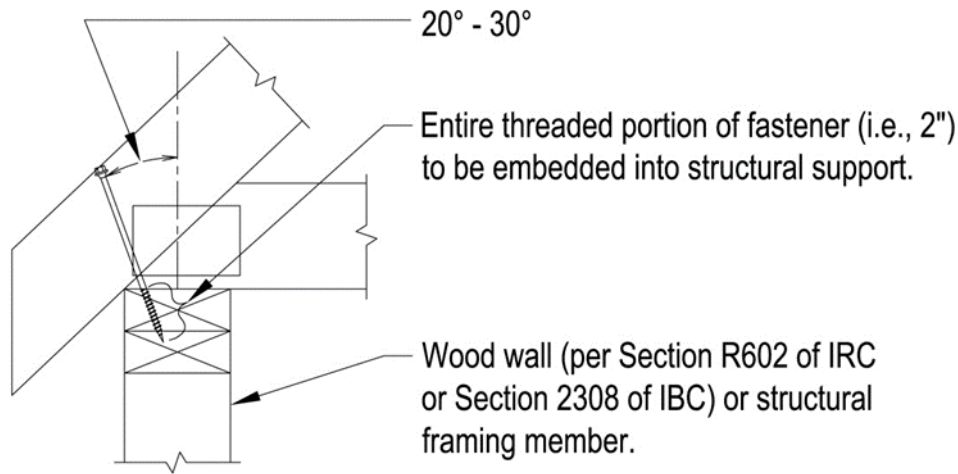


FIGURE 6: FASTENER ORIENTATION REQUIREMENTS FOR ATTACHING WOOD TRUSSES, RAFTERS OR SCL FROM ABOVE TO THE TOP OF A WOOD WALL OR STRUCTURAL FRAMING MEMBER

- 6.2.2.3 Locate the fastener so that it penetrates within $\pm 1/4$ " of the centerline of the narrow edge of the truss, rafter or SCL and at or near the center of the wall top plate(s) or wood structural framing member.
- 6.2.2.4 Use a $1/2$ " low RPM/high torque drill to drive the fastener head flush with the surface of the wood structural framing member.

6.3 Single Top Plate Installation

- 6.3.1 Select a TimberLOK® fastener with a length sufficient to fully embed the 2" threaded portion of the fastener into the wall top plates or wood structural framing member, see Table 1.
- 6.3.2 Where the truss, rafter or SCL is located directly over a wall stud, insert the fastener at the joint between the inside top edge of the stud and the inside bottom edge of the top plate at an upward angle from vertical of 20° to 30°, as shown in Figure 7.

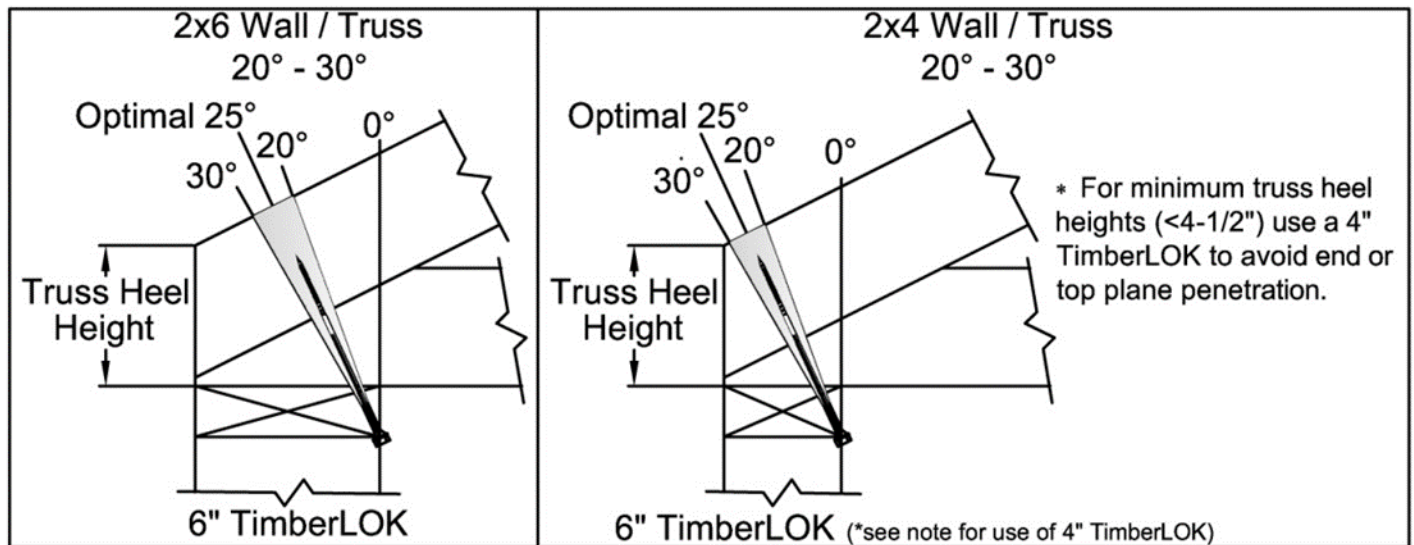


FIGURE 7: INSTALLATION OF TIMBERLOK® FASTENERS INTO A SINGLE TOP PLATE

- 6.3.3 Ensure that the angle is sufficient to prevent the fastener from protruding out of the truss, rafter or SCL.
- 6.3.4 Locate the fastener so that it penetrates within $\pm 1/4$ " of the centerline of the narrow edge of the truss, rafter or SCL and at or near the center of the wall top plate(s) or wood structural framing member.

- 6.3.5 Use a ½" low RPM/high torque drill to drive the fastener head flush with the surface of the wall framing or wood structural framing member.
- 6.3.6 Where the centerline of the truss, rafter or SCL is not located directly over the stud, install the fastener vertically up through the top plate and into the truss, rafter or SCL as shown in Figure 5b.

7 TEST ENGINEERING SUBSTANTIATING DATA

- 7.1 FastenMaster® TimberLOK® test reports and supporting data for determining:
 - 7.1.1 Comparative testing of fasteners for the assessment of TPR by SBCRI.
 - 7.1.2 Uplift capacity of TimberLOK® fasteners as evaluated for head pull-through and withdrawal of fasteners.
 - 7.1.3 TimberLOK® heavy duty wood screw performance when used as a truss hold-down.
 - 7.1.4 Comparative equivalency for use as an alternative material in accordance with IBC Section 104.11 and IRC Section R104.11.
- 7.2 Some information contained herein is the result of testing and/or data analysis by other sources which conform to IBC Section 1703 and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.
- 7.3 Where appropriate, DrJ's analysis is based on design values that have been codified into law through codes and standards (e.g., *IBC*, *IRC*, *NDS®*, and *SDPWS*). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.

8 FINDINGS

- 8.1 TPR is not a significant concern for TimberLOK® fasteners at allowable design load levels.
- 8.2 The H2.5A connectors had some significant TPR as defined in Section 5.5.6.3, but in no case was TPR in excess of ⅛" at the allowable design load.
- 8.3 Comparing the fastener test results in Table 4, TPR is not expected to be a significant concern for TimberLOK® fasteners in 2x6 walls, since the loading is less eccentric than the H2.5A connectors and only slightly more eccentric than the tested 2x4 connection.
- 8.4 When used and installed in accordance with this TER and the manufacturer's installation instructions, TimberLOK® fasteners can be used as an acceptable alternative to toe-nail connections, metal hurricane and seismic clips/straps or nails to resist the uplift and lateral loads as provided for in Table 3.
- 8.5 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.9 are similar) states:

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, not less than 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*.

- 8.6 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this evaluation, they are listed here.
 - 8.6.1 No known variations

9 CONDITIONS OF USE

- 9.1 Structural framing members (e.g., wood, masonry, concrete, steel, etc.) connected with TimberLOK® fasteners shall be designed in accordance with the requirements of their specific design standards/specifications as referenced in the building code adopted by the jurisdiction in which the project is to be constructed.
- 9.2 Loads applied shall not exceed those recommended by the manufacturer or as defined in this TER.
- 9.3 Where required by the *building official*, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of *permit* application.
- 9.4 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.
- 9.5 *Design loads* shall be determined in accordance with the building code adopted by the *jurisdiction* in which the project is to be constructed and/or by the Building Designer (e.g., *owner* or *registered design professional*).
- 9.6 At a minimum, this product shall be installed per Section 6 of this TER.
- 9.7 This product is manufactured under a third-party quality control program in accordance with *IBC Section 104.4* and *110.4* and *IRC Section R104.4* and *R109.2*.
- 9.8 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the *owner* or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the *building official* for acceptance.
- 9.9 The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer's instructions, the *building official's* inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.

10 IDENTIFICATION

- 10.1 The TimberLOK® described in this TER is identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance.
- 10.2 Additional technical information can be found at fastenmaster.com.

11 REVIEW SCHEDULE

- 11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjcertification.org.
- 11.2 For information on the current status of this TER, contact DrJ Certification.