SBC ASSOCIATION

Research Report

Long Span Truss Installation

SRR No. 1506-08

Structural Building Components Association (SBCA)

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SBCA is an APPROVED SOURCE

This research report is based on practical scientific research (literature review, testing, analysis, etc.), with the goal of supporting strategic needs for code and standards development and market expansion. 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:

Long span trusses, (i.e. trusses with clear spans 60' or greater), can pose significant risk to installers. The dimensions and weight of a long span truss can create instability, buckling and collapse of one or many trusses, if not handled, installed, restrained and braced properly. As such, long span trusses require more detailed safety and handling measures than shorter span trusses. This research report provides guidelines for proper handling and installation of long span trusses – both wood and cold-formed steel.

Key Definitions:

Truss – An engineered structural component, assembled from structural members, connected to each other to create a rigid structural framework by utilizing the geometric strength of triangles. The final component is designed to carry its own weight as well as superimposed design loads. Trusses are designed and erected to carry loads within the plane of the component.

Wood Truss – A truss fabricated out of structural wood members connected to each other with metal connector plates.

Cold-Formed Steel Truss – A truss fabricated out of cold-formed steel structural members connected to each other with fasteners.

Building Designer – Owner of the building, or individual contracted by the owner, who performs the design of the building structural system. When mandated by the local jurisdiction, the Building Designer shall be a registered design professional.

Truss Design Engineer – An Individual who is licensed to practice engineering as defined by the legal requirements of the jurisdiction in which the building is to be constructed and who reviews and approves the truss design drawings.

Contractor – Owner of a building, or individual contracted by the owner, who constructs the building in accordance with the construction documents and the Truss Submittal Package. The term "Contractor" shall include those subcontractors who have a direct contract with the contractor to construct all or a portion of the construction.

Truss Submittal Package – Package consisting of each individual truss design drawing, and, as applicable, the truss placement diagram, cover sheet, truss index sheet, lateral restraint and diagonal bracing details designed in accordance with generally accepted engineering practice, applicable BCSI-defined lateral restraint and diagonal bracing details, and any other structural details germane to the trusses.

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

Before the 2009 edition of the *International Building Code (IBC)*, the building codes didn't require a registered design professional (RDP) to be responsible for temporary bracing OR the inspection of permanent bracing. These were typically tasks assigned to the general contractor (or truss erection subcontractor). Truss industry safety literature, like Building Component Safety Information (BCSI), "Guide to Good Practice for Handling, Installing, Restraining, and Bracing of Metal Plate Connected Wood Trusses", was a step toward realizing professional expertise is paramount to safely install long-span wood trusses.[1] A similar document was developed for cold-formed steel trusses as well.

ANSI/TPI 1-2014

Since 2009, the *IBC* has required the design of permanent bracing for metal plate connected wood trusses to be handled by a RDP under contract with the *owner* of a project for trusses that span 60 feet or more.

ANSI/TPI 1, is a referenced standard for wood trusses in the *International Residential Code (IRC)* and *IBC* which also requires additional responsibilities, including restraint and bracing design, as well as special inspection, to be performed by a contracted RDP.

> **2.3.1.6 Long Span Truss Requirements**
> **2.3.1.6.1 Restraint/Bracing Design.** In all cases where a Truss clear span is 60 ft. (18 m) or greater, the Owner shall contract with any Registered Design Professional for the design of the Temporary Installation Restraint/Bracing and the Permanent Individual Truss Member Restraint and Diagonal Bracing.

[1] http://seaoo.org/downloads/Presentations_CONF/seaoo_2012_conference__woeste__wood_truss_responsibilities_when_rdf_mandated.pdf

2.3.1.6.2 Special Inspection. In all cases where a Truss clear span is 60 ft. (18 m) or greater, the Owner shall contract with any Registered Design Professional to provide special inspections to assure that the Temporary Installation Restraint/Bracing and the Permanent Individual Truss Member Restraint and Diagonal Bracing are installed properly.

International Building Code (IBC) – 2015

Wood Trusses

2303.4.1.1 Truss design drawings. The written, graphic and pictorial depiction of each individual truss shall be provided to the building official for approval prior to installation. Truss design drawings shall also be provided with the shipment of trusses delivered to the job site. Truss design drawings shall include, at a minimum, the information specified below:

13. Maximum axial tension and compression forces in the truss members;
14. Required permanent individual truss member restraint location and the method and details of restraint/bracing to be used in accordance with Section 2303.4.1.2.

2303.4.1.2 Permanent individual truss member restraint. Where permanent restraint of truss members is required on the truss design drawings, it shall be accomplished by one of the following methods:

1. Permanent individual truss member restraint/bracing shall be installed using standard industry lateral restraint/bracing details in accordance with generally accepted engineering practice. Locations for lateral restraint shall be identified on the truss design drawing.
2. The trusses shall be designed so that the buckling of any individual truss member is resisted internally by the individual truss through suitable means (i.e., buckling reinforcement by T-reinforcement or L-reinforcement, proprietary reinforcement, etc.). The buckling reinforcement of individual members of the trusses shall be installed as shown on the truss design drawing or on supplemental truss member buckling reinforcement details provided by the truss designer.
3. A project-specific permanent individual truss member restraint/bracing design shall be permitted to be specified by any registered design professional.

2303.4.1.3 Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with any qualified registered design professional for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for all trusses with clear spans 60 feet (18 288 mm) or greater.

1705.5.2 Metal-plate-connected wood trusses spanning 60 feet or greater. Where a truss clear span is 60 feet (18288 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

Cold-formed Steel (CFS) Trusses

2211.3 Truss design. Cold-formed steel trusses shall be designed in accordance with AISI S214, Sections 2211.3.1 through 2211.3.4 and accepted engineering practice.

2211.3.1 Truss design drawings. The truss design drawings shall conform to the requirements of Section B2.3 of AISI S214 and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section B6(a) or B 6(c) of AISI S214 where these methods are utilized to provide restraint/bracing.

2211.3.3 Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with a registered design professional for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater. Special inspection of trusses over 60 feet (18 288 mm) in length shall be in accordance with Section 1705.2.

1705.2.4 Cold-formed steel trusses spanning 60 feet or greater. Where a cold-formed steel truss clear span is 60 feet (18 288 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

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B2.3 Truss Design Drawings. The truss design drawings shall consist of the individual truss design drawings and referenced details, if any. The truss design drawings shall be part of the truss submittal package and include, at a minimum, the information included below:

14. Locations of required permanent individual truss member restraint in accordance with Section B6(a) or B6(c), if required, and

B6 Design of Permanent Individual Truss Member Restraint/Bracing

Where permanent individual truss member restraint/bracing is required, it shall be accomplished by one of the following methods:

(a) Standard Industry Details. Standard industry permanent individual truss member restraint/bracing details supplied in accordance with B3.4.

(c) Project-Specific Design. A project-specific permanent individual truss member restraint/bracing design by any registered design professional, as specified in the contracts or construction documents, and supplied in accordance with B3.4.

International Residential Code (IRC) - 2015

The *IRC* does not include specific language for long-span roof trusses (wood or cold-formed steel) and provides guidance as follows which reference SBCA's CFSBCSI and BCSI for bracing requirements:

Wood Trusses

R802.10.2.1 Applicability limits. The provisions of this section shall control the design of truss roof framing when snow controls for buildings, not greater than 60 feet (18 288 mm) in length perpendicular to the joist, rafter or truss span, not greater than 36 feet (10 973 mm) in width parallel to the joist, rafter or truss span, not more than three stories above grade plane in height, and roof slopes not smaller than 3:12 (25 percent slope) or greater than 12:12 (100-percent slope). Truss roof framing constructed in accordance with the provisions of this section shall be limited to sites subjected to a maximum design wind speed of 140 miles per hour (63 m/s), Exposure B or C, and a maximum ground snow load of 70 psf (3352 Pa). For consistent loading of all truss types, roof snow load is to be computed as: 0.7 pg.

R802.10.3 Bracing. Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the construction documents for the building and on the individual truss design drawings. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practice such as the SBCA Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses.

CFS Trusses

R804.1.1 Applicability limits. The provisions of this section shall control the construction of cold-formed steel roof framing for buildings not greater than 60 feet (18 288 mm) perpendicular to the joist, rafter or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist span or truss, less than or equal to three stories above grade plane and with roof slopes not less than 3:12 (25-percent slope) or greater than 12:12 (100-percent slope). Cold-formed steel roof framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 139 miles per hour (62 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3350 Pa).

R804.3.6 Roof trusses. Cold-formed steel trusses shall be designed and installed in accordance with AISI S100, Section D4[2]. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the SBCA Cold-Formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses. Trusses shall be connected to the top track of the load-bearing wall in accordance with Table R804.3, either with two No. 10 screws applied through the flange of the truss or by using a 54-mil (1.37 mm) clip angle with two No. 10 screws in each leg.

S214

B2.3 Truss Design Drawings. The truss design drawings shall consist of the individual truss design drawings and referenced details, if any. The truss design drawings shall be part of the truss submittal package and include, at a minimum, the information included below:

14. Locations of required permanent individual truss member restraint in accordance with Section B6(a) or B6(c), if required, and

B6 Design of Permanent Individual Truss Member Restraint/Bracing

Where permanent individual truss member restraint/bracing is required, it shall be accomplished by one of the following methods:

(a) Standard Industry Details. Standard industry permanent individual truss member restraint/bracing details supplied in accordance with B3.4.

(c) Project-Specific Design. A project-specific permanent individual truss member restraint/bracing design by any registered design professional, as specified in the contracts or construction documents, and supplied in accordance with B3.4.

Analysis:

For structures designed for the *IBC* or *IRC*, utilizing either wood or CFS trusses and trusses span less than 60 feet, the guidance provided in BCSI and CFSBCSI is typically adequate.

When trusses span 60 feet or more a registered design professional is required to design the permanent bracing.

- For wood trusses: information on the forces that the registered design professional needs to design the permanent truss bracing is included on the truss design drawings per 2303.4.1.1, items 13 & 14.
- For CFS trusses: information on the forces that the registered design professional needs to design the permanent truss bracing is included on the truss design drawings per AISI S214, B2.3 and B6.

[2] AISI S100, Section D4 in the 2012 edition references S214.

An example method for installing long span trusses is included in the following section.

Example:

The following is one recommended method for installing long span trusses at 24" o.c. There are other methods used to accomplish the same installation but SBCA encourages communication with both a professional engineer with wood truss experience and truss designer to discuss different methods before considering other options.

STEP 1: On the ground, ensure level bearing, set and position the first five trusses. Plumb and properly brace the trusses to the ground.

Photo 1: Ground Bracing on First Five after Bearing Timbers are Leveled

STEP 2: Attach 27" (or longer) 2x4 lumber spacer pieces to the top chord every six feet to hold trusses plumb and properly spaced. Fasten the end of each spacer with two 16d box nails. Install sheathing beginning at heel and alternating 4x8 and 4x4 sheets up to truss peak.

Photo 2: Sheathing on First Five with Alternating 4x4 and 4x8 Sheets

STEP 3: Brace webs laterally and diagonally where required by the Truss Design Drawing. Install bottom chord permanent lateral bracing every ten feet and install the diagonal bracing.

Photo 3: Diagonal/Lateral Web Bracing on First Five Trusses as Specified

STEP 4: Hoist the first set of five trusses ("superstructure") off the ground and raise into position above exterior walls. This provides a solid foundation to laterally support additional trusses.

Photo 4: Raising of "Superstructure" Set of Trusses off Ground

STEP 5: Hoist the sixth truss into position. The goal is to install the remaining trusses as efficiently and safely as possible. Use the appropriate spreader bar to keep each truss rigid. Specially designed lifting equipment is available for this purpose. (See WTCA's BCSI 1-03, pgs. 7-9 for hoisting information).

Photo 5: Spreader Bar Attached to End of Crane for More Rigid Hoisting

STEP 6: Install 4x8 sheathing in the alternating gaps so that two feet extends past the sixth truss. Fasten the sheathing to trusses per construction documents.

Photo 6: Installation of Top Chord Sheathing as Trusses are Installed

STEP 7: Hoist the seventh truss into place and attach the sheathing to the top chord. At the same time, the crew can install the permanent web and bottom chord bracing.

Photo 7: Hoisting the 7th Truss

STEP 8: Repeat steps 6 and 7 with the remaining trusses using the sheathing each time as both the temporary and permanent bracing. This approach can result in a fully sheathed and permanently braced roof system in the same time it takes to install the trusses with only temporary bracing.

Photo 8: Installing and Bracing Each Truss

Additional Considerations:

Inspect Before Installing

Inspect each truss thoroughly prior to hoisting into place to take care of any damaged truss members. Undiagnosed or unfixed damage has the potential to cause much bigger problems once the truss is airborne.

Maintain Truss Straightness during Hoisting

Have you ever heard of a truss acting like a “wet noddle”? During the hoisting process, long span trusses like to snake, often shaking, bending and flexing out of shape. It is very important to provide support so the trusses flex as little as possible. Invest in a spreader bar to prevent this from happening.

A Good Crane Operator is Helpful

Finding a crane operator with previous long span truss experience can be very beneficial in determining the best approach for hoisting the superstructure and developing an overall plan. Efficiency and safety must meet at the same point and an experienced operator knows where that point is.

Build the First Five on the Ground

It is very important to ensure the bearing points are level. Building the first five on the ground makes the assembly process much easier and the assembly can be built precisely and safely without being off the ground. Keep in mind the superstructure provides the plumb and square foundation needed to attach the remaining trusses. As more trusses are added to the superstructure once it is in position on the building, the assembly becomes increasingly rigid.

Sheath Top Chord as You Install Trusses

This is an extremely effective method of developing much-needed rigidity to the installation process, with an added bonus of saving significant time by applying permanent top chord bracing immediately. This process is also much safer as all the work is being done from a plywood deck.

Install All Permanent Bracing Immediately

Once your crew become comfortable with the step-by-step approach, the web member and bottom chord bracing can be installed in the time it takes to release the hoist, pick up, and set the next truss. Installing all the permanent diagonal bottom chord and web member bracing sooner than later saves time in the long run and maintains the rigidity of the entire roof system as it’s being installed.

References and Substantiating Data:

Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses, Structural Building Components Association (SBCA)

ANSI/TPI 1, National Design Standard For Metal Plate Connected Wood Truss Construction, Truss Plate Institute.

Cold-Formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses, Cold-Formed Steel Council (CFSC)

AISI S214 North American Standard for Cold-Formed Steel Framing – Truss Design

Additional References:

Grundahl, Kirk and Piek, Tony, 2004, “Knowledge is Power: Developing a Strategy for Long Span Truss Installation,” Structural Building Components Magazine, March.

Structural Building Components Association, “Long Span Jobsite Package”

Wood Truss Council of America, 2005, “A Strategy for Installing Long Span Trusses at 24" o.c.”