Wood Truss Bracing Rules Updated

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Photo courtesy FB Buildings

**ONCE THE STATE CODES OR LOCAL JURISDICTIONS ADOPT THE 2009 INTERNATIONAL BUILDING CODE (IBC), OWNERS OF A PROJECT WITH METAL-PLATE-CONNECTED (MPC) WOOD TRUSSES WILL BE REQUIRED TO ENGAGE A REGISTERED PROFESSIONAL TO DESIGN AND INSPECT BOTH TEMPORARY AND PERMANENT BRACING FOR SUCH TRUSSES WHEN SPANNING 18 M (60 FT) AND GREATER. WHAT DOES THIS MEAN FOR DESIGNERS OF THESE SCHOOLS, PLACES OF WORSHIP, AND RETAIL PROJECTS?**

The owner’s responsibility for engaging a design professional for these purposes is also defined by American National Standards Institute/Truss Plate Institute (ANSI/TP1) 1-2007, National Design Standard for Metal Plate Connected Wood Truss Construction, which is the 2009 IBC-referenced standard for MPC wood trusses.

Before the 2009 IBC, the code did not require a registered design professional (RDP) to be responsible for the temporary bracing or the inspection of the permanent bracing. These items were usually left up to the general contractor (or truss erection subcontractor). Truss industry safety literature recognized the professional expertise needed to safely erect long-span wood trusses by making the recommendation:

Consult a Professional Engineer for trusses longer than 60’ [i.e. 18 m].

The approach of ‘recommending’ professional involvement in temporary bracing for erecting...
long-span trusses has not provided consistent results over the past 35 years as construction-related injuries or deaths have been reported in the media. (See also Figure 1, page 56.) With the implementation of the new code requirements for installing 18 m and greater wood trusses, the number of truss-related accidents should be greatly reduced.

This article explores the new requirements under the 2009 IBC, pointing to areas of professional responsibility per ANSI/ TPI 1-2007 frequently overlooked by designers specifying MPC wood trusses. It also provides background information on two parallel-chord-truss long-term deflection issues—design considerations to prevent roof ponding and brittle floor covering failures.

**Truss bracing design and the new special inspection requirements**

Figure 2 (page 58) gives an example of a complex roof system under construction. From IBC Chapter 23 on Wood, Section 2303.4–Trusses:

**2303.4.1.3 Trusses spanning 60 feet or greater.** The owner 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.

This section requires the owner to “contract with any qualified registered design professional” for the design of the temporary and permanent truss bracing. It highlights the need for owners to allocate funding for the truss bracing designs during the project’s contract stage.

It should be noted “any qualified registered professional” can assume the role of temporary and permanent bracing designer for the project. Realizing that wood trusses are typically designed by a truss engineer and approved by the RDP of record (i.e., building designer) after the contract phase of the project, the use of the word “any” allows the owner (or owner’s agent) the flexibility of engaging an RDP with expertise in wood truss bracing design and inspection. Modern long-span roof truss systems can be complicated as illustrated in Figure 2.

From IBC Chapter 17, Section 1704–Special Inspections:

**1704.1 General.** Where application is made for construction as described in this section, the owner or the registered design professional in responsible charge acting as the owner’s agent shall employ one or more approved agencies to perform inspections during construction on the types of work listed under Section 1704.

This paragraph requires owners to “employ one or more approved agencies to perform inspections” on certain work
listed under Section 1704. An “approved agency” must meet the requirements set forth in Section 1703 regarding independence, equipment, and personnel. Section 1704.6.2 identifies a type of truss work that must be inspected:

**1704.6.2 Metal-plate-connected wood trusses spanning 60 feet or greater.** Where a 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.

The practical value of these sections clearly require the owner (or his/her agent) to “employ one or more approved agencies to perform inspections during construction” of the temporary truss bracing work and permanent truss bracing work “in accordance with the approved truss submittal package.” For the 2009 IBC, Section 2303.4.3 defines the content of the “Truss submittal package.”

It is not precisely clear how the new requirements for the design and inspection of wood truss bracing will be approached or managed by the local building code departments. Referring to the last sentence in 2009 IBC Section 107.3.4.1:

**107.3.4.1 General…** The registered design professional in responsible charge shall be responsible for reviewing and coordinating submittal documents prepared by others, including phased and deferred submittal items, for compatibility with the design of the building.

The temporary and permanent bracing designs per 2009 IBC Section 2303.4.1.3 could logically be submitted as part of the Truss Submittal Package (Section 2303.4.3). Regardless of when the temporary and permanent bracing designs are submitted to the authority having jurisdiction (AHJ), the construction documents should contain a list of the deferred submittals that specifically includes temporary and permanent bracing designs for the project. The responsibility and process for deferred submittals are defined by the second paragraph of 2009 IBC Section 107.3.4.2:

**107.3.4.2 Deferral of any submittal items shall have the prior approval of the building official.**
A step-down hip system with piggybacked common trusses is depicted.  
Photo courtesy ITW Building Components Group

The registered design professional in responsible charge shall list the deferred submittals on the construction documents for review by the building official.

In summary, the 2009 IBC defines new requirements for the design and inspection of both temporary and permanent MPC wood truss bracing. It should be noted the language in ANSI/TP1 1-2007 on wood truss bracing responsibilities for the application of long-span trusses is consistent with the 2009 IBC requirements.

Specifying MPC wood trusses

While some responsibilities defined by the 2007 ANSI/TP1 1 standard overlap responsibilities defined by the 1995 and 2002 editions, the new Chapter 2 (“Standard Responsibilities in the Design and Application of MPC Wood Trusses”) addresses additional issues and information valuable to all parties involved in MPC wood truss construction.

This article, of course, should be viewed only as a starting point for learning the designer’s responsibilities when using MPC wood trusses—all RDPs are strongly encouraged to obtain a copy of ANSI/TP1 1-2007 for study and familiarity of the complete standard. The remainder of this article is dedicated to the definition of the ‘building designer,’ along with emphasis on a couple of parallel-chord-truss design requirements new to ANSI/TP1 1-2007.

Building designer defined

ANSI/TP1 1-2007, Section 2.2, defines the BD with respect to the application of MPC wood trusses:

Building Designer: Owner of the Building or the Person that Contracts with the Owner for the design of the Framing Structural System and/or who is responsible for the preparation of the Construction Documents. When mandated by the Legal Requirements, the Building Designer shall be a Registered Design Professional.

Building designer responsibilities

For the purpose of discussion, one can assume the building designer is legally required to be a registered design professional, so hereafter the term will be BD/RDP. Sections 2.3.2 (“Requirements of the Registered Design Professional”) define the responsibilities of the BD/RDP engaged by the owner.

They are outlined by four subsections:

- 2.3.2.1—Construction Documents;
- 2.3.2.2—Deferred Submittals;
- 2.3.2.3—Review Submittal Packages; and
- 2.3.2.4—Required Information in the Construction Documents.

The requirements in Section 2.3.2.4(a) through (h) are frequently not completed by some BD/RDPs. In a nutshell, specifications by the BD/RDP related to
Creep deflection

All elements listed in Section 2.3.2.4 are important for the BD/RDP to consider and make specifications warranted for a specific building. Some specifiers may not have the requisite background to create informed documentation in regard to the long-term creep deflection behavior of parallel-chord wood trusses as required by two subsections—(2) and (5)(b) of 2.3.2.4(h):

**2.3.2.4 Required Information in the Construction Documents.**

The Registered Design Professional for the Building, through the Construction Documents, shall provide information sufficiently accurate and reliable to be used for facilitating the supply of the Structural Elements and other information for developing the design of the Trusses for the Building.

The following excerpts from Section 2.3.2.4 highlight the creep-related provisions:

(h) Criteria related to serviceability issues including:

(2) Any dead load, live load, and in-service creep deflection criteria for flat roofs subject to ponding loads...

(5) Any deflection and vibration criteria for floor Trusses including...

(b) Any dead load, live load, and in-service creep deflection criteria for floor Trusses supporting stone or ceramic tile finishes.

The following paragraphs discuss the role of creep deflection as it may impact the possibility of flat roof ponding or a failure of brittle surfaces (*e.g.* ceramic tile) on floor trusses.

**Creep factor for flat roofs**

Subsection (2) of 2.3.2.4(h) addresses dead and live loads and associated creep deflection for flat roofs subject to ponding action. Probably the most common flat roof design specification is a roof slope of 1:48. Creep deflection behavior of wood beams and wood truss components is difficult to predict. ANSI/TPI 1-2007 Section 7.6.1 gives an equation for calculating the deflection (time-dependent or creep) to be included in the total deflection calculation for MPC trusses. The deflection equation in Section 7.6.1 has the following form:

\[
\text{Total Load Deflection} = K_c \times \text{Sustained Load Deflection} + \text{Short-term Load Deflection}
\]

The minimum creep factors given—1.5 for dry lumber and 2.0 for green or wet service conditions—match the equation for solid-sawn lumber in American Forest and Paper Association (ANSI/AF&PA) NDS-2005, *National Design Specification for Wood Construction ASD/LRFD*. They may not be adequate for a flat roof (such as a 1:48 slope) wood truss.

The first step in evaluating the protection afforded by the total deflection equation in ANSI/TPI 1-2007 is to realize some snow loads in northern climates and other roof loads can be 'sustained' even though they are not technically a 'dead load.' An HVAC unit is fixed to the structure and it is clearly a sustained load that should be multiplied by the creep factor \(K_c\) when the affected trusses are checked for total load deflection.

For the case of parallel-chord roof trusses with potential for ponding action, the BD/RDP should detail and make specifications to ensure HVAC unit loads resting on a couple of trusses are specified for all stress analyses of the affected trusses. They must also ensure the HVAC loads and other sustained loads are included in the total load deflection check using an appropriate \(K_c\). In other words, HVAC loads should be specified as dead loads and verified on the Truss Design Drawings (TDD) during review.

The ANSI/TPI 1-2007 *Commentary & Appendices* provides discussion and recommendations on the creep deflection issue. After some discussion of research on the subject, the ANSI/TPI 1-2007 Commentary recommends a minimum creep factor.
adjustment for a total dead load of 1.2 kPa (25 psf) or greater:

For floor truss applications with a total dead load of 25 psf or greater where the Registered Design Professional for the Building or the Building Designer does not specify adjustment factors for serviceability issues (per Sections 2.3.2.4[h][6] or Section 2.4.2.4[h][6], respectively), a creep factor, $K_c$, of 2.0 is recommended as a minimum adjustment in lieu of the 1.5 factor for seasoned lumber used in dry conditions.

It should be noted the use of 2.0 versus 1.5 is only a recommendation; it does not address the creep potential of sustained loads significantly above 1.2 kPa (25 psf). The authors have published one method for estimating a creep factor based on the results of long-term (i.e. 10-year) testing of MPC floor trusses. The calculation method includes the ratio of ‘sustained load’ to total design load which is known to be an important variable for predicting creep deflection of dimension lumber. The authors also discuss prescriptive measures that a BD/RDP may consider and specify for minimizing the likelihood of a flat roof ponding failure.

**Creep factor for floors with stone or ceramic tile finishes**

When ceramic tile and grout failures occur one to five years after the time of construction on wood-joint framing systems, creep deflection appears to be a contributing factor. As previously cited, Subsection (5)(b) addresses the requirement of design loads and creep deflection criteria for floor trusses supporting stone or ceramic tile finishes.

With the increased customer preference for stone and ceramic tile, it is important the BD/RDP communicates the dead and live design loads for the completed floor to the affected parties through the construction documents.

For a typical residential carpeted or hardwood finish floor, designers often use a 40-10-0-5 psf (top chord live, top chord dead, bottom chord live, bottom chord dead) load specification. The ‘carpeted floor on wood subfloor’ dead load specification (i.e. 479 Pa [10 psf]) may be woefully inadequate for some ceramic tile installation methods installed on wood trusses (including I-joist or solid-sawn joist framing).

To assess and specify an adequate top chord dead load for a ceramic tile installation, the BD/RDP must first determine which installation method will be used for the selected tile.
based on the floor truss spacing. The selected method impacts total design dead load. This step may require coordination with the tile installer.

Tile industry installation methods are contained in the Tile Council of North America’s 2011 TCNA Handbook for Ceramic Tile Installation. This guide lists typical weights of each installation method; the weight must be added to the dead load of the specific floor construction and other dead loads (e.g., a kitchen island with granite countertop) to obtain the total dead loads for the area.

The impact of creep deflection on ceramic tile installation performance should be considered by the BD/RDP when specifying floor trusses. Some floor live loads can also be ‘sustained.’ For example, a large piano rested primarily on two floor trusses is technically a live load, but acts ‘sustained’ with respect to creep deflection.

The ratio of all sustained loads to total floor load is an important variable for assessing the potential role of creep deflection on in-service performance of stone or tile installations. The potential for a creep induced failure of stone or ceramic tile on wood floor trusses can be minimized by specifying a creep factor based on the results of long-term tests of MPC floor trusses subjected to a sustained loading.
Conclusion
ANSI/TPI 1-2007 is the 2009 IBC-referenced standard for MPC wood trusses. With the implementation of the new code requirements for installing wood trusses with spans 18 m (60 ft) and greater, the number of accidents should greatly be reduced—a benefit to owners, BD/RDPs, general contractors, truss erectors, and construction workers involved in the process of wood truss installation.

The safe installation of long span trusses requires professional engineering knowledge of the structural behavior of MPC wood trusses and commensurate design and inspection experience related to the sequential process of handling and temporary bracing of a roof truss system. Without the aforementioned knowledge and experience, it is unsafe to attempt long span truss installation. The new code requirement for owners to engage a qualified registered design professional for the purpose of design and inspection of the temporary truss bracing was the missing component needed to consistently ensure the safe erection of long-span MPC wood trusses.

Before the 2009 edition of the International Building Code, the BD/RDP for a project was responsible for the permanent truss bracing design without needing to inspect the installation. With the new requirement for the BD/RDP to inspect the permanent truss bracing, related failures should be greatly reduced as a primary cause of snow-load-induced roof failures.

In the authors’ experience, BD/RDPs frequently overlook areas of professional responsibility per ANSI/TPI 1-2007 when specifying MPC wood trusses. The BD/RDP should carefully review Chapter 2 of ANSI/TPI 1-2007 early in a project’s design phase because broad design aspects can be affected by seemingly unrelated truss issues. For example, the specification of a flat roof structure verses a pitched roof can require additional specifications well beyond just the design slope of the top chord and all required loads per the applicable building code.

Notes
1 This comes from Building Component Safety Information (BCSI) 2008, Guide to Good Practice for Handling, Installing, Restraining, and Bracing of Metal Plate Connected Wood Trusses.
2 Visit www.tpiinst.org/publication-tpi1.html#TPI12007.
4 See the authors’ article, “Creep Deflection in Design of Metal Plate Connected Wood Trusses” in the American Society of Civil Engineers’ ASCE Practice Periodical on Structural Design and Construction (vol. 16, no. 1).
6 See note 4.