Code Requirements for Residential Roof Trusses

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This article outlines the related 2018 International Residential Code (IRC) and the 2018 International Building Code (IBC) requirements for residential truss engineering and delivery.

There are many roles played in the design and delivery of residential wood roof trusses. Engineers can play various roles in this process, and it is essential to understand which role you play. This article discusses the scope of work required of the various roles as defined by the various codes and standards for residential roof truss. If a building falls within the IRC, all roles can be played by non-engineers, unless the jurisdiction requires the construction documents to be prepared by a Registered Design Professional.

Code Requirements

The *International Residential Code* (IRC) is the governing code for one- and two-family dwellings. It is a prescriptive code. For those elements that fall outside of the prescriptive criteria, engineering design (i.e., using the IBC) is required (See IRC R301.1.3). The IRC does not have prescriptive provisions for the design and installation of prefabricated wood trusses, but they are allowed per Section R801.10. The applicability limits for trusses are found in Section R802.10.2.1. These must be followed in order to stay within the purview of the IRC. The limits that apply when snow loads control the design are:

- Building width not greater than 60 feet perpendicular to the truss span
- Truss span not greater than 36 feet
- Minimum roof slope of 3:12
- Maximum roof slope of 12:12
- Maximum design wind speed of 140 miles per hour (63 m/s), Exposure B or C
- Maximum ground snow load of 70 psf (3352 Pa), with roof snow load, computed as $0.7p_g$

The IBC becomes the governing code for the truss design and associated load paths if the structure falls outside of these limits (See IRC R301.1.3).

The following is a summary of the IRC requirements for wood Trusses (capitalized terms are defined by ANSI/TPI 1-2014, *National Design Standard for Metal Plate Connected Wood Truss Construction*, Section 2.2, published by the Truss Plate Institute (TPI)):

- Wood Trusses shall be designed in accordance with accepted engineering practice, and the design and manufacture of metal-plated wood Trusses shall comply with ANSI/TPI 1 (R802.10.2). A read-only version of the full ANSI/TPI 1 document can be downloaded for free at **https://goo.gl/j7cK9E**.
- The Truss Design Drawings shall be prepared by a Registered Design Professional where required by the statutes of the jurisdiction in which the project is to be constructed in accordance with Section R106.1 (R802.10.2). Note that under the IRC, both the residence and the wood Truss design could be performed by persons who are not Registered Design Professionals. There may be times when the Building Official will require the Truss Design Drawings to be prepared and stamped by a Registered Design Professional even though the structure was not. The key to this IRC provision is that if the jurisdiction requires the Construction Documents to be prepared by a Registered Design Professional, then the Truss Design Drawings shall also be prepared by a Registered Design Professional.
- Truss Design Drawings shall be provided to the Building Official and approved prior to installation (R802.10.1).
- Truss Design Drawings shall be provided with the shipment of the Trusses delivered to the job site (R801.10.1).
- Truss Design Drawings shall include the following information:
  - o Slope or depth, span, and spacing
  - o Location of all joints
  - o Reaction forces and required bearing widths
  - o Top and bottom chord uniform and concentrated loads
  - o Joint connector type and description such as size, thickness, and the dimensioned location of each joint connector
  - o Lumber size, species, and grade for each member
  - o Adjustments to lumber and connector design values for conditions of use
  - o Connection requirements for Truss to girder and Truss ply-to-ply
  - o Calculated deflection ratio and/or maximum description for live and total load
  - o Information to allow the Building Designer to design the size, connections, and anchorage of the permanent continuous lateral bracing
  - o Required permanent Truss member bracing locations
- Truss bracing requirements are found in Section R802.10.3. This section requires Trusses to be braced to prevent rotation and to provide lateral stability. It allows the bracing requirement to be specified in the construction documents or on the individual Truss design drawings. It also states, "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." See the Building Component Safety Information Book* (BCSI), which has the above reference guide as a section. (**https://goo.gl/phc1gj** or **https://goo.gl/c9YWGb**)

The requirements for wood Trusses in the IBC (2303.4) are very similar to the IRC. Some of the differences include:

1) The IBC specifically addresses environmental design criteria such as wind, rain, snow, and seismic.

2) The IBC requires the consideration of drag strut loads and other lateral loads.
3) The IBC requires specifically listing maximum uplift loads with the reaction forces.
4) The IBC not only requires the Truss Design Drawings to show the location of permanent individual Truss member restraint locations, but it also requires the method and details of restraint/bracing to be used (2303.4.1.1.14).
5) The bracing requirements of IBC Section 2304.1.2 specifically allow the use of T-reinforcement or L-reinforcement, and proprietary reinforcement, so that the buckling of any individual Truss member is resisted internally by the individual Truss. (These are also in ANSI/TPI 1 and the BCSI document.) The IBC also allows a project-specific permanent bracing design by any Registered Design Professional.
6) Trusses spanning 60 feet or more require a Registered Design Professional to design the temporary installation restraint/bracing and the permanent individual Truss member restraint/bracing (2303.4.1.3). Special inspection of the Truss member bracing is also required where a Truss clear span is 60 feet or greater (1705.5.1).
7) IBC Section 2303.4.5 specifically requires written concurrence and approval of a Registered Design Professional before Truss members and components can be cut, notched, drilled, spliced, or altered.

ANSI/TPI 1 is the Standard required by both the IRC and the IBC. It establishes the minimum requirements for the design and construction of metal-plate-connected wood Trusses. Chapter 2 of this Standard defines the roles and responsibilities of the various players (Owner, Building Designer, Truss Manufacturer, and Truss Designer), and it is essential to know which role you are playing. Section 2.2 defines the Building Designer as, "Owner of the Building or the Person that contracts with the Owner for the design of the Building 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." Under the IRC, if the jurisdiction does not require the Building Designer to be an engineer, an Owner or a non-engineer may play the role of the Building Designer. This could be problematic because there are technical responsibilities placed on the Building Designer by ANSI/TPI 1. The Truss Designer is defined as, "Person responsible for the preparation of the Truss Design Drawings." When the Truss Designer is required to be a Registered Design Professional, the Truss Manufacturer engages this engineer. ANSI/TPI 1 also references the BCSI document noted above. It is important to understand the bracing details in this document. A few key elements of ANSI/TPI 1, with reference sections in parenthesis, are listed below:

1) The Owner is required to engage a Building Designer in preparing the Construction Documents and reviewing the Truss Submittal Package (2.3.1.3).
2) The Owner or Owner's representative shall be responsible for ensuring that the Truss Submittal Package is reviewed by the Contractor and the Building Designer (2.3.1.5 and 2.3.4.2).
3) The Construction Documents shall show in detail that they conform to the Legal Requirement, including the Building Code (2.3.2.1).
4) The Construction Documents shall list the Truss design as a Deferred Submittal, and the Building Designer shall review the

Truss Submittal Package for "compatibility" and "general conformance" with the design of the Building (2.3.2.2 and 2.3.2.3).

5) The Construction Documents shall provide information sufficiently accurate and reliable to be used for the design of the Trusses and shall provide among other things "… the location, direction, and magnitude of all dead, live, and lateral loads applicable to each Truss, including … snow drift and unbalanced snow loads" (2.3.2.4.d). (Note that ANSI/TPI 1 puts the burden of calculating the load on each Truss, including the snow drift load, on the Building Designer.)
6) The serviceability criteria shall be included in the Construction Documents (2.3.2.4.g).
7) Permanent Individual Truss Member Restraint/Bracing shall be per the BCSI unless the Building Designer specifies a project-specific bracing design (2.3.3.1.1, 2.3.3.1.2, 2.3.3.1.3, and 2.3.3.2).
8) Several requirements must be met by the Contractor, including reviewing the Truss Submittal Package and then forwarding it to the Building Designer for review. The Contractor shall not proceed with the Truss installation until the Truss Submittal Package has been reviewed by the Building Designer (2.3.4.2 and 2.3.4.3). The contractor must also check the Trusses for damage both prior to installation and after installation (2.3.4.6, 2.3.4.7, 2.3.4.8, and 2.3.4.9).
9) The Contractor shall provide to the Truss Manufacturer a copy of all Construction Documents pertinent to the Building Structural System and the design of the Trusses, including the name of the Building Designer if not noted on the Construction Documents (2.3.4.1).
10) Where the Legal Requirements mandate a Registered Design Professional for the Building, each individual Truss Design Drawing shall bear the seal and signature of the Truss Designer (2.3.5.3). An exception allows only the Cover/Truss Index Sheet to be stamped.
11) The Truss Designer is only responsible for "individual" Trusses, not the roof system. Section 2.3.5.2 states, "The Truss Designer shall be responsible for the design, in accordance with this Standard, of each singular Truss depicted on the Truss Design Drawing." It is critical to understand that, per the TPI Standard, the Truss Designer does not have the responsibility to calculate loads for individual Trusses, nor does the Truss Designer have the responsibility for the roof system.
12) The Truss Submittal Package consists of each individual Truss Design Drawing, the Truss Placement Diagram, the Cover/Truss Index Sheet, Lateral Restraint and Diagonal Bracing details, and any other structural details germane to the Trusses (2.2).
13) The Truss Placement Diagram is only an illustration identifying the assumed location of each Truss. It does not need to be stamped because it does not have engineering input (2.3.5.4).

Implementation

1) Building Officials, Contractors, Owners, and Building Designers should be cognizant of and enforce the requirement that the Contractor and the Building Designer review the Truss Submittal Package prior to the installation of the Trusses. Building Officials should establish procedures to ensure that this code requirement is followed.
2) Many engineering drawings have general notes that require the Trusses to be designed and stamped by a registered engineer. It is important to understand that the stamp is for individual Trusses and not for the Trusses acting together as a system. Many engineers falsely assume that this stamp is for the individual Trusses as well as for the roof system.
3) Truss web bracing locations are provided on the Truss Design Drawings in the Truss Submittal Package. The BCSI document usually provides the bracing details. Many Truss webs do not align with adjacent Trusses, making continuous Lateral Restraint bracing impossible to install. In these cases, T or L bracing will be required. Construction Documents should provide details and instructions for when T or L bracing is required.
4) Truss web bracing is critical to the stability of the roof system, yet very few residential projects have engineering observation of completed roof systems. Unless the Truss spans 60 feet or more, special inspection of the Truss web bracing installation is not required. This is an area where the code requirements could be improved.
5) Many projects have general notes that state that snow drift and unbalanced snow loading are required to be considered in the Truss design, but the Construction Documents do not provide the actual values of the snow drift loads and the unbalanced loads for each Truss. This is contrary to ANSI/TPI 1, Section 2.3.2.4(d). It is important to understand that the responsibility for calculating and providing the loads applied to each Truss rests with the Building Designer.
6) A functioning roof system is the responsibility of the Building Designer and consists of Trusses, bracing, blocking, connections to structure, diaphragms, and an understanding of the load path of all forces. The Truss Submittal Package is only one piece of the system.
7) If a portion of the roof system falls outside of the scope of the IRC, then that portion, including the associated load paths, will require engineering analysis. If the Building Designer is not an engineer, then an engineer who is not filling the role of the Building Designer could be engaged for a limited scope to design and stamp the elements that fall outside of the scope of the IRC.

This article intends to educate engineers about the roles and division of responsibilities for residential wood Trusses. It is critical to understand the specific scope of the Truss Designer as defined in ANSI/TPI 1. The Truss Designer is responsible for individual Truss Design Drawings using loading information obtained from the Truss Manufacturer, who gets information from the Contractor in the form of selected information from the Construction Documents. The Building Designer is responsible for ensuring that the Truss loads given to the Truss Designer are accurate. The Building Designer is also responsible for ensuring that all Trusses act together as a roof system. All players need to understand and fulfill their responsibilities as outlined in ANSI/TPI 1 in order to achieve a safe and code-conforming building.

Look for a forum piece in an upcoming issue of STRUCTURE where the author will share his experiences, opinions, and recommendations to improve the practice.▪

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