Improving the Practice of Residential Wood Truss Roof Systems

By Brent Maxfield, S.E.

This article is a follow-up from the author's article, *Code Requirements for Residential Roof Trusses*, in the March 2019 issue of STRUCTURE. (The terms in this article beginning with capital letters are defined in Section 2.2 of ANSI/TPI 1-2014, *National Design Standard for Metal Plate Connected Wood Truss Construction*, published by the Truss Plate Institute (TPI) – **www.tpinst.org**).

The ANSI/TPI 1 standard (incorporated into the *International Building Code* (IBC) and *International Residential Code* (IRC) by reference) defines the responsibilities of the various parties associated with the design, fabrication, and erection of metal plate connected wood Trusses. If all responsibilities were adhered to, the system would work. It is my opinion that very seldom are all the responsibilities fulfilled as intended.

The Building Designer, according to ANSI/TPI 1, is defined 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." The ANSI/TPI 1 Standard places technical responsibilities on the Building Designer regarding the information required for the design of the Trusses and the review of the Truss Submittal Package, yet the IRC allows this individual to be someone other than an engineer. I feel that, because of these technical responsibilities, the code should require that an engineer perform them. I am not arguing that the entire residential structure is required to be designed by an engineer, only the roof truss system and its associated load paths.

The Truss Designer (defined by ANSI/TPI 1 as the "Person responsible for the preparation of the Truss Design Drawings") has very specific and limited responsibilities under the ANSI/TPI 1 Standard. This individual is responsible for ensuring that each truss is designed for the loads provided by the Building Designer on the Construction Documents. It is the Building Designer who must provide the loading diagrams for every truss on the project (including the snow drift loading diagrams). The Building Designer also has the responsibility of ensuring that all components of the roof system function as intended.

Based on my experience observing residential wood truss projects, it is my opinion that all wood Truss Manufacturers should have engineers on staff who oversee all projects. These engineers should be responsible for calculating the loads (including snow drift) on every Truss using the design loads provided on the Construction Documents. They should be the ones stamping the Truss Design Drawings and preparing an engineered Truss bracing plan that coordinates the location of each truss and shows the required Truss bracing for all Trusses of the roof system. I feel that the current system of stamping only individual Truss Design Drawings should not be allowed because the engineer stamping the drawings is not required to understand or be responsible for the entire roof system. The stamp gives a false sense of security.

Let me share with you a few of my personal experiences.

Experience and Opinions

On a project for a close family member for which I was the Building Designer, the Truss Submittal Package had each Truss Design Drawing stamped by the Truss Designer. Rather than a "general conformance" review (see ANSI/TPI 1 2.3.2.3), my review was very thorough. During my review, I discovered that the girder Truss did not have enough load in the web members, even though the loading on the Truss seemed correct. I called the Truss Manufacturer to explain my concern. I was told that it was done correctly and it was stamped by the Truss Designer. Following an impassioned discussion, the Truss Manufacturer reluctantly agreed to let me talk to the Truss Designer directly. Once I explained my concerns to the Truss Designer (an engineer), he quickly understood the problem and said that the technician had used a top chord bearing end jack truss instead of a bottom chord bearing end jack. The issue was quickly resolved with the Truss Manufacturer. Had I not performed a thorough review, the girder Trusses would have been severely under-designed. The engineer stamp on the Truss Design Drawings gave a false sense of security because the location of the load provided to the Truss Designer was not correct.

On the same project, I discovered that one of the girder Trusses was not constructed per the Truss Design Drawing. The roof was erected with a critical error. After alerting the Truss Manufacturer of the error, they said they would get an engineered fix for the issue. I got a stamped "fix" from the same Truss Designer. The fix was inadequate. During a conversation with the Truss Designer, I explained the problem with his stamped fix, and he said, "That is not what I was told by the Truss Manufacturer." Here again, the Truss Designer relied on information provided by someone who was not an engineer and provided a stamped drawing that did not work. Once the Truss Designer understood the issue, he quickly came up with a proper fix.

Individual Truss Design Drawings show webs that must be braced, but the Truss Designer does not coordinate the continuous lateral bracing with adjacent Trusses. Many times, webs do not align. ANSI/TPI 1 and BCSI-B3 place the responsibility of stabilizing the

Continuous Lateral Bracing on the Building Designer. In my experiences, Truss bracing is rarely installed correctly. Very few residential projects have structural observation of the Truss bracing installation.

The technicians working for the Truss Manufacturer, who input the Truss framing and loads into the computer software, are almost always not engineers nor is there an engineer in the facility. These technicians are the ones who usually calculate the loads, including the snow drift, for each Truss. At times, they make changes to the Truss framing shown on the Construction Documents to make a more economical system, but they may not be qualified to evaluate the impacts the changes could have on the structural system. Most Building Designers believe that they are delegating the responsibility for an entire roof system, but ANSI/TPI 1 makes it clear that the Truss Designer is only responsible for the design of individual Trusses using loads provided by the Building Designer. The burden to verify the Truss loading diagrams transferred from the Truss Manufacturer to the Truss Designer rests with the Building Designer.

The Truss Submittal Package is required by IRC Section R802.10.1 to be submitted and approved by the Building Official prior to Truss installation. This critical step is not happening in most parts of the country. Building Officials must have better enforcement of this requirement.

My Recommendations

As I expressed above, I believe that Truss Manufacturers should have engineers on staff who oversee the Truss design and stamp a coordinated Truss system, engineered for the requirements provided on the Construction Documents. This is what is done by the steel joist industry. I feel that the stamp by a Truss Designer who is only stamping individual Truss components should not be allowed. This change is not likely to happen anytime soon, so engineers must work within the current system. I make the following recommendations.

1) Roof System
   a. Delegate the design of the roof system. Understand that the Truss Designer will not do more than stamp individual Truss Design Drawings. This delegated design will be from an additional engineer. Require that the Truss Manufacturer engage a structural engineer (separate from the Truss Designer) who will be responsible for the design of the wood Truss roof system. This engineer will 1) Be responsible for the Truss layout and will work with the Building Designer if the Truss layout is changed from the layout shown on the construction documents; 2) Oversee the calculation of the loads on each Truss including the snow drift loads; 3) Ensure that the loads for every individual Truss provided to the Truss Designer are correct; 4) Provide a bracing plan that coordinates the web bracing for every Truss and clearly shows how and where the diagonal bracing should be located for the Continuous Lateral Bracing, or where "L" or "T" bracing should be used; 5) Be responsible for the Truss-to-Truss connections; and 6) Stamp the Truss bracing plan. Alternatively, you could do the following:
   b. Perform the responsibilities listed above and ensure that your fee is adequate to provide this oversight. Most of these are required by the IRC and the IBC.
2) Web Bracing
   a. Become familiar with the SBCA *Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses*. Require that <u>all</u> Truss webs that require bracing as shown on the Truss Design Drawings use an "L" or "T" brace, with an exception to allow horizontal bracing only if 3 or more webs align and a diagonal brace is provided from the top chord to the bottom chord. Provide the details for these braces on the Construction Documents.
3) Truss Submittal Package
   a. Insist that you review the Truss Submittal Package prior to Truss installation and ensure that the items as noted above are carefully reviewed.

Until the requirements in ANSI/TPI 1 are changed, engineers must be more vigilant in their responsibilities as outlined above, or they must clearly and specifically delegate the responsibility to a third engineer who will function as a wood Truss roof system engineer.▪

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Possible Scope of Work for a Delegated Wood Truss Roof System Engineer

1) Provide a Truss placement plan that clearly shows the dimensioned location of all Trusses, clearly labeled.
2) Provide Truss-to-Truss connection requirements clearly labeled. Each Truss-to-Truss connection will identify the calculated load, the specific connector model to be used, and the number and type of nails or screws that must be used with the connector.
3) Show details for the anchorage of the Trusses to the supporting structure as indicated on the Construction Documents. (Remember that, per ANSI/TPI 1, the Building Designer is responsible for specifying the Truss-to-structure anchorage.)
4) Provide anchorage of gable end Trusses and the required out-of-plane reinforcement for these gable end Trusses.
5) Show locations of field blocking to maintain the proper load path.
6) Provide all other elements and details necessary to certify that the erected Trusses will act as an entire system capable of transferring the roof loads through the system to the elements providing resistance.
7) Certify that the loads provided for each Truss to the Truss Designer by the Truss Manufacturer are in conformance with the loading requirements provided in the Construction Documents. This includes certifying that the snow drift loads were properly calculated and applied to each Truss.
8) Provide a bracing plan that is coordinated with every individual Truss Design Drawing. Show all necessary permanent bracing of Truss webs and the Truss bottom chords. Show locations of Continuous Lateral Bracing and provide details and the locations of diagonal bracing. Also, provide details of the brace connections. Indicate which bracing is to be accommodated with "T" or "L" bracing with appropriate details.