Technical Q & A

Calculating Truss Uplift

by Ryan J. Dexter, P.E.

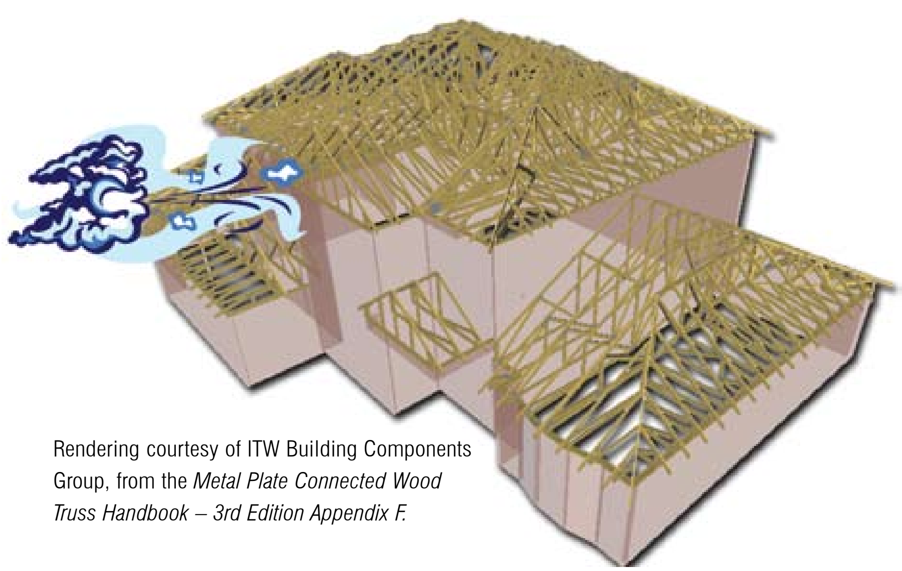
When to use the MWFRS and C&C methods for analyzing wind loads.

ASCE 7 is the standard that defines the minimum design loads that should be placed on a structure regardless of the material used (e.g., steel, wood, concrete, etc.). When it comes to wind load analysis, *ASCE 7-2005* delineates two distinct methods: Main Wind Force-Resisting System (MWFRS) and Components & Cladding (C&C). Many people ask which of these methods should be used when designing truss uplift connections. Let's take a look.

Main Wind Force-Resisting System

ASCE 7 Section 6.2 defines MWFRS as "an assemblage of structural elements assigned to provide support and stability for the overall structure. The system generally receives wind loading from more than one surface." The assemblage of structural elements is defined in the ASCE 7 Commentary:

> "(it) can consist of a structural frame or an assemblage of structural elements that work together to transfer wind loads acting on the entire structure to the ground. Structural elements such as cross-bracing, shear walls, roof trusses, and roof diaphragms are part of the MWFRS when they assist in transferring overall loads."



Rendering courtesy of ITW Building Components Group, from the *Metal Plate Connected Wood Truss Handbook – 3rd Edition Appendix F.*

ASCE 7 makes two main points about using the MWFRS level loads for roof-to-wall connection forces:

- The Commentary clearly states that MWFRS loads are an assembly of elements (i.e., roof trusses) that transfer loads acting on the structure to the ground. Roof-to-wall uplift connections are developed through an assembly of roof framing members caused by forces acting on the entire roof, and this uplift force must transfer down the load path to the foundation of the structure.
- *ASCE 7* states that the MWFRS "generally receives load from more than one surface." This implies that applications where load is derived from only one surface may still fall under the MWFRS method.

at a glance

- Truss or rafter uplift connections should be designed for wind load using *ASCE 7* MWFRS method, while the member design of the individual truss should use C&C loads to generate member forces.
- Visit www.sbcindustry.com/technotes.php for SBCA's Tech Note on this issue.
- The SBCA Load Guide also contains information about uplift connections for structural building components.

Components & Cladding

ASCE 7 Section 6.2 also defines C&C as "elements of the building envelope that do not qualify as part of the MWFRS." The Commentary adds: "Components receive wind loads directly from cladding and transfer the load to the MWFRS, while cladding receives wind loads directly." Roof coverings (i.e., OSB sheathing, roofing membranes, etc.) are an example of cladding. The negative pressures on the roof covering and fasteners should be calculated according to C&C level loads. As an example, a building envelop *component* applies load to the truss chords or web members of a roof truss. These load-resisting members of a roof truss receive wind load and are therefore designed due to applied forces coming from C&C level loads.

An example of a structural element designed for both MWFRS and C&C is roof decking. When checking out-of-plane forces on the roof deck, C&C level loads should be used, while MWFRS level loads should be applied to diaphragm design. Similarly, trusses should resist C&C applied loads, while using MWFRS applied loads to determine the flow of loads to calculation uplift and bearing reactions.

Typically, the Truss Design Engineer provides the roof truss design. Both building code referenced truss standards *ANSI/TPI 1-2007: National Design Standard for Metal Plate Connected Wood Truss Construction and AISI S214-07: North American Standard for Cold-Formed Steel Framing – Truss Design* require the Truss Design Engineer's truss design drawings to provide all reactions on the truss. Furthermore, both standards require the Truss Design Engineer to provide "Truss-to-Truss connection and Truss field assembly" requirements. The roof-to-wall connection is not part of the Truss Design Engineers scope of work. Finally, both standards require the Building Designer to design and detail "all anchorage designs required to resist uplift, gravity, and lateral loads and Truss-to-Structural Element connections, but not Truss-to-Truss connections."

A conflict may arise when the Truss Design Drawing includes end reactions that are different than the Building Designer's calculation of roof-to-wall anchorage forces. In some cases, building departments faced with this conflict in loads have required the use of Truss Design Drawing anchorage forces in lieu of the Building Designer's design forces. This should not be necessary since it is within the Building Designer's scope of responsibility per *TPI 1-2007* and *AISI S214-07*. The Building Designer reserves the right to use the truss design anchorage forces, but any discrepancies in force must be resolved by the Building Designer.

We recommend that the Building Designer develop a relationship with the Truss Design Engineer to provide Truss Design Drawings that include end reactions based on MWFRS level loads and that the truss member design uses C&C loads. Moreover, the Building Designer should resolve any difference in the forces that they have calculated and those that the Truss Design Engineer have reported.

SBCA, in partnership with its Chapters, has created a new Tech Note, "MWFRS versus C&C for Truss Uplift Connection for Wind Design Method" to summarize information in this article. SBCA *Tech Notes* can be viewed online at www.sbcindustry.com/technotes.php.

The *SBCA Load Guide* also provides insight into the issue of uplift connections as well as specifying and applying loads to structural building components. The *SBCA Load Guide* can be downloaded at www.sbcindustry.com/loads.php. SBC

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