The first two Standard of Care articles discussed deferred submittals and truss-to-truss connections. This article explores truss minimum required bearing width issues from the perspective of the design community.

Prior to delving into this subject, it should be noted that, within the context of this article, the terms “bearing length” and “bearing width” are one and the same. “Bearing length” answers the question from a truss viewpoint—what length of truss must be supported for a calculated reaction? “Bearing width” answers the question from the building perspective—how wide must a supporting member be to adequately resist the truss reaction? “Bearing width” is used within this article for consistency with model building codes and the National Design Standard for Metal Plate Connected Wood Truss Construction (TP1).1

Section 107 of the 2012 International Building Code (IBC®)2 and Section R106 of the 2012 International Residential Code (IRC®)3 establish minimum requirements for construction documents. TP1 Sections 2.3.2.4 and 2.4.2.4 expand on the model code requirements and detail specific items the construction document must include to adequately develop each truss design.

**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, and shall provide the following:

(a) All Truss and Structural Element orientations and locations.
(b) Information to fully determine all Truss profiles.
(c) All Structural Element and Truss support locations and bearing conditions (including the allowable bearing stress).
(d) The location, direction, and magnitude of all dead, live, and lateral loads applicable to each Truss including, but not limited to, loads attributable to: roof, floor, partition, mechanical, fire sprinkler, attic storage, rain and ponding, wind, snow (including snow drift and unbalanced snow), seismic; and any other loads on the Truss;
(e) All anchorage designs required to resist uplift, gravity, and lateral loads.
(f) Truss-to-Structural Element connections, but not Truss-to-Truss connections.
(g) Permanent Building Stability Bracing; including Truss anchorage connections to the Permanent Building Stability Bracing.
(h) Criteria related to serviceability issues including:
   (1) Allowable vertical, horizontal or other required deflection criteria.
   (2) Any dead load, live load, and in-service creep deflection criteria for flat roofs subject to ponding loads.
   (3) Any Truss camber requirements.
   (4) Any differential deflection criteria from Truss-to-Truss or Truss-to-adjacent Structural Element.
   (5) Any deflection and vibration criteria for floor Trusses including:
      (a) Any stringback bridging requirements.
      (b) Any dead load, live load, and in-service creep deflection criteria for floor Trusses supporting stone or ceramic tile finishes.

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**Editor’s Note:**
The purpose of this article series is to identify truss-related structural issues sometimes missed due to the day-in and day-out demands of truss design/production and the fragmented building design review and approval process. This series will explore issues in the building market that are not normally focused upon, and provide recommended best-practice guidance. As with the previous two articles (November 2014 and December 2014), the objective is to raise awareness of these issues and, ultimately, improve overall quality of truss roof and floor system construction.
(6) Moisture, temperature, corrosive chemicals and gases expected to result in:
(a) Wood moisture content exceeding 19 percent,
(b) Sustained temperatures exceeding 150 degrees F, and/or
(c) Corrosion potential from wood preservatives or other sources that may be detrimental to Trusses.

2.4.2.4 Required Information in the Construction Documents.
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(e) All anchorage designs required to resist uplift, gravity, and lateral loads.
(f) Adequate Truss-to-Structural Element connections, but not Truss-to-Truss connections.
(g) Permanent Building Stability Bracing; including Truss anchorages connections to the Permanent Building Stability Bracing.
(h) Criteria related to serviceability issues including:
(1) Allowable vertical, horizontal or other required deflection criteria.
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(3) Any Truss camber requirements.
(4) Any differential deflection criteria from Truss-to-Truss or Truss-to-adjacent Structural Element.
(5) Any deflection and vibration criteria for floor Trusses including:
(a) Any strongback bridging requirements.
(b) Any dead load, live load, and in-service creep deflection criteria for floor Trusses supporting stone or ceramic tile finishes.
(b) Moisture, temperature, corrosive chemicals and gases expected to result in:
(a) Wood moisture content exceeding 19 percent,
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(c) Corrosion potential from wood preservatives or other sources that may be detrimental to Trusses.

One specific item requires the building designer to specify the allowable bearing stress of the support material for all structural element and truss bearing locations. The majority of construction drawings prepared by design professionals identify the support material(s) and bearing width(s) in sufficient detail to determine the allowable bearing stress of the support material. For example, a 2x4 wood bearing wall is specified with No. 2 or better Spruce-Pine-Fir (SPF) studs and plates. The maximum bearing width this wall can provide is 3 1/2 inches (2x4). The allowable bearing stress for the wall plates is equal to the compression perpendicular-to-grain value of 425 psi as listed in Table 4A of the National Design Specification® NDS® Supplement for visually graded (No. 2) SPF dimension lumber (see online version to view this table). This information meets the intent of TPI 1.

There are occasions in residential construction when the wood wall size is indicated and lumber species is missing. In such cases, truss designers are encouraged to communicate with the building designer and/or contractor to verify the material to use. Design professionals and/or building designers expect truss designers to be aware of the support material bearing width with respect to the truss reactions. Additionally, TPI 1 Section 2.3.5.1 and 2.4.5.1 assign responsibility to the truss designer to design trusses, based on criteria contained in the construction documents or provided in writing from the building designer as supplied to the truss designer by the truss manufacturer.

2.3.5.1 Preparation of Truss Design Drawings. The Truss Design Engineer shall supervise the preparation of the Truss Design Drawings based on the Truss design criteria and requirements set forth in the Construction Documents or as otherwise set forth in writing by the Registered Design Professional for the Building as supplied to the Truss Design Engineer by the Contractor through the Truss Manufacturer.

2.4.5.1 Preparation of Truss Design Drawings. The Truss Designer is responsible for the preparation of the Truss Design Drawings based on the Truss design criteria and requirements set forth in the Construction Documents or as otherwise set forth in writing by the Building Designer as supplied to the Truss Designer by the Truss Manufacturer.

Truss designers typically have a variety of tools available to them (e.g., truss design software and reference tables, see Table 1 on page 20) to evaluate truss reactions for a specified bearing width, wood species and grade (in the case of wood plates). Truss technicians should use these tools to calculate and evaluate in-service truss bearing conditions.

IRC Section R502.11.4 and R802.10.1, IBC Section 2303.4.1.7 and TPI 1 Section 2.3.5.5 and 2.4.5.4 specify the minimum information each truss design drawing must contain, including the required bearing width at each support location.

2.3.5.5 Information on Truss Design Drawings. Truss Design Drawings shall include, at a minimum, the information specified below:

Continued on page 18
(a) Building Code used for design, unless specified on Cover/Truss Index Sheet.
(b) Slope or depth, span and spacing.
(c) Location of all joints and support locations.
(d) Number of plies if greater than one.
(e) Required bearing widths.
(f) Design loads as applicable, including:
   (1) Top Chord live load (for roof Trusses, this shall be the controlling case of live load or snow load);
   (2) Top Chord dead load;
   (3) Bottom Chord live load;
   (4) Bottom Chord dead load;
   (5) Additional loads and locations;
   (6) Environmental load design criteria (wind speed, snow, seismic, and all applicable factors as required to calculate the Truss loads); and
   (7) Other lateral loads, including drag strut loads.
(g) Adjustments to Wood Member and Metal Connector Plate design values for conditions of use.
(h) Maximum reaction force and direction, including maximum uplift reaction forces where applicable.
(i) Metal Connector Plate type, manufacturer, size, and thickness or gauge, and the dimensioned location of each Metal Connector Plate except where symmetrically located relative to the joint interface.
(j) Size, species and grade for each Wood Member.
(k) Truss-to-Truss connection and Truss field assembly requirements.
(l) Calculated span to deflection ratio and/or maximum vertical and horizontal deflection for live and total load and KCR as applicable.
(m) Maximum axial tension and compression forces in the Truss members.
(n) Fabrication tolerance per Section 6.4.10.
(o) Required Permanent Individual Truss Member Restraint location and the method of Restrain/Bracing to be used per Section 2.3.3.

2.4.5.4 Information on Truss Design Drawings. Truss Design Drawings shall include, at a minimum, the information specified below:
(a) Building Code used for Design, unless specified on Cover/Truss Index Sheet.
(b) Slope or depth, span and spacing.
(c) Location of all joints and support locations.
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(e) Required bearing widths.
(f) Design loads as applicable, including:
   (1) Top Chord live load (for roof Trusses, this shall be the controlling case of live load or snow load);
   (2) Top Chord dead load;
   (3) Bottom Chord live load;
   (4) Bottom Chord dead load;
   (5) Additional loads and locations;
   (6) Environmental load design criteria (wind speed, snow, seismic, and all applicable factors as required to calculate the Truss loads); and
   (7) Other lateral loads, including drag strut loads.
(g) Adjustments to Wood Member and Metal Connector Plate design values for conditions of use.

(h) Maximum reaction force and direction, including maximum uplift reaction forces where applicable.
(i) Metal Connector Plate type, manufacturer, size, and thickness or gauge, and the dimensioned location of each Metal Connector Plate except where symmetrically located relative to the joint interface.
(j) Size, species and grade for each Wood Member.
(k) Truss-to-Truss connection and Truss field assembly requirements.
(l) Calculated span to deflection ratio and/or maximum vertical and horizontal deflection for live and total load and KCR as applicable.
(m) Maximum axial tension and compression forces in the Truss members.
(n) Fabrication tolerance per Section 6.4.10.
(o) Required Permanent Individual Truss Member Restraint location and the method of Restrain/Bracing to be used per Section 2.3.3.

It is imperative a truss designer understand the design parameters input into truss design software and the resulting output. When an excessive bearing width is calculated and displayed on a truss design drawing (TDD), the truss designer or truss engineer needs to explore solutions that meet the bearing parameters specified by the building designer. A wood bearing failure is not catastrophic; however, finish damage, cracks and sagging result from local wood crushing (see Figure 1).

Two primary items determine the minimum required truss bearing width—truss lumber species and the building material supporting the truss. Lumber grade also has an effect if Southern Pine or machine-grade lumber (i.e., machine stress rated, MSR, or machine evaluated lumber, MEL) is used. Truss bearing widths included on a TDD are generally calculated using properties of the lumber in the truss. However, these values will be insufficient if the bearing capacity of the supporting member is less than the bearing capacity of the wood in the truss. Most truss design software compare the calculated minimum bearing width to an available bearing width input by the truss designer. The minimum required bearing width and available bearing width is typically shown on each TDD. When the minimum required bearing width exceeds the input available width, a warning note is typically displayed. An example of one such note is:

**WARNING:** Required bearing size at joint(s) greater than input bearing size.
Standard of Care Issues
Continued from page 18

A bearing size warning or caution note displayed on a TDD may sometimes be neglected or marginalized by a truss designer. However, the truss designer should try to be proactive in resolving bearing width issues. It is the truss designer who knows if the warning note pertains to the truss or the support structure. Dependence solely on TDD notes to communicate minimum bearing width requirements can contribute to review oversights and/or insufficient installation, as critical information can easily be overlooked or misunderstood given the large number of TDDs for a given project. Two preemptive methods are direct communication with the building designer and/or placing a highly visible note on the truss placement diagram (TPD) when the truss approval process is used.

Truss designers must be extremely cautious with large truss reactions, especially reactions associated with girder trusses. The authors have seen girder truss reactions in excess of 30,000 lbs. and required bearing lengths exceeding 17 inches. Large reactions and inadequate bearing lengths can cause severe plate crushing and wall covering damage, as shown in Figure 1. A table was published in the April 2007 issue of SBC to assist truss designers with evaluating truss reactions. Truss designers are encouraged to reference Table 1 for maximum allowable reactions associated with specific species and sizes of wood wall plate material.

Large reactions present three additional areas of concern that are beyond the scope of this article: column capacity, foundation size, and associated large uplift reactions in high wind areas. Regarding large uplift reactions, published pre-manufactured tie-down connectors rarely exceed 10,000 lbs., with a majority less than 3000 lbs. Therefore, the truss designer has a responsibility to discuss large reactions with the building designer and help find a solution.

The truss industry has an opportunity to assist building designers when bearing width issues arise. Supplemental pre-fabricated metal bearing hardware for single-ply trusses is one option. Manufacturers’ literature contains published values for design, and the installation can be easily verified. Trusses with large gravity load reactions may require a column cap to obtain sufficient bearing area. Additionally, increasing the number of plies may be a solution. The additional cost of an extra ply may be at least partially offset with smaller chord sizes, lower lumber grade, fewer webs and/or eliminating special hardware. If these solutions are unacceptable, the truss designer can discuss building changes with the building designer.

Some solutions proposed by the truss industry to remedy truss bearing issues only succeed in addressing part of the problem. For instance, one method is to extend a web member through the truss bottom chord allowing the truss to bear directly on the end grain of the web. This greatly increases the bearing capacity for the truss, since compression parallel to grain stress is typically 2-3 times greater than compression perpendicular to grain values. However, the bearing issue most likely still exists for the support material, unless this material is steel. Another method recommends replacing the very top plate of the wood stud bearing wall with a species and grade that is the same as the truss chord. The problem with this suggestion is that the reaction from the truss is transferred into the wall stud(s) through the wall plates in contact with the stud. In order for this solution to be acceptable, both top plates and the sole plate need to be replaced with a wood species and grade that is the same or better as the truss to perform as anticipated.

Field installation of truss bearing blocks is one option that can be used successfully to increase the bearing area and reduce the required bearing stress on both the truss chord and support material. However, a sealed TDD should be obtained from the truss design engineer indicating the size, species, grade, orientation, location(s) and connection of the block(s) to the truss, and manufacturing facilities should provide all required materials. Otherwise, it has been the authors’ experience that bearing blocks are not installed or improper materials and/or fasteners are used.

The building code and ANSI/ITI require construction documents to contain specific information that allows truss designers to investigate minimum bearing widths. Checking required truss and support material bearing width and communicating potential problems to the contractor and building designer helps ensure satisfactory performance, improves the quality of truss construction, minimizes downstream construction defects, and helps make the truss designer/truss manufacturer an important member of the design and construction team. SBC

<table>
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<th>Species (F.)</th>
<th>Plate Size</th>
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Table 1. Maximum Truss Reaction (lbs.) Based on Allowable Compression Stress Perpendicular to Grain (FcL) of the Lumber Plate.1 2

1 Reaction values are based on Cm, Cg and C1 = 1.0.
2 Reaction values assume that the truss bears on the full width of the lumber plate.
3 Reaction values can be increased by 1.16B if the lumber plate is Dense Select Structural, Dense No. 1 or Dense No. 2.
4 Use the reaction value in this row if the truss is located at least 3 feet from the end of the lumber plate.

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