Hey Truss Manufacturer, What's Your Fabrication Tolerance?

by Bill Bolduc, P.E., S.E.

What's your fabrication tolerance? Be prepared to answer this question. If you have not been asked yet, there is a good chance you will be asked in the near future. When you confidently answer this question in a clear and succinct manner, you show that you are a quality manufacturer that is in control of design and fabrication.

This question will likely come from several sources and different people in your company will be asked at various times.

- Your plant personnel will be asked by your Third Party Quality Inspector/ Auditor.
- Your truss design manager and truss technicians will be asked by the firm that provides you sealed truss design drawings.
- The people setting up the truss design software will be asking this question.
- The plan examiner from the building department will be asking this question.
- Field inspectors from the building department will be asking this question.
- Over time even framing contractors and home builders will be asking this question.
- In the event of a claim or lawsuit, you may even be asked by an attorney. See sidebar below.

The Fabrication Tolerance: A Simple Concept

The concept of the Fabrication Tolerance was introduced in ANSI/TPI 1-2002 National Design Standard for Metal Plate Connected Wood Truss Construction. ANSI/TPI 1-2002 is the reference standard for metal plate connected wood trusses in the 2003 and 2006 versions of the International Residential Code® and International Building Code® (IBC). The concept is simple. Each truss manufacturer establishes a tolerance that is used for the plated connections in the trusses that are manufactured. This tolerance is used in two places:

1. The in-plant quality control process uses the Fabrication Tolerance as a clear criterion for the pass/fail of any joints selected for inspection.

2. The engineering of the truss plates on the truss design drawings are adjusted to allow for imperfections allowed within the Fabrication Tolerance.

SBCA Legal Counsel Kent Pagel warns about the legal implications of establishing a consistent Fabrication Tolerance:

"There ought to be significant legal concerns on the part of any component manufacturer where the Fabrication Tolerances shown on the truss design drawings are less than the Fabrication Tolerances used by the manufacturer for their quality control procedures. The argument that would be later advanced in the event of a collapse, product fall-down or construction defect case would simply be that the design assumes a certain quality of manufacturing and that was not met and is most likely the cause of the [failure/defect]. A 3rd party inspection agency should likewise be concerned as they would be viewed in a litigation or arbitration as the entity responsible to regulate manufacturers who ignore the rules."

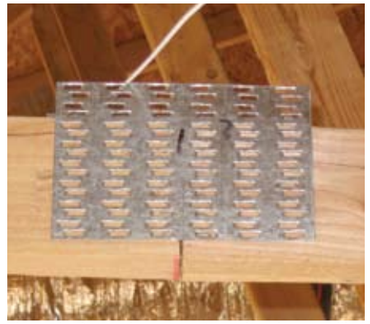

Figure 1. Plate misplacement. Engineering specified bottom edge of plate at the bottom edge of the chord.

Figure 2. Pitch-pocket under plate area.

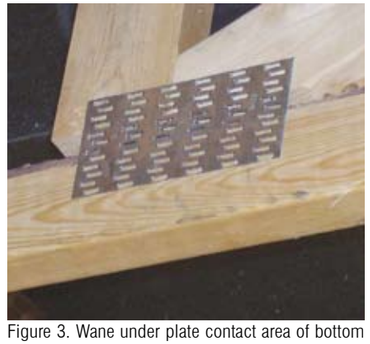

Figure 3. Wane under plate contact area of bottom chord.

Obviously, the same Fabrication Tolerance must be used in both the in-plant quality control and on the truss design drawings. To keep this coordinated, ANSI/TPI 1 requires that this information be stated on each truss design drawing. Some plate sizes used will be affected by the Fabrication Tolerance.

What is the Fabrication Tolerance?

The Fabrication Tolerance is the percentage of the plate contact area on a given member of a joint that is allowed to be ineffective due to any of the following conditions:

- the position of the metal connector plate on the joint
- the embedment of the teeth into the wood
- the quality of the lumber at the contact area under the metal connector plate

The occurrence of any of these conditions will reduce the strength of the connection:

- If the plate is positioned differently from what is specified on the truss design drawing, one or more of the members in the joint will have fewer teeth and less strength than intended by the truss design drawing. (See Figure 1)
- If there is a small gap (embedment gap) between the metal plate and the wood surface, the strength of the connection is reduced. The ANSI/TPI 1 standard allows a gap up to and including 1/32" before some reduction in capacity must be considered. (See Table 1) If any teeth are flattened (i.e., not embedded perpendicular to the wood surface) the capacity is reduced.
- If a lumber characteristic, such as a knot, wane, or pitch pocket, is under the plate contact area, the strength of the connection is reduced. (See Figures 2 and 3) This can occur even if the lumber is the correct grade specified on the truss design drawing. For example, #2 Grade of structural light framing lumber typically allows wane to be up to ½ the width of the member for up to ¼ the length of the member. Although this is acceptable for many structural uses, it would usually be unacceptable for one half of a member width under the plate contact area to be into wane.

Tooth Embedment Gap, G	G=0"	0"< G ≤ 1/32"	1/32"< G ≤ 1/16"	1/16"< G ≤ 3/32"	G > 3/32"
Tooth Effectiveness	119%	100%	60%	40%	0%

Table 1. Tooth Effectiveness with Various Embedment Gaps

What's Your Fabrication Tolerance?

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A Simple Concept Became Overly Complicated

The first attempt to formalize the Fabrication Tolerance concept was in ANSI/TPI 1-2002. This version of the standard used the Quality Control Factor, or C_q, to adjust plate holding values for the corresponding Fabrication Tolerance established by the truss manufacturer. C_q was designed to be similar to the load duration factor in that a normal value (for roof trusses) was typically 1.00 (this represented a 20 percent reduction in plate holding values) and in some cases it could be increased up to 1.25 (this represented no reduction in plate holding values). ANSI/TPI 1-2002 requires that C_q be shown on the truss design drawing. This presentation of C_q was confusing to most of us.

The good news is that the industry realized the confusion caused by the way C_q was initially presented and improved things in ANSI/TPI 1-2007. In the 2007 version, the Fabrication Tolerance was clarified and brought to the forefront. The Fabrication Tolerance is now required to be shown on the truss design drawing per ANSI/TPI 1-2007. ANSI/TPI 1-2007 no longer requires C_q on the truss design drawing since it can be determined from the Fabrication Tolerance.

The value of C_q was also changed in the 2007 version. Table 2 shows how each of these relates to the Fabrication Tolerance. If someone asks "What's your quality control factor?", you should answer in terms of your Fabrication Tolerance. You will also need to explain the relationship between C_q and the Fabrication Tolerance per Table 2.

Most of the software for metal plate connected wood trusses designed in accordance with ANSI/TPI 1-2007 now places the Fabrication Tolerance on the truss design print-out. The entire truss might be designed with one Fabrication Tolerance for all joints, or a separate Fabrication Tolerance might be assigned on a per joint basis depending on design restraints (see the exceptions below).

What Is the Correct Value for the Fabrication Tolerance?

There is no single correct value. The correct value is the value that has been established by the truss manufacturer. That is why you must be prepared to answer: "What's your Fabrication Tolerance?".

It depends on the quality control procedures used by the truss manufacturer. The Fabrication Tolerance may be any value from 0% to 30% (or even higher). What is important is that the Fabrication Tolerance shown on the truss design drawings matches (or exceeds) the Fabrication Tolerance used by the truss manufacturer for their quality control procedures. The third party agency that audits the plant's quality control procedures must also agree that the quality procedures ensure results that justify the Fabrication Tolerances shown on the truss design drawings.

Typically, truss manufacturers will use a more liberal Fabrication Tolerance for roof trusses (plates embedded into the wide face of the lumber) than for floor trusses (with plates embedded into the narrow edge of the lumber). This is due to the greater geometric complexity of roof trusses and the manufacturing process that may require placement of a truss plate on the underside of the connection for roof trusses.

If the Fabrication Tolerance is less than 20% for roof trusses (plates into wide face) or less than 11% for floor trusses (plates into narrow edge), the ANSI/TPI 1-2002 (Section 3.2.4.2) requires that "... the Truss Manufacturer shall provide to the approved inspection agency, or through other means, justification ..." for the lower Fabrication Tolerance. ANSI/TPI 1-2007 does not have this requirement. See Table 2 for the relationship between the Fabrication Tolerance and the Quality Control Factor, C_q.

Fabrication Tolerance	Quality Control Factor, C_q	
	Per ANSI/TPI 1-2002	Per ANSI/TPI 1-2007
0%	1.25	1.00
10%	1.125	0.90
11%	1.11	0.89
20%	1.00	0.80
30%	0.875	0.70

Table 2. Equivalent Quality Control Factor for Various Fabrication Tolerances

Are There Any Exceptions?

If a joint cannot be plated with the normal inventory of plates, most truss design software will allow an exception. An attempt can by made to specify a plate with a lower Fabrication Tolerance than normally specified by the truss manufacturer. In this case ANSI/TPI 1 requires that the truss design drawing show that an exception was taken.

The truss design drawing must indicate that the joint was designed using a modified Fabrication Tolerance. The truss manufacturer must recognize this and apply the required additional quality criteria to this joint.

References in the Building Code

The 2003, 2006 and 2009 versions of the IBC successively include more guidance as to the minimum information to be submitted to the building department for plan review and inspection of projects involving wood trusses. Each of these codes references the ANSI/TPI 1 standards. The 2003 and 2006 versions reference ANSI/TPI 1-2002, while the 2009 version references ANSITPI 1-2007. The 2006 IBC Section 2303.4.2 states that the requirements of the ANSI/TPI 1 must be met in addition to the requirements stated in the IBC.

Conclusion

The 2002 and 2007 editions of ANSI/TPI 1 have significantly improved and clarified the quality requirements for metal plate connected wood truss construction. As building designers, building owners, code officials and contractors learn more about these changes, they will ask questions. If you are prepared with clear answers you will show that you are a quality manufacturer that is in control of the design and fabrication of wood trusses. SBC

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What's Your Fabrication Tolerance?*

"We recently reviewed all of the settings in the software used to select plates. We had access to a knowledgeable person from our plate supplier to help us understand the details. Our TPI QC Fabrication Tolerance is set to 20% for roof trusses and 11% for floor trusses."

–Joe Butcher, P.E. • Vice President • Heart Truss & Engineering • Lansing, MI

"We use a tolerance of 20% for roof trusses and 11% for floor trusses. This provides a good balance between plate sizes and economy. It also works well with our In-Plant WTCA QC process."

–Glenn McClendon • Vice President • Sun State Components of Nevada

*Editor's Note: The tolerances given are not intended to be a representative sample.

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