Tending to Deflection

Improving the Performance & Serviceability of Trusses

A PRIMARY FOCUS of truss design is ensuring each truss component has sufficient capacity or strength to safely support design loads. Designing components with adequate strength is very important and a primary requirement of the building code. Another design requirement of equal importance is deflection and stiffness.

These serviceability issues rarely affect life-safety and are sometimes marginalized by strength design. However, the vast majority of truss complaints received by component manufacturers (CMs) relate to serviceability performance. An awareness of the typical serviceability issues that can adversely affect truss performance is crucial. Many potential complaints and problems can be alleviated by a truss technician during the design phase.

Sections within ANSI/TPI 1-2014 (TPI 1) outline specific responsibilities and design requirements that should be familiar to truss technicians. Section 2.3.2.4 lists information a design professional or building designer must include in the construction documents. Subsection (g) identifies six serviceability issues that are often part of the project specifications. These include:

1. Allowable vertical, horizontal or other required deflection criteria.

2. Dead load, live load and in-service creep deflection criteria for roofs subject to ponding loads.

3. Truss camber requirements.

4. Criteria for differential deflection from truss to truss or truss to adjacent structural member(s).

5. Deflection and vibration criteria for floor trusses including:
  a. Strongbacking requirements.
  b. Dead load, live load and in-service creep deflection criteria for floor trusses supporting stone or ceramic tile finishes.

6. Moisture, temperature, corrosive chemicals and gases expected to result in:
  a. Wood moisture content exceeding 19%.
  b. Sustained temperatures exceeding 150°F.
  c. Corrosive potential from wood preservatives or other sources that can be detrimental to the trusses.

Although this information may be absent from some construction documents, an astute truss design technician with a strong understanding of the various situations that cause or contribute to each of these issues can implement design practices to mitigate potential in-service problems. In fact, many serviceability issues can be avoided by paying close attention to deflection.
Deflection is the amount that a member displaces or sags under the influence of loads that create resistance forces in truss members. With the exception of scissors trusses, the performance or deflection of a truss is generally based on the amount of vertical movement relative to a horizontal line (think a horizontal plane such as the ceiling plane). The building code and industry standards provide guidance and limitations for acceptable vertical movement relative to member span. Truss deflection analysis compares calculated displacement to a code-prescribed limit. A calculated displacement less than the prescribed limit is generally considered acceptable.

However, establishing a deflection limit based solely on member span does not ensure satisfactory performance. As a span becomes longer, the corresponding deflection limits become larger (i.e., a 60-foot span using an L/180 deflection criterion has an allowable deflection of 4 inches) and may not work well, either visually, as in the case of a sagging roof line, or based on perception, as in the case of a floor that feels “soft” or “spongy.” The I joist industry worked through I joist deflection issues years ago and promoted “stiffer” deflection ratios (i.e., L/480 instead of L/360 and so forth) to yield fewer bouncy floors for building occupants. Additionally, some industry standards, such as those for the application of ceramic tile, define stiffer floor deflection ratios to ensure good performance of their product’s application. Subsequently, some building codes adopted stiffer floor performance parameters within code tables or by referencing an industry standard.

Table 7.6-1 of TPI 1 and associated footnotes contain truss deflection limits for typical truss applications. These deflection limits are consistent with typical minimum building code requirements but do not preclude a truss design technician from using stiffer criteria when the in-service application warrants. Two examples help place deflections in perspective:

• A 25-foot span floor truss common to apartment buildings could have total load and live load deflections of 1-1/4 inches and almost 7/8 of an inch, respectively, and meet the L/240 and L/360 minimum code deflection criteria.

• A 48-foot span roof truss could have total load and live load deflections of almost 3-1/4 inches and 2-1/2 inches, respectively, and meet minimum code deflection criteria of L/180 and L/240.

Some truss design software permits the truss design technician to limit the truss deflection to a specified maximum amount. This feature becomes invaluable for long truss spans or when large loads are present.

Truss design technicians can mitigate potential truss performance issues and call-backs by accounting for the magnitude of the deflection up front. Doing so can minimize the downstream costs of fixing deflection-based cracking, differential deflection humps in ceilings and bouncy floors—a potential boost for

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customers' perceptions of quality and level of satisfaction.

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