Archived Technical Note Cover Page

Cold-Formed Steel Engineers Institute (CFSEI) Technical Notes are reviewed and revised on a regular basis. Often, during the review process, the evaluation of the note shows that the material is no longer current to specific codes, standards, or research. When the information is not current, but still has technical merit and value, it is archived rather than withdrawn. The note that follows falls into that category.

Specifying Pre-Engineered CFS Floor and Roof Trusses – 551f-98

This note was archived June, 2013. The information contained in this note is obsolete and predates the publication of the North American Standard for Cold-Formed Steel Framing – Truss Design (AISI S214-07) and the Code of Standard Practice for Cold-Formed Steel Structural Framing (AISI S202-11). A new technical note is in the process of being authored.

Additional information on this subject matter may be obtained in the publications listed above, the Cold-Formed Steel Building Component Safety Information (CFSBCSI) from the Structural Building Components Association (SBCA) Cold-Formed Steel Council and truss manufacturers..

LGSEA

TECHNICAL NOTE

On Cold-Formed Steel Construction

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SPECIFYING PRE-ENGINEERED COLD-FORMED STEEL ROOF AND FLOOR TRUSSES

Summary: Pre-engineered cold-formed steel (CFS) roof trusses are commonly specified by structural engineers, architects, and contractors as a framing option for roof construction. This Tech Note reviews the issues a framing system specifier should consider to assure the intent of the design is being met. This document also includes a suggested model specification for CFS roof trusses and an overview of the "Standard Practice for Cold-Formed Steel Truss Design Responsibilities."

Introduction

Cold-formed steel (CFS) roof trusses have emerged as a viable alternative to pre-engineered wood trusses in commercial and residential construction. Among the reasons for their increased use is the similarity of framing principles, non-combustibility, and durability. Pre-engineered CFS trusses also offer many of the same competitive advantages that helped the wood truss industry become dominant in commercial and residential construction markets.

Many architects and engineers have specified the cold-formed "C" shape framing member for use in roof and floor trusses. As the use of steel trusses has grown, so has the variety of proprietary shapes, fabrication methods, and installation techniques. In some cases, this has contributed to some confusion among architects and engineers about what constitutes good practice when specifying CFS trusses. This *Tech Note* is intended to eliminate this confusion by providing the architect and engineer with standard guidelines and resources they can use when specifying CFS roof trusses.

The Design Guide

Recognizing the developing market for CFS trusses, the steel industry and CFS truss manufacturers conducted a significant amount of research over a period of years. These efforts were channeled into the development of a document entitled "*Design Guide for Cold-Formed Steel Trusses*" which was published by the American Iron and Steel Institute (AISI) with the assistance of the Light Gauge Steel Engineers Association. This Design Guide prescribes minimum strength and serviceability requirements for the design of CFS trusses. Also discussed are many issues related to truss design, including loads, member strength evaluation, unbraced length, serviceability, and suggested load test procedures. The guidelines contained in this document are based on the AISI *"Specification for the Design of Cold-Formed Steel Structural Members."*

The members of the LGSEA Truss Committee continue to monitor developments in the use of CFS trusses, and make recommendations and ammendments to the Design Guide.

Design Responsibilities

Included as Appendix A of the Design Guide is the "Standard Practice for Cold-Formed Steel Truss Design Responsibilities," which was adapted from a similar document developed by the Wood Truss Council of America. The Standard Practice defines the design responsibilities of the individuals and organizations involved in the preparation, submittal, review and approval of truss design drawings and the placement plan for CFS trusses. The Standard Practice is also presented as industry standard practice. It is not intended to preclude governing laws or regulations or to preclude provisions that are agreed upon by the parties involved. However, the Standard Practice can also serve as a useful tool for individuals who specify CFS trusses.

The Standard Practice defines all the parties normally involved in the procurement and placement of the truss package. These parties include the Architect, the Engineer-of-Record, the Owner, the Contractor, the Truss Manufacturer and Truss Designer, and the Building Designer. The Building Designer is a term that includes all members in the group of professionals who are responsible for preparing the construction design documents. The Truss Designer, also known as the specialty engineer or the delegated engineer, is the structural engineer who has the responsiblity for the design of the CFS truss, and components and connections that make up the truss.

The methods used by the steel truss industry to design and manufacture their components are very similar to the methods used by the wood truss industry. Typically,

a technician for the Truss Manufacturer uses the Construction Design Documents to prepare a Truss Placement Plan and a profile of each truss component. The Truss Manufacturer also takes off the load criteria and any special serviceability items required for the truss design. The Truss Manufacturer may also analyze the trusses using software from the truss system supplier or may allow the Truss Designer to perform the analysis. In either case, the Truss Designer is responsible for reviewing the analysis output and sealing the Truss Design Drawings (if required by the contract documents).

The Construction Design Documents prepared by the Building Designer should include the infomation necessary for the Truss Designer to perform his work. Section 3.0 of the Standard Practice lists all the items recommended be included in the Construction Design Documents. (see box inset at right). This should not preclude any additional information as required by the local building official.

Clear communications plays a vital role in building design and construction, and it is essential that an orderly communications process be established at the outset of a program. It is recommended that designated individuals from the Architectural and/or Engineering firm, the Owner, the Contractor, and the Truss Manufacturer be identified in order to avoid the pitfalls associated with having too many individuals acting as the responsible parties. It also is very important that the Building Designer clearly spell out the applicable Building Code, all applicable load criteria, load combination critieria and serviceability criteria (deflection limits, etc.).

3.0 Building Designer Responsibilities

*(*from the *Design Guide for Cold-Formed Steel Trusses, Appendix A: Standard Practice For Cold-Formed Steel Truss Design Responsibilities,* adapted from the *"Standard Practice for Metal Plate Connected Wood Truss Design Responsibilities",* [1,2]*)*

3.1 Design a structure suitable to ensure that the intended function of each truss is not affected by adverse influences including, but not limited to, moisture, temperature, corrosive chemicals and gases;

3.2 Prepare the construction design documents, showing all trusses areas, which must provide as a minimum the following:

- 3.2.1 All truss orientations and locations;
- 3.2.2 Information to fully determine all truss profiles;
- 3.2.3 Adequate support of the truss and all truss bearing conditions;
- 3.2.4 Permanent bracing design for the structure including the trusses, except as provided in 3.4 and 6.2.11. [1]
- 3.2.5 The location, direction and magnitude of all dead and live loads applicable to each truss including, but not limited to, loads attributable to: roof, floor, partition, mechanical, fire sprinkler, attic, storage, wind, snow drift and seismic;
- 3.2.6 All truss anchorage designs required to resist uplift, gravity, and lateral loads;
- 3.2.7 Allowable vertical and horizontal deflection criteria;
- 3.2.8 Proper transfer of design loads affecting the truss; and
- 3.2.9 Adequate connections between truss and non-truss components, except as noted in Section 6.2.8. [1]

3.3 Review and approve the truss placement plan and each truss design drawing for conformance with the requirements and intent of the construction design documents, the effect of each truss design drawing and truss placement plan on other parts of the structure, and the effect of the structure on each truss.

3.4 Specify permanent lateral bracing where indicated by the truss designer on the truss design drawing, to prevent buckling of the individual truss members due to design loads. The building designer shall specify how the permanent lateral bracing is to be anchored or restrained to prevent lateral movement if all truss members, so braced, buckle together. This shall be accomplished by: (a) anchorage to solid end walls; (b) permanent diagonal bracing in the plane of the web members; of (c) other means when demonstrated by the Building Designer to provide equivalent bracing.

Bracing

While roof trusses are the major component of the structural roof system, construction (temporary) and permanent truss bracing also are required to complete the system. The basic requirements and design parameters for construction and permanent bracing of CFS trusses are reviewed in Technical Notes produced by the LGSEA ("*Design Guide for Construction Bracing of Cold-Formed Steel Trusses"*, TN #551d; and "*Design Guide for Permanent Bracing of Cold-Formed Steel Trusses,"* TN #551e).

SUGGESTED SPECIFICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes pre-engineered, pre-fabricated cold formed steel framing elements. Work includes:
   1. Cold formed steel open web floor trusses.
   2. Cold formed steel roof trusses.
   3. Anchorage, bracing and bridging.

B. Related work
   1. Drywall attachment
   2. Roofing, fascia, soffit

1.02 REFERENCES

A. Reference standards:
   1. ASTM:
      a. ASTM A653/A653M-97 "Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy- Coated (Galvanealed) by the Hot Dip Process."
      b. ASTM A780-93a "Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings."
   2. American Welding Society (AWS)
      a. AWS D1.1 "Structural Welding Code - Steel."
      b. AWS D1.3 "Structural Welding Code - Sheet Steel."

1.03 PERFORMANCE REQUIREMENTS

A. AISI "Specifications": Cold-formed steel truss members and components shall be engineered in accordance with AISI's "Specification for the Design of Cold-Formed Steel Structural Members, (1996 Edition)."

B. Structural Performance: Design, engineer, fabricate, and erect cold-formed steel trusses to withstand specified design loads within limits and under conditions required.
   1. Design Loads: As specified.
   2. Deflections: Live load deflection meeting the following (unless otherwise specified):
      a. Floor Trusses: Vertical deflection less than or equal to 1/360 of the span.
      b. Roof Trusses: Vertical deflection less than or equal to 1/240 of the span.
   3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change (range) of 120 deg F (67 deg C).

1.04 SUBMITTALS

A. Submit manufacturer's product data and installation instructions for each type of cold-formed steel framing and accessory required.

B. Submit drawings showing member type, configuration, location, spacing, size and thickness of members, method of attachment to supporting members, method of connecting member to member, erection details, supplemental bracing, strapping, splices, bridging, and other accessories and details required for proper installation.

C. Submit detailed floor truss and roof truss layouts.

D. Submit truss drawings, sealed and signed by a qualified registered Professional Engineer, verifying ability to meet local code and design requirements.
   Include:
   1. Description of design criteria.
   2. Engineering analysis depicting member stresses and truss deflection.
   3. Truss member sizes and gauges and connections at truss joints.
   4. Truss support reactions.
   5. Top chord, Bottom chord and Web bracing requirements.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Fabrication shall be performed by an experienced cold-formed steel truss fabricator with not less than three satisfactory experiences designing and fabricating cold-formed steel truss systems equal in material, design, and extent to the systems required for this Project.
   1. Cold Formed steel truss system installation shall be performed by an experienced installer approved by the steel truss system fabricator.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code—Steel" and AWS D1.3 "Structural Welding Code—Sheet Steel."
   1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers or bundles, fully identified by manufacturer's name, job number, and truss number. Exercise care to avoid damage during unloading, storing and erection.

B. Store trusses on blocking, pallets, platforms or other supports off the ground or in an upright position sufficiently braced to avoid damage from excessive bending.

C. Protect trusses and accessories from corrosion, deformation, damage and deterioration when stored at job site. Keep trusses free of dirt and other foreign matter.

1.07 PROJECT CONDITIONS

A. During construction, adequately distribute all loads applied to trusses so as not to exceed the carrying capacity of any one truss or group of trusses.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: *(As specified in the Contract Documents).*

2.02 COMPONENTS

A. System components: *(Cold-formed steel floor truss and roof truss components provided by the manufacturer, as specified in the Contract Documents)* .

B. Provide manufacturer's standard steel truss members, bracing, bridging, blocking, reinforcements, fasteners and accessories with each type of steel framing required, as recommended by the manufacturer for the applications indicated and as needed to provide a complete cold-formed steel truss system.

2.03 MATERIALS

A. Materials:
   1. All component gauges: Fabricate components of structural quality steel sheet per ASTM A653 with a minimum yield strength of 33,000 psi, or as specified by the Truss Designer.
   2. Bracing, bridging and blocking members: Fabricate components of commercial quality steel sheet per ASTM A653 for with a minimum yield strength of 33,000 psi.

B. Cold formed steel truss components: Provide sizes, shapes and thicknesses (gauge/mm) indicated. Cold-formed steel thicknesses shall be stated in "minimum uncoated thicknesses."
   1. Minimum Uncoated-Steel Thickness: 22 ga., 0.0269 inch (0.68 mm).
   2. Minimum Uncoated-Steel Thickness: 20 ga., 0.0329 inch (0.83 mm).
   3. Minimum Uncoated-Steel Thickness: 18 ga., 0.0428 inch (1.11 mm).
   4. Minimum Uncoated-Steel Thickness: 16 ga., 0.0538 inch (1.37 mm).
   5. Minimum Uncoated-Steel Thickness: 14 ga., 0.0677 inch (1.72 mm).

C. Finish: Provide components with protective coating complying with ASTM A924, minimum G60 coating, or equal.

D. Fastenings:
   1. Manufacturer recommended self-drilling, self-tapping screws with corrosion-resistant finish. Fasteners shall be of sufficient size and number to ensure the strength of the connection, as specified by the Truss Designer.
   2. Welding: Comply with AWS D1.1 when applicable and AWS D1.3 for welding base metals less than 1/8" thick.
   3. Other fasteners as accepted by truss engineer.

2.04 FABRICATION

A. Factory fabricate cold-formed steel trusses plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.
   1. Fabricate truss assemblies in jig templates.
   2. Cut truss members by sawing or shearing or plasma cutting (torch cutting not allowed).
   3. Fasten cold-formed steel truss members by welding or screw fastening, or other methods as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to cold-formed steel truss component manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.

B. Care shall be taken during handling, delivery and erection. Brace, block, or reinforce truss as necessary to avoid member and connection overstress.

C. Fabrication Tolerances: Fabricate trusses to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet (1:960).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine structure, substrates and installation conditions. Do not proceed with cold-formed steel truss installation until unsatisfactory conditions have been corrected.

B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 INSTALLATION, GENERAL

A. General:
   1. Erection of trusses, including proper handling, safety precautions, temporary bracing and other safeguards or procedures are the responsibility of the Contractor and contractor's installer.
   2. Exercise care and provide erection bracing required to prevent toppling or dominoeing of trusses during erection.

B. Erect trusses with plane of truss webs vertical and parallel to each other, and locate at the design spacings as indicated on the construction design documents.
C. Provide proper lifting equipment suited to sizes and types of trusses required, applied at lift points recommended by truss fabricator. Exercise care to avoid damage to truss members during erection and to keep horizontal bending of the trusses to a minimum.
D. Members, components, and connection plates shall be straight and free of defects.
E. Provide framing anchors as indicated or accepted on the engineering design drawing or erection drawings. Anchor trusses securely at bearing points.
F. Install roof framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations.
   1. Cutting, notching, and drilling of truss members, components, and connections shall be prohibited, unless approved by the truss engineer.
   2. Fasten cold-formed steel roof framing by welding or screw fastening, as standard with fabricator. Wire tying of roof framing is not permitted.
   a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to cold-formed roof framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
   c. Install roof framing in one-piece lengths, unless splice connections are indicated.
   d. Provide temporary bracing and leave in place until trusses are permanently stabilized.
G. Erection Tolerances: Install trusses to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet (1:960) and as follows:
   a. Space individual trusses no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.03 OPEN WEB FLOOR TRUSS INSTALLATION

A. Install perimeter joist track or belly band sized to match trusses. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated or as recommended by the manufacturer.
B. Install trusses bearing on supporting framing, level, straight, and plumb, adjust to final position, brace, and reinforce. Install trusses over supporting framing with a minimum end bearing of 1-1/2 inches (38mm), or per manufacturer.
C. Space trusses not more than 2 inches (51 mm) from abutting walls, and as follows:
   1. Truss Spacing: 12 inches (305 mm).
   2. Truss Spacing: 16 inches (406 mm).
   3. Truss Spacing: 24 inches (610 mm).
   4. Truss Spacing: As indicated.
D. Frame openings per manufacturer's shop drawings..
E. Install bridging at each end of trusses and at intervals indicated. Fasten bridging at each truss intersection as follows:
   1. Bridging: Cold-rolled steel channel, fastened to bottom flange of trusses.
   2. Bridging: Flat, steel-sheet straps of width and thickness indicated, fastened to bottom flange of trusses.
   3. Bridging: Combination of flat, steel-sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of trusses and secure solid blocking to joist webs.
F. Secure trusses to load-bearing interior walls to prevent lateral movement of bottom flange.
G. Install miscellaneous truss framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.04 ROOF TRUSS INSTALLATION

A. Install, bridge, and brace trusses according to manufacturer's recommendations and requirements of this Section.
B. Space trusses as follows:
   1. Truss Spacing: 16 inches (406 mm).
   2. Truss Spacing: 24 inches (610 mm).
   3. Truss Spacing: 32 inches (813 mm).
   4. Truss Spacing; 48 inches (1220 mm).
C. Do not alter, cut, or remove truss members or connections of trusses.
D. Erect trusses with plane of truss webs plumb and parallel to each other. Align, and accurately position at spacings indicated.
E. Erect trusses without damaging truss members or connections.
F. On steel-framed walls, align truss bottom chords with load-bearing studs or continuously reinforce track to transfer loads to structure.
G. Anchor trusses securely at all bearing points.
H. Install continuous bridging and permanent truss bracing per truss design requirements..
I. Install necessary roof cross and diagonal bracing per design professional recommendations.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanizing repair paint according to ASTM A 780 and the manufacturer's instructions.

B. Physical Repairs: Damaged chords, webs, or complete trusses shall be repaired or replaced as directed and approved by a Registered Professional Engineer. Any altered or replaced members must be approved by the truss engineer.

References

1. American Iron & Steel Institute, "Design Guide for Cold-Formed Steel Trusses", Publications\ RG-95-18, December 1995.
2. ANSI/TPI 1-1995 Appendix A (1995), *Standard Practice for Metal Plate Connected Wood Truss Design Responsibilities*, Wood Truss Council of America.
3. American Iron & Steel Institute, "Cold-Formed Steel Design Manual", 1986 with 1989 addendum.
4. Light Gauge Steel Engineers Association, "Design Guide for Construction Bracing of Cold-Formed Steel Trusses", Technical Note 551d.
5. Light Gauge Steel Engineers Association, "Design Guide for Permanent Bracing of Cold-Formed Steel Trusses", Technical Note 551e.

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