

DESIGN GUIDE FOR CONSTRUCTION BRACING OF COLD-FORMED STEEL TRUSSES

Summary: Prefabricated and site fabricated cold-formed steel trusses have proven to be efficient and structurally-sound roof structures. 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. Unfortunately, the design of construction bracing is often neglected, forcing the installing contractor to plan how the trusses will be braced during construction. In this *Tech Note*, the basic requirements and design parameters for construction bracing of cold-formed steel truss systems will be reviewed.

Introduction

The majority of truss-related accidents occur during installation, not as the result of improper truss design or fabrication. Proper construction (temporary) bracing is critical for preventing these accidents and ensuring the trusses will remain stable until the roof sheathing and other remaining structural components are installed.

The design procedures and technical requirements discussed in this publication may be applied to pitched roof systems where truss spacing of up to 24 inches on-center is specified. The design recommendations and details shown are based on the collective experience of the author and other leading design professionals in the cold-formed steel framing industry, and are meant to serve only as a guide to the qualified engineer, architect, or building designer.

Section 1: General Design Procedure

The following suggested design guidelines should be considered as the minimum requirements:

1. Determine the truss member axial forces to be used for the design of the construction bracing system. As a minimum, use a loading of 5 psf or the truss span divided by 7 - which ever is greater. (Example: *For a truss with a 42 ft. span, use a minimum loading of $42/7 = 6$ psf.*)
2. Using the proper amount of loading (determined above) and the member size of the truss top chord, determine the maximum spacing allowed for the lateral bracing.

3. Design the top chord lateral brace and connection at each truss for a force equal to 2 percent of the top chord axial force.

4. The truss top chord diagonal braces shall be designed to transfer the cumulative force from the lateral braces to the exterior walls. Determine the spacing of the diagonal bracing based on the capacity of the diagonal brace used and the connection strength.

5. Determine the number of trusses to be supported by the ground bracing system. Design the ground bracing members and connections for the cumulative force from each line of top chord lateral braces. (Find the worst case loading by comparing the installation brace forces with the forces generated by a minimum wind of 50 mph, or greater if required by the local conditions. Wind load should be calculated by using the cumulative projected area of all truss members needed to support the ground brace system.) Design of the members and connections may use the 4/3 allowable stress increase factor if wind governs the design.

6. Design the bottom chord lateral and diagonal bracing members and connections in a manner similar to the top chord bracing system.

7. Require cross bracing in the web plane at each end of the building and at 20 ft. on-center.

Abbreviations

DB-f = diagonal brace force	ga. = gauge
BC = bottom chord	lbs = pounds
GB-f = ground brace force	psf = pounds per square foot
LB-f = lateral brace force	sds = self-drilling screw
TC = top chord	

Section 2: Design Example

PROJECT DATA

Truss span: 42 ft. (Figure 1)
 Truss chord forces (from full design loads = 37 psf)
 Member A: 4,120 lbs. compression
 Member B: 3,340 lbs. compression
 Member C: 2,535 lbs. compression
 Member G: 3,885 lbs. tension
 Member H: 3,885 lbs. tension
 Member I: 3,170 lbs. tension
 Projected area of all truss members = 45 sq. ft. per truss

Capacity of #10-16 x 3/4" sds = 276 lbs. each (20 ga. to 18 ga.).

DESIGN

Construction design load = 42 ft. span / 7 = 6 psf > 5 psf
 - use 6 psf.

Using a design load of 6 psf, re-analyze the truss and determine the maximum allowable unbraced length of the truss top chord. For this example, the maximum allowable unbraced length was assumed to be 8 feet.

Truss TC forces (due to construction design load)

Member 1-2: 4,120 lbs. x (6 psf / 37 psf) = 670 lbs.
 Member 2-3: 3,340 lbs. x 0.162 = 545 lbs
 Member 3-4: 2,535 lbs. x 0.162 = 410 lbs.

Lateral brace forces: per truss

Line 1: LB-f = 670 lbs. x 0.02 = 14 lbs.
 Line 2: LB-f = 670 lbs. x 0.02 = 14 lbs.
 Line 3: LB-f = 545 lbs x 0.02 = 11 lbs.
 Line 4: LB-f = 410 lbs x 0.02 = 9 lbs. (near ridge)

Sum of forces = 14 + 14 + 11 + 9 = 48 lbs. per truss (on each slope).

Diagonal brace force (maximum) = 48 lbs. / 0.7071
 = 68 lbs. per truss (assumed diagonal brace installed at 45 degrees).

Try spacing diagonal braces at 20 ft. on-center (every 10 trusses)

Maximum diagonal brace force = 68 lbs. per truss
 x 10 trusses = 680 lbs.

Quantity of screws required to attach diagonal brace = 680 lbs. / 276 lbs. = 2.5 - use a minimum of 3. (3 screws are required at the outside bay - braces in bays closer to the ridge will have a lower load and may require fewer screws for attachment.)

Maximum lateral brace force - 14 lbs. per truss
 x 10 trusses = 140 lbs. - use 2 #10 sds

Design the diagonal brace for a minimum load of 680 lbs. (not shown)

Summary

Top chord lateral and diagonal braces for this design: (see Figure 2)

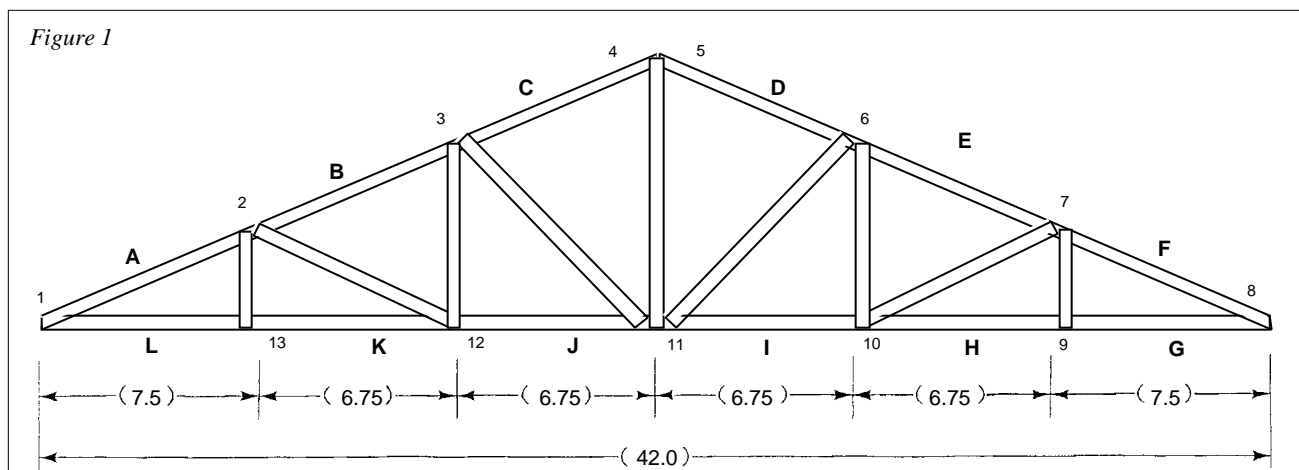
Lateral braces - space at 8 ft. on-center, maximum.

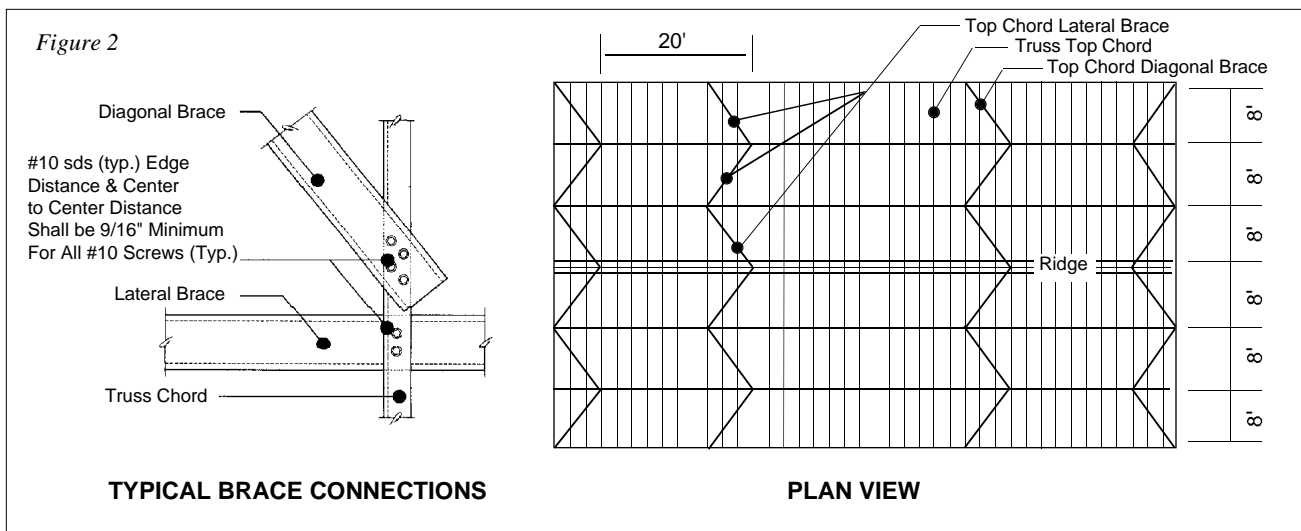
Provide a brace near ridge and at the exterior wall.
 Connect the brace to each truss with a minimum of 2 - #10-16 x 3/4" sds. Lap lateral braces a minimum of 2 trusses at all splices.

Diagonal braces - space at 20 ft. on-center maximum.

Connect brace to each truss with a minimum of 2-#10-16 x 3/4" sds, except at each end of braces in the outside bay (nearest the exterior wall) where 3-#10-16 x 3/4" sds are used. Do not splice diagonal braces.

For additional guidance on truss bracing design, refer to LGSEA Technical Notes "Permanent System Bracing of Cold-Formed Steel Roof Trusses (TN-551a)", "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses," (TN-551e), and "Field Installation Guide for Cold-Formed Steel Roof Trusses."





GROUND BRACING

This example describes the method for supporting 6 trusses with ground bracing prior to the installation of top chord diagonal bracing *Figure 3*).

$$GB-f = (14 \text{ lbs. per truss} \times 6 \text{ trusses}) / \cos 50 = 130 \text{ lbs. per brace.}$$

In locations where wind governs design, the following design procedure may be appropriate:

Projected area: = 45 sq. ft. x 1.4 shape factor = 63 sq. ft. per truss (loads shall conform to the local code requirements).

$$P = 6.4 \text{ psf} \times 63 \text{ sq. ft.} = 403 \text{ lbs. per truss.}$$

$$GB-f = (403 \text{ lbs.} / 42 \text{ ft. span}) \times 8 \text{ ft. lateral brace spacing} \times 6 \text{ trusses} / \cos 50 = 720 \text{ lbs.}$$

Wind governs and GB-f = 720 lbs.

#10 sds capacity = 276 lbs. x 4/3 = 370 lbs. each.

Quantity of screws required = 720 lbs. / 370 lbs. = 1.9.

Use a minimum of 2-#10 sds.

Design each ground brace, ground stake, etc. for a load of 720 lbs. (not shown).

Summary - Ground Brace System

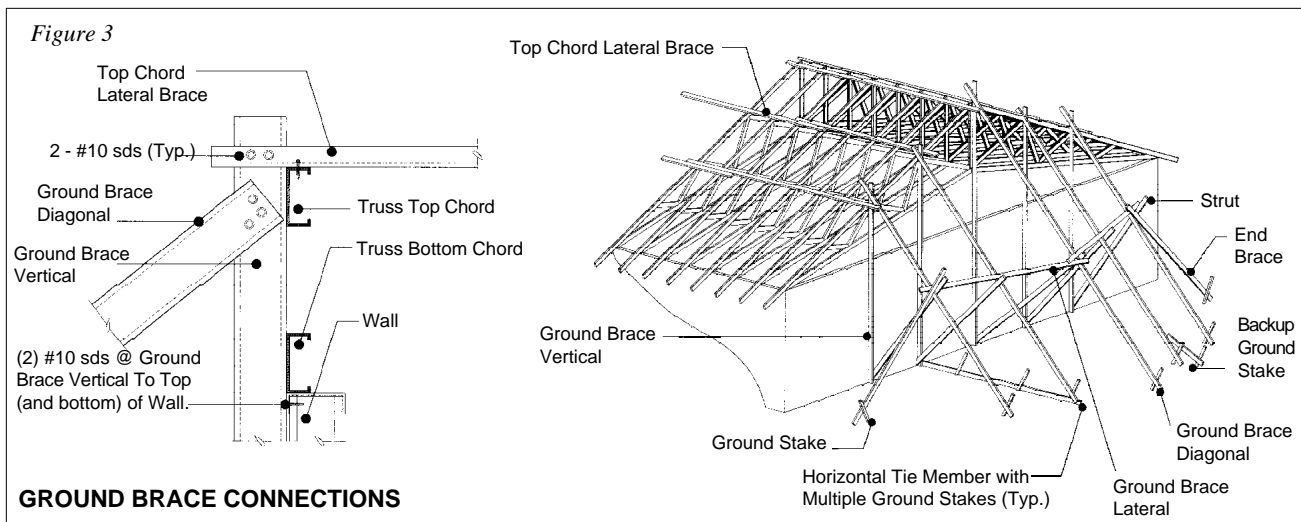
Install ground brace diagonals in line with each row of top chord lateral bracing (angle of ground brace diagonal should not exceed 50 degrees).

Install ground bracing when the first truss is installed.

Install a maximum of 6 trusses before installing the truss top chord diagonal bracing.

Provide a lateral brace on each diagonal ground brace at mid-span and an end brace at ends of the lateral brace (minimum requirements: designer shall specify all brace members and connections).

Use a minimum of 2-#10-16 x 3/4" sds at all member attachments (i.e., top chord lateral brace to ground brace vertical, ground brace diagonal to ground brace vertical, etc.).



Summary: Bottom chord and Web Bracing

Bottom chord members are typically in tension. If desired, the same design procedures used for the top chord bracing system may be conservatively used to design the bottom chord bracing system (see Figure 4). (Lateral brace is not required at the exterior wall lines.)

Lap all lateral braces a minimum of 2 trusses at all splices.

Provide blocking between all trusses at exterior walls.

As an alternative, the bottom chord bracing may be designed prescriptively using the following general requirements:

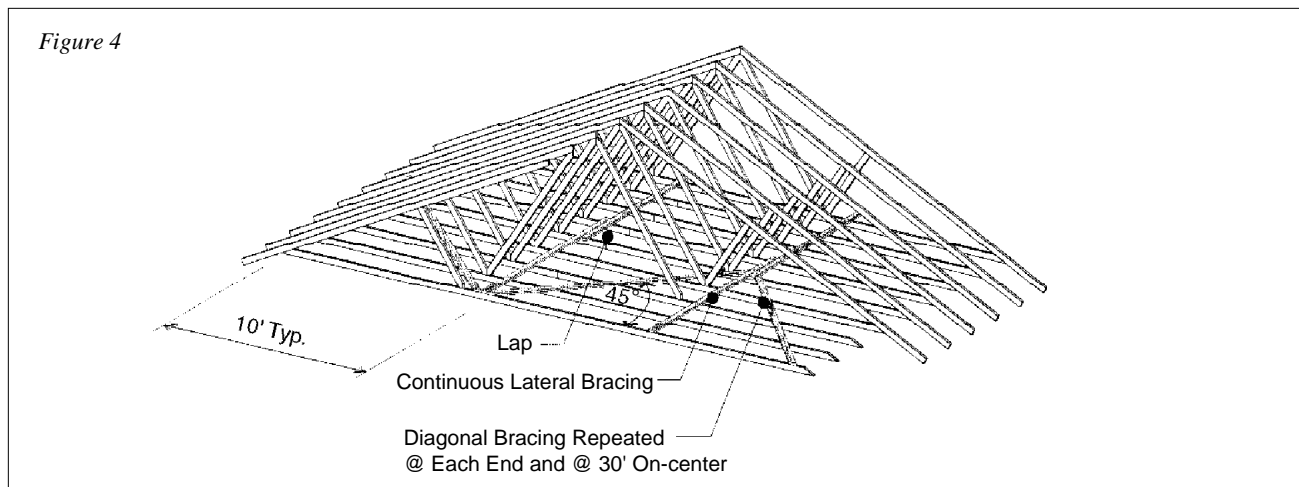
- Lateral bracing: Space at 10 ft. on-center, maximum.
- Diagonal bracing: Space at 30 ft. on-center, maximum (every 15 trusses).

Attach lateral and diagonal braces to each truss with a minimum of 2-#10-16 x 3/4" sds, except use 3-#10 sds at each end of each diagonal brace.

Web bracing is typically designed prescriptively using the following general requirements:

- Cross bracing shall be installed at each end of the building and at 20 ft. on-center throughout the remainder of the building.
- Attach each cross brace to each truss with a minimum of 2-#10-16 x 3/4" sds.

Web cross bracing shall be installed in the plane of the web and in line with the bottom chord lateral bracing.



References

1. Truss Plate Institute, "Temporary Bracing Of Metal Plate Connected Wood Trusses", DSB-89.
2. American Iron & Steel Institute, "Design Guide For Cold-Formed Steel Trusses", Publication RG-95-18, December 1995.
3. Truss Plate Institute, "HIB-91 Summary Sheet - Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses", (brochure).
4. American Iron & Steel Institute, "Cold-Formed Steel Design Manual", 1986 with 1989 addendum.

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