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Subject:	FW: Trusses Gable End Wall Bracing
Date:	Friday, January 31, 2014 1:28:28 PM

From: dsps@wisconsin.gov [mailto:dsps@wisconsin.gov]
Sent: Tuesday, January 28, 2014 5:16 PM
To: DSPS PracticeFAQ1
Subject: Trusses Gable End Wall Bracing

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Currently trussed gable end walls are not being designed per SPS321.02(1)(c) to withstand a horizontal wind pressure of 20 pounds per square foot. SPS321.27(1)addresses dead & live loads only, and SPS321.27(7)Roof Trusses (a) isn't clear on the TP1 and the NDS design. SPS321.25 Wood Frame Walls (1) Stud Configuration. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall, makes the studs in a gable truss nonconforming. From the BCSI Building Component Safety Information on pages 45-48 it states that the truss manufacturer designs the gable end truss only for gravity and/or uplift, and the Building Designer is Responsible for the Gable End Frame Bracing (that rarely happens). The web bracing requirements provided by the truss manufacturer are designed for snow & deadloads, not wind. I propose the State of Wisconsin develop charts & diagrams in the code to assist builders & inspectors when, were & how to properly brace truss gable walls, or language in the code requiring the truss manufacturer to provide a design. Providing the needed information will save the contractor from having to pay a building designer to design for wind loads against a trussed gable wall.

(11) BOLTS AND ANCHORS. The allowable shear on steel bolts and anchors shall not exceed the values given in Table 321.26.

Table 321.26
ALLOWABLE SHEAR ON BOLTS AND ANCHORS

Bolt or Anchor Diameter (inches)	Embedment[1] (inches)	Allowable Shear (pounds)
1/4	4	270
3/8	4	410
1/2	4	550
5/8	4	750
3/4	5	1100
7/8	6	1500
1	7	1850
1 1/8	8	2250

[1]Bolts and anchors shall be solidly embedded in mortar or grout.

(12) JOINTS. Joints in masonry construction shall be constructed in accordance with ACI 530.1.

(13) CLEANING. Chemical cleaning agents shall be prevented from harming the metal reinforcement of structural components and shall not be of a strength which will adversely affect the mortar.

History: Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (3) and cr. Table 21.26–B1 Register, February, 1985, No. 350, eff. 3–1–85; am. (9) (b), Register, January, 1989, No. 397, eff. 2–1–89; am. (6) (b), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (2), am. (5) (c), (7) (a) 3., 4., (b), r. (14), Register, November, 1995, No. 479, eff. 12–1–95; CR 02–077: am. (7) (a) 4. Register May 2003 No. 569, eff. 8–1–03; CR 08–043: r. and recr. (1), (5) (a), (8) and (12), renum. (3) (intro.) and (a) to be (3) (a) and (b) and am. (3) (a), am. (4) (b) and (7) (a) 2., r. (5) (c), Tables 21.26–B and B1, cr. (7) (a) 5. to 7. and (c) Register March 2009 No. 639, eff. 4–1–09; CR 09–104: am. (8) (a) 3. Register December 2010 No. 660, eff. 1–1–11; correction in (9) (c) made under s. 13.92 (4) (b) 7., Stats., Register January 2011 No. 661; **correction in (3) (a), (6) (b), (7) (a) 6., (11) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.**

Subchapter VIII — Roof and Ceilings

SPS 321.27 Roof design and framing. (1) STRUCTURAL DESIGN. (a) *General.* Roof and roof–ceiling assemblies shall support all dead loads plus the minimum live loads under par. (c) and s. SPS 321.02.

(b) *Applicability of tables.* The joist and rafter tables in the appendix are valid for roofs with a minimum slope of 3 in 12. Lesser slopes require engineering analysis or shall be provided with a ridge beam.

(c) *Sloped roof snow loads.* Snow loads specified in s. SPS 321.02 (1) (b) 2. may be reduced for roof slopes greater than 30° by multiplying the snow load by Cs. The value of Cs shall be determined by the following:

$$Cs = 1 - \frac{(a-30)}{40}$$

where a is the slope of the roof expressed in degrees.

Note: A roof pitch of 7 in 12 is equal to 30°.

(2) LATERAL RESTRAINT OF WALLS. Provisions shall be taken to absorb the horizontal thrust produced by a sloping roof through the use of wall ties, ceiling joists, beams at the ridge or at the wall or a system designed through structural analysis.

(3) UPLIFT AND SUCTION FORCES. (a) *General.* 1. Roofs shall withstand a pressure of at least 20 pounds per square foot acting upward normal to the roof surface.

2. Roof overhangs, eaves, canopies and cornices shall withstand an upward wind pressure of at least 20 pounds per square foot applied to the entire exposed area.

(b) *Anchorage.* 1. Roof framing members spanning more than 6 feet measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using engineered clips, straps or hangers.

2. Roof framing members spanning 6 feet or less measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using toe–nailing or engineered clips, straps or hangers.

Note: For information on toe nailing, see the fastener schedule table in the Appendix.

(4) ROOF RAFTERS. (a) *General.* 1. Rafters shall be notched to fit the exterior wall plate and fastened to the wall.

2. Collar ties shall be installed on the upper third of every third pair of abutting roof rafters or every 48 inches, whichever is less.

Note: Collar ties are intended to provide stability to the roof at the ridge. Lateral restraint for the walls must be provided in accordance with sub. (2).

(b) *Ridge boards.* 1. Where rafters meet to form a ridge, the rafters shall be attached to a ridge board.

2. The ridge board shall have a depth at least equal to the length of the cut end of the rafter abutting it.

3. Where all rafters are placed directly opposite each other or are offset at the ridge board by less than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 1 inch.

4. Where one or more rafters are offset at the ridge board by more than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 2 inches.

(c) *Ridge beams.* Rafters shall be attached to ridge beams using engineered clips, straps or hangers or the connection shall be designed through structural analysis.

(d) *Bearing.* The required bearing for wood rafters shall be in accordance with the NDS adopted in Table 320.24–2, except in no case shall the bearing be less than 1½ inches on wood or metal or less than 3 inches on masonry or concrete.

(e) *Ladders.* 1. Overhangs at gable end walls of more than 12 inches shall be provided with ladders which extend into the structure a distance no less than the length of the overhang.

2. The ladders shall be fastened at the wall.

3. The interior end of each ladder shall be attached to a rafter or truss with a hanger.

Note: For the purposes of this section, a ladder is defined as a perpendicular projection extending beyond the face of the wall below.

(5) CEILING JOISTS. (a) Ceiling joists shall be nailed to exterior walls and to the ends of rafters.

(b) Ends of ceiling joists shall be lapped at least 3 inches and be fastened either with 3–16d nails or in accordance with the floor joist requirements under s. SPS 321.22 (4) (a) 1. d.

Note: See the fastener table in the Appendix for a nailing schedule for ceiling joists.

(c) Where ceiling joists are placed at right angles to the rafters, the lookout joist or ties shall be fastened to the parallel ceiling joists or rafters using engineered clips, straps or hangers or the connection shall be designed through structural analysis.

(6) VALLEY AND HIP RAFTERS. (a) *Valley rafters.* 1. Where no bearing is provided under valley rafters at the intersection of 2 roof areas, the valley rafters shall be doubled in thickness and shall be at least 2 inches deeper than the required common rafter to permit full bearing at the beveled end.

2. Where ridges are provided at different elevations, vertical support shall be provided for the interior end of the lower ridge board or ridge beam.

(b) *Hip rafters.* Where no bearing is provided under hip rafters, the hip rafters shall be of the same thickness as common rafters and shall be at least 2 inches deeper than required to permit full contact with the jack rafter.

(7) ROOF TRUSSES. (a) Metal plate connected wood roof trusses shall be designed in accordance with TPI 1 and the NDS adopted under s. SPS 320.24.

(b) Truss members shall not be cut, bored or notched, except as allowed under sub. (8) (d).

(c) If connection is provided to stabilize a non–load bearing wall, a slotted expansion joint or clip shall be used.

(8) NOTCHING AND BORING. (a) *General.* 1. Notching and boring of beams or girders is prohibited unless determined through structural analysis.

1. At the top of all exterior door and window openings, unless using self–flashing windows that provide at least one inch of flashing around the opening, including the corners.

2. At the intersection of chimneys or other masonry construction with frame walls.

3. Under and at the ends of masonry, wood or metal copings and sills.

4. Continuously above all projecting wood trim.

5. Where porches, decks or stairs attach to a wall or floor assembly of wood frame construction.

6. At wall and roof intersections.

7. At built–in gutters.

Note: See s. SPS 321.26 (5) for additional flashing requirements with masonry cavity walls and s. SPS 321.28 (7) for additional flashing requirements with roofing.

(4) WATER–RESISTIVE BARRIER REQUIREMENTS. (a) *General.* 1. Exterior walls of wood or metal frame construction shall be provided with a water–resistive barrier from the highest point to the bottom of the permanent weather–resistant covering.

Note: Acceptable water–resistive barrier materials include polymeric–based house wraps and spray–applied water–resistive barriers installed per the manufacturer's instructions, #15 or greater asphalt–saturated felts that comply with ASTM D 226 for type I felt and extruded foam sheathing with permanently taped joints. Duct tape or similar will not result in a permanently taped joint.

2. Structural products with an integral water–resistive barrier may be approved by the department as a complete assembly.

(b) *Material compatibility.* The water–resistive barrier material shall be compatible with the other materials in the wall with which it will come into contact.

Note: Spray–applied water–resistive barriers may not be compatible with foam plastic insulation.

(c) *Performance requirements.* 1. Polymer–based house wraps shall meet all of the following requirements:

a. A water vapor permeability rating of 5 perms or higher when tested in accordance with ASTM E96.

b. An acceptable water–resistance rating determined in accordance with ASTM D779, AATCC 127 or CCMC 07102.

Note: Asphalt–saturated felt or "tar paper" is not a polymeric–based house wrap.

Note: For more information on the water–resistance tests and their results, see the International Code Council Evaluation Services Acceptance Criteria AC 38.

2. Spray–applied water–resistive barriers shall be approved under the International Code Council Evaluation Services.

Note: For approval criteria, see ICC–ES acceptance criteria AC 212 or successor document.

(d) *Application.* 1. Horizontal seams in sheet or strip material shall be overlapped such that the upper layer extends over the lower layer at least 2 inches.

2. Vertical seams in sheet or strip materials shall be overlapped at least 6 inches.

3. Any rips, tears or voids shall be patched in accordance with subds. 1. and 2.

(e) *Penetrations.* 1. Penetrations caused by fasteners of the water–resistive barrier or the weather–resistant exterior covering do not require sealing.

2. Penetrations of 5 square inches or less with an annular space of no more than ½ inch shall be sealed with caulk or similar material.

3. Penetrations of greater than 5 square inches shall be flashed in accordance with sub. (3).

History: Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, March, 2001, No. 543, eff. 4–1–01; CR 02–077: cr. (3) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: am. (2), renum. (3) (c) to be (3) (d), cr. (3) (c) and (4) Register March 2009 No. 639, eff. 4–1–09.

SPS 321.25 Wood frame walls. Unless designed through structural analysis, wood frame walls shall comply with the following requirements.

(1) STUD CONFIGURATION. Wood studs shall comply with the size and spacing requirements indicated in Table 321.25–A. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall.

Note: See Appendix for acceptable nailing schedule.

Note: See s. SPS 321.10 for requirements on treating wood for decay and termite resistance.

(2) TOP PLATES. (a) *General.* Except as allowed under subd. 3., top plates shall be provided and configured as follows:

1. Studs at bearing walls shall be capped with double top plates.

2. End joints in double top plates shall be offset at least 2 stud spaces.

3. Double top plates shall be overlapped at the corners and at intersections of partitions.

4. The plate immediately above the stud may have a joint only when directly over the stud.

(b) *Notching and boring.* 1. When piping or ductwork is placed in an exterior wall or an interior load–bearing wall, such that at least half of the top plate is removed, the plate shall be reinforced with a steel angle at least 2 inches by 2 inches by 20 gauge thick.

Note: 20 gauge is approximately 0.036 inch.

2. The steel angle shall span the gap and extend at least to the midpoint of the adjacent stud spaces.

3. Other equivalent materials may be used in accordance with s. SPS 321.02.

(c) *Exceptions.* 1. A single top plate may be used in place of a double top plate provided a rafter is located directly over the studs and the plate is securely tied at the end joints, corners and intersecting walls. Joints may occur in single top plates only when directly over a stud.

2. A continuous header, consisting of two 2–inch members set on edge, may be used in lieu of a double plate if tied to the adjacent wall.

(3) WALL OPENINGS. Where doors or windows occur, headers shall be used to carry the load across the opening.

(a) *Header size.* The size of headers shall be determined in accordance with the spans and loading conditions listed in Tables 321.25–B, 321.25–C and 321.25–D. Headers for longer spans shall be designed by an engineering method under s. SPS 321.02.

(b) *Header support.* Headers in bearing walls shall be supported in accordance with subd. 1. or 2. or 3.

1. Headers 3 feet or less in length shall be directly supported on each end by either:

a. The single common stud and a shoulder stud; or

b. The single common stud with a framing anchor attached.

2. Headers greater than 3 feet but less than or equal to 6 feet in length shall be directly supported on each end by the single common stud and a shoulder stud.

3. Headers greater than 6 feet in length shall be directly supported on each end by the single common stud and 2 shoulder studs.

(4) NOTCHING. Notching and boring of columns or posts is prohibited unless designed through structural analysis. Studs shall not be cut or bored more than $^1/_3$ the depth of the stud, unless the stud is reinforced.

(5) PARTITIONS. Load–bearing partitions shall be placed over beams, girders, or other load–bearing partitions. Load–bearing partitions running at right angles to the joists shall not be offset from the main girder or walls more than the depth of the joist unless the joists are designed to carry the load.

(6) POSTS AND COLUMNS. (a) *General.* 1. Posts and columns shall be installed to resist imposed loads.

2. Posts and columns shall bear directly over the middle $^1/_3$ of a footing.

3. Posts and columns shall be restrained at the top and bottom to resist displacement.

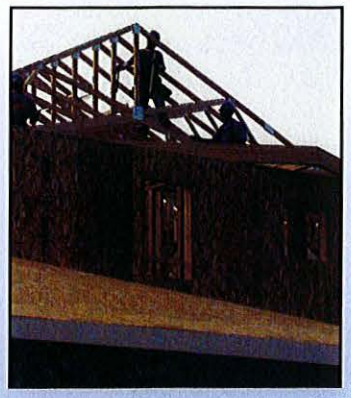
4. All columns shall be positively attached to the beams they support using clips, straps or saddles.

IMPORTANT SAFETY INFORMATION

BCSI

BUILDING COMPONENT SAFETY INFORMATION

Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses



NOTICE

NOTICE! WARNING! CAUTION! DANGER!

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TRUSS PLATE INSTITUTE

2008 EDITION PUBLISHED MAY 2008

WEB REINFORCEMENT FOR SINGLE-PLY TRUSSES[1]								
Specified CLR	Size of Truss Web	Type & Size of Web Reinforcement				Grade of Web Reinforcement	Minimum Length of Web Reinforcement	Minimum Connection of Web Reinforcement to Web
		T	L	Scab[2]	I			
1 Row	2x4	2x4	2x4	2x4		Same species and grade or better than web member	90% of Web or extend to within 6" of end of web member, whichever is greater	16d (0.131x3.5") nails @ 6" on-center[2]
	2x6	2x6	2x6	2x6				
	2x8	2x8	2x8	2x8				
2 Rows	2x4	---	---	---	2-2x4			
	2x6	---	---	---	2-2x6			
	2x8	---	---	---	2-2x8			

[1]Maximum allowable web length is 14'.
[2]For Scab Reinforcement use 2 rows of 10d (0.120x3") nails at 6" on-center to attach reinforcement to web

TABLE B3-2

Individual Web Reinforcement (Shop Applied)

☑ Proprietary metal reinforcement products and Stacked Web Reinforcement are installed by the Truss Manufacturer at the Truss plant and eliminate the need for additional jobsite reinforcement of the Webs.

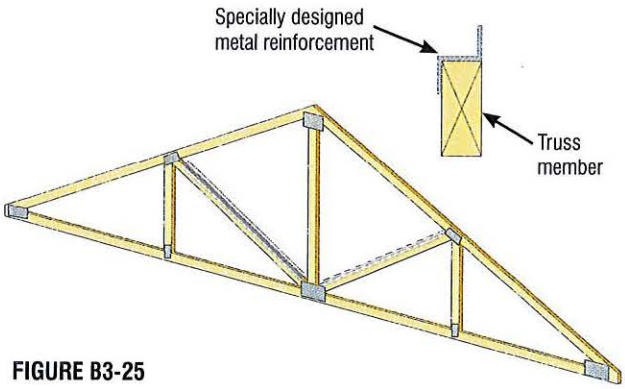


FIGURE B3-25

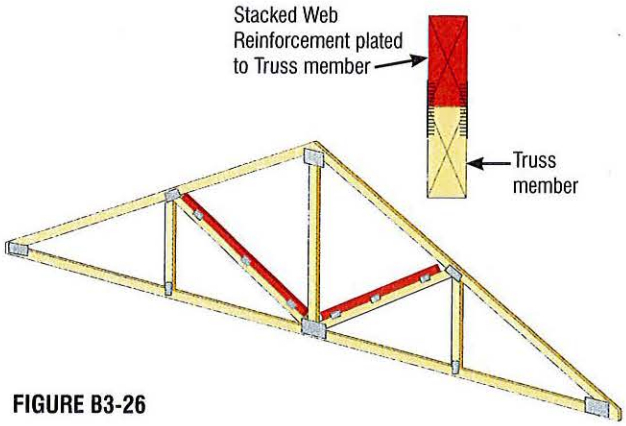


FIGURE B3-26

☑ Permanent Building Stability Bracing for wind, seismic and/or other lateral Loads acting perpendicular to the plane of the Trusses will always be needed in every Building.

Gable End Frame Permanent Bracing

☑ Permanent Bracing in the Web Member Plane, installed at each end of the Building, serves to transfer lateral Loads acting against the end walls and gable ends of the Building into the roof and/or ceiling Diaphragm. The Building Designer is responsible for the design of this Permanent Building Stability Bracing.

☑ Metal plate connected Gable End Frames are often used directly above the end walls of a Building to save the Contractor the time and expense of having to field frame the end wall to match the roof slope.

☑ Most manufactured Gable End Frames contain only vertical "studs" (as opposed to the typical triangulated web members) and are designed to transfer only vertical roof Loads (gravity and/or uplift) directly into a continuous bearing below. Web member reinforcement shown on the TDD for these frames is required to prevent column buckling of the web members due to the vertical Loads applied to the Truss.

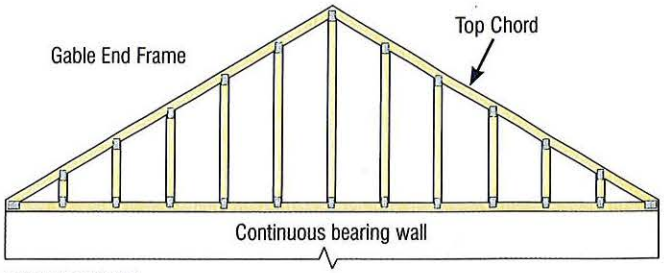


FIGURE B3-27

☑ In service, Gable End Frames also experience lateral Loads parallel and perpendicular to their plane. The Gable End Frame shall be incorporated into the wall design by the Building Designer.

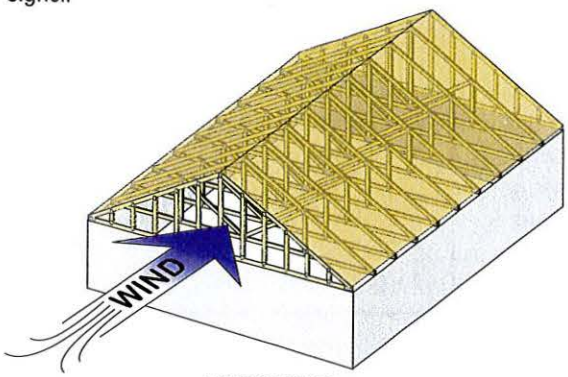


FIGURE B3-28

☑ Gable End Frames rely on properly designed and installed Structural Sheathing, Bracing and Connections to the bearing wall, and roof and Ceiling Diaphragms to be able to adequately transfer lateral Loads acting parallel and perpendicular to its plane.

☑ The Building Designer, Truss Designer and Contractor all play a vital role in Gable End Frame bracing.

Building Designer Responsibilities for Gable End Frame Bracing

☑ The Building Designer, knowing the intended flow of Loads for the entire Building, is responsible for taking the resultant Loads that exist within the Gable End Frame and safely transferring these Loads into the ground. This typically involves transferring the Loads through additional Bracing from the Gable End Frame to the roof and Ceiling Diaphragms.

☑ Gable End Frame Bracing is designed by considering a number of factors including:

- The length, spacing, species and size of the Gable End Frame studs
- Gravity Loads
- Lateral Loads (wind and seismic)

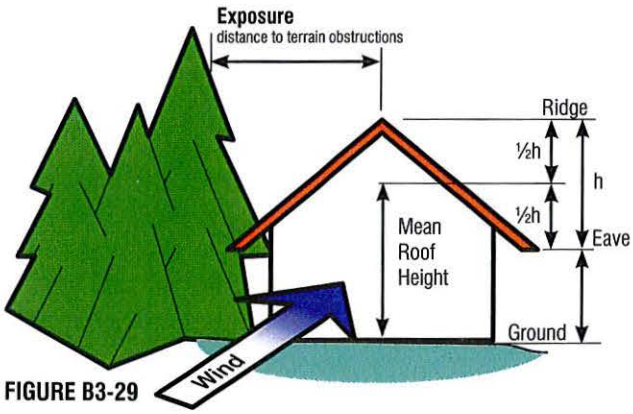


FIGURE B3-29

☑ The Building Designer, through detailing in the Construction Documents, is responsible for all Gable End Frame Bracing, including the Bracing member size and locations, attachment to Trusses, gable end sheathing, and fastener size and locations including any mechanical Connectors required.

☑ Other factors the Building Designer shall consider include:

- Thickness and type of roof, wall and ceiling sheathing
- Transfer of Load between the Gable End Frame Bottom Chord and wall below
- Attachment of Structural Sheathing to the wall/Gable End Frame interface and attachment of wall to foundation to resist uplift and lateral Loads

Truss Designer Responsibilities for Gable End Frame Reinforcement

☑ The Truss Designer must note on the TDD for the Gable End Frame the type and location of Permanent Individual Truss Member Restraint (PITMR) requirements to resist the vertical Loads assumed in the design of the frame. Examples include single or double L, T, U, Scab, horizontal L or any other means of reinforcement deemed appropriate to restrain the out-of-plane buckling of the vertical "studs."

☑ The Truss Designer is responsible for indicating the loading and environmental design assumptions used in the design of the Gable End Frame to conform to the Loads specified in the Construction Documents.

☑ In order to assist the Building Designer in determining the Bracing required to transfer lateral Loads from the Gable End Frame into the roof and/or Ceiling Diaphragm, many Truss Designers provide standard design tables and details based on the typical design assumptions used by Building Designers.

Minimum Stud Size Species and Grade	Stud Spacing	Without Brace	1x4 L-Brace	2x4 L-Brace	DIAGONAL BRACE	2 DIAGONAL BRACES AT 1/3 POINTS
		Maximum Stud Length				
2x4 SPF Std/Stud	12" O.C.	4-9-12	5-6-7	7-10-0	9-7-7	14-5-3
2x4 SPF Std/Stud	16" O.C.	4-4-7	4-9-8	6-9-6	8-8-14	13-1-5
2x4 SPF Std/Stud	24" O.C.	3-9-10	3-11-0	5-6-7	7-7-4	11-4-14

Diagonal braces over 6'-3" require a 2x4 T-Brace attached to one edge. Diagonal braces over 12'-6" require 2x4 I-braces attached to both edges. Fasten T and I braces to narrow edge of web with 10d common wire nails 8in o.c., with 3in minimum end distance. Brace must cover 90% of diagonal length.

MAXIMUM WIND SPEED = 100 MPH
MAX MEAN ROOF HEIGHT = 30 FEET
CATEGORY II BUILDING
EXPOSURE B or C
ASCE 7-93
DURATION OF LOAD INCREASE : 1.60

STUD DESIGN IS BASED ON COMPONENTS AND CLADDING
CONNECTION OF BRACING IS BASED ON MWFRS.

SAMPLE ONLY

FIGURE B3-30

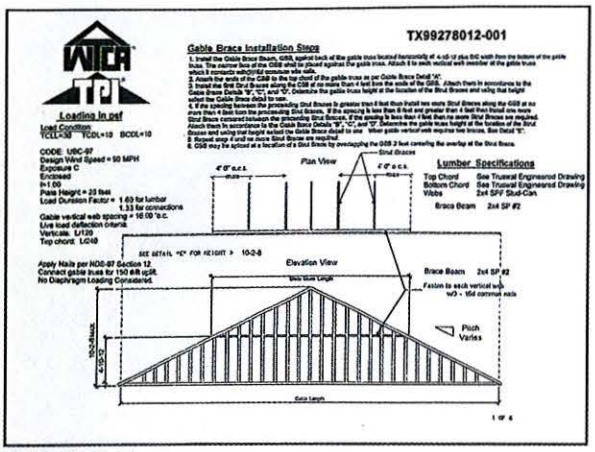


FIGURE B3-31

☑ These tables and details do some of the work of the Building Designer with respect to incorporating the Gable End Frame into the overall structural design, but do not take the place of a complete flow of Loads analysis by the Building Designer.

Contractor Responsibilities for Gable End Frame Bracing

☑ The Contractor is responsible for properly installing the Gable End Frame as detailed in the Construction Documents and within the Truss Submittal Package.

Gable End Frame Bracing/Reinforcement Requirements

☑ If the lateral Load is large enough, and the vertical studs are long enough, the Gable End Frame may require Bracing to prevent it from rotating at the Gable End Frame/end wall interface, along with Diagonal Bracing and/or Web Reinforcement to prevent the vertical Webs from bending excessively. Serviceability failures often occur if the Gable End Frame is not properly braced.

☑ Gable End Frame Bracing/reinforcement helps prevent these types of serviceability failures and safely transfers forces from the Gable End Frame into the associated Diaphragms.

Lateral Force transfer to roof and Ceiling Diaphragms

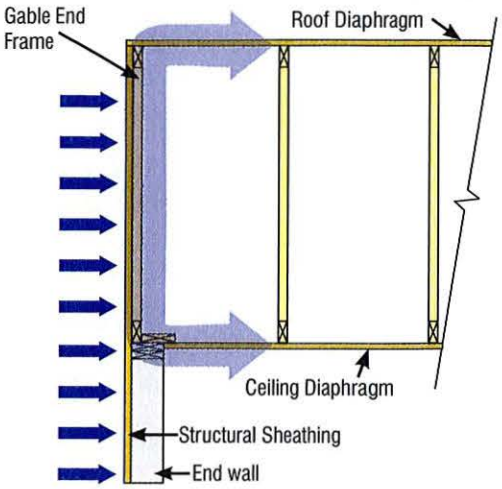


FIGURE B3-32

Potential Modes of Failure

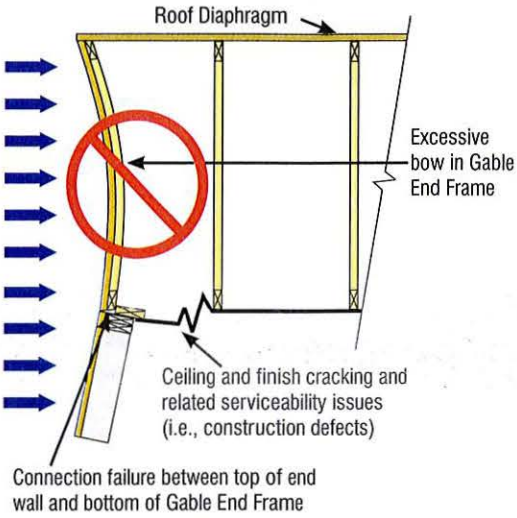
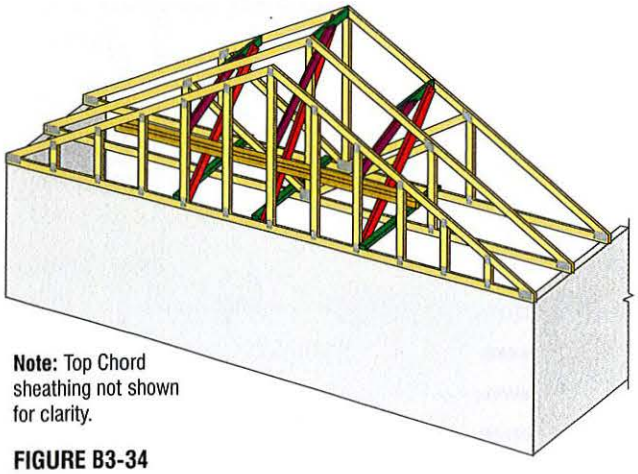


FIGURE B3-33

☑ Typical Gable End Frame Bracing/reinforcement details include Blocking at the ceiling and roof level Diaphragms, gable stud reinforcement, horizontal reinforcement and/or Diagonal Bracing, mechanical Connectors/straps and specific fastener size and frequency schedules.

☑ Examples of Gable End Frame Bracing/reinforcement.



Note: Top Chord sheathing not shown for clarity.

FIGURE B3-34

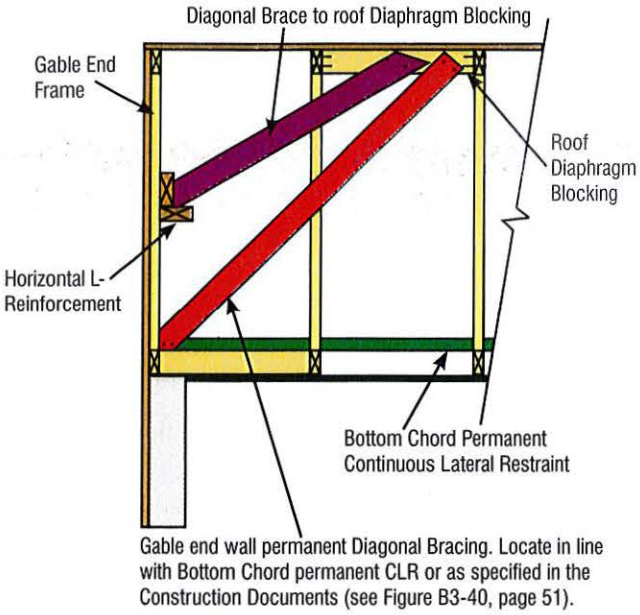


FIGURE B3-35

Note: The Diagonal Brace from the top of the end wall to the top chord of the Truss will impart a vertical force to the Truss Top Chord. This is in addition to any uplift forces the roof sheathing will impart to the Truss from wind. The Load from this brace must be considered in the design and attachment of the supporting Truss.

☑ Examples of Gable End Frame Web Reinforcement.

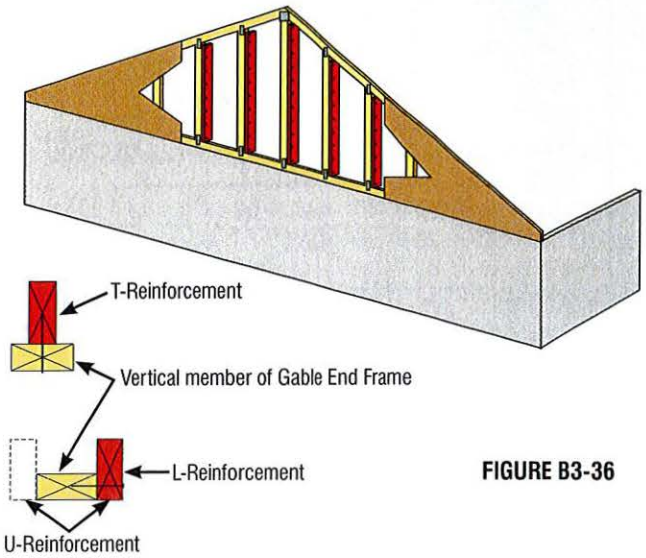


FIGURE B3-36

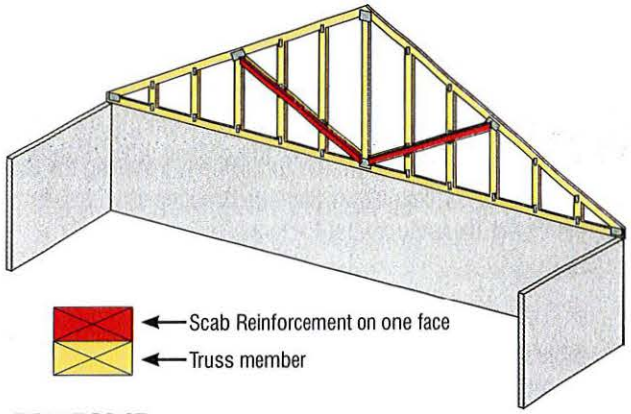


FIGURE B3-37

B3 BCSI-B3 SUMMARY SHEET - PERMANENT RESTR

Spans over 60' may require complex permanent bracing.

WARNING! Disregarding Permanent Restraint/Bracing is a major cause of truss field performance problems and has been known to lead to roof or floor systems collapse.
¡ADVERTENCIA! *Descuidar el Arriostre/Restricción Permanente es una causa principal de problemas de rendimiento del truss en campo y había conocido a llevar al derrumbamiento del sistema del techo o piso.*

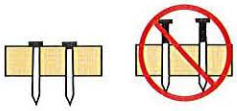
CAUTION! Spans over 60' may require complex permanent bracing. Please always consult a Registered Design Professional.
¡CAUTELA! *Tramos sobre 60 pies pueden requerir arriostre permanente complejo. Por favor, siempre consulte a un Profesional Registrado de Diseño.*

RESTRAINT/BRACING MATERIALS & FASTENERS
MATERIALES Y CIERRES DE RESTRICCIÓN/ARRIOSTRE

☑ Common restraint/bracing materials include wood structural panels, gypsum board sheathing, stress-graded lumber, proprietary metal products, and metal purlins and straps.
Materiales comunes de arriostrar/restringir incluyen paneles estructurales de madera, entablado de yeso, madera graduada por esfuerza, productos de metal patentados, y vigas de soporte y tiras de metal.

MINIMUM ATTACHMENT REQUIREMENTS FOR LUMBER RESTRAINT/BRACING[1,2]

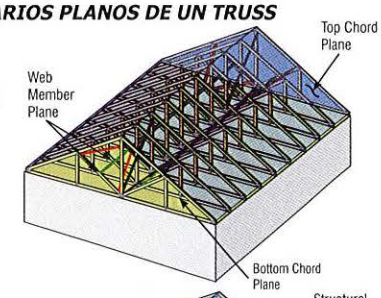
Lumber Size	Minimum Nail Size	Minimum Number of Nails per Connection
2x4 stress-graded	10d (0.128x3") 12d (0.128x3.25") 16d (0.131x3.5")	2
2x6 stress-graded	10d (0.128x3") 12d (0.128x3.25") 16d (0.131x3.5")	3



[1] Other attachment requirements may be specified by the Truss Designer or Building Designer.
[2] The size and attachment for bracing materials such as wood structural panels, gypsum board sheathing, proprietary metal restraint/bracing products, and metal purlins and straps are provided by the Building Designer.

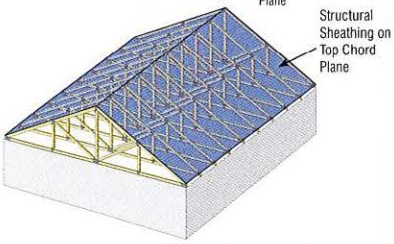
PERMANENT BRACING FOR THE VARIOUS PLANES OF A TRUSS
ARRIOSTRE PERMANENTE PARA VARIOS PLANOS DE UN TRUSS

☑ Permanent Bracing is important because it,
a) prevents out-of-plane buckling of truss members,
b) helps maintain proper truss spacing, and
c) resists and transfers lateral loads from wind and seismic forces.
El arriostre Permanente es importante porque,
a) impide el torcer fuera-de-plano de los miembros del truss,
b) ayuda en mantener espaciamiento apropiado de los trusses, y
c) resiste y pasa las cargas laterales de viento y fuerzas sísmicas aplicadas al sistema del truss.



☑ Trusses require Permanent Bracing within ALL of the following planes:
1. Top Chord Plane
2. Bottom Chord Plane
3. Web Member Plane

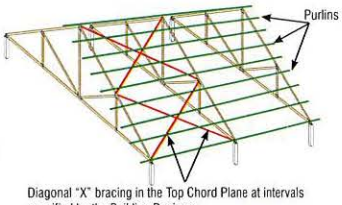
Trusses requieren Arriostre Permanente dentro de TODOS los siguientes planos:
1. Plano de la Cuerda Superior
2. Plano de la Cuerda Inferior
3. Plano del Miembro Secundario



CAUTION! Without Permanent Bracing the truss, or a portion of its members, will buckle (i.e., fail) at loads far less than design.
¡CAUTELA! *Sin el Arriostre Permanente, del truss, o un parte de los miembros, torcerán (ej. fallarán) de cargas muchas menos que las cargas que el truss es diseñado a llevar.*

1. PERMANENT BRACING FOR THE TOP CHORD PLANE
1. ARRIOSTRE PERMANENTE PARA EL PLANO DE LA CUERDA SUPERIOR

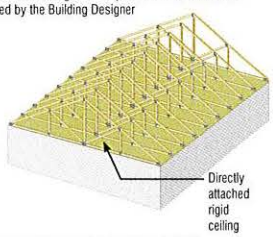
☑ Use plywood, oriented strand board (OSB), or wood or metal structural purlins that are properly braced.
Use contrachapado, panel de fibras orientadas (OSB), o vigas de soporte de madera o metal que son arriostrados apropiadamente.



Diagonal "X" bracing in the Top Chord Plane at intervals specified by the Building Designer

☑ The Truss Design Drawing (TDD) provides information on the assumed support for the top chord.
El Dibujo del Diseño de Truss (TDD) provee información sobre el soporte supuesto para la cuerda superior.

☑ Fastener size and spacing requirements and grade for the sheathing, purlins and bracing are provided in the building code and/or by the Building Designer.
El tamaño de cierre y requisitos de espaciamiento y grado para el entablado, vigas de soporte y arriostre son provistos en el código del edificio y/o por el Diseñador del Edificio.



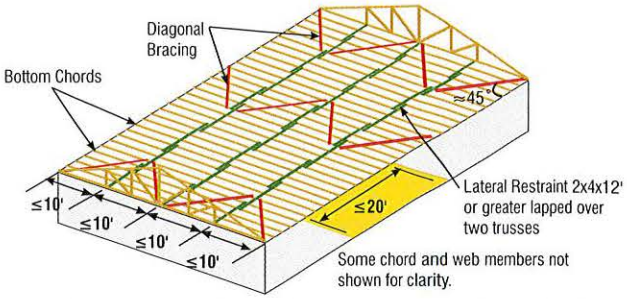
2. PERMANENT BRACING FOR THE BOTTOM CHORD PLANE
2. ARRIOSTRE PERMANENTE PARA EL PLANO DE LA CUERDA INFERIOR

☑ Use rows of continuous Lateral Restraint with Diagonal Bracing, gypsum board sheathing or rigid ceiling.
Use filas de Restricción Lateral Continua con Arriostre Diagonal, entablado de yeso o techo rigído.

☑ The TDD provides information on the assumed support for the bottom chord.
El TDD provee información sobre el soporte supuesto para la cuerda inferior.

☑ **Install bottom chord permanent Lateral Restraint at the spacing indicated on the TDD and/or by the Building Designer with a maximum of 10' on center.**

Instale Restricción Lateral permanente de la cuerda inferior al espaciamiento indicado en el TDD y/o por el Diseñador del Edificio con un máximo de 10 pies en el centro.



Lateral Restraint and Diagonal Bracing used to brace the Bottom Chord Plane.

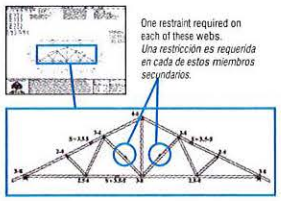
3. PERMANENT BRACING FOR THE WEB MEMBER PLANE
3. ARRIOSTRE PERMANENTE PARA EL PLANO DEL MIEMBRO SECUNDARIO

Web Member Permanent Bracing collects and transfers buckling restraint forces and/or lateral loads from wind and seismic forces. The same bracing can often be used for both functions.
Arriostre Permanente de los Miembros Secundarios recogen y pasan fuerzas de restricción de torcer y/o cargas laterales de viento y fuerzas sísmicas. A menudo el mismo arriostre puede ser usado para ambos funciones.

Individual Web Member Permanent Restraint & Bracing
Restricción y Arriostre Permanente de Miembros Secundarios Individuales

☑ Check the TDD to determine which web members (if any) require restraint to resist buckling.
Revisa el TDD para determinar cuales miembros secundarios (si algunos) requieren restricción para resistir el torcer.

☑ Restrain and brace with,
A. Continuous Lateral Restraint & Diagonal Bracing, or
B. Individual Member Web Reinforcement.
Restrinja y arriostre con,
A. Restricción Lateral Continua y Arriostre Diagonal, o
B. Refuerzo de Miembros Secundarios Individuales.

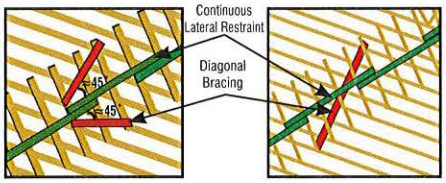


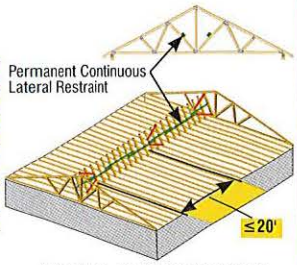
A. Continuous Lateral Restraint (CLR) & Diagonal Bracing
A. Restricción Lateral Continua (CLR) y Arriostre Diagonal

☑ Attach the CLR at the locations shown on the TDD.
Sujete el CLR en las ubicaciones mostrados en el TDD.

☑ Install the Diagonal Bracing at approximately 45° to the CLR and position so that it crosses the web in close proximity to the CLR. Attach the Diagonal Brace as close to the Top and Bottom Chords as possible and to each web it crosses. **Repeat every 20' or less.**
Instale el Arriostre Diagonal a aproximadamente 45 grados al CLR y lo coloque para que cruce la cuerda muy cerca del CLR. Sujete el Arriostre Diagonal como cercano a las cuerdas inferior y superior como sea posible y a cada cuerda que lo cruza. ***Repita cada 20 pies o menos.***

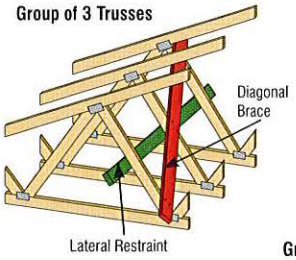
EXAMPLES OF DIAGONAL BRACING WITH CONTINUOUS LATERAL RESTRAINT

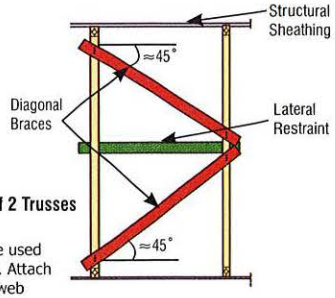




Note: Some chord and web members not shown for clarity.

Group of 3 Trusses





Group of 2 Trusses

☑ Lateral Restraint & Diagonal Bracing can also be used with small groups of trusses (i.e., three or less). Attach the Lateral Restraint & Diagonal Brace to each web member that they cross.
Restricción Lateral y Arriostre Diagonal también puede ser usado con grupos pequeños de trusses (ej. tres o menos). Sujete la Restricción Lateral y el Arriostre Diagonal a cada miembro secundario que los cruzan.

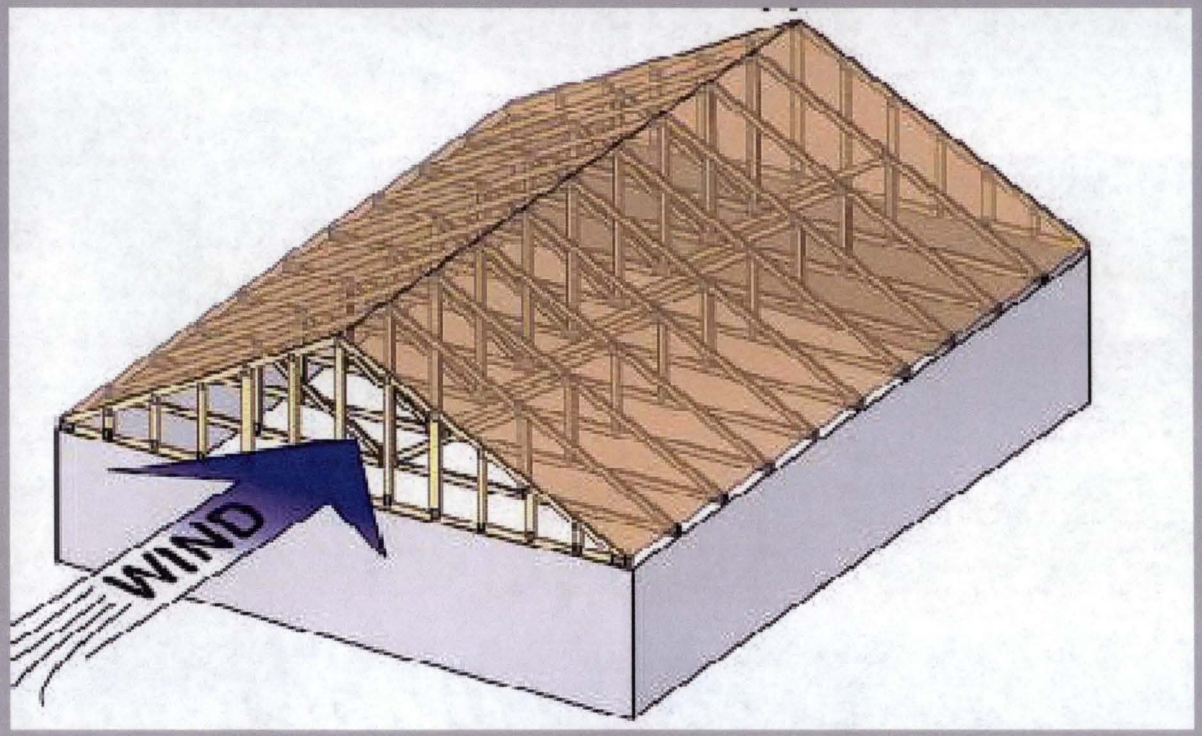
RESTRICCIÓN/ARRIOSTRE PERMANENTE DE L

Tramos más de 60 pies pueden requerir arriostre permanente complej

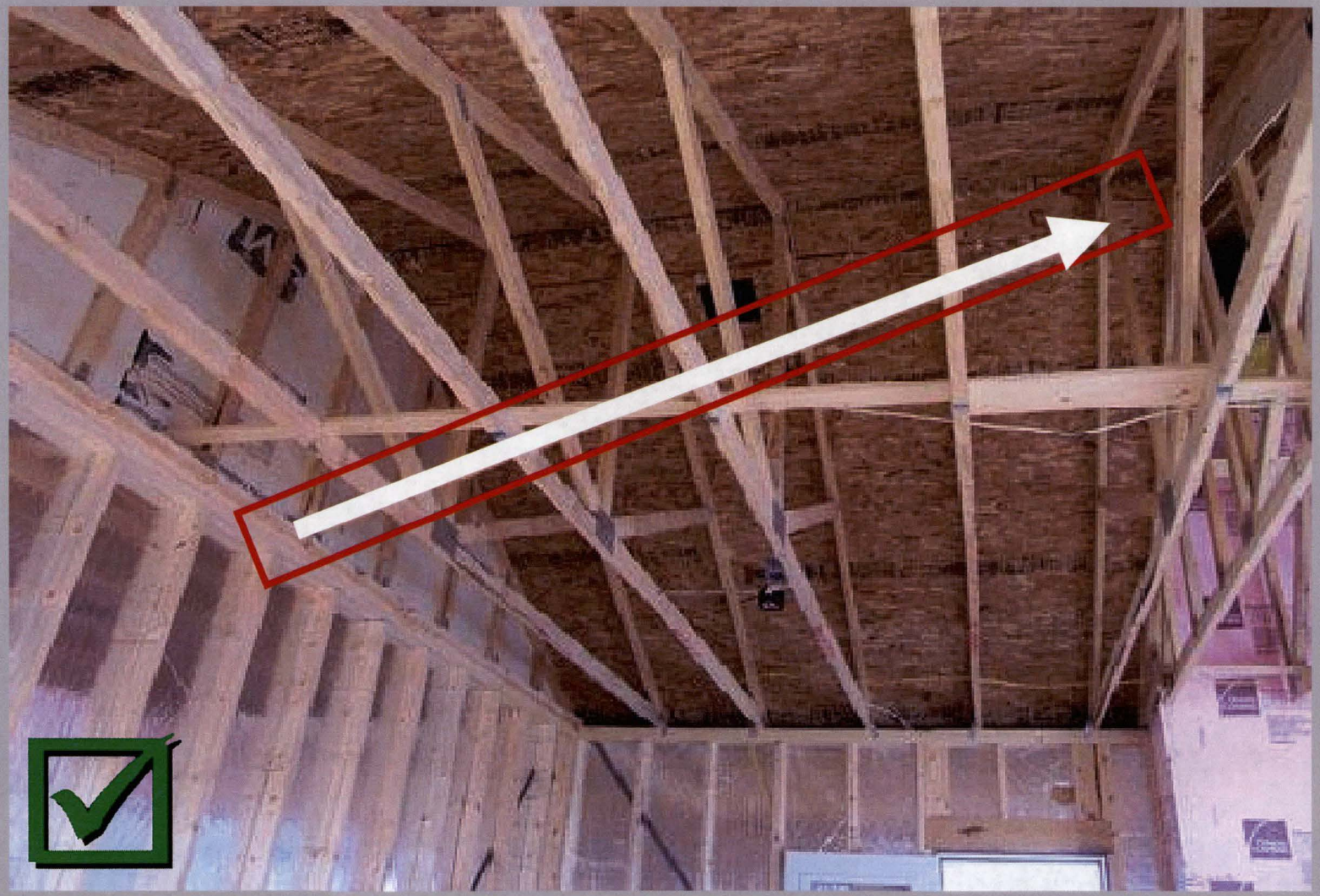
B3 Web Member Permanent Building Stability Bracing to Transfer Wind Forces

BCSI: PAGE 46

- Permanent Building Stability Bracing (PBSB) will always be need for every building
- The Building Designer is Responsible for the design of the PBSB



Gable End Bracing



B3 Gable End Frame Permanent Bracing

BCSI: PAGE 46

- GEFs often must transfer lateral loads (applied both parallel & perpendicular to their plane)
- Sheathing, bracing & connections must be designed for this transfer
- The Building Designer is responsible for this

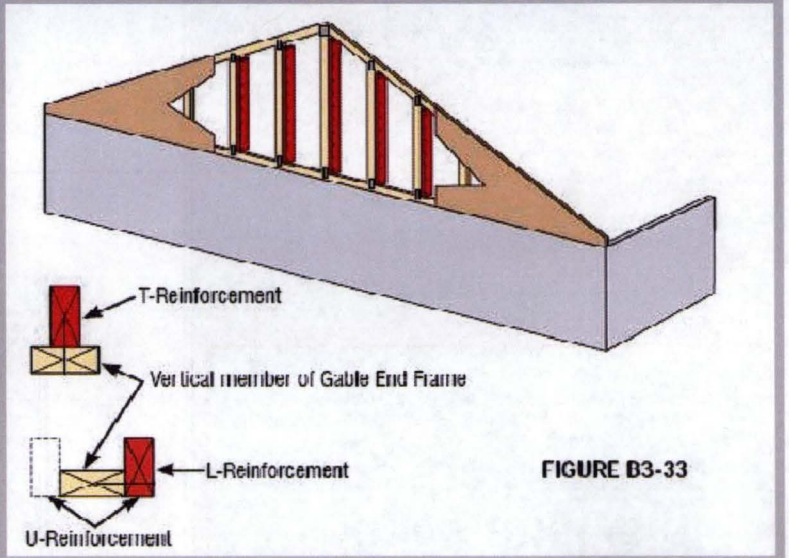
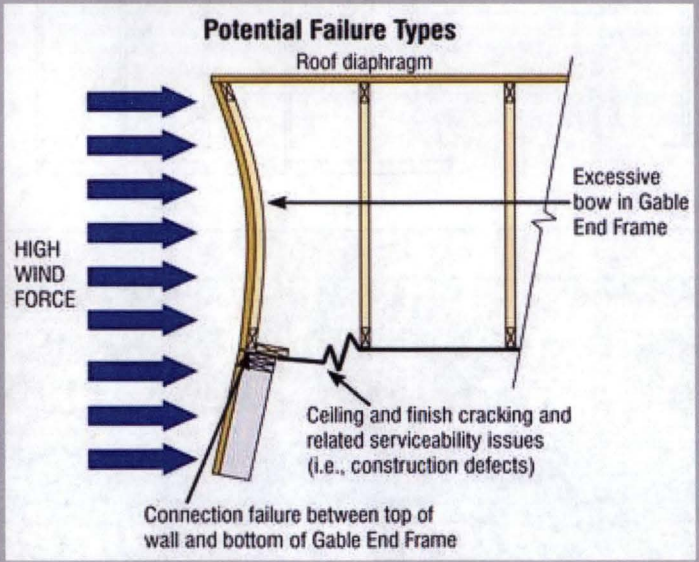
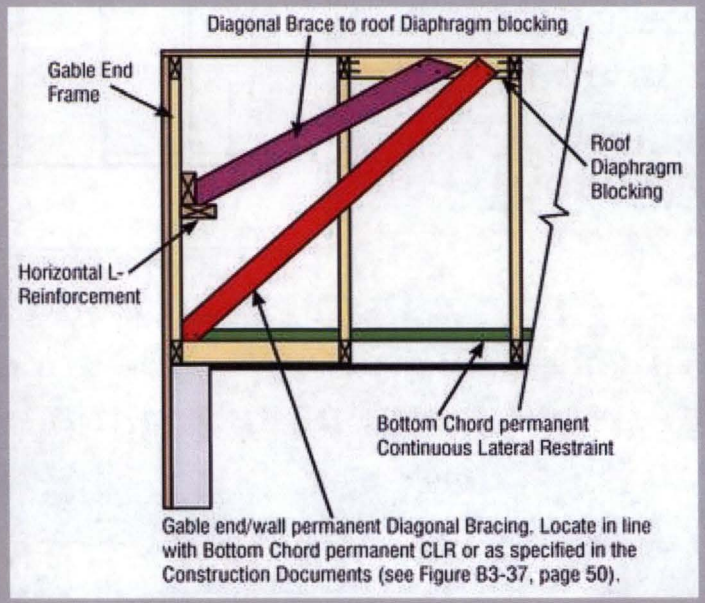


FIGURE B3-33

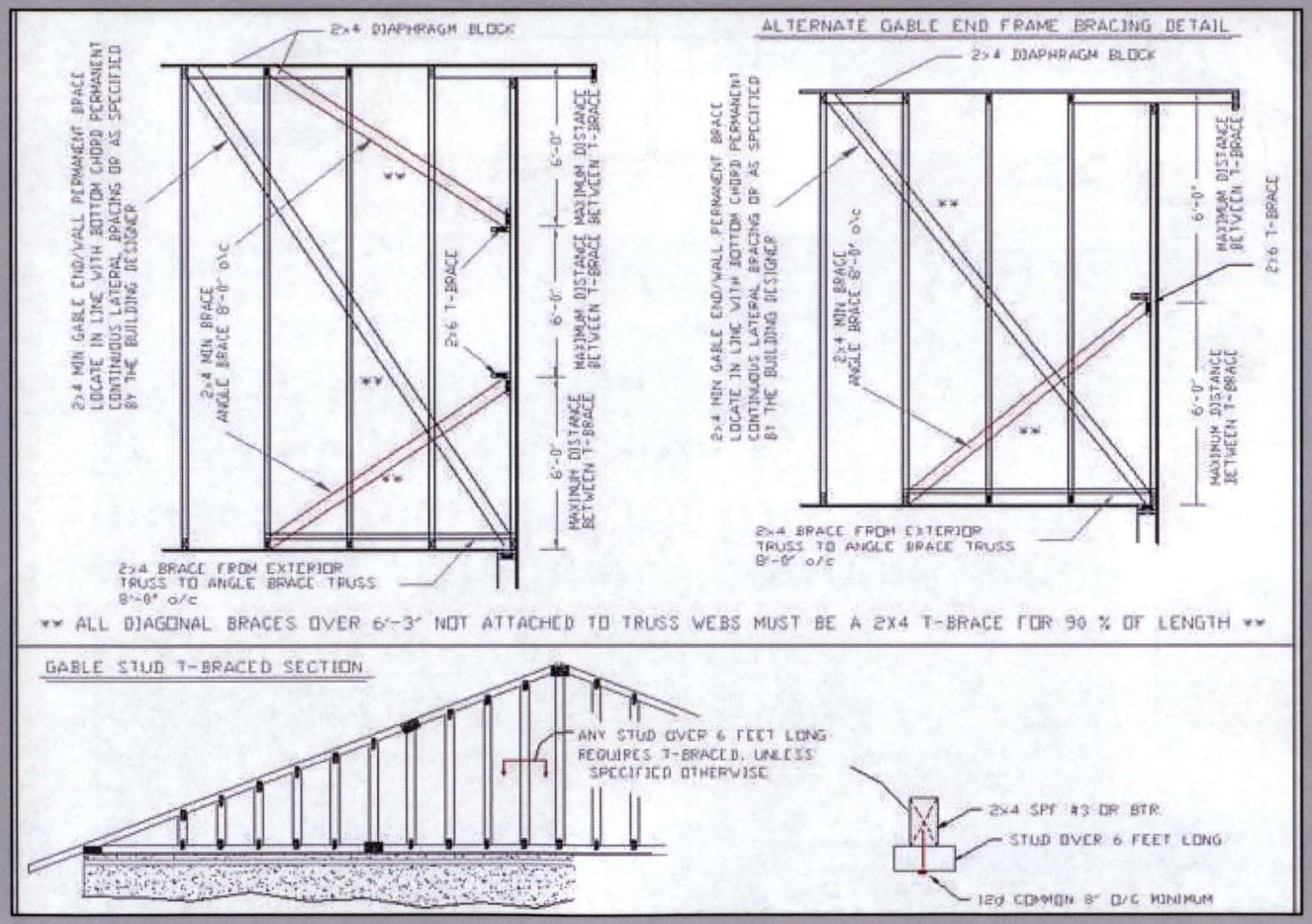




B3 Gable End Frame Permanent Bracing

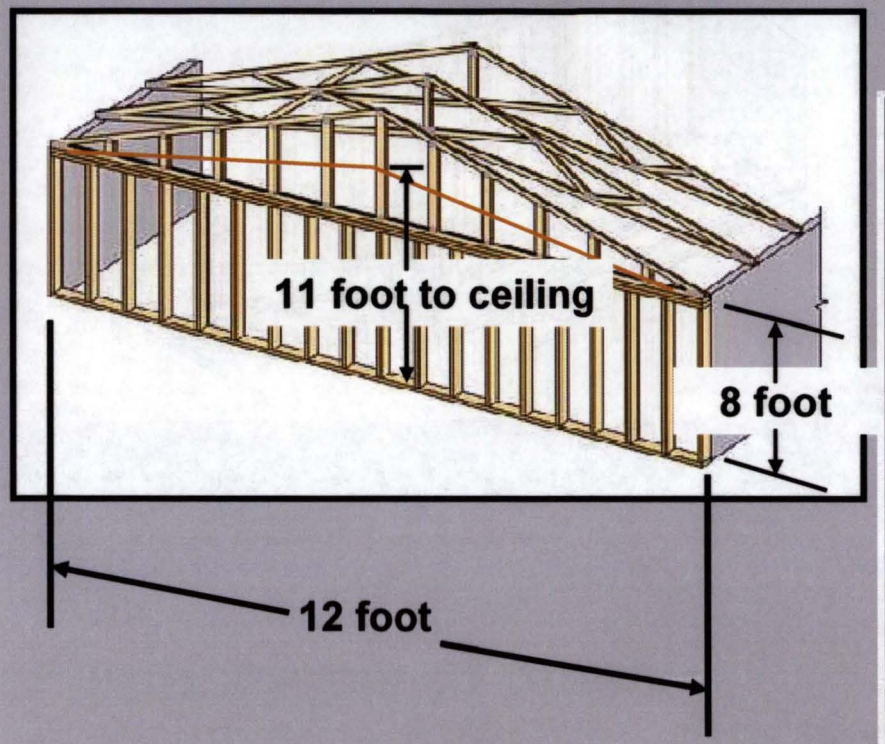
BCSI: PAGE 49

- **Designers have developed "standard" details based on "typical" design assumptions to assist the Building Designer in determining bracing required to transfer the lateral loads applied to the Gable End.**



- **These details DO NOT take the place of a complete flow of loads analysis by the Building Designer**

Wind beams to laterally support studs



Design max. for double top plates #2 SPF 2x6

WoodWorks®

COMPANY	PROJECT
Dec. 15, 2009 15:34	wind_beam.wwb

Design Check Calculation Sheet
Sizer 8.2

LOADS:

Load	Type	Distribution	Pattern	Location [ft] Start	End	Magnitude Start	End	Unit
Load1	Wind	Full UDL				80.0		plf
Load2	Wind	Triangular		0.00	6.00	0.0	30.0	plf
Load3	Wind	Triangular		6.00	12.00	30.0	0.0	plf

MAXIMUM REACTIONS (lbs) and BEARING LENGTHS (in) :

	0'	12'
Unfactored:		
Dead	20	20
Other	570	570
Factored:		
Total	583	583
Bearing:		
Load Comb	#2	#2
Length	0.50*	0.50*
Cb	1.00	1.00

*Min. bearing length for beams is 1/2" for exterior supports

Lumber n-ply, S-P-F, No.1/No.2, 2x6", 2-Plys
Self-weight of 3.33 plf included in loads;
Lateral support: top= at supports, bottom= at supports;

Analysis vs. Allowable Stress (psi) and Deflection (in) using NDS 2005 :

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	fv = 50	Fv' = 180	fv/Fv' = 0.28
Bending(+)	fb = 1474	Fb' = 1513	fb/Fb' = 0.97
Live Defl'n	0.79 = L/181	0.80 = L/100	0.99

ADDITIONAL DATA:

FACTORS:	F/E	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	Cn	LC#
Fv'	135	1.33	1.00	1.00	-	-	-	-	1.00	1.00	1.00	2
Fb'+	875	1.33	1.00	1.00	1.000	1.300	1.00	1.00	1.00	1.00	-	2
Fcp'	425	-	1.00	1.00	-	-	-	-	1.00	1.00	-	-
E'	1.4 million		1.00	1.00	-	-	-	-	1.00	1.00	-	2
Emin'	0.00 million		1.00	1.00	-	-	-	-	1.00	1.00	-	2

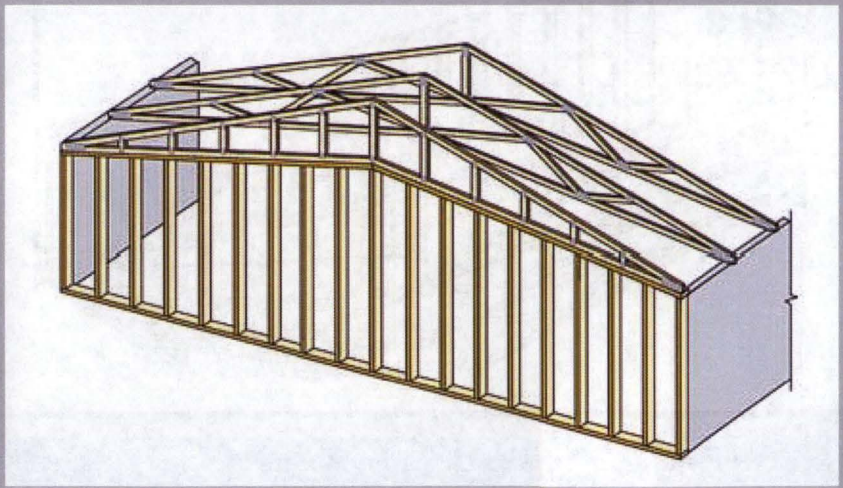
Custom duration factor for Wind load = 1.33

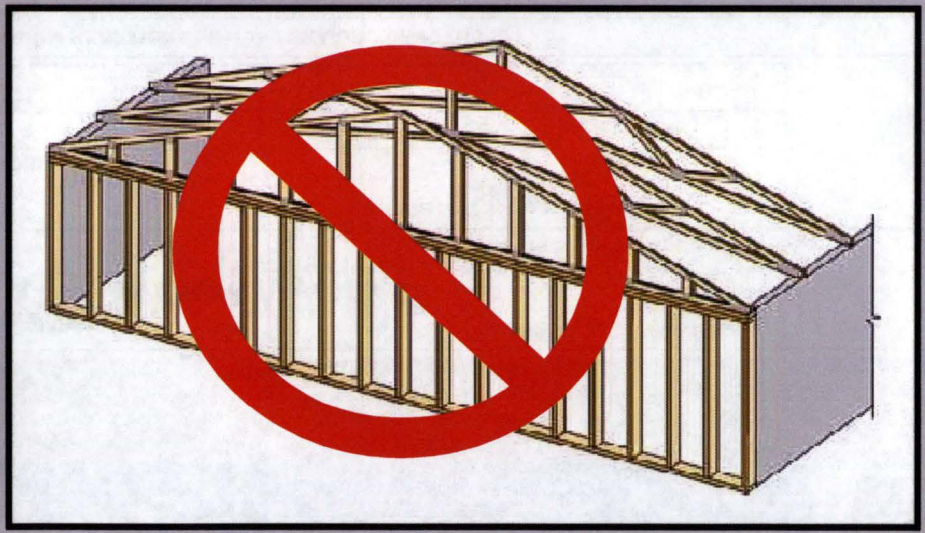
```
Shear      : LC #2  = .67D+W, V =    590, V design =    551 lbs
Bending(+) : LC #2  = .67D+W, M =   1858 lbs-ft
Deflection: LC #2  = .67D+W  (live)
            LC #2  = .67D+W  (total)
   EI =     29e06 lb-in2/ply
D=dead  L=live  S=snow  W=wind  I=impact  Lr=roof live  Lc=concentrated
```

B3 Gable End Frame Detailing

BCSI: PAGE 50

- The GEF should match the profile of the adjacent trusses
- Avoid using a flat bottom chord GEF when adjacent trusses have sloped bottom chords as this creates a "hinge" at the wall/gable interface that is difficult and sometimes impossible to brace



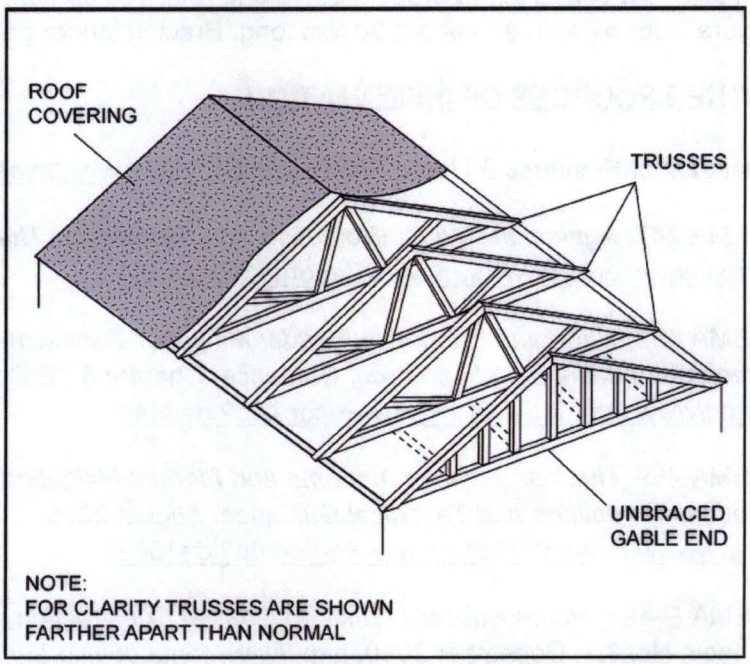


Brace Gable End Roof Framing

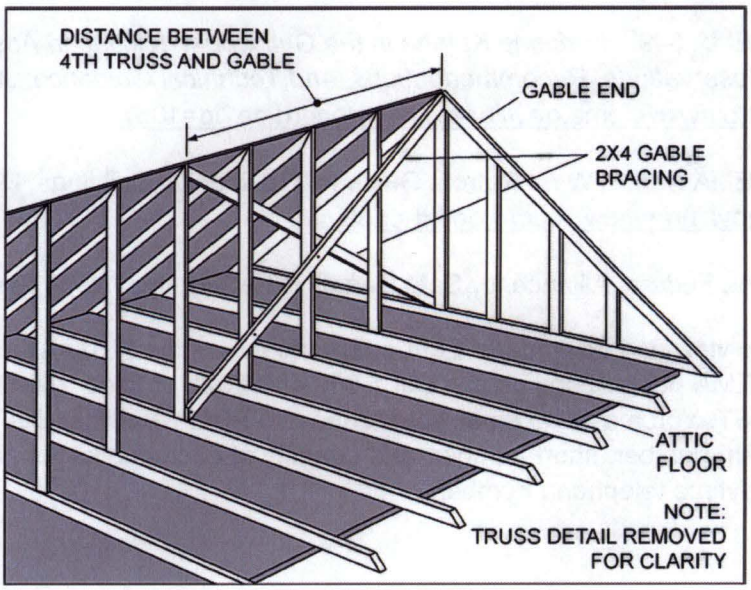
FEMA

PROTECTING YOUR PROPERTY FROM HIGH WINDS

Gable end roofs are more susceptible to damage from high winds than hip or flat roofs. The gable end presents a large, flat obstacle to the wind and receives its full force. If the framing of the gable end and the entire roof is not adequately braced to resist the wind, the roof can fail. Roof failures, especially in unbraced gable roofs, are a common cause of major damage to structures and their contents in high winds.



If your property has a gable roof, check to see whether the roof framing is braced. The top figure shows a cutaway view of an unbraced gable end roof. This is a truss roof, but some gable end roofs are constructed with rafters rather than trusses. Both types should be braced as shown in the bottom figure. If you are unsure whether your gable end roof is adequately braced, check with your local building department. After inspecting your roof framing, a building official can tell you whether bracing is required and if so, how it should be added.



BENEFITS OF UTILIZING THIS MITIGATION STRATEGY

- Helps to prevent roof failure, which can lead to major damage of a structure and its contents
- Helps to prevent injuries to occupants

TIPS

Keep these points in mind if you have bracing added to a gable end roof:

✓ Bracing can be added fairly easily, but you should have a contractor perform the work to make sure that the bracing is properly designed and attached.

✓ If you have a building official inspect your roof framing, ask about other changes you may be able to make to your property to protect it from high winds.

✓ The detail featured on this Fact Sheet provides increased resistance of the gable end to wind loads. For another gable end retrofit that meets current building code requirements, see FEMA P-804, *Wind Retrofit Guide for Residential Buildings*.

ESTIMATED COST

If you hire a contractor to brace a gable end roof, you can expect to pay about $100 for each gable end. This figure is for a gable end about 30 feet long. Bracing longer gable ends may be slightly more expensive.

OTHER SOURCES OF INFORMATION

Institute for Business & Home Safety (IBHS), http://www.disastersafety.org.

FEMA 247, *Against the Wind: Protecting Your Home from Hurricane Wind Damage*, December 1993, http://www.fema.gov/library/viewRecord.do?id=1641.

FEMA 488, *Hurricane Charley in Florida: Mitigation Assessment Team Report, Observations, Recommendations and Technical Guidance*, Chapter 8, "Building Envelope Performance," April 2005, http://www.fema.gov/library/viewRecord.do?id=1444.

FEMA 489, *Hurricane Ivan in Alabama and Florida: Mitigation Assessment Team Report, Observations, Recommendations and Technical Guidance*, August 2005, http://www.fema.gov/library/viewRecord.do?id=1569.

FEMA P-499, *Home Builder's Guide to Coastal Construction*, "Roof Sheathing Installation," Technical Fact Sheets No. 7.1, December 2010, http://www.fema.gov/library/viewRecord.do?id=2138.

FEMA 549, *Hurricane Katrina in the Gulf Coast: Mitigation Assessment Team Report, Building Performance Observations, Recommendations, and Technical Guidance*, July 2006, http://www.fema.gov/library/viewRecord.do?id=1857.

FEMA P-804, Wind Retrofit Guide for Residential Buildings, December 2010, http://wwwfema .gov/library/iewRecord.do?id-4569.

The Federal Alliance for Safe Homes (FLASH), http://www.flash.org.

To view and download FEMA publications visit the FEMA Library at http://www.fema.gov/library. To obtain FEMA publications please call 1-800-480-2520 or fax 1-240-699-0525 Monday through Friday 8 a.m. – 5 p.m. EST. You may also email your request to FEMA-Publications-Warehouse@dhs.gov. Please provide the title, item number, short number, and quantity of each publication, along with your name, address, zip code, and daytime telephone number.

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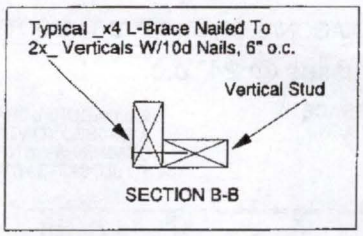
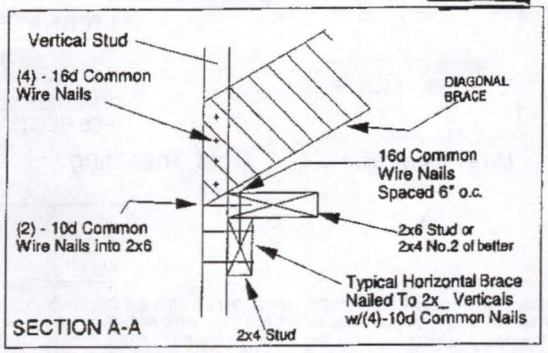
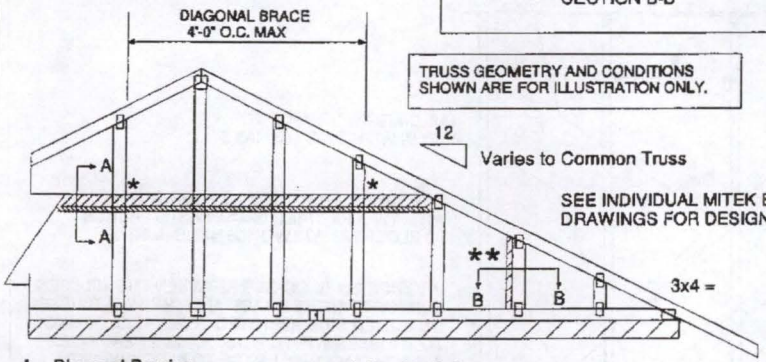
JANUARY 1, 2009	Standard Gable End Detail	ST-GE90-001

MiTek Industries, Chesterfield, MO

MiTek Industries, Inc.







TRUSS GEOMETRY AND CONDITIONS SHOWN ARE FOR ILLUSTRATION ONLY.

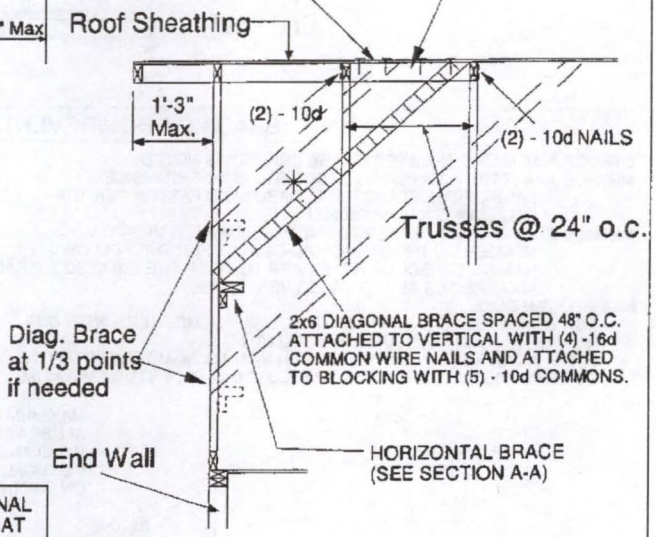
SEE INDIVIDUAL MITEK ENGINEERING DRAWINGS FOR DESIGN CRITERIA

PROVIDE 2x4 BLOCKING BETWEEN THE FIRST TWO TRUSSES AS NOTED. TOENAIL BLOCKING TO TRUSSES WITH (2) - 10d NAILS AT EACH END. ATTACH DIAGONAL BRACE TO BLOCKING WITH (5) - 10d COMMON WIRE NAILS.

(4) - 8d NAILS MINIMUM, PLYWOOD SHEATHING TO 2x4 STD SPF BLOCK

* - Diagonal Bracing Refer to Section A-A

** - L-Bracing Refer to Section B-B



NOTE:
1. MINIMUM GRADE OF #2 MATERIAL IN THE TOP AND BOTTOM CHORDS.
2. CONNECTION BETWEEN BOTTOM CHORD OF GABLE END TRUSS AND WALL TO BE PROVIDED BY PROJECT ENGINEER OR ARCHITECT.
3. BRACING SHOWN IS FOR INDIVIDUAL TRUSS ONLY. CONSULT BLDG. ARCHITECT OR ENGINEER FOR TEMPORARY AND PERMANENT BRACING OF ROOF SYSTEM.
4. "L" BRACES SPECIFIED ARE TO BE FULL LENGTH. GRADES: 1x4 SRB OR 2x4 STUD OR BETTER WITH ONE ROW OF 10d NAILS SPACED 6" O.C.
5. DIAGONAL BRACE TO BE APPROXIMATELY 45 DEGREES TO ROOF DIAPHRAM AT 4'-0" O.C.
6. CONSTRUCT HORIZONTAL BRACE CONNECTING A 2x6 STUD AND A 2x4 STUD AS SHOWN WITH 16d NAILS SPACED 6" O.C. HORIZONTAL BRACE TO BE LOCATED AT THE MIDSPAN OF THE LONGEST STUD. ATTACH TO VERTICAL STUDS WITH (4) 10d NAILS THROUGH 2x4. (REFER TO SECTION A-A)
7. GABLE STUD DEFLECTION MEETS OR EXCEEDS L/240.
8. THIS DETAIL DOES NOT APPLY TO STRUCTURAL GABLES.
9. DO NOT USE FLAT BOTTOM CHORD GABLES NEXT TO SCISSOR TYPE TRUSSES.

Minimum Stud Size Species and Grade	Stud Spacing	Without Brace	1x4 L-Brace	2x4 L-Brace	DIAGONAL BRACE	2 DIAGONAL BRACES AT 1/3 POINTS
		Maximum Stud Length				
2x4 SPF Std/Stud	12" O.C.	5-1-15	6-1-13	8-8-7	10-3-13	15-5-12
2x4 SPF Std/Stud	16" O.C.	4-8-4	5-3-15	7-6-7	9-4-8	14-0-12
2x4 SPF Std/Stud	24" O.C.	4-1-2	4-4-3	6-1-13	8-2-5	12-3-7

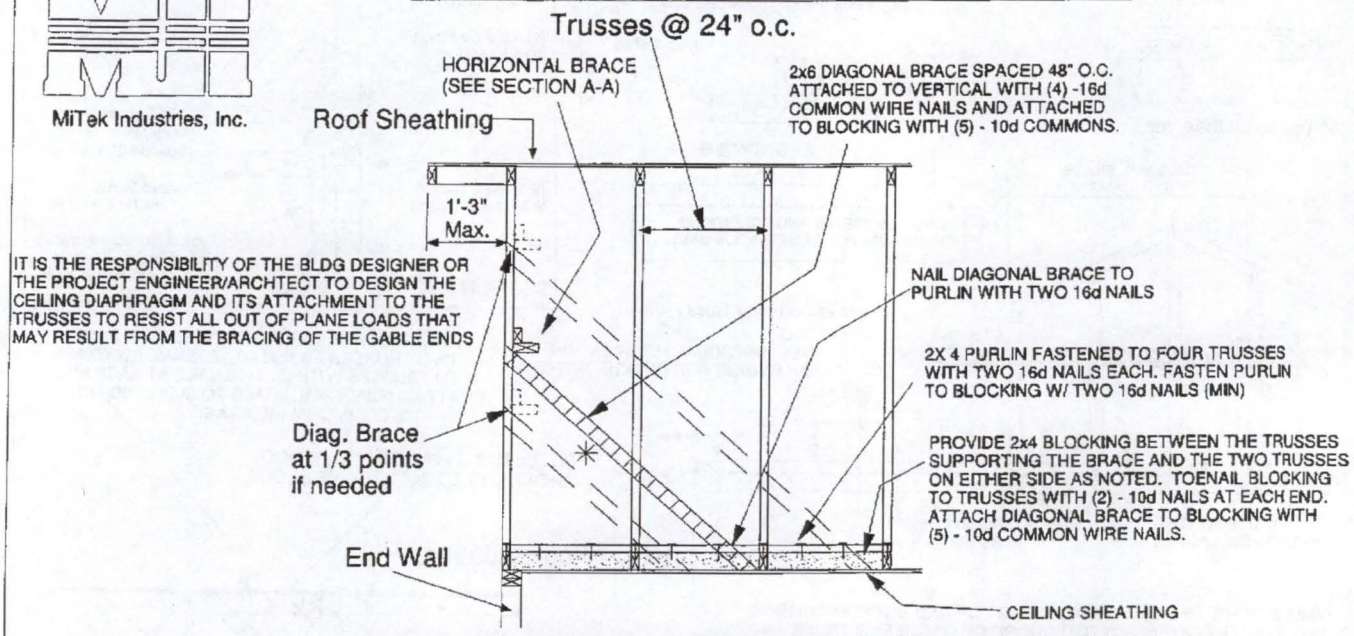
✳ Diagonal braces over 6'-3" require a 2x4 T-Brace attached to one edge. Diagonal braces over 12'-6" require 2x4 I-braces attached to both edges. Fasten T and I braces to narrow edge of web with 10d common wire nails 8in o.c., with 3in minimum end distance. Brace must cover 90% of diagonal length.

MAXIMUM WIND SPEED = 90 MPH
MAX MEAN ROOF HEIGHT = 30 FEET
CATEGORY II BUILDING
EXPOSURE B or C
ASCE 7-98, ASCE 7-02, ASCE 7-05
DURATION OF LOAD INCREASE : 1.60

STUD DESIGN IS BASED ON COMPONENTS AND CLADDING.
CONNECTION OF BRACING IS BASED ON MWFRS.

MiTek Industries, Inc.

ALTERNATE DIAGONAL BRACING TO THE BOTTOM CHORD



BRACING REQUIREMENTS FOR STRUCTURAL GABLE TRUSSES

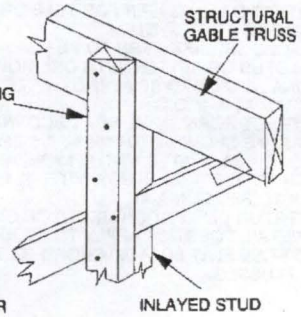
STRUCTURAL GABLE TRUSSES MAY BE BRACED AS NOTED:

METHOD 1 : ATTACH A MATCHING GABLE TRUSS TO THE INSIDE FACE OF THE STRUCTURAL GABLE AND FASTEN PER THE FOLLOWING NAILING SCHEDULE.

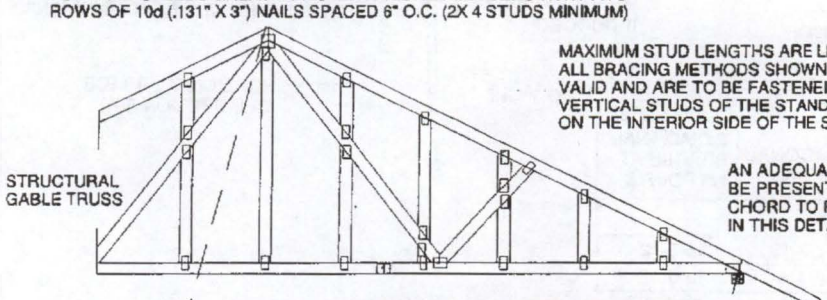
METHOD 2 : ATTACH 2X _ SCABS TO THE FACE OF EACH VERTICAL MEMBER ON THE STRUCTURAL GABLE PER THE FOLLOWING NAILING SCHEDULE. SCABS ARE TO BE OF THE SAME SIZE, GRADE AND SPECIES AS THE TRUSS VERTICALS

NAILING SCHEDULE:

- FOR WIND SPEEDS 120 MPH OR LESS, NAIL ALL MEMBERS WITH ONE ROW OF 10d (.131" X 3") NAILS SPACED 6" O.C.
- FOR WIND SPEEDS GREATER 120 MPH NAIL ALL MEMBERS WITH TWO ROWS OF 10d (.131" X 3") NAILS SPACED 6" O.C. (2X 4 STUDS MINIMUM)

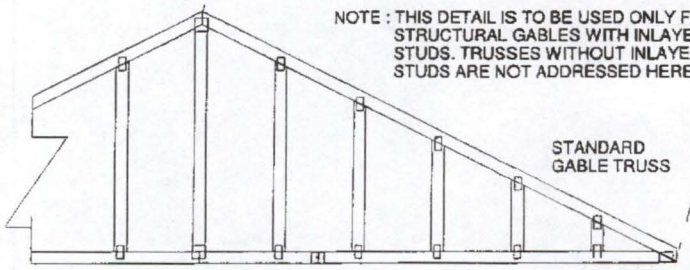


MAXIMUM STUD LENGTHS ARE LISTED ON PAGE 1. ALL BRACING METHODS SHOWN ON PAGE 1 ARE VALID AND ARE TO BE FASTENED TO THE SCABS OR VERTICAL STUDS OF THE STANDARD GABLE TRUSS ON THE INTERIOR SIDE OF THE STRUCTURE.



AN ADEQUATE DIAPHRAGM OR OTHER METHOD OF BRACING MUST BE PRESENT TO PROVIDE FULL LATERAL SUPPORT OF THE BOTTOM CHORD TO RESIST ALL OUT OF PLANE LOADS. THE BRACING SHOWN IN THIS DETAIL IS FOR THE VERTICAL/STUDS ONLY.

NOTE : THIS DETAIL IS TO BE USED ONLY FOR STRUCTURAL GABLES WITH INLAYED STUDS. TRUSSES WITHOUT INLAYED STUDS ARE NOT ADDRESSED HERE.



MiTek Industries, Inc.

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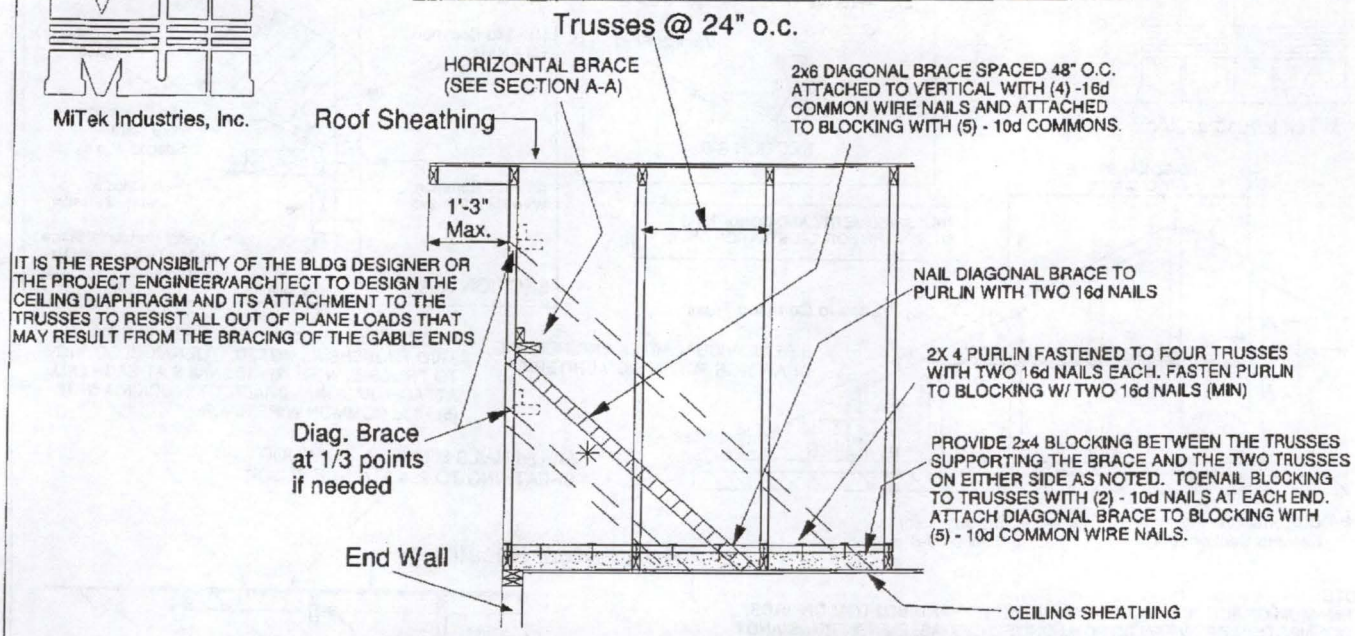

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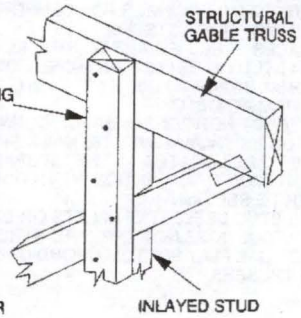

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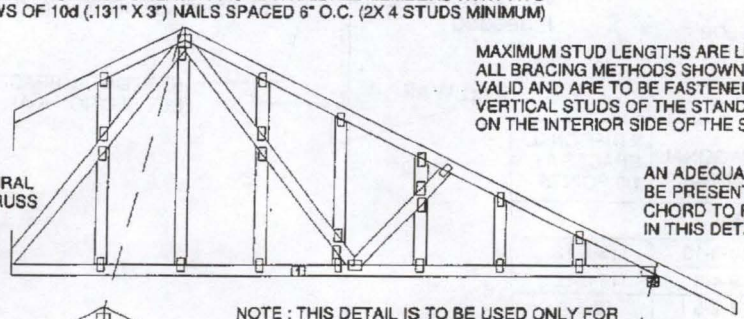

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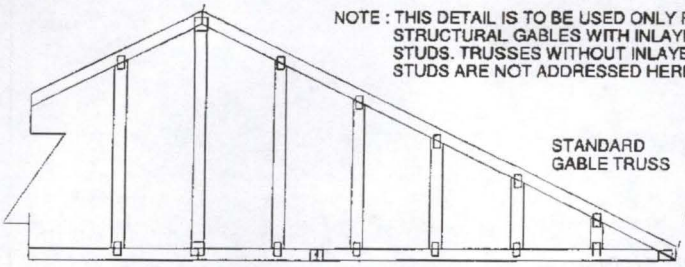
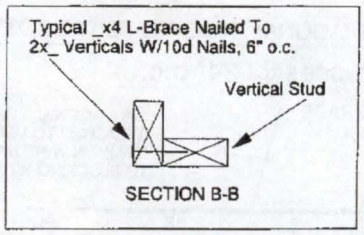
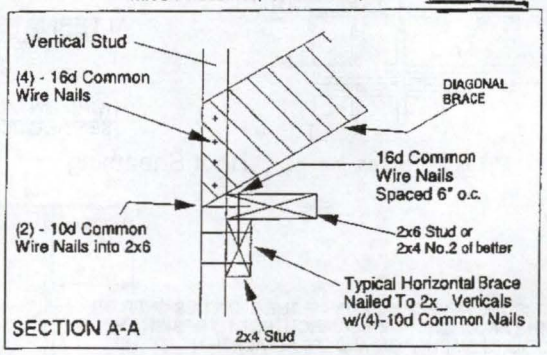


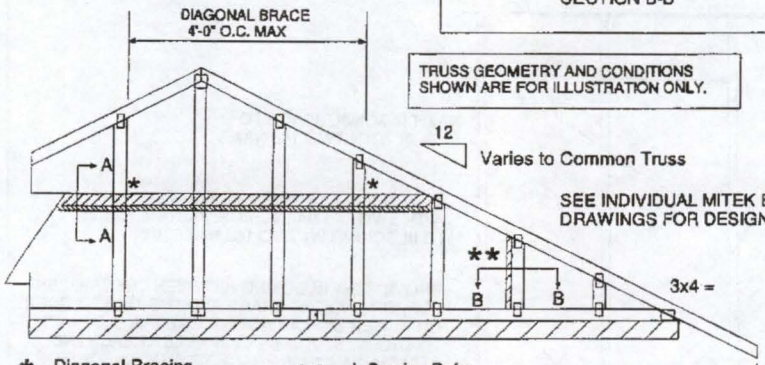
JANUARY 1, 2009	Standard Gable End Detail	ST-GE90-001

MiTek Industries, Chesterfield, MO

MiTek Industries, Inc.







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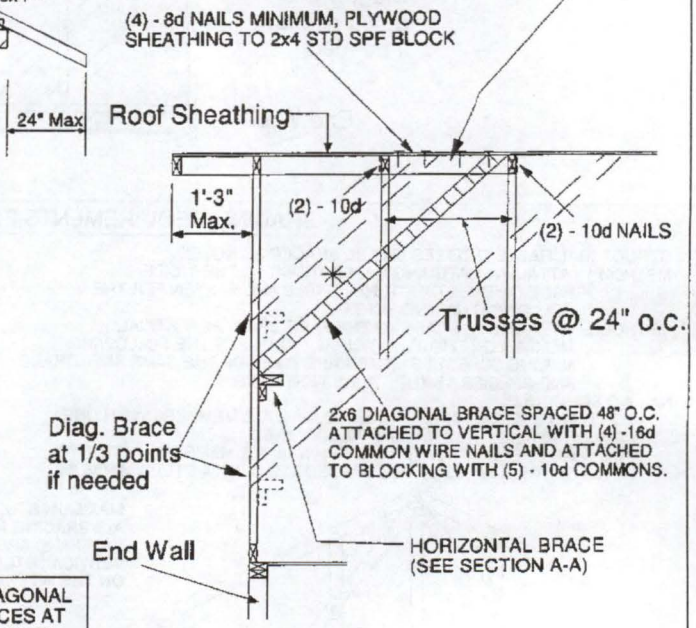

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