

Wood Trusses: Theory, Practice & Problems

March 2015



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Learning Objectives

- ***Gain a general understanding of truss behavior***
- ***Learn how to read a truss shop drawing***
- ***Understand the importance of temporary and permanent restraint/bracing***
- ***Recognize issues associated with gable end trusses***
- ***Understand how truss repairs are implemented***

Recognition



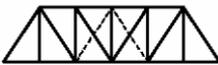
Truss Plate Institute



RELIABLE TRUSS

3

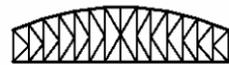
What is a truss?



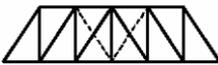
Pratt



Parker



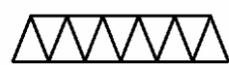
K-Truss



Howe



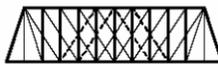
Camelback



Warren



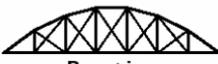
Fink



Double Intersection Pratt



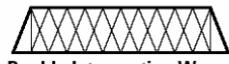
Warren (with Verticals)



Bowstring



Baltimore



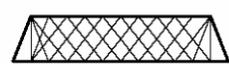
Double Intersection Warren



Waddell "A" Truss



Pennsylvania



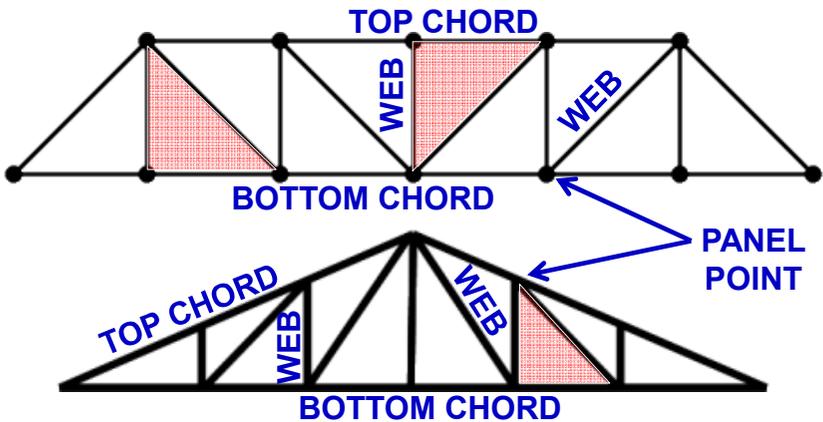
Lattice

4

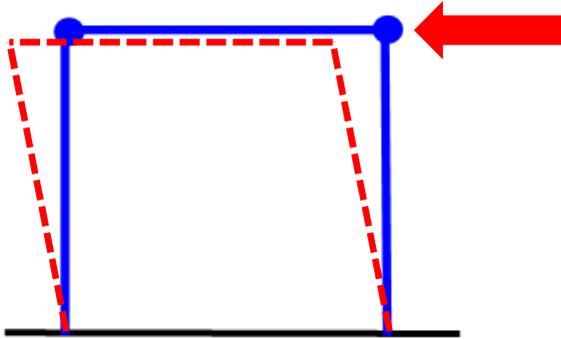
What is a truss?



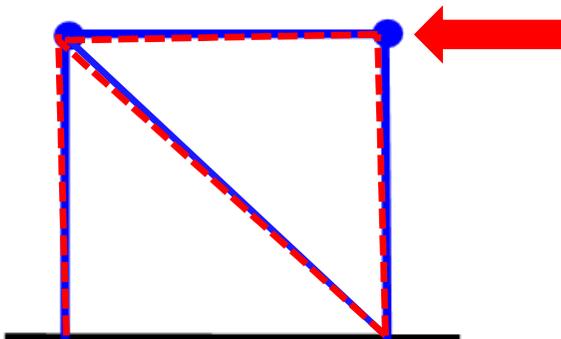
What is a truss?



What is a truss?

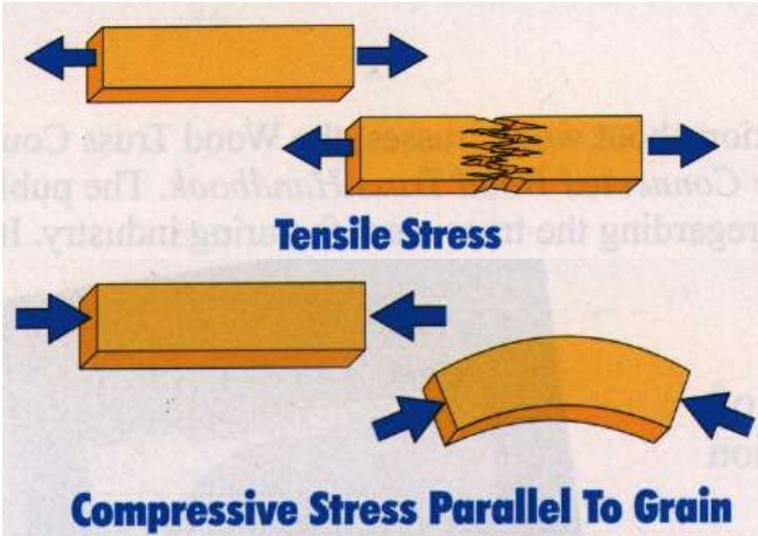


What is a truss?



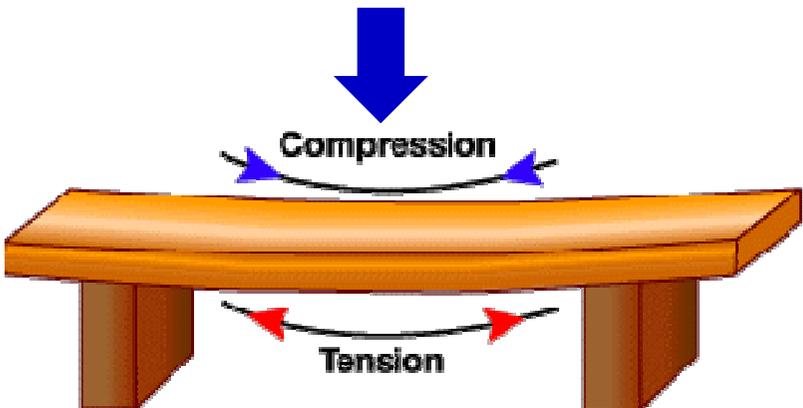
*****Triangulation*****

What is a truss?



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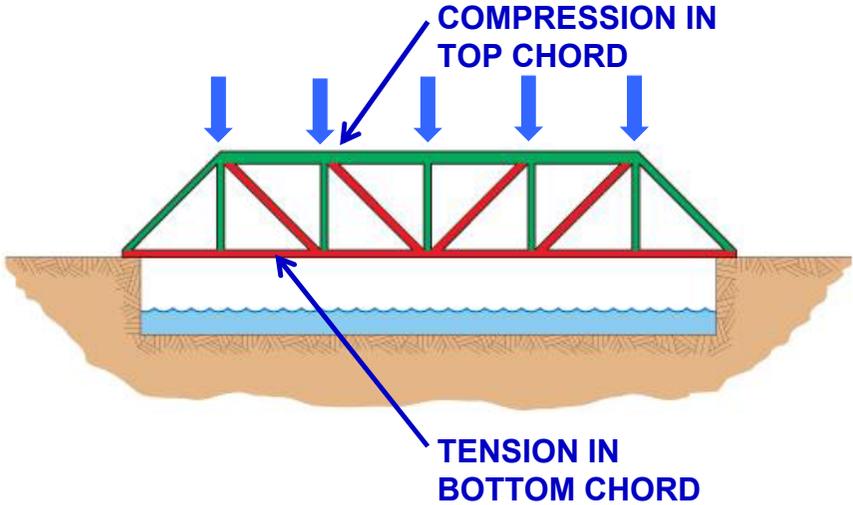
What is a truss?



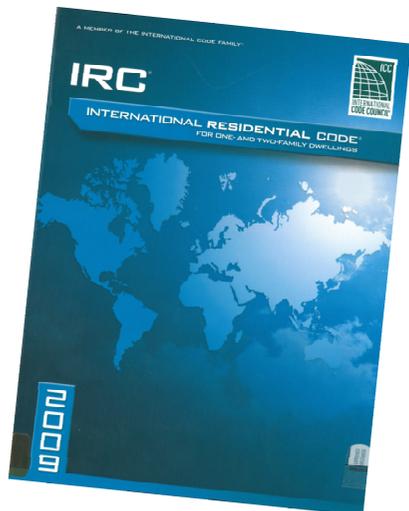
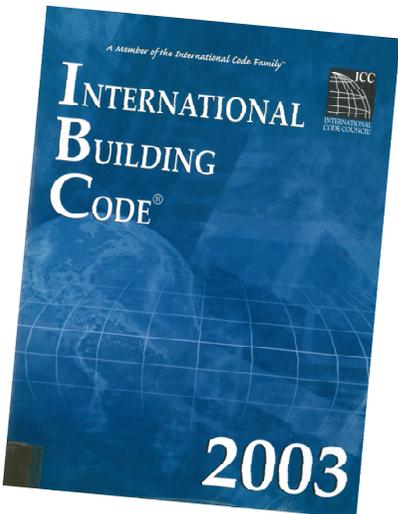
Bending Stress

10

What is a truss?



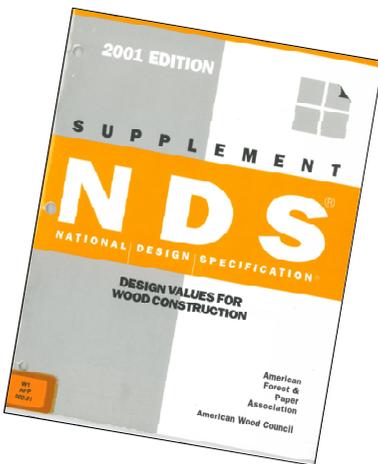
Truss Design



Truss Design



Wood Design Stresses



- Many different species of wood
- Different qualities of wood
- Different Grading Rules Agencies

Wood Design Values

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)						Grading Rules Agency
		Bending F_b	Tension parallel to grain F_t	Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain F_c	Modulus of Elasticity E	
SPRUCE-PINE-FIR								
Select Structural	2" & wider	1250	700	135	425	1400	1,500,000	NLGA
No.1/No.2		875	450	135	425	1150	1,400,000	
No.3	2" & wider	500	250	135	425	650	1,200,000	
Stud		675	350	135	425	725	1,200,000	
Construction	2"-4" wide	1000	500	135	425	1400	1,300,000	
Standard		550	275	135	425	1150	1,200,000	
Utility		275	125	135	425	750	1,100,000	

**Species/ Size F_b F_t F_v $F_{c\perp}$ F_c E Agency
Grade**

Wood Design Values

Modification Factors:

- **C_D – Load Duration Factor**
 - 1.0 Live Load; 1.15 Snow Load; 1.60 Wind Load
- **C_M – Wet Service Factor**
- **C_t – Temperature Factor**
- **C_F – Size Factor**
- **C_i – Incising Factor**

Allowable Wood Design Values

Tension:

- $F_t' = F_t \times C_D \times C_M \times C_T \times C_F \times C_i$

Compression Parallel to Grain:

- $F_c' = F_c \times C_D \times C_M \times C_T \times C_F \times C_i \times C_p$

C_p – Column Stability Factor

- Accounts for buckling
- Function of slenderness of compression element

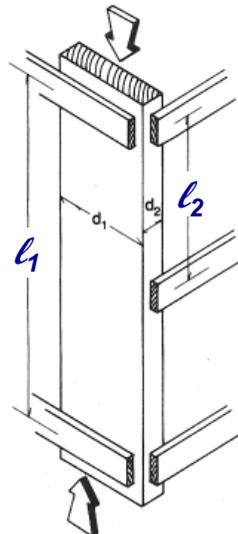
Allowable Wood Design Values

Slenderness Ratio

$$\ell_e/d$$

Limitations

- General: $\ell_e/d \leq 50$
- Construction: $\ell_e/d \leq 75$
- Short Term Loads (Other than Gravity Loads): $\ell_e/d \leq 80$



Allowable Wood Design Values

Column Stability Factor, C_p

$$C_p = \frac{1 + (F_{cE}/F_c^*)}{2c} - \sqrt{\left(\frac{1 + (F_{cE}/F_c^*)}{2c}\right)^2 - \frac{(F_{cE}/F_c^*)}{c}}$$

where

- $F_c^* = F_c \times C_D \times C_M \times C_T \times C_F \times C_i$
- $c = 0.8$ for sawn lumber

Allowable Wood Design Values

$$F_{cE} = \frac{K_{cE} E'}{(l_e/d)^2}$$

where

- E' = modulus of elasticity (adjusted)
- $K_{cE} = 0.3$ for visually graded lumber
= 0.384 for machine-evaluated lumber
= 0.418 for machine-stress-rated lumber

Allowable Wood Design Values

How does the slenderness ratio affect the allowable compression stress?

- 2"x4" - No. 1/No. 2 Spruce-Pine-Fir
- Snow Load Condition – $C_D = 1.15$
- No Wet-Use, Temperature, Incising Issues

l_e/d	F_c'	P_{allow}
10	1,385 psi	7,270#
26	557 psi	2,924#
50	164 psi	861#

For the same 2"x4" in tension, the allowable tension stress (F_t') is 518 psi, and the allowable tension load is 2,717# regardless of the length.

Truss Connections

- Chords and webs are interconnected through metal truss plates
- Light-gage metal with integral teeth that are pressed into the lumber
- Proprietary
- Design governed by TPI "National Design Standard for Metal Plate Connected Wood Truss Construction"

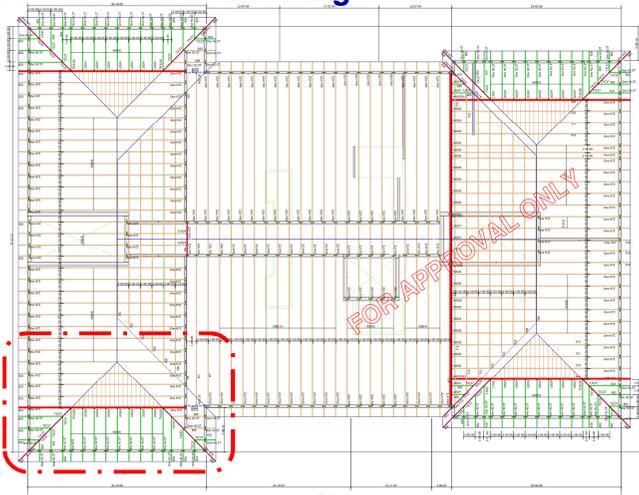


Wood Truss Drawings

- **Truss Placement Diagrams**
- **Truss Design Drawings**

Wood Truss Drawings

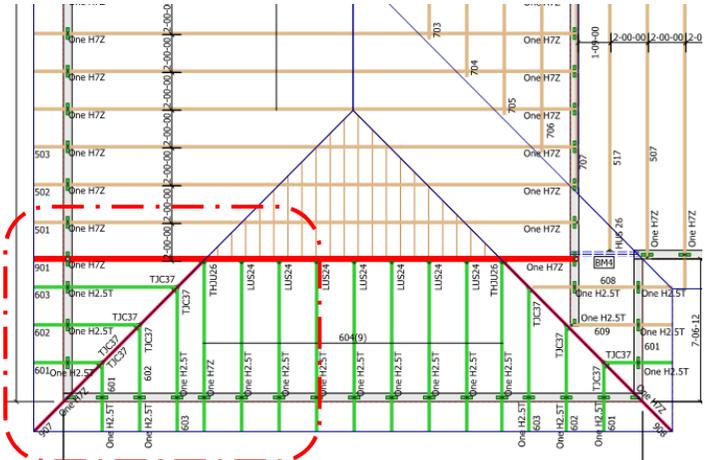
- **Truss Placement Drawings**



Wood Truss Drawings

- Truss Placement Drawings

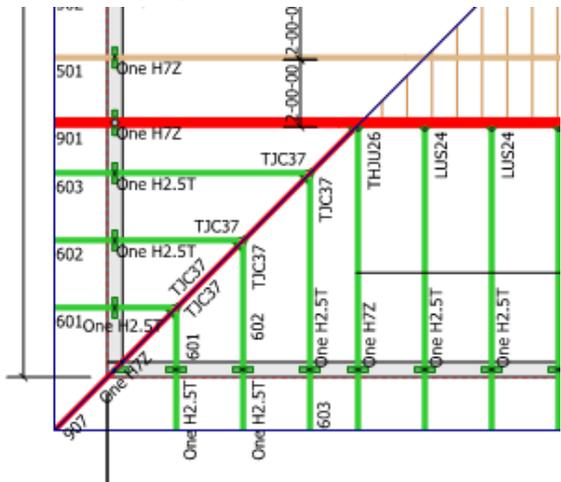
- Common Trusses
- Hip and Jack Trusses
- Girder Truss
- Overbuild (Valley Set)



Wood Truss Drawings

- Truss Placement Drawings

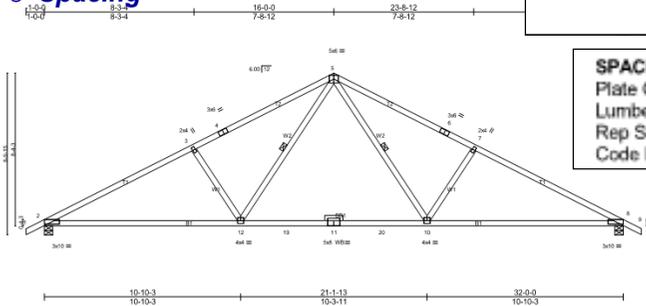
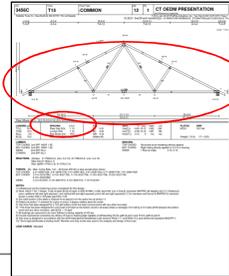
- Truss IDs
- Spacings/Dimensions (FT-IN-16th)
- Hangers*
- Hurricane Anchors*



Wood Truss Drawings

Truss Design Drawings

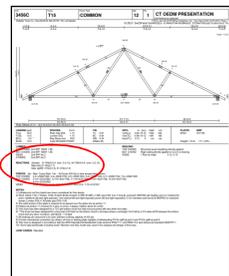
- **Truss Geometry**
 - **Dimensions/Height/Heel Height**
 - **Pitch**
 - **Joint Numbers**
 - **Member Designations**
 - **Spacing**



Wood Truss Drawings

Truss Design Drawings

- **Truss Bearing**
 - **Reactions**
 - **Gravity**
 - **Uplift**
 - **Lateral**
 - **Bearing Width**

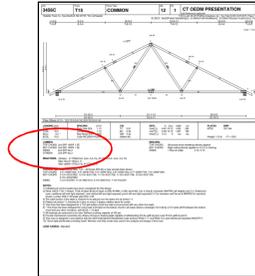


REACTIONS. (lb/size) 2=1786/0-5-8 (min. 0-2-13), 8=1786/0-5-8 (min. 0-2-13)
 Max Horz 2=183(LC 7)
 Max Uplift 2=-574(LC 8), 8=-574(LC 8)

Wood Truss Drawings

Truss Design Drawings

- Lumber
 - Species
 - Grade

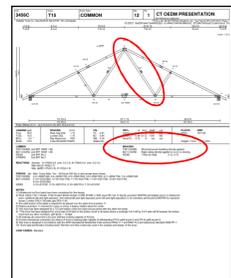
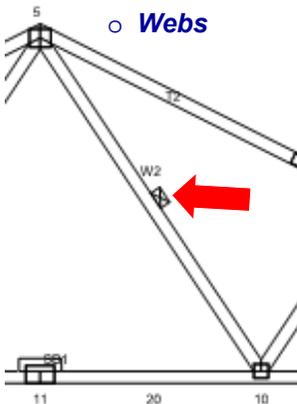


LUMBER-
 TOP CHORD 2x4 SPF 1650F 1.5E
 BOT CHORD 2x4 SPF 1650F 1.5E
 WEBS 2x4 SPF No.2
 OTHERS 2x4 SPF No.2

Wood Truss Drawings

Truss Design Drawings

- Permanent Restraint/Bracing
 - Top Chord
 - Bottom Chord
 - Webs



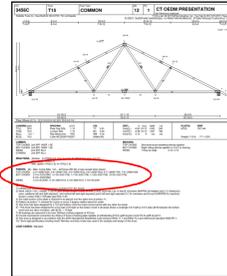
BRACING-
 TOP CHORD
 BOT CHORD
 WEBS

Structural wood sheathing directly applied.
 Rigid ceiling directly applied or 2-2-0 oc bracing.
 1 Row at midpt 5-12, 5-10

Wood Truss Drawings

Truss Design Drawings

- **Member Forces**
 - Tension & Compression
 - Chords and Webs

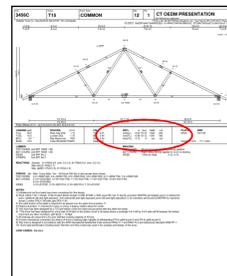


FORCES. (lb) - Max. Comp./Max. Ten. - All forces 250 (lb) or less except when shown.
 TOP CHORD 2-3=-2996/1928, 3-4=-2658/1795, 4-5=-2506/1832, 5-6=-2506/1832, 6-7=-2658/1794, 7-8=-2996/1928
 BOT CHORD 2-12=-2322/2562, 12-19=-832/1706, 11-19=-832/1706, 11-20=-832/1706, 10-20=-832/1706,
 8-10=-2322/2562
 WEBS 3-12=-612/391, 5-12=-800/1014, 5-10=-800/1014, 7-10=-612/391

Wood Truss Drawings

Truss Design Drawings

- **Deflections**
 - Live Load (Snow Load)
 - Total Load
 - Actual and Relative Deflections

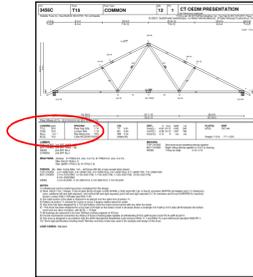


DEFL	in (loc)	l/def	L/d
Vert(LL)	-0.65 10-12	>592	240
Vert(TL)	-0.98 10-12	>391	180
Horz(TL)	0.12 8	n/a	n/a

Wood Truss Drawings

Truss Design Drawings

- Design Loads
 - Live Loads and Dead Loads
 - Top Chord and Bottom Chord
 - Uniform Loads and Concentrated Loads
 - Also see NOTES for other loads and loading conditions

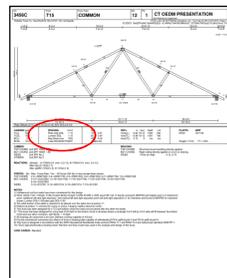


LOADING (psf)	
TCLL	30.0
TCDL	10.0
BCLL	0.0
BCDL	10.0

Wood Truss Drawings

Truss Design Drawings

- Design Criteria
 - Model Building Code
 - TPI Standard
 - Lumber Stress Adjustment Factors (DOL = Duration of Load)

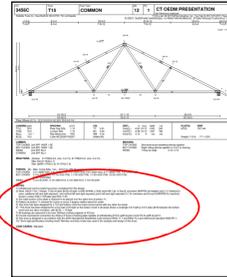


SPACING-	2-0-0
Plate Grip DOL	1.15
Lumber DOL	1.15
Rep Stress Incr	YES
Code	IRC2009/TPI2007

Wood Truss Drawings

Truss Design Drawings

- **Additional Information (NOTES)**
 - **Fastening requirements for multi-ply (girder trusses)**
 - **Proprietary fasteners for truss-to-truss connections**
 - **Special design loads / conditions (e.g. wind, unbalanced snow, attic live load)**



NOTES

- 1) 2-ply truss to be connected together with 10d (0.131"x3") nails as follows:
 - Top chords connected as follows: 2 X 8 - 2 rows at 0-9-0 oc, 2 X 6 - 2 rows at 0-9-0 oc.
 - Bottom chords connected as follows: 2 X 8 - 2 rows at 0-2-0 oc.
 - Webs connected as follows: 2 X 4 - 1 row at 0-9-0 oc, 2 X 6 - 2 rows at 0-9-0 oc.

Wood Truss Drawings

Truss Design Drawings

- **P.E. Certification**
 - **Individual Truss Design Drawings or cover sheet for Truss Design Drawing package should be signed and sealed by a Professional Engineer licensed in the State of Connecticut**



Wood Truss Drawings

Truss Design Drawings

- **Deferred Submittals**
 - **IBC 2012 (§107.3.4.1)**

“...deferred submittals are defined as those portions of the design that are not submitted at the time of the application and are to be submitted to the building official within a specified period.”

“The registered design professional in responsible charge shall list the deferred submittals on the construction documents for review by the building official.”

“Documents for deferred submittal items shall be submitted to the registered design professional ...who shall review and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and found to be in general conformance to the design of the building”

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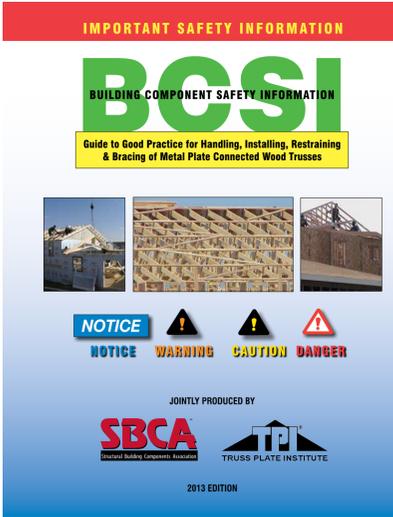
Truss Restraint | Bracing

What are the consequences if trusses are not properly braced/restrained?



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Truss Bracing



Building Component Safety Information “Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses”

- Structural Building Components Association / Wood Truss Council of America
- Truss Plate Institute

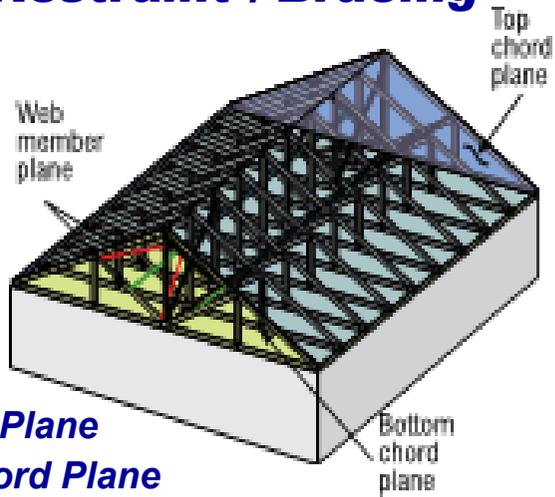
www.sbcindustry.com

Truss Restraint | Bracing

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

- B1 – Guide to Handling, Installing, Restraining & Bracing Trusses
- B2 – Truss Installation and Temporary Restraint/Bracing
- B3 – Permanent Restraint Bracing of Chords & Web Members
- B4 – Construction Loading
- B5 – Truss Damage, Jobsite Modifications & Installation Errors
- B7 – Temporary & Permanent Restraint/Bracing for Parallel Chord Trusses
- B8 – Using Toe-Nailed Connections to Attach Trusses at Bearing Locations
- B9 – Multi-Ply Girders
- B10 – Post Frame Truss Installation & Temporary Restraint/Bracing
- B11 – Fall Protection & Trusses

Truss Restraint | Bracing



- *Top Chord Plane*
- *Bottom Chord Plane*
- *Web Member Plane*

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Truss Restraint | Bracing

Temporary Restraint/Bracing

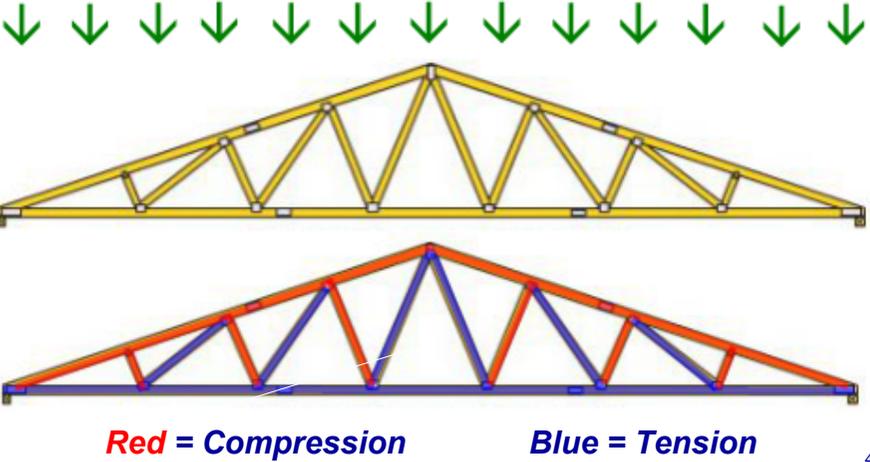


During construction, unbraced or improperly braced or restrained trusses are particularly vulnerable to racking and buckling.

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Temporary Truss Restraint | Bracing

Truss Stresses Primarily Due to Gravity Loads



Permanent Truss Restraint | Bracing

- Guidelines for Temporary Restraint/Bracing per BCSI B2

B2 Truss Installation & Temporary Restraint/Bracing
Instalación de Trusses & Restricción/Aristote Temporal

FOR TRUSSES UP TO 2'-0" ON CENTER AND 80' IN LENGTH
PARA TRUSSAS HASTA 2 PIES DE CENTRO Y HASTA 80 PIES DE LONGITUD

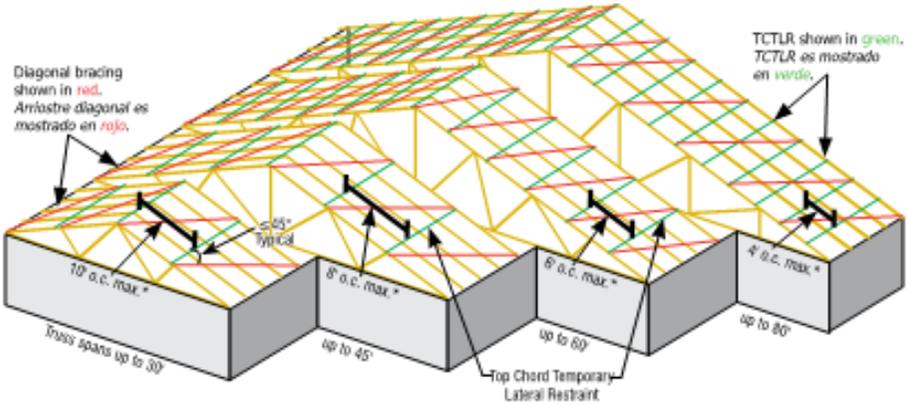
REQUIREMENTS FOR TOP CHORD TEMPORARY LATERAL RESTRAINT (CYCLER)
REQUISITOS PARA LA RESTRICCIÓN LATERAL TEMPORAL (CYCLER)

CHECK THESE ITEMS BEFORE BRACING SELECTION/INSTALLATION AND CORRECT AS NEEDED
REVISAR ESTOS PUNTOS ANTES DE SELECCIONAR LA RESTRICCIÓN/INSTALACIÓN Y CORREGIRLO SI ES NECESARIO

REVISION B2-01 SUMMARY SHEET **RESUMEN B2-01**

Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing



Need both lateral restraint (green) and diagonal bracing (red) to maintain spacing and to inhibit buckling

Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

- Frequency of lateral bracing is a function of the truss span.

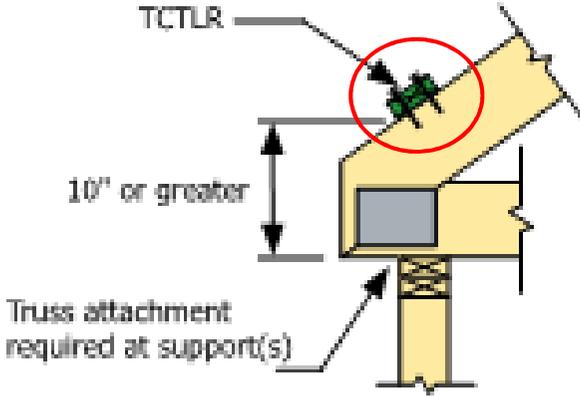
Maximum Top Chord Temporary Lateral Restraint Spacing ^{a*}	
Truss Span	TCTLR Spacing
Up to 30'	10' on-center maximum
30' - 45'	8' on-center maximum
45' - 60'	6' on-center maximum
60' - 80' ^{a*}	4' on-center maximum

Based on 2'-0" o.c. truss spacing

Truss Bracing

Top Chord Temporary Restraint/Bracing

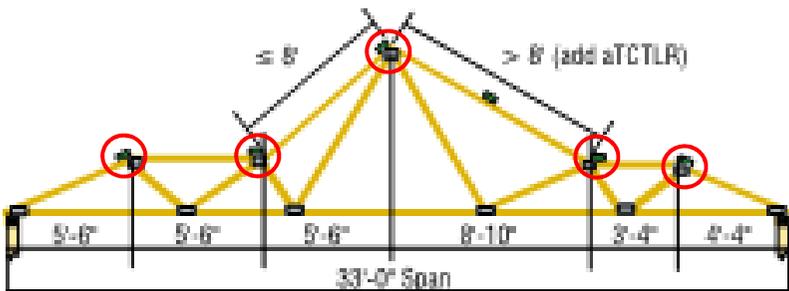
- If truss has a heel height of 10" or more, horizontal bracing must be provided over the support



Truss Restraint / Bracing

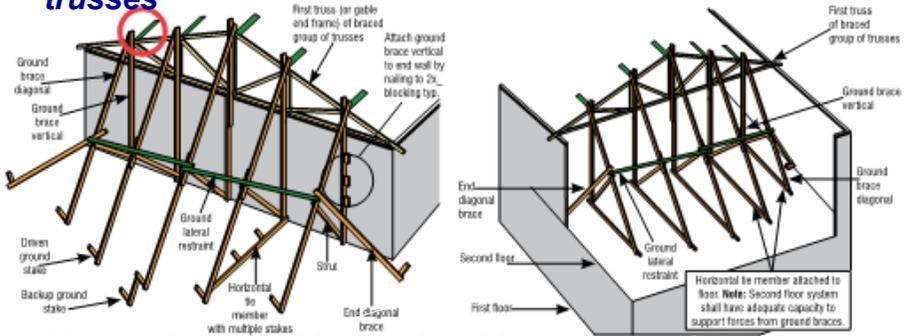
Top Chord Temporary Restraint/Bracing

- If truss has a geometry with multiple breaks in roof pitch, a horizontal brace must be provided at each break.



Truss Restraint | Bracing Top Chord Temporary Restraint/Bracing

- Before starting the truss installation sequence, ground bracing must be established to stabilize the initial trusses

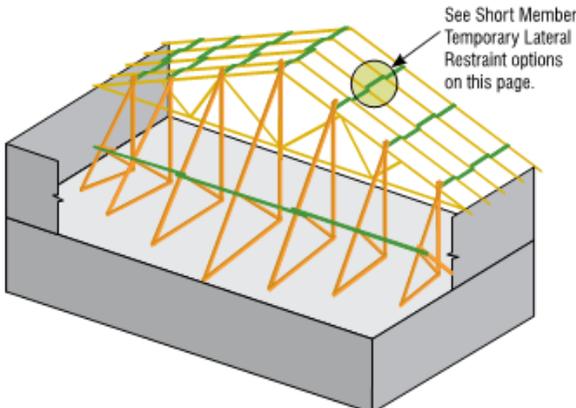


- Must coincide with top chord lateral restraint rows
- May be exterior or interior

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Truss Restraint | Bracing Initial Top Chord Temporary Restraint/Bracing

- First five trusses are to be installed and restrained using “short member temporary lateral restraint”.

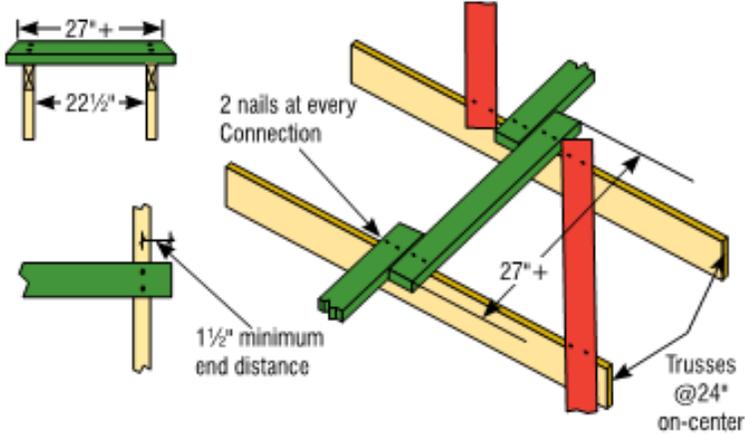


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Truss Restraint | Bracing

Initial Top Chord Temporary Restraint/Bracing

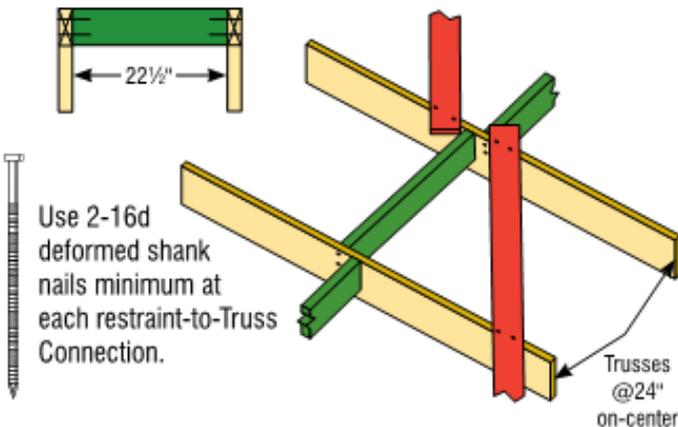
- Short Member Temporary Lateral Restraint – Option 1



Truss Restraint | Bracing

Initial Top Chord Temporary Restraint/Bracing

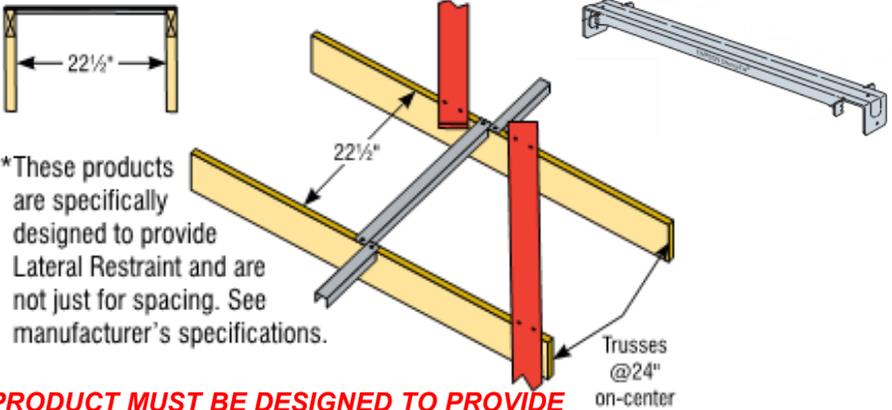
- Short Member Temporary Lateral Restraint – Option 2



Truss Restraint | Bracing

Initial Top Chord Temporary Restraint/Bracing

- Short Member Temporary Lateral Restraint – Option 3

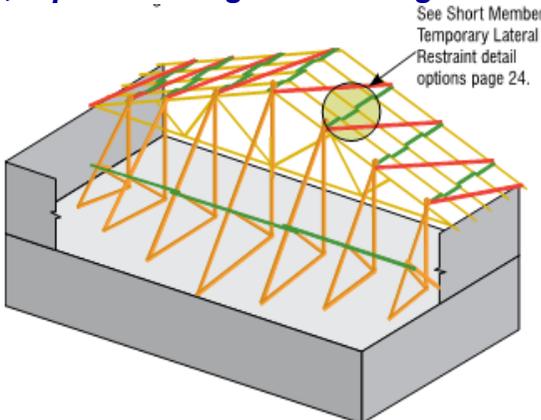


PRODUCT MUST BE DESIGNED TO PROVIDE LATERAL RESTRAINT, NOT JUST SPACING!!!!

Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

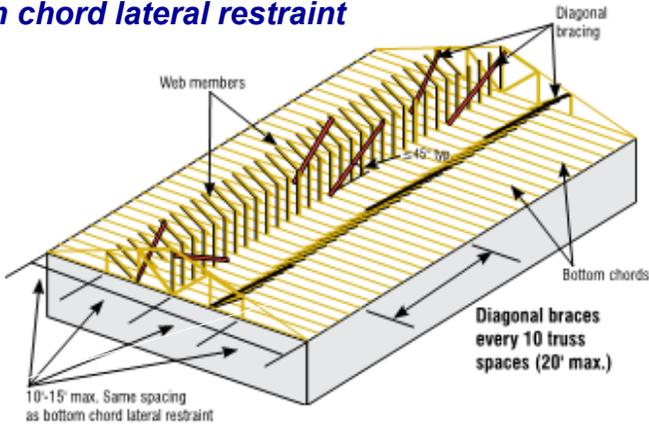
- After "short member temporary lateral restraint" is installed, top chord diagonal bracing is added



Truss Restraint | Bracing

Web Member Temporary Restraint

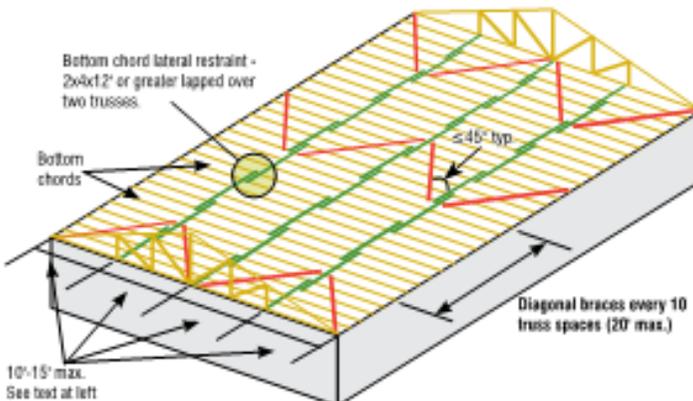
- Intermittent diagonal braces are added between the top and bottom chords to match the spacing of the bottom chord lateral restraint



Truss Restraint | Bracing

Bottom Chord Temporary Restraint/Bracing

- Continuous rows of lateral restraint and intermittent diagonal bracing in bottom chord plane

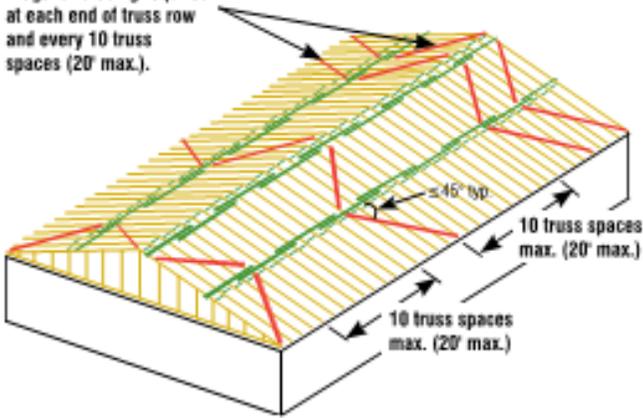


Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

- Option 1 – Long Length Continuous Lateral Restraint

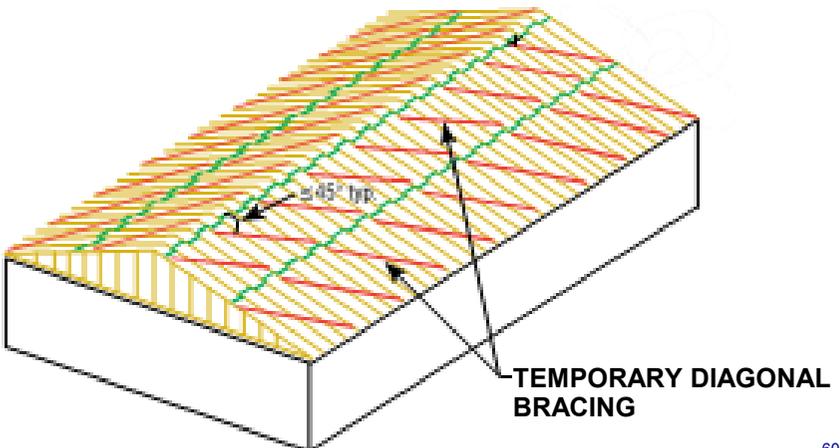
Diagonal bracing required at each end of truss row and every 10 truss spaces (20' max.).



Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

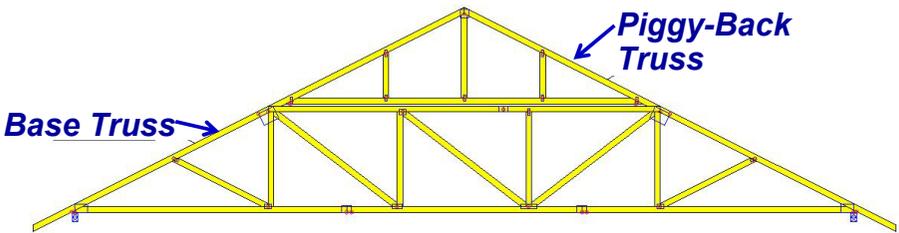
- Option 2 – Short Member Continuous Lateral Restraint



Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

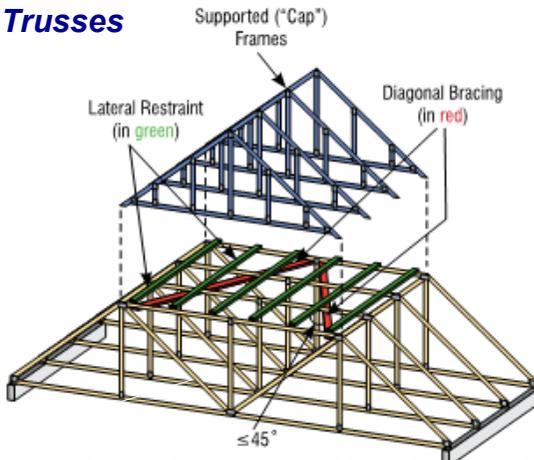
- Piggy-Back (Cap) Trusses



Truss Restraint | Bracing

Top Chord Temporary Restraint/Bracing

- Piggy-Back Trusses



**** Permanent Lateral Restraint/Bracing Must Be Installed ****

Truss Restraint | Bracing

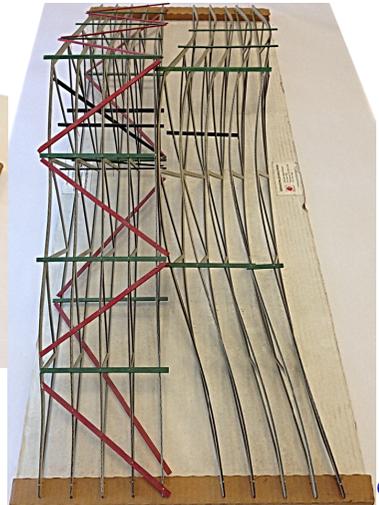
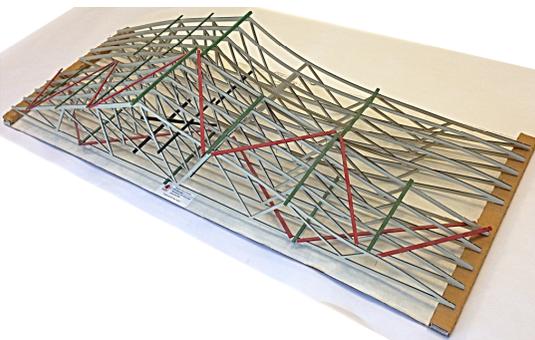
Temporary Restraint/Bracing

- **Special Inspections**
 - **Current State Building Code – Based on 2003 IBC**
 - **No Special Inspections Requirements for Temporary Restraint/Bracing**
 - **Upcoming Building Code – Based on 2012 IBC**
 - **§1705.5.2 – “Where a truss clear span is 60 feet or greater, the special inspector shall verify that the temporary installation restraint/bracing...are installed in accordance with the approved truss submittal package”**

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Truss Restraint | Bracing

Temporary Restraint/Bracing



BREAK

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Permanent Truss Restraint | Bracing

Building Code Requirements for Permanent Bracing

- IBC 2003: None.
- IRC 2009:
 - R802.10.3 Bracing.** Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the construction documents for the building and on the individual truss design drawings. In the absence of specific bracing requirements, trusses shall be braced in accordance with the Building Component Safety Information (BCSI 1-03) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses.
- IBC 2012: Requires bracing per standard industry lateral/restraint bracing details or engineered bracing design.
- IRC 2012: Very similar to IRC 2009.

Permanent Truss Restraint | Bracing

- Guidelines for Permanent Restraint/Bracing per BCSI B3

B3 BCSI-B3 SUMMARY SHEET - PERMANENT RESTRAINT/BRACING OF CHORDS & WEB MEMBERS
 Truss Clear Span of 60' or greater may require complex permanent bracing. Please always consult a Registered Design Professional.

RESTRICIÓN/ARRIOSTRE PERMANENTE DE LAS CUERDAS Y LOS MIEMBROS SECUNDARIOS
 Trusses sobre 60 pies o más pueden requerir detalles permanentes complejos. Por favor, consulte siempre a un profesional registrado de diseño.

Permanent Truss Restraint / Bracing

Loads

- Dead
- Live
- Snow
- Wind
- Earthquake

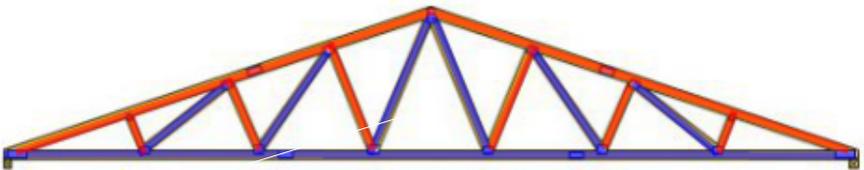
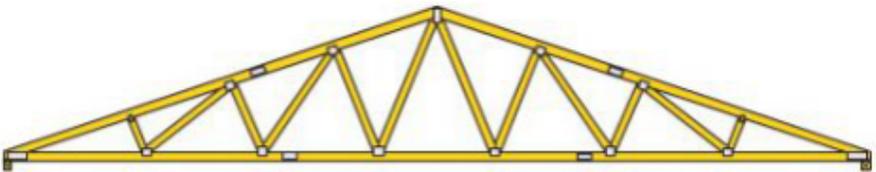
Common Load Combinations for Roof Trusses

- Dead + Live
- Dead + Snow
- Dead + 0.75(Live + Snow)
- 0.6(Dead) + Wind

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Permanent Truss Restraint / Bracing

Truss Stresses in Gravity Load Combination



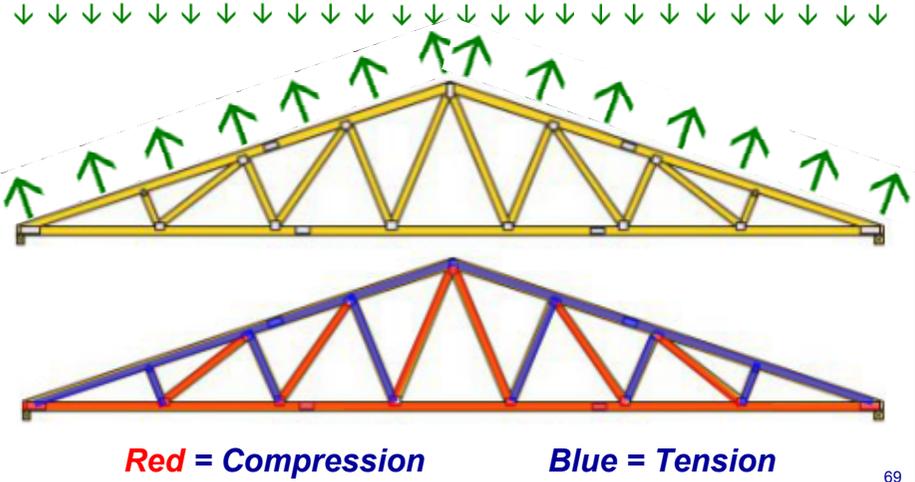
Red = Compression

Blue = Tension

68

Permanent Truss Restraint | Bracing

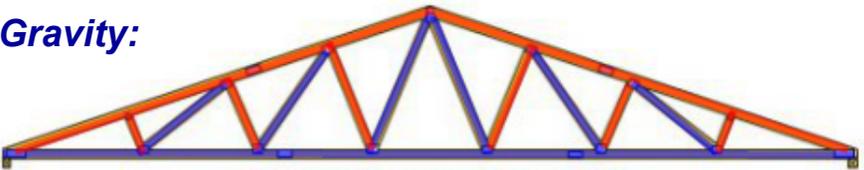
Truss Stresses in Wind Uplift Load Combination



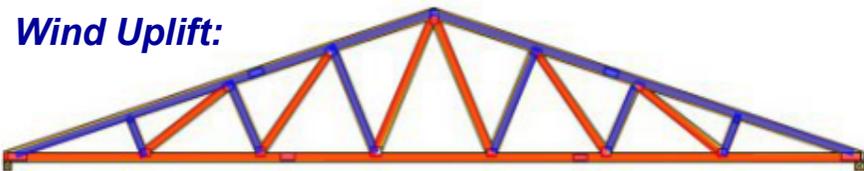
Permanent Truss Restraint | Bracing

Gravity vs. Wind Uplift Loading Conditions

Gravity:



Wind Uplift:

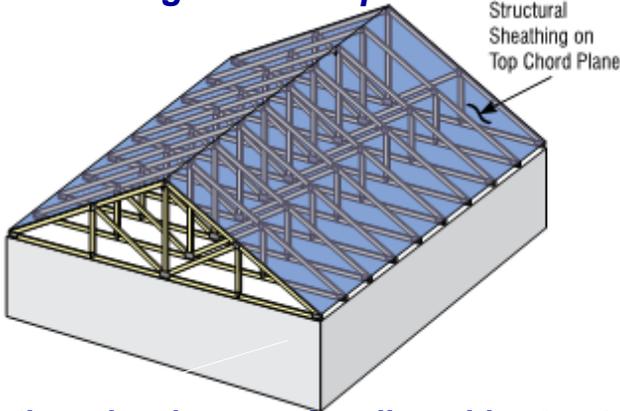


Red = Compression

Blue = Tension

Permanent Truss Restraint / Bracing Top Chord Lateral Restraint/Bracing

- Roof sheathing braces top chord of truss

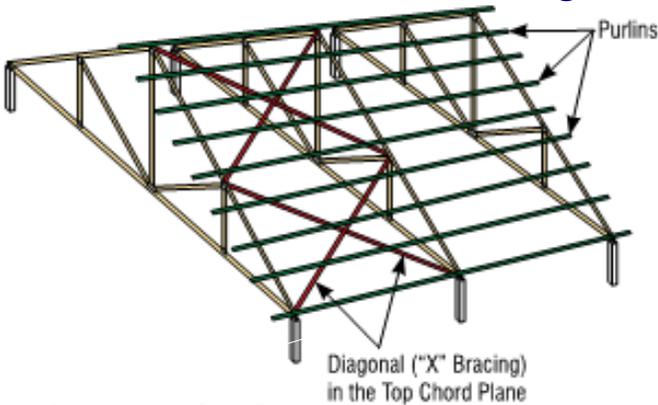


- Alternative: closely spaced purlins with structural sheathing

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Permanent Truss Restraint / Bracing Top Chord Lateral Restraint/Bracing

- Purlins without structural sheathing



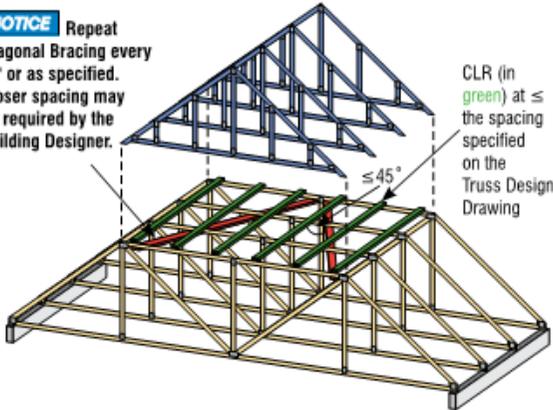
- X-bracing required

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Permanent Truss Restraint | Bracing Top Chord Lateral Restraint/Bracing

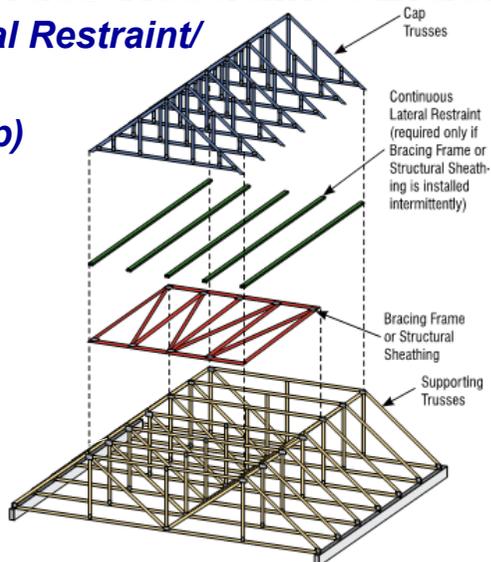
• Piggyback (Cap) Trusses

NOTICE Repeat Diagonal Bracing every 10' or as specified. Closer spacing may be required by the Building Designer.



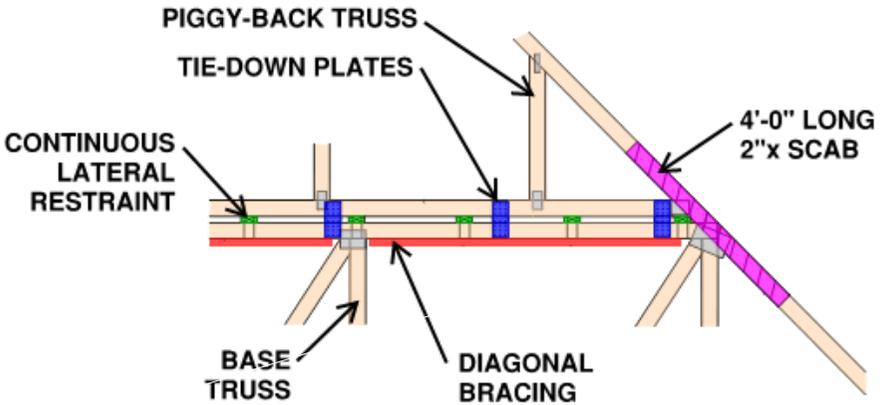
Permanent Truss Restraint | Bracing Top Chord Lateral Restraint/ Bracing

• Piggyback (Cap) Trusses



Permanent Truss Restraint | Bracing Top Chord Lateral Restraint/Bracing

- Piggyback (Cap) Trusses



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Permanent Truss Restraint | Bracing Top Chord Lateral Restraint/Bracing

- Piggyback (Cap) Trusses

**Diagonal
Bracing Is
Important!**

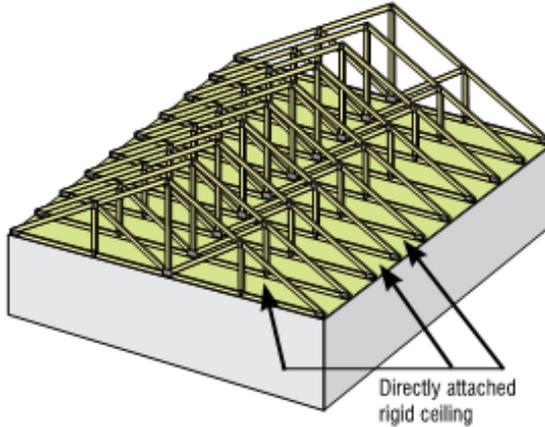


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Permanent Truss Restraint / Bracing

Bottom Chord Lateral Restraint/Bracing

- *Directly attached rigid ceiling*

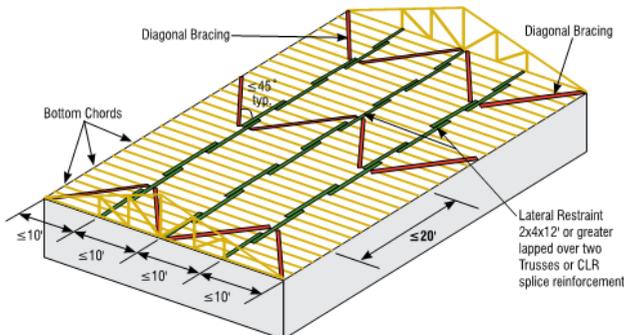


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Permanent Truss Restraint / Bracing

Bottom Chord Lateral Restraint/Bracing

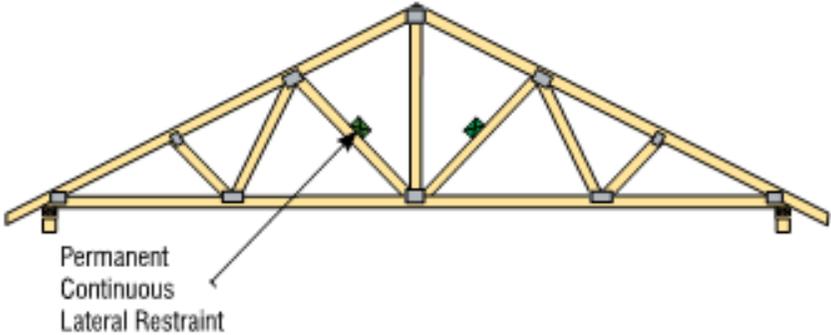
- *No directly attached rigid ceiling*



- *Requires continuous lateral restraint bracing and intermittent diagonal bracing.*
- *Lateral restraint spacing dependent upon wind uplift.*

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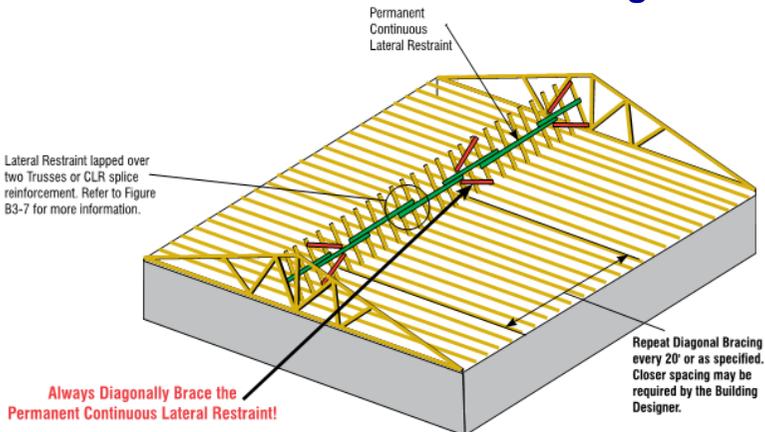
Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing



- Locations indicated in Truss Design Drawings

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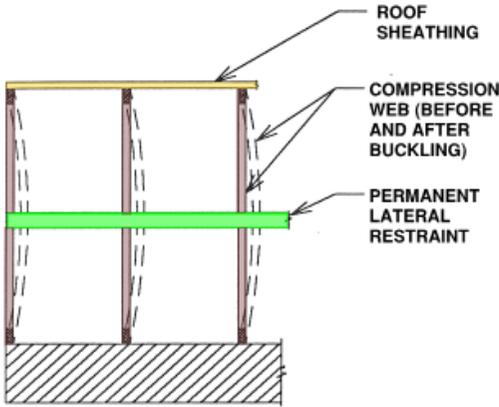
Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing



- Requires continuous lateral restraint bracing and intermittent diagonal bracing.

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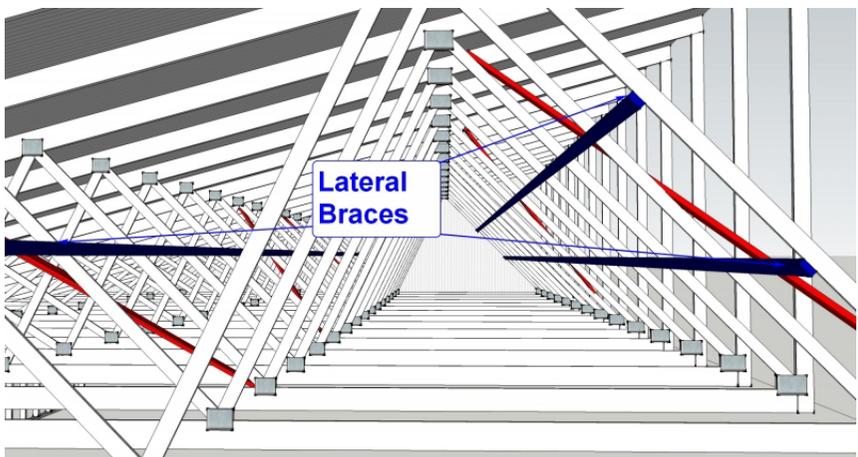
Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing



- Continuous lateral restraint alone will not prevent buckling of the compression web

81

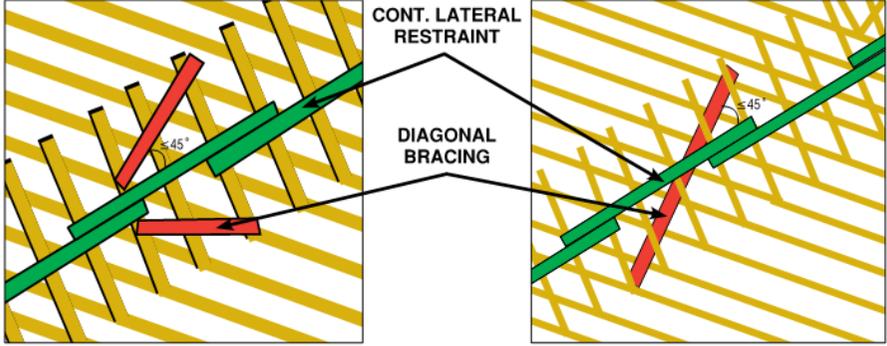
Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing



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Permanent Truss Restraint / Bracing

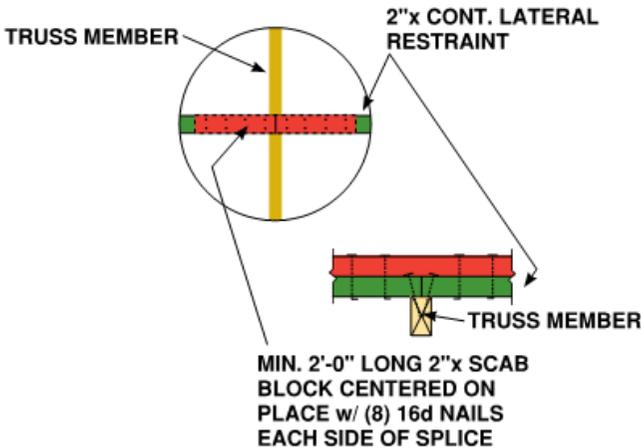
Web Member Lateral Restraint/Bracing



Permanent Truss Restraint / Bracing

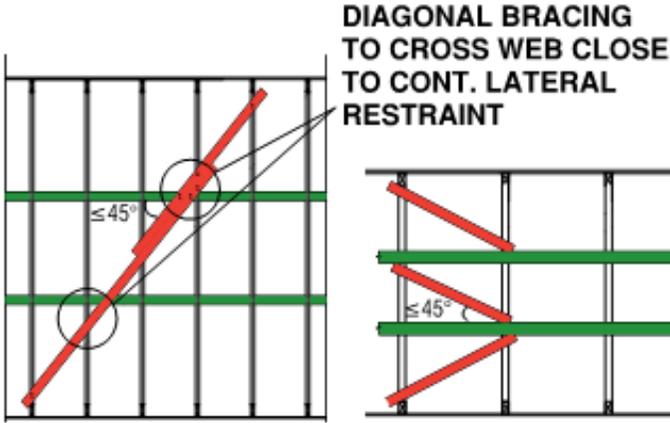
Web Member Lateral Restraint/Bracing

- Optional Splice for Continuous Lateral Restraint

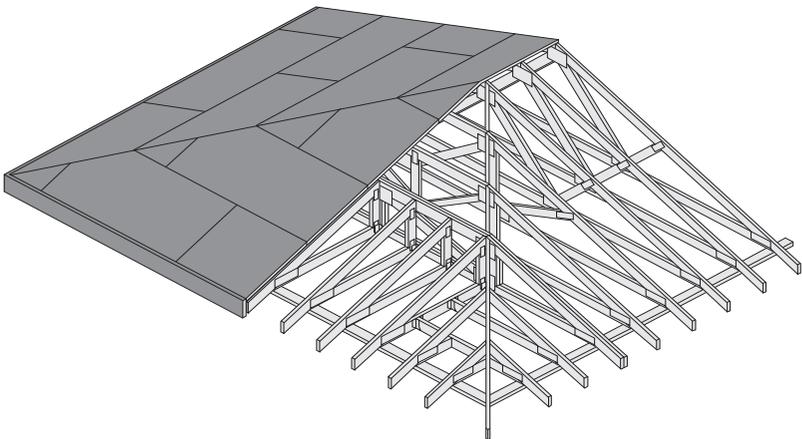


Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing

- Two rows of continuous lateral restraint



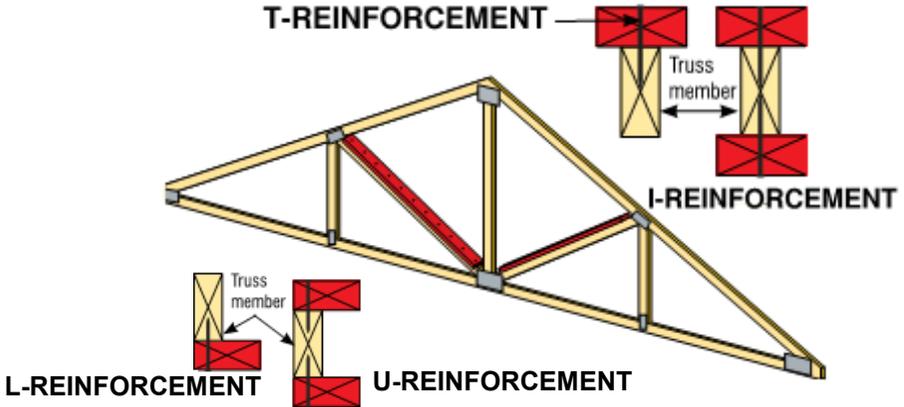
Permanent Truss Restraint | Bracing Web Member Lateral Restraint/Bracing



- Trusses step down at hip end – webs do not align

Permanent Truss Restraint / Bracing Web Member Lateral Restraint/Bracing

- Alternatives to continuous lateral restraint



- Individual web member reinforcement

Permanent Truss Restraint / Bracing Web Member Lateral Restraint/Bracing

- Alternatives to continuous lateral restraint

WEB REINFORCEMENT FOR SINGLE-PLY TRUSSES¹

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			

¹Maximum web length is 14'.

²Attach Scab Reinforcement to web with two rows of minimum 10d (0.120x3") nails at 6" on-center.

Permanent Truss Restraint / Bracing

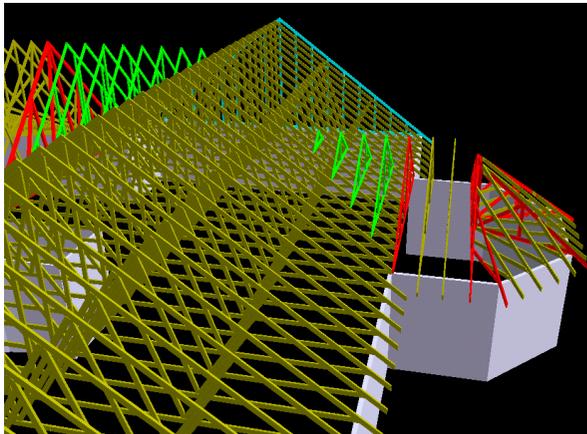
Special Inspections

- **Current State Building Code – Based on 2003 IBC**
 - **No Special Inspections Requirements for Permanent Restraint/Bracing**
- **Upcoming Building Code – Based on 2012 IBC**
 - **§1705.5.2 – “Where a truss clear span is 60 feet or greater, the special inspector shall verify that the permanent individual truss member restraint/bracing...are installed in accordance with the approved truss submittal package”**
 - **Connecticut reducing trigger from 60 feet to 30 feet.**

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Permanent Truss Bracing

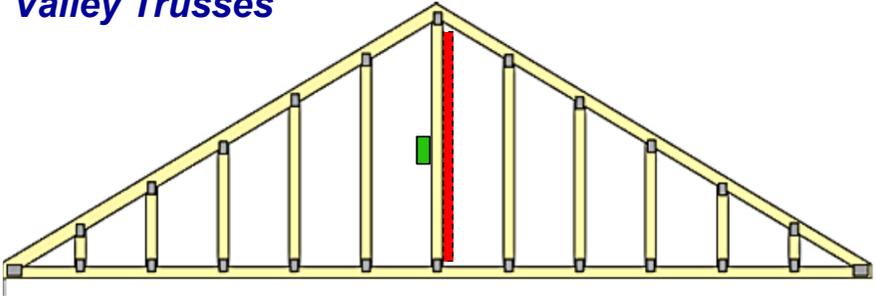
Valley Trusses



- **Common at roof intersections**

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Permanent Truss Bracing Valley Trusses

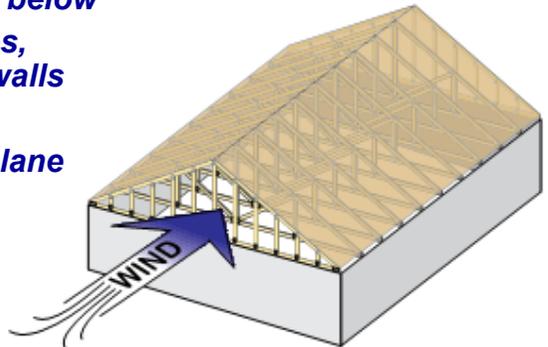
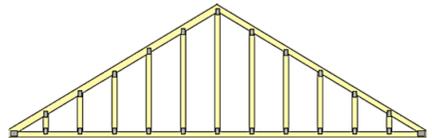


- Prefabricated stud walls of varying height
- Deliver loads to trusses below
- Must be anchored to resist uplift
- Taller studs may require permanent restraint/bracing similar to truss webs
- Also applicable at tall cap (piggy-back) trusses.

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Permanent Truss Bracing Gable End Trusses

- Prefabricated stud walls
- Deliver gravity loads and uplift loads to walls below
- Unlike valley trusses, located in exterior walls
- Must resist out-of-plane wind!

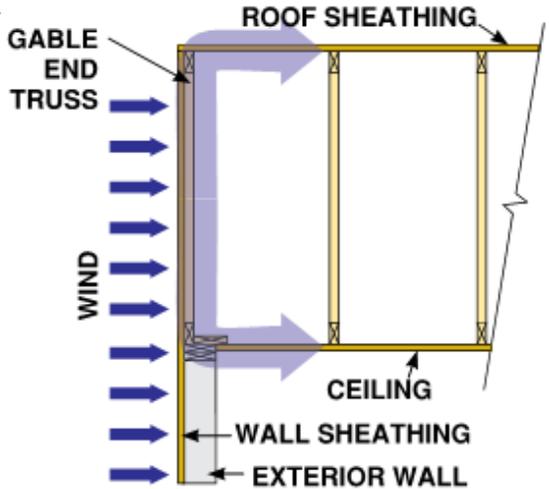


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Permanent Truss Bracing

Gable End Trusses

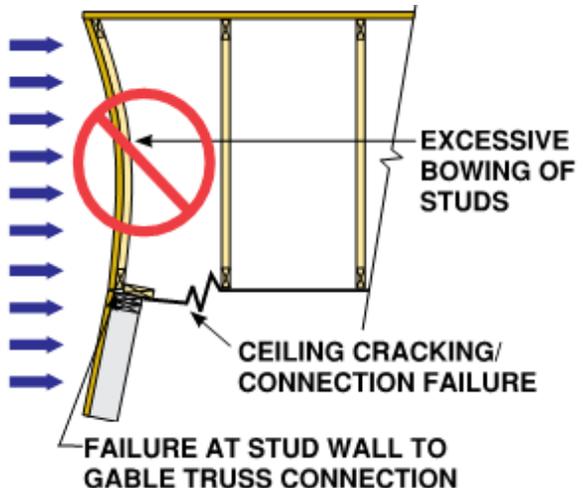
- Need to establish load path by which to transfer lateral wind loads (pressure or suction) from the exterior wall surface into the structure so that they can ultimately be delivered down to the foundation.



Permanent Truss Bracing

Gable End Trusses

- Potential Points of Failure



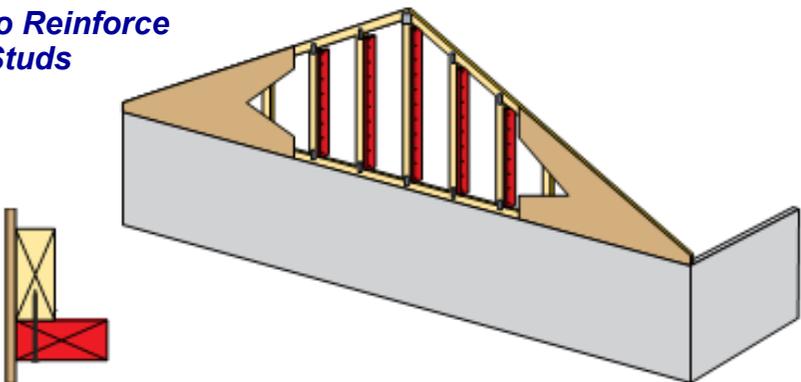
Permanent Truss Bracing Gable End Trusses



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Permanent Truss Bracing Gable End Trusses

- Add L-Braces to Reinforce Studs

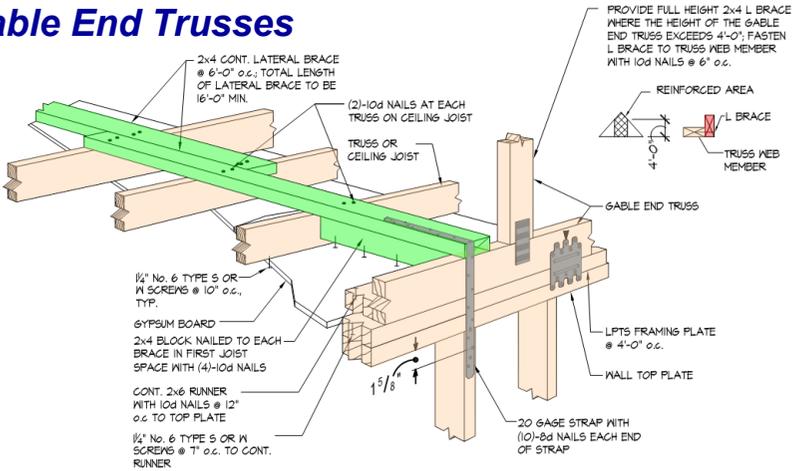


- Still need to transfer loads at ceiling elevation

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Permanent Truss Bracing

Gable End Trusses

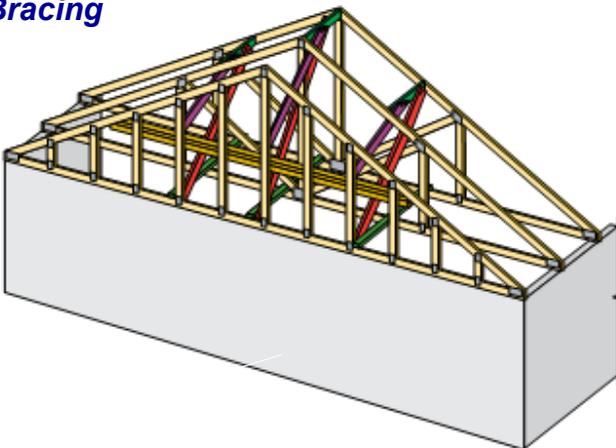


TYPICAL DETAIL OF CEILING BRACING AT GABLE END WALL TRUSS
NO SCALE

Permanent Truss Bracing

Gable End Trusses

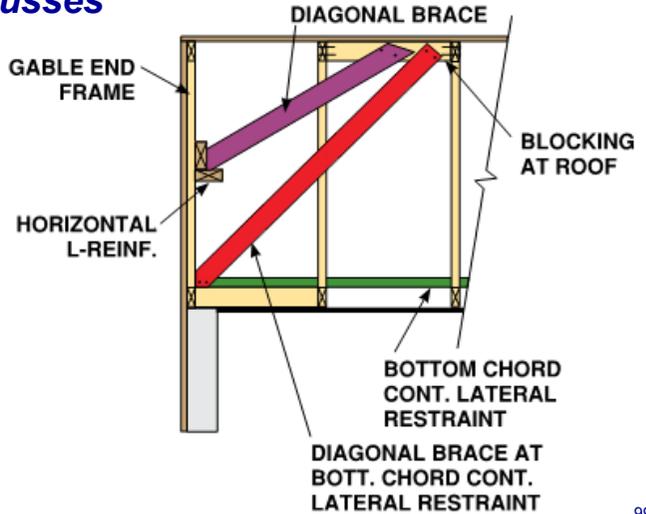
- Add Bracing



Permanent Truss Bracing

Gable End Trusses

- Add Bracing



Truss Repairs

- Damage During Handling/Storage



Truss Repairs

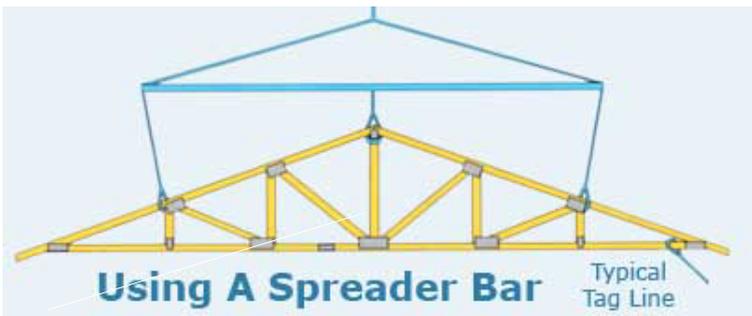
- Damage During Handling/Storage
- Damage During Erection



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Truss Repairs

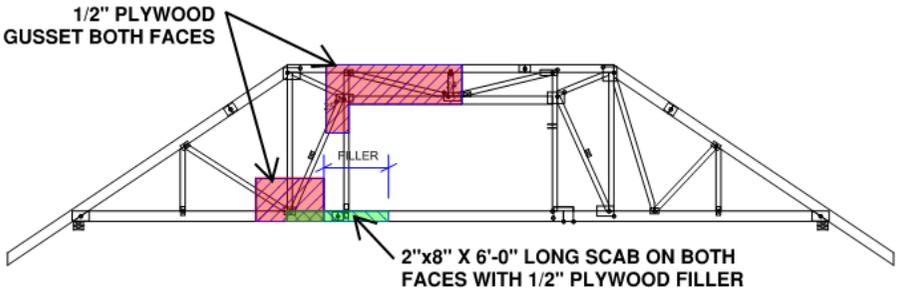
- Damage During Handling/Storage
- Damage During Erection



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Truss Repairs

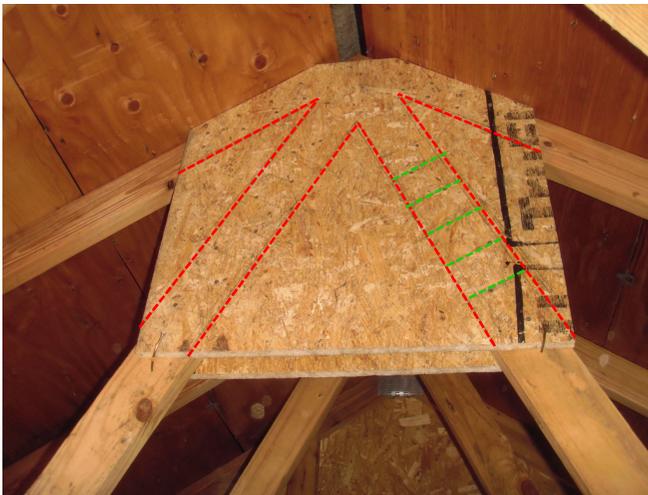
- Repairs often include the addition of wood structural sheathing (i.e. plywood or OSB) gussets, 2"x scabs or a combination thereof
- Strict adherence to fastening requirements are essential.



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Truss Repairs

- Plywood Gusset Repair



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Acknowledgements



Truss Plate Institute



Tim LaChapelle, P.E.

RELIABLE TRUSS

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Appendix "A"

Sample Truss Design Drawing

Job 3456C	Truss T15	Truss Type COMMON	Qty 12	Ply 1	CT OEDM PRESENTATION
---------------------	---------------------	-----------------------------	------------------	-----------------	-----------------------------

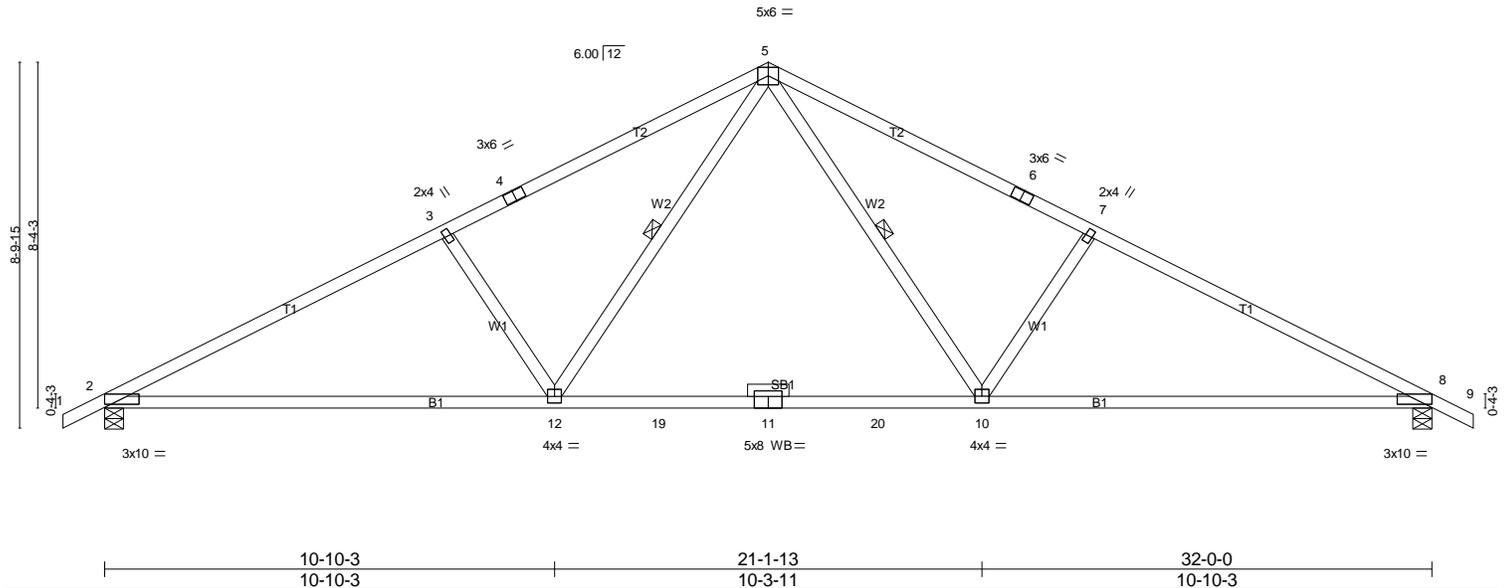
Reliable Truss Co., New Bedford, MA 02745, Tim LaChapelle

7.610 s Jan 29 2015 MiTek Industries, Inc. Tue Feb 24 09:13:25 2015 Page 1

ID:ZECf_SwZ0Fwhb?zkAt4DQZzi_rc-NWpTr941MJ9fidchZ_S7GAbTNSJgCi1LdhUVmzi_Pu

1-0-0	8-3-4	16-0-0	23-8-12	32-0-0	33-0-0
1-0-0	8-3-4	7-8-12	7-8-12	8-3-4	1-0-0

Scale = 1:55.3



10-10-3	21-1-13	32-0-0
10-10-3	10-3-11	10-10-3

Plate Offsets (X,Y)-- [2:0-10-0,0-0-14], [8:0-10-0,0-0-14]	
LOADING (psf)	SPACING- 2-0-0
TCLL 30.0	Plate Grip DOL 1.15
TCDL 10.0	Lumber DOL 1.15
BCLL 0.0 *	Rep Stress Incr YES
BCDL 10.0	Code IRC2009/TPI2007
CSI.	DEFL. in (loc) l/defl L/d
TC 0.91	Vert(LL) -0.65 10-12 >592 240
BC 0.94	Vert(TL) -0.98 10-12 >391 180
WB 0.34	Horz(TL) 0.12 8 n/a n/a
(Matrix-M)	
PLATES	GRIP
MT20	197/144
Weight: 113 lb	FT = 20%

LUMBER-	BRACING-
TOP CHORD 2x4 SPF 1650F 1.5E	TOP CHORD Structural wood sheathing directly applied.
BOT CHORD 2x4 SPF 1650F 1.5E	BOT CHORD Rigid ceiling directly applied or 2-2-0 oc bracing.
WEBS 2x4 SPF No.2	WEBS 1 Row at midpt 5-12, 5-10
OTHERS 2x4 SPF No.2	

REACTIONS. (lb/size) 2=1786/0-5-8 (min. 0-2-13), 8=1786/0-5-8 (min. 0-2-13)
 Max Horz 2=183(LC 7)
 Max Uplift 2=574(LC 8), 8=574(LC 8)

FORCES. (lb) - Max. Comp./Max. Ten. - All forces 250 (lb) or less except when shown.
 TOP CHORD 2-3=2996/1928, 3-4=2658/1795, 4-5=2506/1832, 5-6=2506/1832, 6-7=2658/1794, 7-8=2996/1928
 BOT CHORD 2-12=2322/2562, 12-19=832/1706, 11-19=832/1706, 11-20=832/1706, 10-20=832/1706,
 8-10=2322/2562
 WEBS 3-12=612/391, 5-12=800/1014, 5-10=800/1014, 7-10=612/391

- NOTES-**
- Unbalanced roof live loads have been considered for this design.
 - Wind: ASCE 7-05; 110mph; TCCL=6.0psf; BCCL=6.0psf; h=25ft; B=48ft; L=32ft; eave=4ft; Cat. II; Exp B; enclosed; MWFRS (all heights) and C-C Exterior(2) zone; cantilever left and right exposed; end vertical left and right exposed; porch left and right exposed; C-C for members and forces & MWFRS for reactions shown; Lumber DOL=1.60 plate grip DOL=1.60
 - The solid section of the plate is required to be placed over the splice line at joint(s) 11.
 - Plate(s) at joint(s) 11 checked for a plus or minus 3 degree rotation about its center.
 - This truss has been designed for a 10.0 psf bottom chord live load nonconcurrent with any other live loads.
 - * This truss has been designed for a live load of 20.0psf on the bottom chord in all areas where a rectangle 3-6-0 tall by 2-0-0 wide will fit between the bottom chord and any other members, with BCCL = 10.0psf.
 - All bearings are assumed to be User Defined crushing capacity of 425 psi.
 - Provide mechanical connection (by others) of truss to bearing plate capable of withstanding 574 lb uplift at joint 2 and 574 lb uplift at joint 8.
 - This truss is designed in accordance with the 2009 International Residential Code sections R502.11.1 and R802.10.2 and referenced standard ANSI/TPI 1.
 - "Semi-rigid pitchbreaks including heels" Member end fixity model was used in the analysis and design of this truss.

LOAD CASE(S) Standard