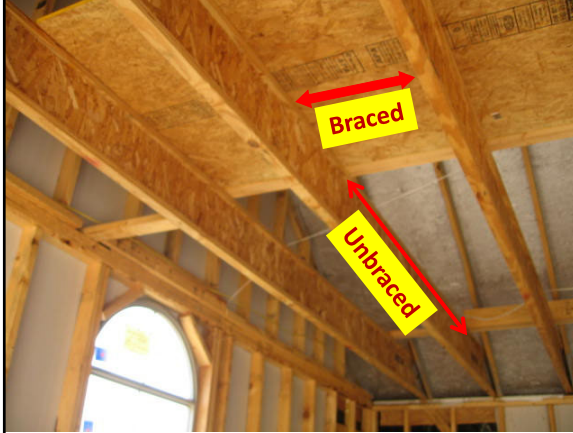


Beam/Header Bracing/Restraint Guidelines

Boise Cascade Engineered Wood Products Webinar



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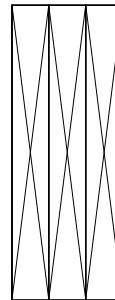
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What Does Beam, Header, Joist Bracing Do?

- ◆ Bracing prevents top or bottom edges from moving laterally to the member's length.
- ◆ For most applications, the top edge is the critical edge.

Top Bracing

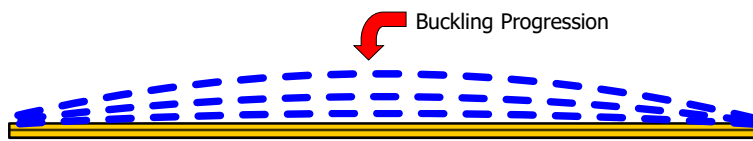


Bottom Bracing



Simple Beam and Column Buckling Progression

- Recognition of beam buckling can be hard to see due to slow time progression of release of fasteners and any framing materials that may try and resist rotational movement at the top or combination of top and bottom.
- Recognition of column buckling is more visible and fast due to more distortion out of plane
- As the out of plane buckling gets larger the amount of resistance to prevent buckling gets larger and the time to failure will be greater.

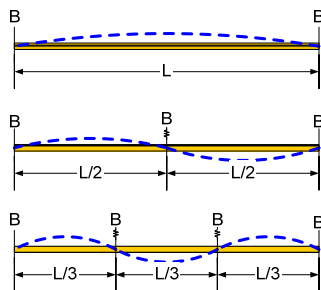


**Simple Span Beam and Column Buckling
(Beam Top View and Column Side View)**

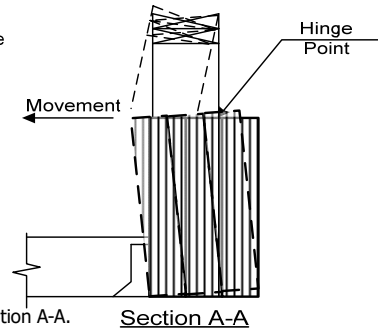


Simple Span Buckling Modes

Simple Span Beam Buckling (Top View)



Term Definitions
 - - - - - Deflected Shape
 B = Brace Location
 L = Brace Length
 n = Brace Sections
 P = Axial Load



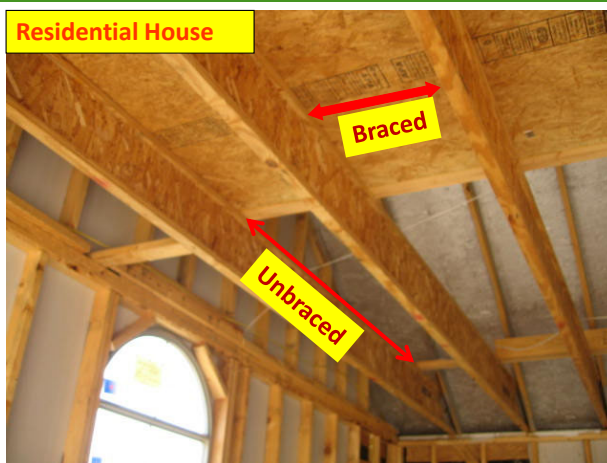
- Bending members such as beams will twist as shown in section A-A.
- Buckling mode is "U" shape for brace each end.
- Buckling mode is "S" shape for multiple braces if stiff.
- Bracing acts like springs with stiffness depending on brace material.



Buckled Floor Joists - "S" Shape



Ceiling Joist – Partially Braced

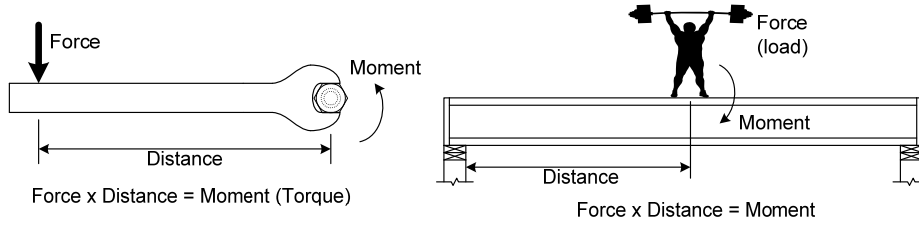


- ◆ Partial sheathing does not provide adequate lateral support.
- ◆ Joist being used as tension tie for roof rafters.
- ◆ Potential unbraced gable endwall framing as well.



Moment

$$\text{Moment} = \text{Force} \times \text{Distance}$$



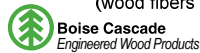
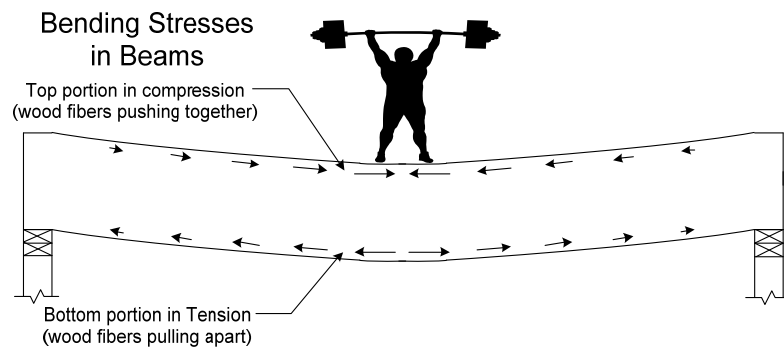
Controls Summary	Value	% Allowable
Pos. Moment	31473 ft-lbs	67.4%
End Shear	5898 lbs	49.3%
Total Load Deflection	L/388 (0.543")	61.9%



Moment

Single Span

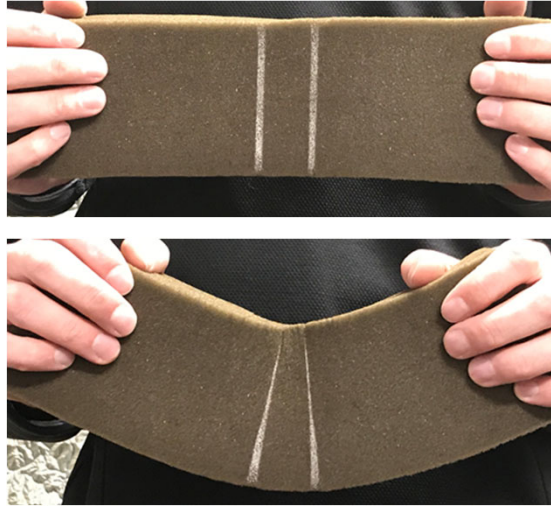
- Top in compression
- Bottom in tension



Moment

Single Span

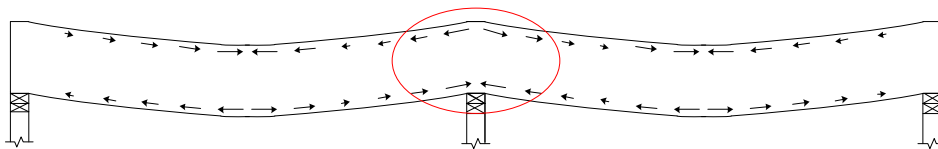
- Top in compression
- Bottom in tension



Moment

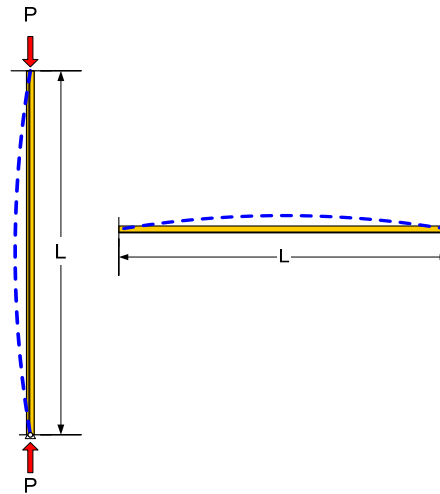
Multiple Spans

- Stress reversal at interior supports
- Top in tension, bottom in compression

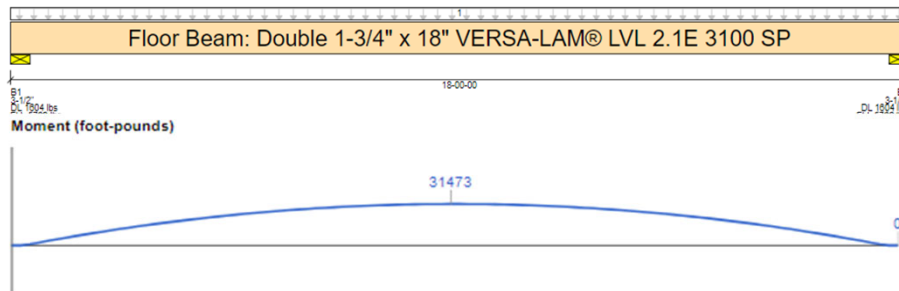


Moment

- ◆ Compression: Laterally Unstable
 - Buckling like a post
 - Bracing required on compression edges to maintain bending capacity
- ◆ Tension: Laterally Stable



Moment – Single Span

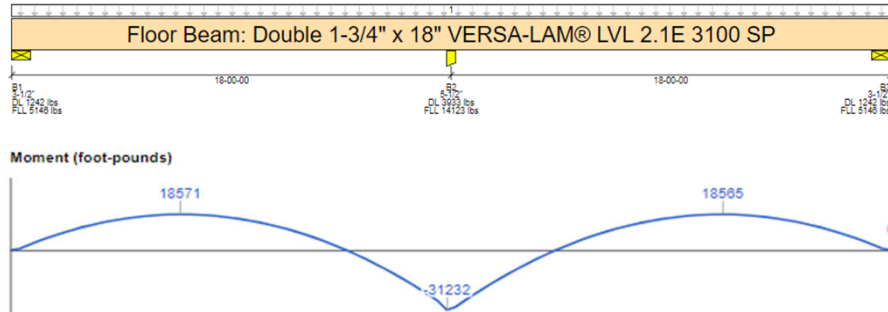


Controls Summary	Value
Pos. Moment	31473 ft-lbs
End Shear	5898 lbs
Total Load Deflection	L/388 (0.543")

- Unstable on top edge
- Stable on bottom edge



Moment – Multiple Spans



Controls Summary	Value
Pos. Moment	23488 ft-lbs
Neg. Moment	-31232 ft-lbs
End Shear	4922 lbs
Cont. Shear	7613 lbs

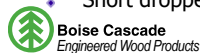
➤ Unstable (compression) on top edge at mid-spans and bottom edge at interior supports



Unbraced Dropped Header



- Short dropped double headers 4 feet or less with no plate generally not a problem.
- Short dropped double headers 8 feet or less with plate generally not a problem.



Column Buckling – “U” Shape



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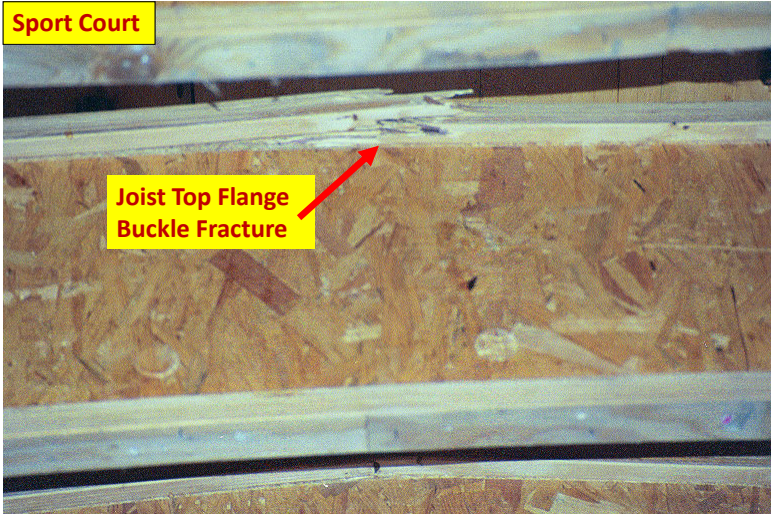
Buckled Roof Joists – “S” Shape



- Sport court ceiling joists supporting low sloped rafters above via vertical supports to bracing on top of joists. Joists are braced on top flange by framing 8’ to 10’ o.c.
- Approximately 42 ceiling joists buckled and fractured on top flange as shown.
- Danger of collapse before extensive fix high due to condition and pending large snow storm.

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Buckled Roof Joist – Top Flange Fracture



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Collapse - Beam and Column Bracing?

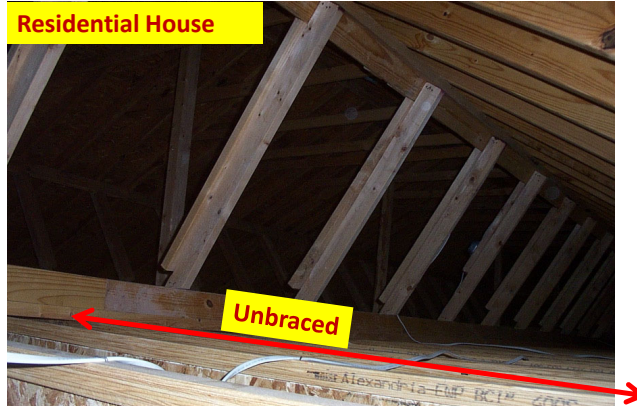


- Horse barn building collapse with posts not embedded in ground and continuous beam over top of posts with staggered butt joints as well. Roof truss construction.
- Appears to be overall building design stability issue with components.

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Unbraced Ceiling Joist

Residential House

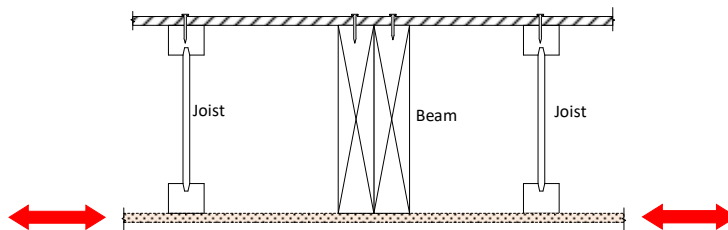


- Ceiling joist with strong back braces/plates at kickers from rafter roof.
- Fix: Additional braces had to be added and joist checked for tension forces as well.



Bracing Examples

Top Edge:
Braced when sheathing extends over and is fastened to all members
Unbraced without sheathing



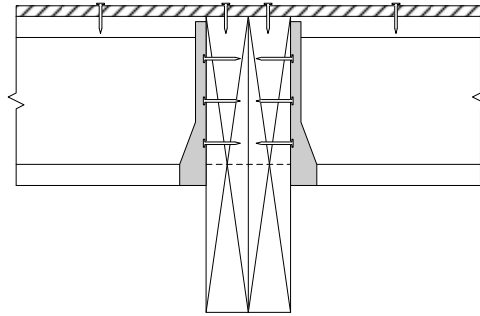
Bottom Edge:
Unbraced without sheathing/gypsum board
Braced when sheathing extends over and is fastened to all members

- Perpendicular framing attached to top of beam laterally braces/restrains top of beam. Spacing of perpendicular framing determines allowable strength of support member below.



Bracing Examples

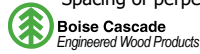
Top Edge:
Braced with or without sheathing



Bottom Edge: **Unbraced**



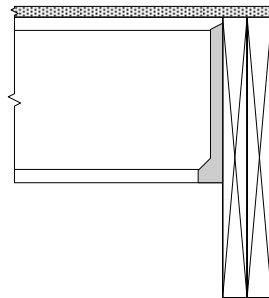
- Perpendicular framing attached to top of beam laterally braces/restrains top of beam. Spacing of perpendicular framing determines allowable strength of support member below.



Boise Cascade
Engineered Wood Products

Bracing Examples

Top Edge:
Without sheathing (unbraced)
When sheathing extends over and is fastened to member (braced)

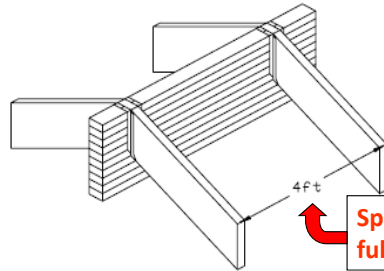


Bottom Edge: **Unbraced**



Boise Cascade
Engineered Wood Products

Partially Braced Member Conditions Possible



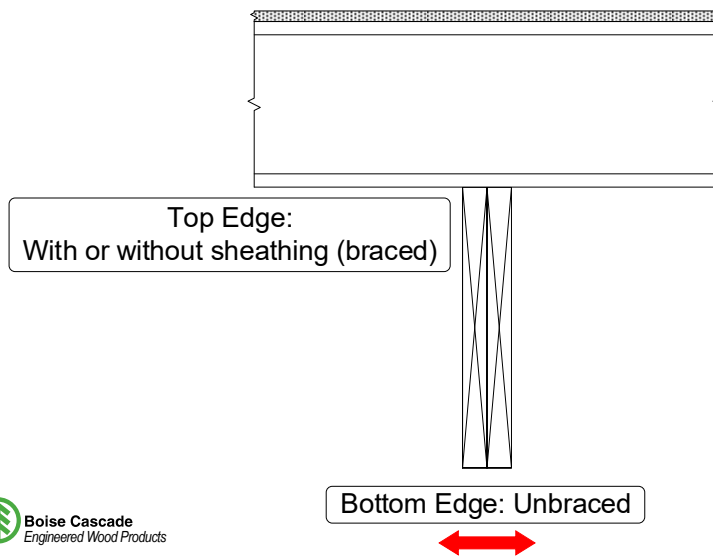
Spacing's of 2 ft. or less are fully braced on top side

- Sheathing attached to top of beam and rafters fully laterally braces/restrains top of beam.
- Hangers are not generally designed for pulling loads parallel to member being supported so cannot be considered as providing adequate lateral support.
- Perpendicular framing attached to top or both sides of beam laterally braces/restrains top of beam. Spacing of and depth of perpendicular framing determines allowable strength of beam.
- Bottom side of beam shall be considered unbraced when no framing is attached to bottom side.



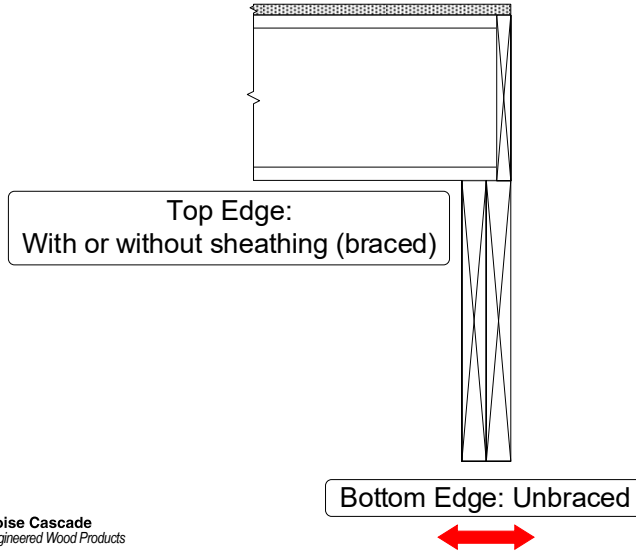
Boise Cascade
Engineered Wood Products

Bracing Examples

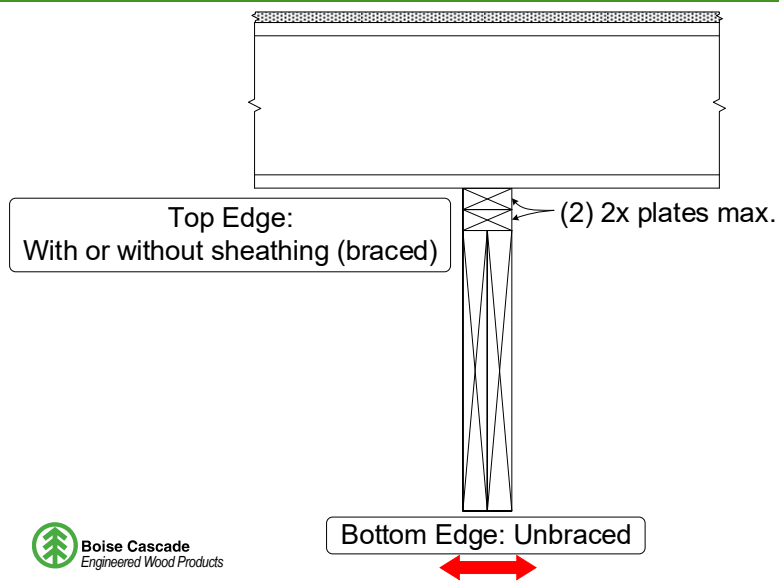


Boise Cascade
Engineered Wood Products

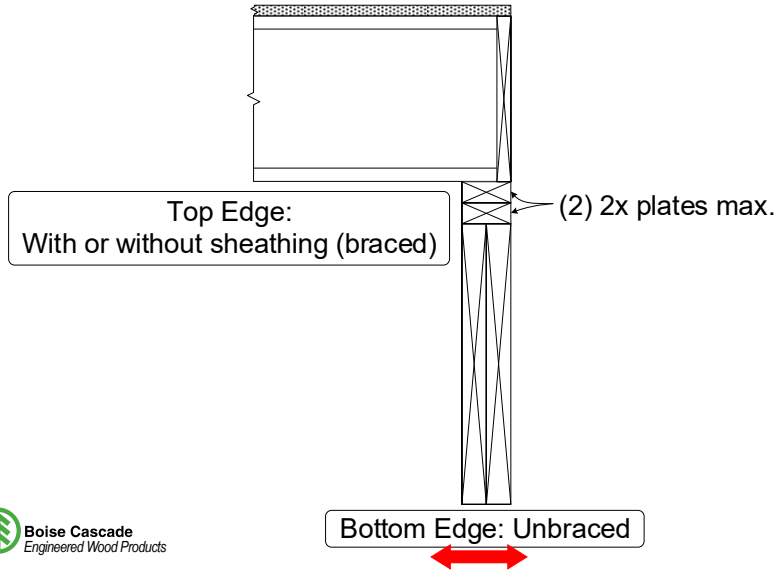
Bracing Examples



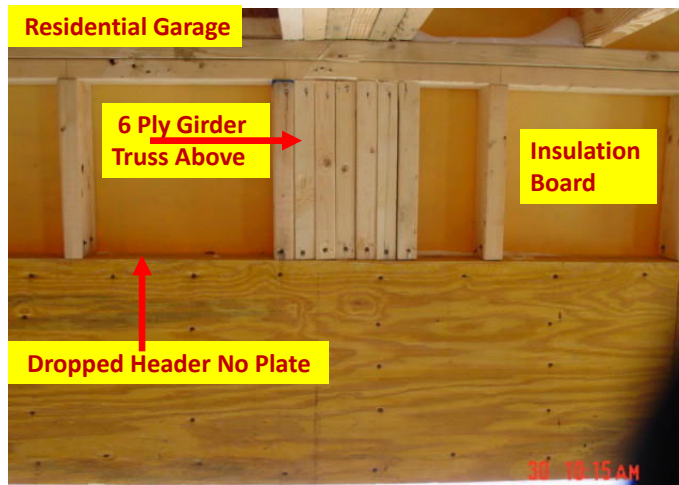
Bracing Examples



Bracing Examples



Dropped Beam Bracing Condition - Garage



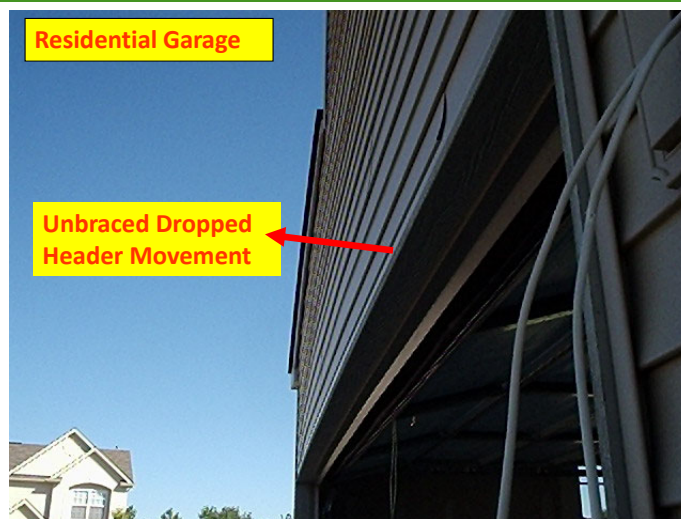
* Fix: Beam moved to bottom of top plate with false header below.

Dropped Beam Bracing Condition 1 - Garage



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Unbraced Dropped Header 2 – No Plate



 **Boise Cascade**
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Unbraced Dropped Header 2 – No Plate

Residential Garage



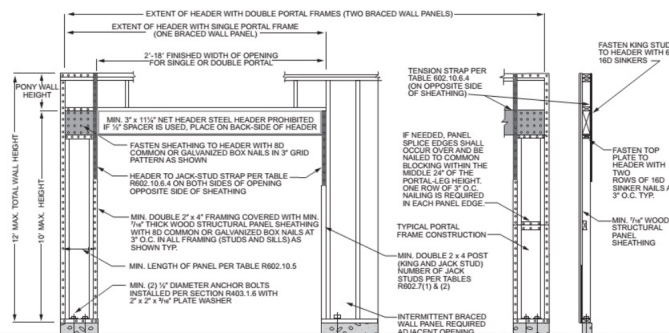
No Header Plate
Header Movement



IRC-2018 Method PFG Portal Frame

R602.10.6.3 Method PFG: Portal frame at garage door openings in Seismic Design Categories A, B and C.

Where supporting a roof or one story and a roof, a Method PFG braced wall panel constructed in accordance with Figure R602.10.6.3 shall be permitted on either side of garage door openings.

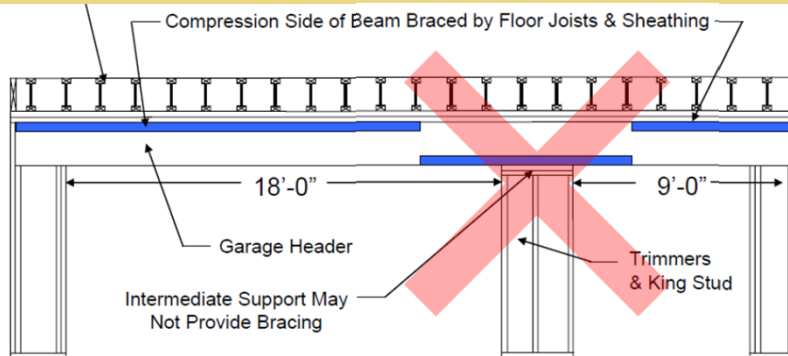


- Detail is for simple span beams only
- Detail is intended to show single portal frame and double portal frame on same detail
- Single portal frame has common wall and beam is not to extend over common wall



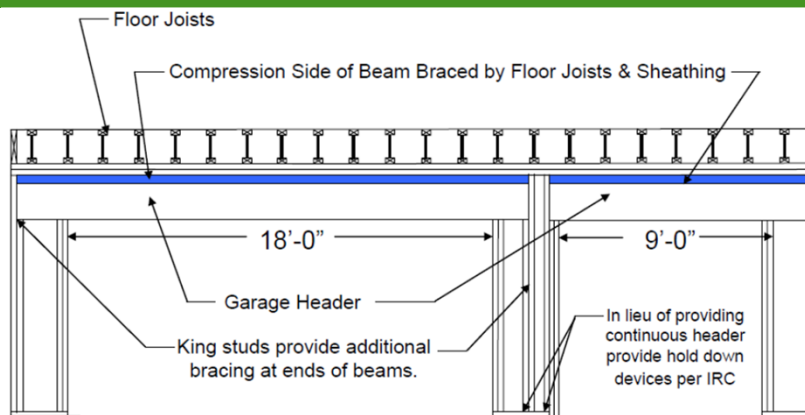
Continuous IRC Portal Header ?

- The portal frame methods in the IRC were not tested for a condition with a header continuous over a center panel, between two openings. If a home is designed by a licensed engineer in this manner, it can be assumed that this condition has been properly analyzed and is structurally sound. The designer should also take into consideration the increased buckling risk of a continuous header that spans multiple garage openings, particularly at intermediate walls or columns that are not sufficiently laterally braced.
- For a home designed according to the prescriptive methods of the IRC, the header must not run continuous over the center support if it is to be in compliance with the code.



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Multiple IRC Garage Door Portal Frames



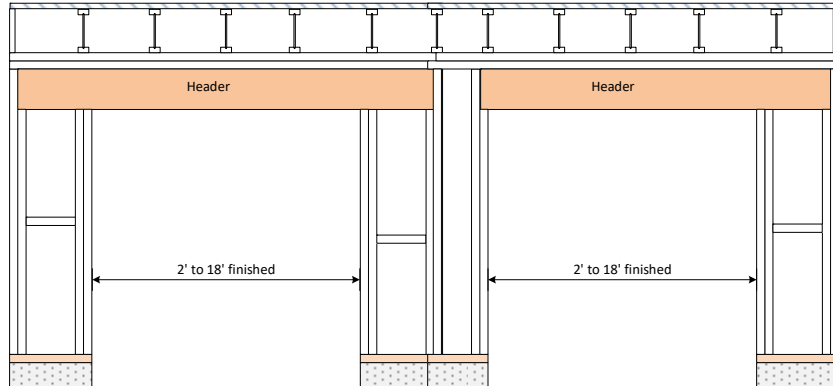
- Single and double portal frames can be used together to frame numerous openings, such as garage doors or windows in sunrooms and still comply with IRC wall bracing requirements as noted in Chapter 6, section R602.
- False headers below beam can also be used to finish framing opening.

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Double and Single Portal Frame Combined

- Must follow the specific portal frame method(s) specified by the building designer for the proper installation details. Details are not shown here.

Perpendicular framing braces top plate and top of beam



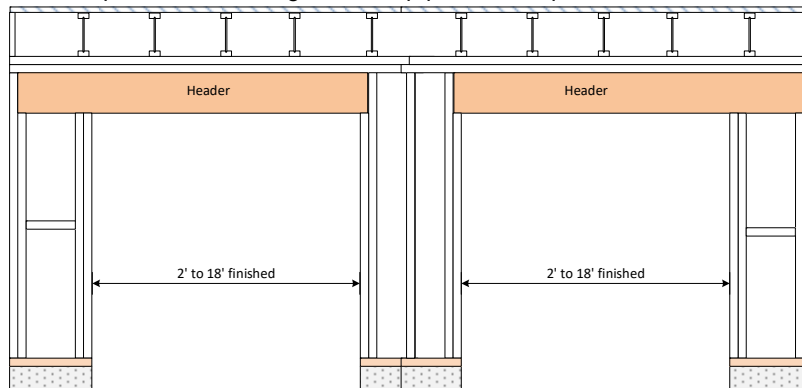
- Beam is braced on top edge when tight to bottom of top plate



Two Single Portal Frames Combined

- Must follow the specific portal frame method(s) specified by the building designer for the proper installation details. Details are not shown here.

Perpendicular framing braces top plate and top of beam



- Beam is braced on top edge when tight to bottom of top plate



WIJMA Dropped Header Guide



WOOD JOIST MANUFACTURERS ASSOCIATION

Dropped Header Design Guide

Consideration of the stability of deep beams is important to ensure proper product application. Typically, designers assume that perpendicularly framed roof or floor systems provide bracing to prevent beam buckling. However, in many parts of the country, framing practices call for "dropping" a header below the roof or floor framing and then building a short wall between the header and top plate. **Figure 1** shows a typical example of this practice – a garage door header. If beam buckling is not considered in the design of a "dropped" header, a performance problem can occur.

Review of "dropped" header applications has been conducted under uniform load, single span conditions. Based on this evaluation, the following recommendations have been developed for engineered lumber products.

In addition, provisions in this guide are based on downward uniform vertical loads only and do not account for additional effects due to lateral loads; such as, wind or seismic. The building designer is responsible for accounting for any design effects due to lateral loads.



Boise Cascade
Engineered Wood Products

WIJMA Dropped Header Guide

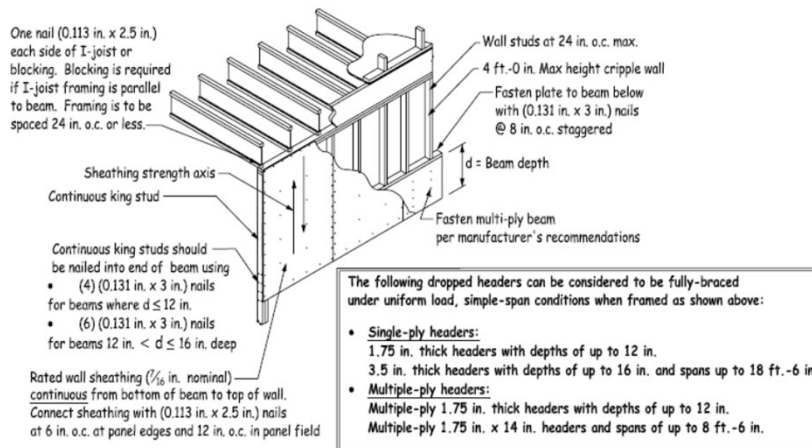


Figure 2: Dropped Header Applications That May Be Considered Fully-Braced



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WIJMA Dropped Header Guide

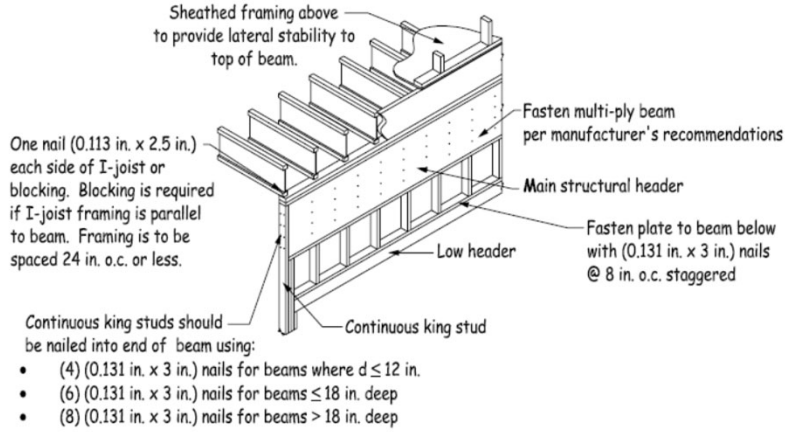
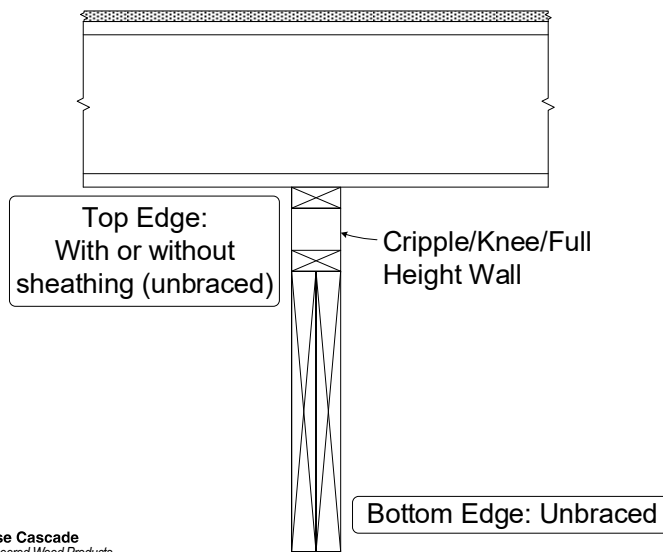


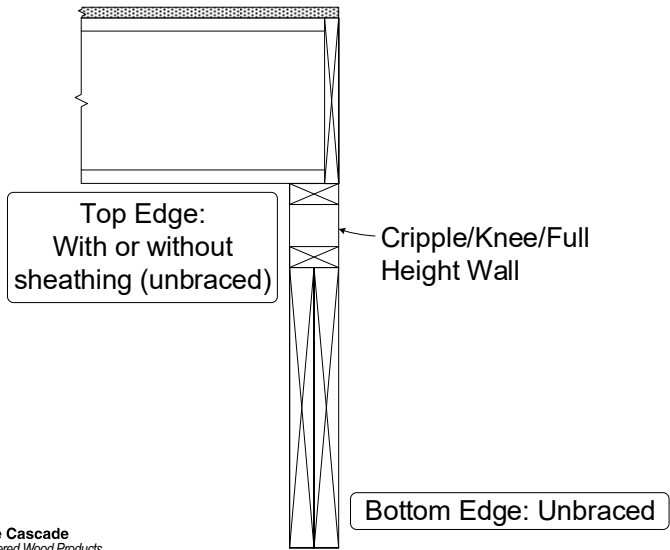
Figure 3: Fully-Braced Alternative to Dropped Header Applications



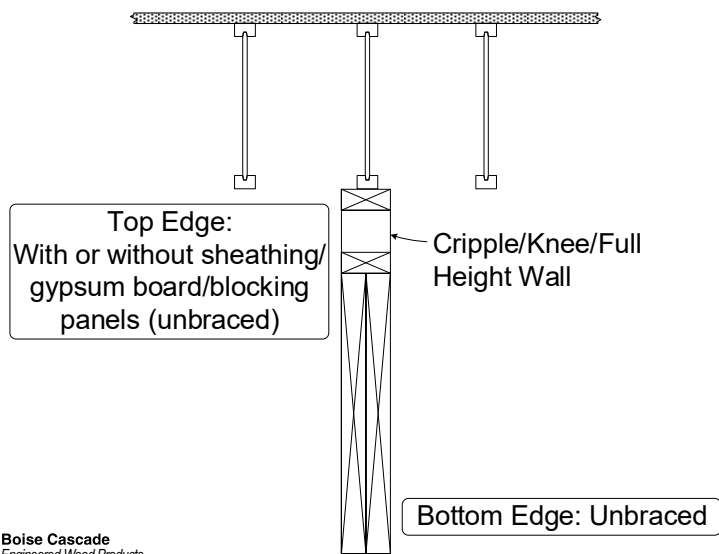
Bracing Examples



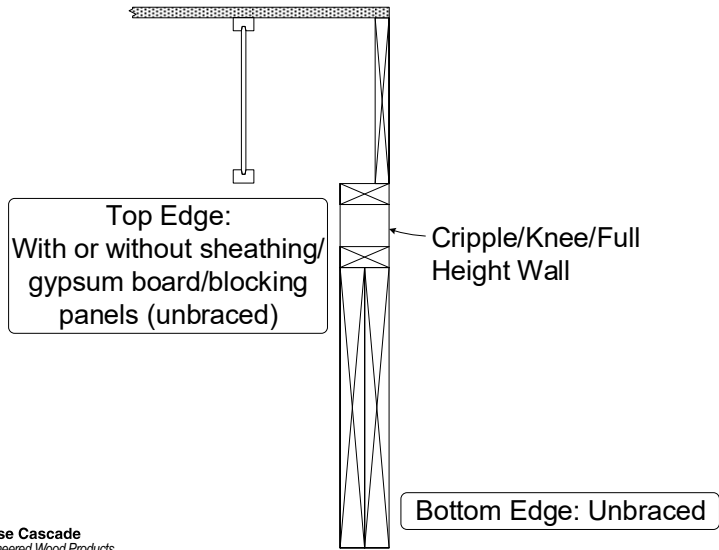
Bracing Examples



Bracing Examples

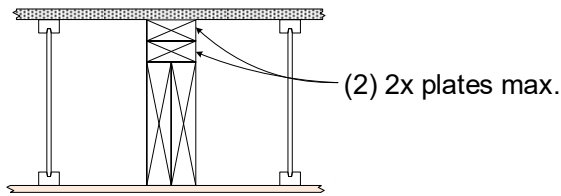


Bracing Examples



Bracing Examples

Top Edge:
Without sheathing (unbraced)
When sheathing extends over and is fastened to member (braced)

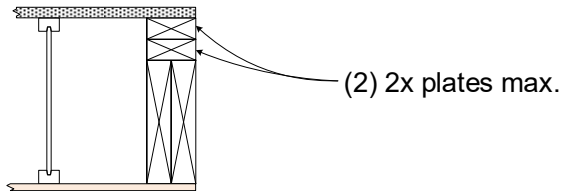


Bottom Edge:
Without gypsum board (unbraced)
When gypsum board extends over and is fastened to member (braced)



Bracing Examples

Top Edge:
Without sheathing (unbraced)
When sheathing extends over and is fastened to member (braced)



Bottom Edge:
Without gypsum board (unbraced)
When gypsum board extends over and is fastened to member (braced)



O.C. Spacing of Bracing

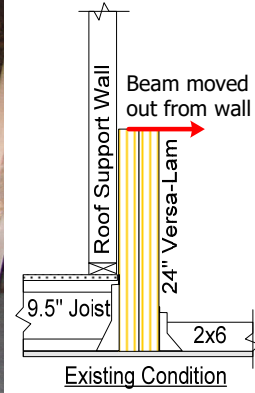
- ◆ Gypsum Board Ceiling/Sheathing
 - Member continuously braced for section installed.
- ◆ Framing Members
 - $\leq 24''$ o.c. - continuously braced.
 - $> 24''$ o.c. – use on-center spacing



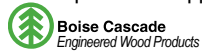
Raised Beam Bracing Condition



Residential House



- ◆ Multi-span double 24" Versa-Lam 42' long beam. Top side fully unbraced for full length.
- ◆ Multiple other support and building design issues.



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Raised Beam Bracing Condition



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24" Deep Unbraced Beam – Stack Wall



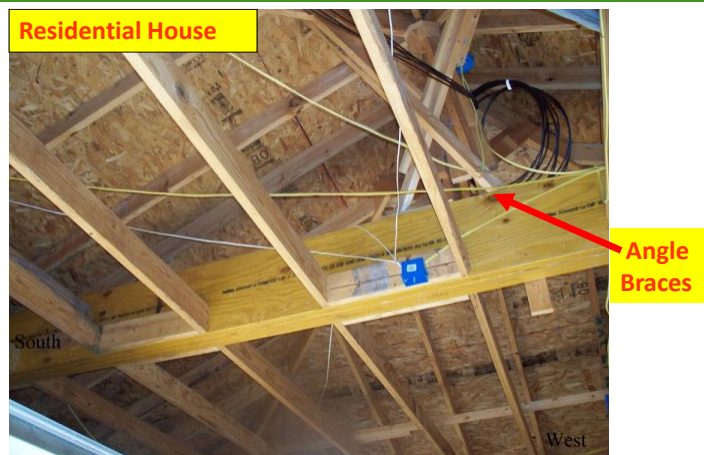
- 24" deep Versa-Lam with mono trusses attached to bottom side of beam on one side with knee wall on top of beam with additional trusses on top of knee wall.
- Beam buckled out during construction at top of beam to open area shown.
- Temp framing shown below beam to support framing above.



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- Fix: Extensive repair not shown but did not force removal of beam or trusses.

Deep Beam Maybe Braced at Midpoint and Ends



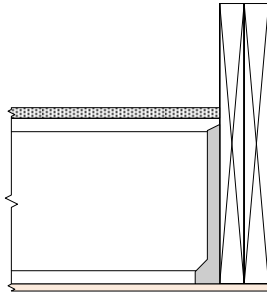
- Top side fully unbraced for full length



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Bracing Examples

Top Edge: Unbraced

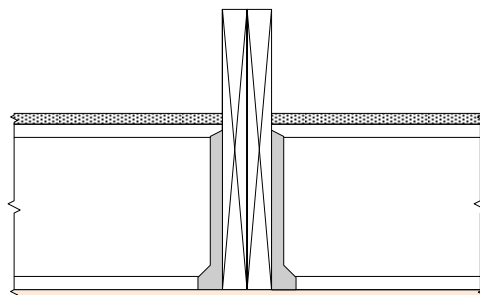


Bottom Edge:
Without gypsum board (unbraced)
When gypsum board extends over and is fastened to member (braced)



Bracing Examples

Top Edge: Unbraced

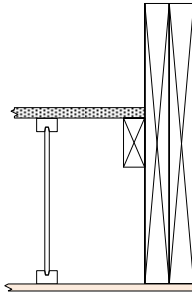


Bottom Edge:
With or without gypsum board (braced)



Bracing Examples

Top Edge:
With or without sheathing (unbraced)

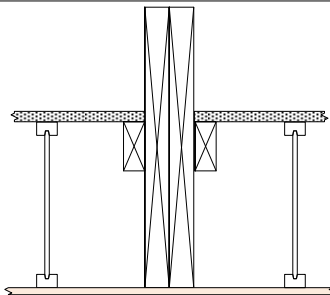


Bottom Edge:
Without gypsum board (unbraced)
When gypsum board extends over and is fastened to member (braced)



Bracing Examples

Top Edge:
With or without sheathing (unbraced)

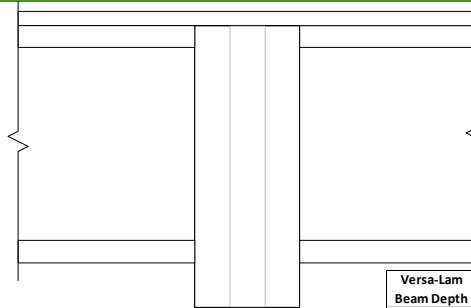


Bottom Edge:
Without gypsum board (unbraced)
When gypsum board extends over and is fastened to member (braced)



Fully Braced – Beam/Joist Depth

Top Flush



Versa-Lam beam bottom edge considered braced for multiple span beams for the following BCI/AJS joist depths (or similar depth lumber joists):

Versa-Lam Beam Depth [in]	Min. AJS/BCI Joist Depth [in]
11.25	9.5
11.875	9.5
14	11.875
16	14
18	14
20	16
24	20

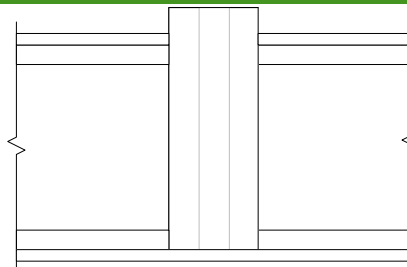
Additional Requirements for Continuously Braced in BC Framing & BC Calc:

- Perpendicular framing on both sides of beam, 2' o.c. or less.
- Sheathing attached to top of beam and framing.
- Joist hangers are full height of joists.
- Multiple ply Versa-Lam beams are connected properly.
- Beam is braced properly at ends with bracing of required depth shown.



Fully Braced – Beam/Joist Depth

Bottom Flush



Versa-Lam beam top edge considered braced for the following BCI/AJS joist depths (and similar lumber joists), and notes below:

Versa-Lam Beam Depth [in]	Min. AJS/BCI Joist Depth [in]
11.25	9.5
11.875	9.5
14	11.875
16	14
18	14
20	16
24	20

Additional Requirements for Continuously Braced in BC Framing & BC Calc:

- Perpendicular framing on both sides of beam, 2' o.c. or less, flush to bottom of joists.
- Direct attached ceiling.
- Joist hangers are full height of joists.
- Multiple ply Versa-Lam beams are connected properly.
- Beam is braced properly at ends with bracing of required depth shown.
- Blocking may be required between joists at beam side's per governing code and/or design professional of record.



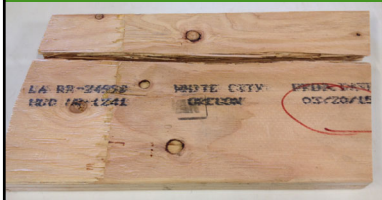
For Beams with Top Edge Raised Above Framing

IRC-2018 Section R602:

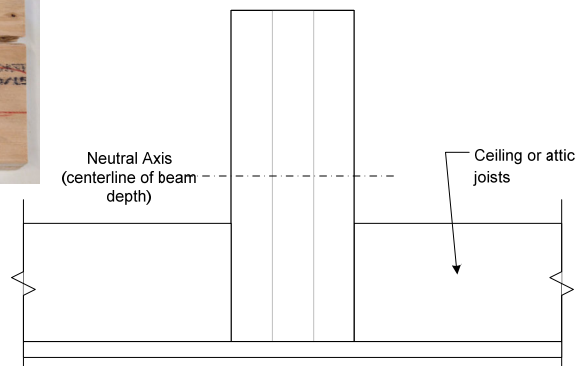
h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.



Bottom Flush – Below Center



Wood relatively weak in tension perpendicular to grain



Design Issues:

- 1) Top edge of beam is unbraced, needs to be designed accordingly.
- 2) Only "light" loads may be applied fully below neutral axis (centerline of beam depth). "Light" loads, though not defined in the building code, are ceiling and attic joist framing.
- 3) Concentrated loads (from other beams, girders, etc.) shall be applied to beam top edge or centered above neutral axis on side to limit cross-grain tension.

Crawl Space Unstable Temporary Beam and Pier



 **Boise Cascade**
Engineered Wood Products

Buckled Beam and Unbraced Lally Column Bearing

Commercial Project

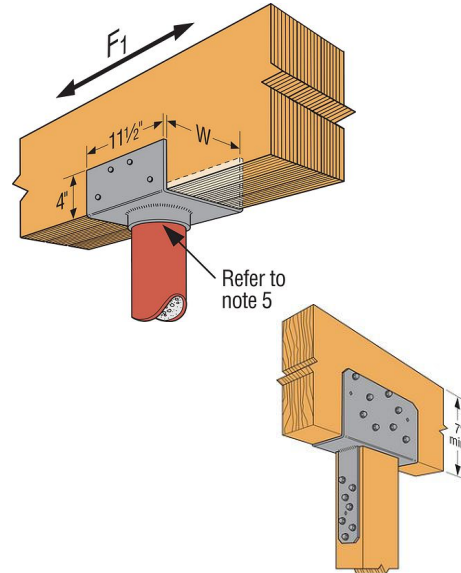


- No resistance at lally column bearing support to prevent lateral sidesway movement.

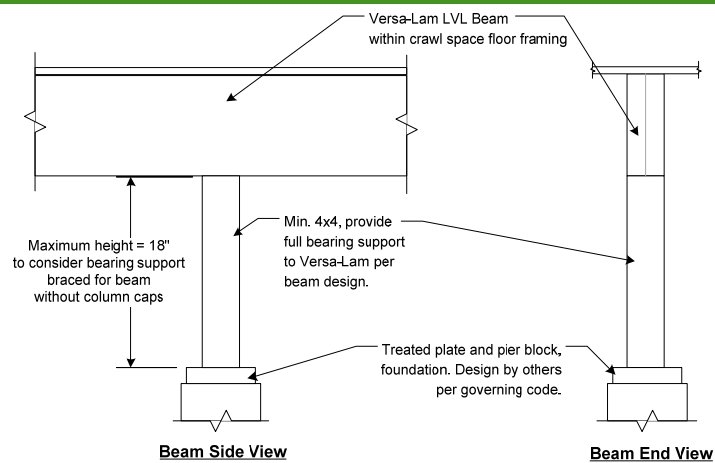
 **Boise Cascade**
Engineered Wood Products

Post Supports

Use of column caps provides adequate bracing at beam support, for bottom edge



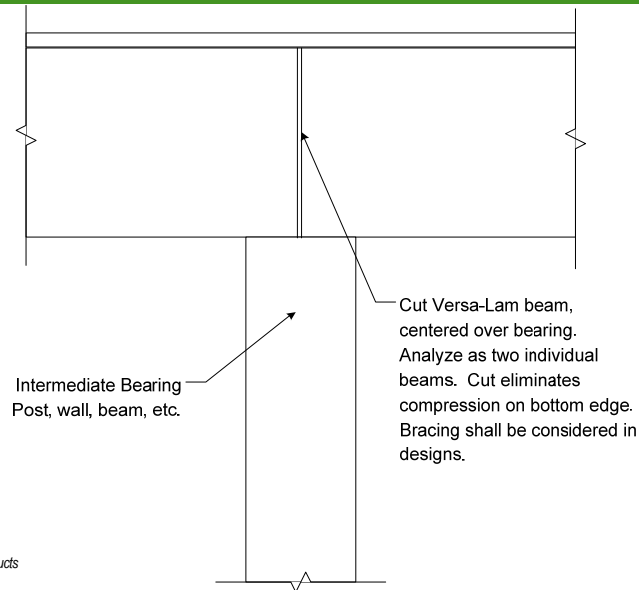
Pier Post Supports – Crawl Space



- Notes:
- 1) Detail intended to floor framing above crawl space only.
 - 2) Typical pier construction would allow for selection of "Braced at Supports" setting in BC Frammer and BC Calc software.
 - 3) Ultimately, it is the responsibility of the building designer of record to ensure that the pier foundation and the connection between the pier foundation and any Versa-Lam LVL beam is adequate to restrain the Versa-Lam LVL Beam.



Cutting Beam over Interior Bearing



New to IRC-2018 Residential Code

IRC-2018 Section R602: Girder and Header Span Reduction When Unbraced

- Spans are given in feet and inches.
- Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine, and spruce-pine-fir.
- Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
- NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.
- Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (for example, cripple studs bearing on the header), tabulated spans for headers consisting of 2 × 8, 2 × 10, or 2 × 12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.



Document References & Wrap Up

- ◆ Go to <http://i-joist.org/policies-publications> to download Dropped Header Design Guide.
- ◆ Go to <http://www.awc.org/pdf/tr14.pdf> to download Technical Report 14 Designing For Lateral-Torsional Stability in Wood Members.
- ◆ Go to <http://www.bc.com/wood/ewp/guides-resources/guides.html> under Guides and Resources to download our product guides and technical notes. Find on list GE-16 bracing technical note.
- ◆ Links below are for viewing 30 minute video on portal frames
- ◆ <https://www.apawood.org/portal-frames-made-right>
- ◆ <https://www.youtube.com/watch?v=dZZC7-FW3-I&feature=youtu.be>

Thank You for Attending This Webinar

Questions?

