Introduction to floor, wall, & roof framing

A course for the novice building inspector (DES170)

Matt Hunter, CBO, BCO
Mid-Atlantic Regional Manager
American Wood Council

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mhunter@awc.org

AMERICAN WOOD COUNCIL

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COURSE DESCRIPTION-NYS DOS APPLICABILITY

This introductory course will focus on basic framing concepts, engineering principles supporting them, and relevant code provisions associated with repetitive, light-frame wood floor, wall, and roof assemblies. Common code violations that will be encountered in the field, along with potential solutions will be illustrated to assist novice inspectors with ensuring building safety and conformance with the International Residential Code (IRC) or applicable state building codes such as the 2020 Residential Code of New York State.

LEARNING OBJECTIVES

Upon completion, participants will be better able to identify:

1

Wood theory & Common Framing Practice

Wood science, strengths & grades of wood. Recognize common industry practice associated with erecting repetitive light-frame solid sawn roof, wall, & roof assemblies and a brief introduction to some common Engineered Wood Products (EWP's).

2

Load Paths in Repetitive Light-Frame

Recognize the multitude of load paths and the critical nature of transmitting these forces safely to the foundation and supporting sub-grade.

3

Wood Framed Assemblies

Understand how wood framed assemblies and geometry work to resist these applied loads and comply with the model codes.

4

Routine Code Violations

Be able to recognize problematic or otherwise non-code compliant framing areas that are routinely identified in repetitive, light frame wood construction.

STRENGTH, RESILIENCY, & DURABILITY

Giant Sequoia-2,500 years old

Photo courtesy of Flickr

Stave Church c. 1150 AD Norway

Photo courtesy of Google

The Horyu-ji temple, Japan, c. 607 AD

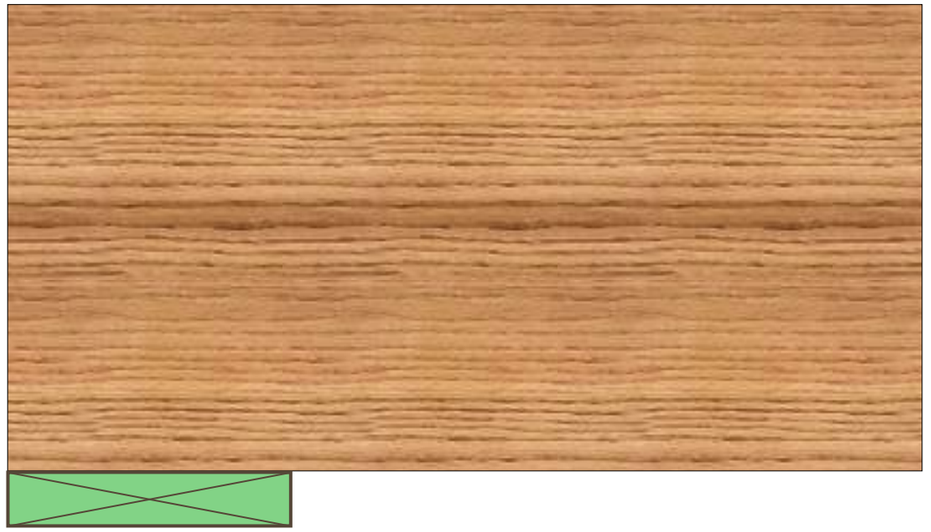
BASIC WOOD CONCEPTS-STRENGTHS

- Wood cells are like tightly bundled tubes glued together with lignin
- Bundle is very strong parallel to axis of the tubes (or grain)

Parallel

Strongest

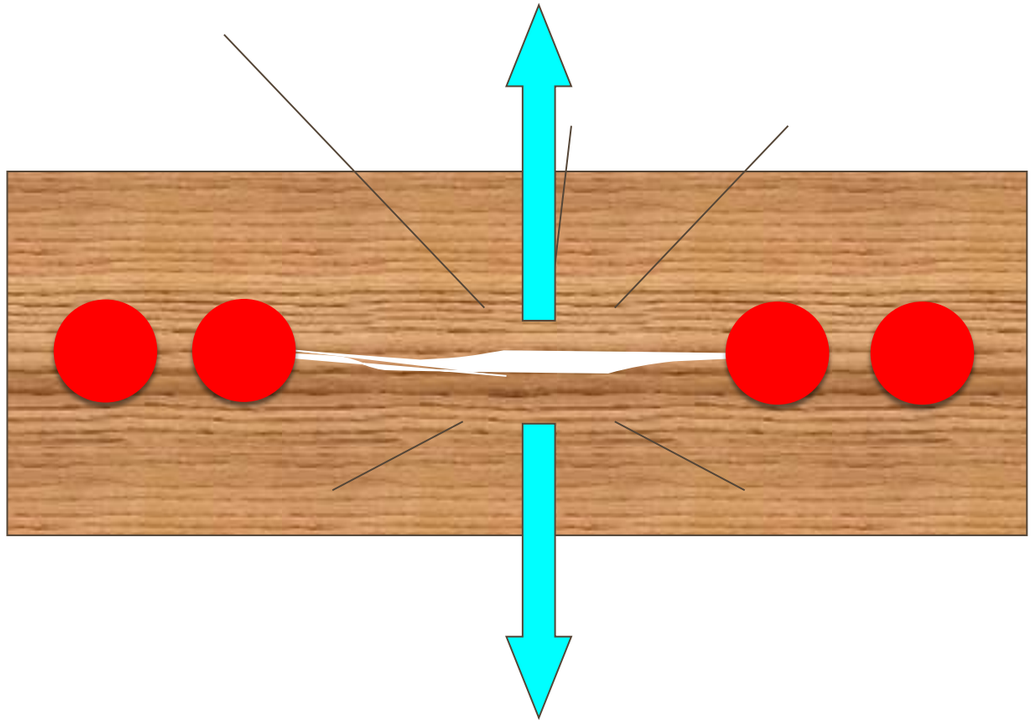
Perpendicular



Less strong

BASIC WOOD CONCEPTS-ISSUE

Suspended heavy loads <u>below the neutral axis are not permitted</u>

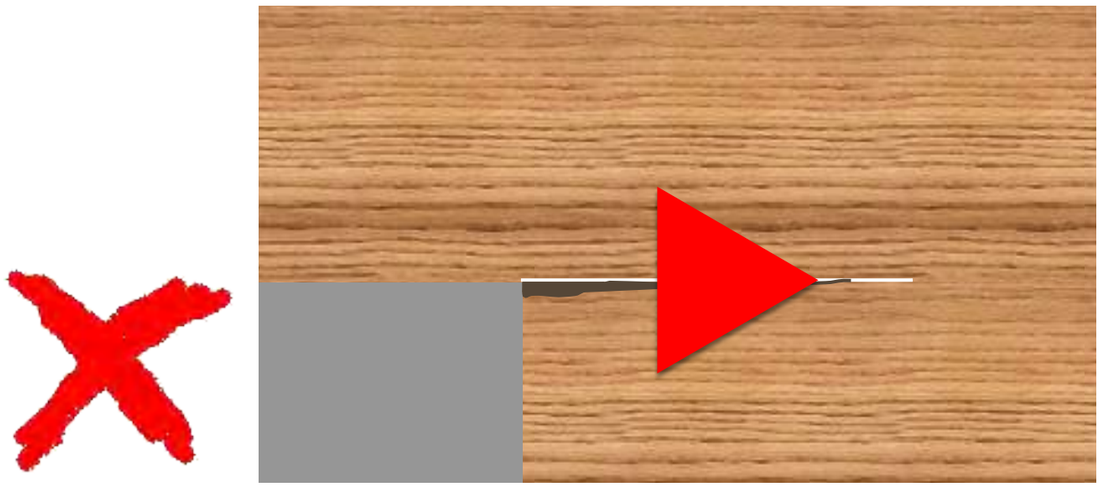


<u>Initiators:</u>

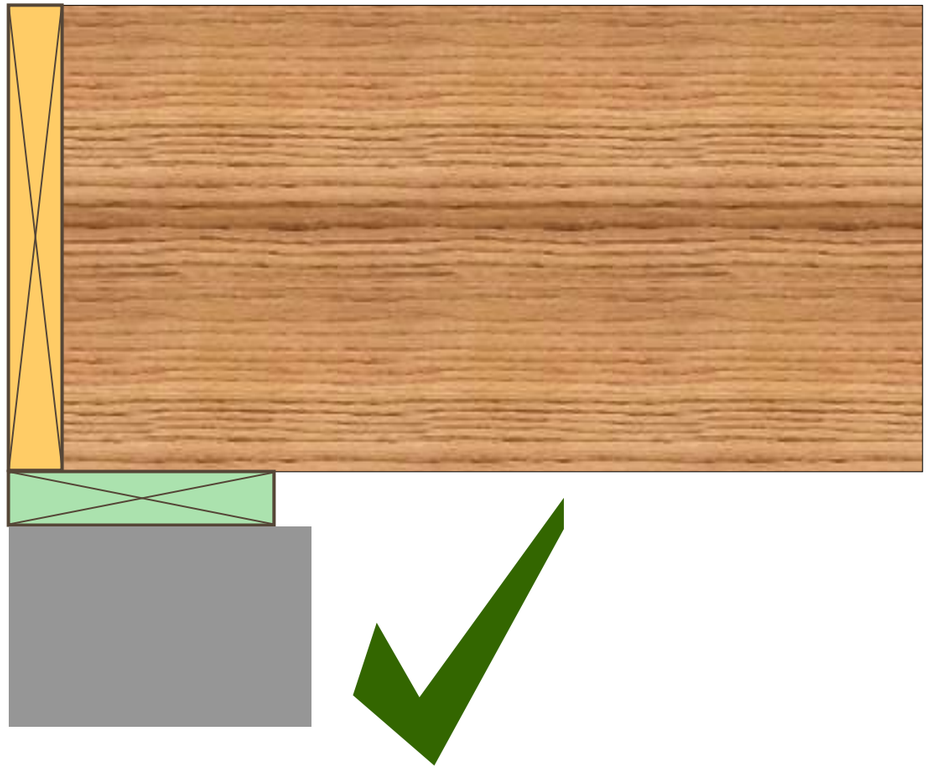
- <u>Notches</u>, square corners
- Large diameter fasteners
- Hanging loads
- <u>Fasteners in or below the neutral axis</u>

BASIC WOOD CONCEPT-SOLUTION

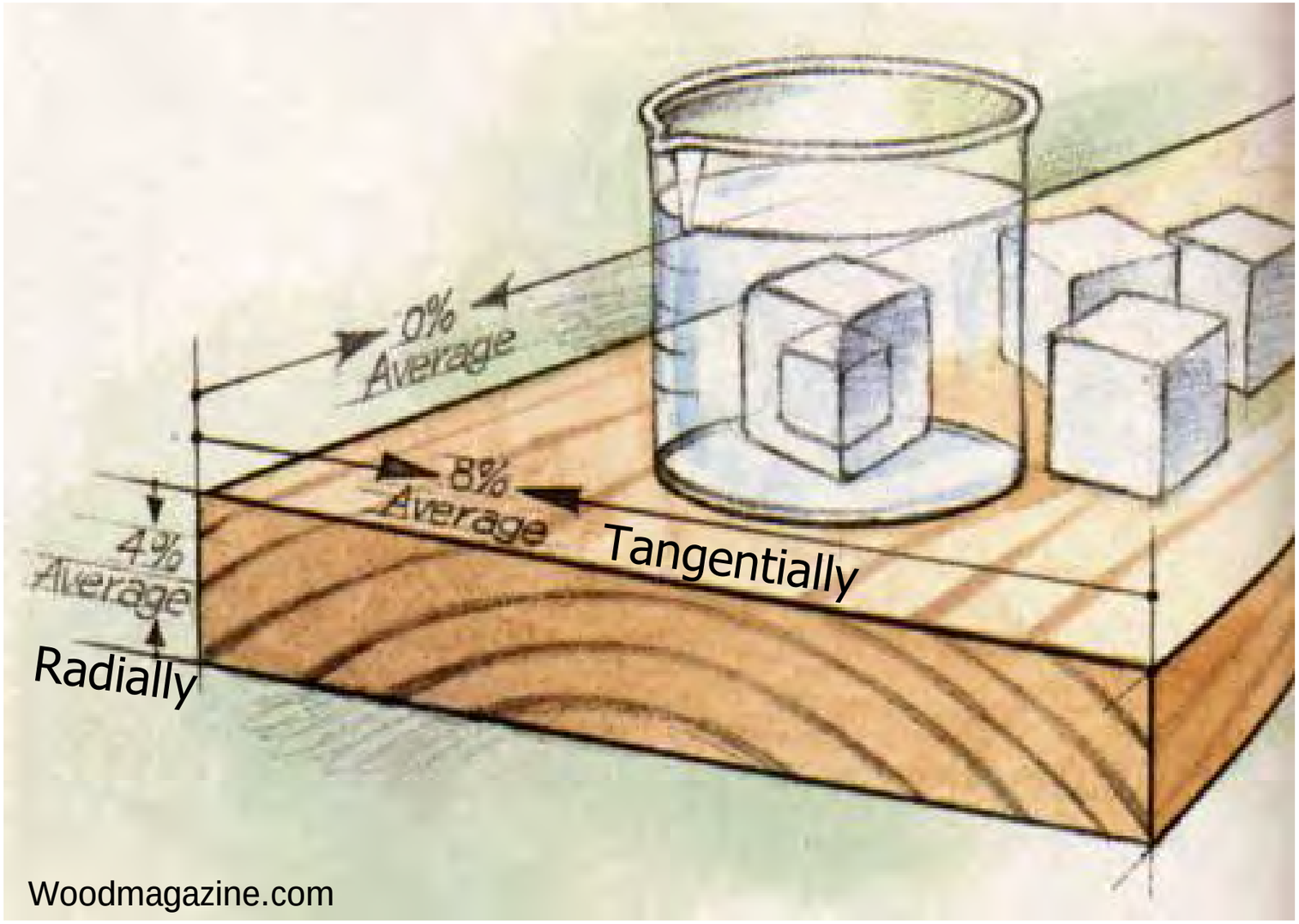
Problem



Solution



WOOD SHRINKS AND IT CAN SWELL!



WOOD CONNECTIONS-KEY CONCEPTS, THEN

- Wood likes compression **parallel to grain**
  - makes connecting wood easy

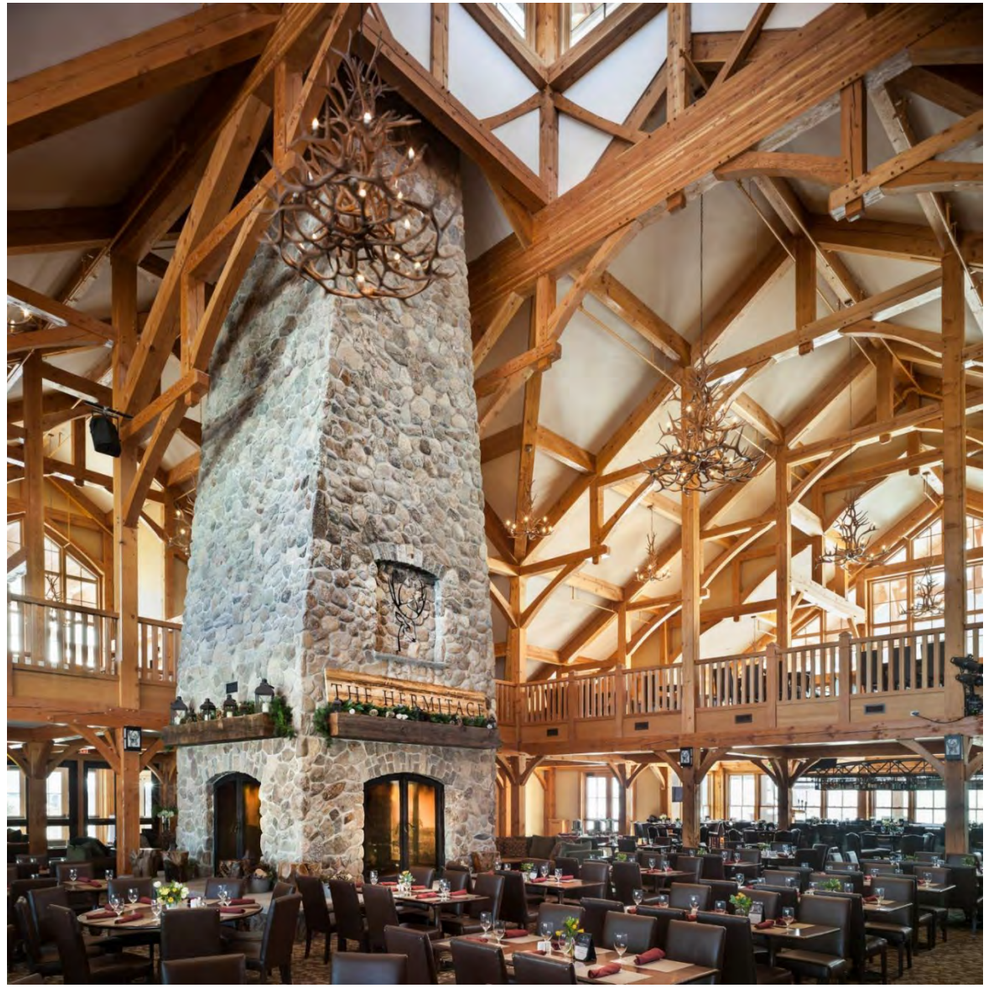


Photo courtesy of Jim DeStefano, AIA, PE

WOOD CONNECTIONS-KEY CONCEPTS, NOW

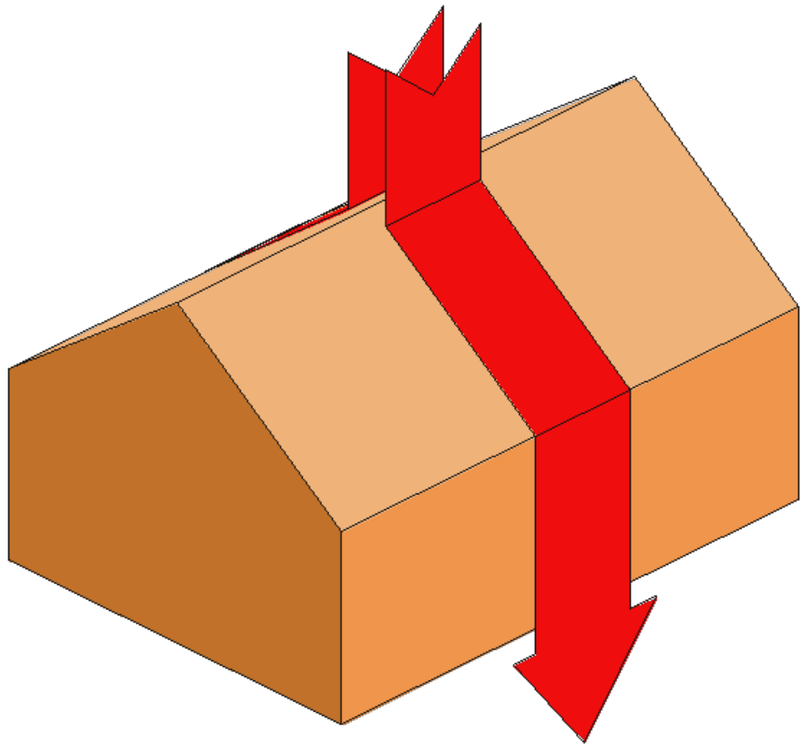
Load Paths <u>Must</u> Be:

- Continuous
- Continuity created by <u>connections</u>
- Ends at the foundation
- Building has hundreds of load paths
- Critical aspect of light wood-frame construction!
- What patterns do you see?

LOADS AND LOAD PATHS-THIS IS IMPORTANT!

VERTICAL LOADS

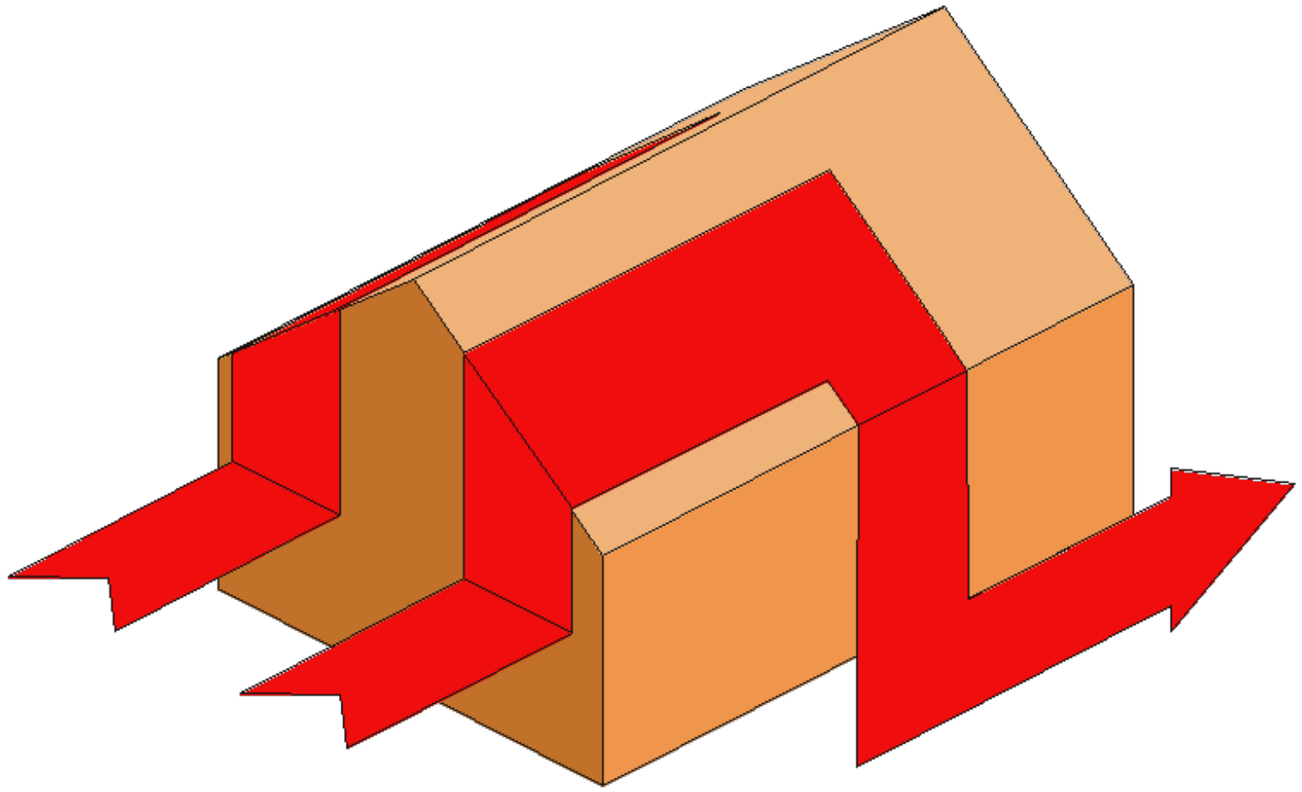
- Dead
- Occupancy
- Roof Live
- Snow



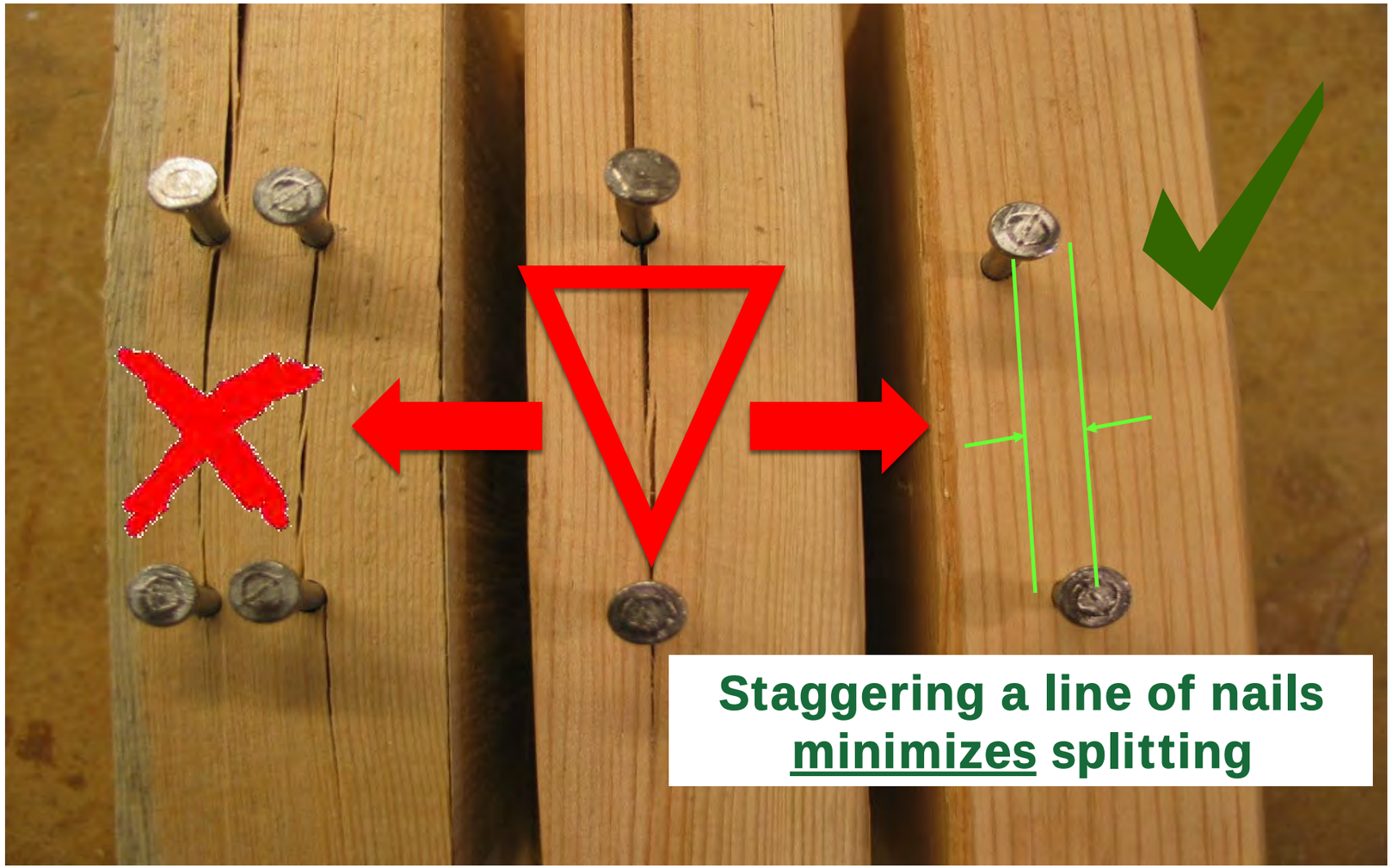
LOADS AND LOAD PATHS-THIS IS IMPORTANT!

LATERAL LOADS

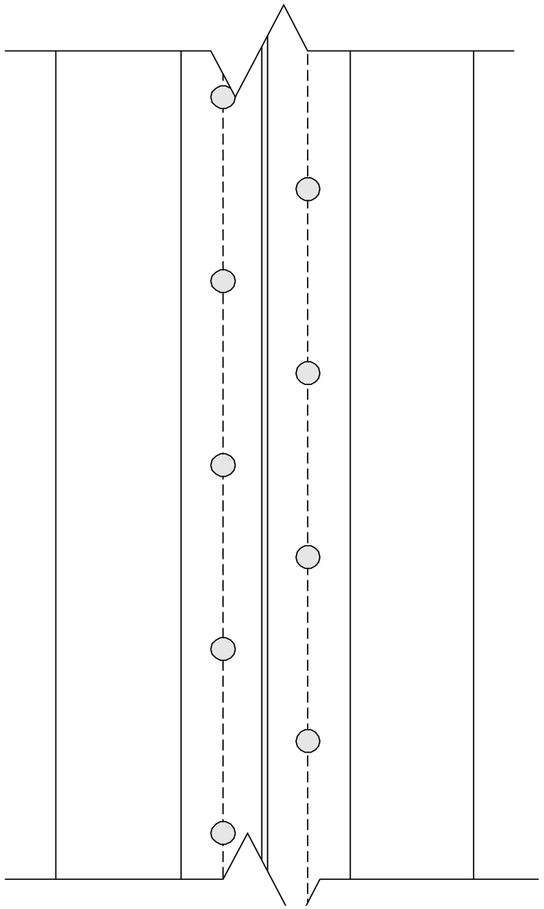
- Wind
- Seismic (Earthquake)



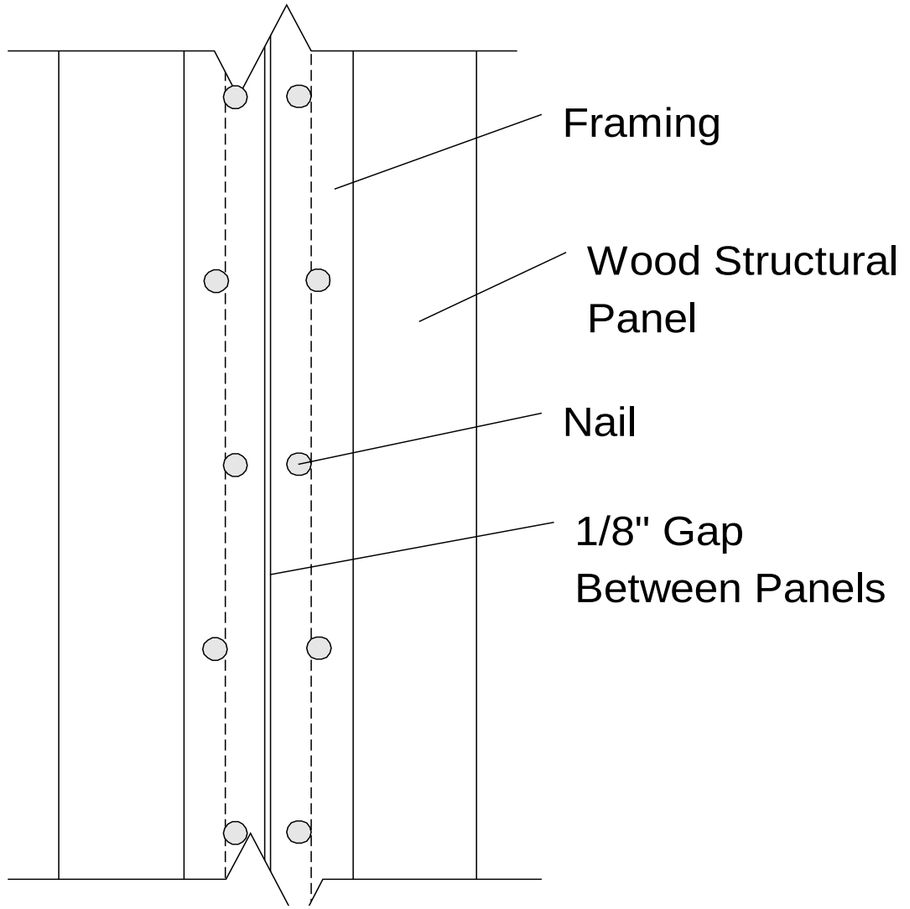
WOOD FASTENERS- PHILOSOPHY



STAGGERED NAILING-BEST CARPENTRY PRACTICE



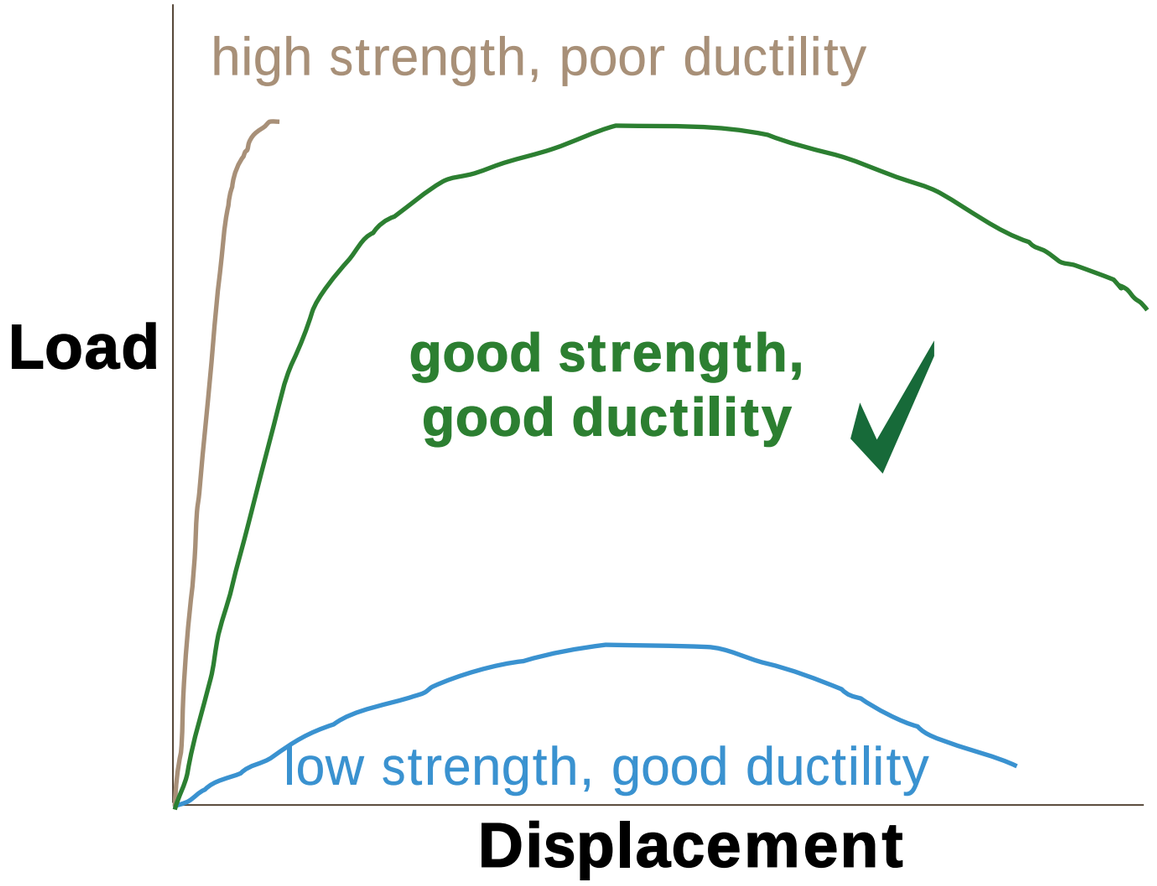
Nailing not staggered



Nailing staggered off centerline

CONNECTION BEHAVIOR

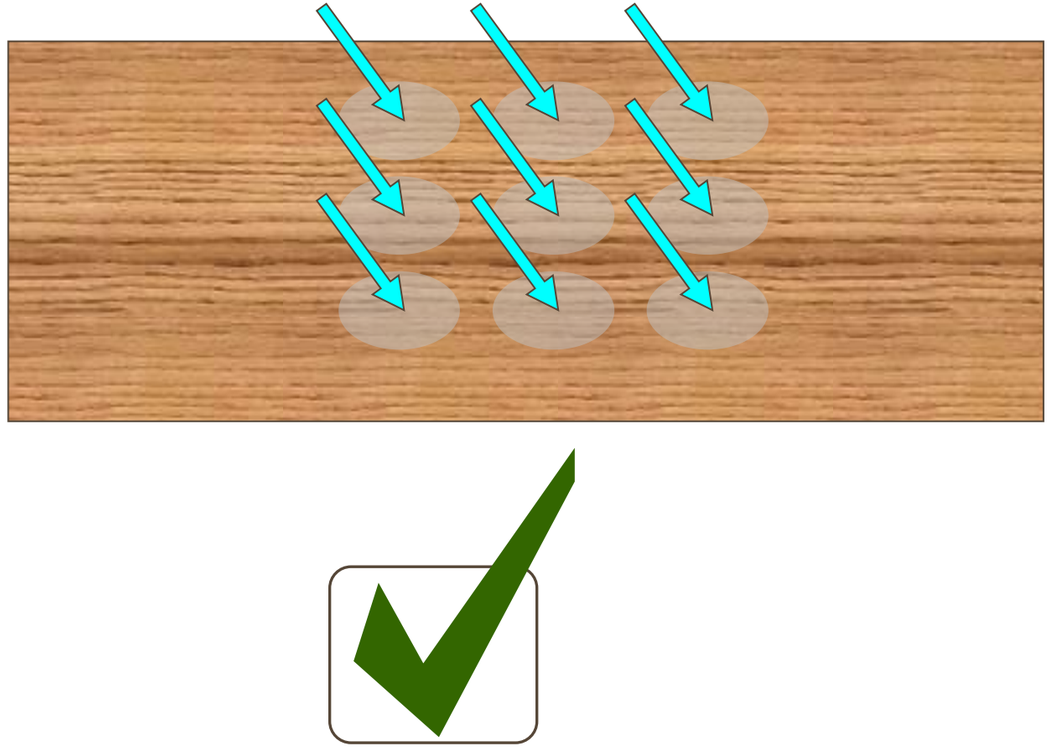
- Balance
- Strength –
  - Size and number of fasteners
- Ductility-
  - Fastener slenderness
  - Spacing
  - End distance



CONNECTING & PENETRATING WOOD - PHILOSOPHY

Mechanical fasteners

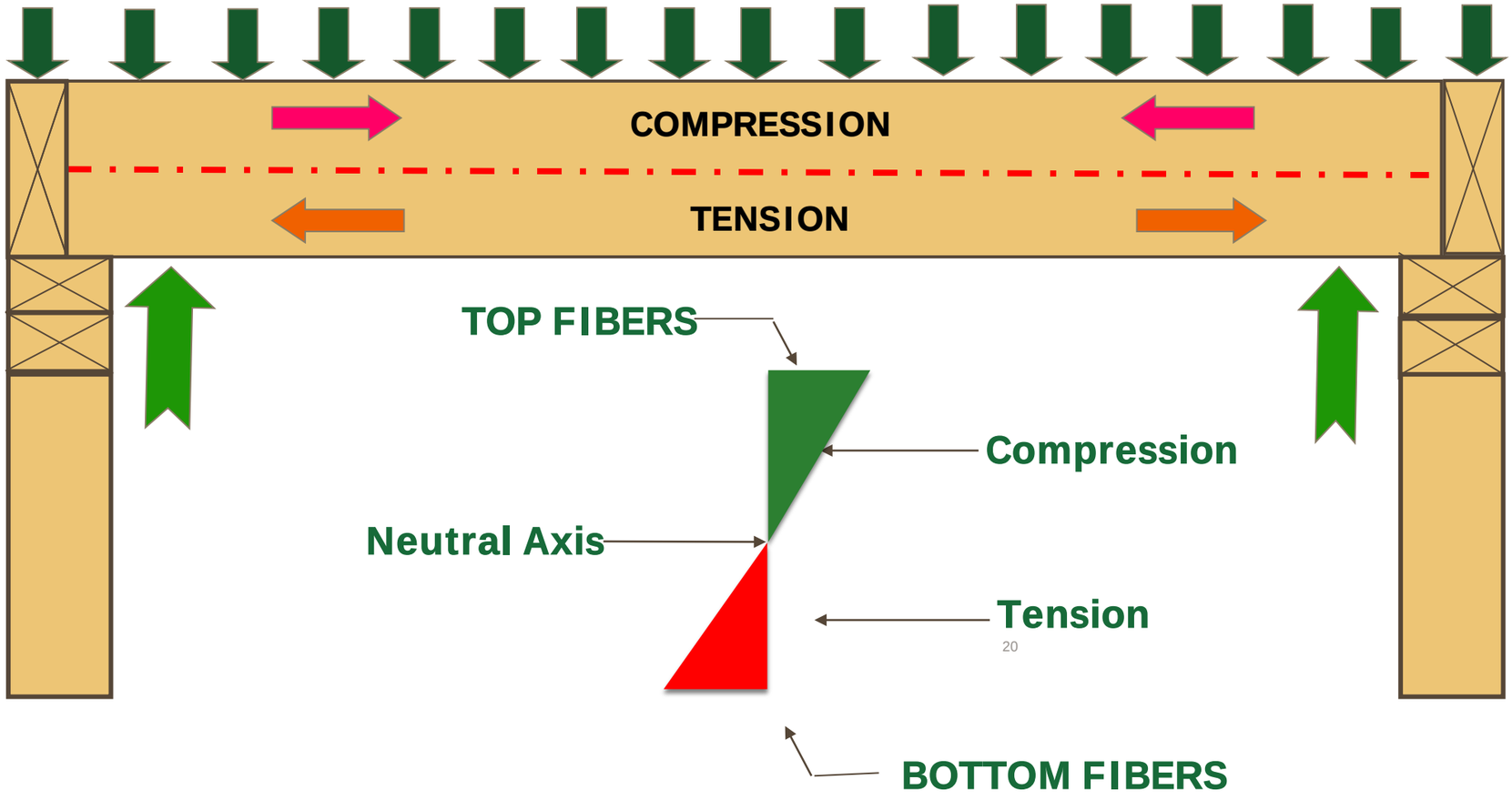
- **Keep them small**
- **Spread them out** over the surface of the wood



Issue is scale of fastener relative to wood member size

FLOOR FRAMING

Loads and how wood floor member react to them



2018 IRC CUTTING, NOTCHING, AND DRILLING OF JOISTS

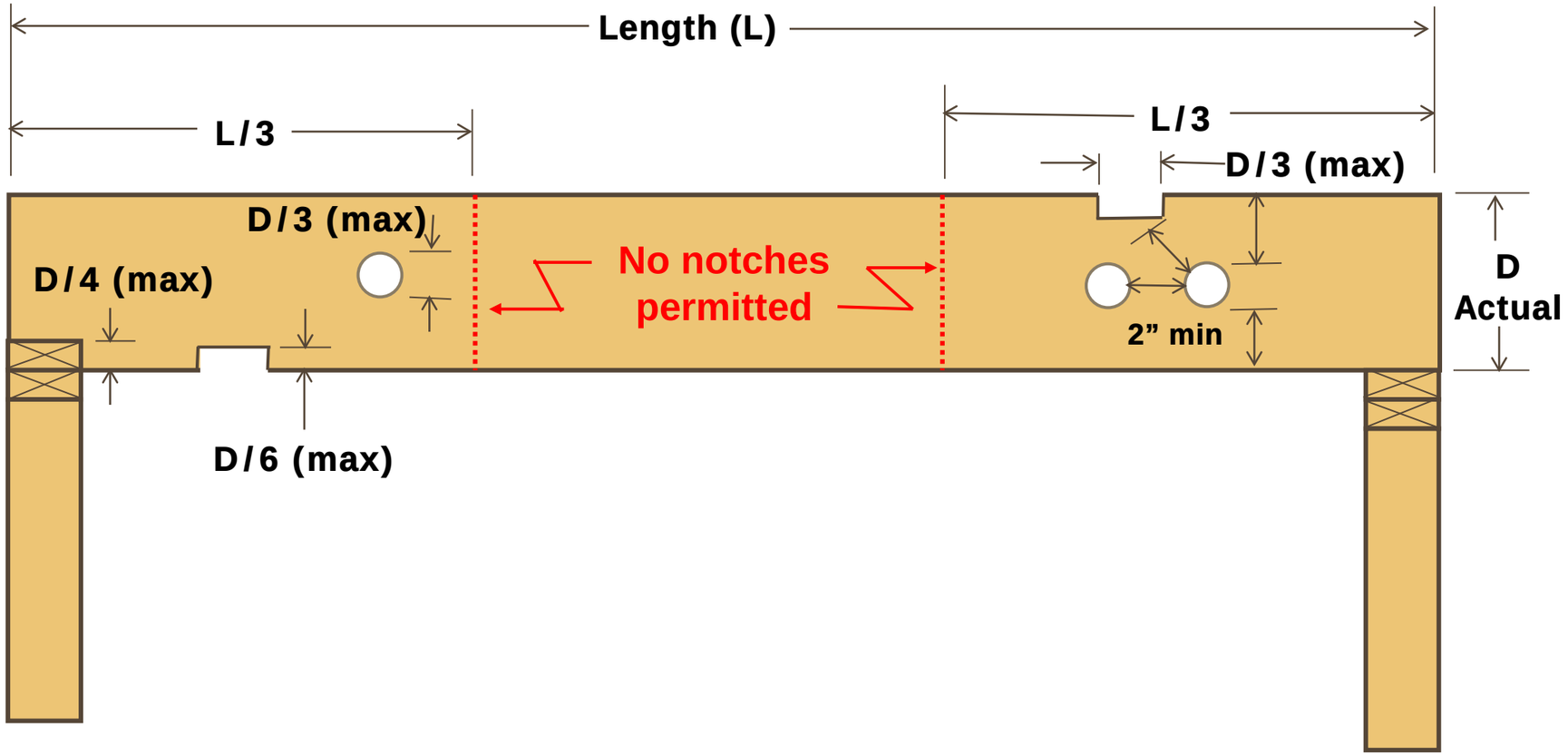


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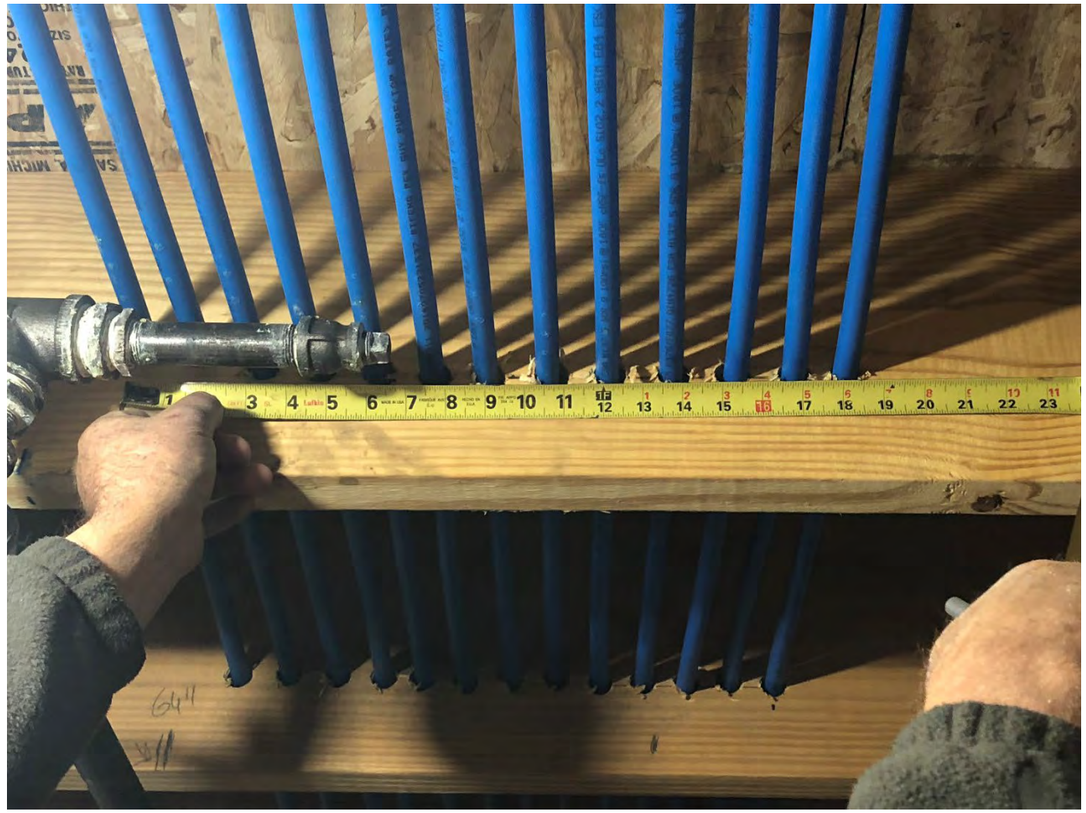
Figure R502.8

CLOSELY SPACED HOLES

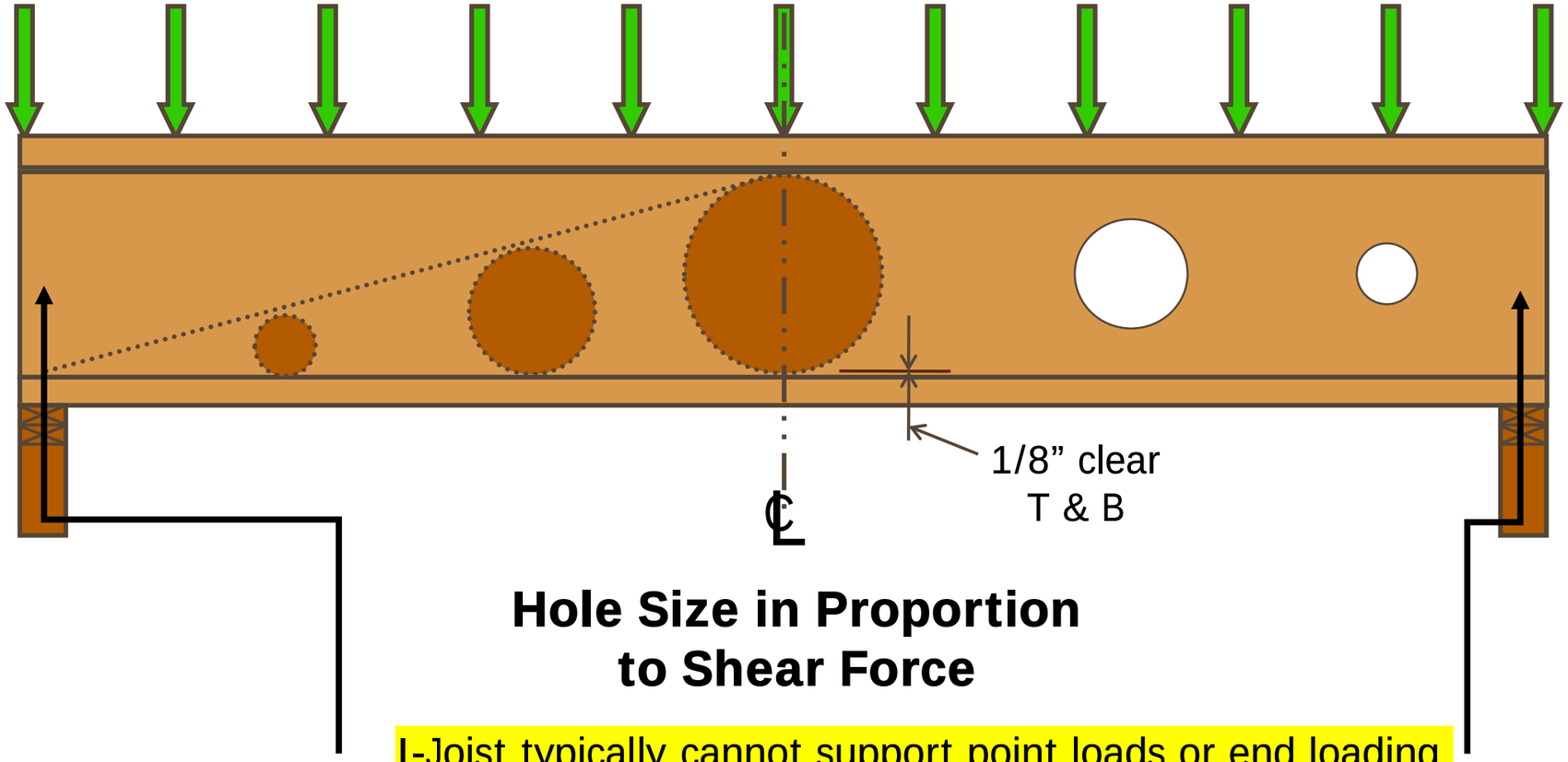


But look how straight the PEX tubing install is!

That’s HOT!.....Not!

HOLES IN I-JOIST WEBS-FLOORS OR RAFTERS

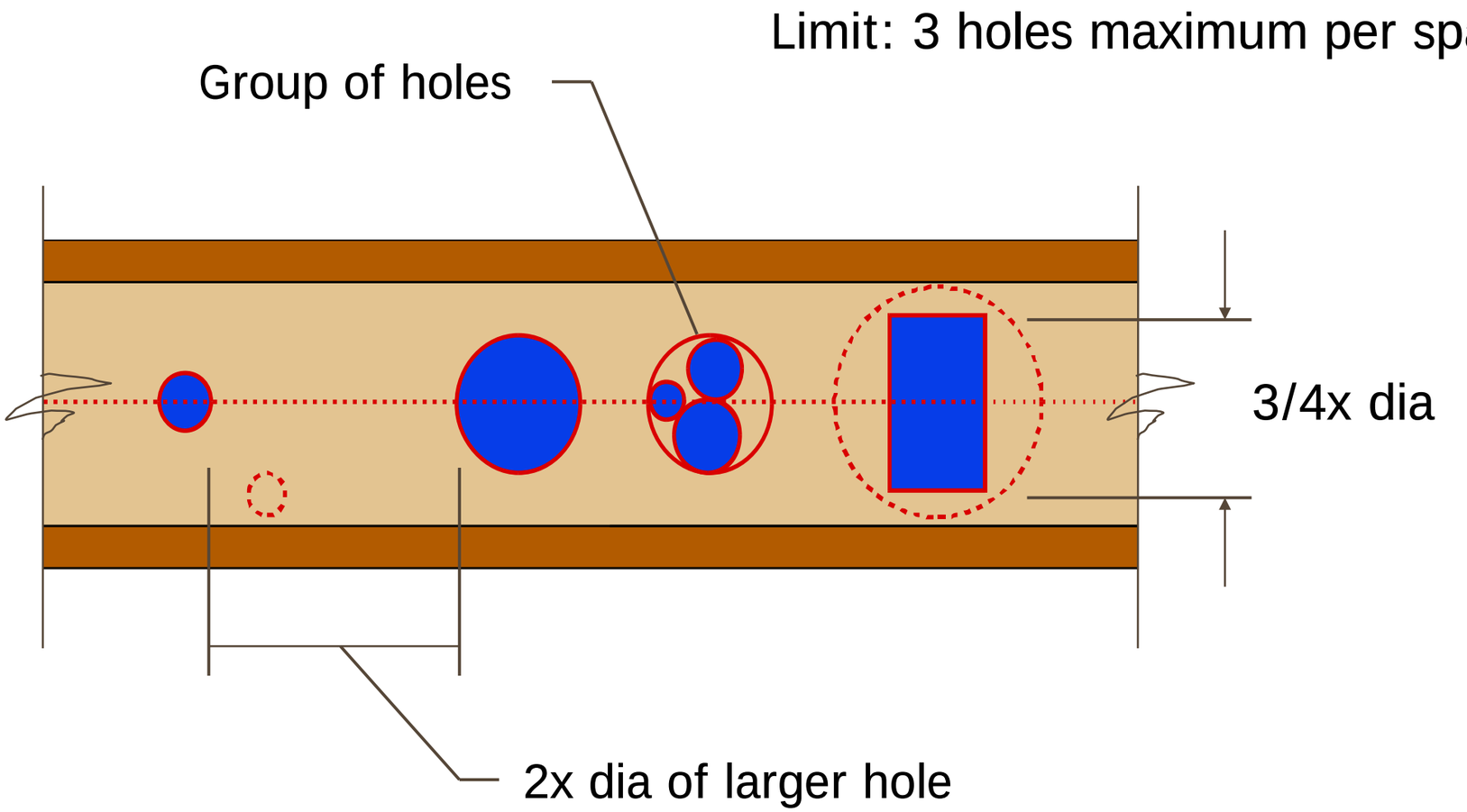
Uniform Loads applied to floor joists or roof rafters



Hole Size in Proportion to Shear Force

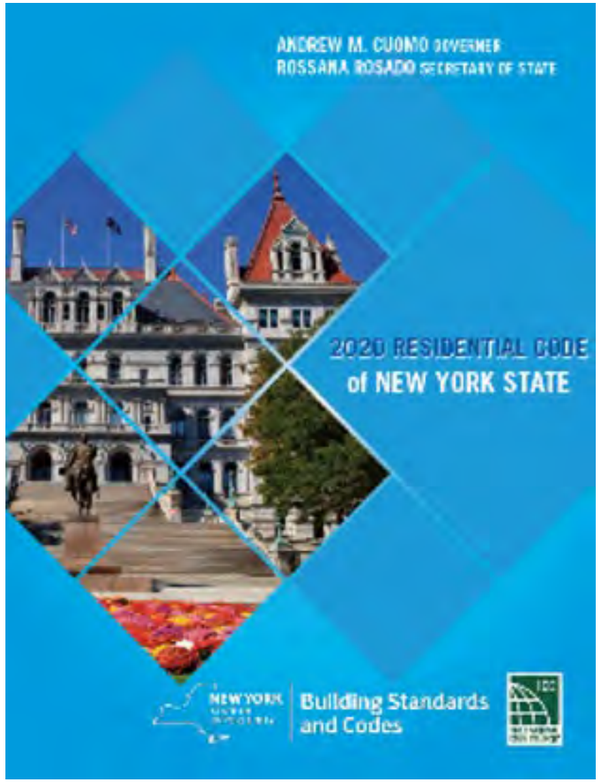
I-Joist typically cannot support point loads or end loading without squash blocks or other blocking details per manufacturer...more on this later!

I-JOIST HOLES



Knockouts

GRADE MARKS REQUIRED



IRC R502.1*: "Sawn lumber shall be identified by a grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with DOC PS 20."

- R602.1 & R802.1 are similar

GRADE MARKS

GRADE MARKS-LOTS OF INFO!

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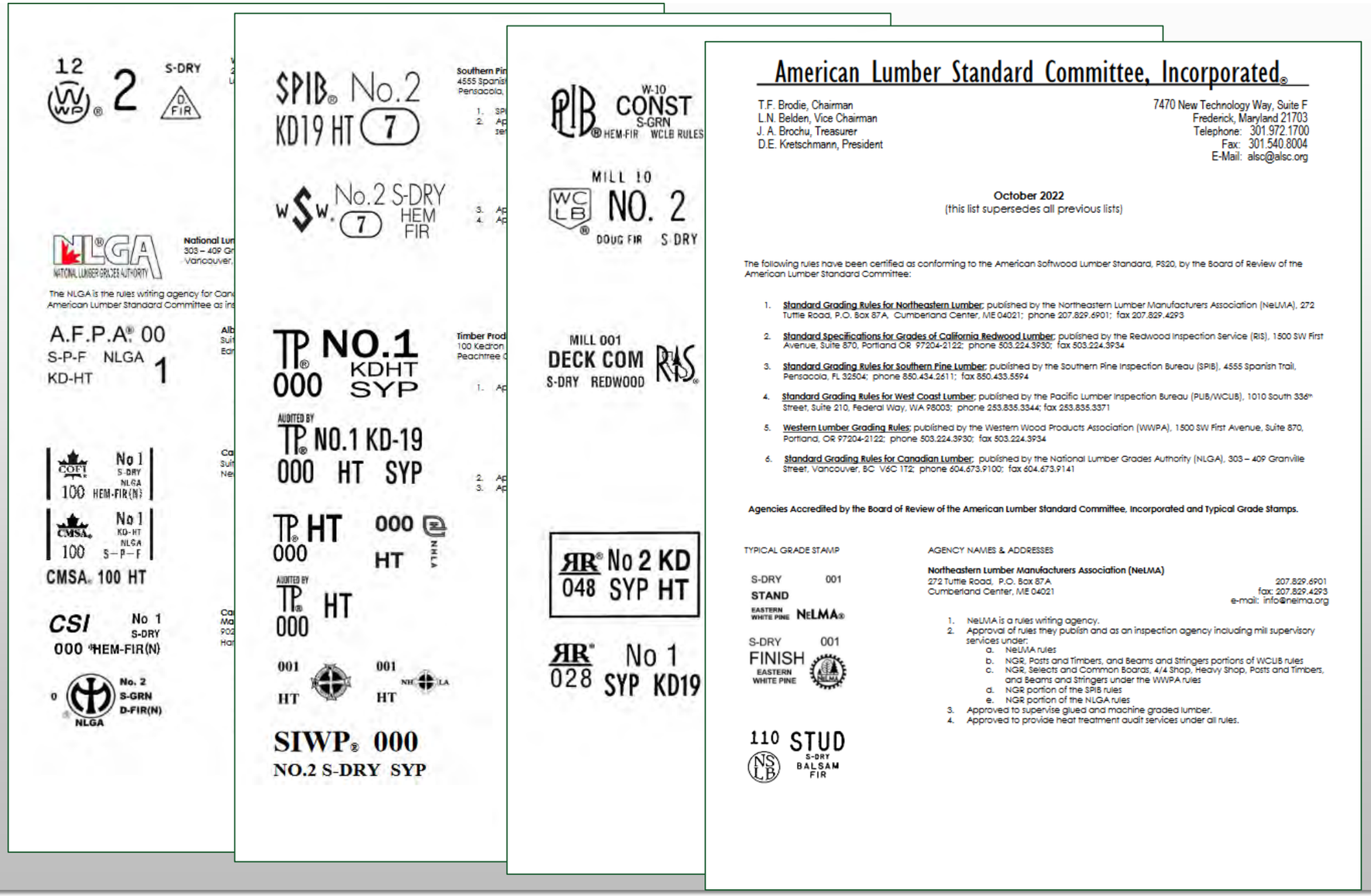
GRADE MARKS

BASIC INFORMATION FROM A GRADE MARK:

a. Agency trademark
b. Mill number
c. Grade designation
d. Species identification
e. Condition of Seasoning

LUMBER FACSIMILE LIST (WWW.ALSC.ORG)



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7470 New Technology Way, Suite F
Frederick, Maryland 21703
Telephone: 301.972.1700
Fax: 301.540.8004
E-Mail: alsc@alsc.org

October 2022
(this list supersedes all previous lists)

The following rules have been certified as conforming to the American Softwood Lumber Standard, PS20, by the Board of Review of the American Lumber Standard Committee:

1. Standard Grading Rules for Northeastern Lumber; published by the Northeastern Lumber Manufacturers Association (NeLMA), 272 Tuttle Road, P.O. Box 87A, Cumberland Center, ME 04021; phone 207.829.6901; fax 207.829.4293
2. Standard Specifications for Grades of California Redwood Lumber; published by the Redwood Inspection Service (RIS), 1500 SW First Avenue, Suite 870, Portland OR 97204-2122; phone 503.224.3930; fax 503.224.3934
3. Standard Grading Rules for Southern Pine Lumber; published by the Southern Pine Inspection Bureau (SPIB), 4555 Spanish Trail, Pensacola, FL 32504; phone 850.434.2611; fax 850.433.5594
4. Standard Grading Rules for West Coast Lumber; published by the Pacific Lumber Inspection Bureau (PLIB/WCLIB), 1010 South 336th Street, Suite 210, Federal Way, WA 98003; phone 253.835.3344; fax 253.835.3371
5. Western Lumber Grading Rules; published by the Western Wood Products Association (WWPA), 1500 SW First Avenue, Suite 870, Portland, OR 97204-2122; phone 503.224.3930; fax 503.224.3934
6. Standard Grading Rules for Canadian Lumber; published by the National Lumber Grades Authority (NLGA), 303 – 409 Granville Street, Vancouver, BC V6C 1T2; phone 604.673.9100; fax 604.673.9141

Agencies Accredited by the Board of Review of the American Lumber Standard Committee, Incorporated and Typical Grade Stamps.

TYPICAL GRADE STAMP

S-DRY 001 STAND EASTERN WHITE PINE NeLMA

S-DRY 001 FINISH EASTERN WHITE PINE

110 STUD S-DRY BALSAM FIR NSLB

AGENCY NAMES & ADDRESSES

Northeastern Lumber Manufacturers Association (NeLMA)
272 Tuttle Road, P.O. Box 87A
Cumberland Center, ME 04021
207.829.6901
fax: 207.829.4293
e-mail: info@nelma.org

1. NeLMA is a rules writing agency.
2. Approval of rules they publish and as an inspection agency including mill supervisory services under:
   a. NeLMA rules
   b. NGR, Posts and Timbers, and Beams and Stringers portions of WCLIB rules
   c. NGR, Selects and Common Boards, 4/4 Shop, Heavy Shop, Posts and Timbers, and Beams and Stringers under the WWPA rules
   d. NGR portion of the SPIB rules
   e. NGR portion of the NLGA rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

LUMBER GRADING

Growth characteristics affecting grade

- Knot size and location
- Knot tightness
- Wane
- Warp
- Slope of Grain
- Splitting
- Checking

NON-ALSC GRADE MARKS

Not permitted as a structural building element
East coast observance

The grade stamp shown above was observed around February 25, 2020 in New York.

The grade stamp shown above was observed around February 20, 2020 in Texas.

The grade stamp shown above was observed around December 10, 2019 in North Carolina.

The grade stamp shown above was observed around November 15,2019 in Georgia.

The grade stamp shown above was observed around October 3, 2019 in Massachusetts.

The grade stamp shown above was observed around August 26, 2019 in Georgia.

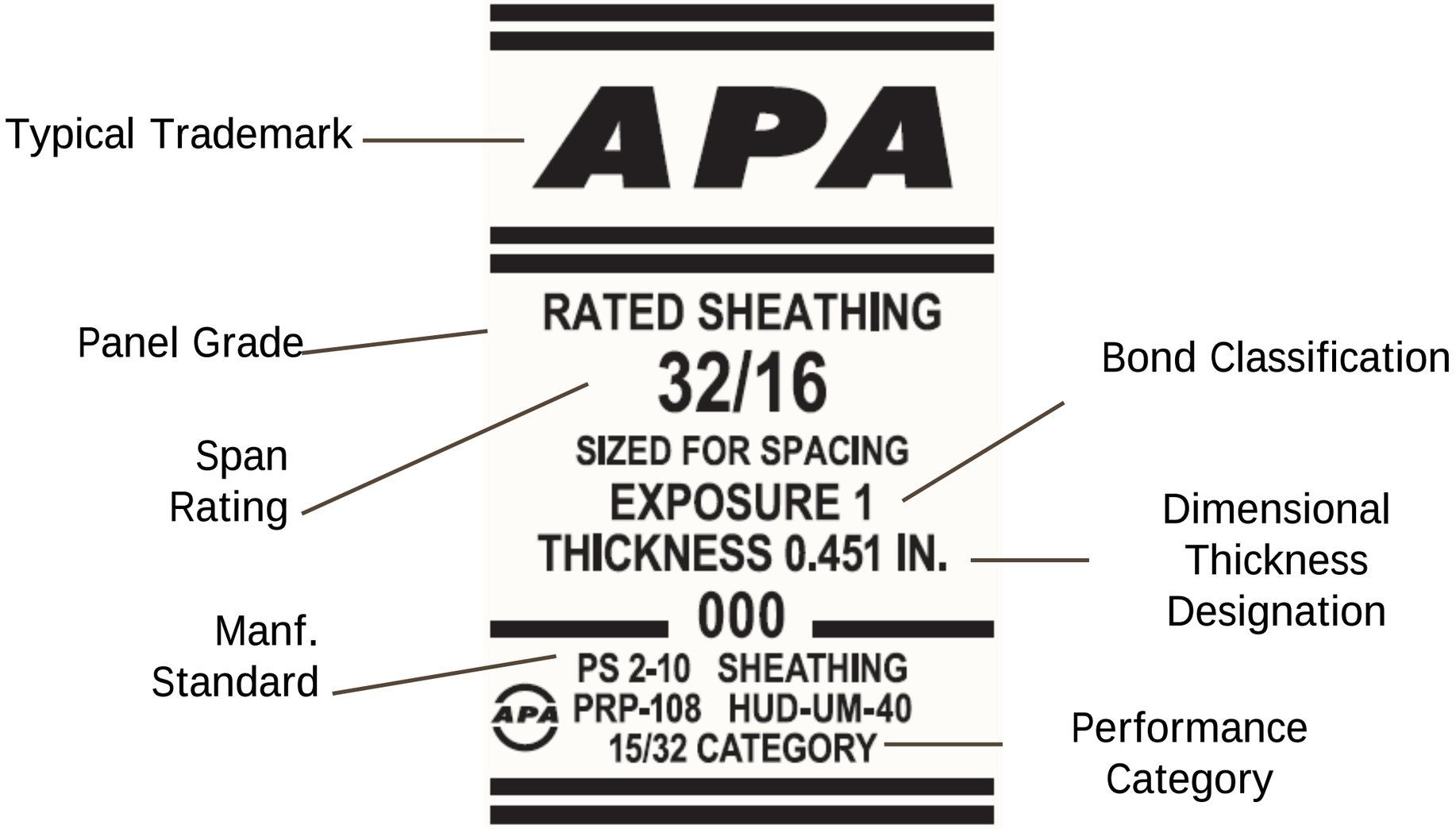
Used with the kind permission of ICC

GRADE MARKS - MECHANICALLY GRADED

FINGER JOINTED LUMBER

- End-jointed lumber is “interchangeable”
- Designated on Grade Mark
  - Vertical use only
  - Heat Resistant Adhesive (HRA)
- Used where fire resistive assemblies are required by the code
- Exterior walls
- Dwelling unit separation

WOOD STRUCTURAL PANELS (WSP) GRADE STAMP



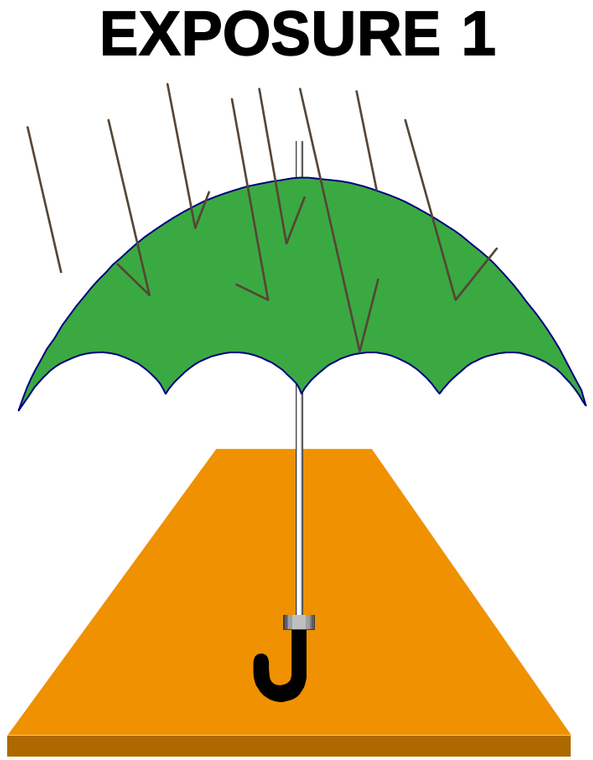
EXPOSURE DURABILITY LEVELS

Exposure 1

- Waterproof glue
- Permit D-grade veneer (plywood)

Exterior

- Waterproof glue and bond throughout
- Minimum C-grade veneer (plywood)
- Permanent exposure to the elements

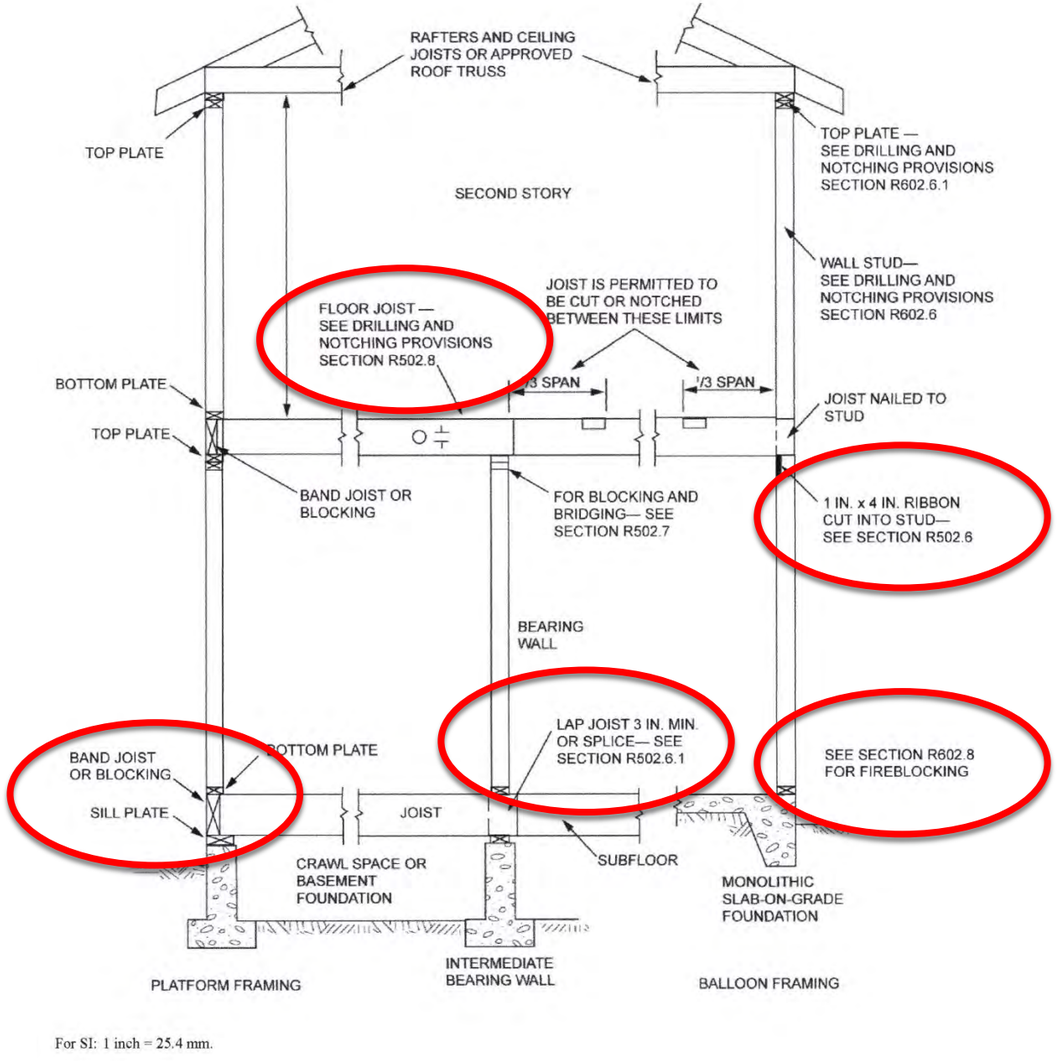


CDX does NOT mean Exterior grade!!!

2021 IRC FLOOR, WALL, AND ROOF FRAMING

Figure R602.3(1)

- Ground-Up approach: first the site, then footings, foundation walls, floor framing, walls, roofs, etc.
- Calls out terms/locations in building
- Directs you to specific chapters, figures, and tables
- Know the progression and what chapters apply in what order



For SI: 1 inch = 25.4 mm.

FIGURE R602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING

With permission from ICC 4/29/21

IRC CHAPTER 3 FOUNDATION ANCHORAGE

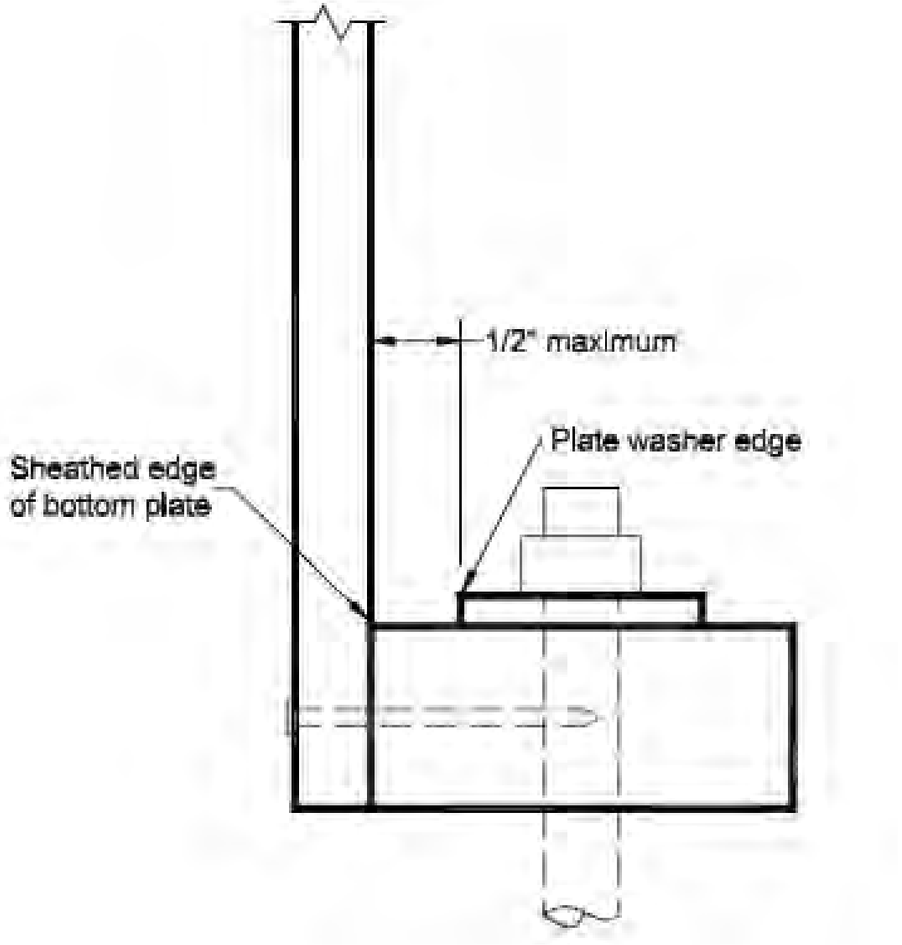
Section R403.1.6

- ½” hot dipped galvanized*
- Fasteners in preservative treated wood see R317.3
- 6’ o/c maximum spacing
- 7” minimum embedment in foundation wall

FOUNDATION ANCHORAGE-CONTINUED

- Located in middle 1/3
- Maximum 12” or 7d from end
- Nut and washer for each bolt
- 2 bolts minimum per section
- Approved anchors

PLATE WASHERS – WHERE REQUIRED



Required in SDC D_0 and in townhouses in SDC C

Must extend to within ½ in. of sheathed edge of bottom plate

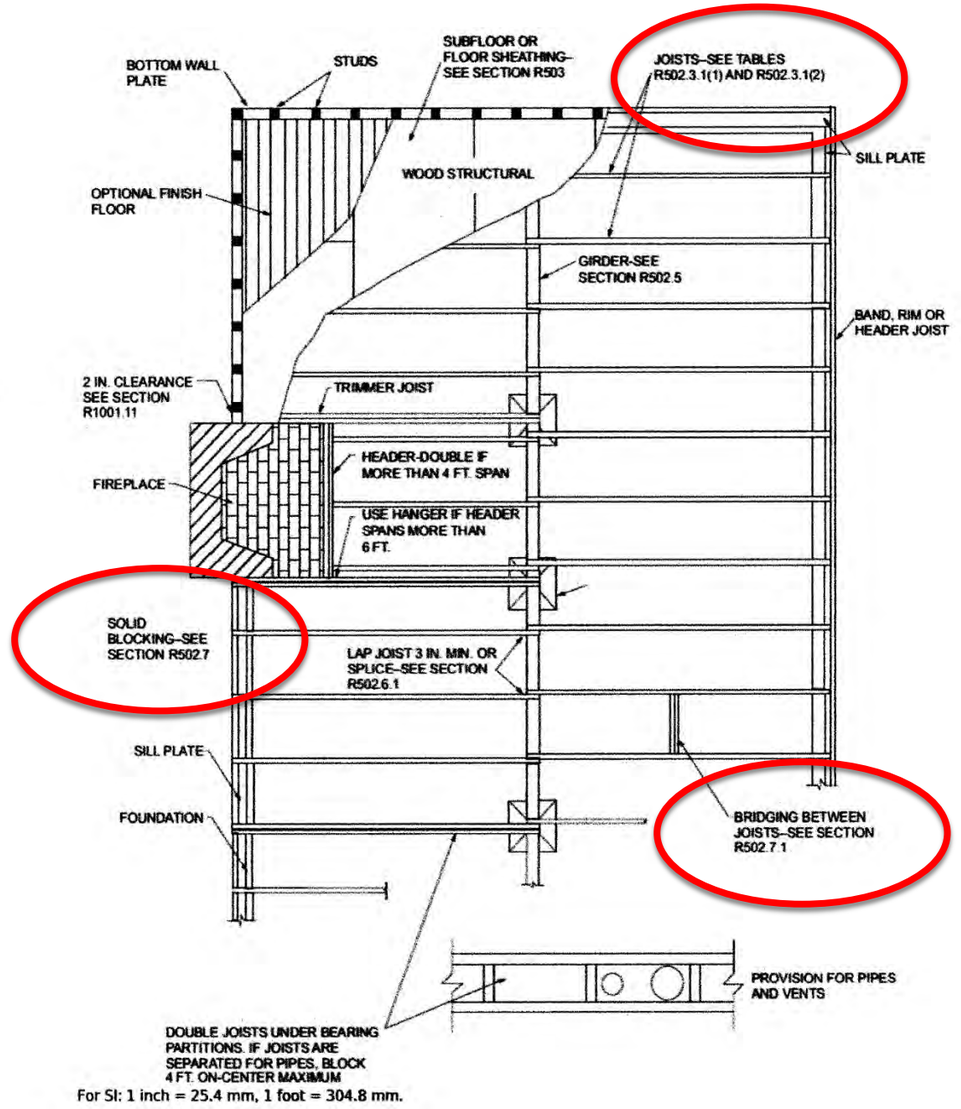
Delays the onset of bottom plate failure

3” X 3” PLATE WASHER REQUIREMENTS*

- Minimum 3" x 3" x 0.229" steel
- Slotted hole permitted
- Placed within ½" of sheathing material
- Automatically satisfied for 2x4 plate

RESIDENTIAL FLOOR FRAMING-2018 IRC

- **Figure R502.2**
  - Become familiar with this one!
  - Call outs specific framing details & Sections
  - Bearing requirements (1.5”)
  - Span Tables
  - Trimmers, headers, rim joist, bridging, clearances, etc.
  - Depicts lapping, supports, point loads, etc.



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RESIDENTIAL FLOOR FRAMING-2018 IRC

- **Figure R502.3.1(1)**
  - 1st See if you are looking at <u>Sleeping or Living Areas</u>!
  - 2nd Verify joist spacing
  - 3rd Verify species and grade
  - 4th Confirm the designed dead load 10 or 20 psf.
  - 5th Verify nominal lumber size
  - 6th Double Check!

CHAPTER 5 FLOORS

TABLE R502.3.1(1)

FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/Δ = 360) [a]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
16	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas fir-larch	#2	10-9	14-2	17-5	20-3	10-1	12-9	15-7	18-1
	Douglas fir-larch	#3	8-7	10-11	13-4	15-5	7-8	9-9	11-11	13-10
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-1	10-6	13-4	16-3	18-10
	Hem-fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern pine	#3	7-11	10-0	11-1	14-4	7-1	8-11	10-10	12-10
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-pine-fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

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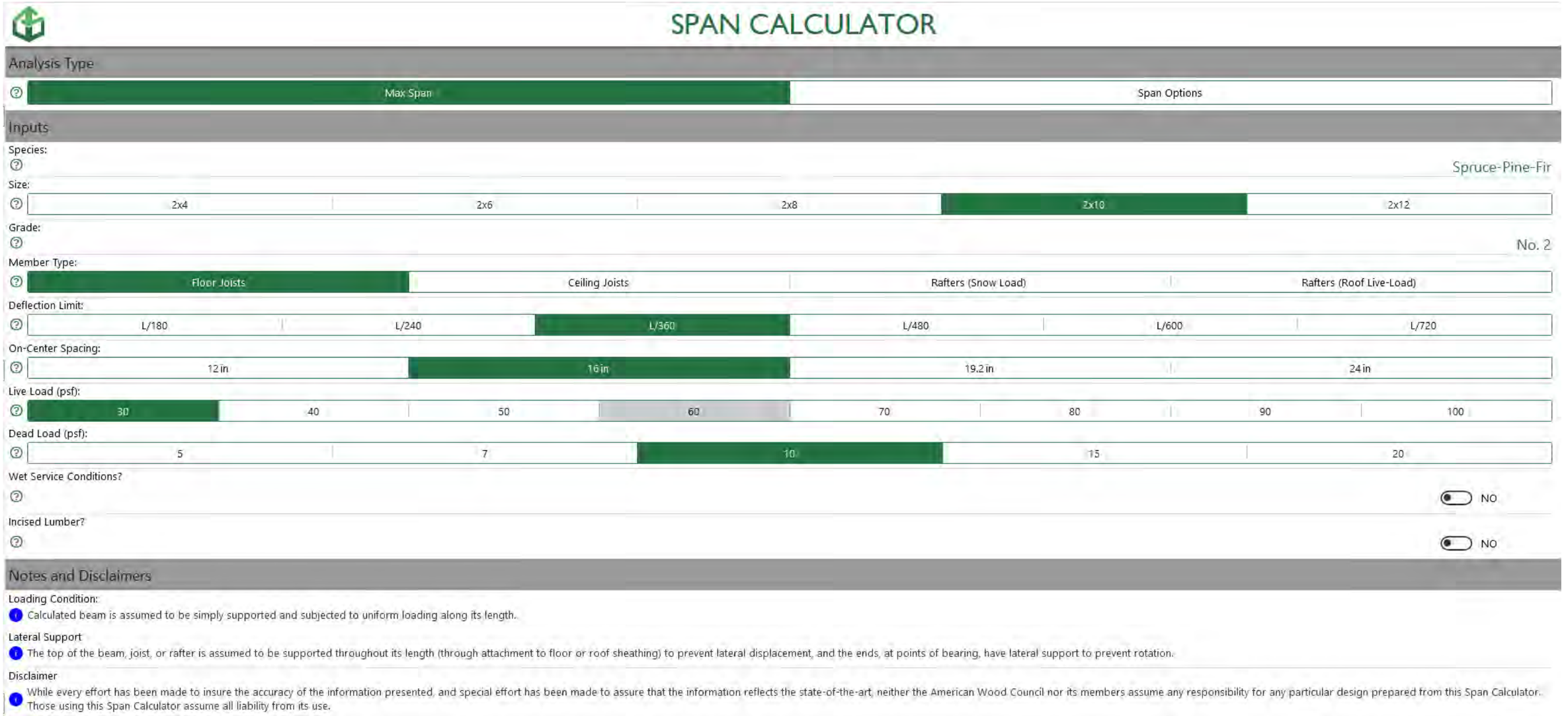
AWC SPAN CALCULATOR – WWW.AWC.ORG



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AWC SPAN CALCULATOR – WWW.AWC.ORG

Max Span Results	
Maximum Horizontal Span	△17 ft 2 in
Minimum Bearing Length, Each End	▽0-3/4 in (0.72in)
Max Span Parameters	
Adjusted Modulus of Elasticity (E')	1,400,000 psi
Adjusted bending design value (Fb')	1,107 psi
Adjusted shear design value parallel to grain (Fv')	135 psi
Adjusted compression design value perpendicular to grain (Fc⊥')	425 psi
Analysis Type	
	Max Span
Inputs	
Species:	Spruce-Pine-Fir
Size:	2x10
Grade:	No. 2
Member Type:	Floor Joists
Deflection Limit:	L/360
On-Center Spacing:	16 in
Live Load (psf):	30
Dead Load (psf):	10
Wet Service Conditions?	NO
Incised Lumber?	NO

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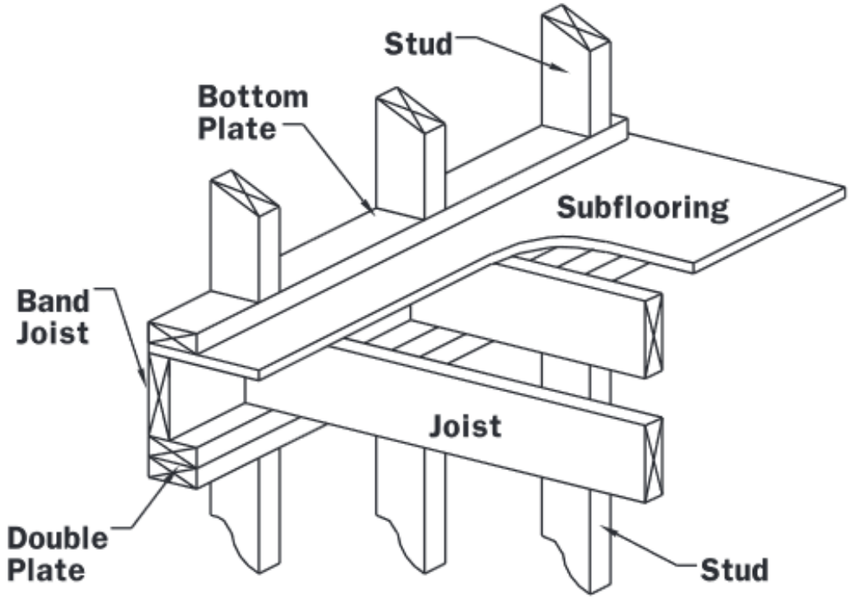
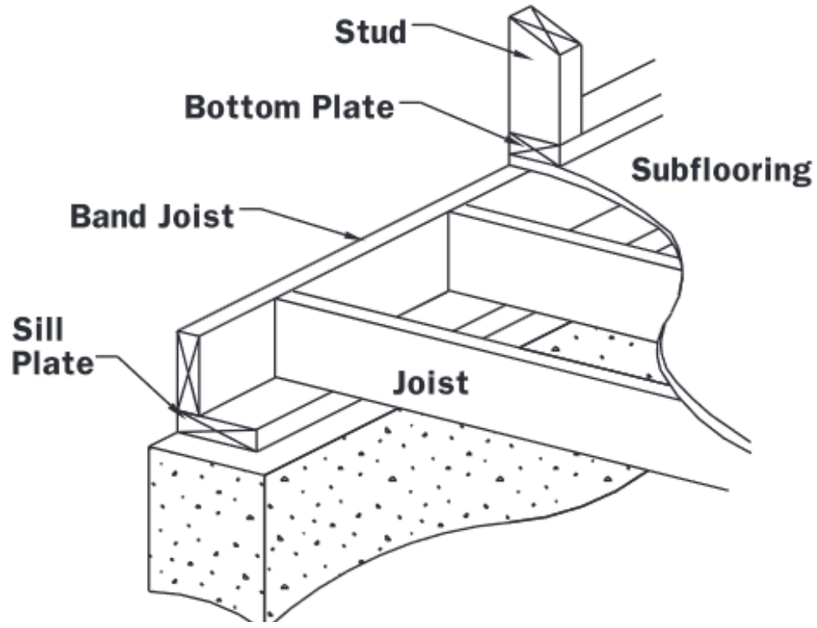
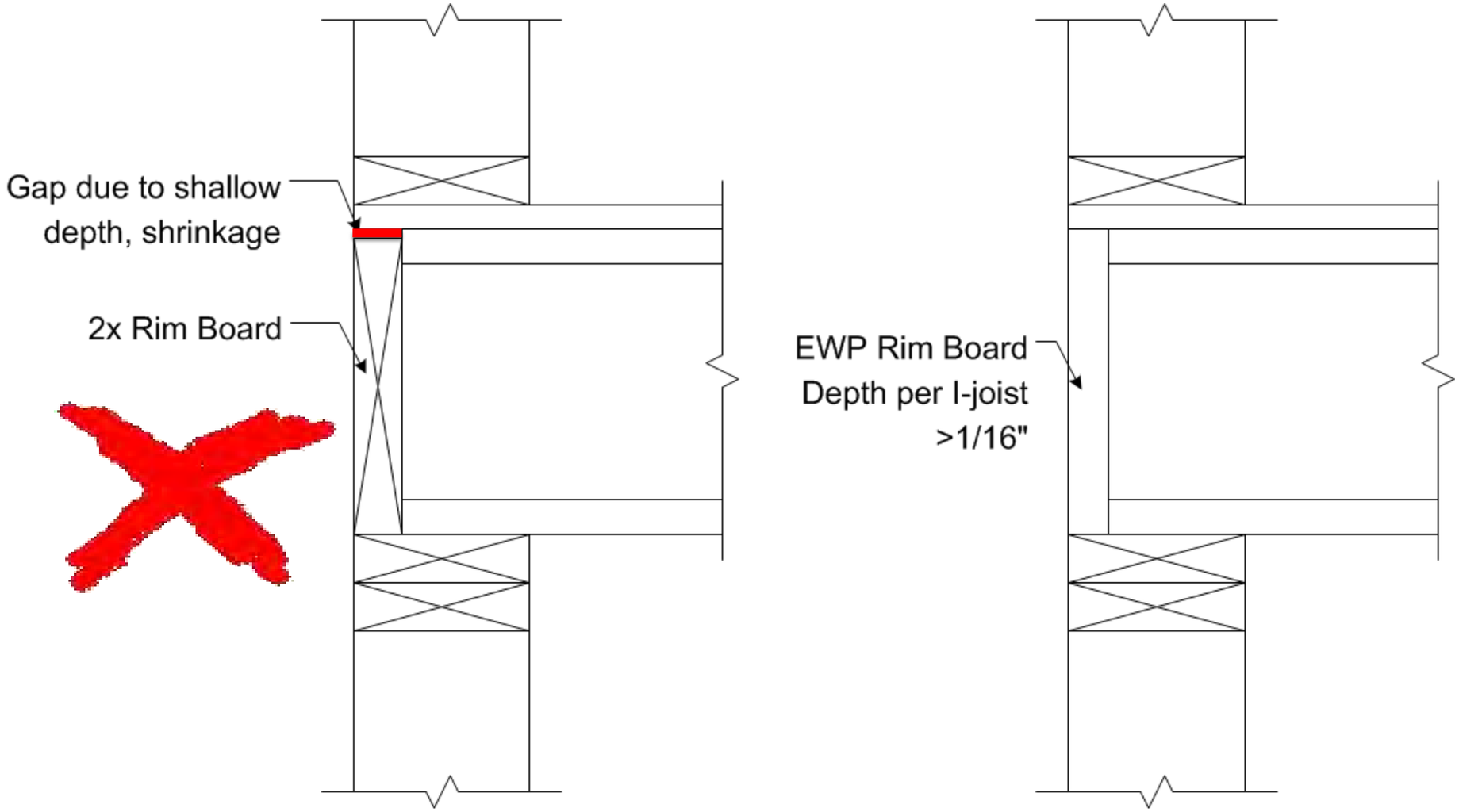
RESIDENTIAL FLOORS - KEY CONCEPTS

- **R502.7** Lateral Restraint
- Joist ends must be supported
- Attachment to band joist, headers, rim Joist, or adjoining Stud
- Other “Approved Means”



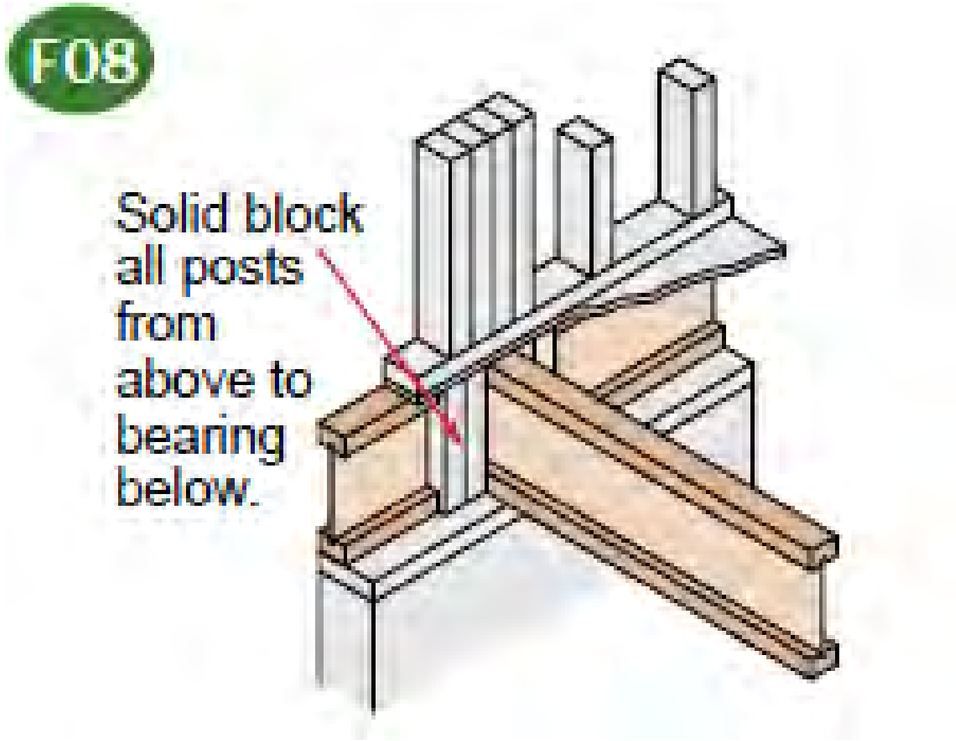


ENGINEERED RIM BOARD FOR I-JOIST SYSTEM



I-JOIST DETAILS – BEARING & POINT LOADS

Concentrated loads shall not bear directly on I-joists!

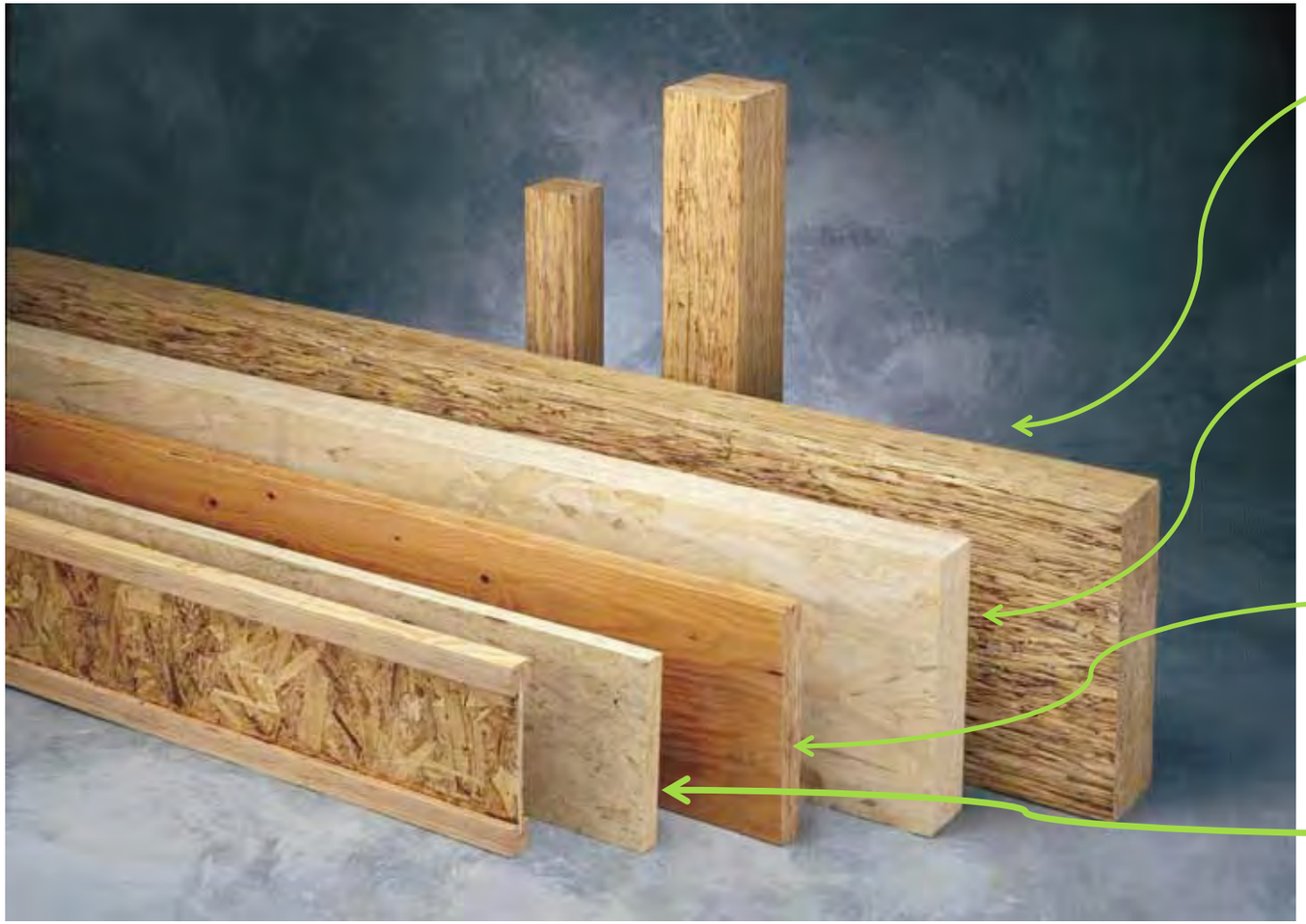


CONVENTIONAL SOLID SAWN FLOORS

FLOOR FRAMING-ENGINEERED WOOD PRODUCTS

- R502.8.2 (floors) & R802.7.2 (roofs) prohibit alterations of EWPs unless permitted by manufacturer or by engineering analysis.

STRUCTURAL COMPOSITE LUMBER (SCL)



- PSL
- LSL
- LVL
- OSL

FLOOR ROUGH FRAMING-CHECKLISTS?

- R403.1.6 Anchor Bolts
- R502 Grade Marks
- 502.4 Joist Alignment
- 502.5 Floor/ girder spans Tables R502.5(1) & R502.5(2)
- 502.6 Bearing
- 502.8 Drilling/Notching
- 502.9 Post & Beam Size-strapping
- 502.10 Floor Openings
- Table R602.3(1) Fastener Table
- Floor Sheathing
- R602.8 & R302.11.1 Fire/Draft Stopping

It can get overwhelming!

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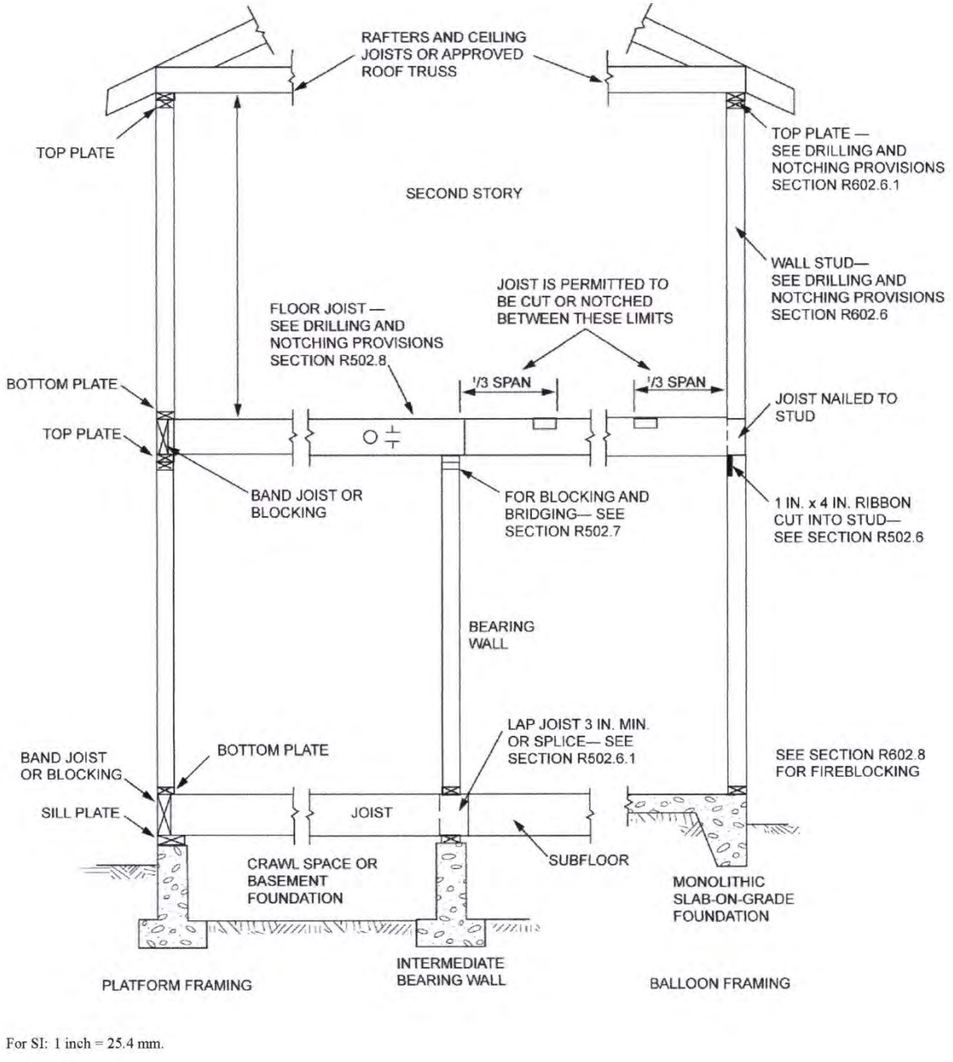
2021 IRC FLOOR, WALL, AND ROOF FRAMING

Figure R602.3(1)

- Calls out terms/locations in building
- Directs you to specific chapters, figures, and tables
- Remember: IRC starts with building planning, drainage, subgrade, footings, foundation walls, floors, framed walls, etc.
- Know the progression, what chapters apply, and their order



For SI: 1 inch = 25.4 mm.

FIGURE R602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING

With permission from ICC 4/29/21

WOOD FRAMING-FASTENER SCHEDULE

Table R602.3(1)

- Common connection configurations
- Fastener: size, type, location
- Roof, walls, floors, sheathing

TABLE R602.3(1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Roof		
1	Blocking between ceiling joists, rafters or trusses to top plate or other framing below	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
	Blocking between rafters or truss not at the wall top plates, to rafter or truss	2-8d common ($2^1/_2$″ × 0.131″); or 2-3″ × 0.131″ nails	Each end toe nail
		2-16d common ($3^1/_2$″ × 0.162″); or 3-3″ × 0.131″ nails	End nail
	Flat blocking to truss and web filler	16d common ($3^1/_2$″ × 0.162″); or 3″ × 0.131″ nails	6″ o.c. face nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Section R802.5.2 and Table R802.5.2(1)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Section R802.5.2 and Table R802.5.2(1)]	Table R802.5.2(1)	Face nail
5	Collar tie to rafter, face nail	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box ($3^1/_2$″ × 0.135″); or 3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d box ($3^1/_2$″ × 0.135″); or 3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
	Wall		
8	Stud to stud (not at braced wall panels)	16d common ($3^1/_2$″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^1/_2$″ spacer)	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^1/_2$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2^1/_2$″ × 0.113″); or 4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail

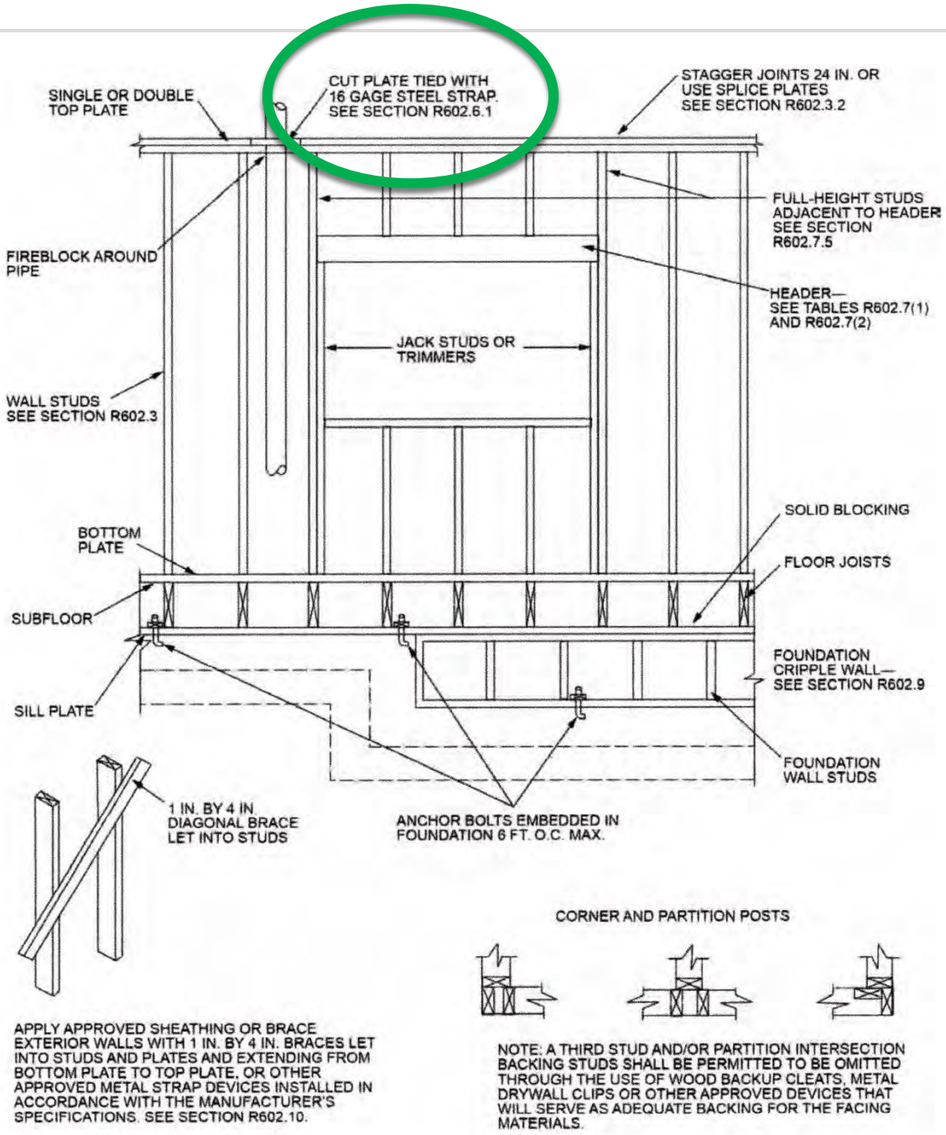
(continued)

With permission from ICC 4/29/21

2021 IRC FRAMING DETAILS

Figure R602.3(2)

- Notice the repetition, the form, the stacking of studs and framing elements
- See the alignment of joists below and on top of studs?
- Note the call out details that point you elsewhere in the code!
- A picture is worth a thousand words here
- Example in green: R602.6.1

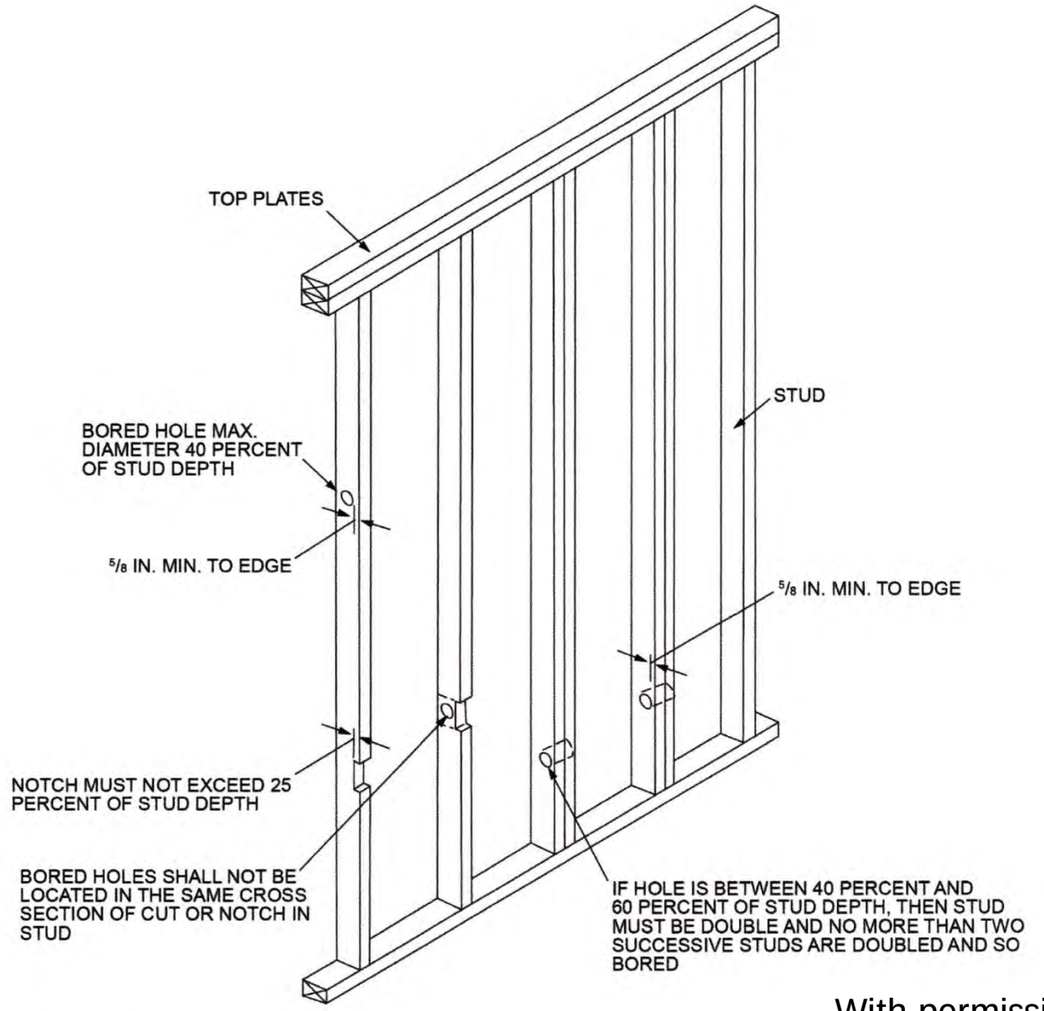


With permission from ICC 4/29/21

2018 IRC EXTERIOR/BEARING WALL DETAIL

Figure R602.6.(1)

- **Notching:**
- Not to exceed 25% of width
- **Boring:**
- Not to exceed 60% of depth
- 5/8” minimum from edge stud
- ≥ 40-60 %, 2x Studs or Stud Shoe



For SI: 1 inch = 25.4 mm.

Note: Condition for exterior and bearing walls.

FIGURE R602.6(1)
NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS

With permission from ICC 4/29/21

2021 IRC WALL FRAMING-PENETRATIONS

Figure R602.6.1

- Exterior or Interior Load-Bearing Walls
- Drilled or Notched ≥50%
- Requires galvanized metal tie, 0.054” thick (16 ga) 1.5” wide, 6” longer on each side of opening, w/ 16-10d 0.148” nails, total (8 per side)
- For 3” PVC pipe w/ ½” clearance on each side=16” long metal tie

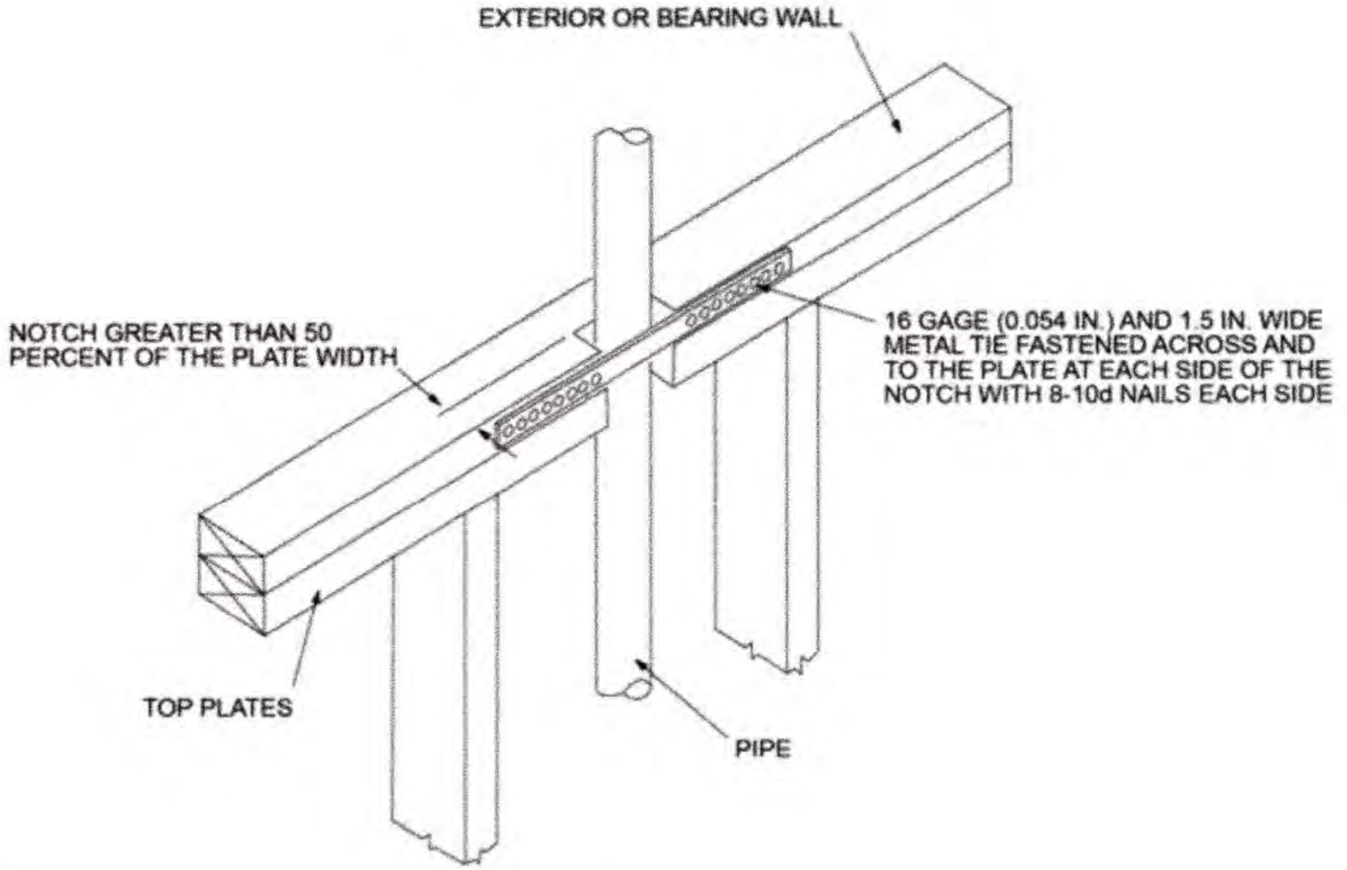


FIGURE R602.6.1
TOP PLATE FRAMING TO ACCOMMODATE PIPING

With permission from ICC 4/29/21

TOP PLATE-PENETRATIONS/STRAPPING

- 16 gauge or 0.054”?
- Galvanized?
- 6” wider?
- 16-10d 0.148” Nails, 8 per side?
- Compliance?
- What about floor-to-floor penetrations?
- See Sections R302.11 and R602.6!

2018 IRC NON-BEARING WALL

Figure R602.6.(2)-Similar to R602.6(1)

- **Notching:**
- Not to exceed 40% of width
- **Boring:**
- Not to exceed 60% of depth
- 5/8” minimum from edge stud
- ≥ 40 %, 2x Studs or Stud Shoe

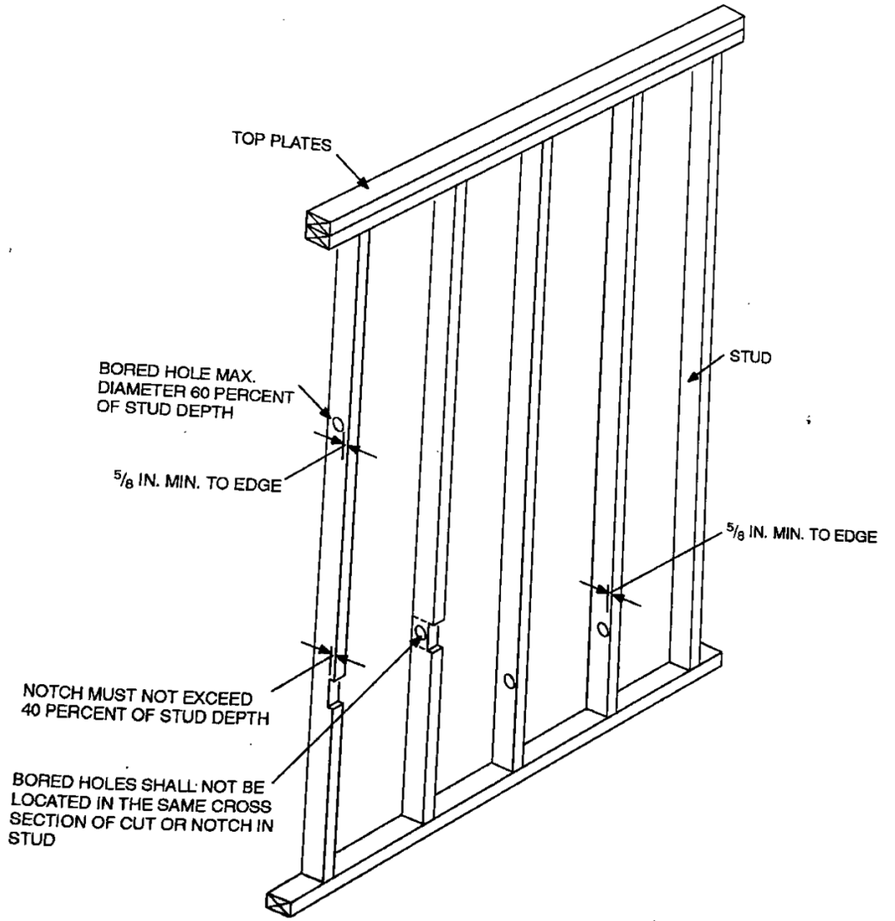
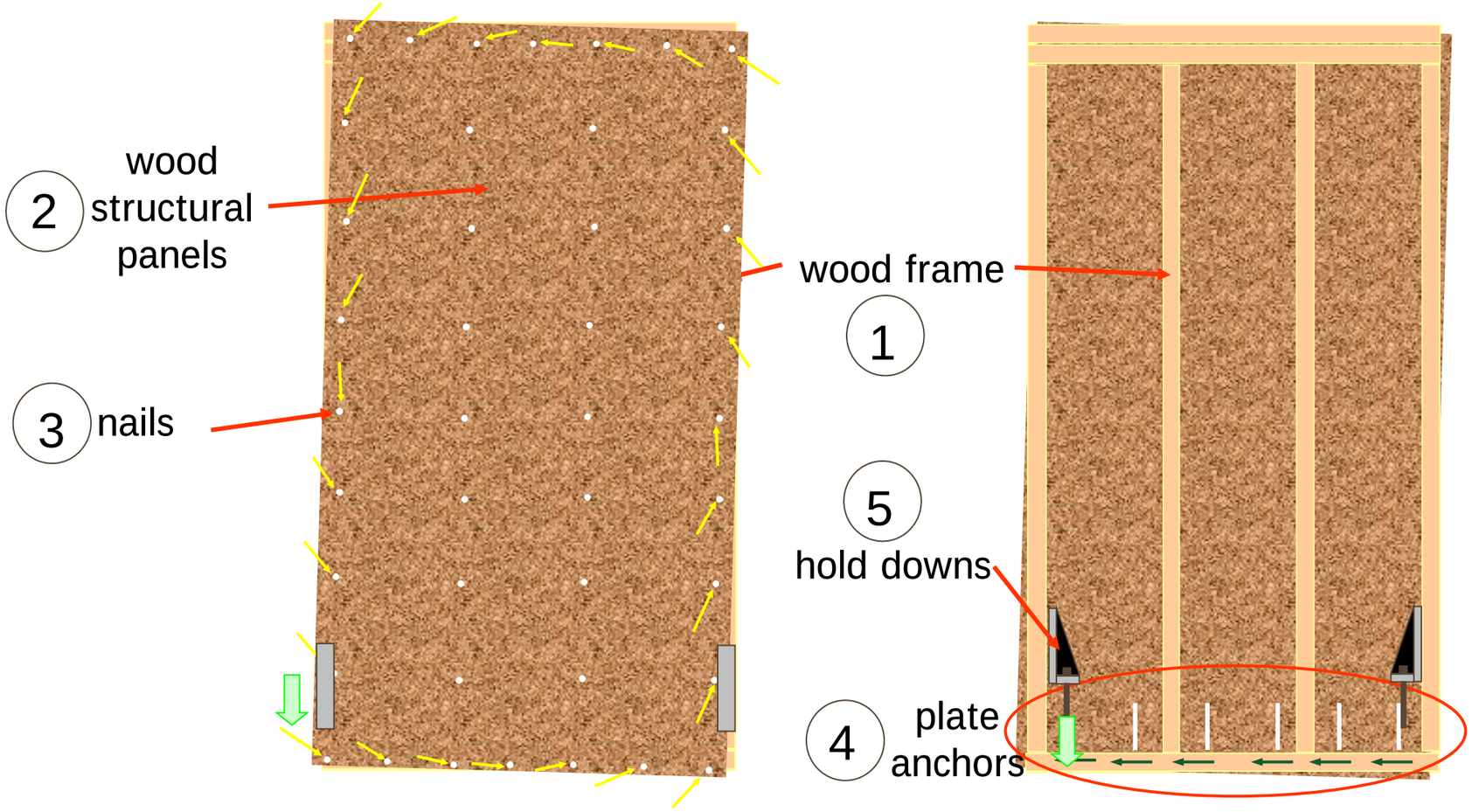


FIGURE R602.6(2)
NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR NONBEARING WALLS

With permission from ICC

WSP WALLS – PARTS….NAILS DO A LOT OF WORK!

Five parts of a SHEAR WALL…similar but different than an IRC Braced Wall Panel.



WOOD FRAMED WALLS

1” x 6” Boards nailed 90° to studs

- Could be Shiplap, Board and Batten, etc.
- Note Let-In, 45° Corner Bracing
- 2 Nails per stud, typical.
- Strong, but not as strong as WSP
- Very common even into early 20th Century

WOOD FRAMED WALLS

WOOD FRAMED WALL EXAMPLES

WALL FRAMING-CHECKLISTS?

- R602.1.1- 602.2 Grade Marks
- R602.3-Design & Construction
- Table R602.3(1)-Fasteners
- R602.3.1-Stud height, plates, bearing, etc.
- R602.3.5 Braced Wall & Load Paths
  R602.4 Non-bearing walls
- R602.6.1 Drilling/Notching Top Plates
- R602.7 Headers & Rim Boards &
  associated Figures (R602.7.1, etc.)
- R602.8 Fireblocking
- R602.10 Wall Bracing (it's own class)
- Table R602.10.4 BWL Methods

It can get overwhelming!

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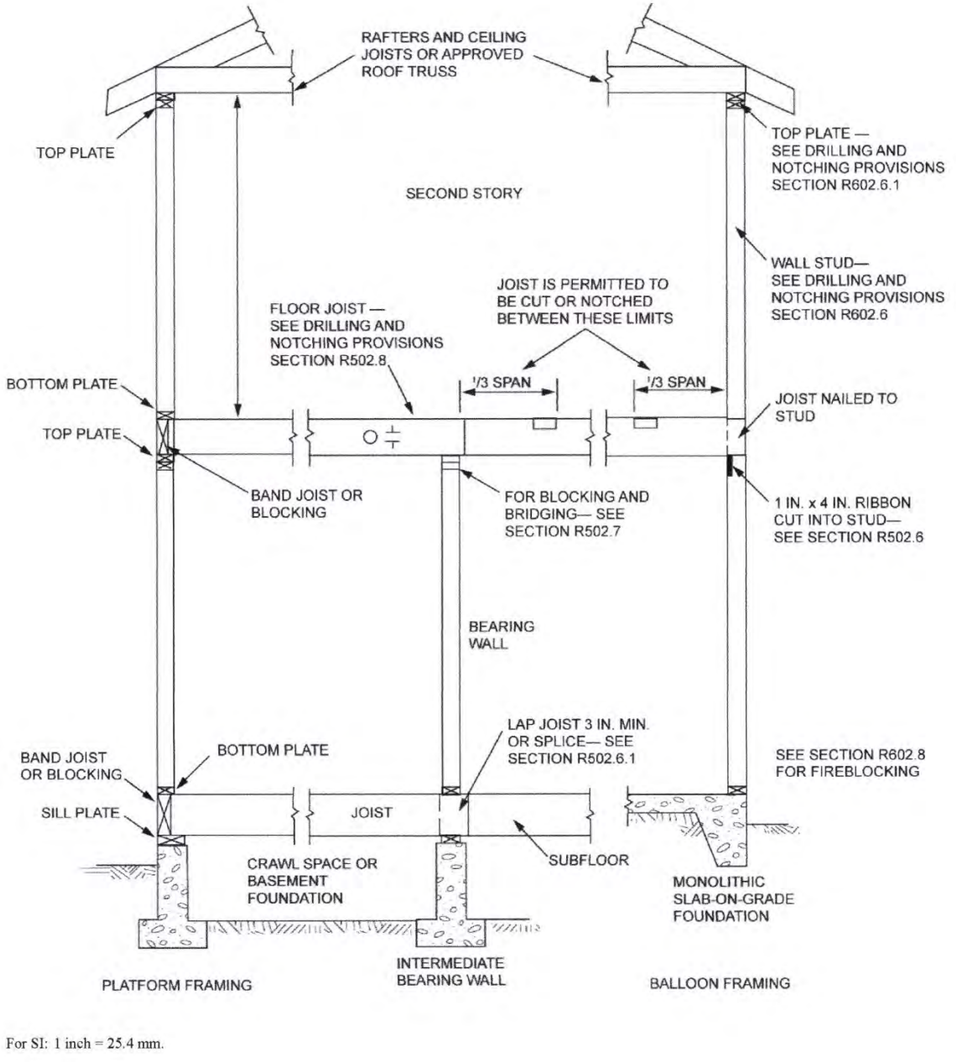
2021 IRC FLOOR, WALL, AND ROOF FRAMING

Figure R602.3(1)

- Calls out terms/locations in building
- Directs you to specific chapters, figures, and tables
- Remember: IRC starts with building planning, drainage, subgrade, footings, foundation walls, floors, framed walls, etc.
- Know the progression, what chapters apply, and their order



For SI: 1 inch = 25.4 mm.

FIGURE R602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING

With permission from ICC 4/29/21

IRC COMPLIANCE-ROOF FRAMING

Rafter Framing Details : R802.4.2

- Framed opposite or max 1.5” offset
- Collar tie or strap
- How defined - See R802.4.6 & R802.5
- Nailed to wall plates, unless…
- Uplift connections per R602.3(1) & R802.11

Figure 3.10b Ridge Board and Ceiling Joist Detail

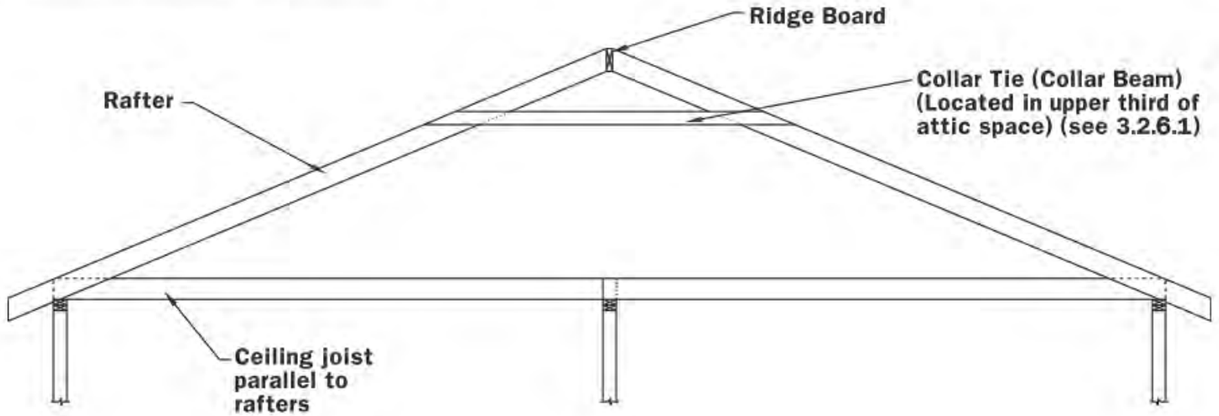
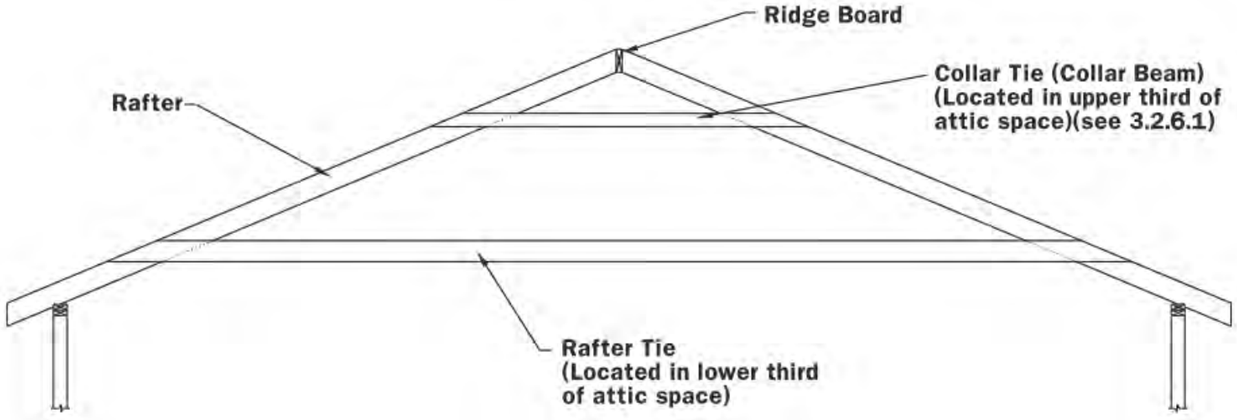
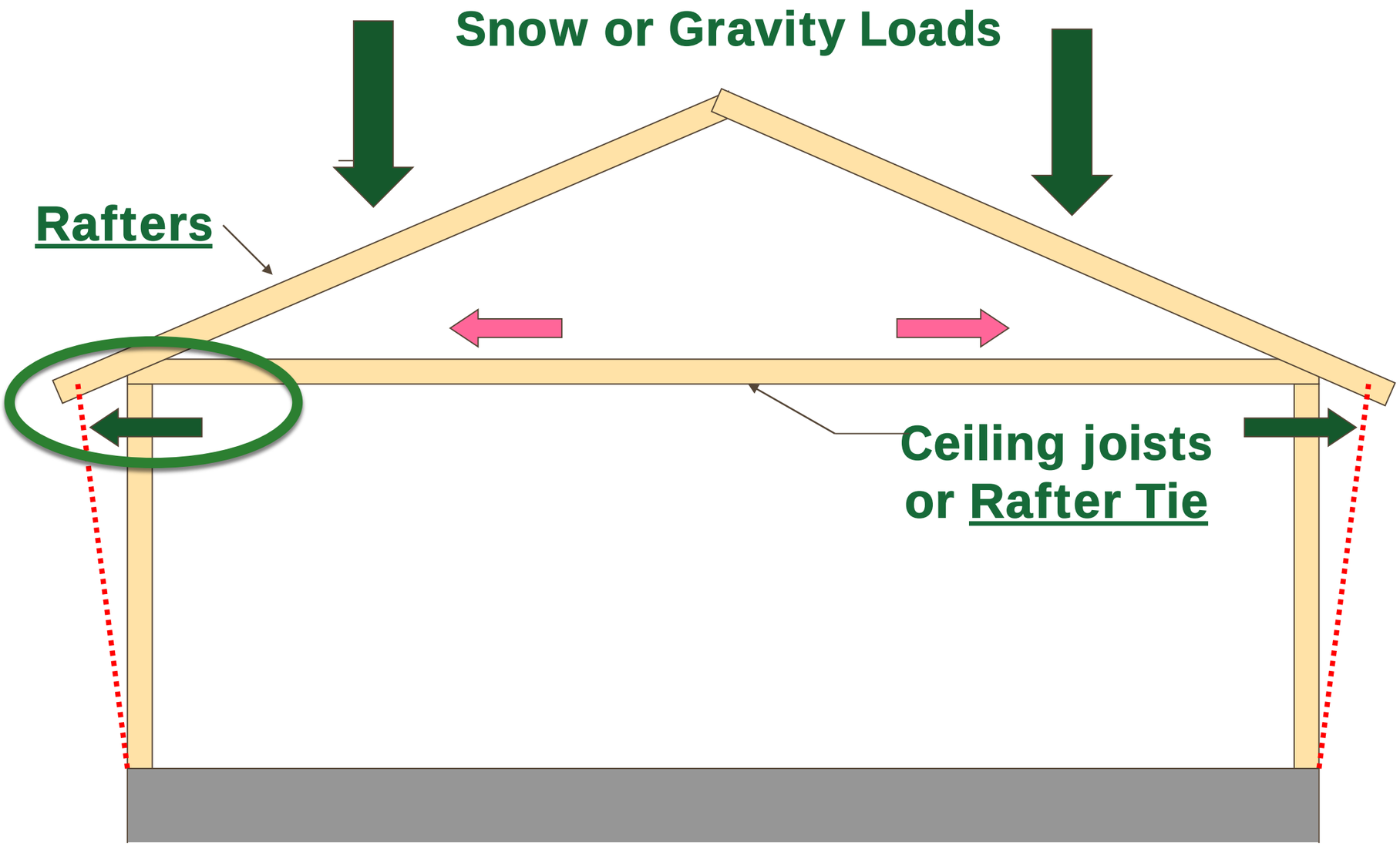


Figure 3.10c Ridge Board and Rafter Tie Detail



ROOF/CEILING FRAMING



SOLID SAWN RAFTERS-TRADITIONAL

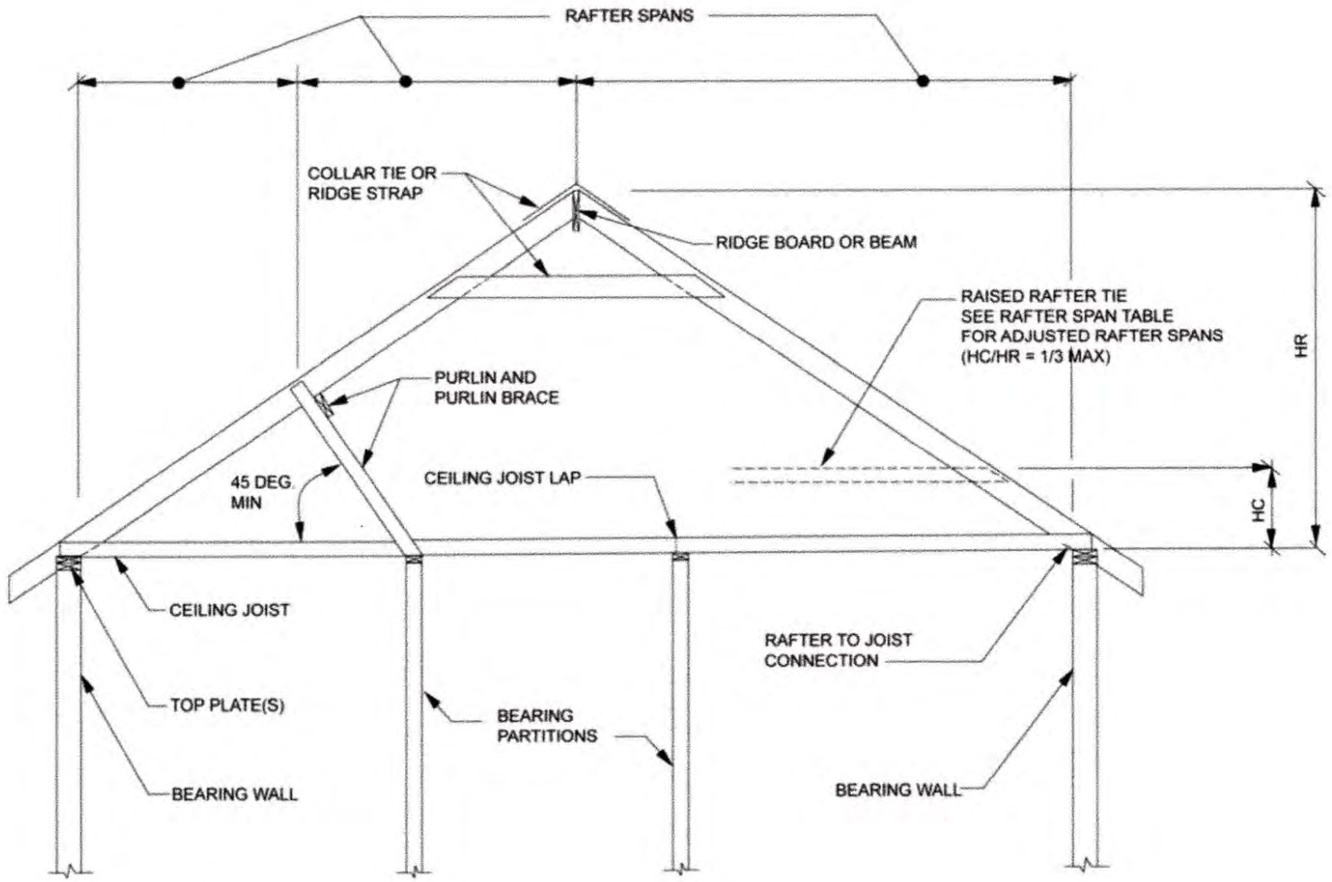
ROOF TRUSSES-MORE COMMON

IRC COMPLIANCE-ROOF FRAMING

Rafter Framing Details: R802.4.2

- Framed opposite* Joined-Collar Tie, Rafter Tie, or Strap
- How defined-See R802.4.6 & R802.5
- Nailed to wall plates, unless...
- Uplift per R602.3(1) & R802.11

*allowance for 1.5” offset



For SI: 1 degree = 0.018 rad.
H_C = Height of ceiling joists or rafter ties measured vertically above the top of rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

FIGURE R802.4.5
BRACED RAFTER CONSTRUCTION

With permission from ICC 4/29/21

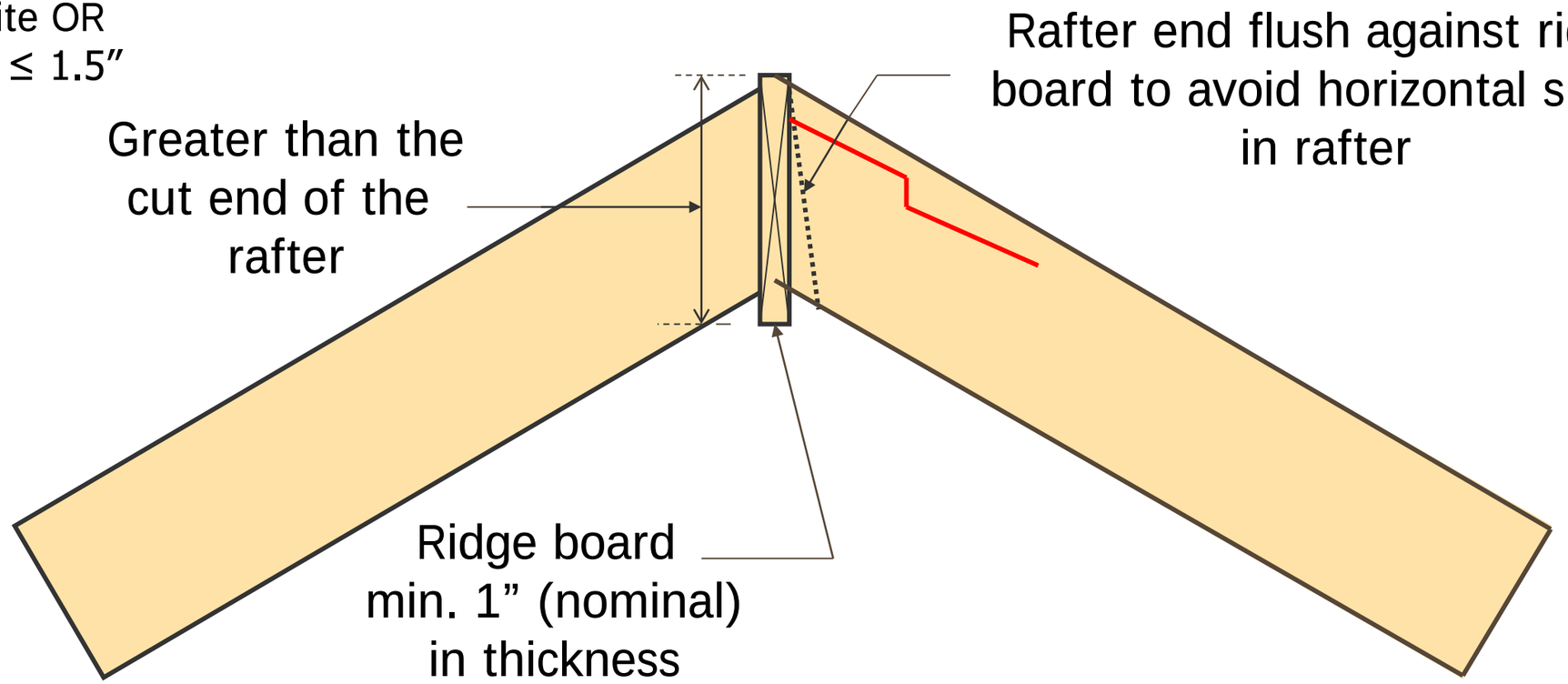
WSP'S-OVERDRIVEN FASTENERS-GUIDANCE

Effect of Overdriven Fasteners on Shear Capacity

https://www.apawood.org/publication-search?q=overdriven&tid=1

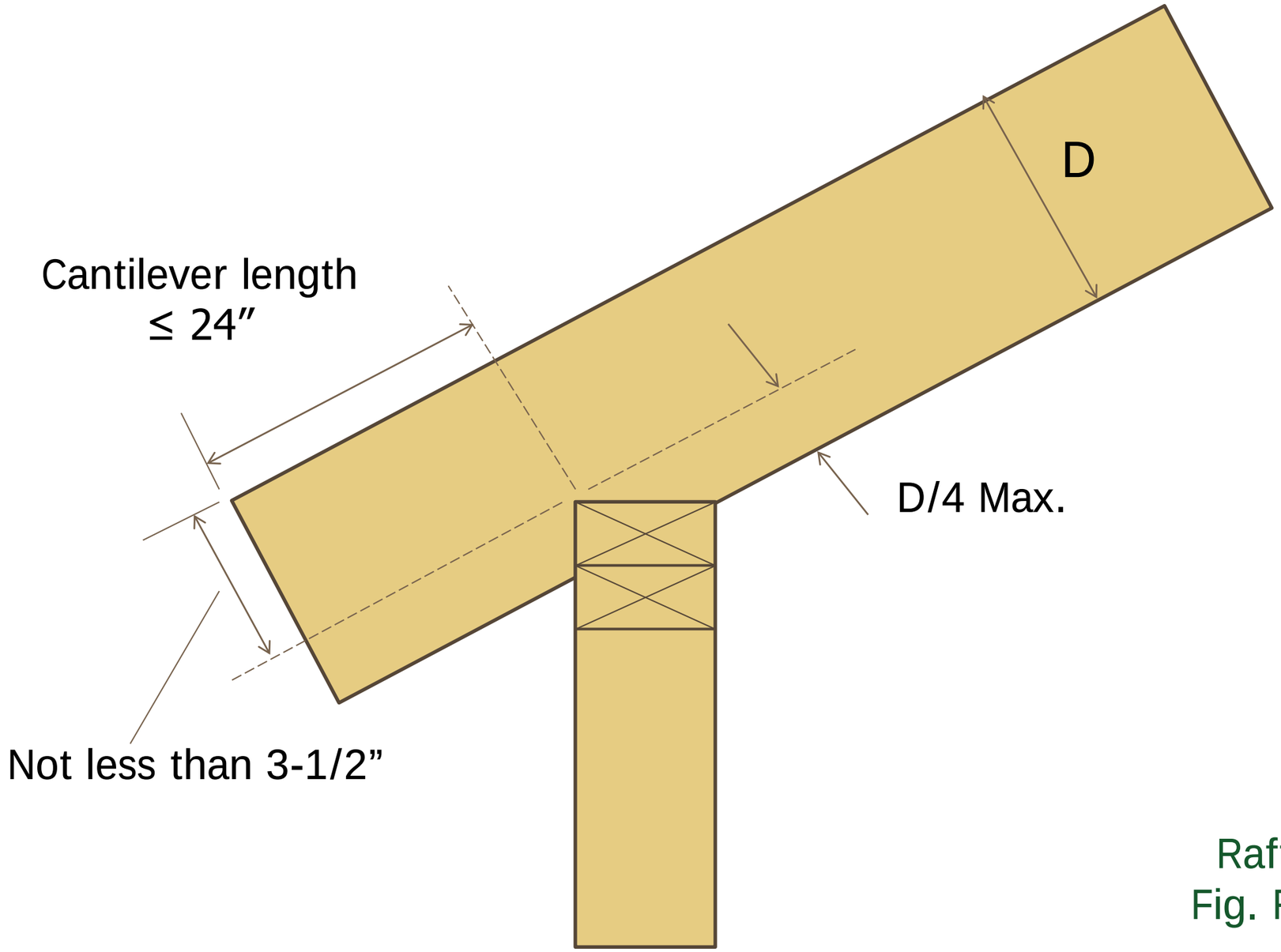
RIDGE BOARD FRAMING REQUIREMENTS

R802.4.2
Framed opposite OR
ridge strap, or ≤ 1.5”



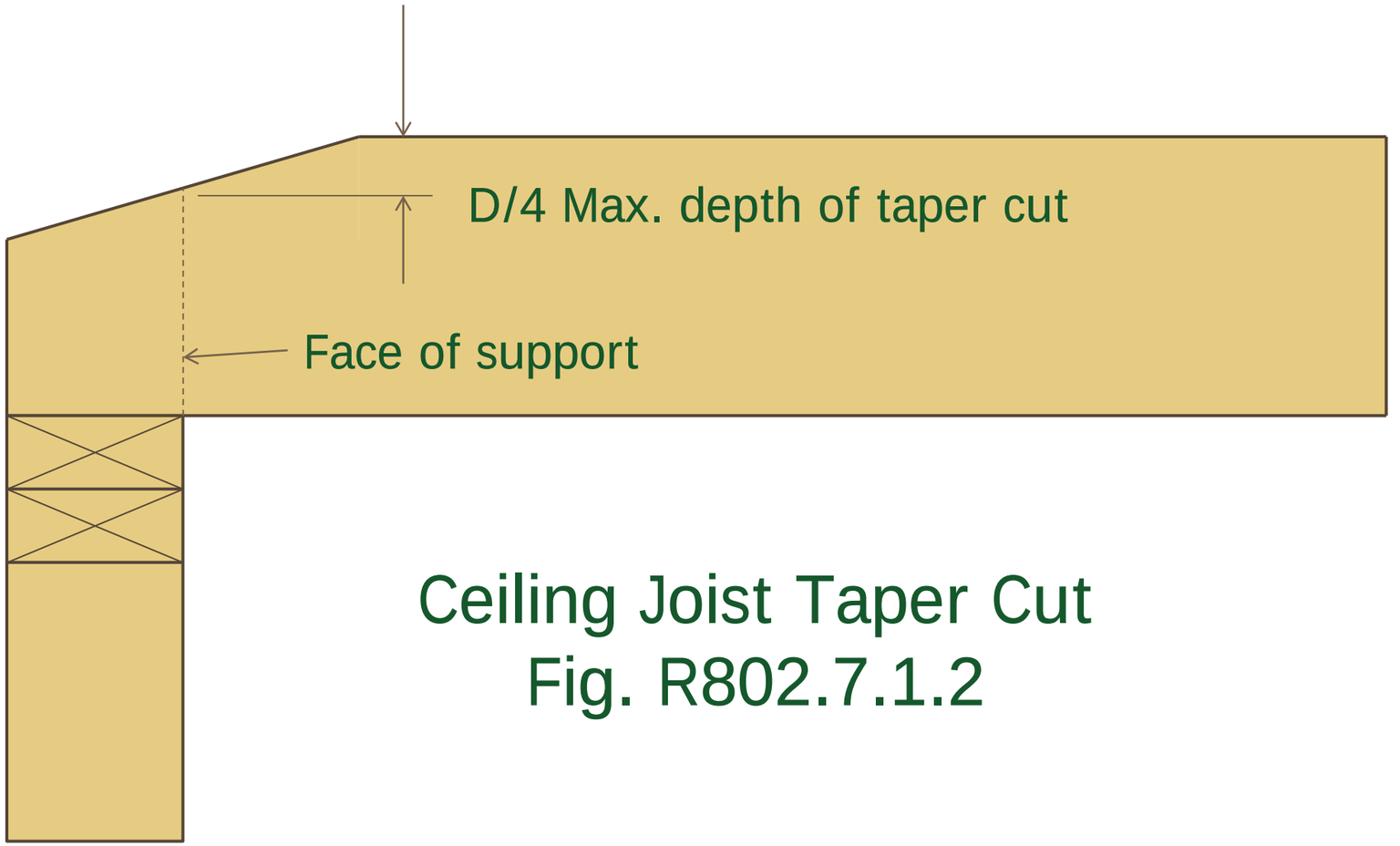
Ridge Board

RAFTER/TOP PLATE CONNECTION



Rafter Notch
Fig. R802.7.1.1

ROOF/CEILING FRAMING 2018 EDITION



Ceiling Joist Taper Cut
Fig. R802.7.1.2

ROOF CEILING COMPLIANCE-IRC CHAPTER 8

Rafter Table: R802.4.1(1)
16” O.C. spacing

- Horizontal span
- Wood species
- Nominal sizes
- O.C. spacing
- Grade
- Dead loads
- Deflection (L/Δ)

TABLE R802.4.1(1)
RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling not attached to rafters, $L/\Delta = 180$)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
16	Hem-fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-11	24-4	Note b
	Hem-fir	#1	9-8	15-2	19-2	23-5	Note b	9-0	13-1	16-7	20-4	23-7
	Hem-fir	#2	9-2	14-2	17-11	21-11	25-5	8-5	12-3	15-6	18-11	22-0
	Hem-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	25-7	Note b
	Southern pine	#1	9-10	15-6	19-10	23-2	Note b	9-1	13-7	17-2	20-1	23-10
	Southern pine	#2	9-0	13-6	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0

With permission from ICC 4/29/21

RAFTER FRAMING-VIOLATION

RAFTER/CEILING JOIST CONNECTION

ROOF TRUSS DESIGN DRAWINGS

- Design professional needed?
- Truss manufacturer provided drawings
- Slope, depth, span, spacing, joints, bearing, lumber species, bracing, etc.
- ALL DESIGNS LOADS! Bottom chord, top chord, concentrated loads, etc.

TRUSSES-CONNECTION DETAILS

PRE-ENGINEERED CONNECTORS AND WOOD MEMBERS

Truss hardware:

- Notice the size of the connector and how it spreads the load out over the wood member
- Note: Middle 1/3-occupied space connectors and bottom chords are **larger.**

TRUSSES-PRIOR TO PLACEMENT

TRUSS FIELD REPAIR

- Signed and Sealed
- May be a WSP gusset or sistered or “sandwiched” 2x solid sawn lumber
- Detailed & specific fastener schedule provided by designer
- Truss Manufacturer - shall provide!

TRUSSES, CONTD.

- Is it easier to spot what is missing vs. what is there?
- Do the trusses in the field match the approved shop drawings?
- Do the plan dates/submittals match?
- Change orders?
- Right truss package, but wrong house?
- Devil is in the details!

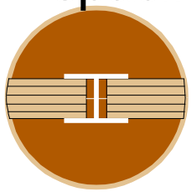
CORRECT PANEL SPACING

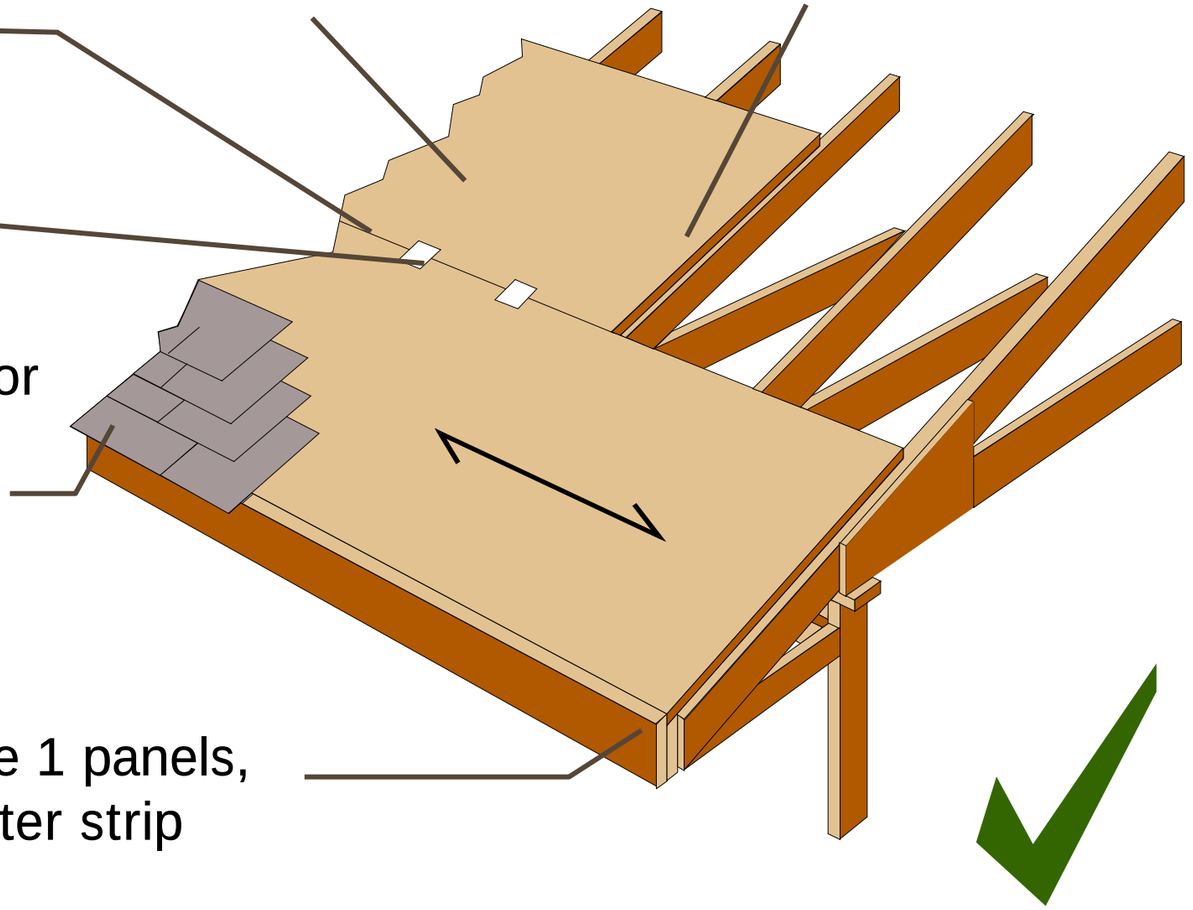
Panel clip or tongue-and-groove edges if required

1/8" spacing

SHEATHING

Stagger ends



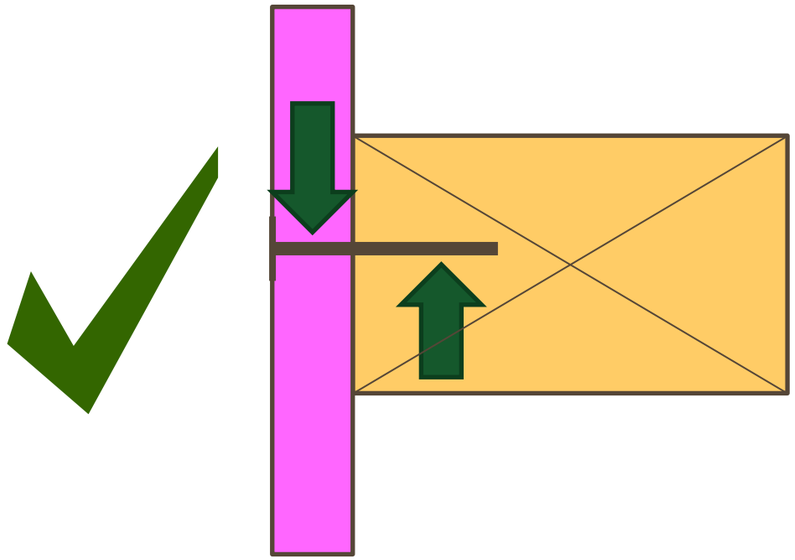


Asphalt or wood shingles or shakes. (refer to manufacturer's recommendations)

Protect edges of Exposure 1 panels, or use Exterior panel starter strip

FASTENING WOOD STRUCTURAL PANELS (WSP'S)

IBC 2304.9.2 Sheathing fasteners. Sheathing nails or other approved sheathing connectors shall be driven so that their head or crown is **flush** with the surface of the sheathing.

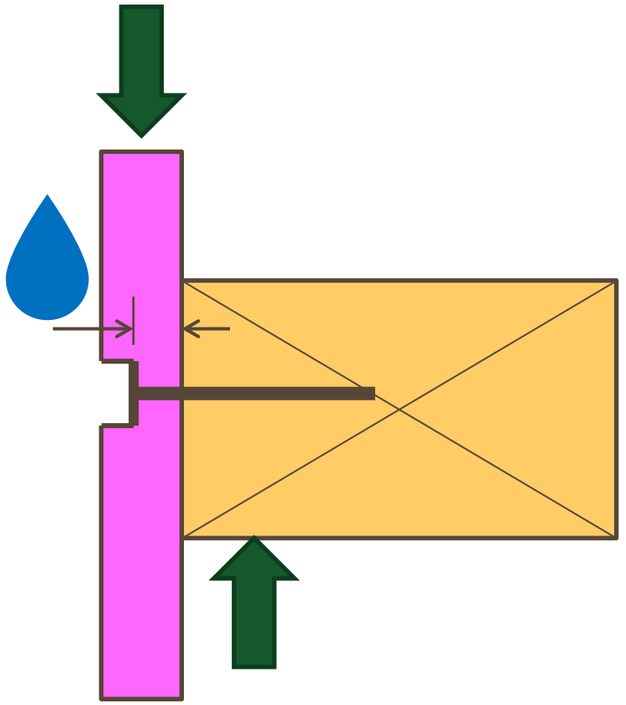


Assuming the panel is fastened properly to the studs, this is happening at every nail, both on the edge and in the field of the panel.

OVERDRIVEN NAILS

Strength Loss:

- If ALL nails 1/16” Overdriven= No Loss
- If ≤ 20% of nails are overdriven no Deeper than 1/8”= No Loss
- If ≥ 20% of perimeter nails are overdriven by 1/16”, or **ANY** nails are overdriven more than 1/8”, additional fasteners are required!



WSP'S-OVERDRIVEN FASTENERS-GUIDANCE

https://www.apawood.org/publication-search?q=overdriven&tid=1

TYPICAL NAIL HEADS

Full Round

ASTM F1667

Offset Round

D-Head

Notched Head

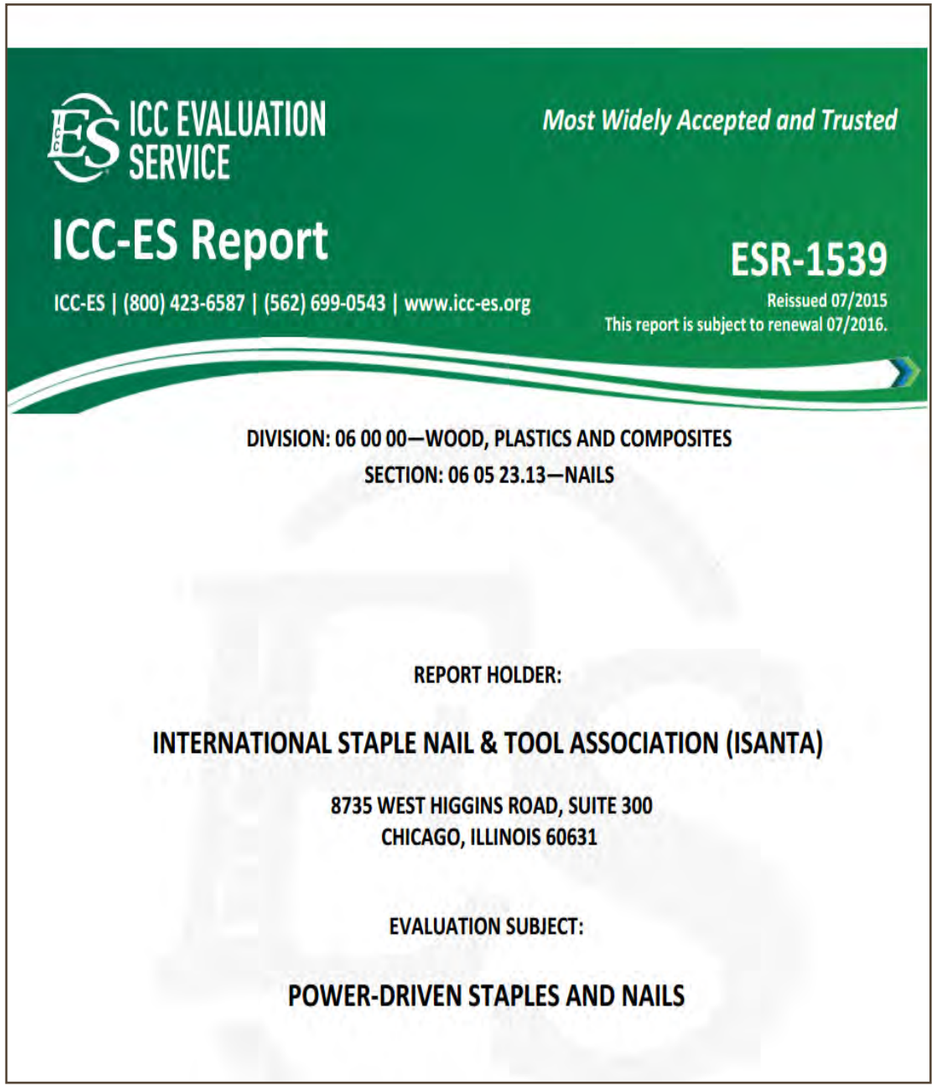
Photos courtesy Falcon Fasteners

ESR 1539

Photos courtesy of Hitachi – Falcon - Hitachi

FASTENERS NOT PRESCRIBED

- Yield Mode Equations can be applied to any cylinder-shaped fastener
- Fastener dimensions and yield strength come from manufacturer
- ICC-ES (www.icc-es.org) Evaluation Service Reports
- Searchable database
- **ESR 1539 (ISANTA) Power-driven staples & nails**



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Reissued 07/2015

This report is subject to renewal 07/2016.

DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

SECTION: 06 05 23.13—NAILS

REPORT HOLDER:

INTERNATIONAL STAPLE NAIL & TOOL ASSOCIATION (ISANTA)

8735 WEST HIGGINS ROAD, SUITE 300

CHICAGO, ILLINOIS 60631

EVALUATION SUBJECT:

POWER-DRIVEN STAPLES AND NAILS

TABLE 1—SCOPE OF NAIL SIZES ADDRESSED IN THIS REPORT[1]

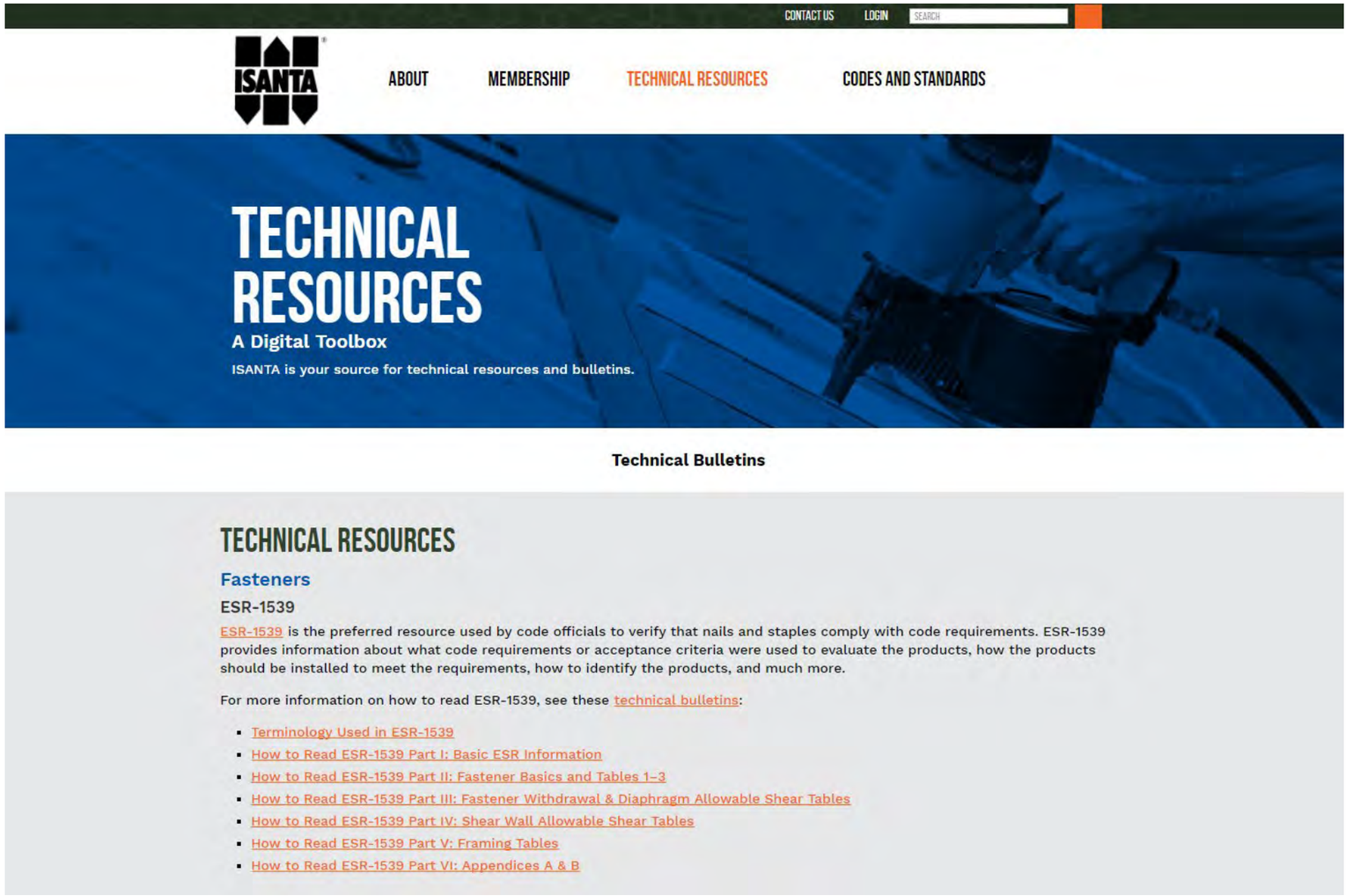
SHANK DIAMETER (inch)	DESCRIBED IN ASTM F1667				OTHERS	
	TYPE AND PENNYWEIGHT	LENGTH (inches)	HEAD DIAMETER (inch)	SHANK STYLE	COMMONLY AVAILABLE LENGTHS[2] (inches)	SHANK STYLES
0.099	6d box	2	0.266	Smooth	2, 2 1/4	Smooth, Ring, Screw
0.113	6d common	2	0.266	Smooth	2, 2 3/8, 2 1/2	Ring, Screw
	8d box	2 1/2	0.297			
	8d cooler	2 3/8	0.281			
0.120	–	–	–	–	3, 3 1/4	Smooth, Ring, Screw
0.128	10d box	3	0.312	Smooth	–	–
0.131	8d common	2 1/2	0.281	Smooth	1 1/2, 2 1/4, 2 3/8, 2 1/2, 3, 3 1/4, 3 1/2, 4	Smooth, Ring, Screw
0.135	16d box	3 1/2	0.344	Smooth	3 1/2	Ring, Screw
0.148	10d common	3	0.312	Smooth	1 1/2, 2 1/2, 3, 3 1/4, 3 1/2	Ring, Screw
	12d common	3 1/4	0.312			
0.162	16d common	3 1/2	0.344	Smooth	2 1/2, 3, 3 1/2	Ring, Screw
0.180	–	–	–	–	5 3/8	Smooth
0.197	–	–	–	–	5 3/8	Smooth

For **SI:** 1 inch = 25.4 mm.

[1]See Appendix B for recognized nail products for each listee.

[2]Includes nail lengths typically associated with Metal Hardware Nails. See Appendix B of this report.

ISANTA WEBSITE – TECHNICAL BULLETINS



http://isanta.org/Technical-Resources

CONNECTORS-DO NOT MODIFY OR ALTER!

- Installation instructions?
- Type and Number of Fasteners?
- Proprietary fasteners? OK?
- Does every hole need a fastener?
- Some connectors can be bent-ONCE!
- Is the connector used correctly for the application?
- What does using the incorrect fastener do for strength, ease of drywall installation, etc.?

ROOF FRAMING-CHECKLISTS?

- **R802.1.1- 802.1.4 Grade Marks**
- **R802.1.5-FRTW, strength loss**
- **Table R802.2 Design & Const.**
- **R802.3 Ridge Board or Beam?-know the difference!**
- **R602.3.5 Braced Wall & Load Paths**
- **Table R802.4.1(1-8) Rafter Span Table-Species, Spacing, Size, Grade, Dead Load/Snow Load Values….pay attention!**
- **R802.4.3-R802.5.2.3 Hips, valleys, collar/rafter ties, etc.**
- **Table R802.5.1(1-2)-Ceiling Joist Spans**
- **R802.6 Rafter tails-bearing, etc.**
- **R803-Roof Sheathing**

It can get overwhelming!

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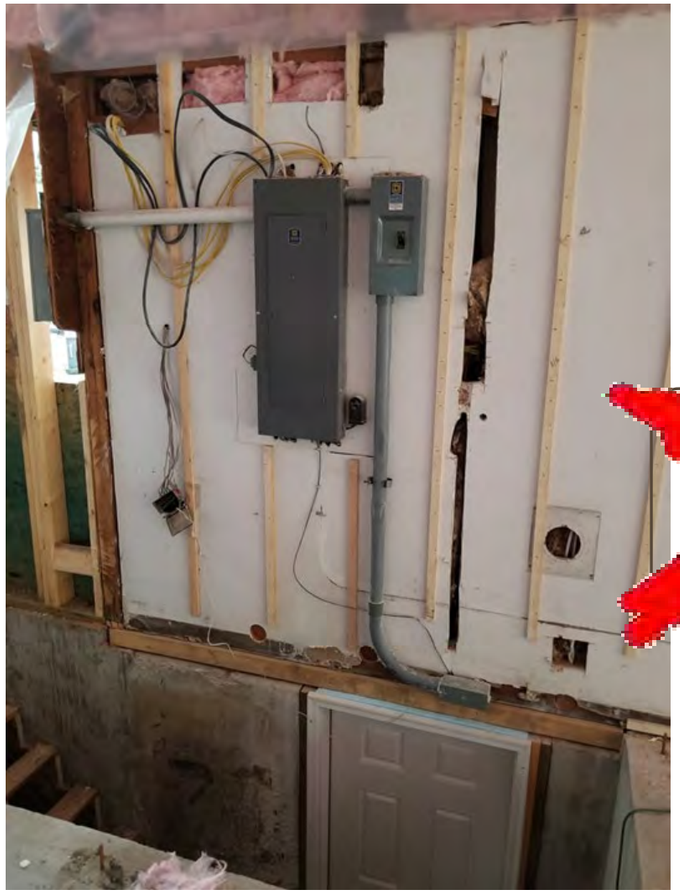
VIOLATIONS OR THE HALL OF SHAME

...should have used the wood stretcher. More nails don't solve short cut studs! Did I mention lack of staggering?

VIOLATIONS OR THE HALL OF SHAME

Sometimes the ability to read the English language is <u>really important</u> or at least know your top from your bottom!

VIOLATIONS OR THE HALL OF SHAME



Giants live in this house or tall electrical main panel

Nail plates and truss top chords are really overrated!

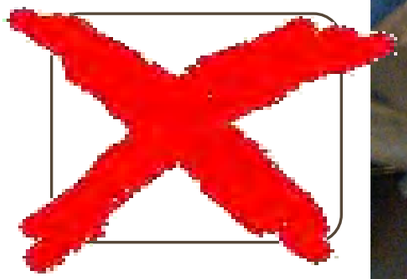
VIOLATIONS OR THE HALL OF SHAME

Not rafters.....

There are no words here...

VIOLATIONS OR THE HALL OF SHAME

It’s a Prince stud, not a King stud!

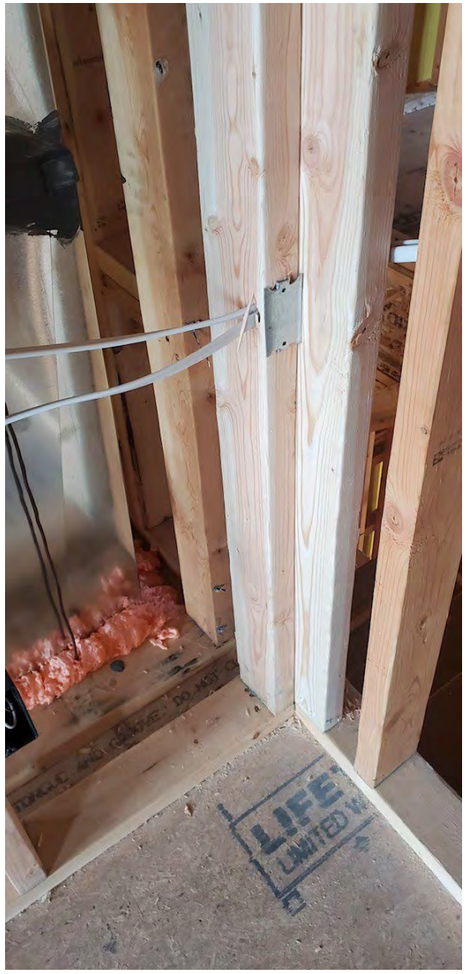


Those were stairs? Really?

RIGHT AND WRONG WAY FOR NAIL PLATES

Who needs nail plates?

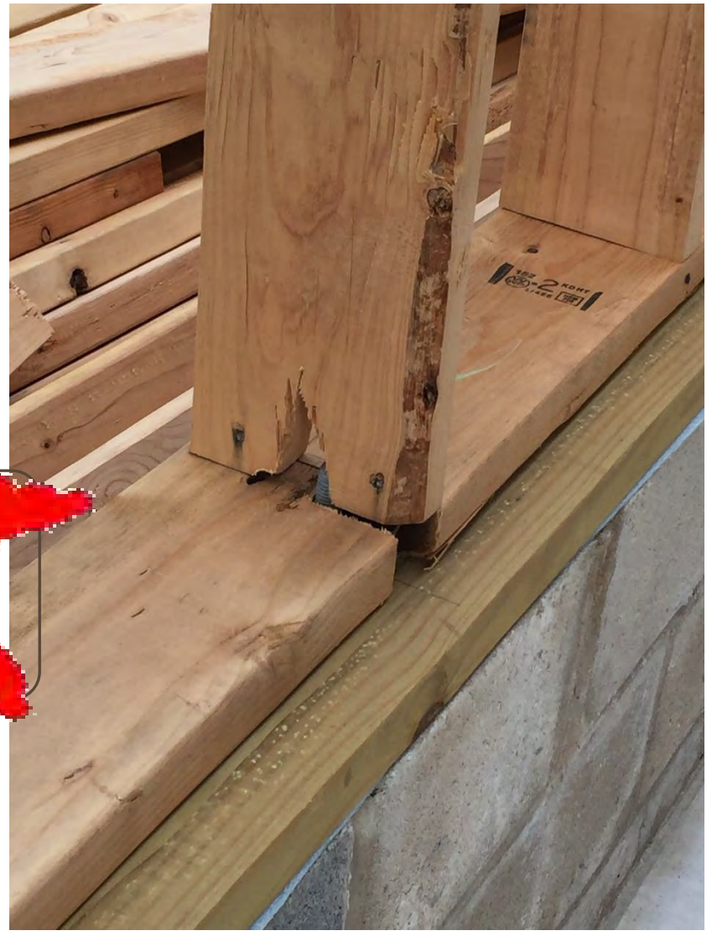
It’s only 200 Amps!



Remember Figure R602.6(1)!

VIOLATIONS OR THE HALL OF SHAME

What do you mean PT plates need to be flush with the foundation wall? Better ventilation this way!
Latest house accessory: pre-rusted nails!



Skyhook studs...latest proprietary technology!

Questions for Matt

Email: mhunter@awc.org

AMERICAN WOOD COUNCIL

info@awc.org | www.awc.org

This concludes the American Institute of Architects Continuing Education Systems Course