Mid-Rise Engineering Considerations for Engineered Wood Products

Presented by Jeff Olson, P.E.

Boise Cascade
Engineered Wood Products

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Wood products take on a seemingly infinite variety of shapes and forms. While many designers are familiar with engineered wood products such as I-joists and structural composite lumber, it is important to understand the structural requirements associated with each in order to achieve proper performance—especially in mid-rise applications. With an emphasis on products used in commercial and multi-family buildings, this presentation will cover product overview, dimensional stability, lateral design, and fire resistance.

Learning Objectives

1. Review engineered wood product options for commercial and multi-family applications.

2. Dimension stability in regards to moisture content changes and the differences between EWP and solid wood products.

3. EWP Lateral design considerations, including information on I-joist diaphragm capacities and the detailing of rim board connections.

4. Fire resistance design, including wood I-joist assembly requirements and SCL char rate equivalency to solid wood.

What is EWP?

Engineered Wood Products (EWP)

Prefabricated Wood I-Joists

Structural Composite Lumber (SCL)

- Laminated Veneer Lumber (LVL)
- Parallel Strand Lumber (PSL)
- Laminated Strand Lumber (LSL)

Other EWP Products

- Glulam
- Plywood
- Metal-Plate Wood Trusses
- Oriented Strand Board (OSB)
- Cross Laminated Timber (CLT)

EWP Code Acceptance

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

104.11.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

2303.1.2 Prefabricated wood I-joists. Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D 5055.

2303.1.9 Structural composite lumber. Structural capacities for structural composite lumber shall be established and monitored in accordance with ASTM D 5456.

Wood I-Joists Product Acceptance

- ICC ES Evaluation Reports
- Allows proprietary product as an alternate building material in the code
- Based upon ASTM Standard D5055
- Approximately 600 tests to qualify one series of I-joists with 4 depths
- Third party certification required

ICC EVALUATION SERVICE

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ICC-ES Evaluation Report **ESR-1336**

Reissued September 1, 2011

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
Section: 06 17 33—Wood I-joists

REPORT HOLDER:

Compliance with the following codes:

- 2009 *International Building Code®* (2009 IBC)
- 2009 *International Residential Code®* (2009 IRC)
- 2006 *International Building Code®* (2006 IBC)
- 2006 *International Residential Code®* (2006 IRC)

Properties evaluated:

- Structural
- Sound ratings
- Fire-resistance ratings
- Floor and roof spans

3.2 Material Specifications:

Flanges: The flanges of the BCI I-joists are laminated veneer lumber that is currently recognized in the approved quality control manual. Flange width, depth and grade requirements are noted in Table 1.

3.2.1 Web: OSB web material is either $^{3}/_{8}$-inch-thick (9.5 mm) or $^{7}/_{16}$-inch-thick (11 mm) Exposure I with a span rating of 24/0.

3.2.2 Adhesive: Adhesives used in the fabrication of the I-joists are exterior-type, heat durable adhesives complying with ASTM D 2559 and ASTM D 5055 and are specified in the approved quality control manual and the Boise Cascade Corporation manufacturing standards.

4.0 DESIGN AND INSTALLATION

4.1 General:

Design and installation of the BCI prefabricated wood I-joists described in this report must comply with the conditions discussed in Sections 4.2 through 4.13 of this report.

4.2 Allowable Capacity:

Table 2 specifies reference design moments, shears, deflection coefficients and I-joist stiffness (*EI*). Reference design reactions are given in Table 3, and are based on a minimum bearing length of either $1^{1}/_{2}$ or $1^{3}/_{4}$ inches (38.1 mm or 44.5 mm) for end supports and $3^{1}/_{2}$ inches (89 mm) at intermediate supports for continuous spans. Other bearing conditions are also shown in the table; linear

EWP Product Acceptance

Design Value Determination

- Lower 5th Percentile value
- Safety factor per ASTM
  - Bending = 2.1
  - Shear = 2.4
- MOE: Mean of test data (serviceability)

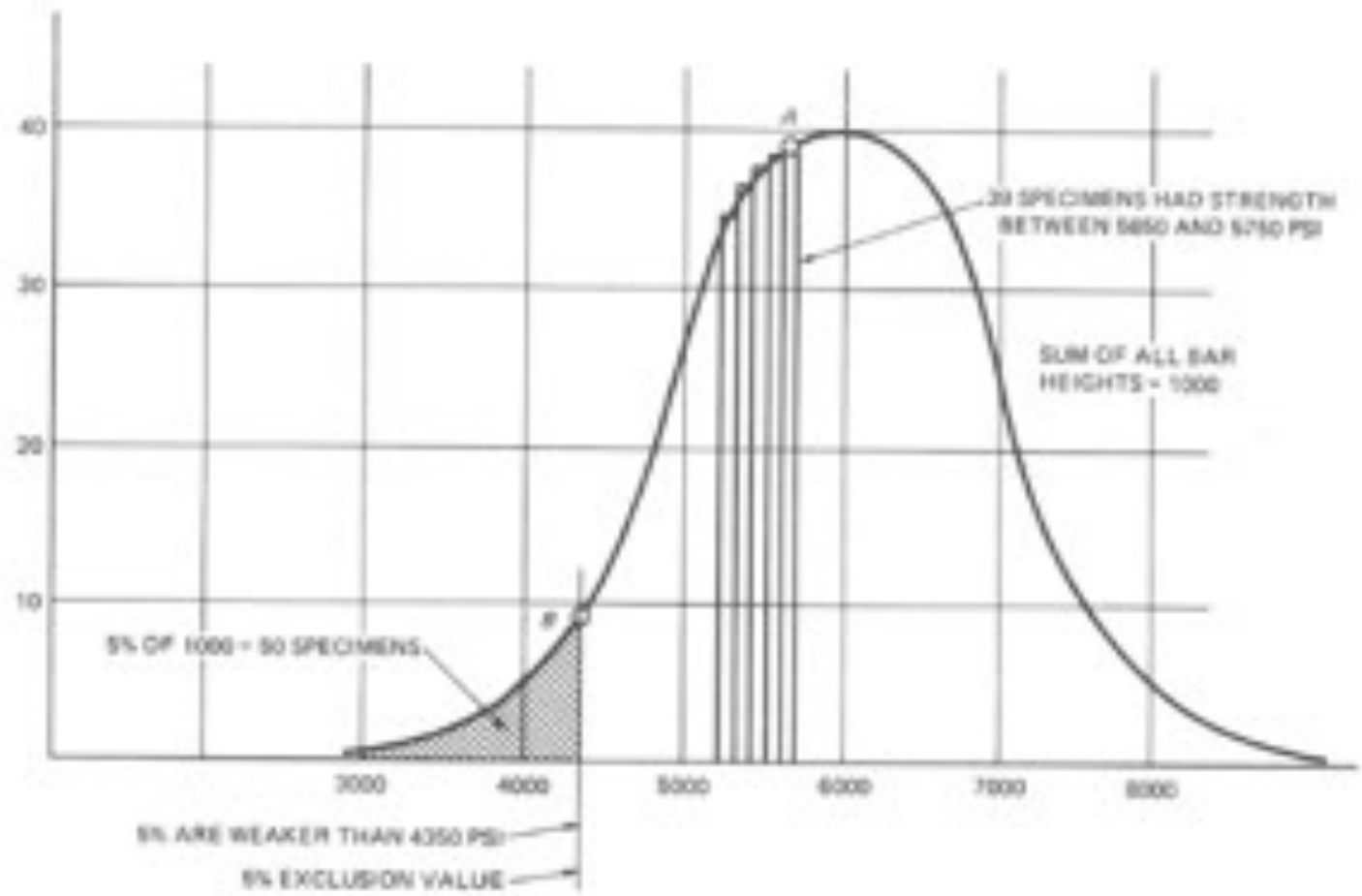


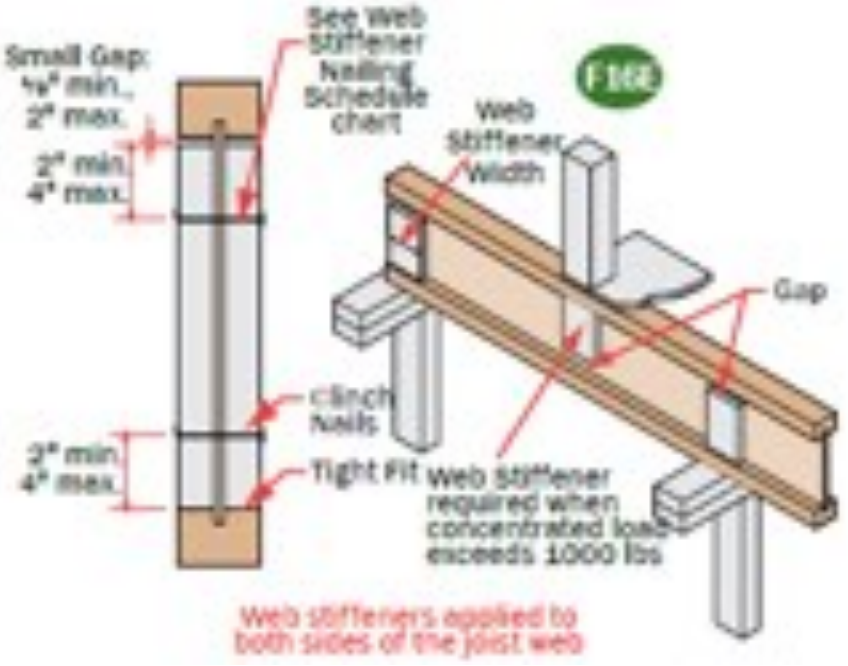
Fig. 4-8. Typical distribution of strength for 1000 specimens.

Wood I-Joists Features

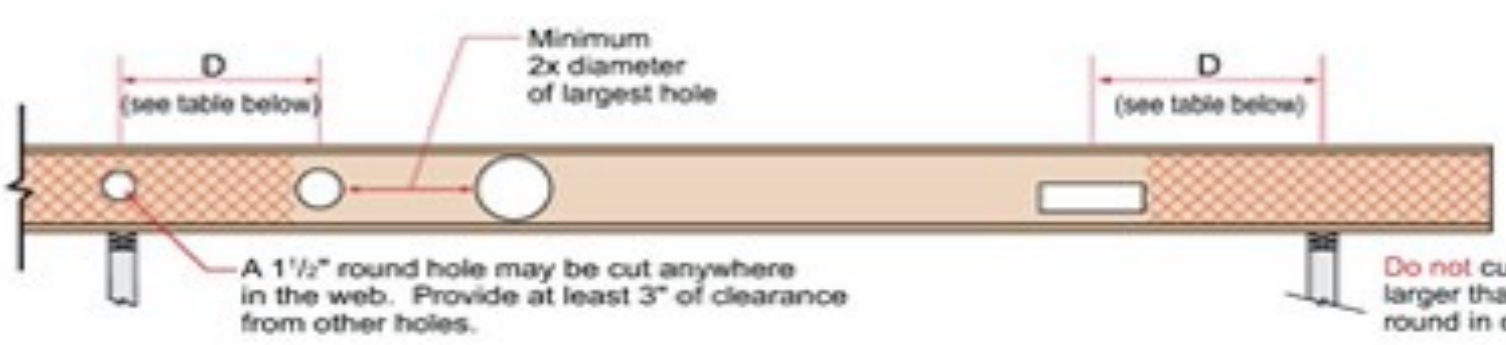
- Variety of flange sizes and joist depths
- Manufactured in 48’ to 66’ lengths
- Manufacturer technical staff to assist engineers, building officials
- Product warranty

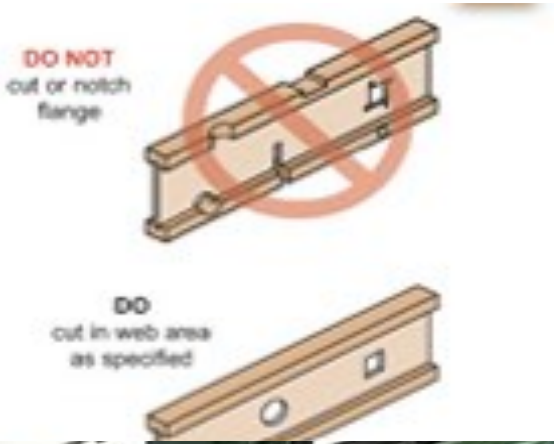
Wood I-Joists: Mid-Rise Features

- Specific Commercial / Multi-Family Technical Literature
- Deep depths available (20”+)
- Web stiffener installation provides higher reaction values
- Large web hole allowances for mechanical



Wood I-Joists Web Holes





MINIMUM DISTANCE (D) FROM ANY SUPPORT TO THE CENTERLINE OF TH											
Round Hole Diameter [in]			2	3	4	5	6	6½	7	8	8⅞
Rectangular Hole Side [in]			-	-	2	4	6	-	-	-	-
Any 9½" Joist	Span [ft]	8	1'-0"	1'-1"	1'-9"	2'-5"	3'-1"	3'-5"			
		12	1'-0"	1'-8"	2'-8"	3'-8"	4'-8"	5'-2"			
		16	1'-0"	2'-2"	3'-6"	4'-11"	6'-3"	6'-11"			
Round Hole Diameter [in]			2	3	4	5	6	6½	7	8	8⅞
Rectangular Hole Side [in]			-	-	-	2	3	4	5	7	8
Any 11⅞" Joist	Span [ft]	8	1'-0"	1'-1"	1'-2"	1'-3"	1'-9"	2'-0"	2'-4"	2'-10"	3'-4"
		12	1'-0"	1'-1"	1'-2"	1'-10"	2'-8"	3'-1"	3'-6"	4'-4"	5'-1"
		16	1'-0"	1'-1"	1'-4"	2'-6"	3'-7"	4'-1"	4'-8"	5'-9"	6'-9"
		20	1'-0"	1'-1"	1'-9"	3'-1"	4'-6"	5'-2"	5'-10"	7'-3"	8'-5"

Structural Composite Lumber

- Laminated Veneer Lumber (LVL)
  - Veneers all oriented in same direction
- Parallel Strand Lumber (PSL)
  - Long strips of veneer glued together
- Laminated Strand Lumber (LSL)
  - 12” long strands
- Oriented Strand Lumber (OSL)
  - 3” – 6” long strands

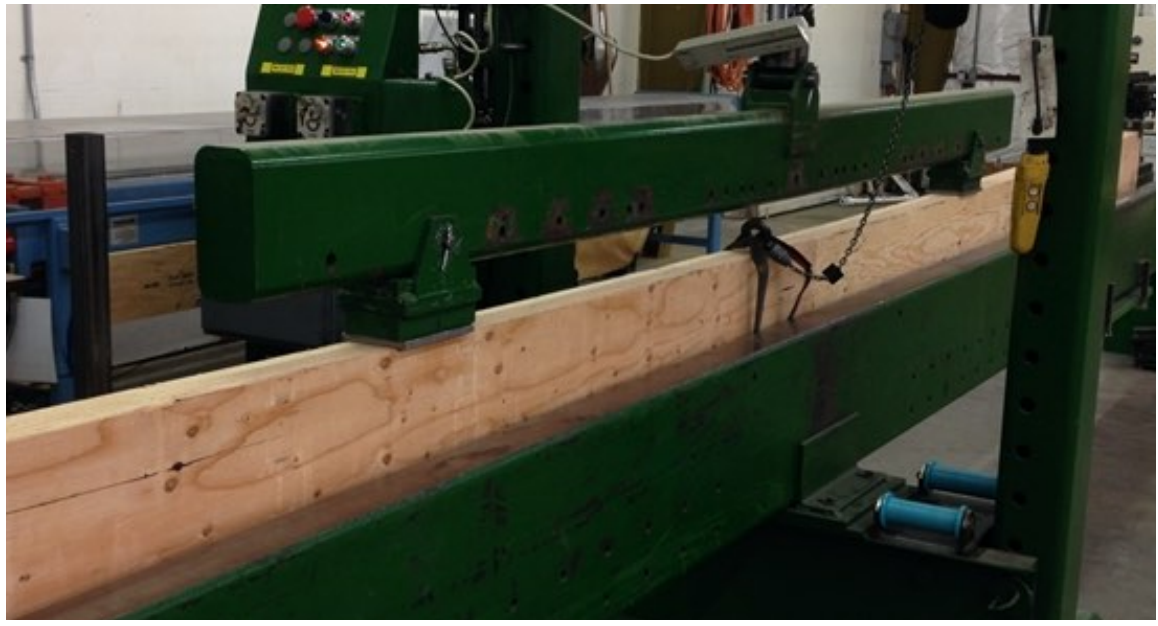
Laminated Veneer Lumber (LVL)

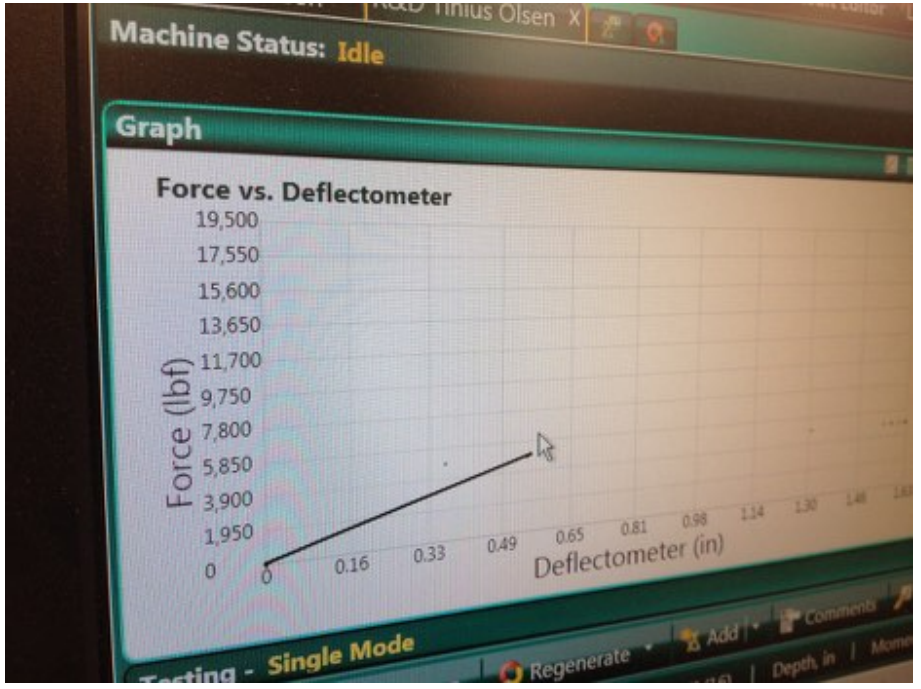
Birch LVL used through out the Hughes Aircraft H-4 Hercules (aka “Spruce Goose”)

SCL Product Acceptance

ASTM D5456

- Strength & Stiffness
- Adhesives
- Durability
- Approximately 1000 tests to qualify a grade of SCL



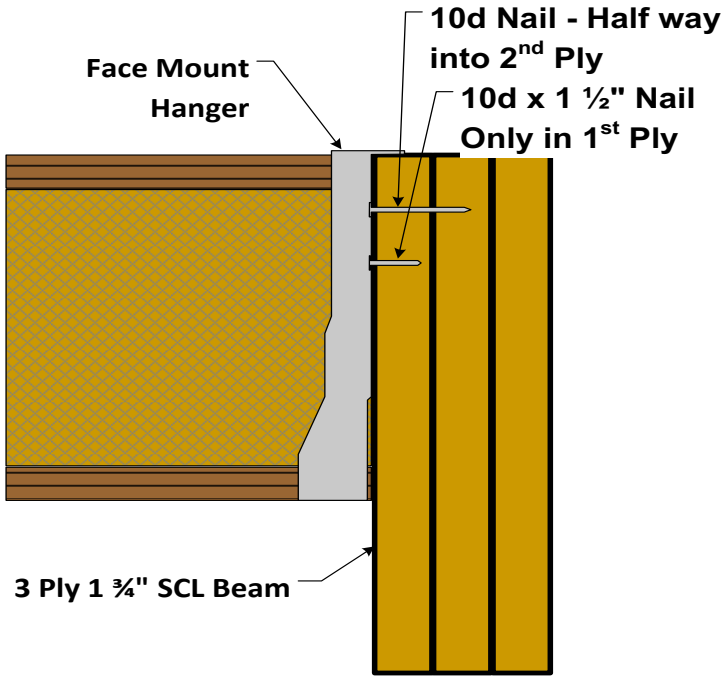


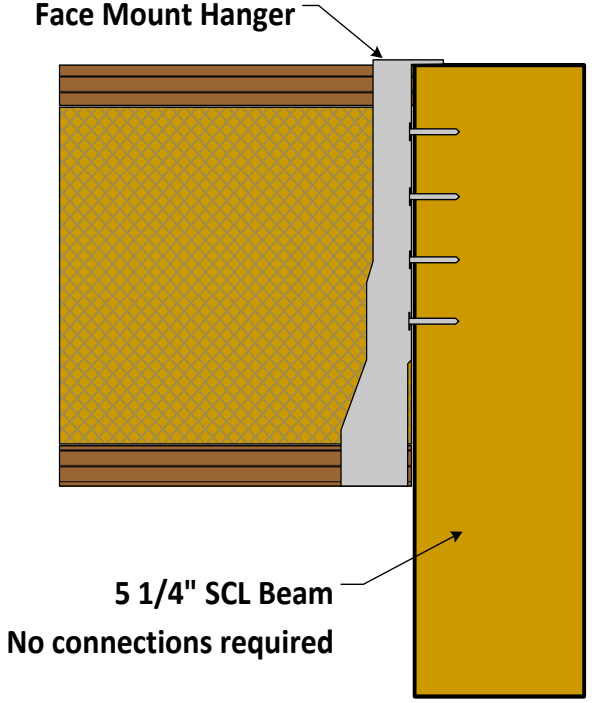
SCL Availability and Use

- Available in 1 ¾”, 3 ½”, 5 ¼”, 7” thicknesses, 1 ¾” most common
- Multiple ply beams must be connected properly for load to be distributed evenly to each ply
- See manufacturer’s literature for nail, self-driving screw, and bolt patterns

Side-Loaded Applications

Number of Members	Maximum Uniform Side Load [plf]							
	Nailed		½" Dia. Through Bolt[5]			⅝" Dia. Through Bolt[5]		
	2 rows 16d Sinkers @ 12" o.c.	3 rows 16d Sinkers @ 12" o.c.	2 rows @ 24" o.c. staggered	2 rows @ 12" o.c. staggered	2 rows @ 6" o.c. staggered	2 rows @ 24" o.c. staggered	2 rows @ 12" o.c. staggered	2 rows @ 6" o.c. staggered
1¾" LVL (Depths of 18" and less)								
2	470	705	505	1010	2020	560	1120	2245
3[5b]	350	525	375	755	1515	420	840	1685
4[5b]	use bolt schedule		335	670	1345	370	745	1495





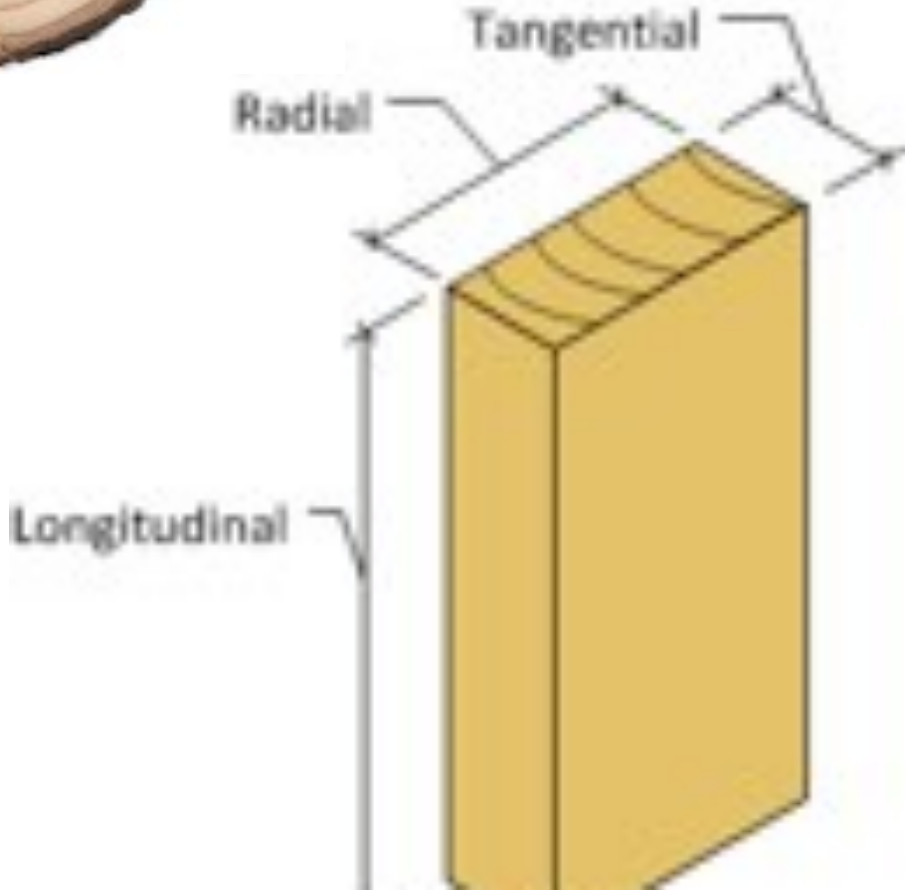
EWP Use in Mid-Rise Structures

Wood Dimension Stability

- Engineered wood typically manufactured at low moisture content (5 - 7%)
- No shrinkage after installation if product kept dry in supply chain
- Slight swelling to equilibrium in most climates

Dimension Stability

- Orthotropic material
- Very little movement in longitudinal direction (log length)
- Shrink/swell ratios:
  - Tangential (along growth rings) / Radial (across growth rings) / Longitudinal = 20 / 10 / 1



Wood Dimension Stability

<u>Example: Platform Framing</u>

Shrinkage (19% to 12% EMC)

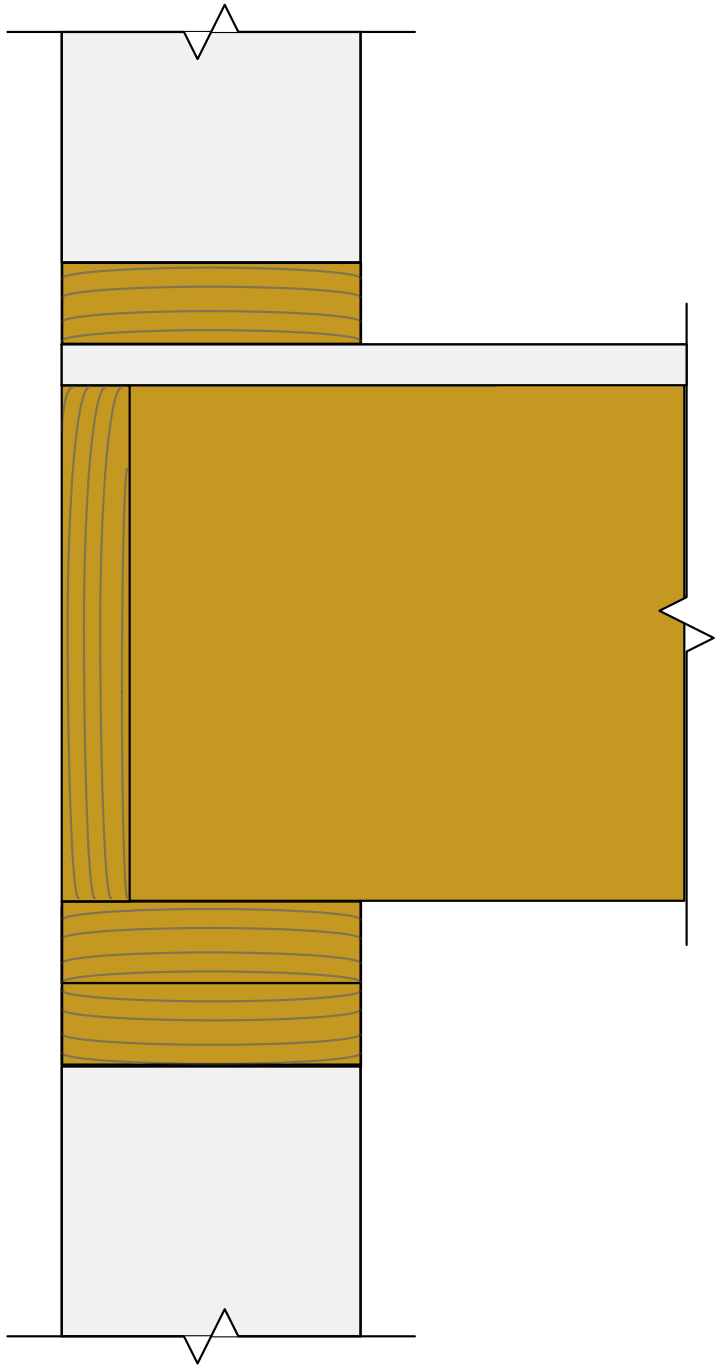
Joist, Rim: 0.21”

Plates: 0.04”

9’ Studs: 0.09”

Total: 0.34”

Values per Forest Product Laboratory Wood Handbook, tangential direction for rim, radial direction for plates



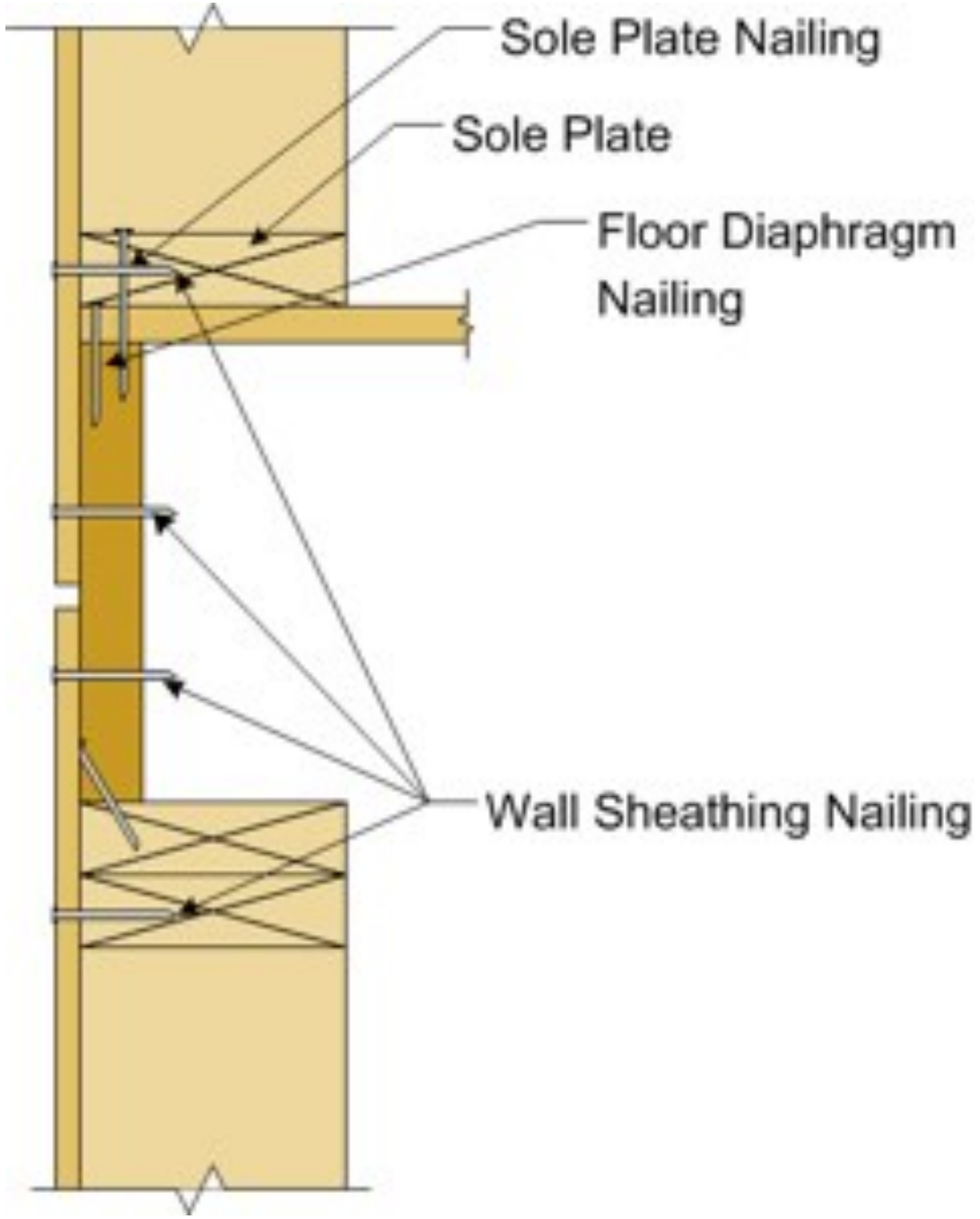
Wood Dimension Stability

Building Code Requirement

2404.3.3:

- Shrinkage analysis required for walls supporting more than 2 floors and roof
- Shrinkage of the wood shall not have adverse effects on the structure or any plumbing, electrical or mechanical systems…

Lateral Load Transfer Design



Wood I-Joist Diaphragms

Each manufacturer tests to establish equivalency to lumber joist diaphragms

- Original APA testing of lumber joists (1950's) – Current wood horizontal diaphragm tables in IBC
- Wood I-joist testing per ICC Acceptance Criteria (full and small scale testing)

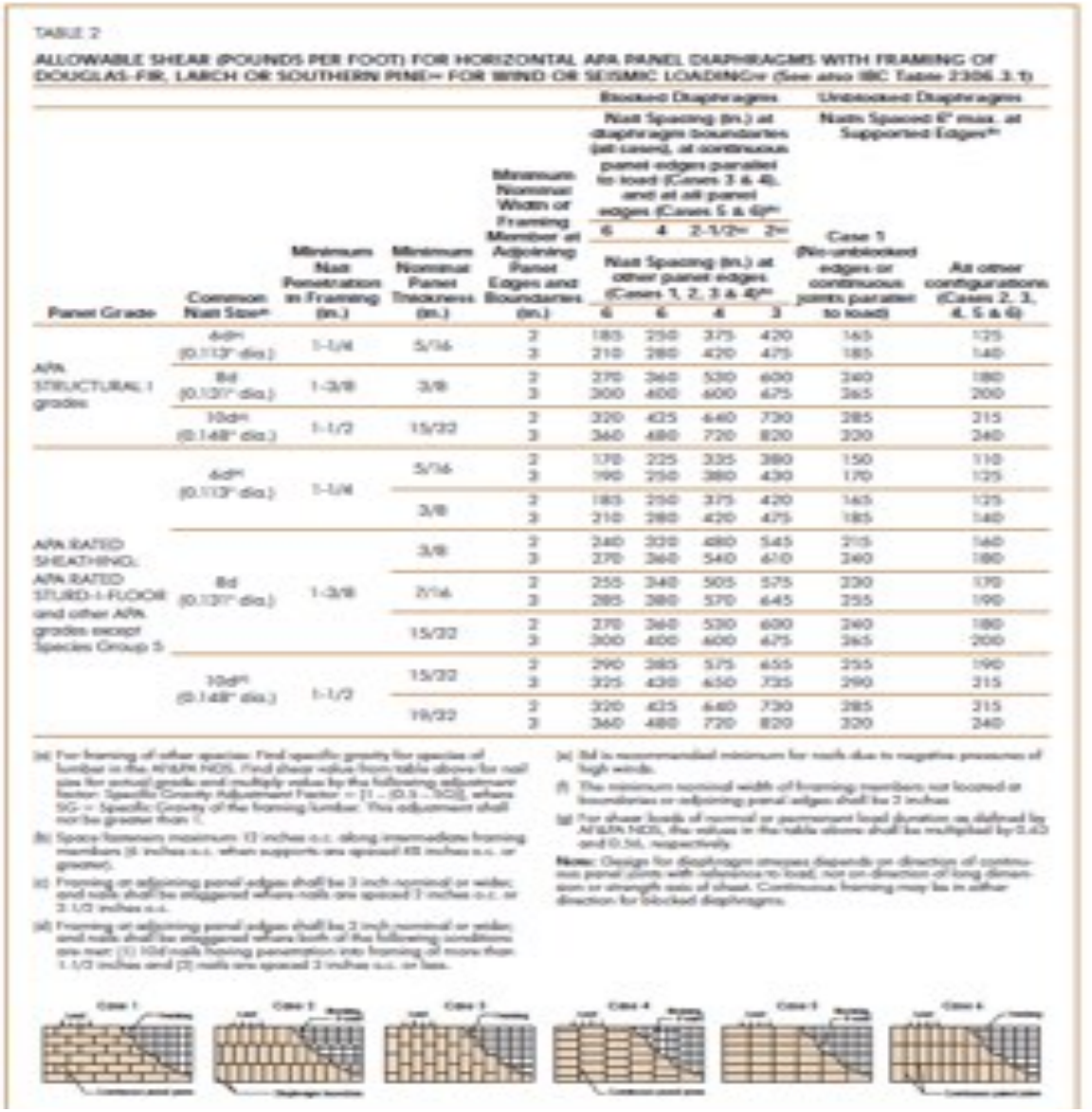


TABLE 2

ALLOWABLE SHEAR (POUNDS PER FOOT) FOR HORIZONTAL APA PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING[b,c] (See also IBC Table 2306.3.1)

Panel Grade	Common Nail Size[d]	Minimum Nail Penetration in Framing (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Framing Member at Adjoining Panel Edges and Boundaries (in.)	Blocked Diaphragms: Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6)[e,f]				Unblocked Diaphragms: Nail Spaced 6" max. at Supported Edges[e,h]	
					6	4	2-1/2[g]	2[g]	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 & 6)
					Nail Spacing (in.) at other panel edges (Cases 1, 2, 3 & 4)[e,f]					
					6	6	4	3		
APA STRUCTURAL I grades	6d[i] (0.113" dia.)	1-1/4	5/16	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	8d (0.131" dia.)	1-3/8	3/8	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	10d[i] (0.148" dia.)	1-1/2	15/32	2	320	425	640	730	285	215
				3	360	480	720	820	320	240
APA RATED SHEATHING; APA RATED STURD-I-FLOOR and other APA grades except Species Group 5	6d[i] (0.113" dia.)	1-1/4	5/16	2	170	225	335	380	150	110
				3	190	250	380	430	170	125
			3/8	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	8d (0.131" dia.)	1-3/8	3/8	2	240	320	480	545	215	160
				3	270	360	540	610	240	180
			7/16	2	255	340	505	575	230	170
				3	285	380	570	645	255	190
			15/32	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	10d[i] (0.148" dia.)	1-1/2	15/32	2	290	385	575	655	255	190
				3	325	430	650	735	290	215
			19/32	2	320	425	640	730	285	215
				3	360	480	720	820	320	240

[a] For framing of other species: Find specific gravity for species of lumber in the NDS. Find shear value from table above for nail size for actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor = [1 - (0.5 - SG)], where SG = Specific Gravity of the framing lumber. This adjustment shall not be greater than 1.

[b] Space fasteners maximum 12 inches o.c. along intermediate framing members (6 inches o.c. when supports are spaced 48 inches o.c. or greater).

[c] Framing at adjoining panel edges shall be 2 inch nominal or wider, and nails shall be staggered where nails are spaced 2 inches o.c. or 2 1/2 inches o.c.

[d] Framing at adjoining panel edges shall be 2 inch nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d nails having penetration into framing of more than 1 1/2 inches and (2) nails are spaced 2 inches o.c. or less.

[e] Nail in recommended minimum for roofs due to negative pressures of high winds.

[f] The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.

[g] For shear loads of normal or permanent load duration as defined by AF&PA NDS, the values in the table above shall be multiplied by 0.63 and 0.56, respectively.

Note: Design for diaphragm stresses depends on direction of continuous panel joints with reference to load, not on direction of long dimension or strength axis of sheet. Continuous framing may be in either direction for blocked diaphragms.

Wood Frame Diaphragms

Where is the wood frame floor diaphragm table now?

- IBC & IRC reference the AWC SDPWS

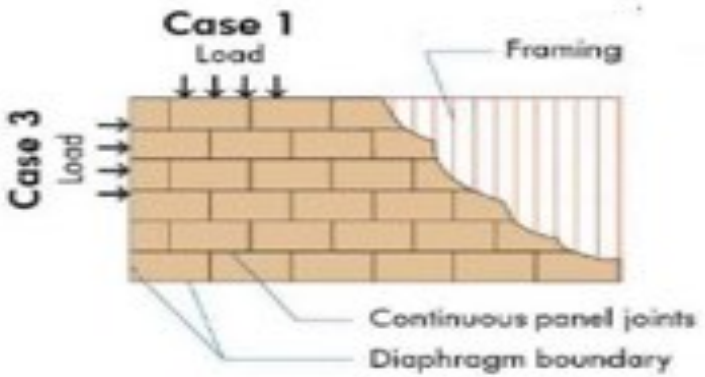
Nail Spacing (in_s) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6)												
6			4			2-1/2			2			
Nail Spacing (in_s) at other panel edges (Cases 1, 2, 3, & 4)												
6			6			4			3			
v_s (plf)	G_a (kips/in_s)		v_s (plf)	G_a (kips/in_s)		v_s (plf)	G_a (kips/in_s)		v_s (plf)	G_a (kips/in_s)		
	OSB	PLY		OSB	PLY		OSB	PLY		OSB	PLY	
370	15	12	500	8.5	7.5	750	12	10	840	20	15	
420	12	9.5	560	7.0	6.0	840	9.5	8.5	950	17	13	
540	14	11	720	9.0	7.5	1060	13	10	1200	21	15	
600	12	10	800	7.5	6.5	1200	10	9.0	1350	18	13	
640	24	17	850	15	12	1280	20	15	1460	31	21	
720	20	15	960	12	9.5	1440	16	13	1640	26	18	
340	15	10	450	9.0	7.0	670	13	9.5	760	21	13	
380	12	9.0	500	7.0	6.0	760	10	8.0	860	17	12	
370	13	9.5	500	7.0	6.0	750	10	8.0	840	18	12	
420	10	8.0	560	5.5	5.0	840	8.5	7.0	950	14	10	
480	15	11	640	9.5	7.5	960	13	9.5	1090	21	13	
540	12	9.5	720	7.5	6.0	1080	11	8.5	1220	18	12	
510	14	10	680	8.5	7.0	1010	12	9.5	1150	20	13	
570	11	9.0	760	7.0	6.0	1140	10	8.0	1290	17	12	
540	13	9.5	720	7.5	6.5	1060	11	8.5	1200	19	13	
600	10	8.5	800	6.0	5.5	1200	9.0	7.5	1350	15	11	
580	25	15	770	15	11	1150	21	14	1310	33	18	
650	21	14	860	12	9.5	1300	17	12	1470	28	16	
640	21	14	850	13	9.5	1280	18	12	1460	28	17	
720	17	12	960	10	8.0	1440	14	11	1640	24	15	

AMERICAN WOOD COUNCIL

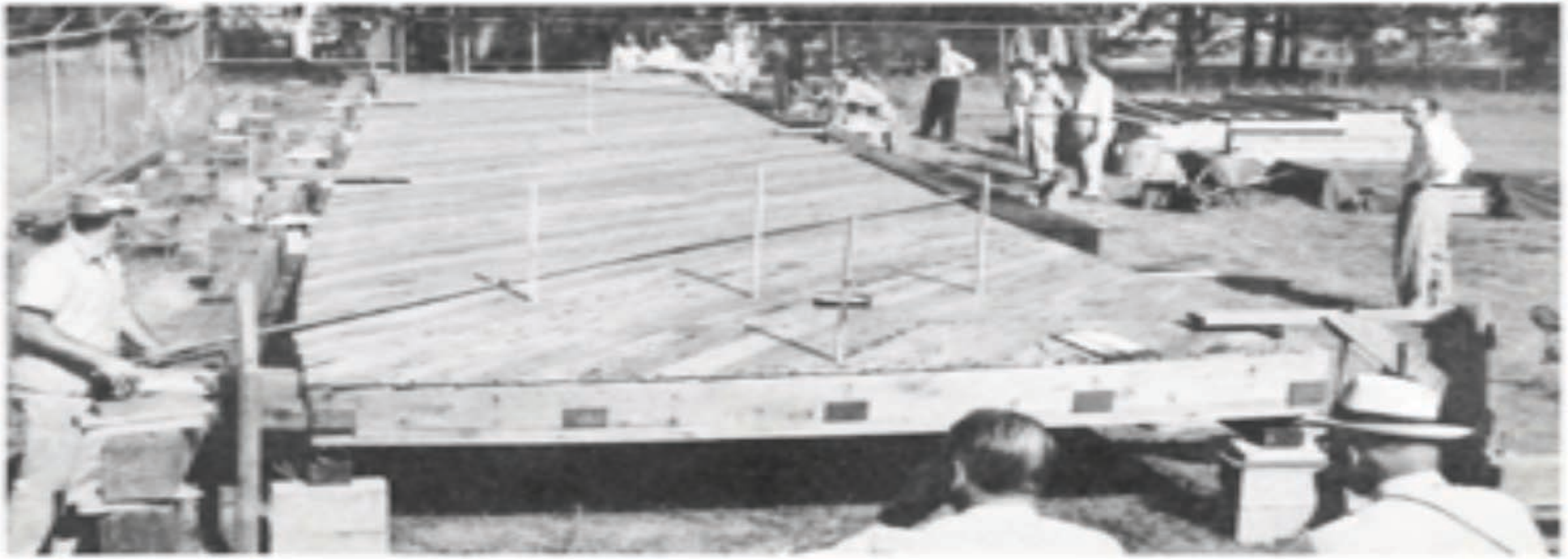
SDPWS

Special Design Provisions for Wind & Seismic with Commentary

2015 EDITION



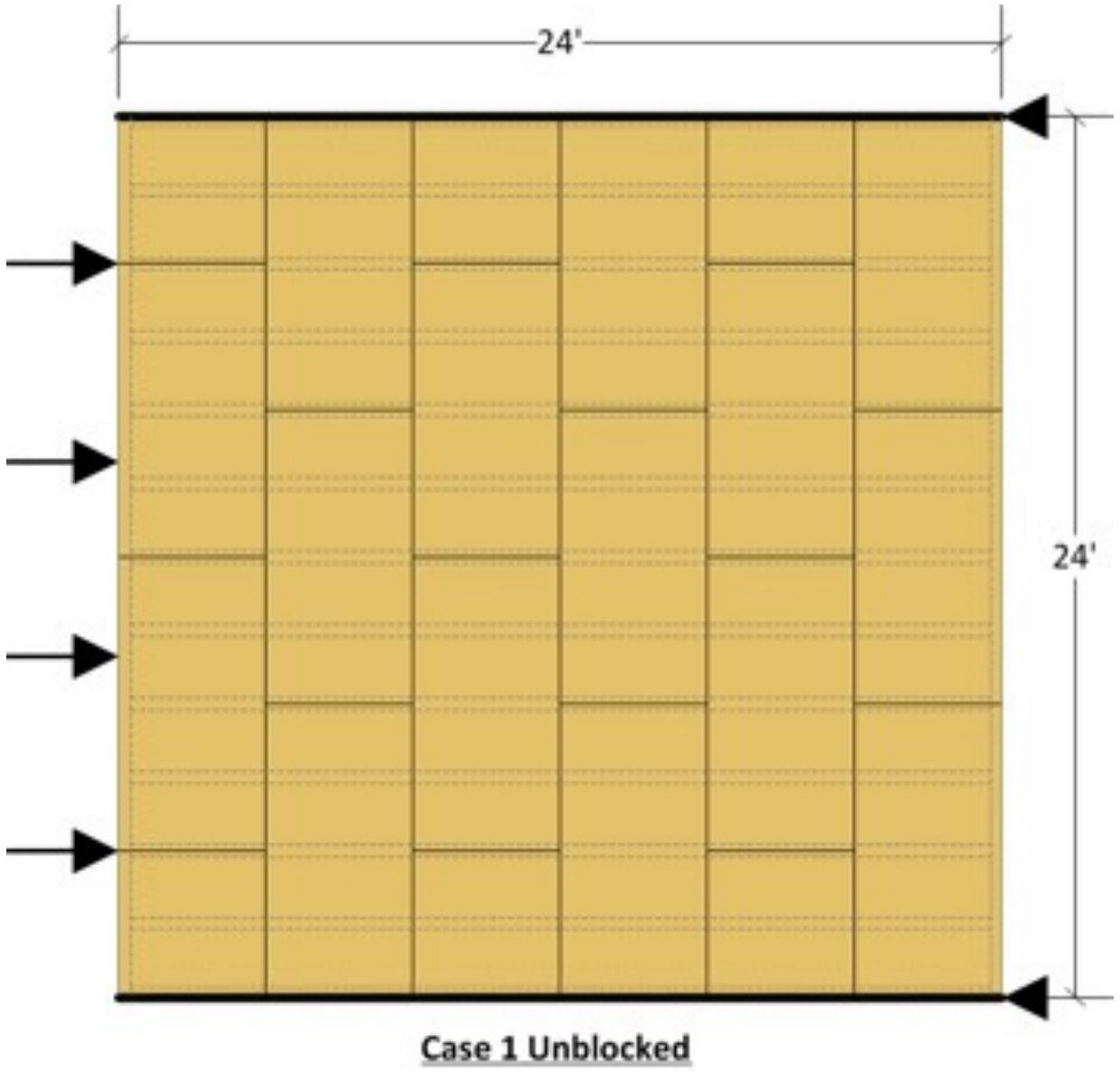
Original Lumber Diaphragm Testing



Testing a 12 by 60-Foot Wood Diaphragm.

I-Joist Diaphragm Testing

I-Joist Diaphragm Testing



Case 1 Unblocked

I-Joist Diaphragm Testing

I-Joist Diaphragm Testing

I-Joist Diaphragms

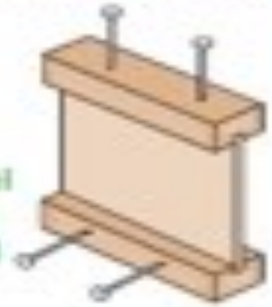
- Consult manufacturer for diaphragm values and limits
- Typical closest allowable nail spacing = 4”
- Most SCL flange joists have connector specific gravity equivalency to Douglas fir

Case 1 Diaphragm: Staggered Sheathing Perpendicular to Joist Length

I-Joist Diaphragms

Manufacturer Literature

Nailing Perpendicular to Glue Lines (Wide Face)



Nailing Parallel to Glue Lines (Narrow Face)

Nail Size	Joists			
	Nailing Perpendicular to Glue Line (Wide Face)		Nailing Parallel to Glue Line (Narrow Face)	
	O.C. Spacing [inches]	End of Joist [inches]	O.C. Spacing [inches]	End of Joist [inches]
8d Box	2	1½	4	1½
8d Common	2	1½	4	3
10d & 12d Box	2	1½	4	3
16d Box	2	1½	4	3
10d & 12d Common	3	2	6	4
16d Sinker	3	2	6	4
16d Common	3	2	6	4

- If more than one row of nails is used, the rows must be offset at least ¼ inch.

A35 connectors may be attached to the side of joist flanges only. Use nails as specified by ; do not attach connectors on both sides of a flange at the same location.

Diaphragm Table (1)

Flange Width	Diaphragm Capacity [lb/ft]	
	Unblocked	Blocked
2”	As permitted for 2x framing in building code	320 lb/ft for 6" o.c. nailing @ panel edges
		425 lb/ft for 4" o.c. nailing, staggered, @ panel edges
2 5/16”	As permitted for 3x framing in building code	360 lb/ft for 6" o.c. nailing @ panel edges
		480 lb/ft for 4" o.c. nailing, staggered @ panel edges
3 1/2”	As permitted for 3x framing in building code	As permitted for 3x framing in building code with nail spacing no closer than 3" o.c.

NOTES:

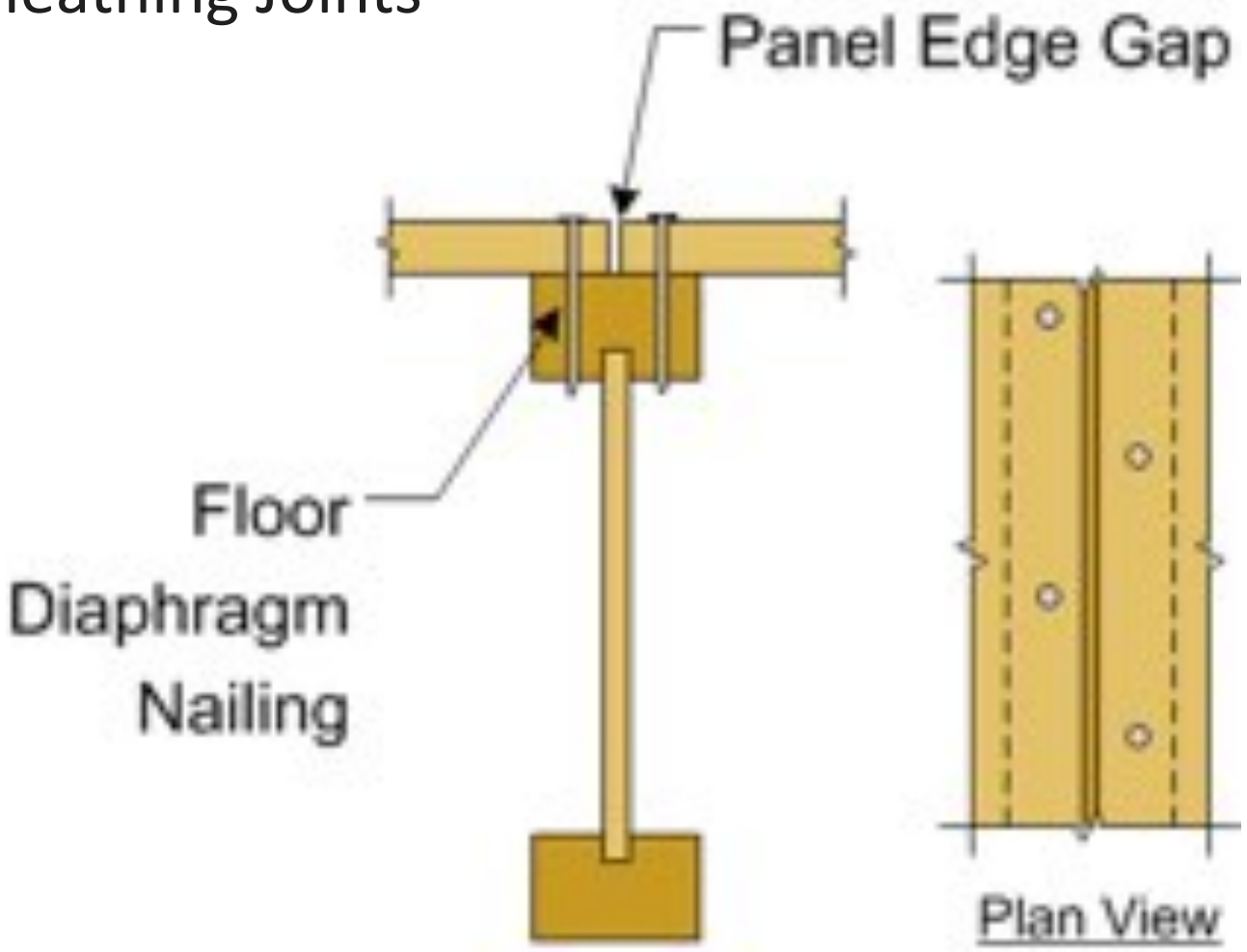
(1) See table 6 of ICC ESR 1336.

(2) joists may be substituted for solid sawn framing in horizontal wood diaphragms as shown in Table 2306.3.1 of the IBC.

(3) Limits controlled by closest allowable nail spacing limits.

I-Joist Diaphragms

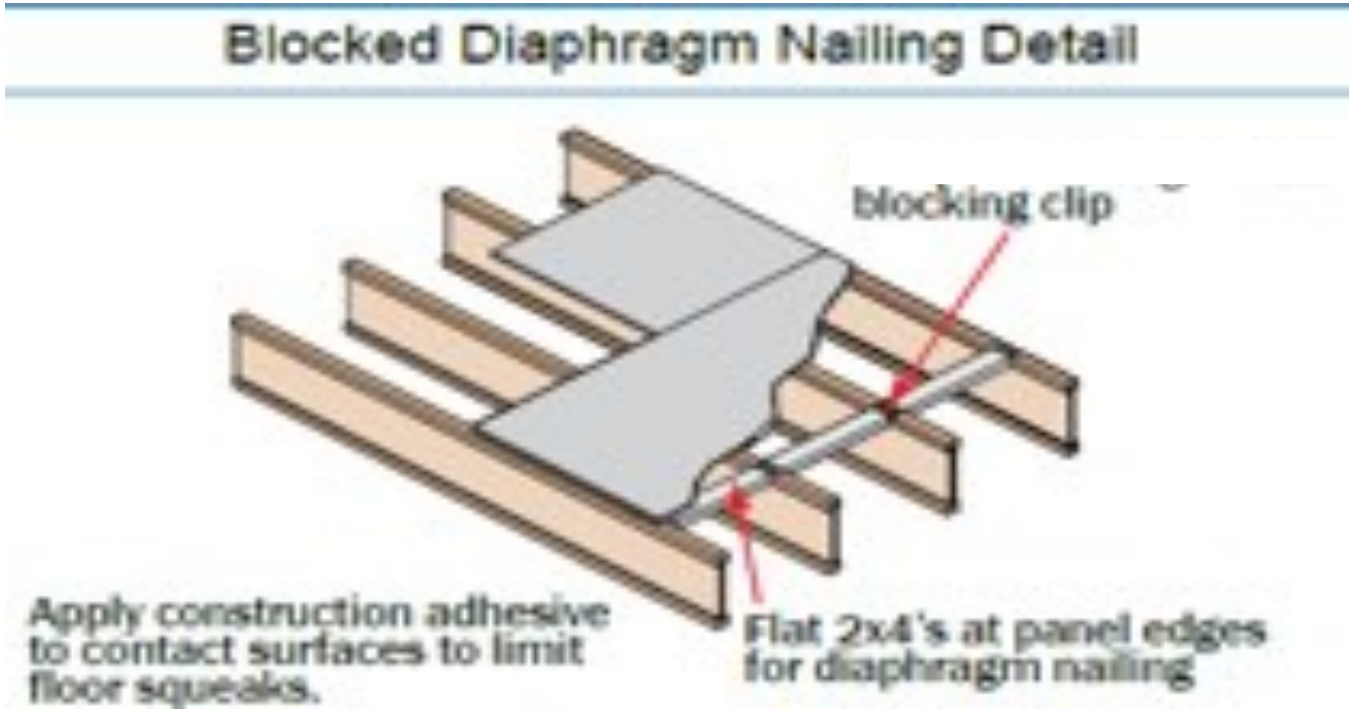
Sheathing Joints

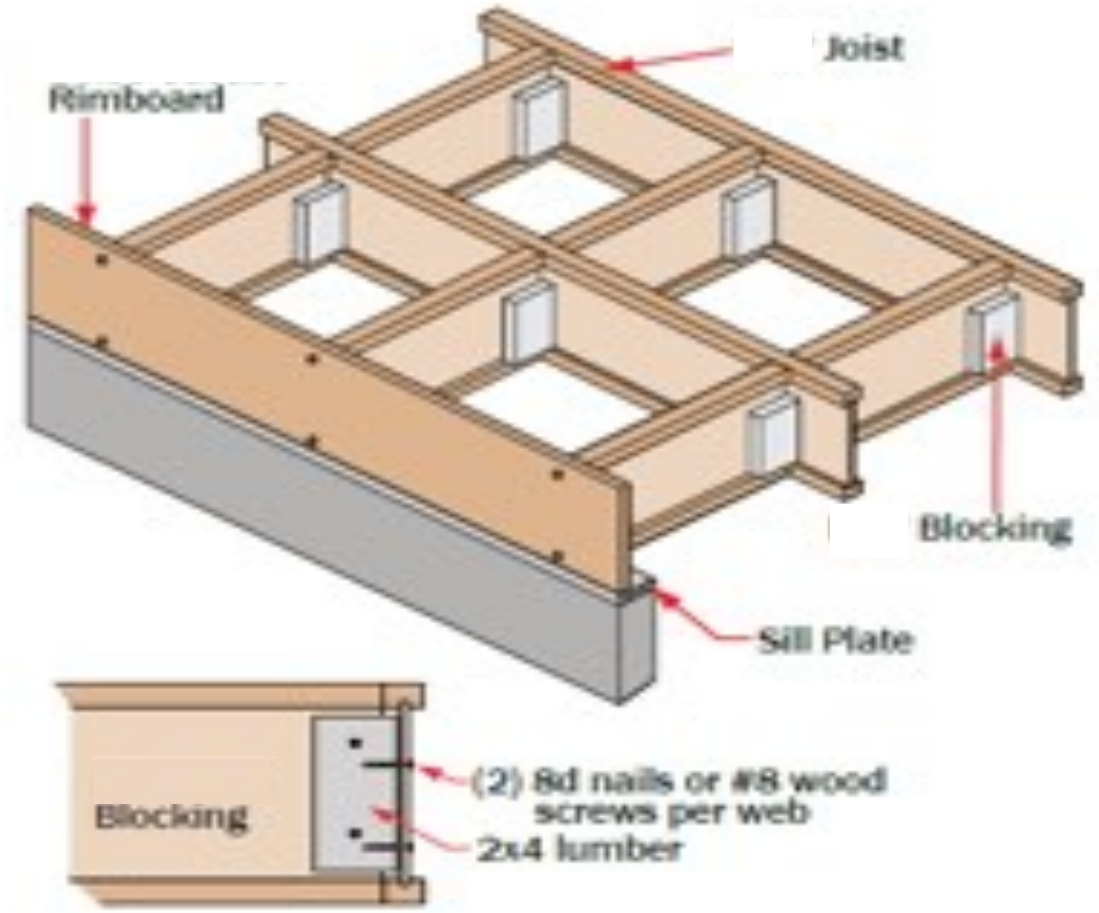


- Wider flange I-joists allow for more area at panel edges, easier to nail in field
- Consult with manufacturer on nail spacing limits, staggering, etc.

Blocked I-Joist Diaphragms

- Blocking: I-joists or flat 2x
- Check with manufacturer





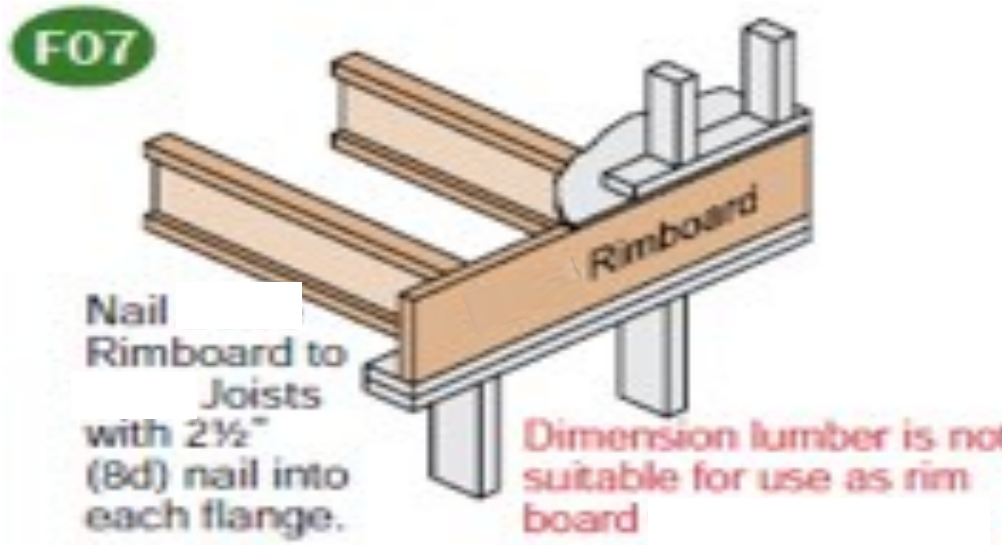
Alternate Diaphragm Fasteners

Proprietary Screws

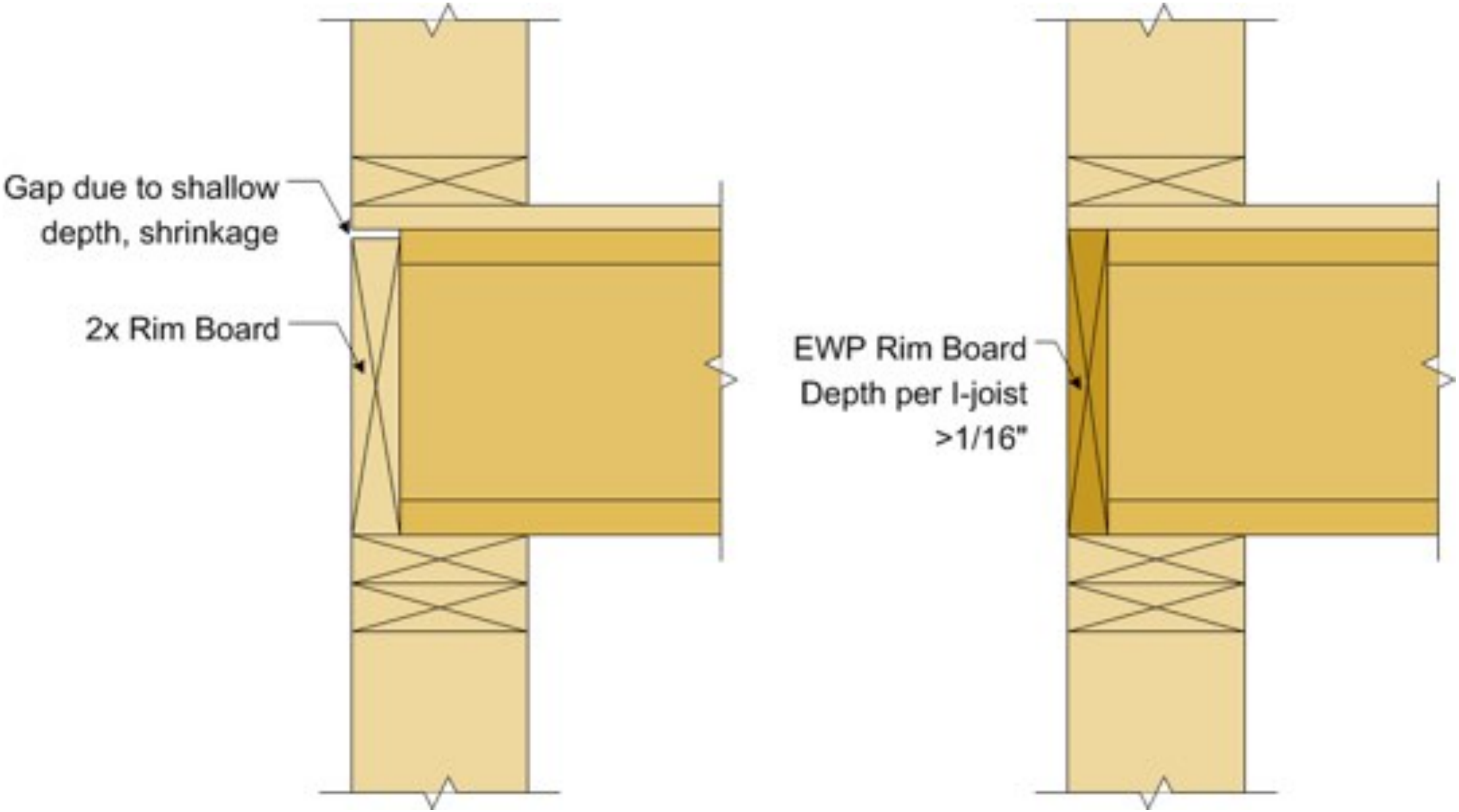
- Typically less ductile failure compared to nails
- Manufacturer shall have evaluation report from accredited agency listing diaphragm values
- Marketed as a value-added product (improved floor performance, less squeaks, etc.)

Engineered Rim Board

- Typical Rim Board Thickness for Mid-Rise: 1 1/4” to 5 1/4” SCL
- Vertical load capacities and lateral design values for diaphragms
- ICC Acceptance Criteria for engineered rim board
- Dimension lumber should not be used as rim board with wood I-Joists

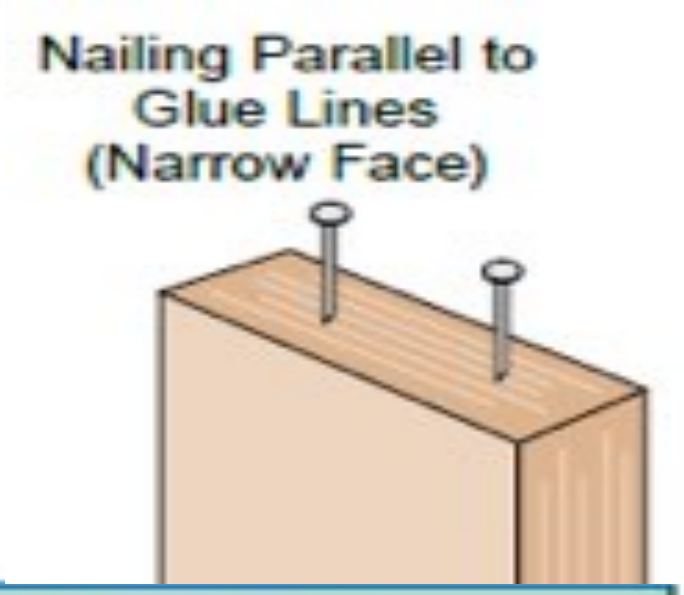


Engineered Rim Board



Engineered Rim Board

- Closest allowable nail spacing controls lateral design
- Thicker rim = tighter allowable spacing



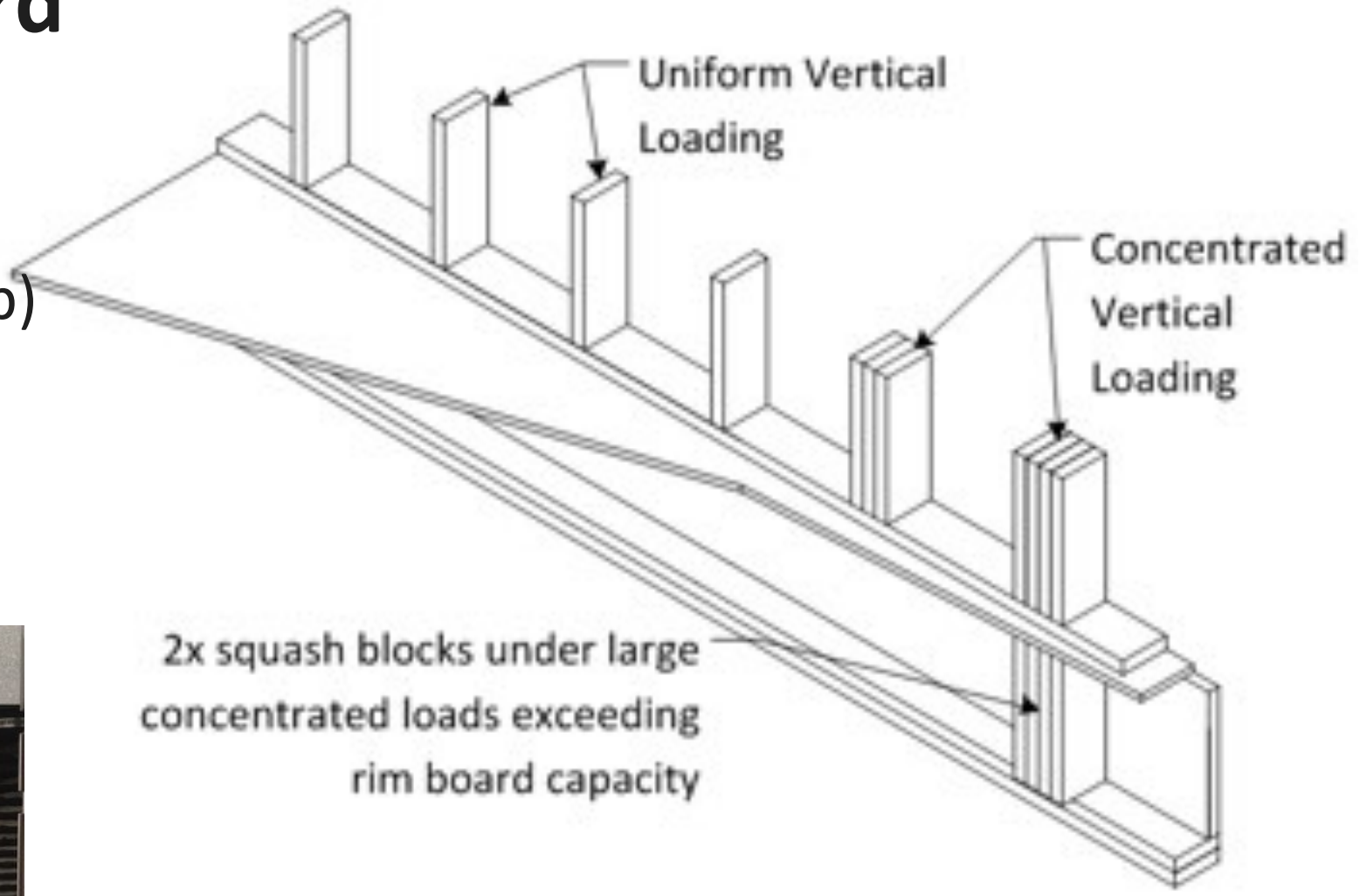
Product	Closest Allowable Nail Spacing - Narrow Face [in]					
	8d Box	8d Common	10d & 12d Box	16d Box	10d, 12d Common & 16d Sinker	16d Common
1 1/8" OSB	3	3	Not allowed with prescriptive rim board			
1 1/4" OSB	4	4	4	4	4	6
1 1/4" – 1 1/2" LVL	3	3	3	3	4	6
1 3/4" LVL	2	3	3	3	4	6

Nail Splitting in Wood

Engineered Rim Board

Vertical Load Capacities

- Uniform load values (lb/ft)
- Concentrated load values (lb)
  - Squash blocks (short studs) may be added for larger loads



1 ¼” & Thicker SCL Rim Board

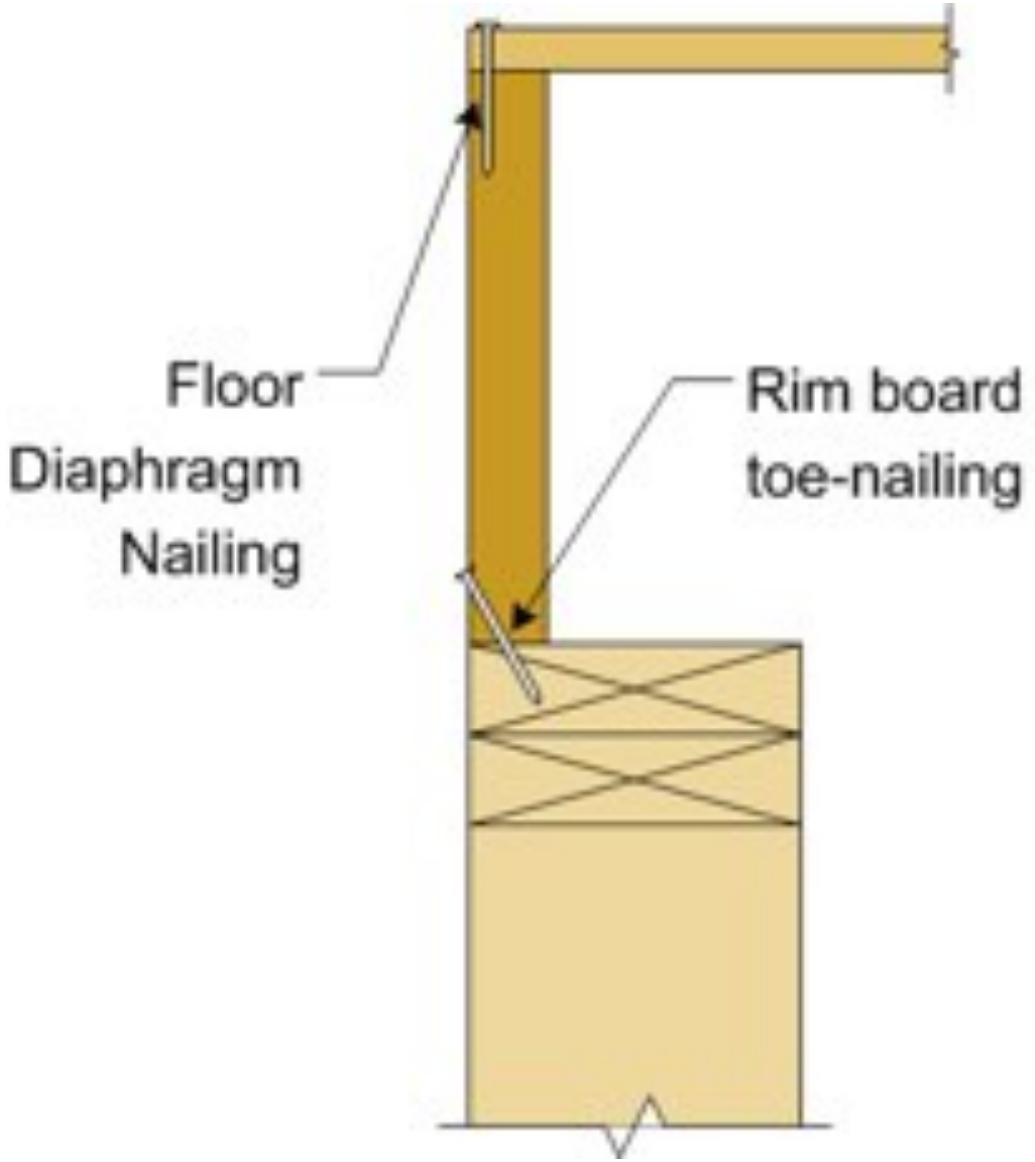
Rim Board Allowable Design Values

- Uniform Vertical Load: >6000 lb/ft
- Lateral Load: Equivalent to 2x lumber (Douglas fir SG = 0.5)

1 ¼” & Thicker SCL Rim Board

Edge Connection – Floor Diaphragm

Nail Size & Spacing	Seismic/Wind (1.6 Load Duration)
8d Common @ 4” oc	360 lb/ft
10d Common @ 4” oc	425 lb/ft



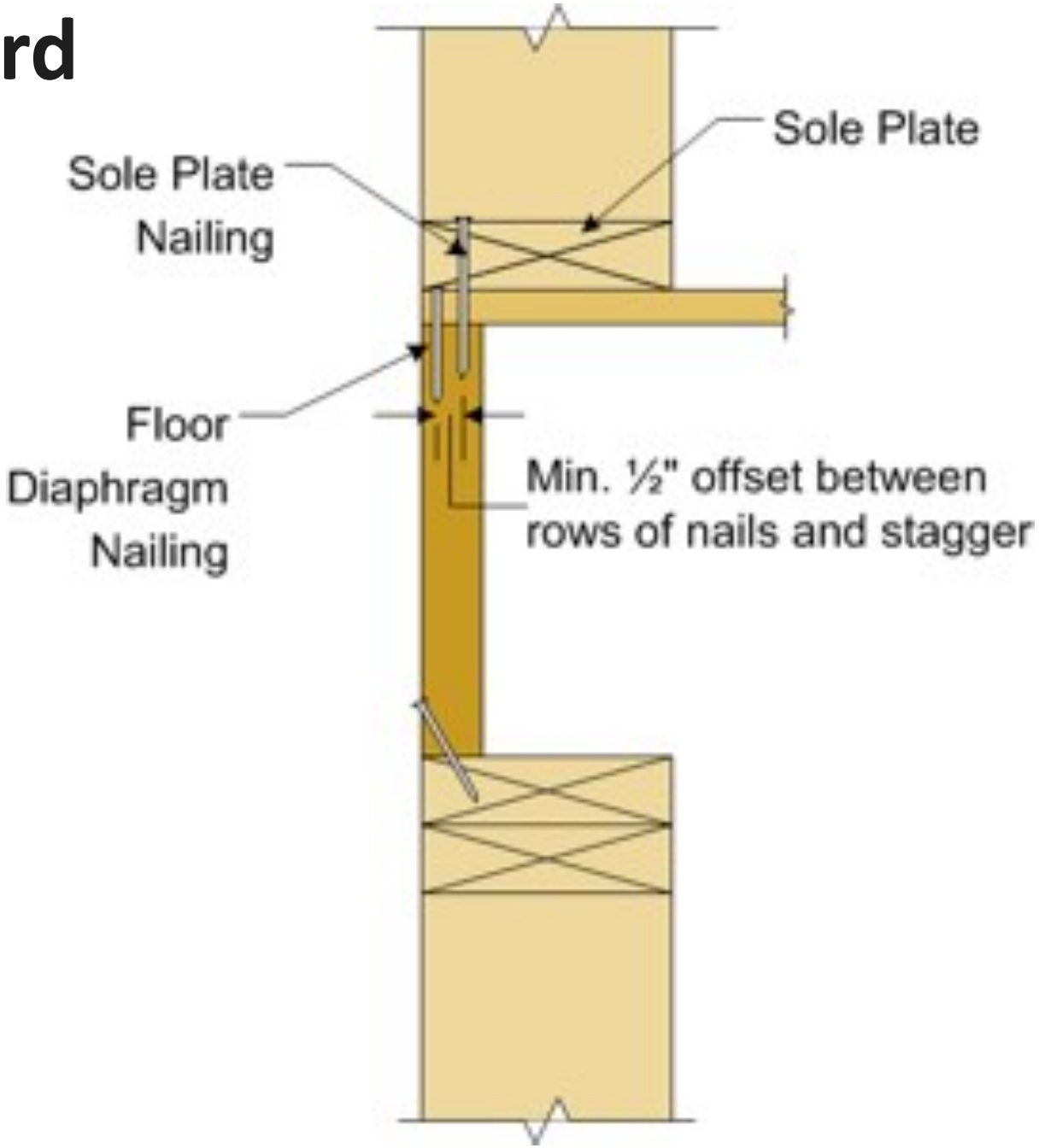
1 ¼” & Thicker SCL Rim Board

Edge Connection – Sole Plate

16d common nails (225 lb)

@ 5” o.c. = 540 lb/ft

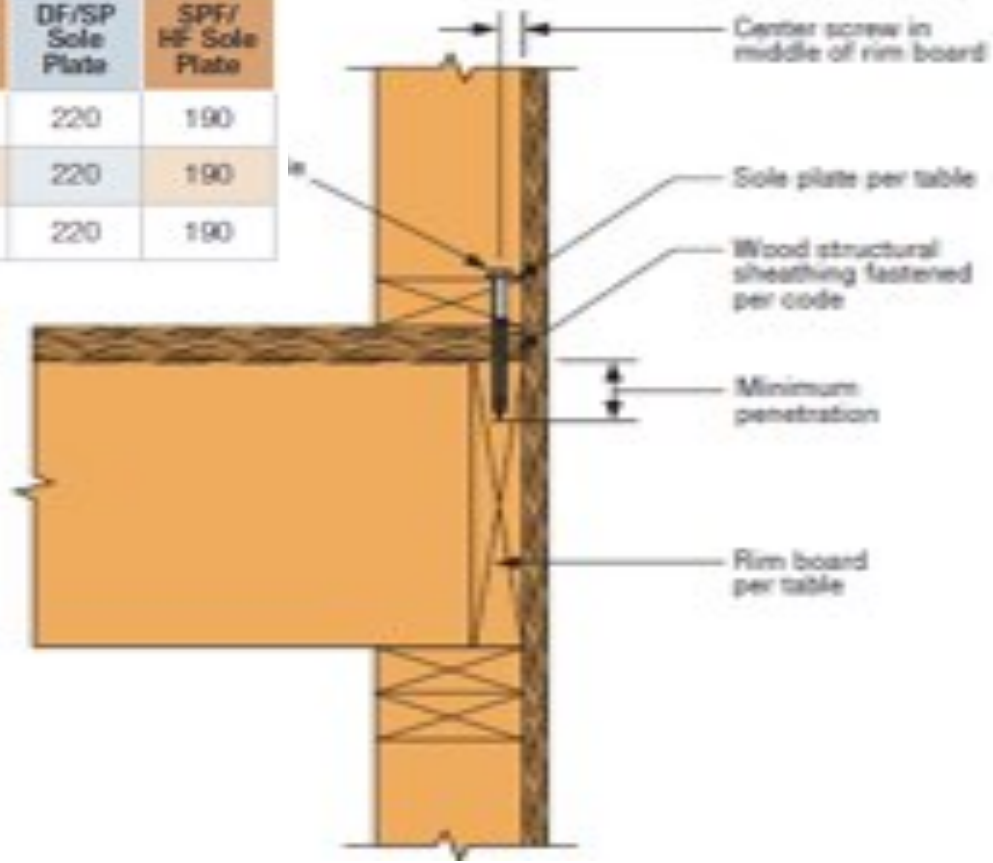
Use of framing anchors, additional blocks, sheathing nailing possible for increased load transfer



Proprietary Self-Driving Lag Screws

Edge Connection – Sole Plate

Size (in.)	Model No.	Sole Plate Nominal Size	Minimum Penetration into Rim Board (in.)	Allowable Loads (lbs)							
				2x DF/SP Rim Board		2x SPF/HF Rim Board		1¼" Min. LVL Rim Board		1¼" Min. LSL Rim Board	
				DF/SP Sole Plate	SPF/HF Sole Plate	DF/SP Sole Plate	SPF/HF Sole Plate	DF/SP Sole Plate	SPF/HF Sole Plate	DF/SP Sole Plate	SPF/HF Sole Plate
⅛ x 4.5	SDS25412	2x	2	250	190	190	190	190	190	220	190
¼ x 5	SDS25500	2x	2	250	190	190	190	190	190	220	190
¼ x 6	SDS25600	2x or 3x	2	250	190	190	190	190	190	220	190



- Min. SCL rim thickness = 1 ¼”
- Closest spacing = 6” on-center
- Reduced values compared to 2x
- 2 rows of screws requires min. 2 5/8” thick rim

1 ¼” & Thicker SCL Rim Board

Additional Nailing from Wall Sheathing

3/8” Sheathing & 8d Common

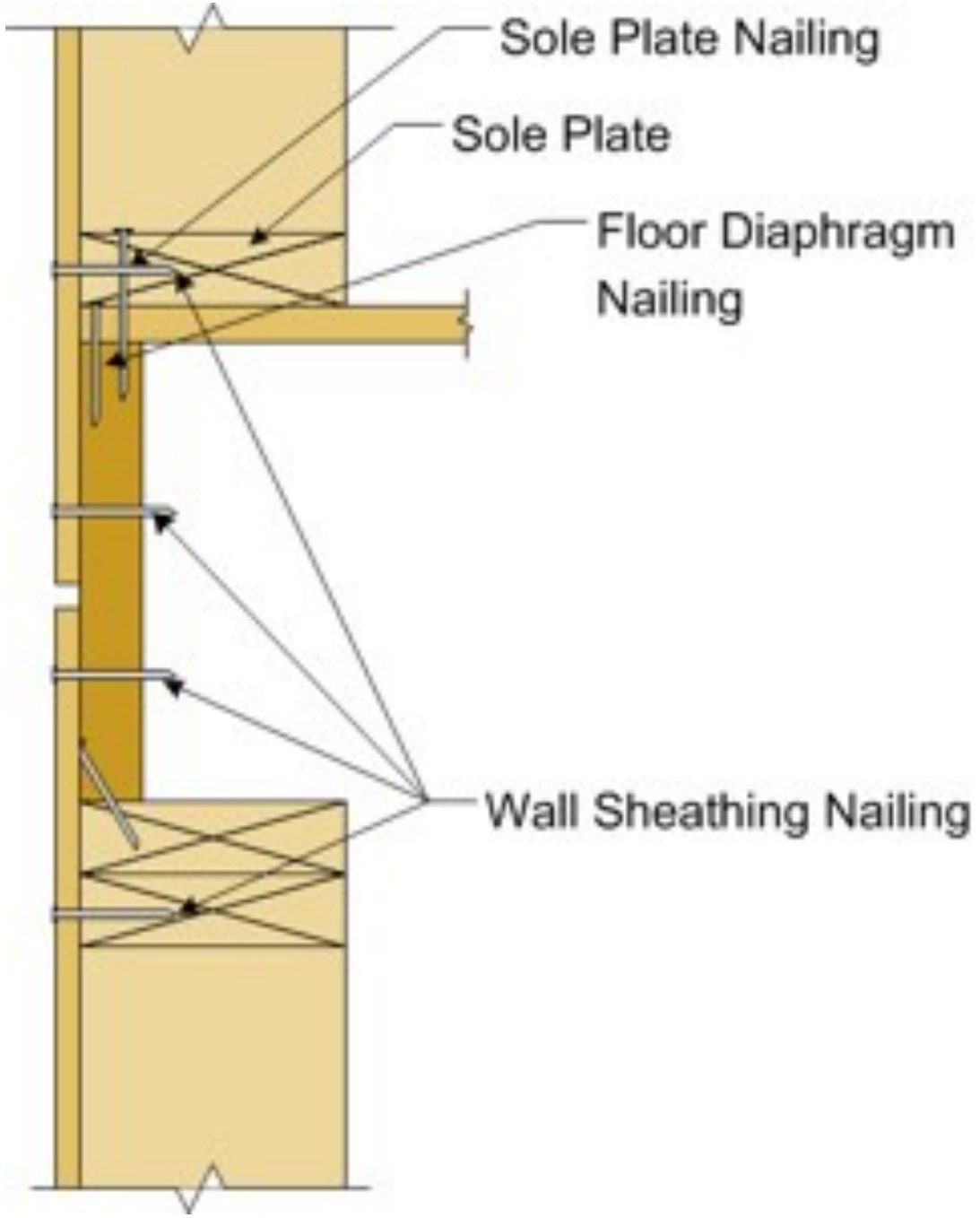
= 113 lb

@ 6” o.c. = 226 lb/ft

7/16” Sheathing & 8d Common

= 116 lb

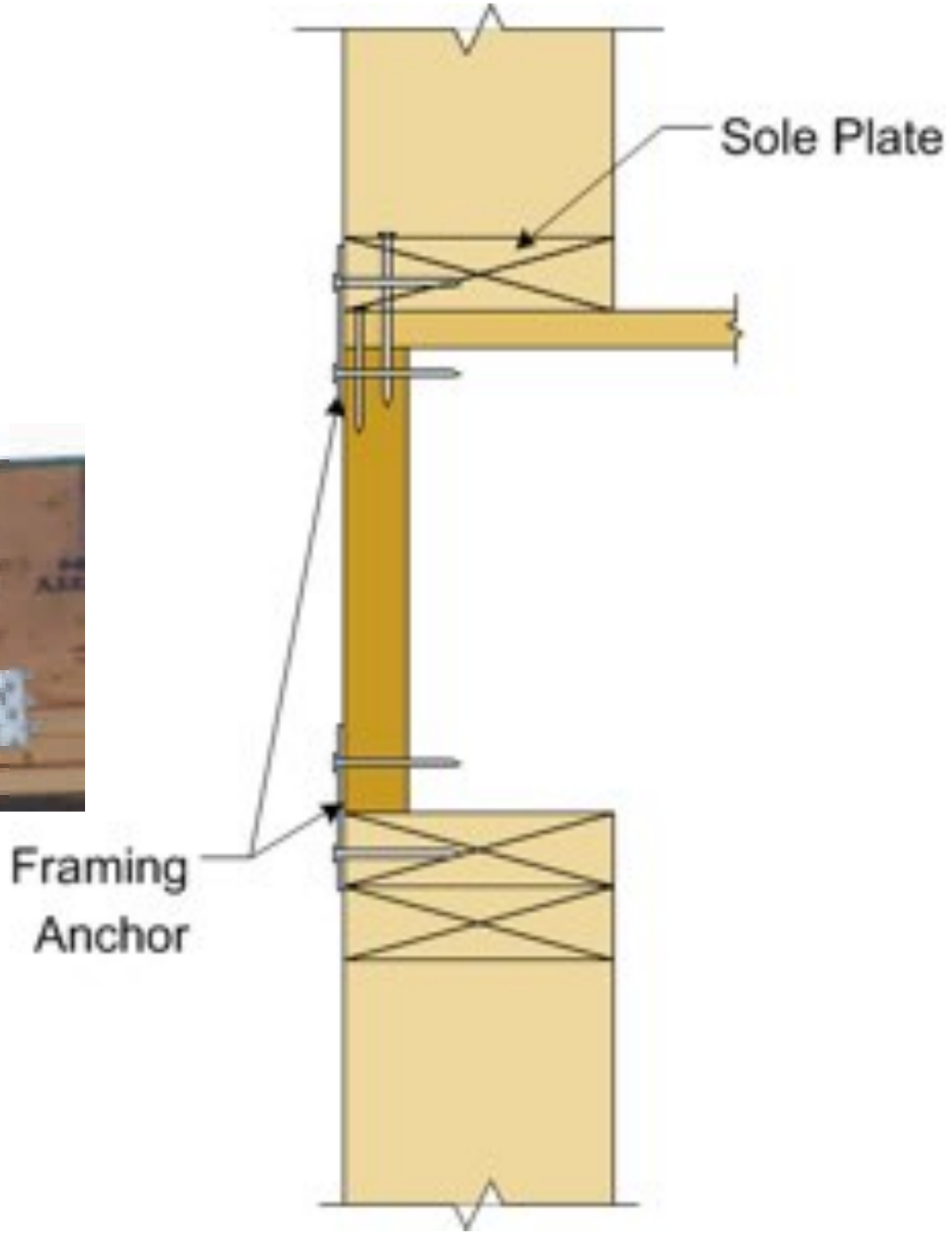
@ 6” o.c. = 232 lb/ft



1 ¼” & Thicker SCL Rim Board

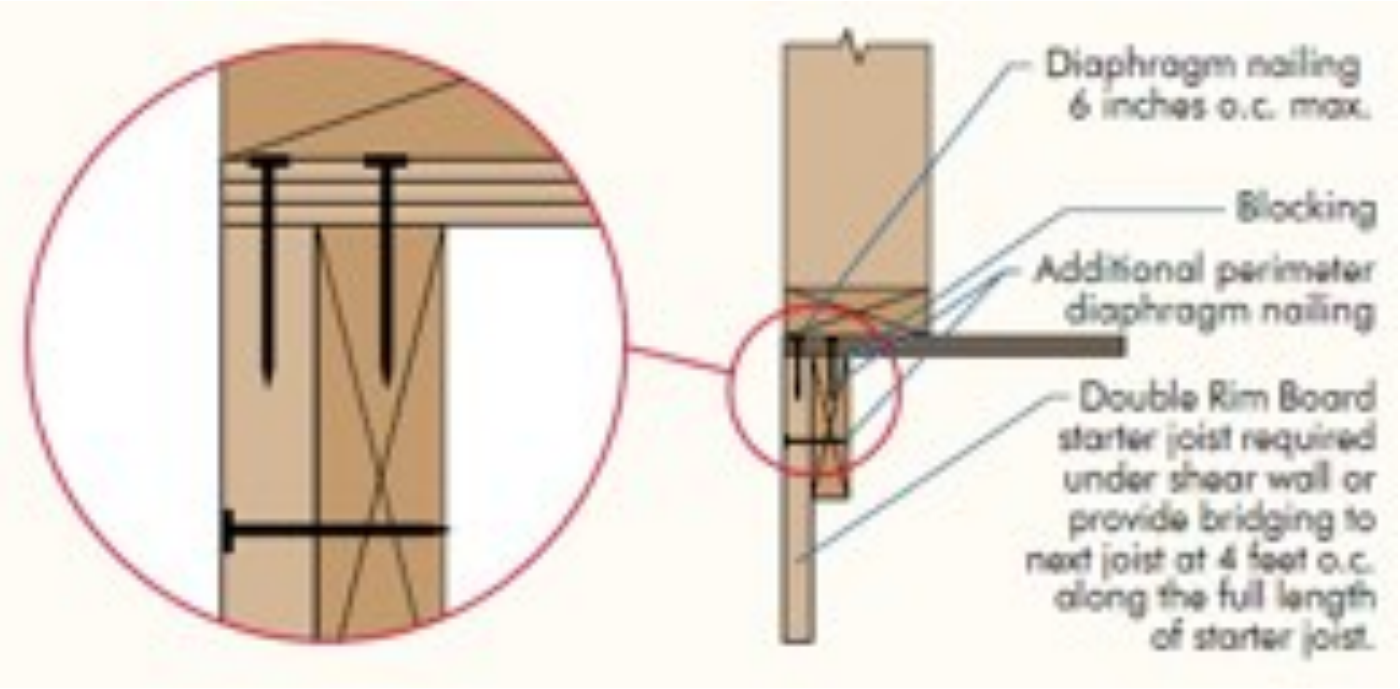
Engineered Design – Framing Anchors

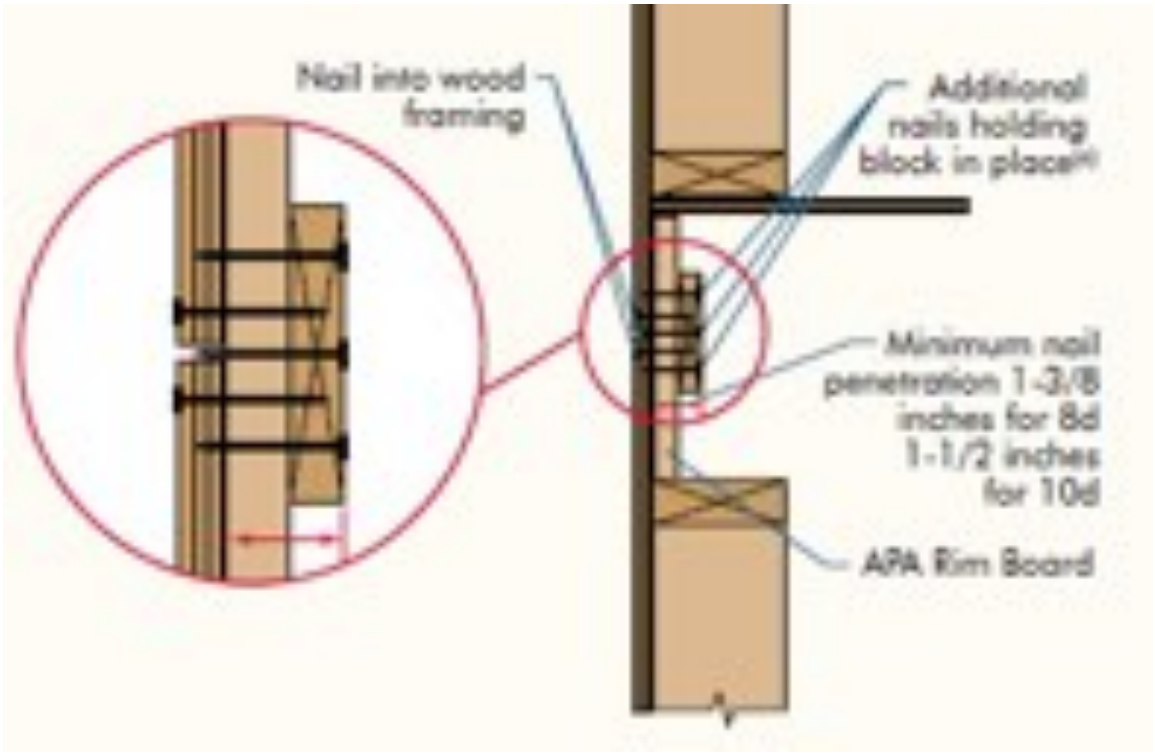
Typical connector w/ nails = 670 lb



1 ¼” & Thicker SCL Rim Board

Alternate Connection Options: APA *Shear Transfer at Engineered Wood Floors*

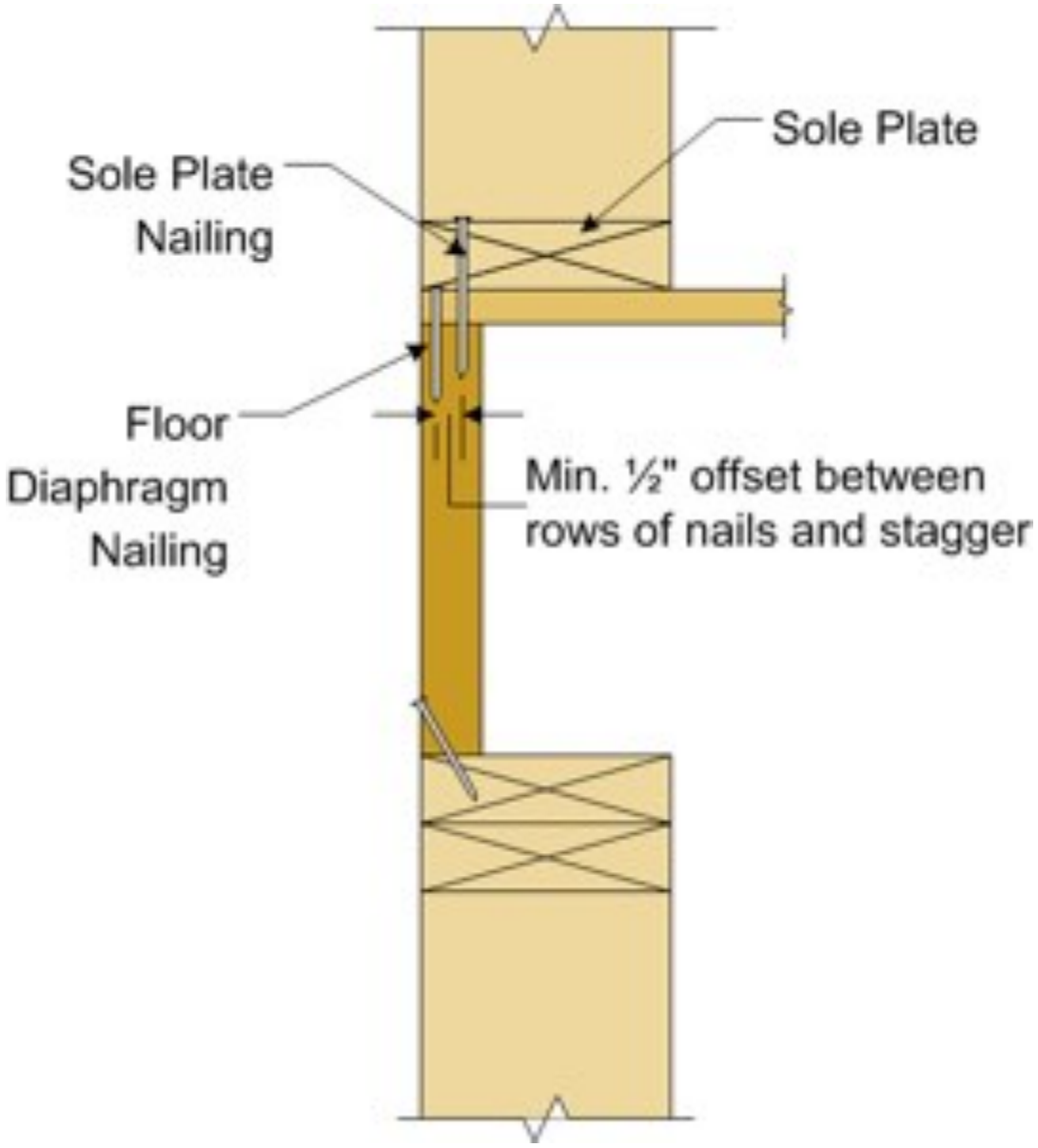




1 ¼” & Thicker SCL Rim Board

Required Rim Thickness

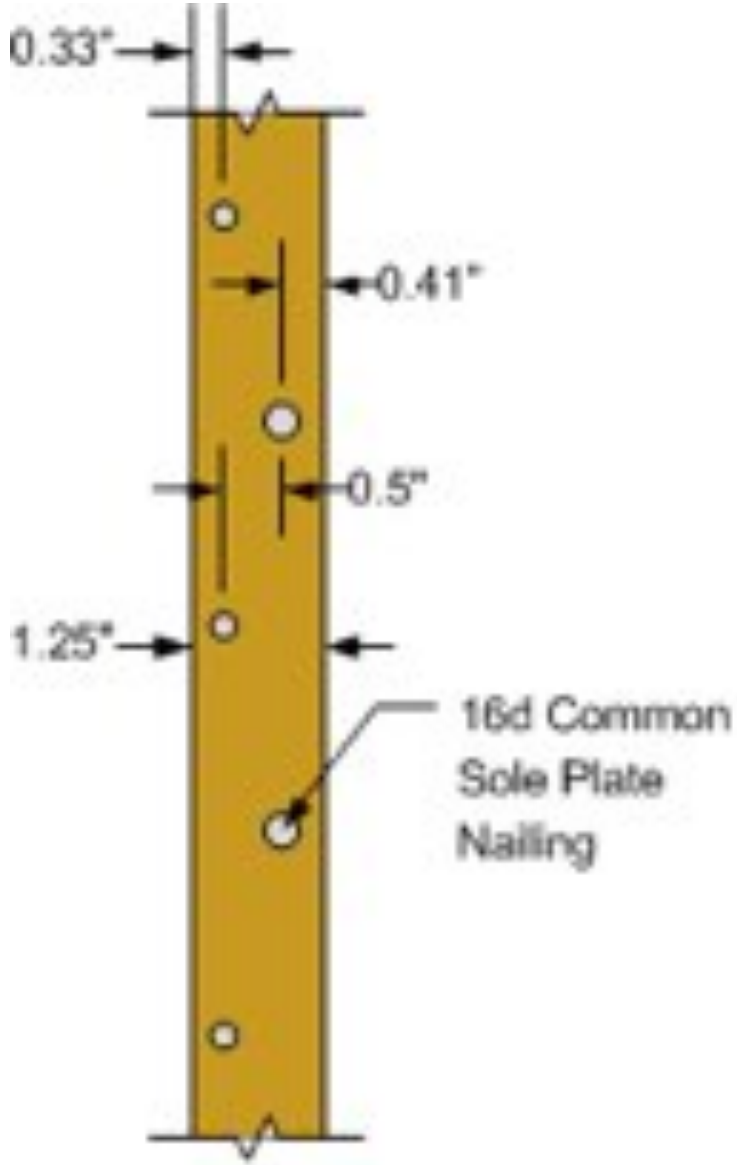
- Specified by EOR
- Min. Edge Distance for nailing = 2.5 x nail diameter
- Min. 0.5” offset between rows
- Multiple shear wall sole plate nail rows require thicker rim
- Additional rim thickness provides more area for nail placement variance



1 ¼” & Thicker SCL Rim Board

Required Rim Thickness: Example

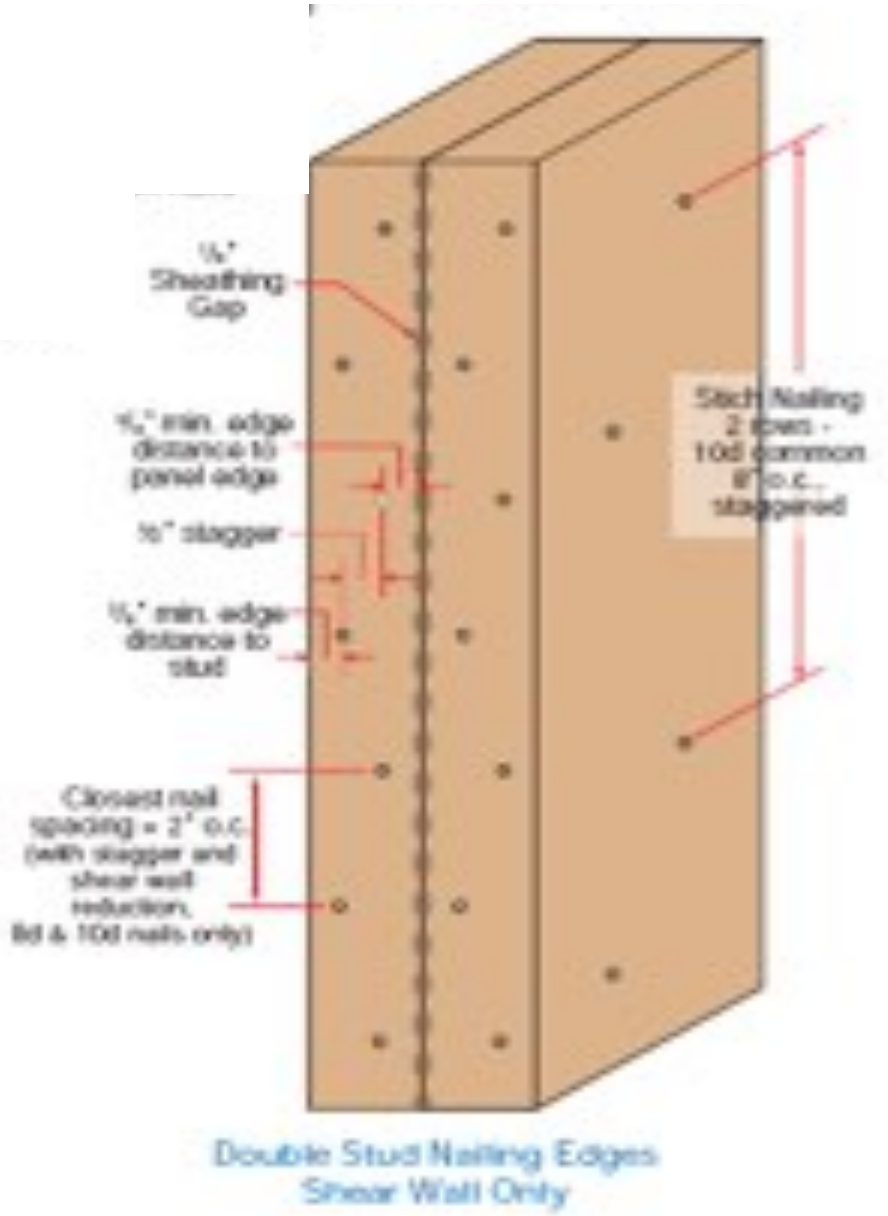
- 10d common diaphragm nail, 16d common sole plate nailing
- Min. Edge Distance
  - 10d cmn = 0.131” x 2.5 = 0.33”
  - 16d cmn = 0.162” x 2.5 = 0.41
- Min. 0.5” offset between rows
- Min. Rim Thickness = 0.33” + 0.41” + 0.5” = 1.24”



Top View

Shear Walls

- SCL has limits for nail spacing into edge of product (similar to rim)
- Contact each manufacturers' engineering department for technical support



Double Stud Nailing Edges
Shear Wall Only

Fire Resistance

Flame Spread

- Surface flammability
- Required for exposed framing
- ASTM E84

Fire Endurance

- System resistance for floor/ceiling assemblies
- Product char rate
- ASTM E119 Fire Tests
- Higher severity of fire exposure

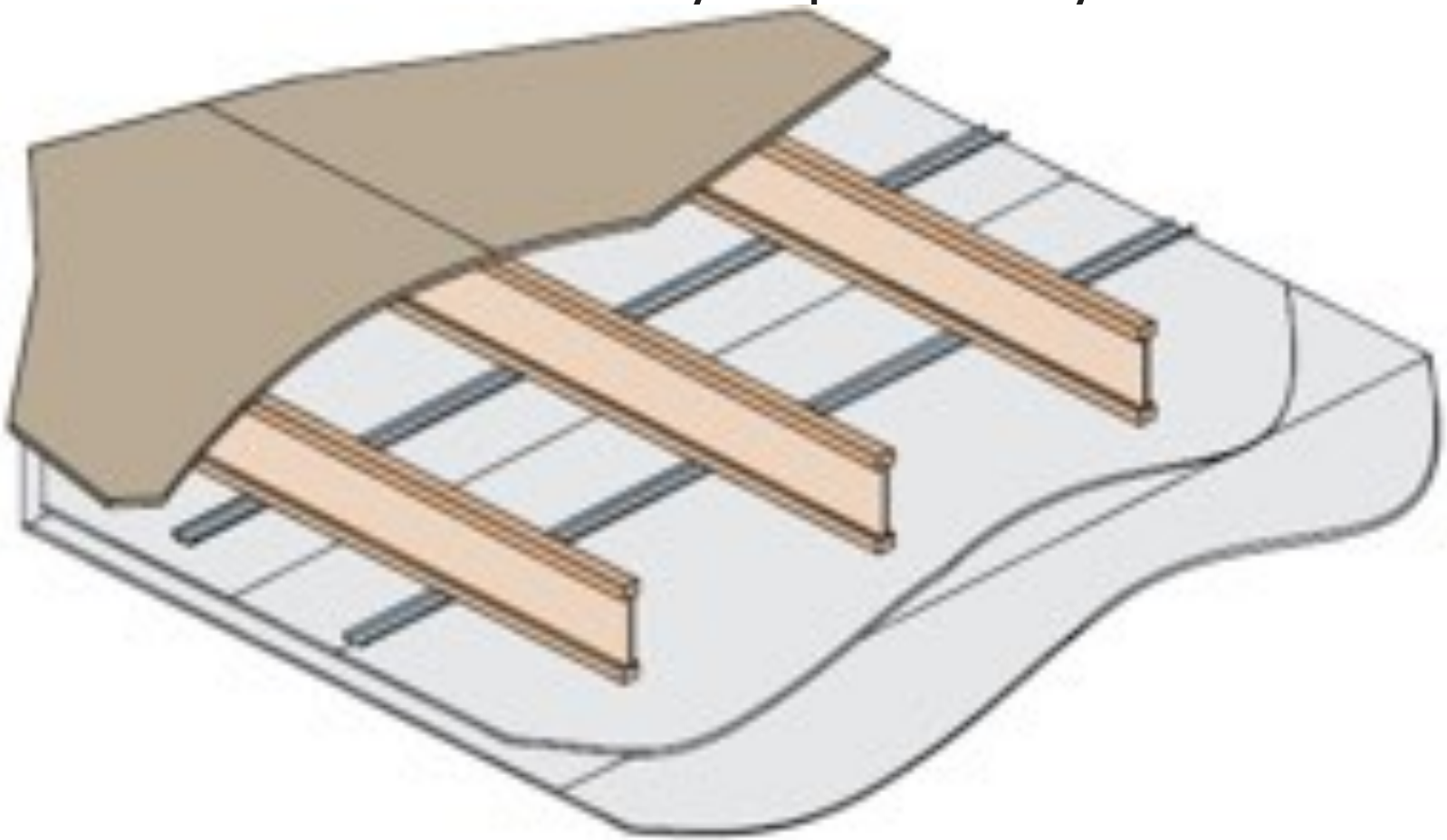
Fire Resistance

Flame Spread – Steiner Tunnel Test – ASTM E84

Fire Endurance – ASTM E119

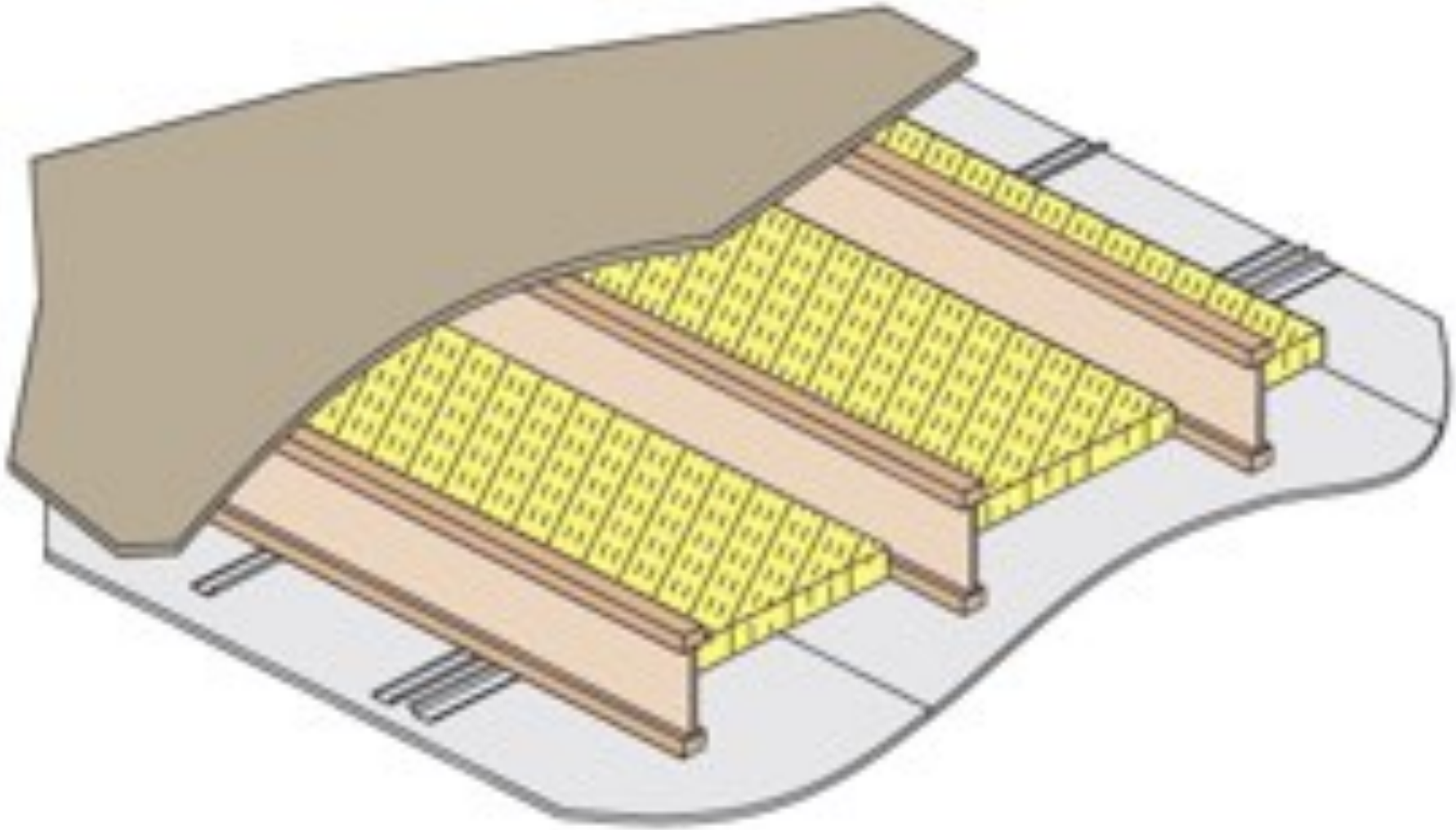
Wood I-Joist Fire Assemblies

- Floor/ceiling assembly per ASTM E-119 fire test
  - 1 Hour: Separation between occupancies
  - 2 Hour: Separation between garage/retail/residence
- Most common 1 hour assembly requires 2 layers of fire-rated gypsum board



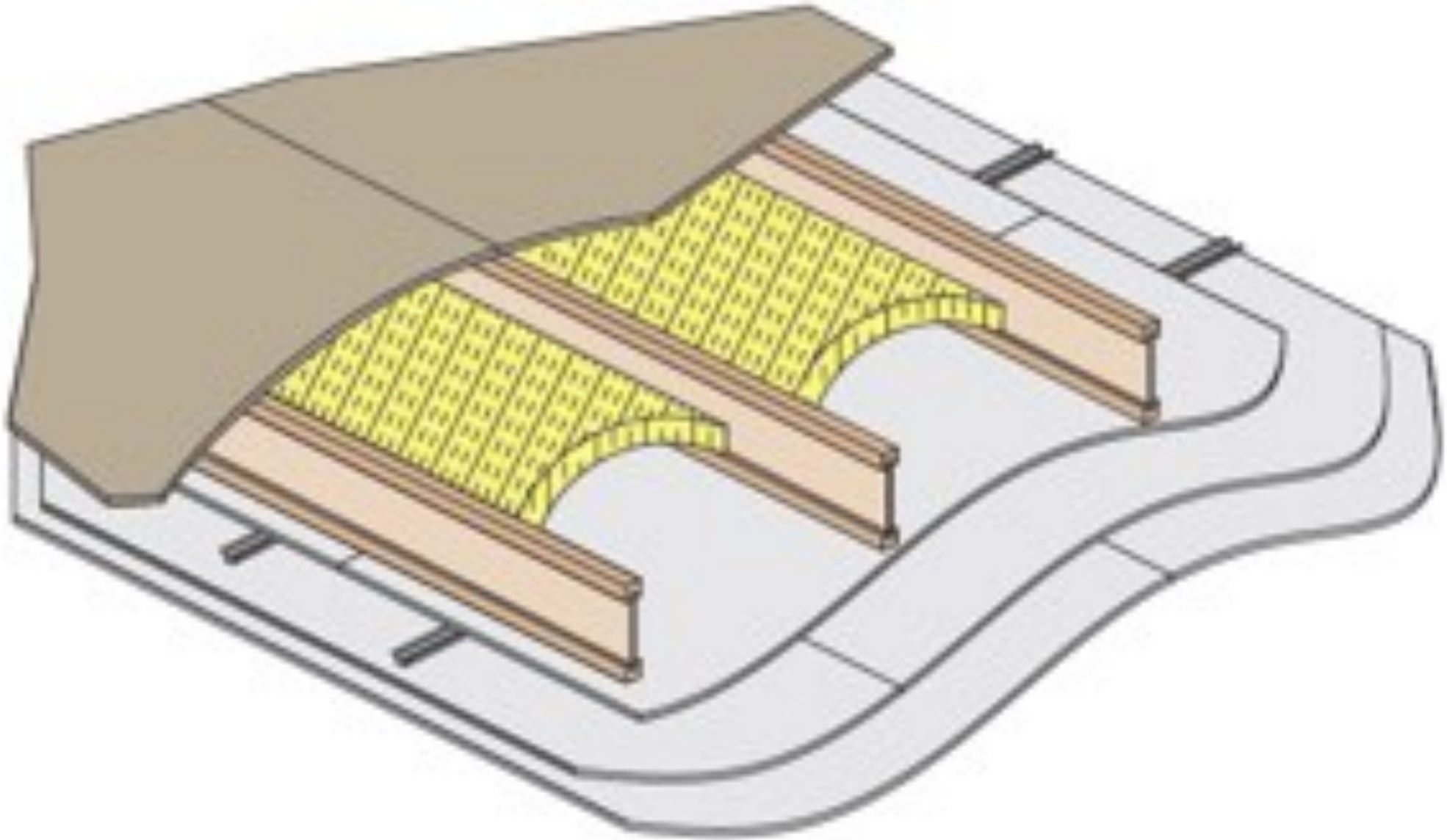
Wood I-Joist Fire Assemblies

- 1 Hour Assembly - 1 Layer of Fire-Rated GWB
  - Require additional fire resistance - mineral wool insulation
  - Require larger joist flanges



Wood I-Joist Fire Assemblies

- 2 Hour Assembly – 3 Layers of Fire-Rated GWB



Wood I-Joist Fire Assembly Components

- Floor Sheathing: Typically 5/8” or 23/32” Plywood/OSB
- Resilient Channel: Required for sound transmission rating (decoupling joist from gypsum board)
- Insulation
  - Mineral wool – Minimum thickness specified
  - Glass fiber – Maximum thickness specified

Fire Assembly Testing

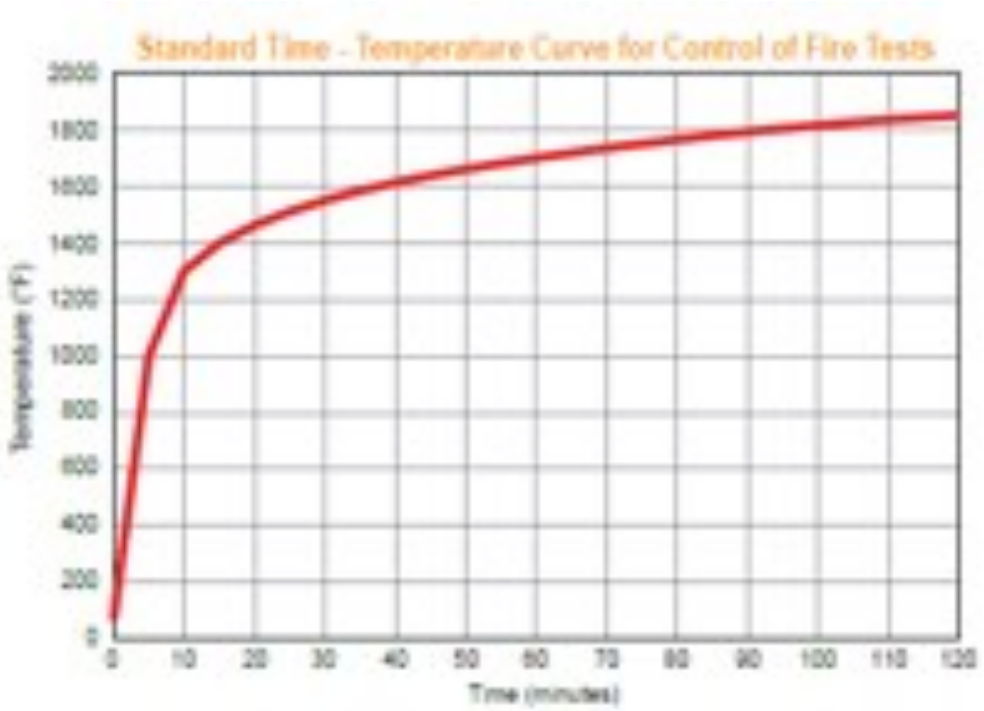
Clockwise:

1) Framing of full scale floor
2) Ceiling components
3) GWB
4) Loading to 100% stress level

Fire Assembly Testing: ASTM E-119

Time – Temperature Curve

- 5:00: 1000 °F
- 10:00: 1300 °F
- 15:00: 1400 °F
- 30:00: 1500 °F
- 60:00: 1700 °F



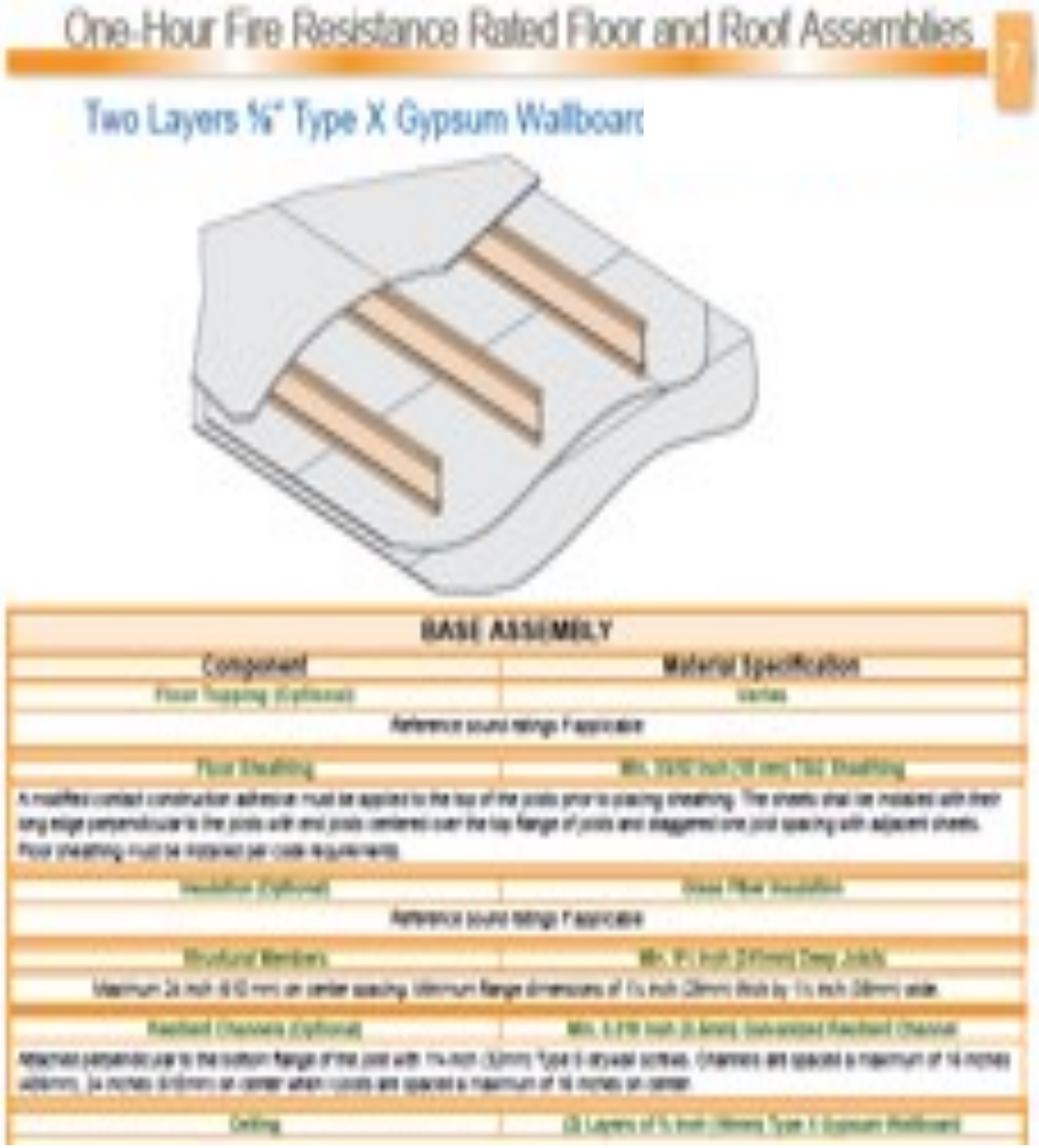
Wood I-Joist Fire Assemblies

Failure Modes

- Structural failure of joist
- Burn through of floor sheathing
- Temperature limit exceeded on decking
- Test is over if any of the above criteria is met

Fire Resistance Assembly Listings

- IBC Chapter 7: Table 721.1(3), starting with assembly 23-1.1
- Manufacturers' ICC ES / APA evaluation reports
- American Wood Council DCA-3
- Gypsum Association: *Fire Resistance & Sound Control Manual*

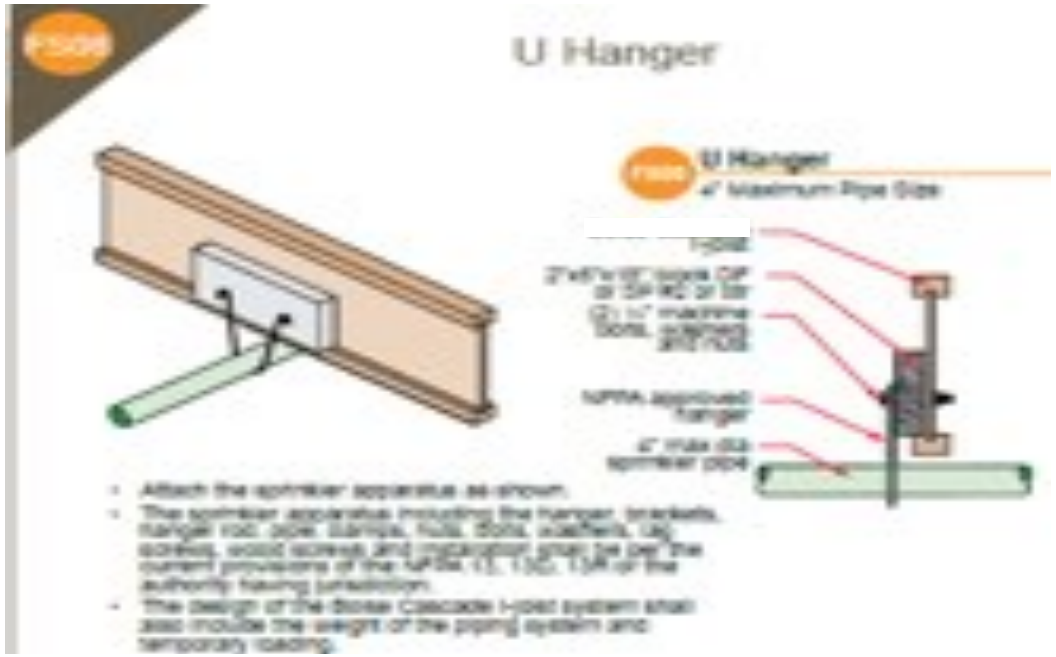


Fire Resistance Assembly – Sound Ratings

- STC (Sound Transmission Class): Resistance to airborne noise transfer (voice, music, etc.)
- IIC (Impact Isolation Class): Absorption of impact sound (footsteps)
- AWC TR 15 – Calculation of Sound Transmission Parameters for Wood-Frame Assemblies

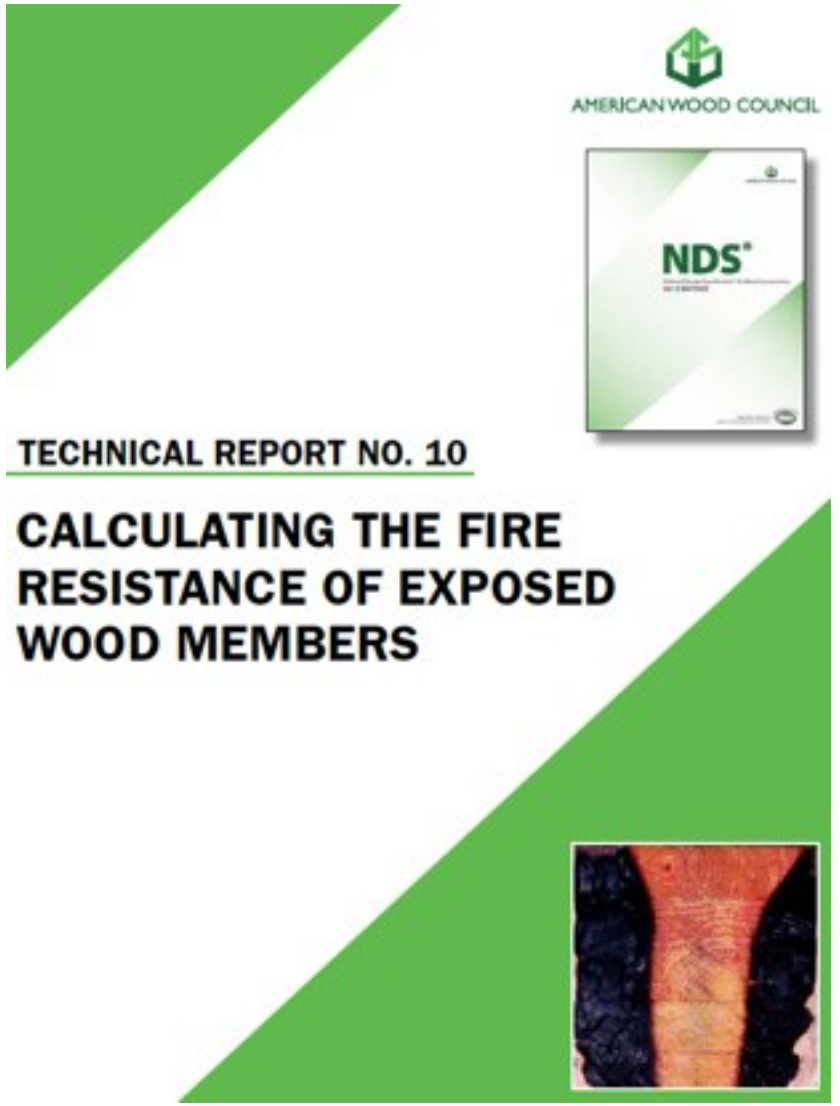
SOUND RATING (w/Resilient Channel)		
Components	**STC**	**IIC**
Base Assembly with Carpet and Padding	54	68
Base Assembly with 3½" (89mm) Insulation	55	46
Base Assembly with additional layer of ⅝" Sheathing and 9½" Insulation	61	50
Base Assembly with Tarkett "Acoustiflor" vinyl and 3½" Insulation	59	50
Base Assembly with cushioned vinyl, ¾" Gypsum Concrete and 3½" Insulation	67	51

Wood I-Joist Fire Sprinkler Attachments

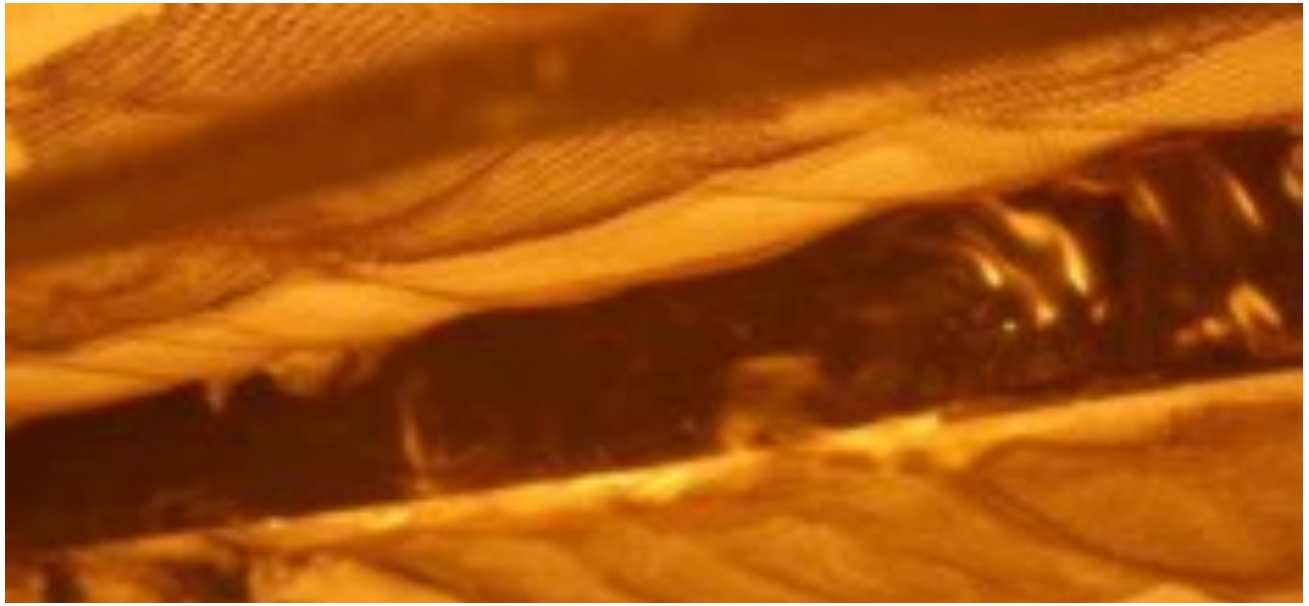


SCL Fire Design

- SCL has the same char rate as solid timber
- Design Methodology prescribed in NDS Chapter 16, calculate endurance time of a wood member exposed to standard fire based upon:
    - the size of wood beam or column
    - percent of maximum allowable design load applied.
- Solid SCL beams only, multiple ply require further analysis
- More information – AWC TR 10



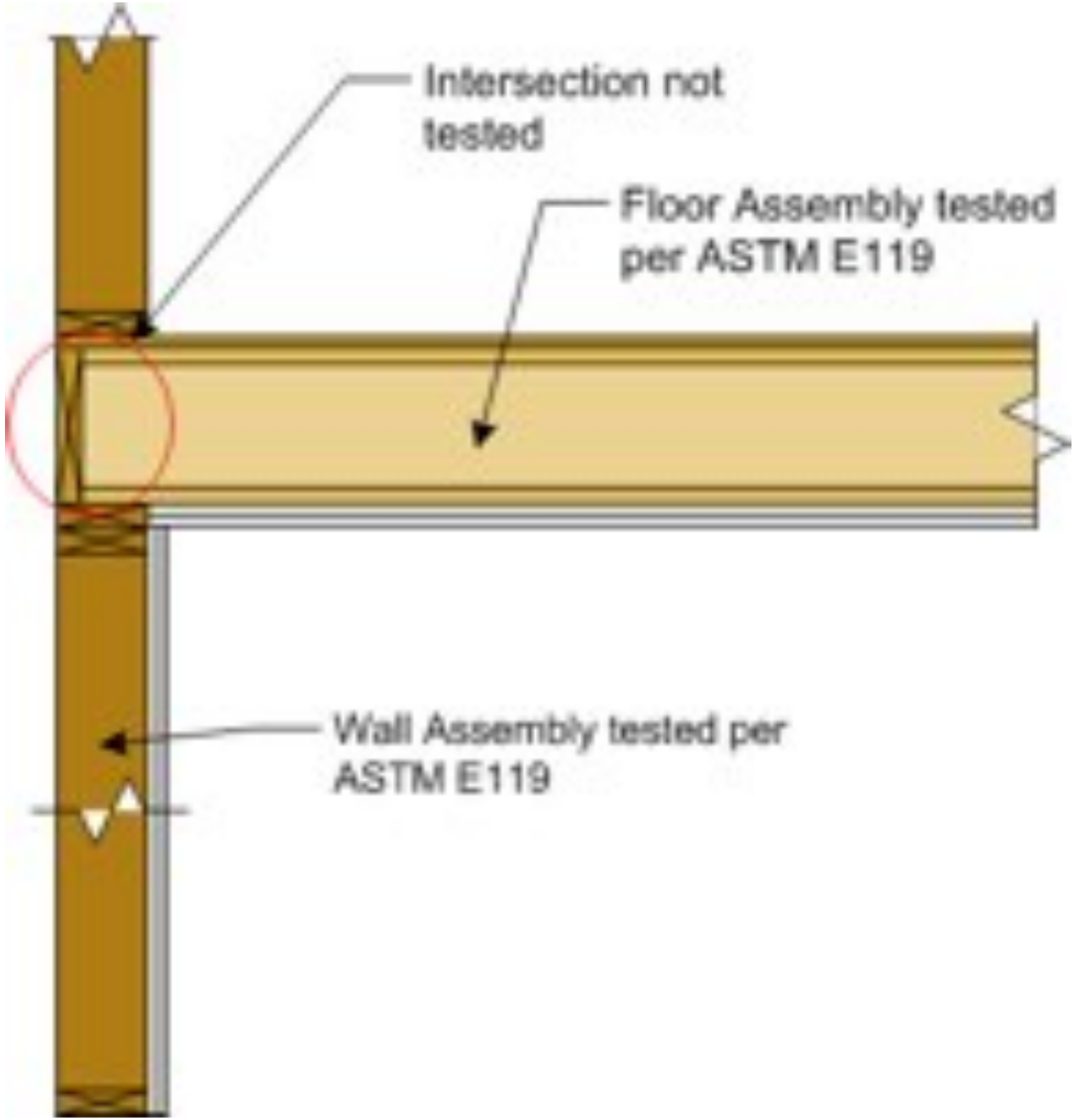
SCL Fire Testing



Type IIIA Wall / Floor Intersection

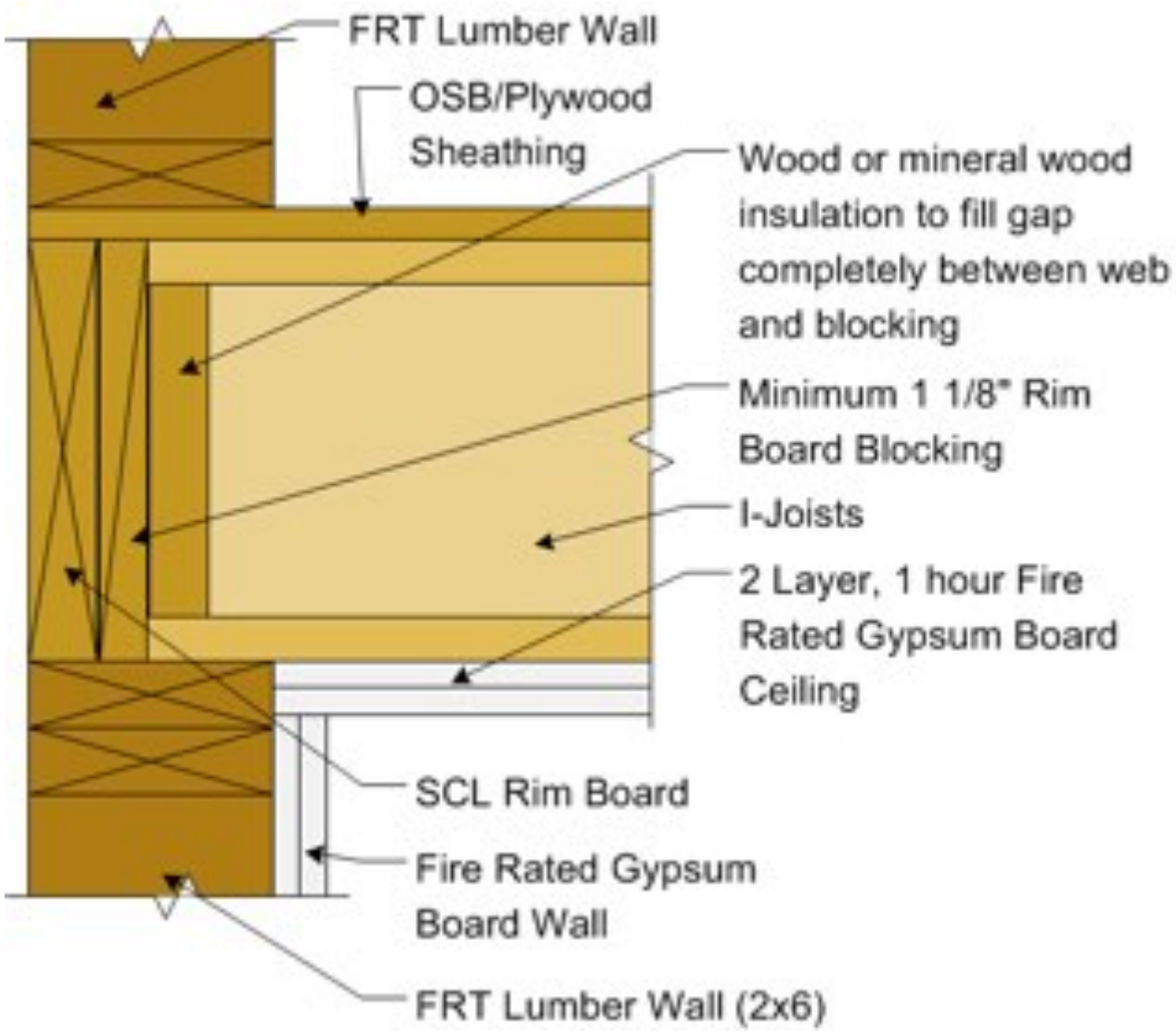
- No standardized fire test for intersection

ASTM Wall Test



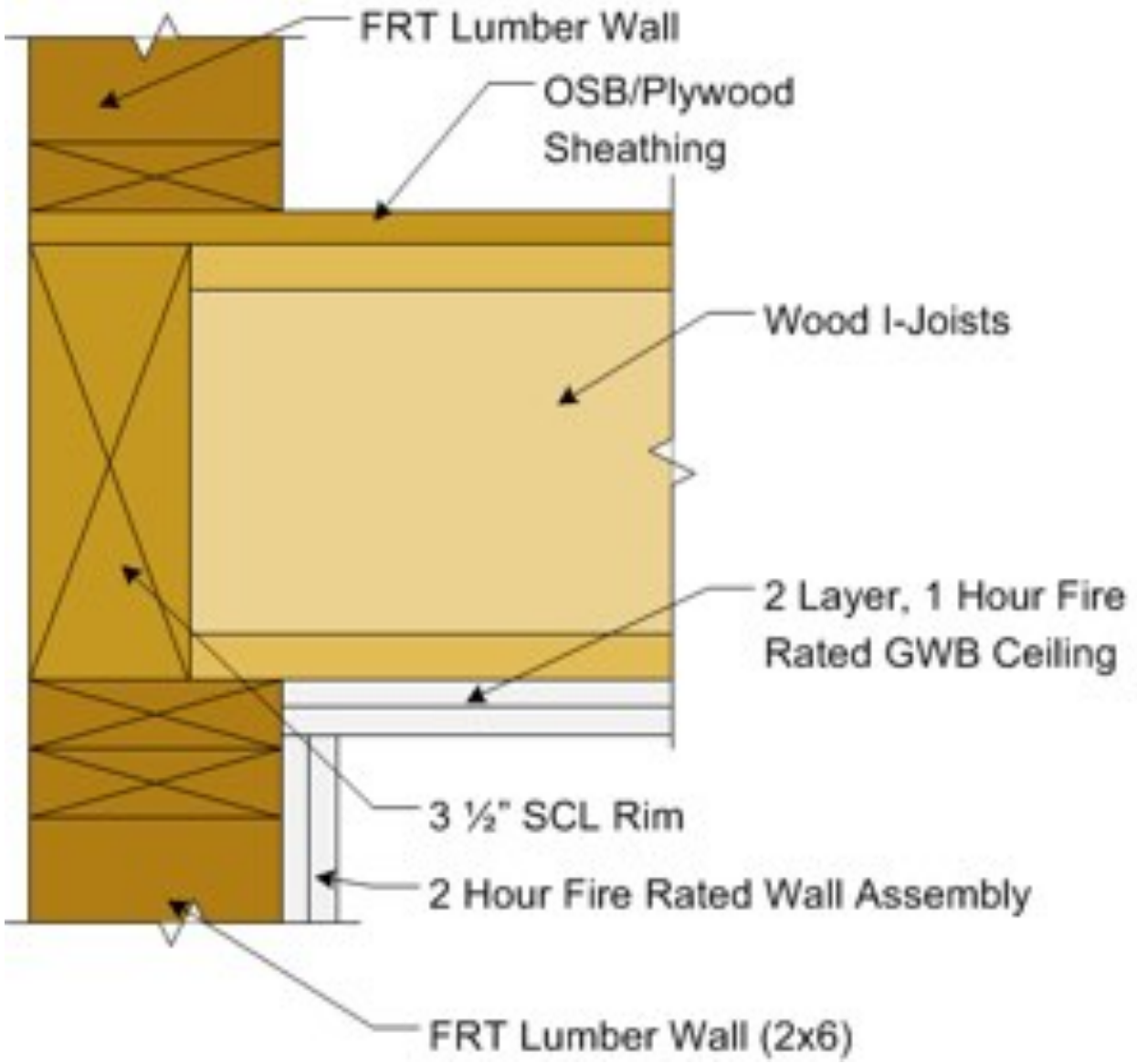
Type IIIA Wall / Floor Intersection

- Multiple SCL rim in lieu of FRT
- Methodology published in AWC DCA3: Fire-Resistance-Rated Wood-Frame Wall and Floor/Ceiling Assemblies



Type IIIA Wall / Floor Intersection

- Thicker SCL rim in lieu of FRT
  - Advantageous for both connections and char
- Methodology published in AWC DCA3: Fire-Resistance-Rated Wood-Frame Wall and Floor/Ceiling Assemblies

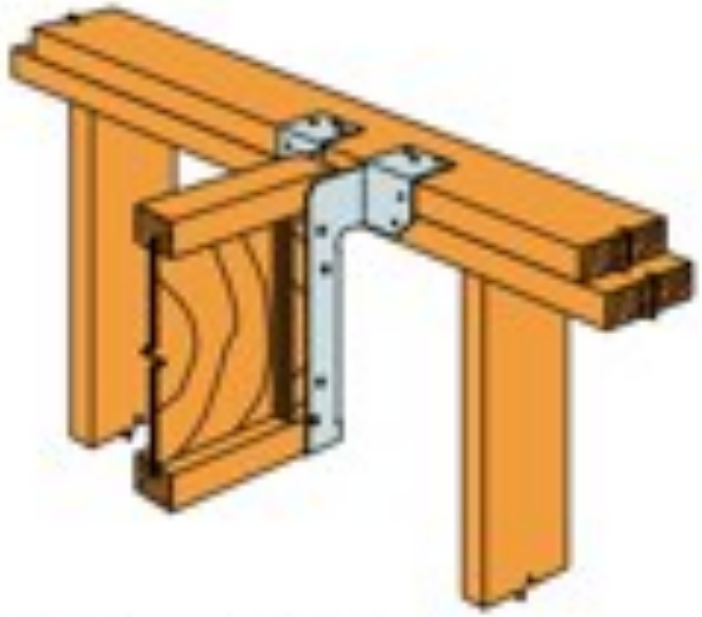


Type IIIA Wall / Floor Intersection

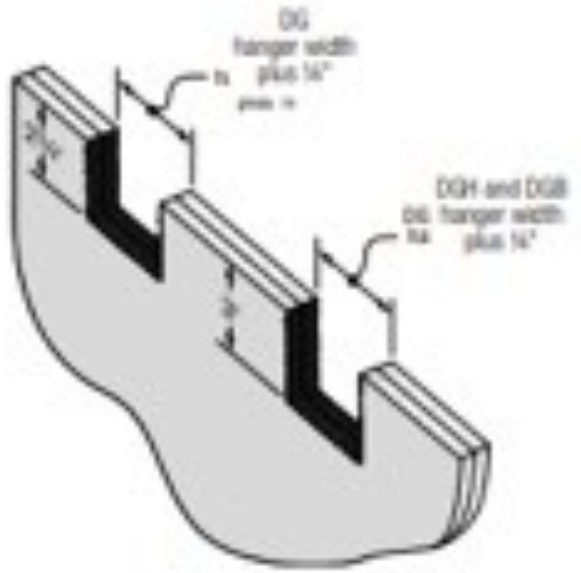
- Fasten-Thru Hangers

DHU Installed (Drywall cutaway)

- Cantilever Hangers



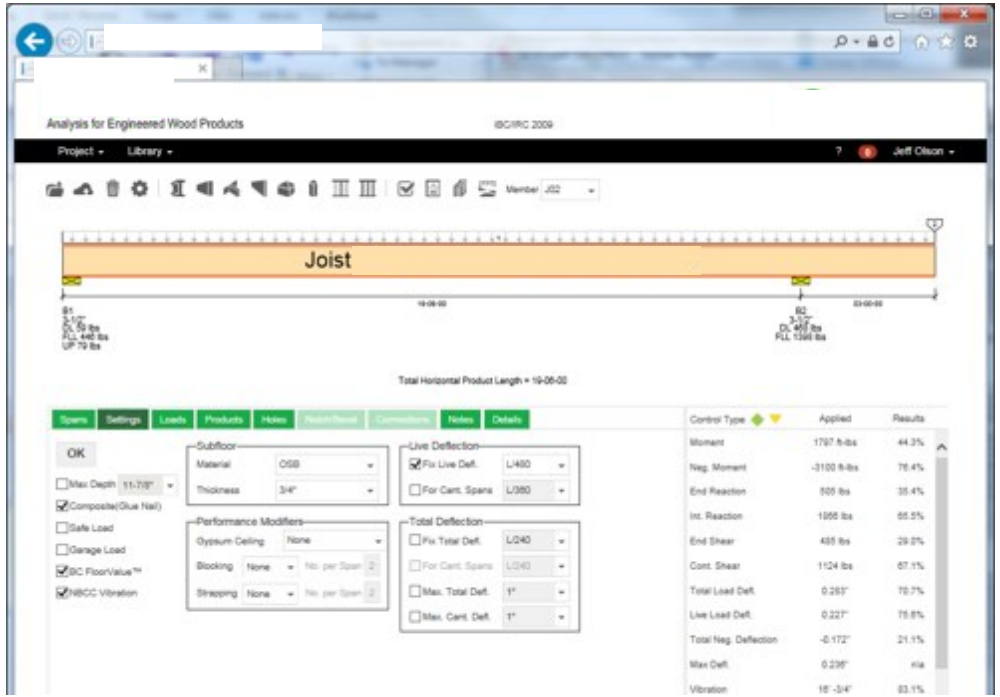
DG Hanger on Stud Wall with I-Joists

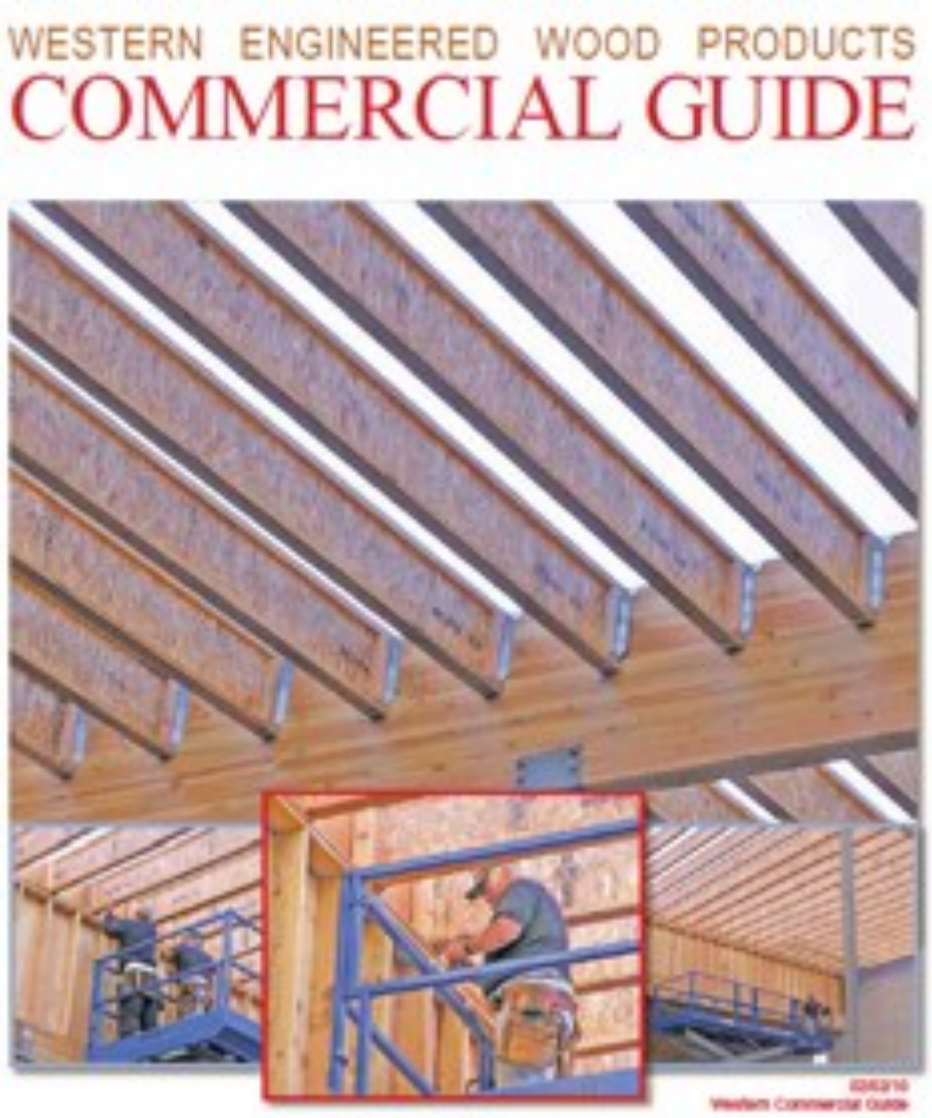


Drywall Notches

EWP Design Resources

- APA The Engineered Wood Association
  - Installation/Application Information
- Individual EWP manufacturers
  - Technical & Fire Design Literature
  - Design Software



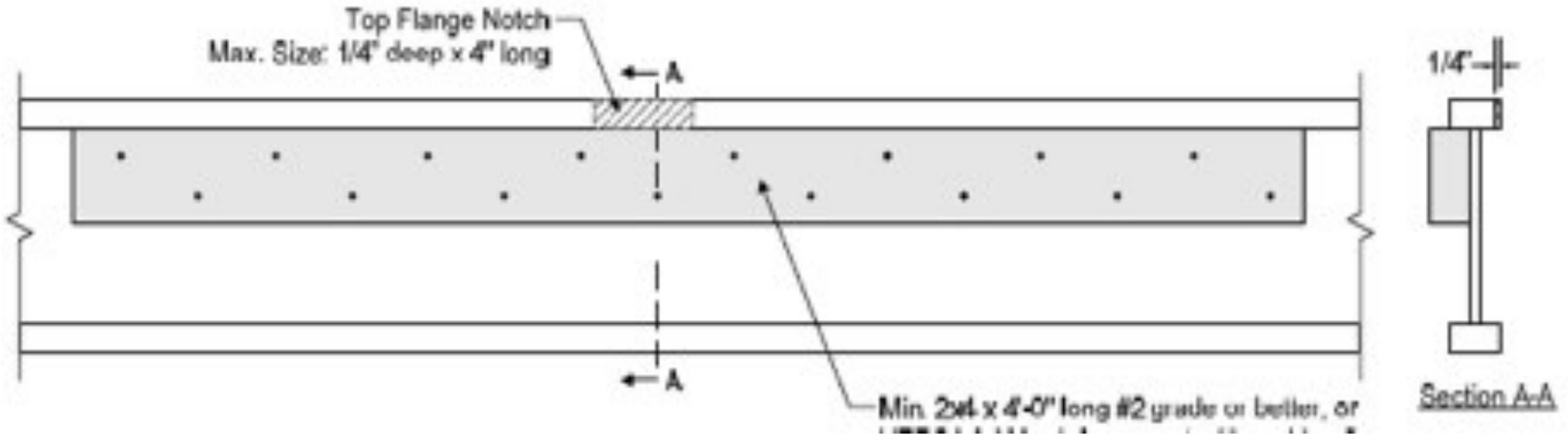


EWP Design Resources

- Wood Design 101: https://www.woodworks.org/wp-content/uploads/Wood-design-structural-properties-performance-fact-sheet.pdf
- Connection Design:
  - AWC Connector Calculator: https://awc.org/codes-standards/calculators-software/connectioncalc
  - ISANTA ICC-ES ESR Evaluation Report: https://www.icc-es.org/wp-content/uploads/report-directory/ESR-1539.pdf
  - Proprietary fasteners
- Fire Design: AWC TR-10 https://awc.org/codes-standards/publications/tr10

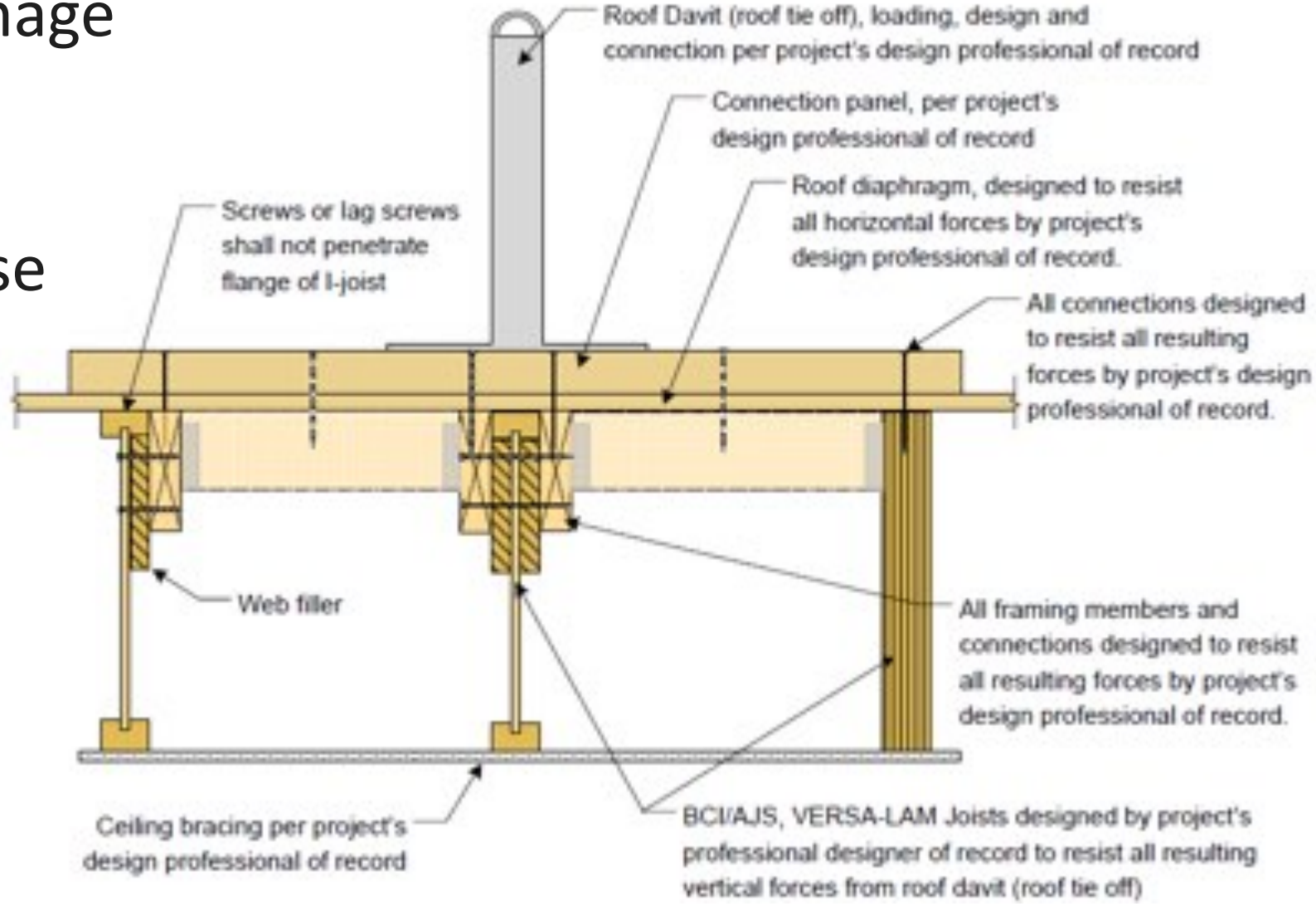
Manufacturers' Engineering Departments

- Technical services including: structural repairs, application review, product acceptance
- Available for all specifiers and building officials



Manufacturers' Engineering Departments

- Repair for In-Field Damage
- Application Details
- Non-typical Product Use



QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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