



Code Compliant Fire-Resistance Design for Wood Construction

(BCD220-2)

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

COURSE DESCRIPTION



Determining the proper code application for wood-frame fire assemblies can be challenging and is often further complicated with increases in a project's size and scale. In a building environment where the ability to maximize height and area is key to cost effectiveness, designers must understand the gamut of fire protection considerations applicable to mid- and low-rise wood structures. This presentation will include code requirements, compliance options and nuances related to assembly selection for required fire-resistance-rated floor/ceiling assemblies, exterior walls, fire barriers, fire partitions, and fire walls. Topics will include distinctions between fire-resistive elements for separation vs. class of construction.

LEARNING OBJECTIVES

Upon completion, participants will be better able to:

1

Apply code requirements and intent for wood frame fire-resistance rated assemblies.

3

Understand the paths to achieving code compliant, fire-resistance rated wood frame assemblies as outlined by the 2015 IBC.

2

Discuss the difference in exterior walls, fire walls, fire barriers, and fire partitions, considering performance expectations, code requirements, and appropriate application.

4

Recognize important nuances in the various methods for demonstrating fire-resistance, including: tested assemblies, prescriptive designs, calculations, and engineering analysis.

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CODE ASSISTANCE – AWC FIELD STAFF



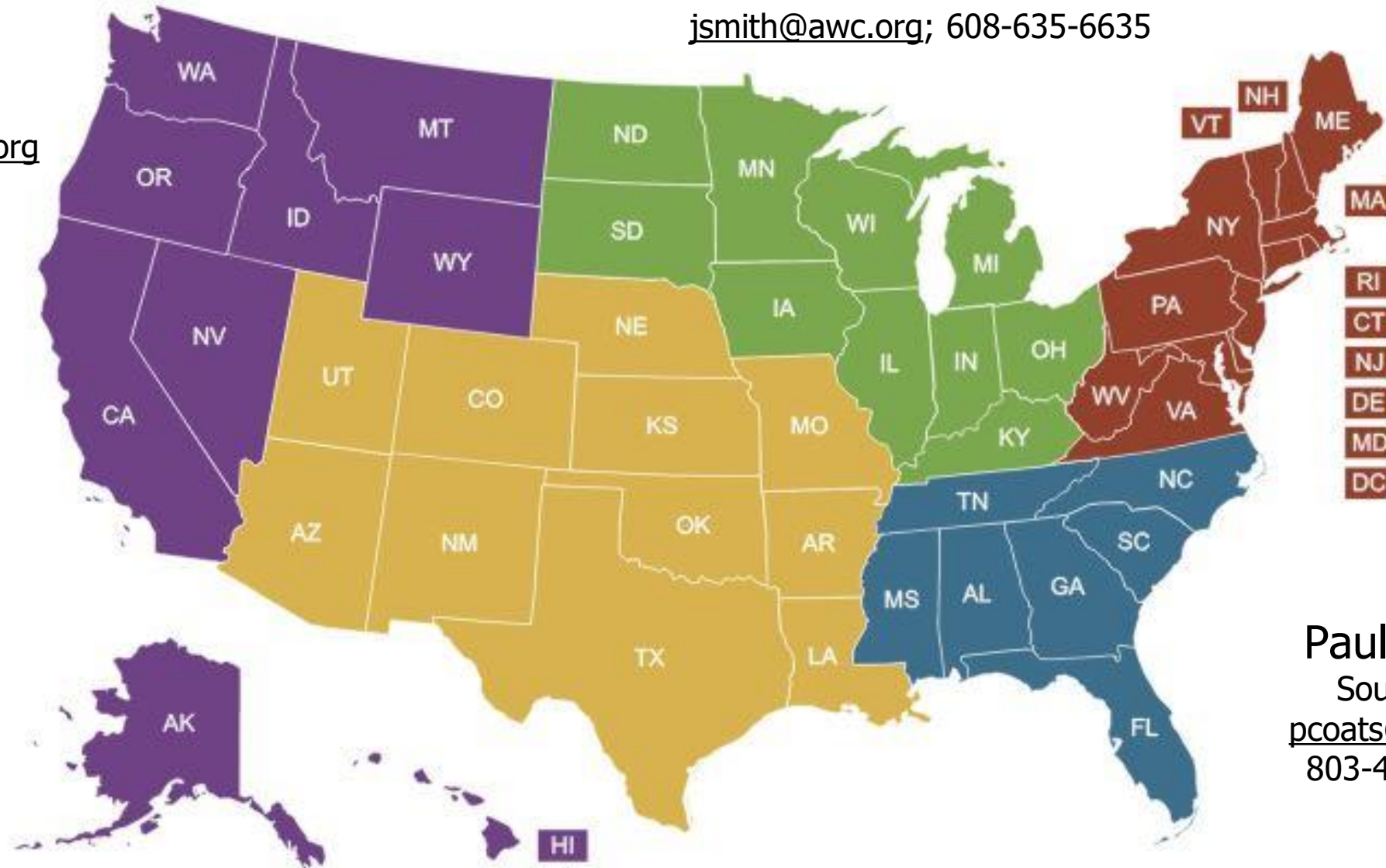
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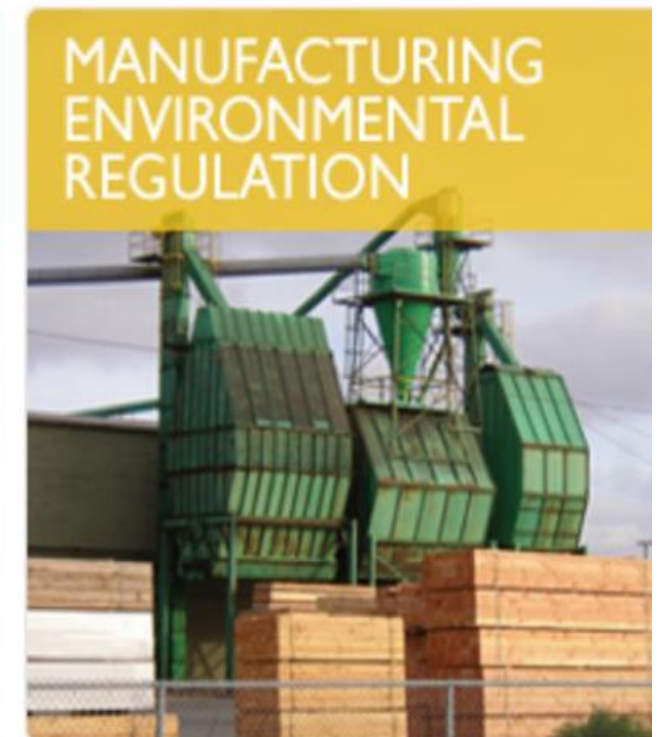
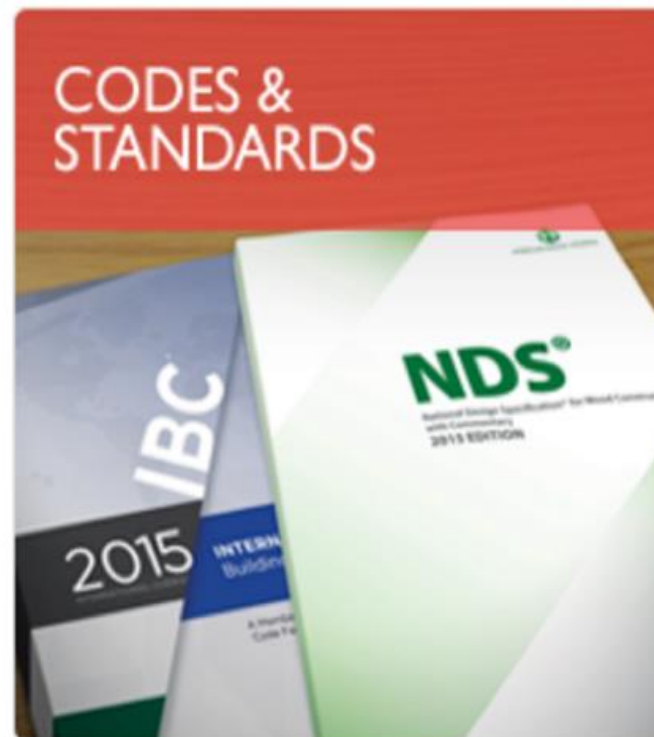


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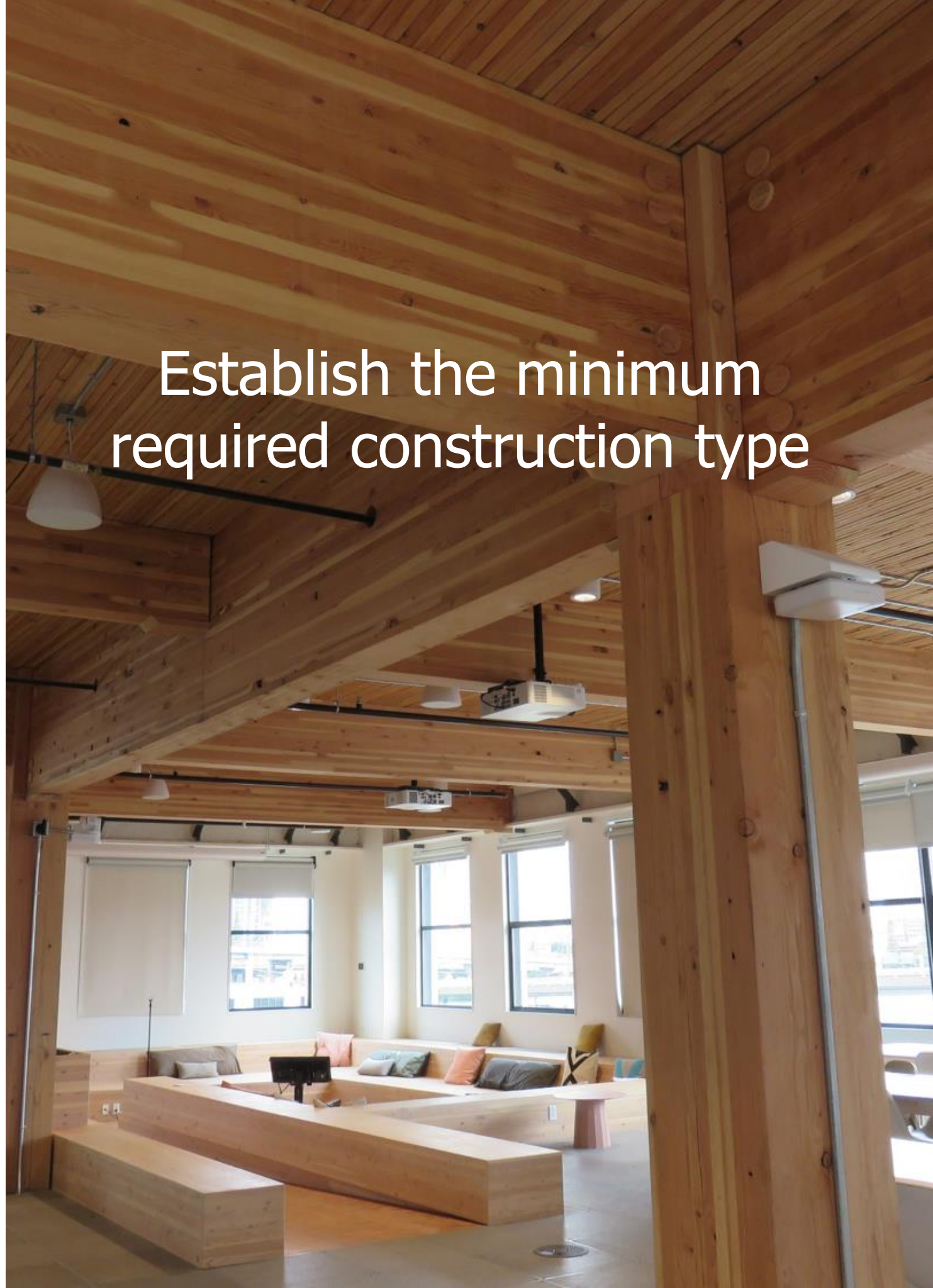


Outline – principles of fire resistance design

- 1. Establish the minimum construction type**
- 2. Know the reason for the fire resistance**
- 3. Know the options for establishing fire resistance**

First principle of fire resistance

Establish the minimum
required construction type



FIRST – MINIMUM CONSTRUCTION TYPE

TABLE 504.3^a
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS ^b	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
H-1, H-2, H-3, H-5	NS ^{c, d}	UL	160	65	55	65	55	65	50	40
	S									
H-4	NS ^{c, d}	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 1, I-3	NS ^{d, e}	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 2, I-2	NS ^{d, f, e}	UL	160	65	55	65	55	65	50	40
	S	UL	180	85						
I-4	NS ^{d, g}	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
R	NS ^{d, h}	UL	160	65	55	65	55	65	50	40
	S13R	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	85	70	60

FIRST – MINIMUM CONSTRUCTION TYPE

TABLE 504.4^{a, b}
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	2	1
	S	UL	6	4	3	4	3	4	3	2
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-4	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
E	NS	UL	5	3	2	3	2	3	1	1
	S	UL	6	4	3	4	3	4	2	2
	NS	UL	11	4	2	3	2	4	2	1

FIRST – MINIMUM CONSTRUCTION TYPE

TABLE 506.2^{a, b}
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, or SM, as applicable) IN SQUARE FEET

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S1									
	SM									
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000
E	NS	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	102,000	74,000	38,000
	SM	UL	UL	79,500	43,500	70,500	43,500	76,500	55,500	28,500

FIRST – MINIMUM CONSTRUCTION TYPE

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame ^f (see Section 202)	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^{e, f}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions							See		
Interior ^d	0	0	0	0	0	0	Section	0	0
							602.4.6		
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 ^{1/2} ^b	1 ^{b,c}	1 ^{b,c}	0 ^c	1 ^{b,c}	0	HT	1 ^{b,c}	0

FIRST – MINIMUM CONSTRUCTION TYPE

$$A_a = [A_t + (NS \times I_f)] \times S_a \text{ (Equation 5-2)}$$

$$I_f = [F / P - 0.25] W / 30 \text{ (Equation 5-5)}$$

FIRST – MINIMUM CONSTRUCTION TYPE

$$A_a = [A_t + (NS \times I_f)] \times S_a \text{ (Equation 5-2)}$$

Includes sprinkler increases

Number of stories up to three

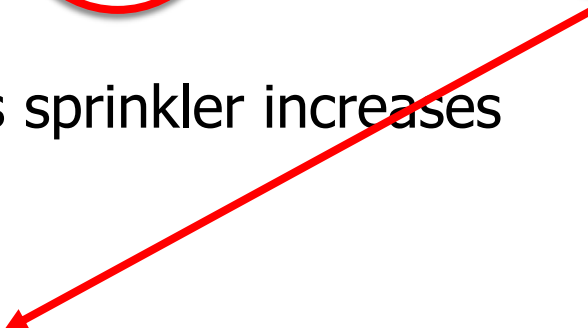
$$I_f = [F / P - 0.25] W / 30 \text{ (Equation 5-5)}$$

FIRST – MINIMUM CONSTRUCTION TYPE

$$A_a = [A_t + (NS \times I_f)] \times S_a \quad (\text{Equation 5-2})$$

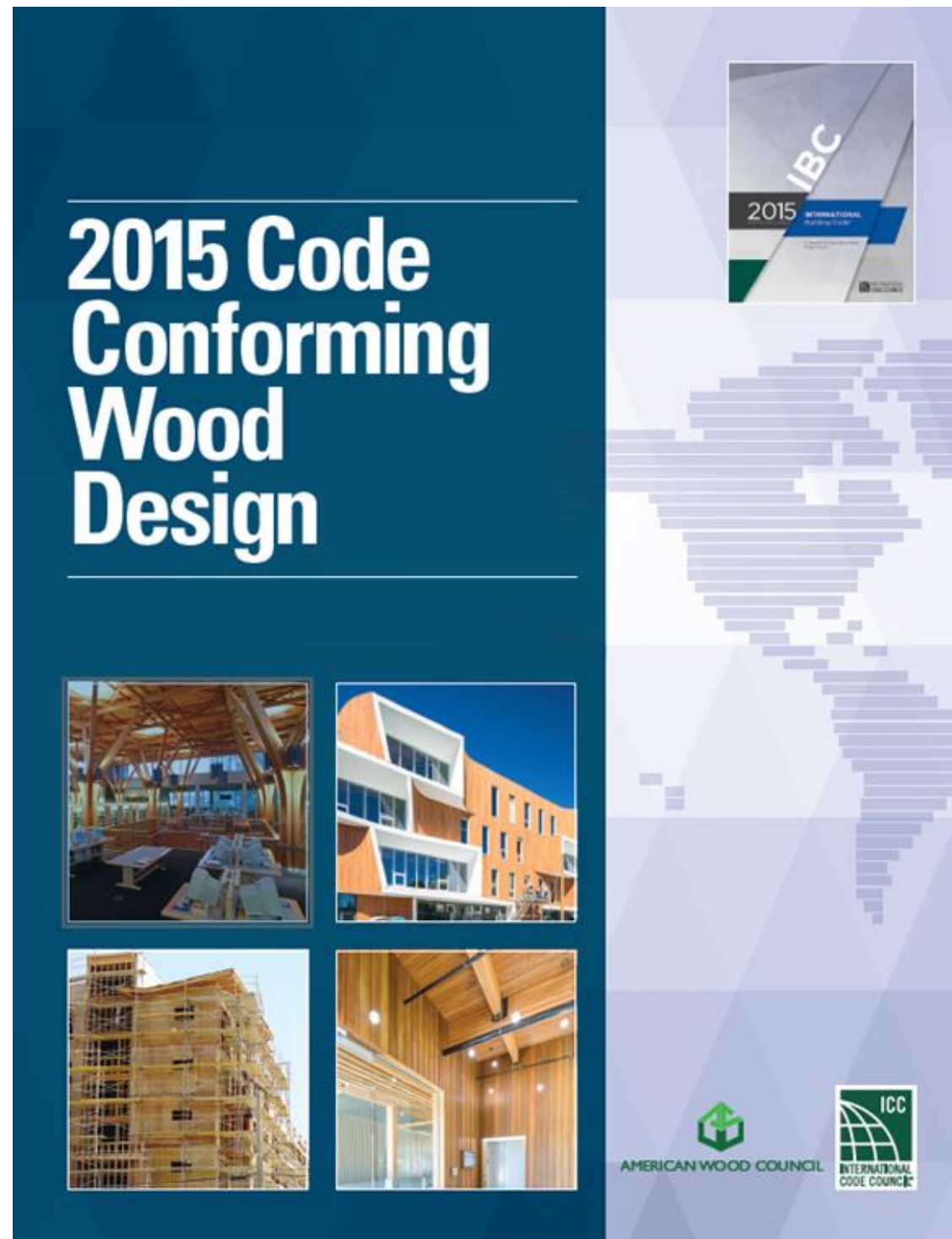
Includes sprinkler increases

Number of stories up to three


$$I_f = [F / P - 0.25] W / 30 \quad (\text{Equation 5-5})$$

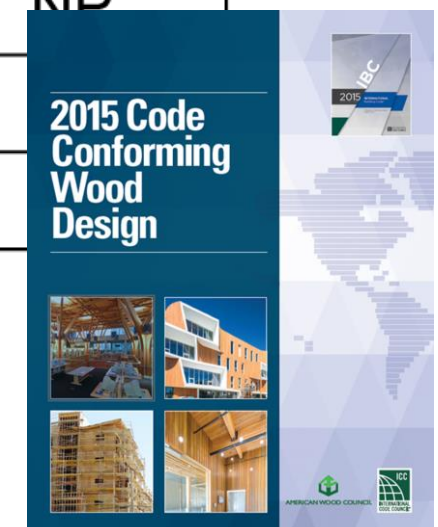
Open frontage factor

FIRST – MINIMUM CONSTRUCTION TYPE



FIRST – MINIMUM CONSTRUCTION TYPE

Group E Nonsprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	23,500	14,500	25,500	12,120	9,500
	50	29,370	25,370	31,870	22,500	11,870
	100	41,120	33,250	44,620	32,370	16,620
2	0-25	23,500	14,500	25,500	NP	NP
	50	29,370	18,120	31,870	NP	NP
	100	41,120	25,370	44,620	NP	NP
3	0-25	23,500	NP	25,500	NP	NP
	50	29,370	NP	31,870	NP	
	100	41,120	NP	44,620	NP	

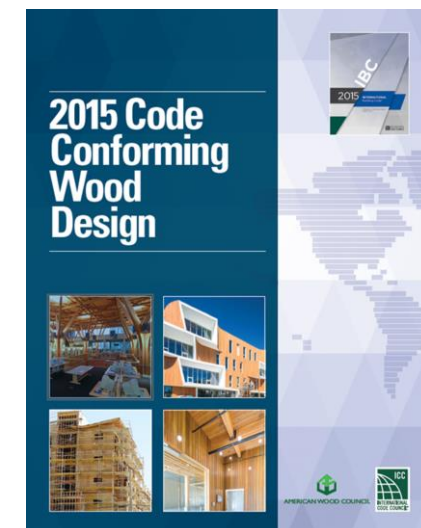


FIRST – MINIMUM CONSTRUCTION TYPE

Group E Nonsprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	23,500	14,500	25,500	12,120	9,500
	50	29,370	25,370	31,870	22,500	11,870
	100	41,120	33,250	44,620	32,370	16,620
2	0-25	23,500	14,500	25,500	NP	NP
	50	29,370	18,120	31,870	NP	NP
	100	41,120	25,370	44,620	NP	NP
3	0-25	23,500	NP	25,500	NP	NP
	50	29,370	NP	31,870	NP	NP
	100	41,120	NP	44,620	NP	NP

Footnotes

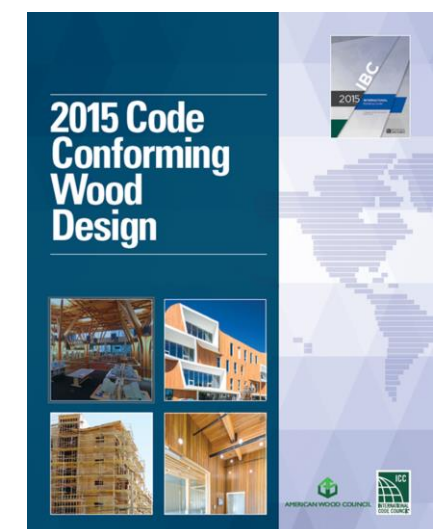
- a.** Frontage based on open space widths of 30 feet or more.
- b.** Interpolation permitted.
- c.** Sprinklers must be provided for Group E occupancies when the fire area exceeds 12,000 square feet in accordance with Section 903.2.3, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.



FIRST – MINIMUM CONSTRUCTION TYPE

Table 15 – Group R, NFPA 13R-Compliant Sprinklered Buildings – Maximum floor area per story

Group R-1, R-2, R-4 Sprinklered Buildings – NFPA 13R Compliant ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3 ^d	0-25	24,000	16,000	20,500	12,000	7,000
	50	30,000	20,000	25,620	15,000	8,750
	100	42,000	28,000	35,870	21,000	12,250
4 ^e	0-25	24,000	16,000	20,500	12,000	NP
	50	30,000	20,000	25,620	15,000	NP
	100	42,000	28,000	35,870	21,000	NP
Group R-3 Sprinklered Buildings- NFPA 13R Compliant ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL
4 ^d	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL



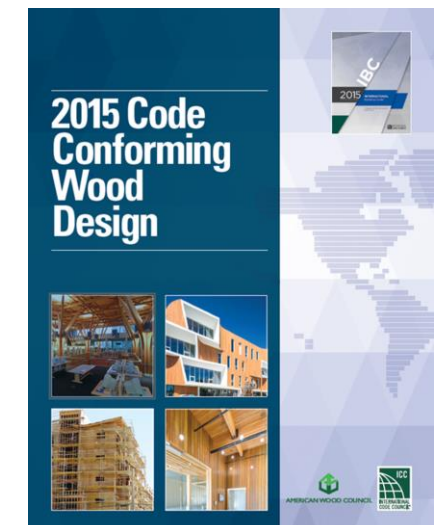
FIRST – MINIMUM CONSTRUCTION TYPE

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2015 Code Conforming Wood Design

Table 16 – Group R, NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group R-1, R-2, R-4 Sprinklered Buildings ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	98,000	64,000	82,000	48,000	28,000
	50	102,000	68,000	87,120	51,000	29,750
	100	114,000	76,000	97,370	57,000	33,250
2, 3	0-25	72,000	48,000	61,500	36,000	21,000
	50	78,000	52,000	66,620	39,000	22,750
	100	90,000	60,000	76,870	45,000	26,250
4	0-25	54,000	36,000	46,120	27,000	NP
	50	58,500	39,000	49,960	29,250	NP
	100	67,500	45,000	57,650	33,750	NP
5	0-25	43,200	28,800	36,900	NP	NP
	50	46,800	31,200	39,970	NP	NP
	100	54,000	36,000	46,120	NP	NP



FIRST – MINIMUM CONSTRUCTION TYPE

- **Minimum construction type**
 - May sometimes be independent of materials chosen
 - Allows greatest flexibility for materials use



FIRST – MINIMUM CONSTRUCTION TYPE

- **Minimum construction type**
 - **Should take into account the final size of building with all future expansions in mind**



Second principle of fire resistance

Know the reason for the
fire resistance



**Noncombustible
(703.5)**

≠

**Fire resistant
(703.2 and 703.3)**

SECOND – REASON FOR THE FIRE RESISTANCE

FIRE-RESISTANCE RATING. The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703.



SECOND – REASON FOR THE FIRE RESISTANCE

- **Building elements (walls, floors, roofs) rated per construction type (704)**
- **Exterior walls (705)**
- **Fire walls (706)**
- **Fire barriers (707)**
- **Fire partitions (708)**
- **Horizontal assemblies (711)**

SECOND – REASON FOR THE FIRE RESISTANCE

- **Building elements (walls, floors, roofs) rated per construction type (704)**
 - **Have general protection requirements in 704**
 - **Do not require opening/penetration protection**
 - **Have ratings based on Table 601**

SECOND – REASON FOR THE FIRE RESISTANCE

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame ^f (see Section 202)	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^{e, f}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions							See		
Interior ^d	0	0	0	0	0	0	Section	0	0
							602.4.6		
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 ^{1/2} ^b	1 ^{b,c}	1 ^{b,c}	0 ^c	1 ^{b,c}	0	HT	1 ^{b,c}	0

SECOND – REASON FOR THE FIRE RESISTANCE

- **Exterior walls (705)**
 - **Have unique structural, continuity, and opening/penetration protection requirements**
 - **Have material requirements based on construction type**
 - **Have ratings based on proximity to lot lines**
 - **Required to be rated for exposure to both sides of the wall only when $FSD \leq 10$ ft. (otherwise interior side of wall is the exposed side for testing)**

SECOND – REASON FOR THE FIRE RESISTANCE

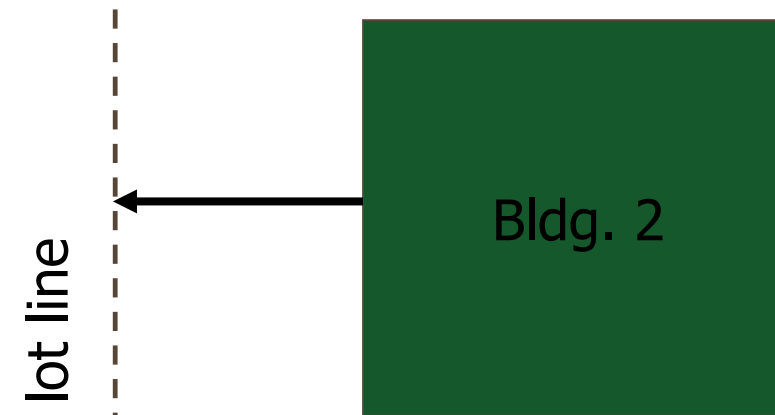
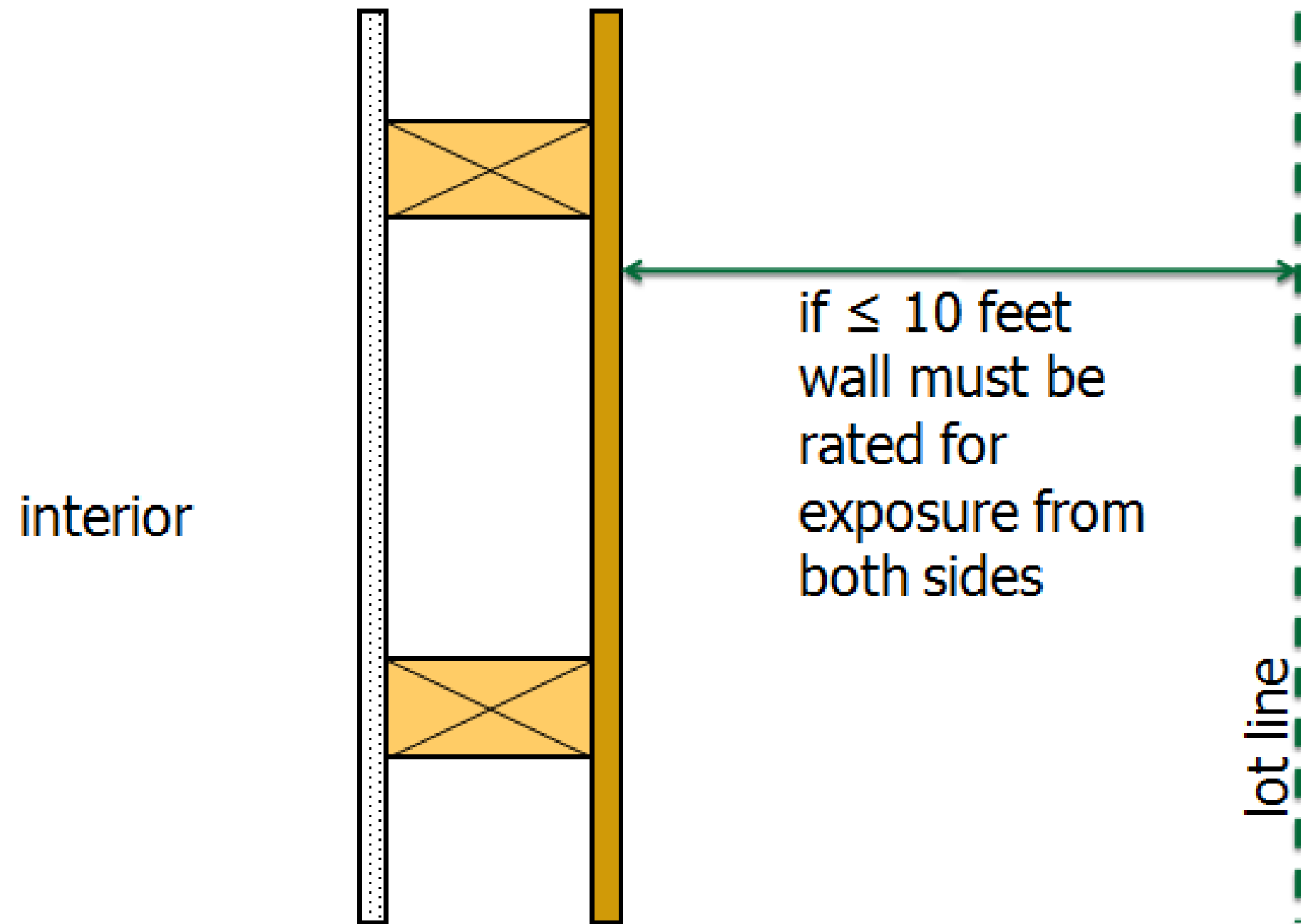


TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE^{a, d, g}

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H ^e	OCCUPANCY GROUP F-1, M, S-1 ^f	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U ^h
$X < 5^b$	All	3	2	1
$5 \leq X < 10$	IA	3	2	1
	Others	2	1	1
$10 \leq X < 30$	IA, IB	2	1	1 ^c
	IIB, VB	1	0	0
	Others	1	1	1 ^c
$X \geq 30$	All	0	0	0

SECOND – REASON FOR THE FIRE RESISTANCE



SECOND – REASON FOR THE FIRE RESISTANCE

Exterior Wall-Floor Intersection – example details

- Types III-A and III-B

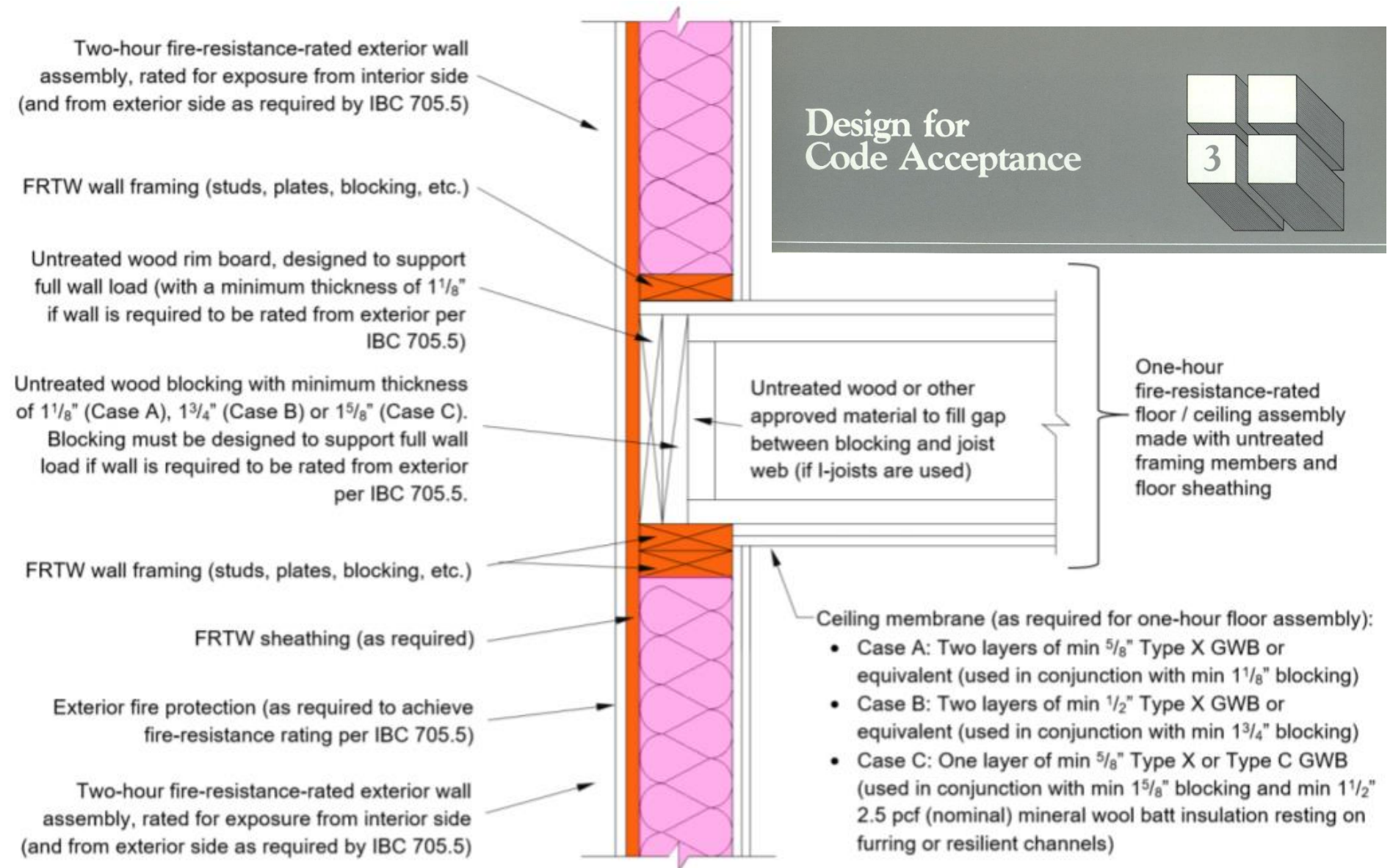


Figure 1A: Example detail for Type III-A exterior wall-floor intersection with rim board and blocking

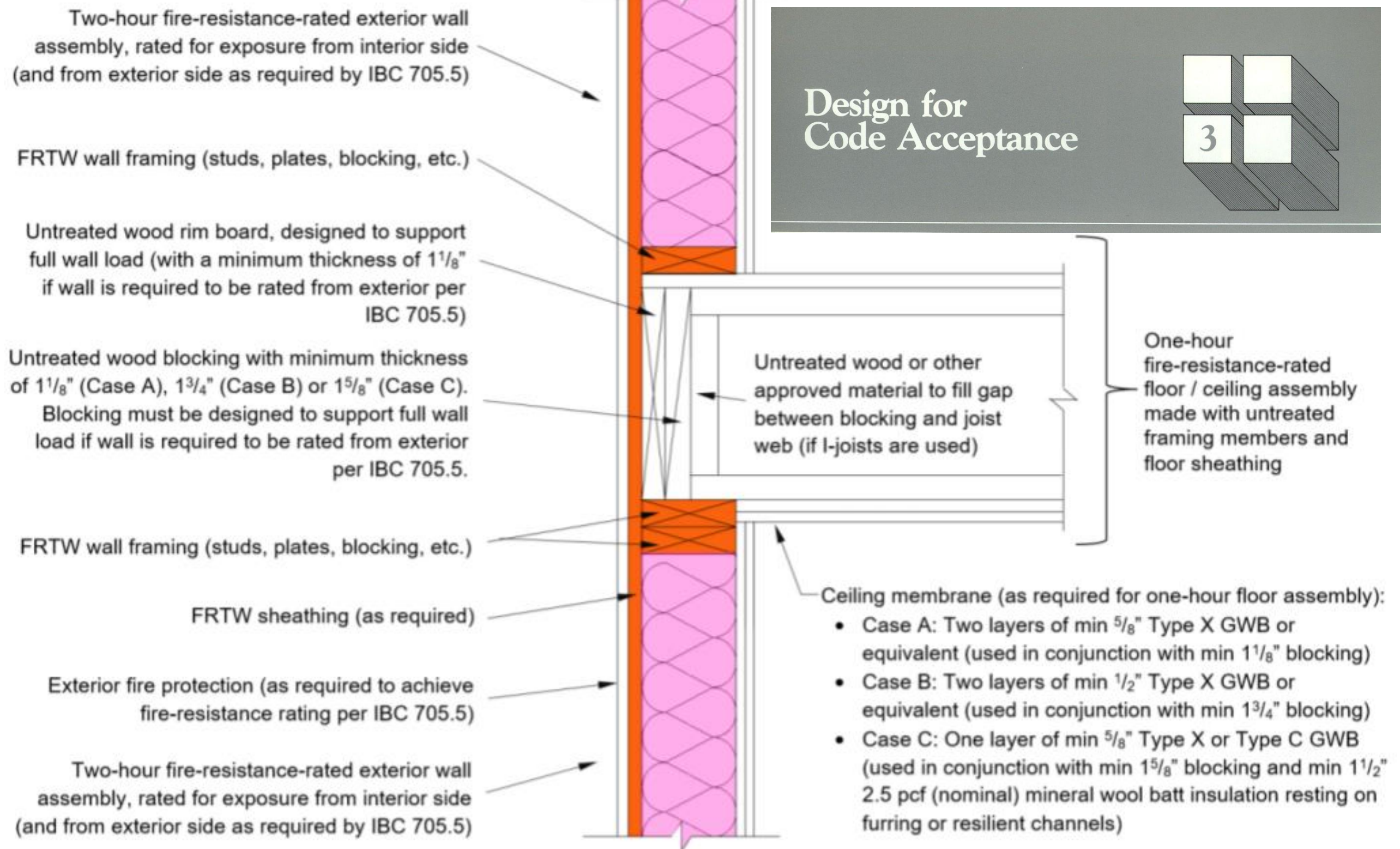


Figure 1A: Example detail for Type III-A exterior wall-floor intersection with rim board and blocking

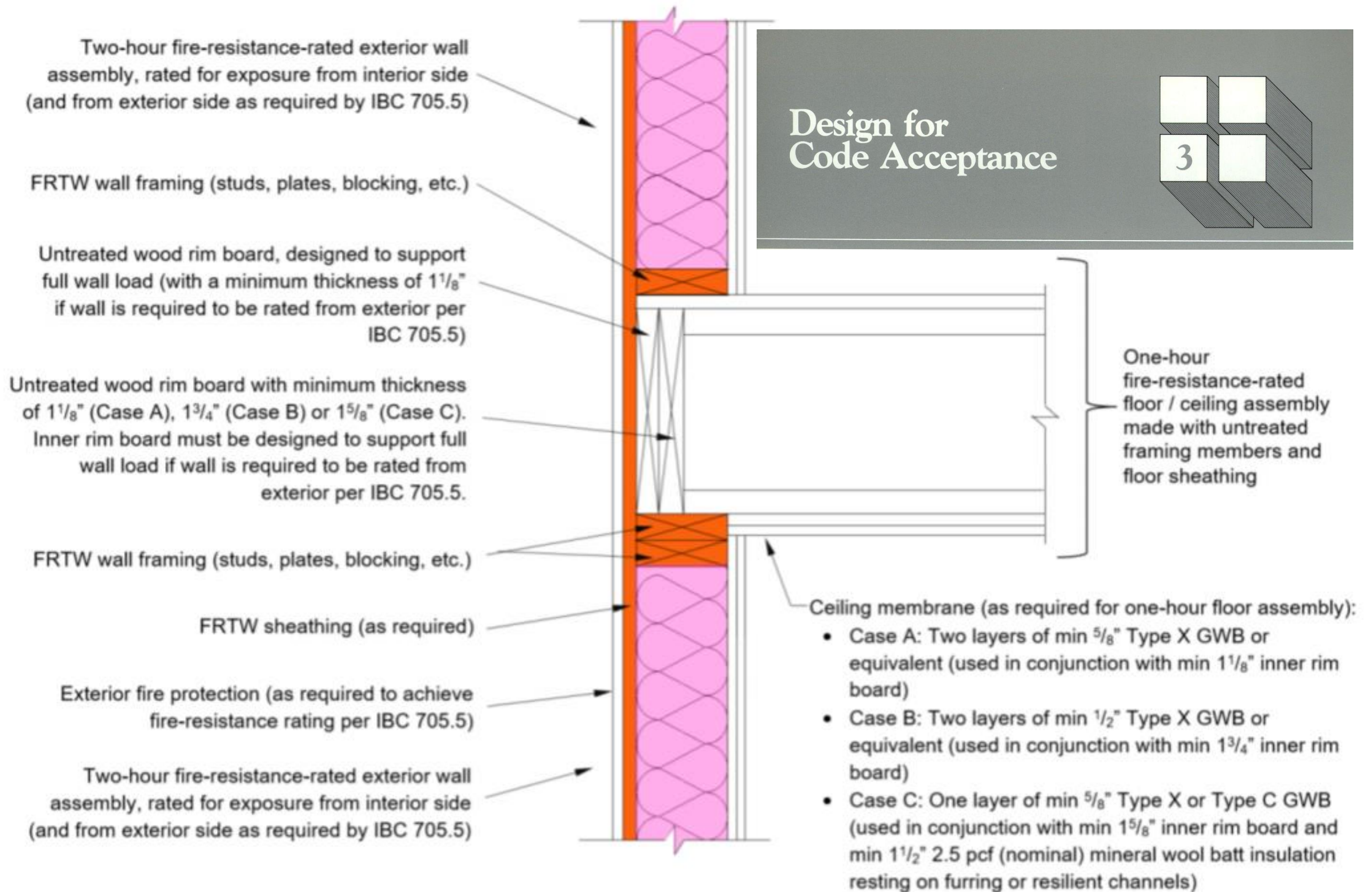


Figure 1B: Example detail for Type III-A exterior wall-floor intersection with two rim boards

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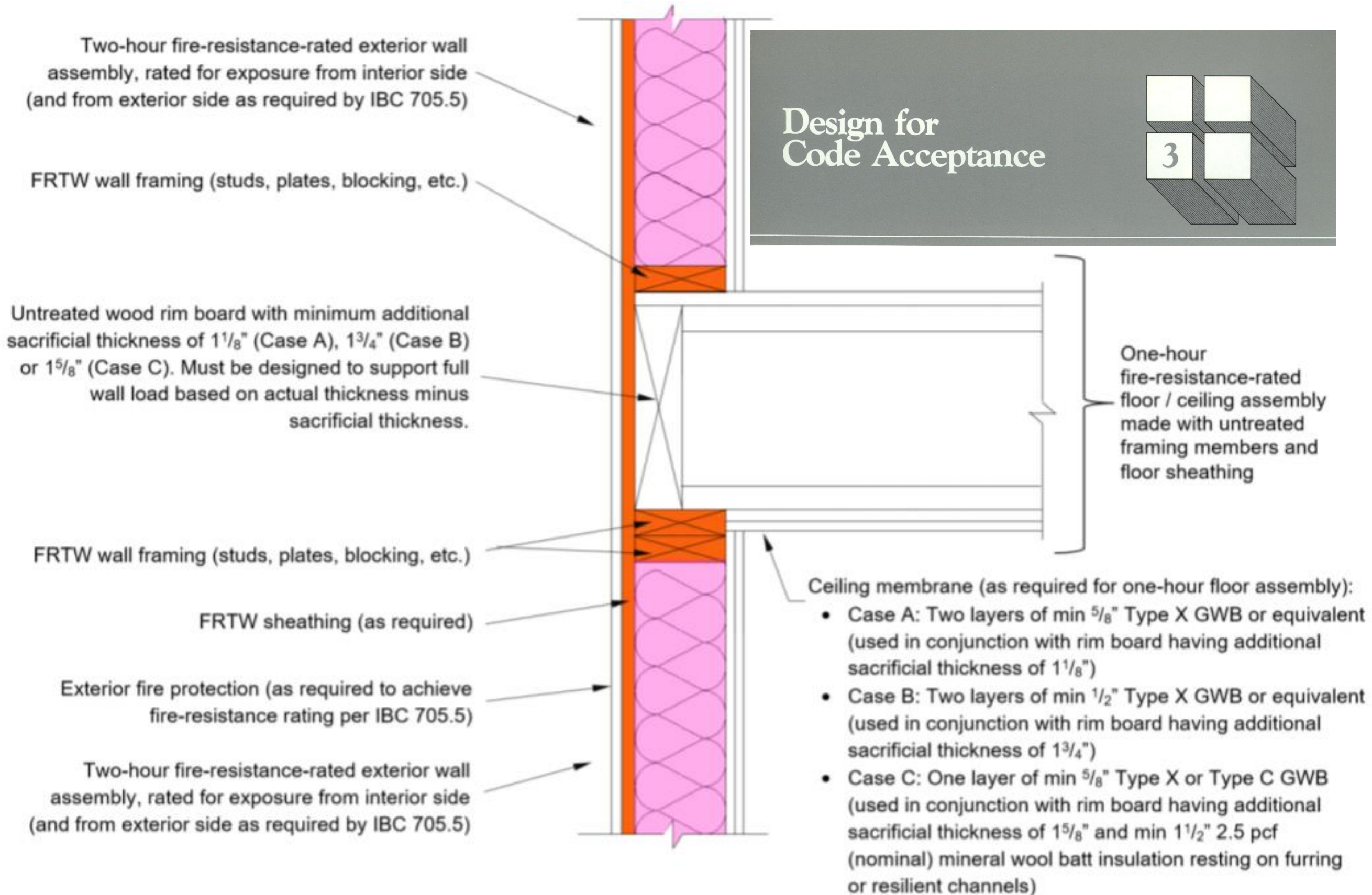
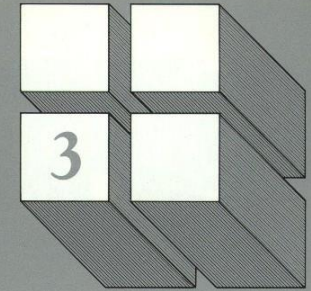


Figure 1C: Example detail for Type III-A exterior wall-floor intersection with single rim board

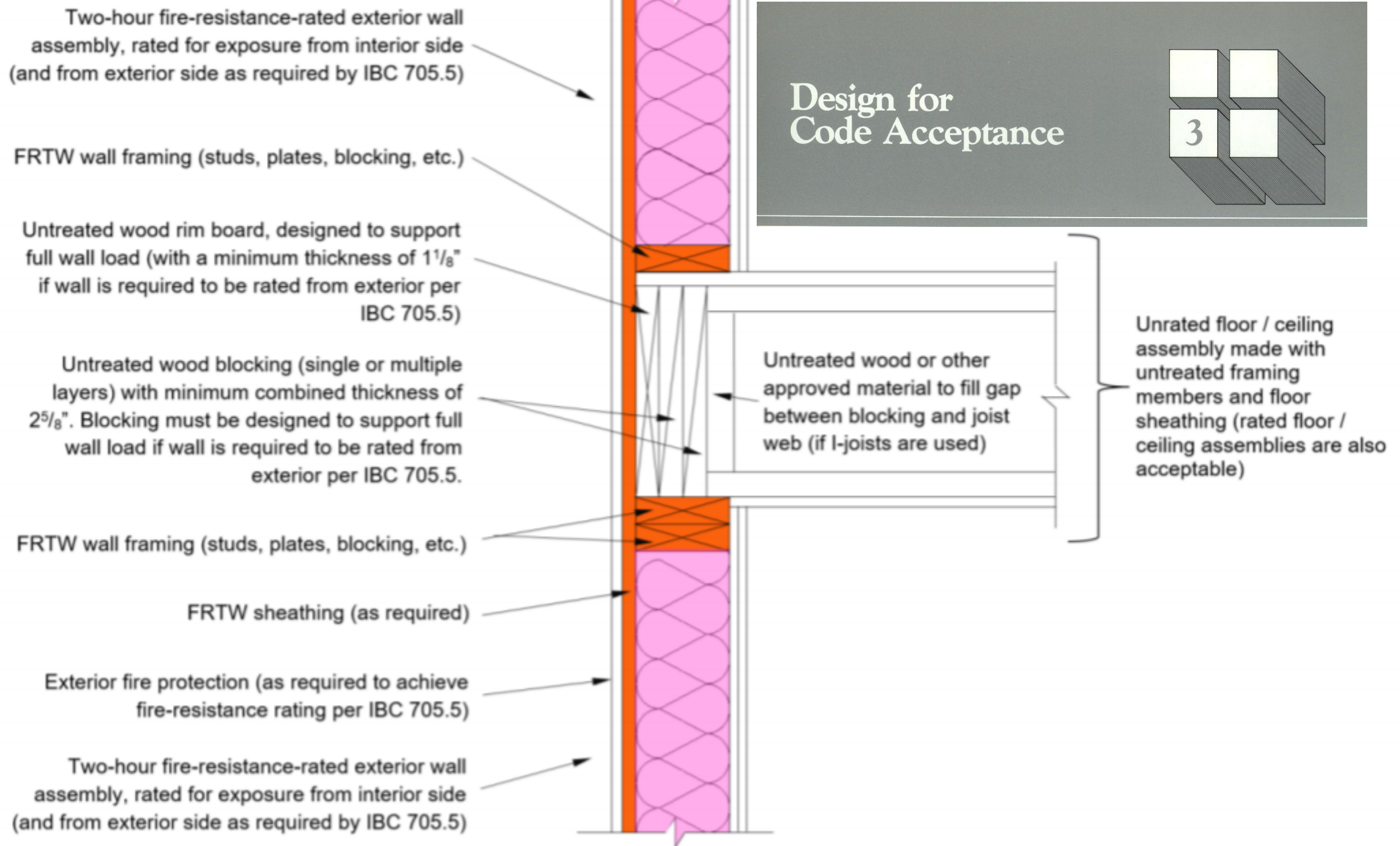


Figure 2: Example detail for Type III-B exterior wall-floor intersection with rim board and blocking

SECOND – REASON FOR THE FIRE RESISTANCE

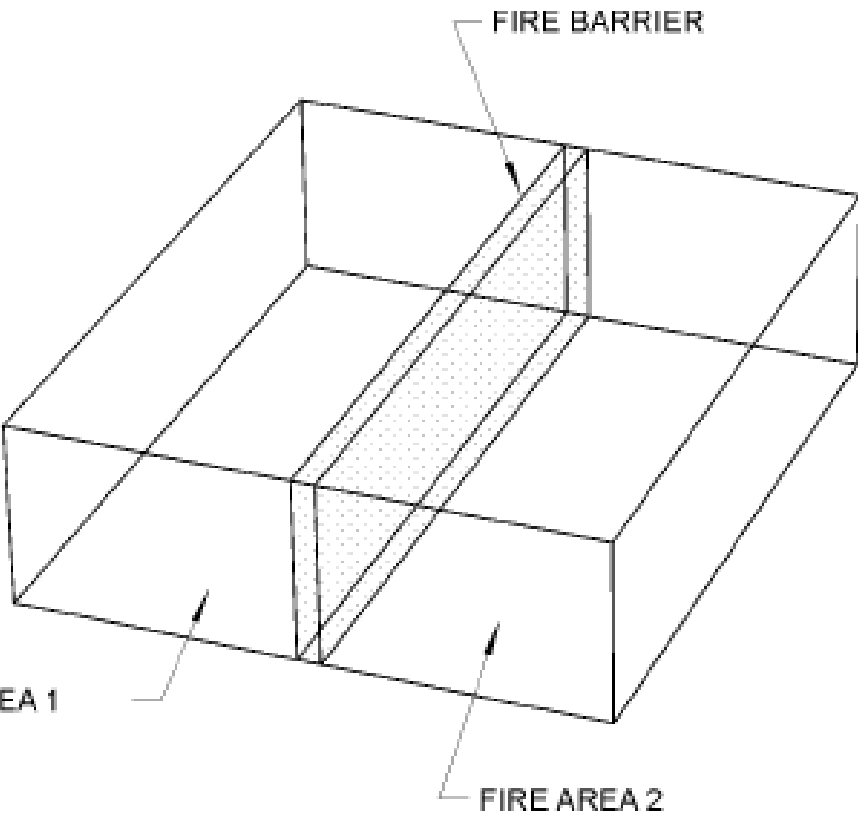
- **Fire walls (706)**
 - **Define separate buildings**
 - **Have unique structural, continuity, and opening/penetration protection requirements**
 - **Have materials requirements based on type of construction (Type V may be wood)**
 - **Have ratings based on occupancy**

SECOND – REASON FOR THE FIRE RESISTANCE

- **Fire barriers (707)**
 - **Create fire resistant separations**
 - **Have unique continuity and opening/penetration protection requirements**
 - **May have any materials permitted by the construction type**
 - **Have ratings based on function**
 - shaft enclosures, exit enclosures, occupancy separations, hazardous material control areas, fire areas, atrium protection, and others

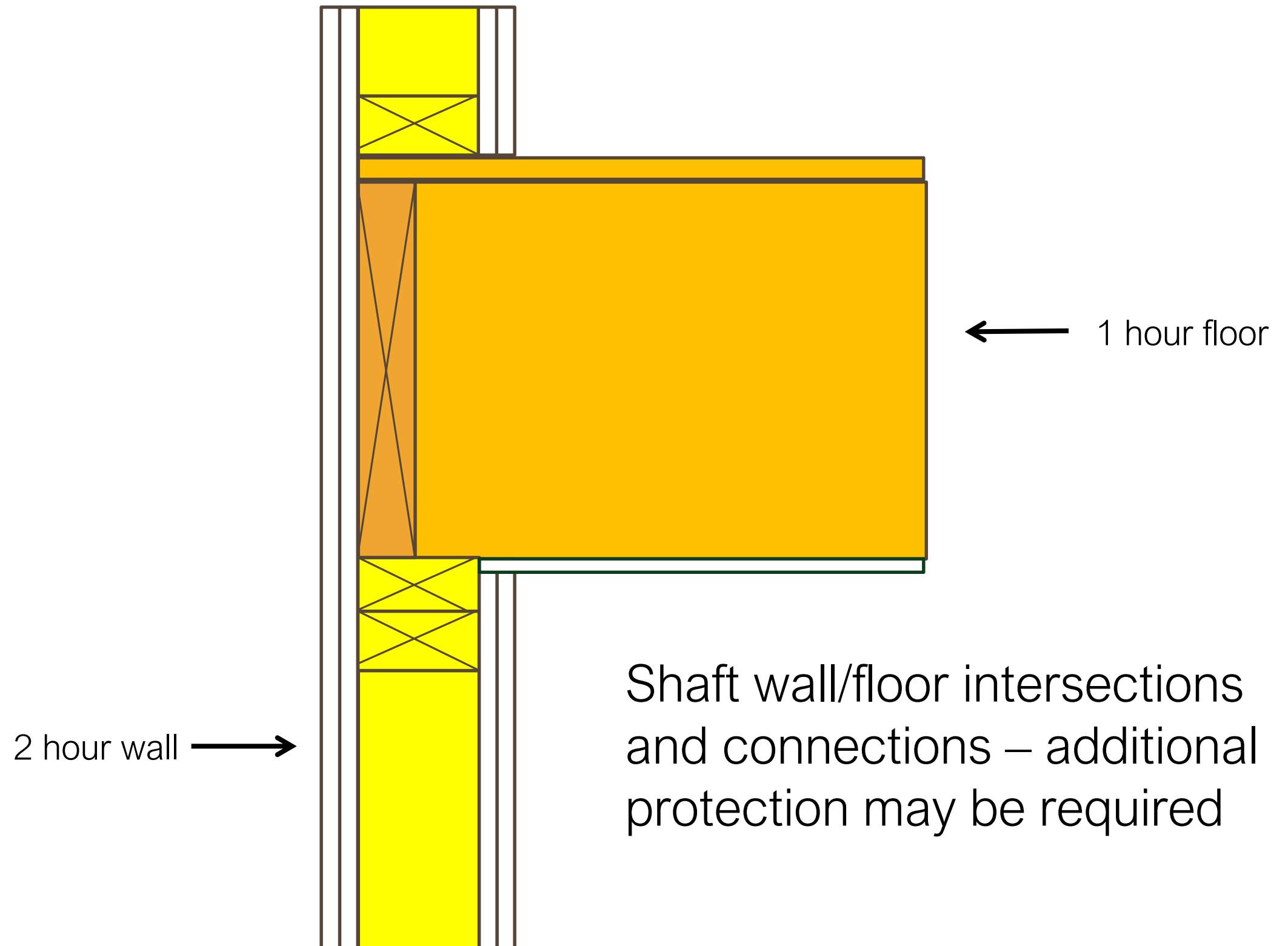
SECOND – REASON FOR THE FIRE RESISTANCE

TABLE 508.4
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)

OCCUPANCY	A, E		I-1 ^a , I-3, I-4		I-2		R ^a		F-2, S-2 ^b , U		B ^c , F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1 ^a , I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R ^a	—	—	—	—	—	—	N	N	1 ^c	2 ^c	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2 ^b , U	—	—	—	—	—	—	—	—	N	N	1	2	NP	NP	3	4	2	3	2	NP
B ^c , F-1, M, S-1											N	N	NP	NP	2	3	1	2	1	NP
H-1											—	—	N	NP	NP	NP	NP	NP	NP	NP
H-2											—	—	—	—	N	NP	1	NP	1	NP
H-3, H-4											—	—	—	—	—	—	1 ^d	NP	1	NP
H-5											—	—	—	—	—	—	—	—	N	NP

BUILDING AREA = FIRE AREA 1 + FIRE AREA 2

SECOND – REASON FOR THE FIRE RESISTANCE



SECOND – REASON FOR THE FIRE RESISTANCE

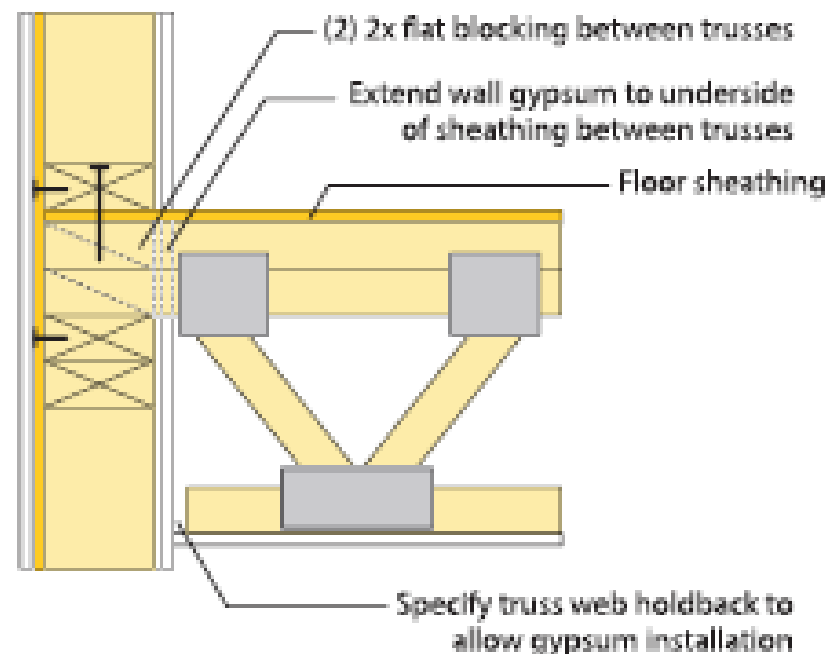


Shaft Wall Solutions For Wood-Frame Buildings

Richard McLain, MS, PE, SE • Technical Director • WoodWorks

FIGURE 11:

Floor-to-Shaft Wall Intersection Detail
with Gypsum Extending to Underside
of Sheathing between Trusses



SECOND – REASON FOR THE FIRE RESISTANCE

- **Fire partitions (708)**
 - **Create fire resistant separations**
 - **Have unique continuity and opening/penetration protection requirements**
 - **May have any materials permitted by the construction type**
 - **Have ratings based on function and sprinkler protection**
 - Dwelling unit separation, tenant space separation, corridor walls, elevator lobby separation

SECOND – REASON FOR THE FIRE RESISTANCE

- **Horizontal assemblies (711)**
 - **Have unique continuity and opening/penetration protection requirements**
 - **Have requirements for supporting construction**
 - **Have ratings based on function**

SECOND – REASON FOR THE FIRE RESISTANCE

- **Penetrations protection (714)**
- **Openings protection (716)**
- **Fire resistant joint systems (715)**
 - **“Joint: The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.”**

SECOND – REASON FOR THE FIRE RESISTANCE

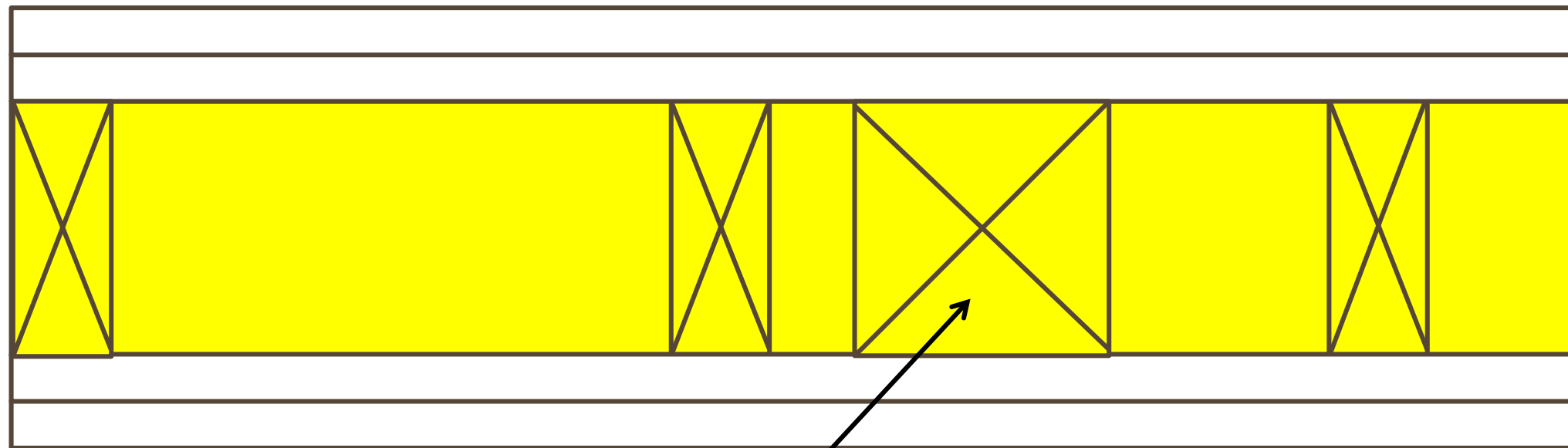
- **Structural connections and building element intersections not always regulated by the code**
- **Supporting construction fire resistance requirements may apply**

SECOND – REASON FOR THE FIRE RESISTANCE

- **704.2 Column protection (IBC 2018 text)**
 - “Exception: Columns that meet the limitations of Section 704.4.1”
- **704.4.1 Light-frame construction (IBC 2018 text)**
 - “Studs, columns, and boundary elements that are integral elements in walls of light-frame construction, and are located entirely between the top and bottom plates or tracks shall be permitted to have required fire-resistance ratings provided by the membrane protection provided for the wall.”

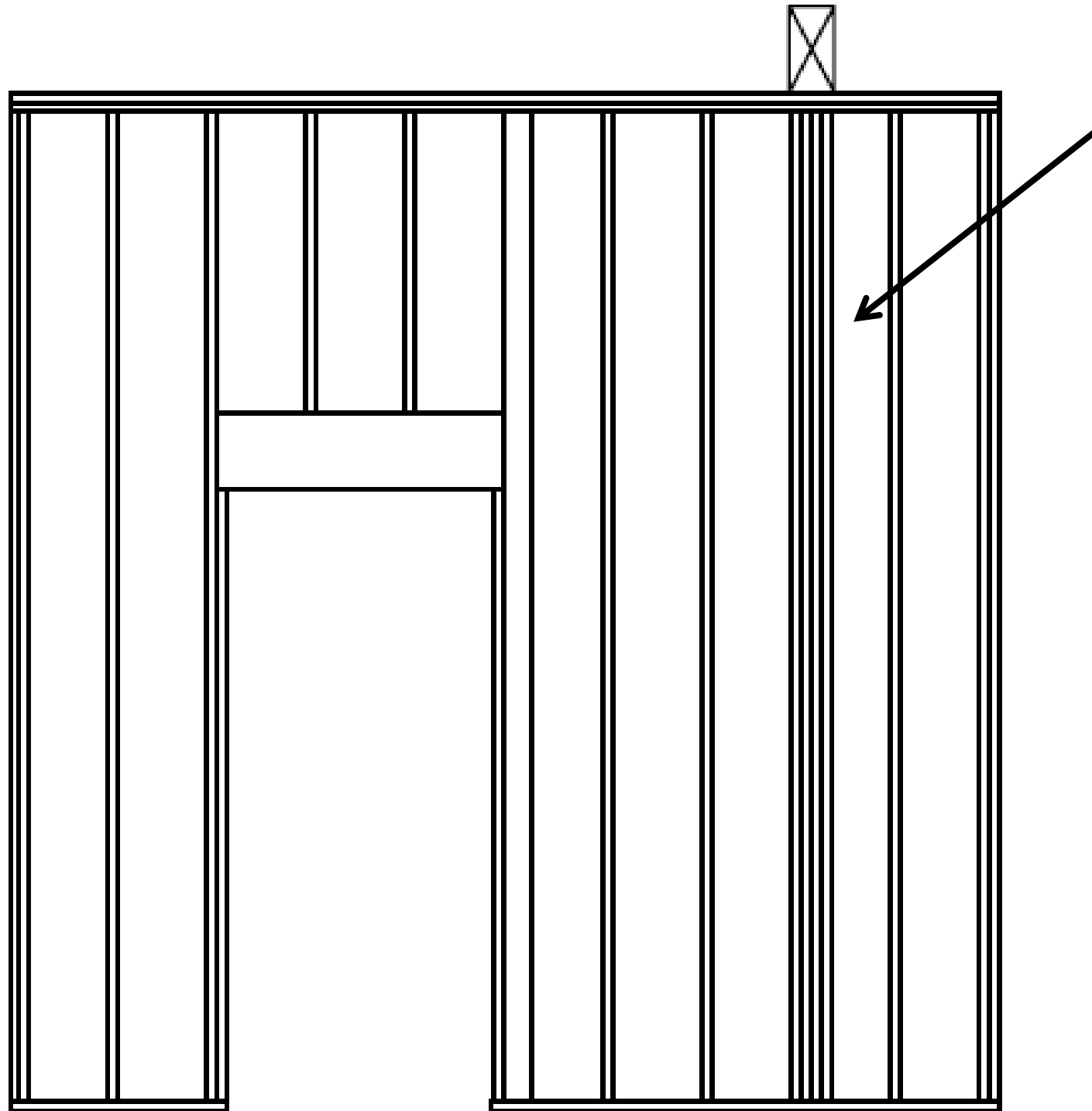
SECOND – REASON FOR THE FIRE RESISTANCE

Rated wall



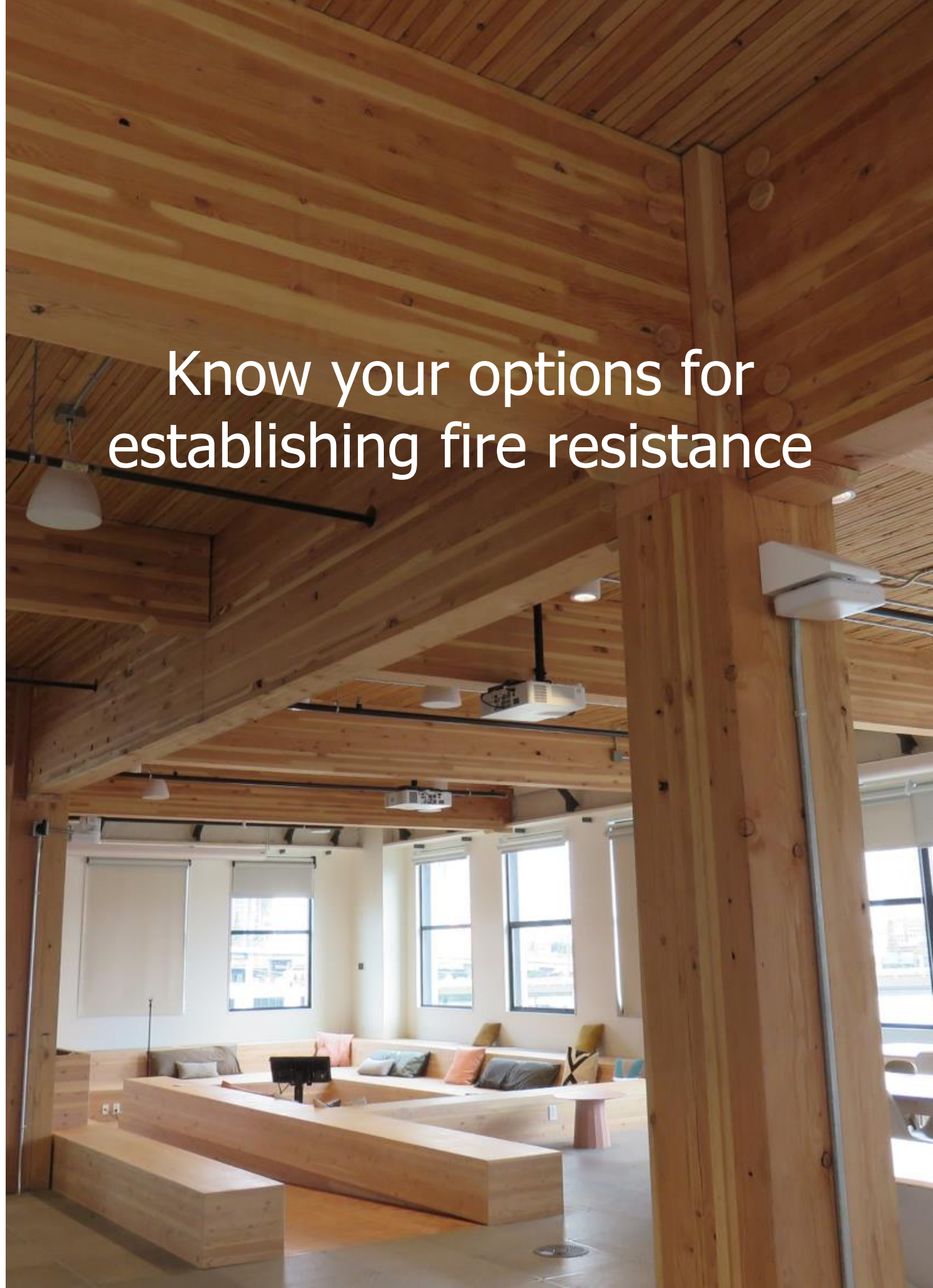
Column needs no separate protection

SECOND – REASON FOR THE FIRE RESISTANCE



Third principle of fire resistance

Know your options for
establishing fire resistance



THIRD – OPTIONS FOR FIRE RESISTANCE

Methods for establishing fire resistance (703)

- 1. Tested fire assembly (ASTM E119 or UL 263)**
- 2. Fire-resistance designs documented in approved sources**
- 3. Prescriptive assemblies using fire-resistance rated designs in Section 721**
- 4. Calculation of fire-resistance per Section 722**
- 5. Engineering analysis based on a comparison of building element, component or assembly designs that have been tested**
- 6. Alternative protection methods per Section 104.11**
- 7. Fire-resistance designs certified by an approved agency**

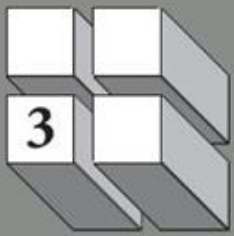
THIRD – OPTIONS FOR FIRE RESISTANCE

- **Tested assembly**
 - **ASTM E119/UL 263 test**
 - **May be listed in fire resistance directories**
 - **Approval may be based on listing or the test report**



THIRD – OPTIONS FOR FIRE RESISTANCE

- **Documentation in approved source**
- **AWC DCA 3 is one example**
- **Fire-Resistive Wood Wall and Floor/Ceiling Assemblies**
- **ASTM E119 or UL 263**
- **NFPA 251**



**Design for
Code Acceptance
3**

Fire-Rated Wood-Frame Wall and Floor/Ceiling Assemblies

Building Code Requirements

For occupancies such as stores, apartments, offices, and other commercial and industrial uses, building codes commonly require floor/ceiling and wall assemblies to be fire-resistance rated in accordance with standard fire tests.

Depending on the application, wall assemblies may need to be rated either from one side or both sides. For specific exterior wall applications, the model building codes allow wood-frame, wood-sided walls to be tested for exposure to fire from the inside only. Rating for both interior and exterior fire exposure is only required when the wall has a fire separation distance of less than 5 feet. Code recognition of one and two-hour wood-frame wall systems is also predicated on successful fire and hose stream testing in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction Materials*.

Fire Tested Assemblies

Fire-rated wood-frame assemblies can be found in a number of sources including the *IBC*, Underwriters Laboratories (UL) *Fire Resistance Directory*, Intertek Testing Services' *Directory of Listed Products*, and the Gypsum Association's *Fire Resistance Design Manual*. The American Wood Council (AWC) and its members have tested a number of wood-frame fire-rated assemblies. Descriptions of successfully tested lumber wall assemblies are provided in [Table 1](#) for one-hour rated wall assemblies and [Table 2](#) for two-hour rated wall assemblies. Lumber shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with the *American Softwood Lumber Standard (PS 20)*.

Descriptions of successfully tested I-joist floor assemblies are provided in [Table 3](#) for one-hour rated floor/ceiling assemblies and [Table 4](#) for two-hour rated floor/ceiling assemblies. I-joists are required to comply with the latest version of ASTM D5055, *Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists*. Additional tests are being conducted and the Tables will be updated periodically.



Conclusions

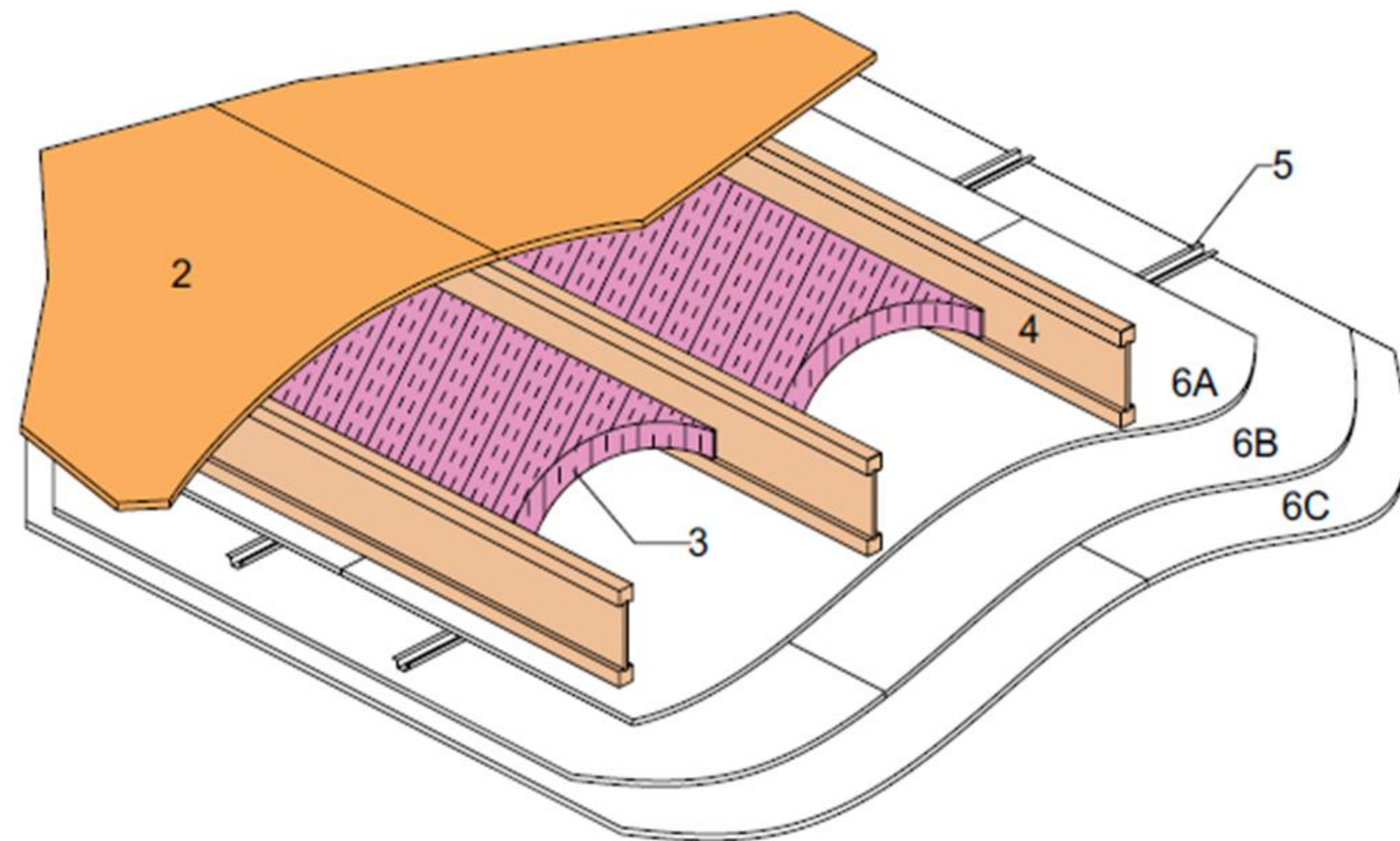
Wood-frame assemblies are used in architectural designs because of their adaptability to style preferences, ease and economies of construction, and energy-saving performance.

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THIRD – OPTIONS FOR FIRE RESISTANCE

WIJ-2.1 Two-Hour Fire-Resistive Ceiling Assembly

Floor^a/Ceiling - 100% Design Load - 2 Hour Rating - ASTM E 119 / NFPA 251



THIRD – OPTIONS FOR FIRE RESISTANCE

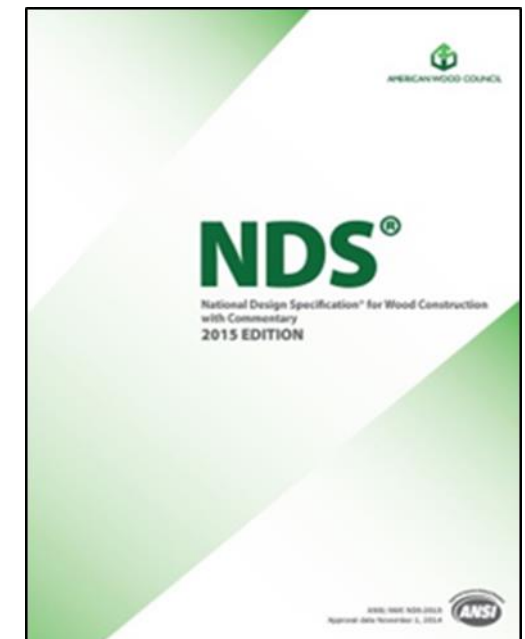
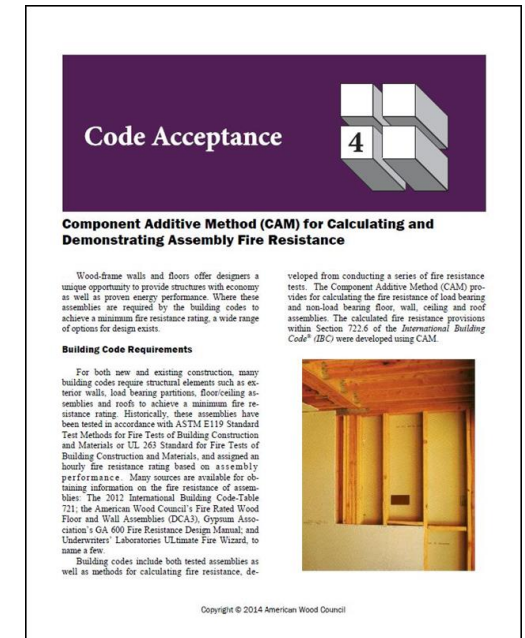
- **Prescriptive assemblies from the code (721)**
- **Based on ASTM E119 or UL 263 testing**

TABLE 721.1(3)—continued
MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS^{a, 9}

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
28. Wood I-joist (minimum I-joist depth 9 1/4" with a minimum flange depth of 1 1/2" and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of 3/8") @ 24" o.c. Unfaced fiberglass insulation or mineral wool insulation is installed between the I-joists supported on the upper surface of the flange by stay wires spaced 12" o.c.	28-1.1	Base layer of 5/8" Type C gypsum wall-board attached directly to I-joists with 1 5/8" Type S drywall screws spaced 12" o.c. with ends staggered. Minimum 0.0179" thick hat-shaped 7/8-inch furring channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 5/8" Type S drywall screws after the base layer of gypsum wall-board has been applied. The middle and face layers of 5/8" Type C gypsum wall-board applied perpendicular to the channel with end joints staggered. The middle layer is fastened with 1" Type S drywall screws spaced 12" o.c. The face layer is applied parallel to the middle layer but with the edge joints offset 24" from those of the middle layer and fastened with 1 5/8" Type S drywall screws 8" o.c. The joints shall be taped and covered with joint compound.	—	—	—	Varies	—	—	2 3/4	—

THIRD – OPTIONS FOR FIRE RESISTANCE

- **Calculated fire resistance (722.6)**
 - **Component Additive Method (CAM)**
 - **Calculated fire resistance of exposed wood members per NDS Chapter 16**

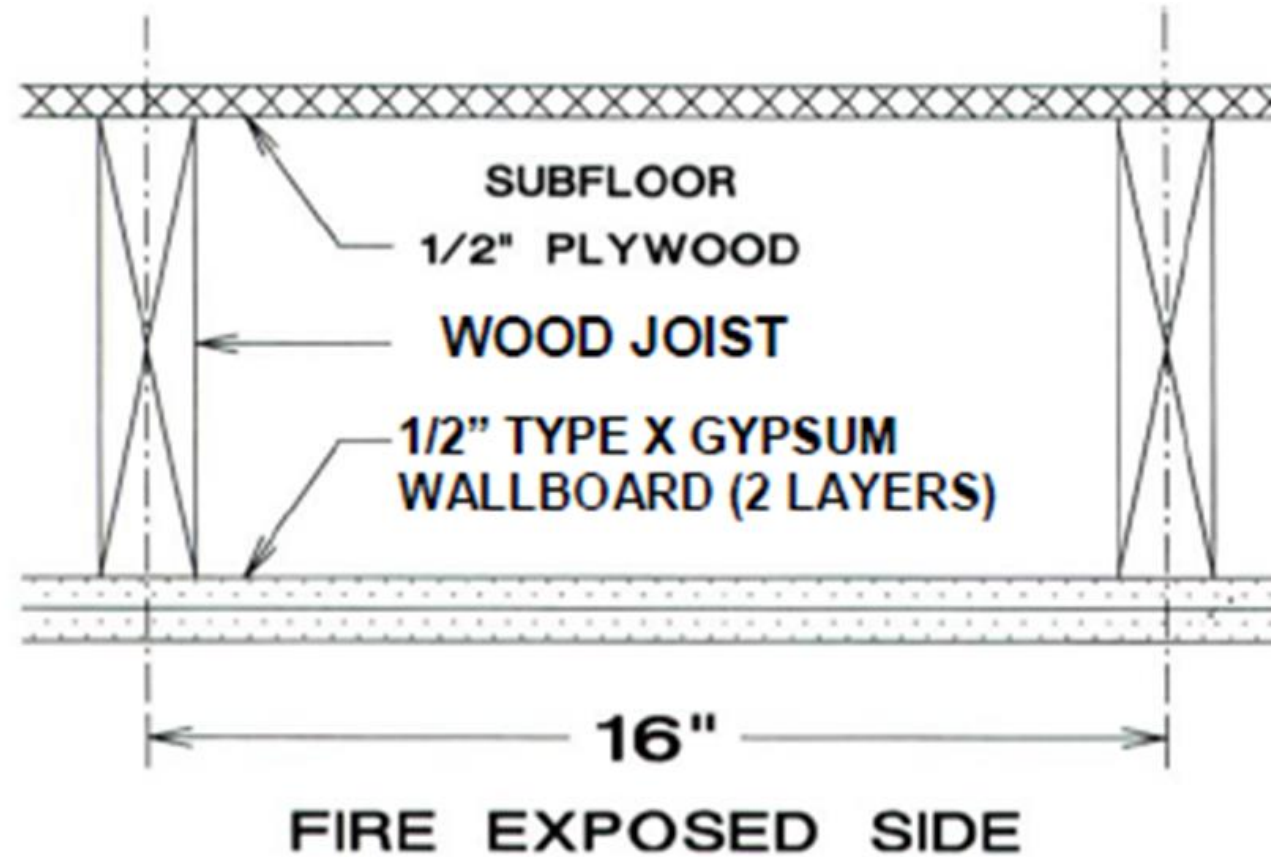


THIRD – OPTIONS FOR FIRE RESISTANCE

TABLE 722.6.2(1)
TIME ASSIGNED TO WALLBOARD MEMBRANES^{a, b, c, d}

DESCRIPTION OF FINISH	TIME ^a (minutes)
$\frac{3}{8}$ -inch wood structural panel bonded with exterior glue	5
$\frac{15}{32}$ -inch wood structural panel bonded with exterior glue	10
$\frac{19}{32}$ -inch wood structural panel bonded with exterior glue	15
$\frac{3}{8}$ -inch gypsum wallboard	10
$\frac{1}{2}$ -inch gypsum wallboard	15
$\frac{5}{8}$ -inch gypsum wallboard	30
$\frac{1}{2}$ -inch Type X gypsum wallboard	25
$\frac{5}{8}$ -inch Type X gypsum wallboard	40
Double $\frac{3}{8}$ -inch gypsum wallboard	25
$\frac{1}{2}$ -inch + $\frac{3}{8}$ -inch gypsum wallboard	35
Double $\frac{1}{2}$ -inch gypsum wallboard	40

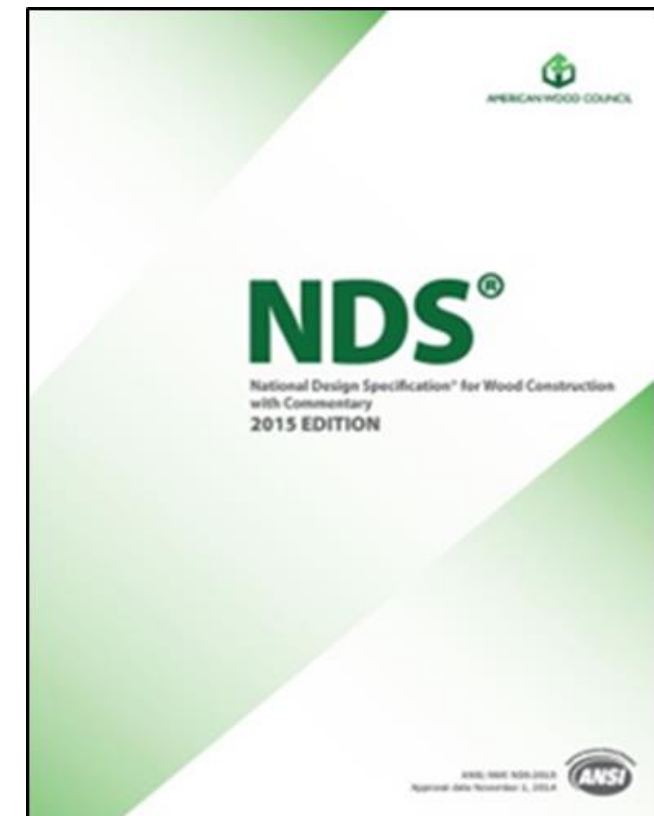
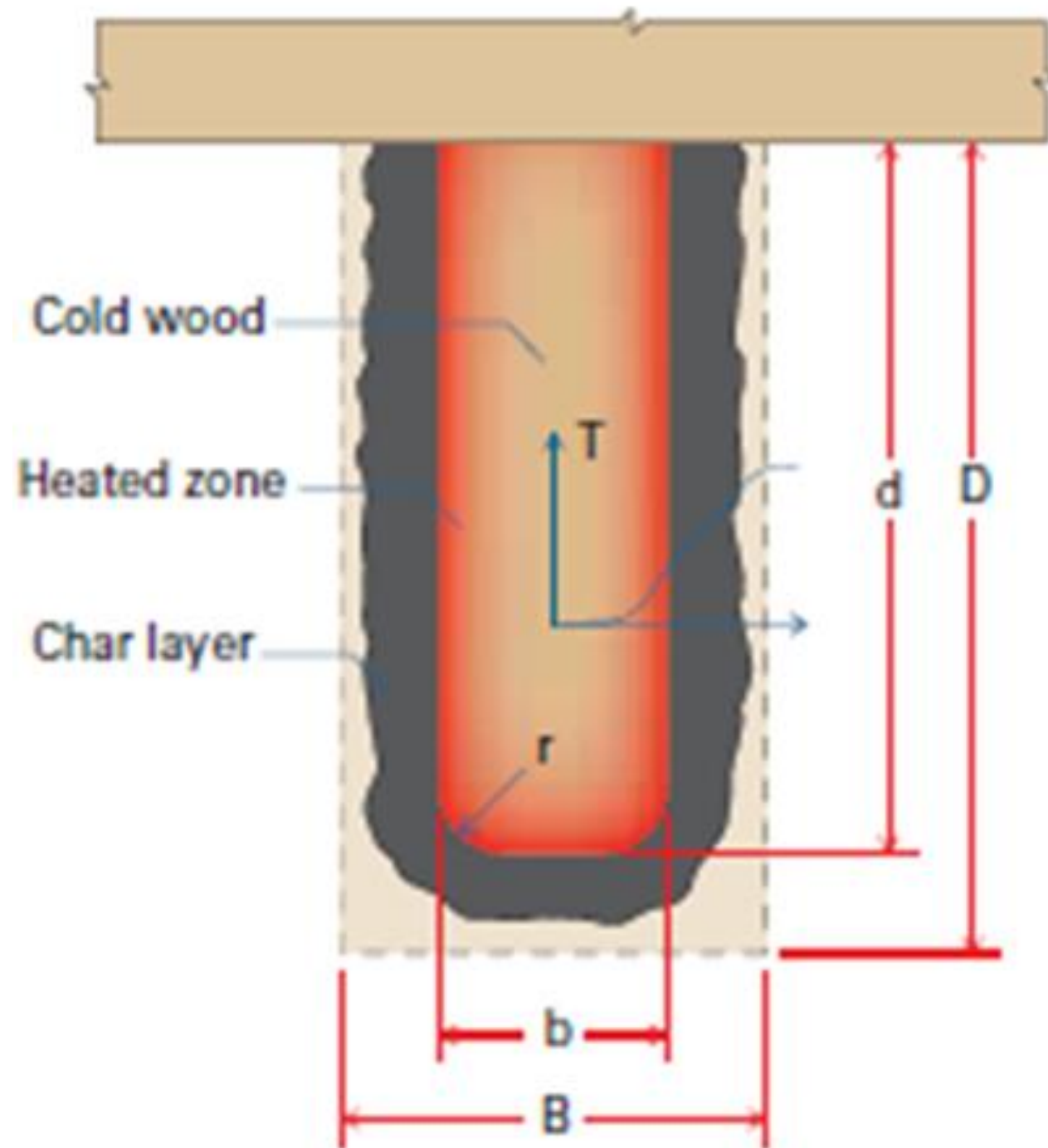
THIRD – OPTIONS FOR FIRE RESISTANCE



1/2 inch Type X Gypsum wallboard	=	25 minutes
1/2 inch Type X Gypsum wallboard	=	25 minutes
Wood joists	=	10 minutes
Combined Assembly Fire Resistance Rating	=	60 minutes

Figure 2 Floor/Ceiling Assembly

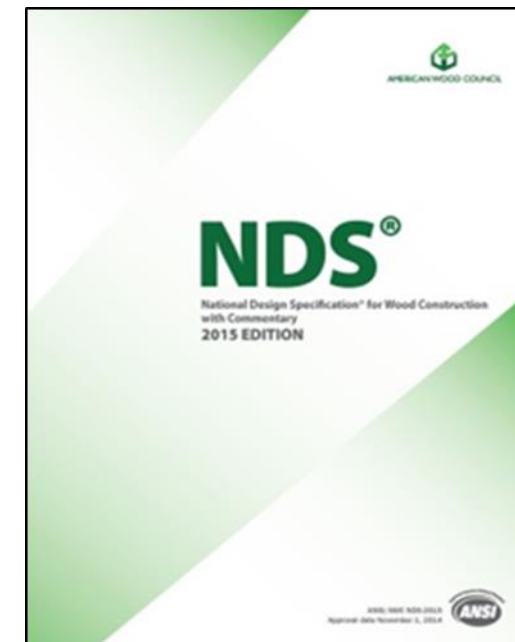
THIRD – OPTIONS FOR FIRE RESISTANCE



THIRD – OPTIONS FOR FIRE RESISTANCE

Table 16.2.1A Effective Char Rates and Char Depths (for $\beta_n = 1.5$ in./hr.)

Required Fire Endurance (hr.)	Effective Char Rate, β_{eff} (in./hr.)	Effective Char Depth, a_{char} (in.)
1-Hour	1.8	1.8
1½-Hour	1.67	2.5
2-Hour	1.58	3.2



THIRD – OPTIONS FOR FIRE RESISTANCE

Technical Report No. 10 (TR10)

- contains background and examples for the method

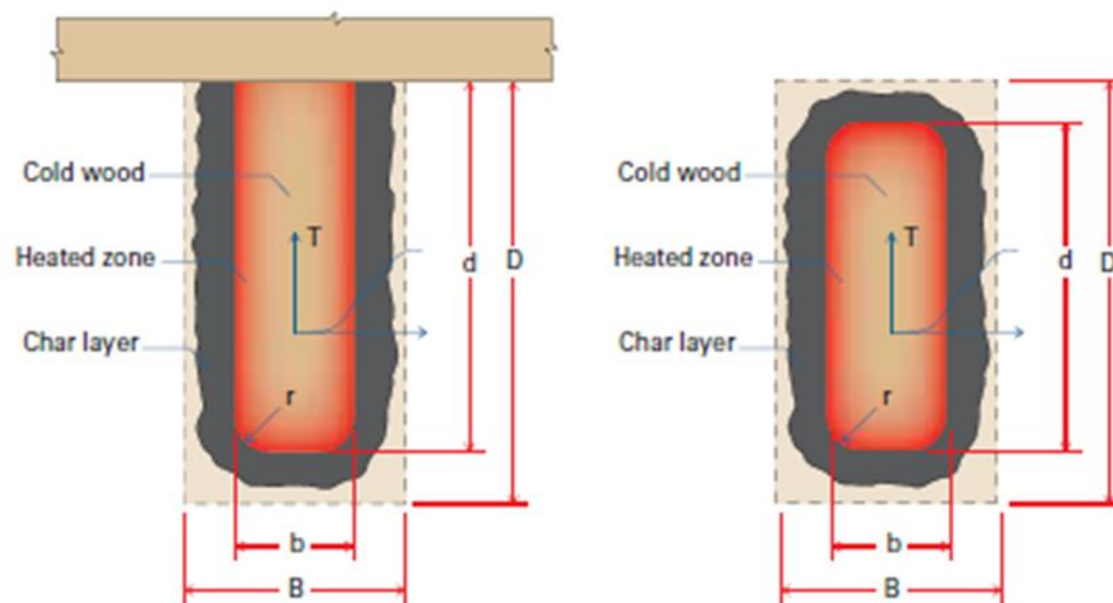
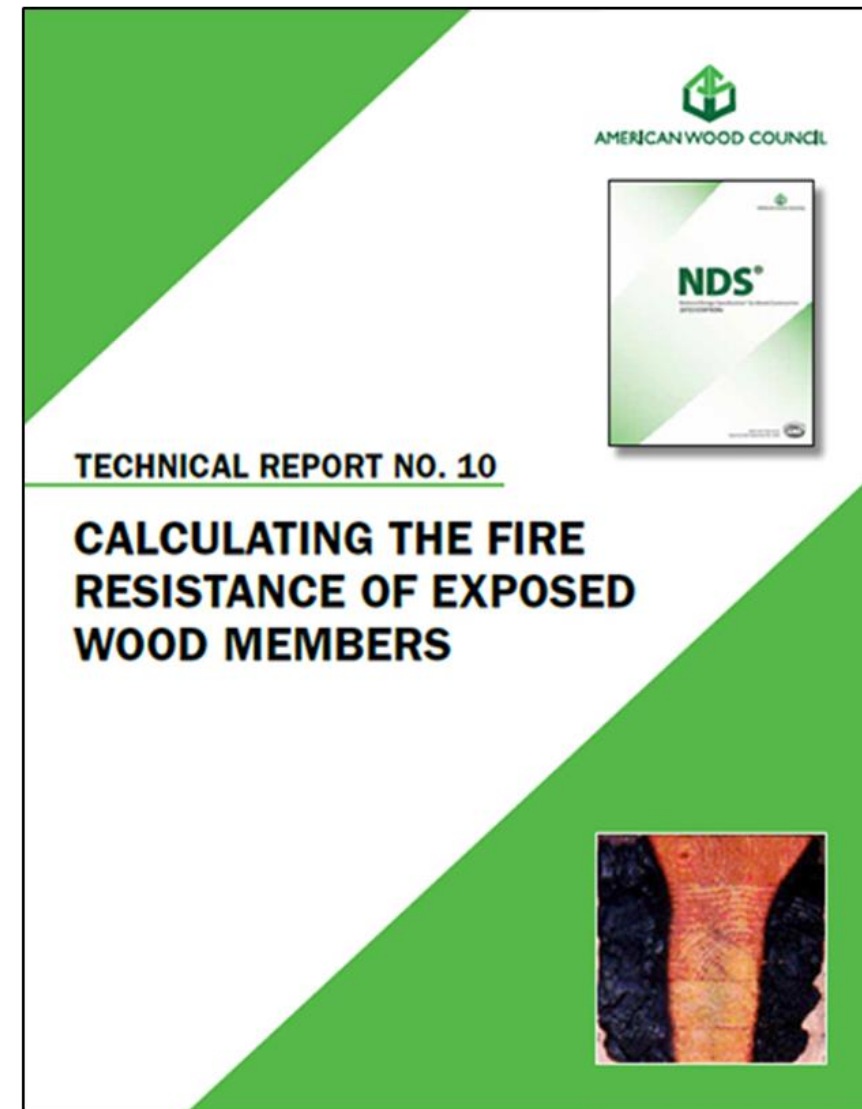


Figure 1-1 Reduction in member breadth and depth over time, t



THIRD – OPTIONS FOR FIRE RESISTANCE

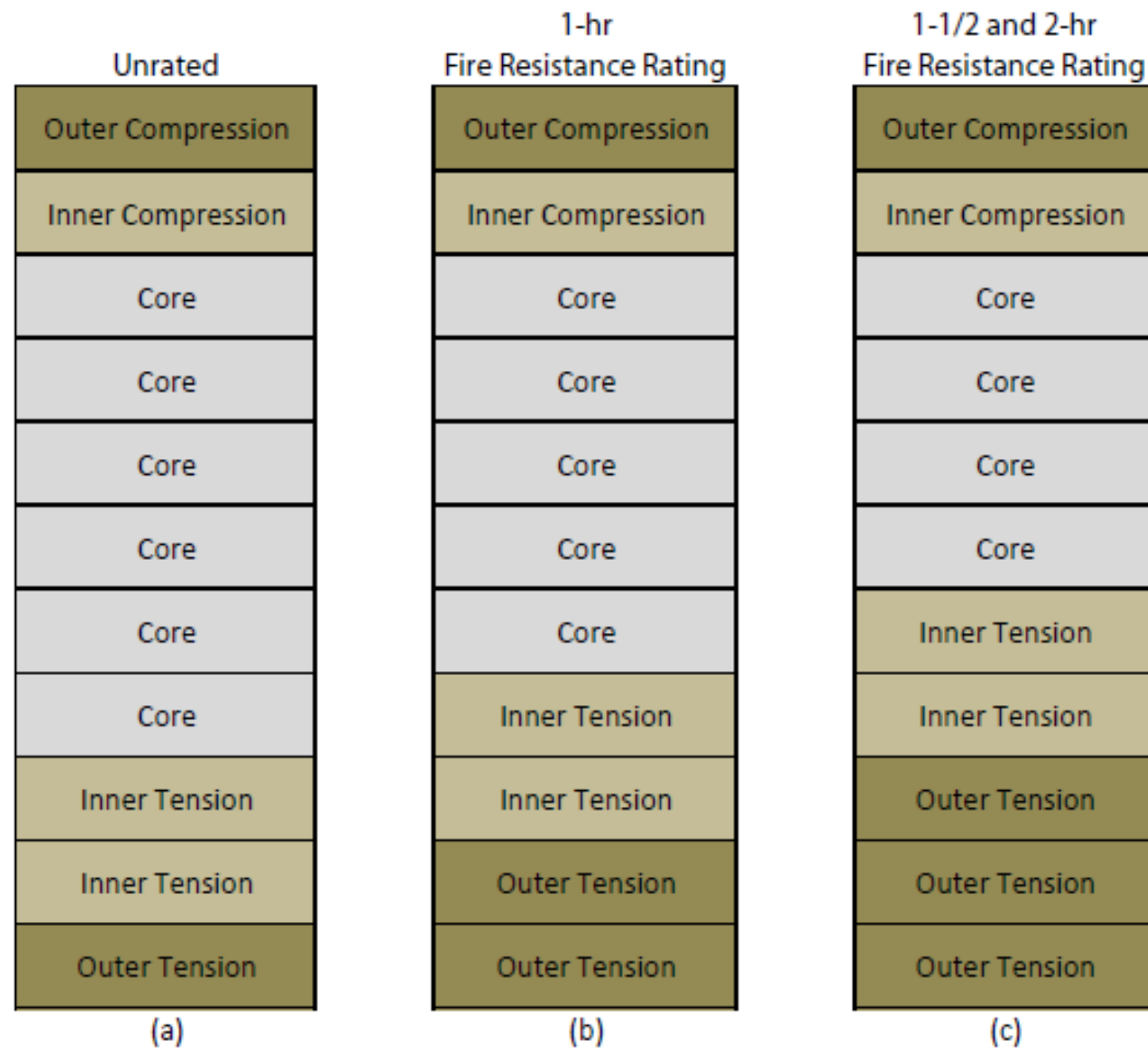


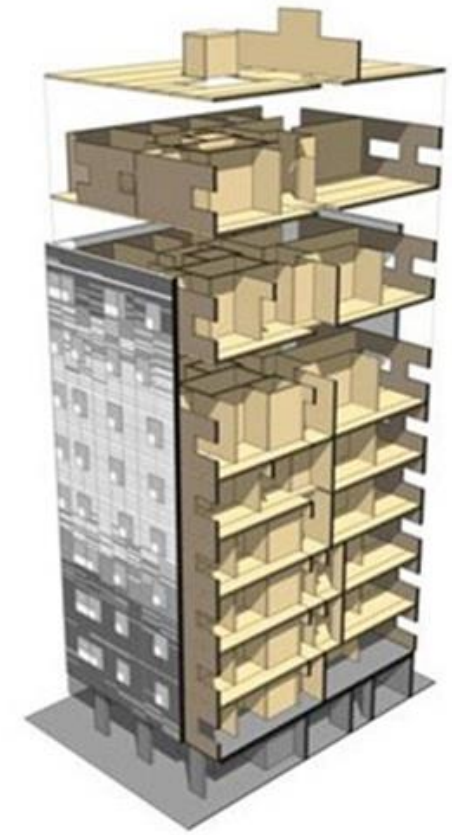
Figure 3-1 Typical glulam unbalanced beam layouts

THIRD – OPTIONS FOR FIRE RESISTANCE

Table 16.2.1B Effective Char Depths (for CLT with $\beta_n=1.5\text{in./hr.}$)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lamm} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

THIRD – OPTIONS FOR FIRE RESISTANCE





THIRD – OPTIONS FOR FIRE RESISTANCE

- **ASTM E119 test**
 - **5-ply CLT (6-7/8")**
 - **Single layer 5/8" Type X wallboard each side**
 - **Achieved 3 hrs. 6 min.**



THIRD – OPTIONS FOR FIRE RESISTANCE



THIRD – OPTIONS FOR FIRE RESISTANCE

Methods for establishing fire resistance (703):

- 1. Tested fire assembly (ASTM E119 or UL 263)**
- 2. Fire-resistance designs documented in approved sources**
- 3. Prescriptive assemblies using fire-resistance rated designs in Section 721**
- 4. Calculation of fire-resistance per Section 722**
- 5. Engineering analysis based on a comparison of building element, component or assembly designs that have been tested**
- 6. Alternative protection methods per Section 104.11**
- 7. Fire-resistance designs certified by an approved agency**

THIRD – OPTIONS FOR FIRE RESISTANCE

- **Protections of connections in the NDS**
 - **Section 16.3**
 - **Protection can be provided by wood or fire-rated gypsum board**



THIRD – OPTIONS FOR FIRE RESISTANCE

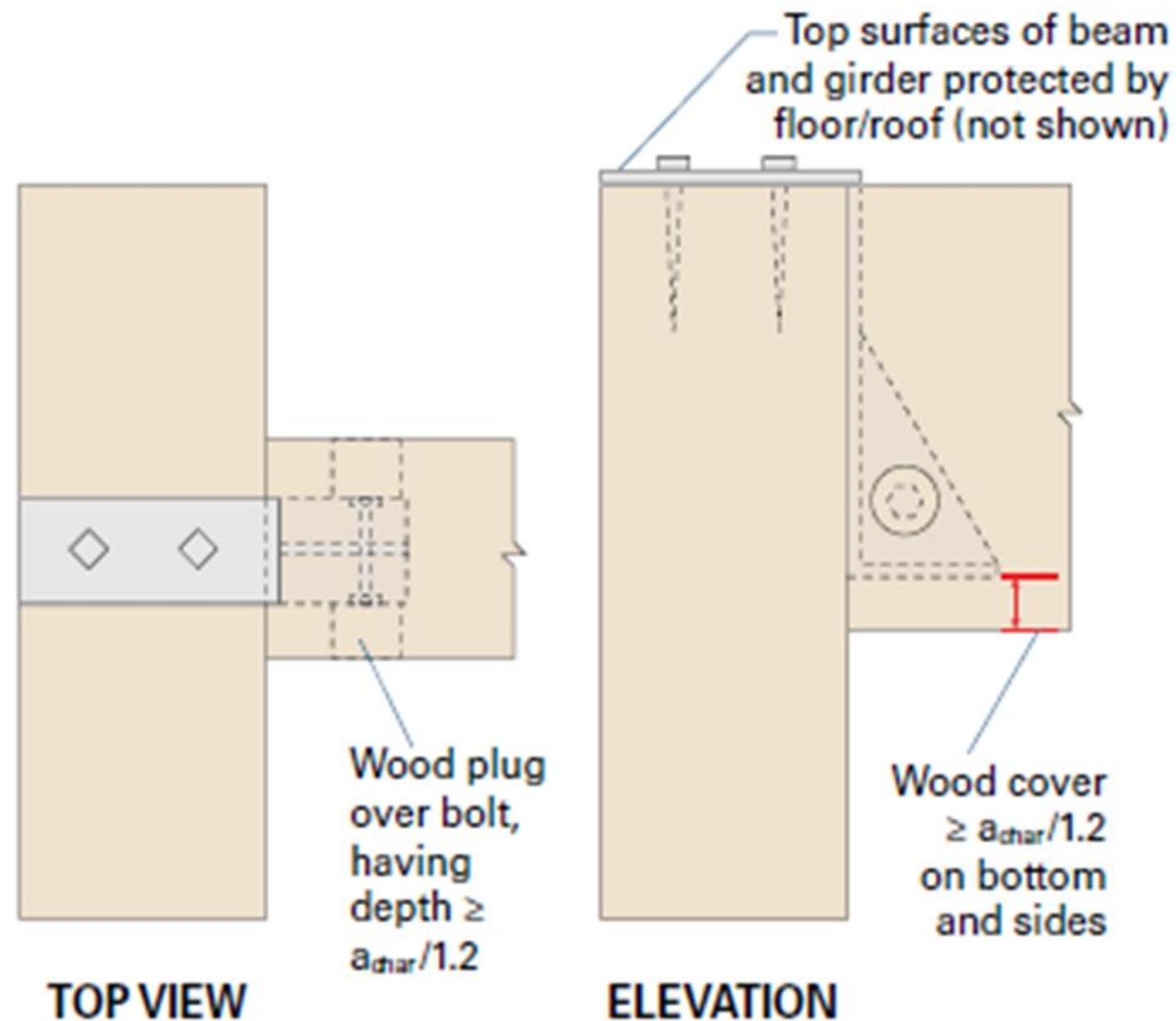
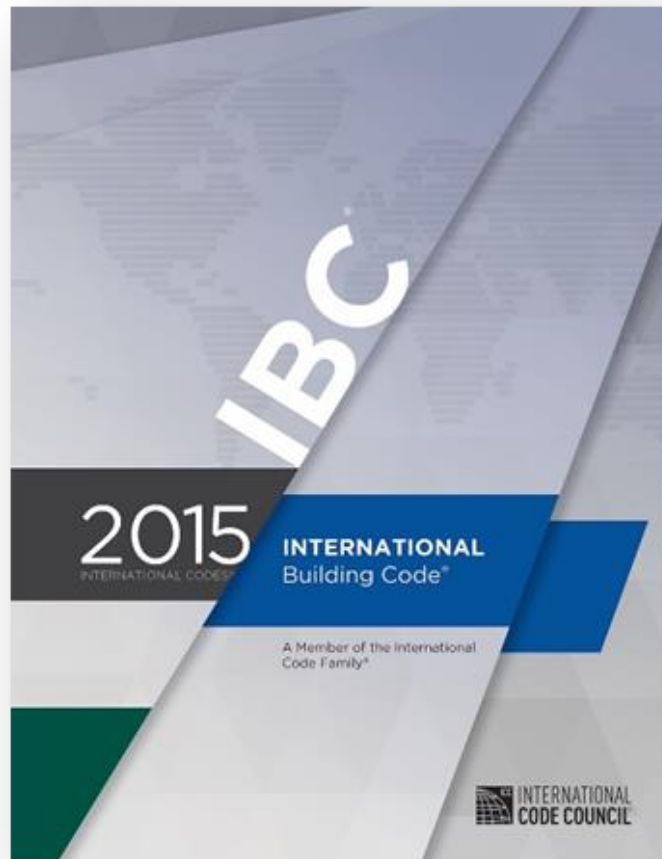


Figure 3-8 Beam to girder – concealed connection

THIRD – OPTIONS FOR FIRE RESISTANCE



PRECAUTIONS DURING CONSTRUCTION

- **IBC/IFC Chapters 33**
 - **Fire-fighting vehicle access and water supply (3310 and 3312)**
 - **Requirements for a fire watch, a fire protection superintendent, and prevention program (3304 and 3308)**
 - **Extensive hot work and roofing requirements (3304, Chapter 35, and 3317)**
 - **Fire extinguishers (3309)**
 - **Standpipes (3311)**
 - **Temporary heating equipment (3303)**
 - **Emergency phones (3309)**



PRECAUTIONS DURING CONSTRUCTION

www.constructionfiresafety.org





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