



Code Compliant Fire Resistance Design for Wood Construction

June 19, 2019

Seattle, Wood Design Symposium

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<http://www.awc.org/education/resources>

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

Fire-Resistant Design for Wood Construction

Course Description



Determining the proper code application for fire resistant wood frame assemblies and exposed wood structural members 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/ceilings and roof/ceilings, interior and exterior walls, fire barriers, fire partitions, and fire walls. Topics will also include distinctions between fire-resistive elements for separation vs. type of construction.

Fire-Resistant Design for Wood Construction

Learning Objectives

Upon completion, participants will be better able to:

- 1 Apply approved methods and alternatives for establishing the fire resistance of wood building elements.
- 2 Discuss the differences in the various requirements for interior and exterior walls, fire walls, fire barriers, and fire partitions, considering performance expectations, code requirements, and appropriate application.
- 3 Understand the paths to achieving code-compliant, fire resistance-rated wood frame assemblies and exposed wood members as outlined by the 2015 IBC.
- 4 Recognize important nuances in the various methods for demonstrating fire resistance including: tested assemblies, prescriptive designs, calculations, and engineering analysis.

Fire-Resistant Design for Wood Construction

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American Wood Council



The **American Wood Council (AWC)** provides wood design and construction information to assist building industry professionals, develops structural and fire performance data on a wide range of traditional and engineered wood products, and engages in long-term research.

AWC is an ANSI accredited standards developer

Code assistance – Awc field staff



Fire-Resistant Design for Wood Construction

Outline: principles of FRR design course

1. What is FRR construction in the code?
2. Know the reason for the fire resistance!
3. Platform floor construction and structural FRR
4. FRR wall types and floor intersections

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fire-resistance rating in the code

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.



Fire Confinement



Structural Performance

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Know the reason for FRR:



Fire Confinement

OR



Structural Performance

OR BOTH !!!

701.2 Multiple use fire assemblies. Fire assemblies that serve multiple purposes in a building shall comply with all of the requirements that are applicable for each of the individual fire assemblies.

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Example: Structural FRR:

- Two-hour enclosure is required to be two-hour fire resistance rated
 - Structurally
 - As a barrier for passage of fire and heat from the outside in and the inside out of the enclosure
- The supporting members of the two-hour enclosure (that are not part of the enclosure) must have a two-hour structural fire resistance rating (CBC 704.1)

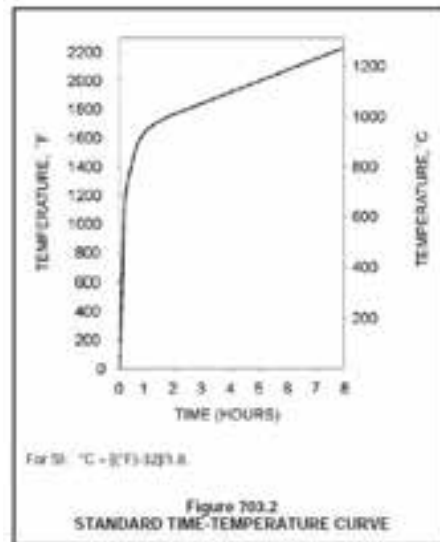


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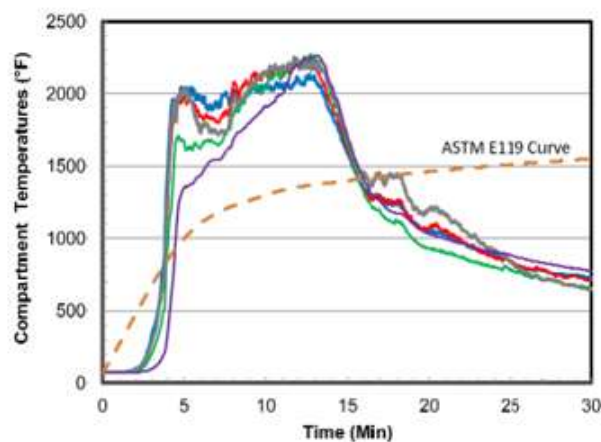
fire-resistance rating in the code

- **E 119 or UL 263**
- **Standard TT curve:**
 - Most fires are not “standard”
 - Standardized test
 - Acceptance criteria:
 - Structural function
 - Temp rise (non fire side)
 - Does not ignite cotton (non fire side)

Fire-Resistant Design for Wood Construction



“Non-Standard Fire” not in the code



Compartment Temperature

Typical “non-standard” TT curve

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fire-resistance rating in the code – options:

- **CBC 703.3, Methods to determine FRR:**
 1. Fire resistance designs documented in approved sources
 2. Prescriptive designs, CBC 721
 3. Calculations, CBC 722
 4. Engineering analysis based on comparison with designs having rating set forth based on testing in E 119 or UL 263
 5. Alternate means, CBC 104.11
 6. Fire resistance designs by approved agency

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fire-resistance rating in the code – options:

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



Fire-Resistant Design for Wood Construction

fire-resistance rating in the code – options:

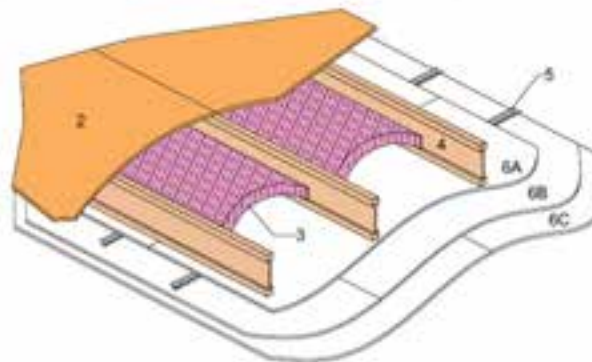
- Documentation in approved source:
- AWC DCA 3 is one example
- Fire-Resistive Wood Wall and Floor/Ceiling Assemblies
- ASTM E119 or UL 263
- NFPA 251



Fire-Resistant Design for Wood Construction

fire-resistance rating in the code – options:

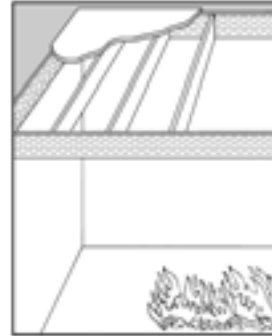
WIJ-2.1 Two-Hour Fire-Resistive Ceiling Assembly
Floor/Ceiling - 100% Design Load - 2 Hour Rating - ASTM E 119 / NFPA 251



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fire-resistance rating in the code – options:

- Documentation in approved source:
 - Forest Products Lab Report FPL-RP-610
 - Based on ASTM E119 or UL 263
 - Address' structural capacity and protection of rim and blocking



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fire-resistance rating in the code – options:

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

TABLE 721.1(a) Prescriptive fire-resistance ratings for wood assemblies

Assembly description	Fire-resistance rating	Minimum fire-resistance rating for wood assemblies				Minimum fire-resistance rating for wood assemblies			
		1 hr	2 hr	3 hr	4 hr	1 hr	2 hr	3 hr	4 hr
2.0. Wood frame construction in areas exposed to fire, with a minimum design fire-resistance rating of 1 1/2 hr, as determined by testing in accordance with ASTM E119 or UL 263, shall be constructed in accordance with the following provisions:	2.0.1	---	---	---	---	---	---	---	---
2.1. Wood frame construction in areas exposed to fire, with a minimum design fire-resistance rating of 1 1/2 hr, as determined by testing in accordance with ASTM E119 or UL 263, shall be constructed in accordance with the following provisions:	2.1.1	---	---	---	---	---	---	---	---
2.2. Wood frame construction in areas exposed to fire, with a minimum design fire-resistance rating of 1 1/2 hr, as determined by testing in accordance with ASTM E119 or UL 263, shall be constructed in accordance with the following provisions:	2.2.1	---	---	---	---	---	---	---	---
2.3. Wood frame construction in areas exposed to fire, with a minimum design fire-resistance rating of 1 1/2 hr, as determined by testing in accordance with ASTM E119 or UL 263, shall be constructed in accordance with the following provisions:	2.3.1	---	---	---	---	---	---	---	---

Fire-Resistant Design for Wood Construction

fire-resistance rating in the code: 2. Prescriptive Design, IBC 721

- **Prescriptive assemblies from the code (721):**

SECTION 721 PRESCRIPTIVE FIRE RESISTANCE

721.1 General. The provisions of this section contain prescriptive details of fire-resistance-rated building elements, components or assemblies. The materials of construction listed in Tables 721.1(1), 721.1(2) and 721.1(3) shall be assumed to have the *fire-resistance ratings* prescribed therein. Where materials that change the capacity for heat dissipation are incorporated into a fire-resistance-rated assembly, fire test results or other substantiating data shall be made available to the *building official* to show that the required *fire-resistance-rating* time period is not reduced.

Fire-Resistant Design for Wood Construction

Calculated fire-resistance rating in the code – IBC 722.6:

- **Calculated fire resistance (722.6):**
- **Component Additive Method (CAM)**
- **Calculated fire resistance of light frame assemblies up to 1 hour FRR**
- ***Ten Rules of Fire Resistance Rating (Harmathy's Rules)***



Fire-Resistant Design for Wood Construction

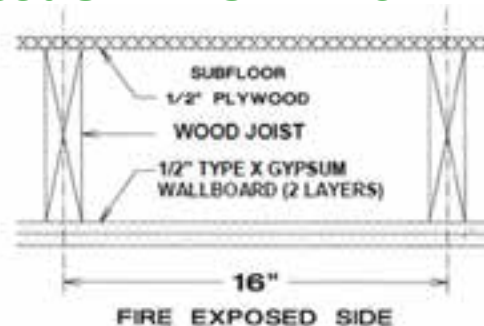
Calculated fire-resistance rating in the code – IBC 722.6:

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

DESCRIPTION OF FINISH	TIME ^e (minutes)
$\frac{1}{8}$ -inch wood structural panel bonded with exterior glue	5
$\frac{1}{4}$ -inch wood structural panel bonded with exterior glue	10
$\frac{3}{8}$ -inch wood structural panel bonded with exterior glue	15
$\frac{1}{2}$ -inch gypsum wallboard	10
$\frac{5}{8}$ -inch gypsum wallboard	15
$\frac{3}{4}$ -inch gypsum wallboard	30
$\frac{1}{2}$ -inch Type X gypsum wallboard	25
$\frac{5}{8}$ -inch Type X gypsum wallboard	40
Double $\frac{1}{2}$ -inch gypsum wallboard	25
$\frac{1}{2}$ -inch + $\frac{1}{4}$ -inch gypsum wallboard	35
Double $\frac{1}{2}$ -inch gypsum wallboard	40

Fire-Resistant Design for Wood Construction

Calculated fire-resistance rating in the code – IBC 722.6:



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

Fire-Resistant Design for Wood Construction

Calculated fire-resistance rating in the code – IBC 722.6:

TABLE 722.6.2(4)
FLOORING OR ROOFING OVER WOOD FRAMING^a

ASSEMBLY	STRUCTURAL MEMBERS	SUBFLOOR OR ROOF DECK	FINISHED FLOORING OR ROOFING
Floor	Wood	$\frac{1}{2}$ -inch wood structural panels or $\frac{1}{4}$ -inch T & G softwood	Hardwood or softwood flooring on building paper resilient flooring, parquet floor felted-synthetic fiber floor coverings, carpeting, or ceramic tile on $\frac{1}{4}$ -inch-thick fiber-cement underlayment or $\frac{1}{2}$ -inch-thick panel-type underlay. Ceramic tile on $1\frac{1}{4}$ -inch mortar bed.
Roof	Wood	$\frac{1}{2}$ -inch wood structural panels or $\frac{1}{4}$ -inch T & G softwood	Finished roofing material with or without insulation

For SI: 1 inch = 25.4 mm.

a. This table applies only to wood joist construction. It is not applicable to wood truss construction.

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Similar to
"Double
wood floor"
required by
footnote m
in table
721.1 (3)

Calculated fire-resistance rating in the code – IBC 722.1 - NDS Ch 16:

Structural FRR up to two hours

- Columns
- Beams
- Tension Members
- ASD only

Products

- Lumber
- Glulam
- SCL
- Decking
- CLT



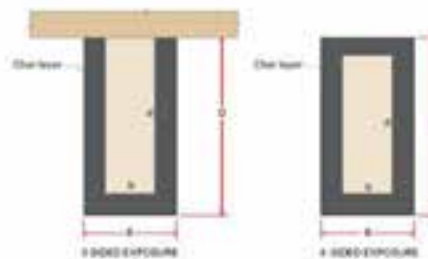
SECTION 722 CALCULATED FIRE RESISTANCE

722.1 General. The provisions of this section contain procedures by which the fire resistance of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated fire resistance of concrete, concrete masonry and clay masonry assemblies shall be permitted in accordance with ACI 216.1/TMS 0216. The calculated fire resistance of steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 29. The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/APA National Design Specification for Wood Construction (NDS).

NDS Ch 16 and TR-10

Table 16.2.1A Effective Char Rates and Char Depths (for $\beta_{\text{eff}} = 1.5 \text{ in./hr.}$)

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



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Ch 7: Fire & Smoke Protection Features

703 Fire-Resistance Ratings and Standardized Fire Tests

Building elements are tested under a standardized test fire exposure for a given duration to:

1. Prevent passage of flame and temperature rise from one side to the other
2. Continue to provide vertical structural support when exposed to fire and elevated temperatures

- **How do calculations work to duplicate structural E119 fire test results?**

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Calculated fire-resistance rating in the code – NDS Ch 16:

Table 16.2.2 Adjustment Factors for Fire Design¹

			ASD					
			Design Stress to Member Strength Factor	Size Factor ²	Volume Factor ³	Flat Use Factor ²	Beam Stability Factor ³	Column Stability Factor ³
Bending Strength	F_b	x	2.85	C_F	C_V	C_{Fu}	C_L	-
Beam Buckling Strength	F_{bE}	x	2.03	-	-	-	-	-
Tensile Strength	F_t	x	2.85	C_F	-	-	-	-
Compressive Strength	F_c	x	2.58	C_F	-	-	-	C_P
Column Buckling Strength	F_{cE}	x	2.03	-	-	-	-	-

1. See 4.3, 5.3, 8.3, and 10.3 for applicability of adjustment factors for specific products.

2. Factor shall be based on initial cross-section dimensions.

3. Factor shall be based on reduced cross-section dimensions.

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Calculated fire-resistance rating in the code – NDS Ch 16:

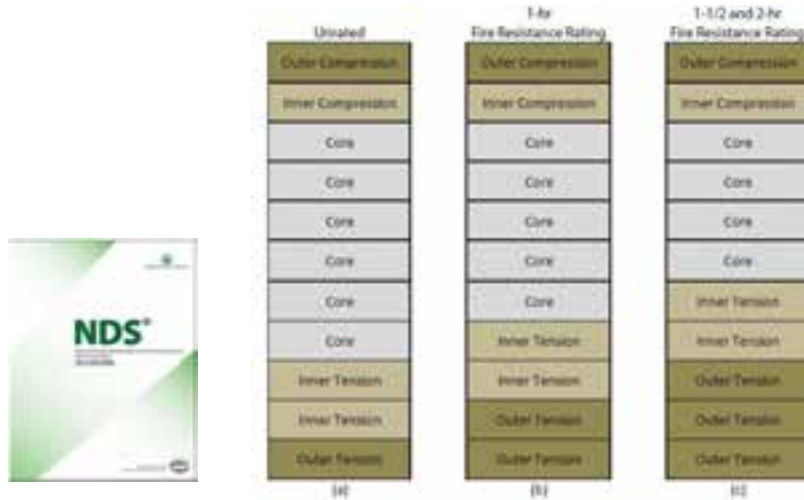
16.2.4 Special Provisions for Structural Glued Laminated Timber Beams

For structural glued laminated timber bending members given in Table 5A and rated for 1-hour fire endurance, an outer tension lamination shall be substituted for a core lamination on the tension side for unbalanced beams and on both sides for balanced beams. For structural glued laminated timber bending members given in Table 5A and rated for 1½- or 2-hour fire endurance, 2 outer tension laminations shall be substituted for 2 core laminations on the tension side for unbalanced beams and on both sides for balanced beams.

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Special Provisions NDS 16.2.4

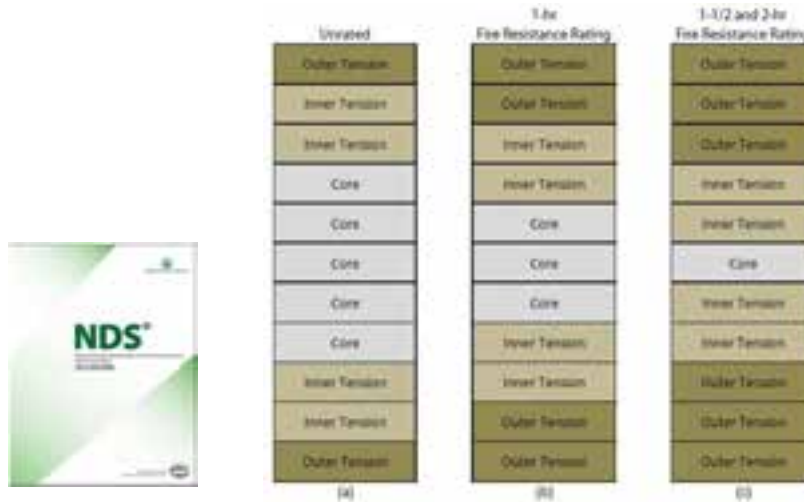
Glued-laminated Timber Tension Lam Provisions – unbalanced



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Special Provisions NDS 16.2.4

Glued-laminated Timber Tension Lam Provisions – balanced



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Calculated fire-resistance rating in the code – NDS Ch 16:

- CLT manufactured with laminations of equal thickness

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, t_{lam} (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

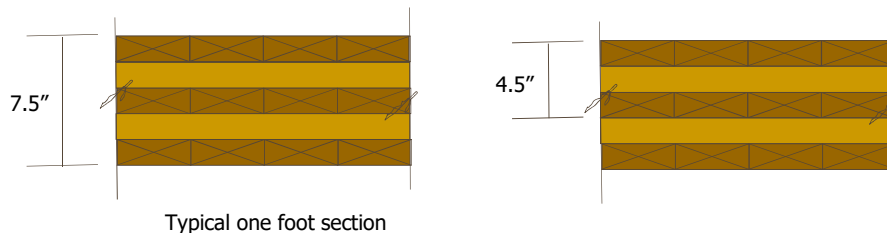


Fire-Resistant Design for Wood Construction

Example CLT Floor Calculation: NDS Chapter 16

Determination of effective residual cross-section

- Assume 5-ply @ 1.5" each ply = 7.5"
- Determine thickness for 1-hour rating
- $a_{char} = 1.8"$ (NDS Table 16.2.1B)
- $d = 7.5" - 1.8" = 5.7"$
- Could conservatively assume 3-ply panel for design



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fire-resistance rating in the code – options (item 4):

- **CBC 703.3, Methods to determine FRR:**
 1. Fire resistance designs documented in approved sources
 2. Prescriptive designs, CBC 721
 3. Calculations, CBC 722
 - 4. Engineering analysis based on comparison with designs having rating set forth based on testing in E 119 or UL 263**
 5. Alternate means, CBC 104.11
 6. Fire resistance designs by approved agency

Fire-Resistant Design for Wood Construction

Calculated fire-resistance rating in the code – NDS Ch 16:

Technical Report No. 10 (TR10)

- contains background and examples for the method

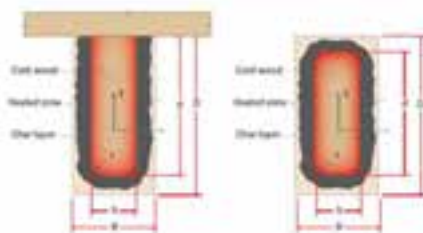


Figure 1-1 Reduction in member breadth and depth over time, t



Fire-Resistant Design for Wood Construction

Behavior of Fire and Materials

- **Wood at high temperature:**
 - low thermal conductivity
 - dimensionally stable
 - inner portion remains cool
 - does not lose strength

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Component Additive Method (CAM)

**DCA 4
Component Additive Method (CAM)
for Calculating and Demonstrating
Assembly Fire Endurance**

Free download at www.awc.org



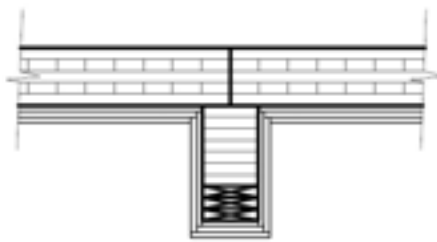
Fire Resistance Design Manual

- 21st Edition (2015)
- See Page 17 for Protection of Wood Column and Beam CAM (very, very conservative but useful)
- Allowed under Section 703.3, items 1 and 3



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2021 Draft IBC Mass Timber CAM



- Proposed CAM method in the 2021 IBC

$$\text{FRR of Element} = \text{FRR of Wood} + \text{FRR of Added Gypsum}$$

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Non-combustible protection:

FS81-18 **AM** (mass timber CAM)

2021
IBC

IBC: 722.7 (New), 722.7.1 (New), TABLE 722.7.1(1) (New), TABLE 722.7.1(2) (New), 722.7.2 (New), 722.7.2.1 (New), 722.7.2.2 (New)

Proponent: Stephen DiGiovanni, representing ICC Ad Hoc Committee on Tall Wood Buildings (TWB) (TWB@iccsafe.org)

TABLE 722.7.1(1)

Required Fire Resistance Rating of Building Element per Tables 601 and 602 (hours)	Minimum Protection Required from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

- 2/3 of Table 601 required FRR from NC protection
- Installation requirements of deemed to comply NC protection

TABLE 722.7.1(2)

PROTECTION PROVIDED BY NONCOMBUSTIBLE COVERING MATERIAL

Noncombustible Protection	Protection Contribution (minutes)
1/2 inch Type X Gypsum Board	30 25
5/8 inch Type X Gypsum Board	40

FLOOR MODIFICATION
FS81-18-DIGIOVANNI-1

Non-combustible protection

FS5-18 **AS**

2021
IBC

IBC: 703.8 (New)

Proponent: Stephen DiGiovanni, representing ICC Ad Hoc Committee on Tall Wood Buildings (TWB)

703.8 Determination of noncombustible protection time contribution. The time, in minutes, contributed to the fire resistance rating by the noncombustible protection of mass timber building elements, components, or assemblies, shall be established through a comparison of assemblies tested using procedures set forth in ASTM E 119 or UL 263. The test assemblies shall be identical in construction, loading, and materials, other than the noncombustible protection. The two test assemblies shall be tested to the same criteria of structural failure.

1. Test Assembly 1 shall be without protection.
2. Test Assembly 2 shall include the representative noncombustible protection. The protection shall be fully defined in terms of configuration details, attachment details, joint sealing details, accessories and all other relevant details.

The noncombustible protection time contribution shall be determined by subtracting the fire resistance time, in minutes, of Test Assembly 1 from the fire resistance time, in minutes, of Test Assembly 2.

Other testing of NC protection:



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Photo Courtesy of ROCKWOOL

Other testing of NC protection:

- Not all mineral wool insulation materials perform the same
- Fiber chemistry



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Other testing of NC protection:

Objective: Quantify contribution of other non-combustible protection in addition to gypsum on Mass Timber

	Unprotected CLT (control test)	Single-Layer Protection	Triple-Layer Protection	Mineral Wool Protection
CLT type/grade	5-Layer V4 (Smartlam)			
CLT panel size	Two 7'x18' panels per test, joined together for an overall size of 14'x18'			
Loading	24 sand-filled barrels, uniformly-distributed for an applied load of 60 psf			
Span	17'-10"			
Load Ratio	75% of ASD moment (including self-weight)			
Noncombustible protection	None	1 layer of 5/8" Type X gypsum wallboard	3 layers of 5/8" Type X gypsum wallboard	2" thick; 8 pcf mineral wool
GWB attachment	None	Type S screws @ 12" o.c. both directions. 1" penetration into CLT. 1.5" edge distance.	Type S screws @ 12" o.c. both directions, staggered 4" each layer. 1" penetration into CLT. 1.5" edge distance.	Type S screws and 1.5" fender washers at
Deflection at End of Test	12.5"	12.5"	12.0"	12.0"
Test duration	149.4 minutes	189.7 minutes	276.8 minutes	261.3 minutes
Noncombustible protection contribution	--	40.3 minutes	127.4 minutes	113 minutes
Time attributed to each layer	--	40.3 min/layer	42.5 min/layer	113 minutes

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2018 Draft NDS Ch 16 Clarification

16.3 Wood Connections



Wood connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. Protection shall be provided by wood, fire-rated gypsum board, other approved materials, or a combination thereof. Where fire endurance is required, connectors and fasteners shall be protected from fire exposure by wood, fire-rated gypsum board, or any coating approved for the required endurance time.

All elements of the wood connection design including connectors, fasteners and portions of the wood members included in the connection design must be protected.

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Review of code...

Know the reason for FRR:

- **To determine FRR, you need the following:**
 - Sprinkler system:
 - NFPA 13, 13R, 13D
 - Type of Construction used (and/or minimum?)
 - Separated occupancy groups (or not)?
 - Any alternate means agreements?
 - Source of particular FRR requirement:
 - Tables 601 and 602
 - Chapters 3,4,5,6,7,9,10,14,15... others?
 - Structural load path for support of elements

2016 CBC, Sprinkler systems: Section 903

903.3.1.1 NFPA 13

903.3.1.2 NFPA 13R

903.3.1.3 NFPA 13D

Critical to know which system in building!

	NFPA 13	NFPA 13R	NFPA 13D
Extent of protection	Equip throughout (Section 903.3.1.1)	Occupied spaces (Section 903.3.1.2)	Occupied spaces (Section 903.3.1.3)
Scope	All occupancies	Low-rise residential	One- and two-family dwellings
Sprinkler design	Density/area concept	4-head design	2-head design
Sprinklers	All types	Residential only	Residential only
Duration	30 minutes (minimum)	30 minutes	10 minutes
Advantages	Property and life protection	Life safety/tenability	Life safety/tenability

2015 IBC Code &
Commentary

Figure 903.3.1
NFPA 13, NFPA 13R, NFPA 13D SYSTEMS

Behavior of Fire and Materials

Protection of light frame construction:

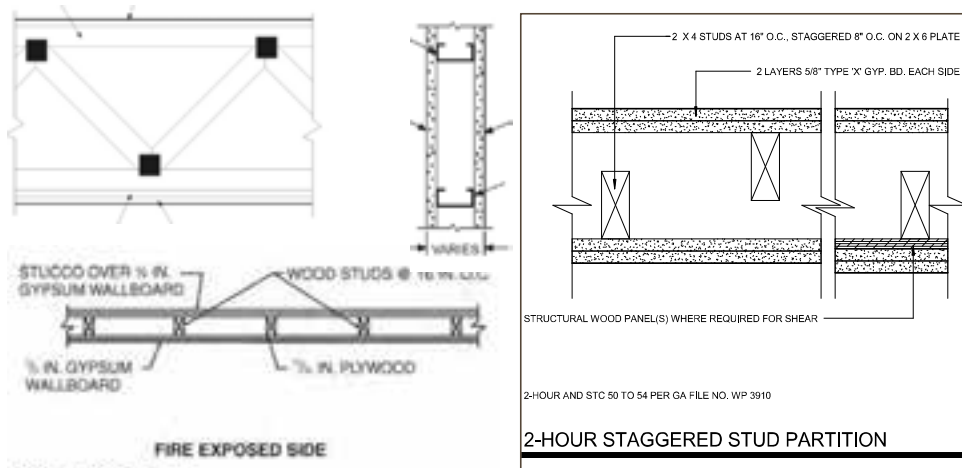


Figure 722.6
EXAMPLE—WOOD STUD WALL WITH WALLBOARD

2012 IBC Code & Commentary

Know the reason for FRR:



Fire Confinement

OR



Structural Performance

OR

BOTH !!!

701.2 Multiple use fire assemblies. Fire assemblies that serve multiple purposes in a building shall comply with all of the requirements that are applicable for each of the individual fire assemblies.

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Know the reason for FRR:

602.1 General. Buildings and structures erected or to be erected, altered or extended in height or area shall be classified in one of the five construction types defined in Sections 602.2 through 602.5. The building elements shall have a fire-resistance rating not less than that specified in Table 601 and exterior walls shall have a fire-resistance rating not less than that specified in Table 602. Where required to have a fire-resistance rating by Table 601, building elements shall comply with the applicable provisions of Section 703.2. The protection of openings, ducts and air transfer openings in building elements shall not be required unless required by other provisions of this code.

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 (see Section 202)	2 ⁺	2 ⁺	1	0	1	0	HT	1	0
Roofing walls									
Exterior ^a	1	2	1	0	2	2	2	1	0
Interior	2 ⁺	2 ⁺	1	0	1	0	1HT	1	0
Nonbearing walls and partitions									
Exterior	See Table 602								
Nonbearing walls and partitions									
Interior ^a	0	0	0	0	0	0	See Section 602.4.5	0	0
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)	1½ ^a	1 ^a	1 ^a	0 ^a	1 ^a	0	HT	1 ^a	0

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Know the reason for FRR:

SECTION 704 FIRE-RESISTANCE RATING OF STRUCTURAL MEMBERS

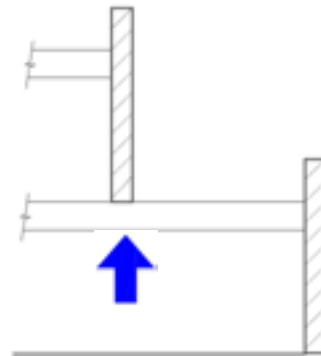
704.1 Requirements. The fire-resistance ratings of structural members and assemblies shall comply with this section and the requirements for the type of construction as specified in Table 601. The fire-resistance ratings shall be not less than the ratings required for the fire-resistance-rated assemblies supported by the structural members.

Exception: Fire barriers, fire partitions, smoke barriers and horizontal assemblies as provided in Sections 707.5, 708.4, 709.4 and 711.2, respectively.

This section forms the basic requirement for structural fire resistance rating along with Table 601. The structural FRR of any members or assemblies must be no less than the FRR of Table 601 building elements or the assemblies they support. There are only a limited few exceptions based on specific conditions in Type "B".

Example: of reason for FRR:

- Two-hour exterior wall is supported by a beam and column system:
- The supporting members of the two-hour exterior wall (that are not part of the enclosure) must have a two-hour structural fire resistance rating (CBC 704.1)



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Platform floor construction and FRR requirements: IBC 202



PRIMARY STRUCTURAL FRAME. The primary structural frame shall include all of the following structural members:

1. The columns;
2. Structural members having direct connections to the columns, including girders, beams, trusses and spandrels;
3. Members of the floor construction and roof construction having direct connections to the columns; and
4. Bracing members that are essential to the vertical stability of the primary structural frame under gravity loading shall be considered part of the primary structural frame whether or not the bracing member carries gravity loads.

Beams typically have direct connections to the columns to be part of the Primary Structural Frame

52

Platform floor construction and FRR requirements: IBC 202



53

Ch 7: Fire, Smoke Protect Features

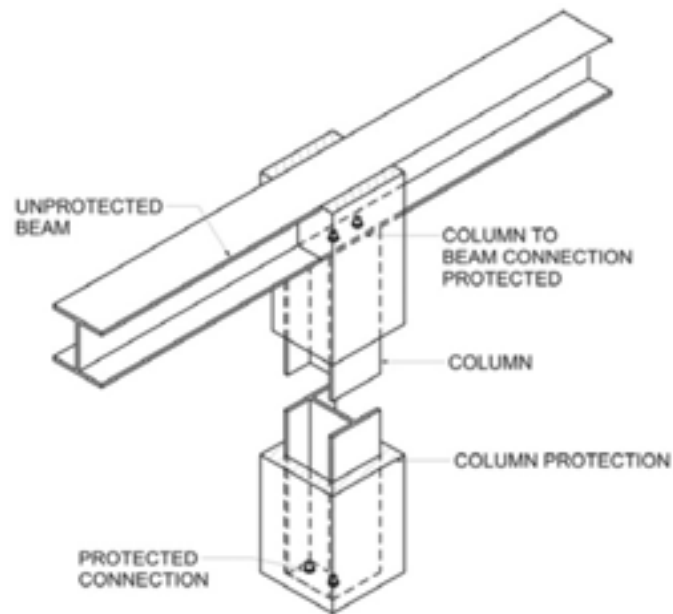


704.2 Column protection. Where columns are required to achieve a fire-resistance rating, the entire column shall be provided individual encasement protection by protecting it on all sides for the full column height, including connections to other structural members, with materials having the required fire-resistance rating. Where the column extends through a ceiling, the encasement protection shall be continuous from the top of the foundation or floor/ceiling assembly below through the ceiling space to the top of the column.

When columns are required to be protected, the protection is required full height on all four sides. **Wood columns with calculated fire resistance are not required to be individually protected.**

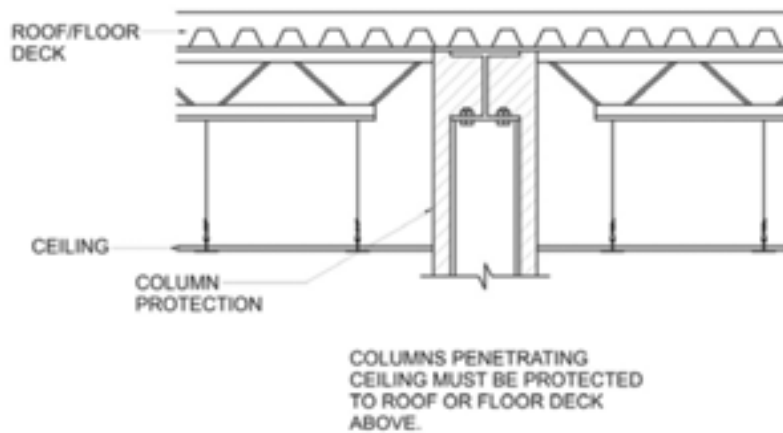


Ch 7: Fire, Smoke Protect Features



2012 IBC Code & Commentary

Ch 7: Fire, Smoke Protect Features



2012 IBC Code & Commentary

Ch 7: Fire, Smoke Protect Features



704.3 Protection of the primary structural frame other than columns. Members of the primary structural frame other than columns that are required to have protection to achieve a fire-resistance rating and support more than two floors or one floor and roof, or support a load-bearing wall or a nonload-bearing wall more than two stories high, shall be provided individual encasement protection by protecting them on all sides for the full length, including connections to other structural members, with materials having the required fire-resistance rating.

See definition of "Primary Structural Frame" Some mistakenly apply this requirement to beams that do not meet the definition of Primary Structural Frame



Earlier 2 hour structural beam and column example:

- Two-hour exterior wall is supported by a beam and column system:
- The supporting members of the two-hour exterior wall (that are not part of the enclosure) must have a two-hour structural fire resistance rating (CBC 704.1)



2-hour Exposed Glulam Beam/Column



Photos Courtesy of Arup

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Platform floor construction and FRR requirements: IBC 202



SECONDARY MEMBERS. The following structural members shall be considered secondary members and not part of the primary structural frame:

1. Structural members not having direct connections to the columns;
2. Members of the floor construction and roof construction not having direct connections to the columns; and
3. Bracing members other than those that are part of the primary structural frame.

60

Old 2012 IBC language:

704.4 Protection of secondary members. Secondary members that are required to have a *fire-resistance rating* shall be protected by individual encasement protection, by the membrane or ceiling of a *horizontal assembly* in accordance with Section 711, or by a combination of both.

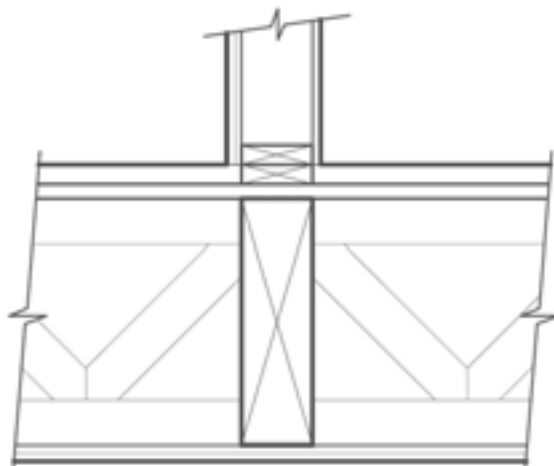


**Old
language**

See: Significant Changes to the International Building Code (and the code change submittal). Both make it clear the rewording of this section in the 2015 IBC is not intended to make changes to the intent stated in the 2012 IBC above.



Platform floor construction and FRR requirements: Secondary beam in floor:



Beam in floor system that has no direct connection to a column is a:

"Secondary Beam"

CBC Section 704.4.2

Structural FRR of secondary wood beam in floor assembly

What about a glued-laminated or SCL beam within an I joist assembly protected with two layers of 5/8" type X gyp board?

It can be shown large wood (not steel) secondary beams within a horizontal assembly always has FRR greater or equal than smaller wood framing elements protected by ceiling membrane...Why?

<p>21. Wood joists, wood I joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" second structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with 4d nails. The second structural panel thickness shall not be less than nominal 1/2" nor less than required by Chapter 23.</p>	<p>21.4.2</p>	<p>Base layer 1/2" Type X gypsum wall board applied at right angles to joist or truss 24" o.c. with 1 1/2" Type S or Type W drywall screws 24" o.c. Face layer 1/2" Type X gypsum wallboard or truss base applied at right angles to joist or truss through base layer with 1 1/2" Type S or Type W drywall screws 12" o.c. at joints and intermediate joint or truss. Face layer Type G drywall screws placed 12" back on either side of face-layer end joints. 12" o.c.</p>	<p>Value</p>	<p>1 1/2</p>
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722 - Harmathy's Ten Rules

- Taken from the "Ten Rules of Fire Endurance Ratings" by T.Z. Harmathy in the May 1965 edition of Fire Technology.

Harmathy's "Ten Rules of Fire Endurance Ratings"

- The "thermal" fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the "thermal" fire endurance's characteristic of the individual layers when exposed separately to fire.
- The fire endurance of a construction does not decrease with the addition of further layers.
- The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities.
- The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.

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722 - Harmathy's Ten Rules (cont'd)

5. Increasing the thickness of a completely enclosed air layer cannot increase the fire endurance of a construction.
6. Layers of materials of low thermal conductivity are better utilized on that side of the construction on which fire is more likely to happen.
7. The fire endurance of asymmetrical constructions depends on the direction of heat flow.
8. The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.
9. Load-supporting elements, such as beams, girders and joists, yield higher fire endurance's when subjected to fire endurance tests as parts of floor, roof, or ceiling assemblies than they would when tested separately.
10. The load-supporting elements (beams, girders, joists, etc.) of a floor, roof, or ceiling assembly can be replaced by such other load-supporting elements which, when tested separately, yielded fire endurance's not less than that of the assembly.

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Secondary members and light frame



704.4 Protection of secondary members. Secondary members that are required to have protection to achieve a *fire-resistance rating* shall be protected by individual encasement protection.

704.4.1 Light-frame construction. Studs and boundary elements that are integral elements in *load-bearing walls* of light-frame construction shall be permitted to have required *fire-resistance ratings* provided by the membrane protection provided for the *load-bearing wall*.

704.4.2 Horizontal assemblies. *Horizontal assemblies* are permitted to be protected with a membrane or ceiling where the membrane or ceiling provides the required *fire-resistance rating* and is installed in accordance with Section 711.

Note: The word "king" from king studs was also removed from the 2012 IBC language now in 704.4.1, also see 2018 IBC change:

Platform floor construction and FRR requirements:

Wood post or column in wall 2018 IBC clarification in 704.2:



AM-OGCV

Clarifies that solid and built-up columns and posts within light frame fire resistance rated stud walls (framed integral between top and bottom plate) do not require individual encasement protection and can be protected by the wall membrane.



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704.2 Built-up columns in light frame walls 2018 IBC Group A Proposal FS 7



- As submitted in FS 7 for 2018 IBC:

704.4.1 Light-frame construction. Studs, ~~columns~~, and boundary elements that are integral elements in ~~load-bearing~~ walls of light-frame construction, ~~and are located entirely between the top and bottom plates~~ shall be permitted to have required fire-resistance ratings provided by the membrane protection provided for the ~~load-bearing~~ wall.

- As modified and approved by committee:

704.4.1 Light-frame construction. 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.

Committee Reason: The committee agreed that built-up solid structural elements, such as 2 or more vertical framing members, within fire-resistance rated walls of light-frame construction that meet the limitations of Section 704.4.1 can be a part of a fire-resistance rated wall assembly without requiring the individual encasement protection of Section 704.2. The modification eliminates redundant language by referencing Section 704.4.1 for limitations. Further, the modification appropriately recognizes steel framing members for the same allowable use.

AM-OGCV

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704.2 Built-up columns in light frame walls 2018 IBC Group A Proposal FS 7



- New language in 2018 IBC: **AM-OGCV**

704.2 Column protection. Where columns are required to have protection to achieve a *fire-resistance rating*, the entire column shall be provided individual encasement protection by protecting it on all sides for the full column height, including connections to other structural members, with materials having the required *fire-resistance rating*. Where the column extends through a ceiling, the encasement protection shall be continuous from the top of the foundation or floor/ceiling assembly below through the ceiling space to the top of the column.

Exception: Columns that meet the limitations of Section 704.4.1.

704.4.1 Light-frame construction. 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.



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Platform floor construction and structural FRR variables:

- **4 basic framing types for wood floors:**
 1. Open web truss construction
 2. Engineered I joist construction
 3. Solid wood joists
 4. Solid panel: CLT, NLT or other?
- **Rated or Not Rated**

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IBC Section 2304.3.3

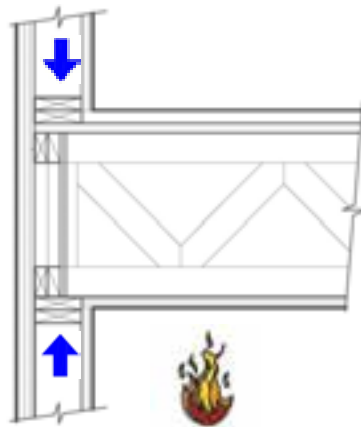
Shrinkage must be accounted for in platform construction:

2304.3.3 Shrinkage. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

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Platform floor construction and structural FRR variables:

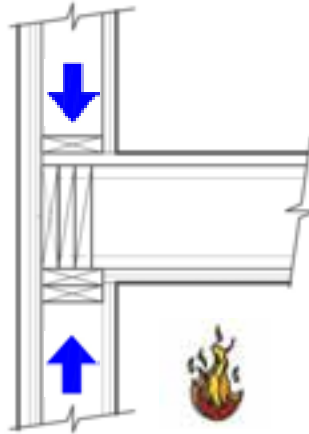
- **Open web truss construction:**



72

Platform floor construction and structural FRR variables:

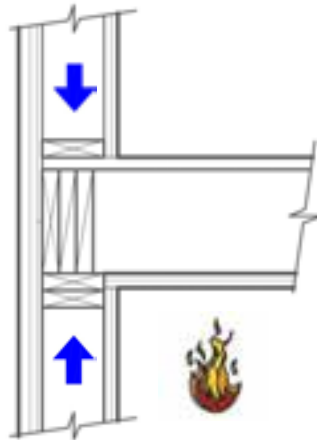
- **Engineered I joist construction:**



73

Platform floor construction and structural FRR variables:

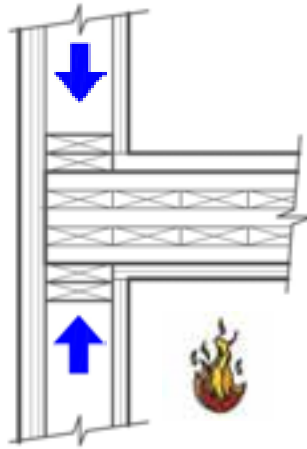
- **Solid wood joist construction:**



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Platform floor construction and structural FRR variables:

- **Solid panel construction:**



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New to 2015 IBC: Platform floor construction CLT with light frame walls



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Provided courtesy: Katerra

2021 IBC: G109-18 AM 2: concealed space in Type IV-HT

2021
IBC

602.4.3 Concealed spaces. ~~Concealed spaces shall not contain combustible materials other than building elements and electrical, mechanical, fire protection, or plumbing materials and equipment. Concealed spaces shall comply with applicable provisions of Section 718. Concealed spaces shall be protected in accordance with one or more of the following:~~

- ~~1. The building shall be sprinklered throughout in accordance with Section 903.3.1.1 and automatic sprinklers shall also be provided in the concealed space.~~
- ~~2. The concealed space shall be completely filled with noncombustible insulation.~~
- ~~3. Surfaces within the concealed space shall be fully sheathed with not less than 5/8 inch Type X gypsum board.~~

Exception: ~~Concealed spaces within interior walls and partitions with a one hour or greater fire resistance rating complying Section 2304.11.2.2 shall not require additional protection.~~

602.4.3 Concealed spaces. Concealed spaces shall not contain combustible materials other than building elements and electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code. Concealed spaces shall comply with applicable provisions of Section 718. Concealed spaces shall be protected in accordance with one or more of the following:

1. The building shall be sprinklered throughout in accordance with Section 903.3.1.1 and automatic sprinklers shall also be provided in the concealed space.
2. The concealed space shall be completely filled with noncombustible insulation.
3. Surfaces within the concealed space shall be fully sheathed with not less than 5/8 inch Type X gypsum board.

Exception: Concealed spaces within interior walls and partitions with a one hour or greater fire resistance rating complying Section 2304.11.2.2 shall not require additional protection.

AM-2,CAH

FLOOR MODIFICATION
G109-18-HIRSCHLER-2

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Cross Laminated Timber (CLT)



Photos provided by FPInnovations

History of CLT

- 1985 First patent for CLT in France
- 1993 First projects in CLT in Switzerland and Germany
- 1995-1996 Development of press technology
- 1998 First multi-story residential building in Styria, Austria
- CLT use (Europe) increased significantly in the early 2000s
 - Driven by the green building movement
 - Due to better efficiencies, product approvals, and improved marketing and distribution channels
 - Over 500 CLT buildings in England
 - US and Canadian use of CLT



CLT Definition & Product Standard

2015 IBC code change established the definition and product standard for CLT:

[BS] CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

CLT is now a “material permitted by this code” in the 2015 IBC



2015 IBC: CLT permitted uses:



- **CLT is now a material permitted by the code:**
- **For Type I and II construction, CLT can be used for balcony and canopy or roof construction**
- **For Type III construction, CLT can be used for the interior building elements including:**
 - **Roof-ceiling assembly,**
 - **Floor-ceiling assembly**
 - **Interior walls**
- **For Type IV or V construction, CLT can be used for anything:**

Horizontal Assemblies



• 711 Horizontal Assemblies

711.2.4.3 Dwelling units and sleeping units. Horizontal assemblies serving as dwelling or sleeping unit separations in accordance with Section 420.3 shall be not less than 1-hour fire-resistance-rated construction.

Exception: Horizontal assemblies separating dwelling units and sleeping units shall be not less than $\frac{1}{2}$ -hour fire-resistance-rated construction in a building of Type IIB, IIIB and VB construction, where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

- **See IBC 420, 708, 711, and 718 for a variety of exceptions based on NFPA 13 sprinklers (903.3.1.1) or NFPA 13R sprinklers (903.3.1.2)**

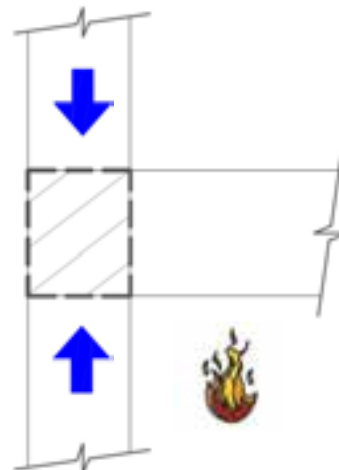
Platform floor construction and structural FRR variables:

- Typically only two levels can share a common atmosphere through openings but there are some exceptions (all covered in Section 712):
- **Unconcealed openings including:**
 - Stairs up to four floors within an individual residential dwelling unit.
 - Mezzanine
 - Atriums
 - Draft curtain and NFPA 13 sprinkler protected escalator and exit access openings

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Platform floor construction and structural FRR variables:

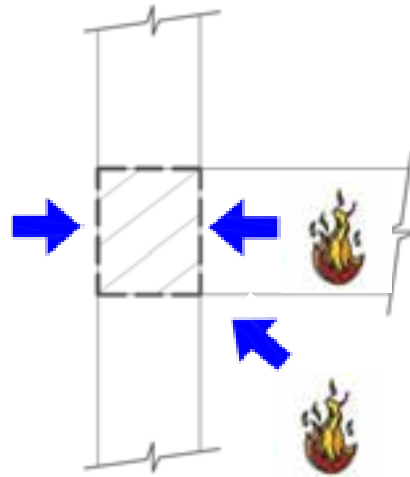
- Typically questions occur regarding **“supporting construction”** at the intersection between walls and floor assemblies... **“in the plane of the wall”**



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Platform floor construction and separation FRR variables:

- Typically questions occur at the intersection between walls and floor assemblies... **"in the plane of the wall"** regarding **"continuity"** of separation



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CLT floor: 2 hour fire test at wall

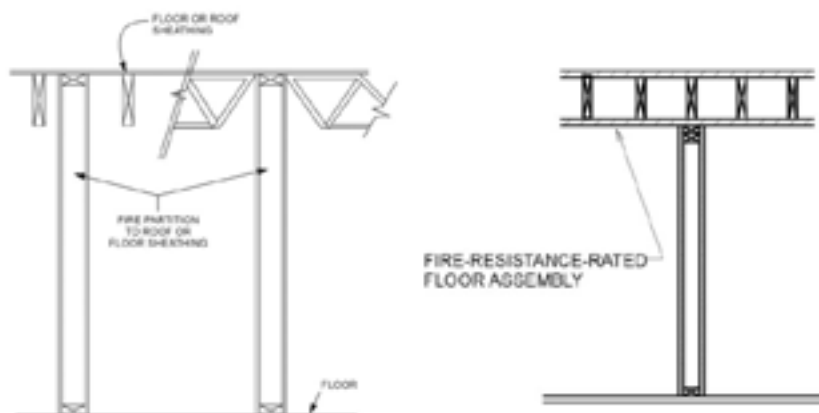


FRR wall types and floor intersections:

- **4 basic FRR rated walls:**
 1. Section 708: Fire Partition
 2. Section 707: Fire Barrier
 3. Section 706: Fire Wall
 4. Section 705: Exterior Wall
- **Floors rated or not ?**
- **Walls supporting or not ? (704.1)**

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Fire Partitions – IBC 708



CONTINUITY OF FIRE PARTITIONS

2012 IBC Code & Commentary

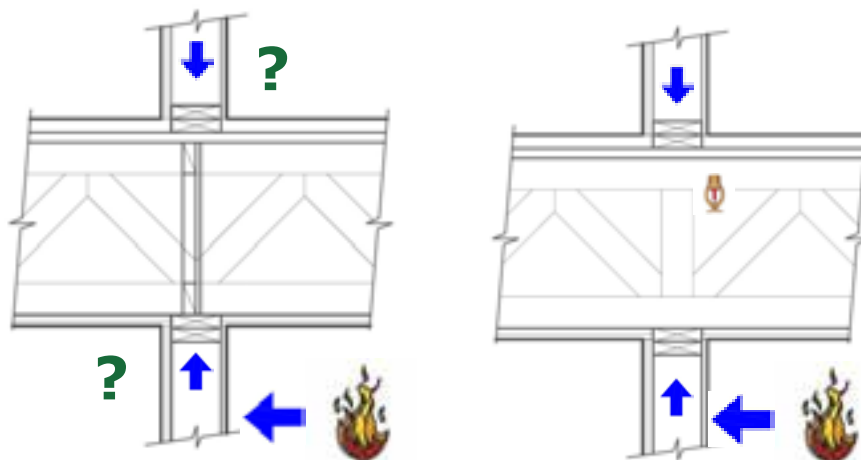
FRR wall types and floor intersections: 708 Fire Partition

- **Fire Partitions separate:**
 1. Tenants in malls (and enclosed tenant spaces in 1 hr. CA SFM reg occupancy groups & high-rise)
 2. Dwelling unit and sleeping units from each other and other uses
 3. Corridor walls
 4. Elevator lobbies
 5. Egress balconies
- **May stop if securely attached to bottom of rated horiz. assembly**
- **Exceptions for support in IIB, IIIB and VB construction (IBC 708.4)**

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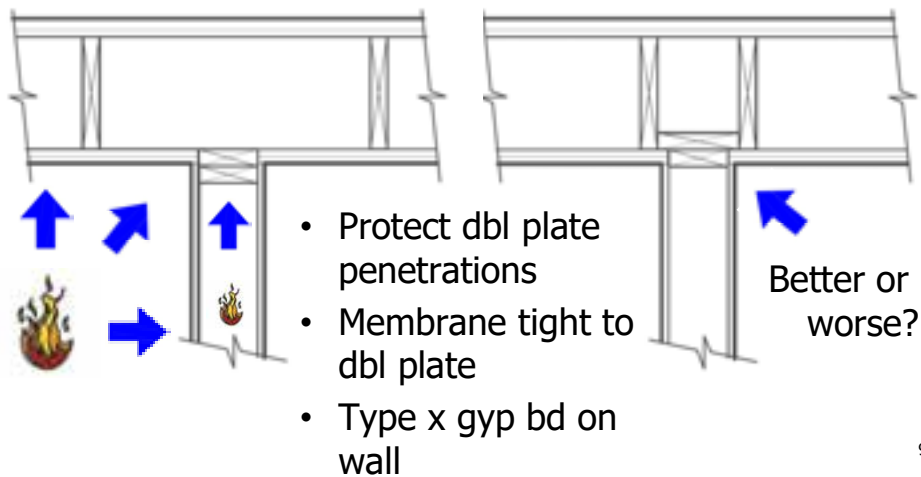
FRR wall types and floor intersections: 708 Fire Partition

- **Fire Partition construction:**



FRR wall types and floor intersections: 708 Fire Partition

• CBC 714.4.2 Exception 7



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FRR wall types and floor intersections: 708 Fire Partition

• CBC 714.4.2 Exception 7

714.4.2 Membrane penetrations. Penetrations of membranes that are part of a horizontal assembly shall comply with Section 714.4.1.1 or 714.4.1.2. Where floor/ceiling assemblies are required to have a fire-resistance rating, recessed fixtures shall be installed such that the required fire resistance will not be reduced.

Exceptions:

7. The ceiling membrane of 1- and 2-hour fire-resistance-rated horizontal assemblies is permitted to be interrupted with the double wood top plate of a wall assembly that is sheathed with Type X gypsum wallboard, provided that all penetrating items through the double top plates are protected in accordance with Section 714.4.1.1 or 714.4.1.2 and the ceiling membrane is tight to the top plates.

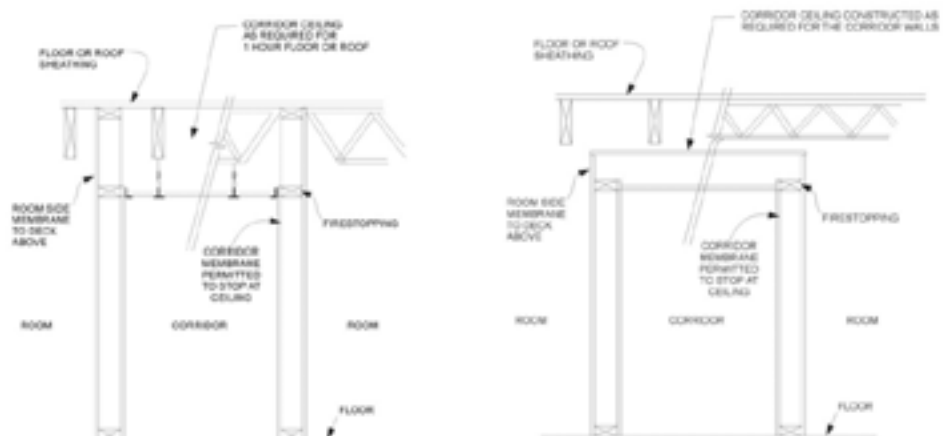
92

Fire Partitions – IBC 708



CONTINUITY OF FIRE PARTITIONS

Fire Partitions at corridors



Fire Partitions at Corridor Walls

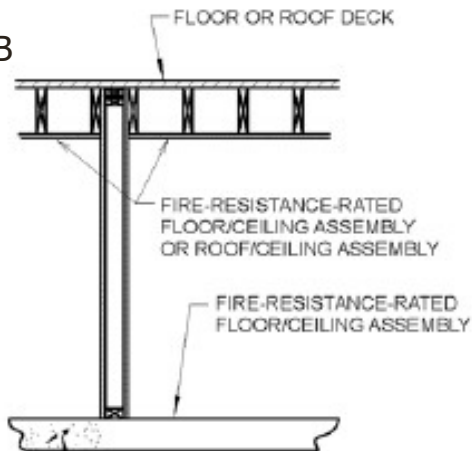
2012 IBC Code & Commentary

Fire Barriers – IBC 707

Supported by assembly of equal or greater fire resistance (with exceptions when required for separating incidental use areas in type IIB, IIIB and VB construction)

Commonly used in:

- Shaft enclosures
- Interior exit stairway
- Exit stairway enclosures
- Exit passageways
- Incidental uses (IBC 509)
- Occupancy separations
- Creating separate fire areas



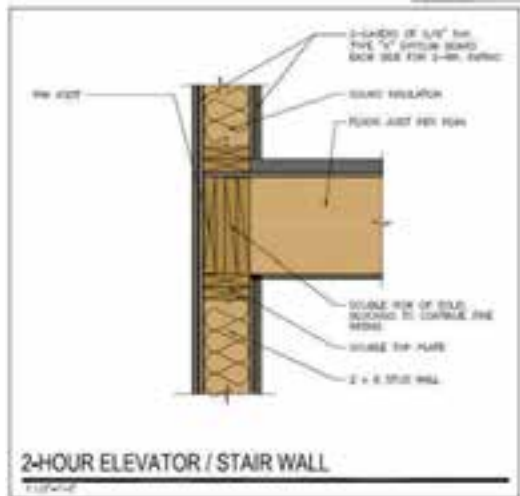
2012 IBC Code & Commentary

FRR wall types and floor intersections: 707 Fire Barrier

- **Fire Barriers separate:**
 1. Shafts
 2. Exit enclosures
 3. Exit passageways
 4. Horizontal exits
 5. Incidental uses
 6. Atriums
 7. Fire areas
- **FRR always extends through concealed space of horizontal assembly**
- **Always supported by similar FRR except 1 hour FRR incidental use separation; Types IIB, IIIB and VB construction (IBC 509)**

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Shaft Walls



Wood Design Focus: Volume 22, Issue 3 by Smith
Slide courtesy of Wood Works

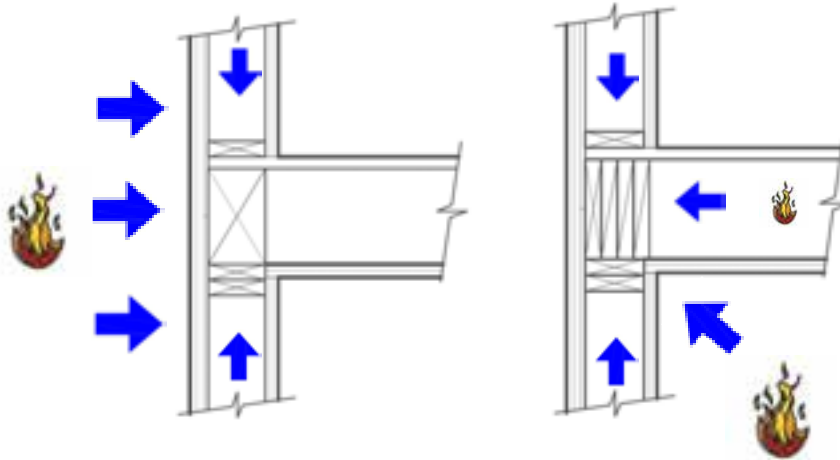
Interior Exit Stairway Enclosures



Slide courtesy of Wood Works

FRR wall types and floor intersections: 707 Fire Barrier

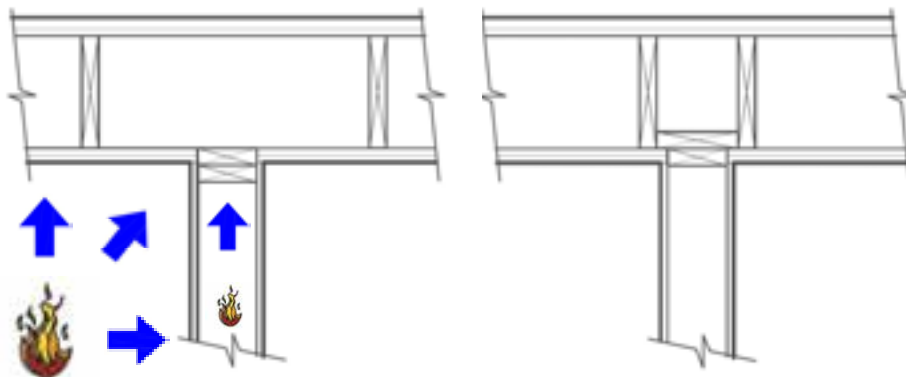
- Fire Barrier construction:**



99

FRR wall types and floor intersections: 707 Fire Barrier

- IBC 714.4.2 Exception 7**

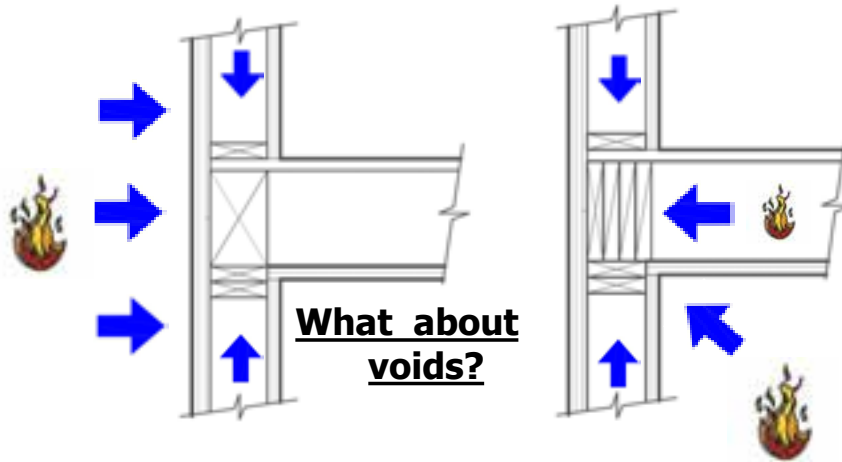


Better or worse?

100

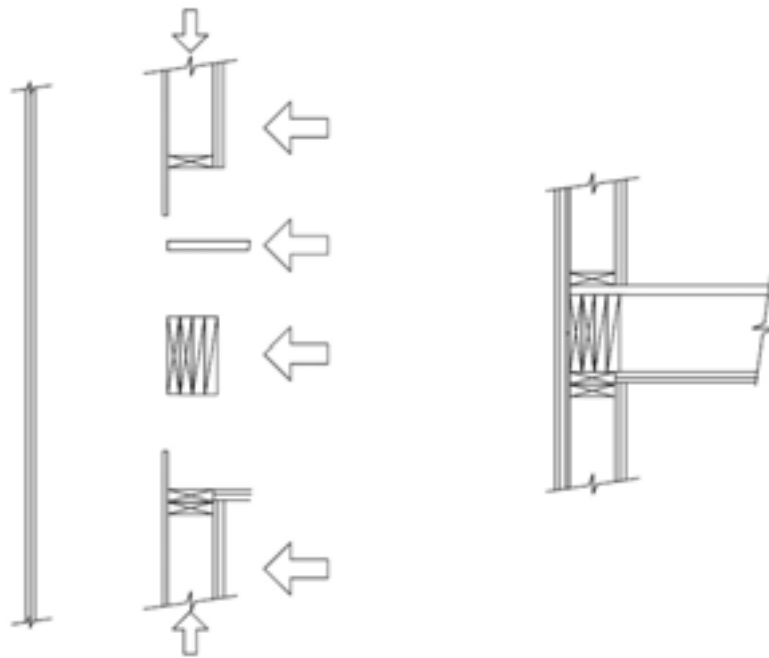
FRR wall types and floor intersections: 707 Fire Barrier

- Fire Barrier construction:**

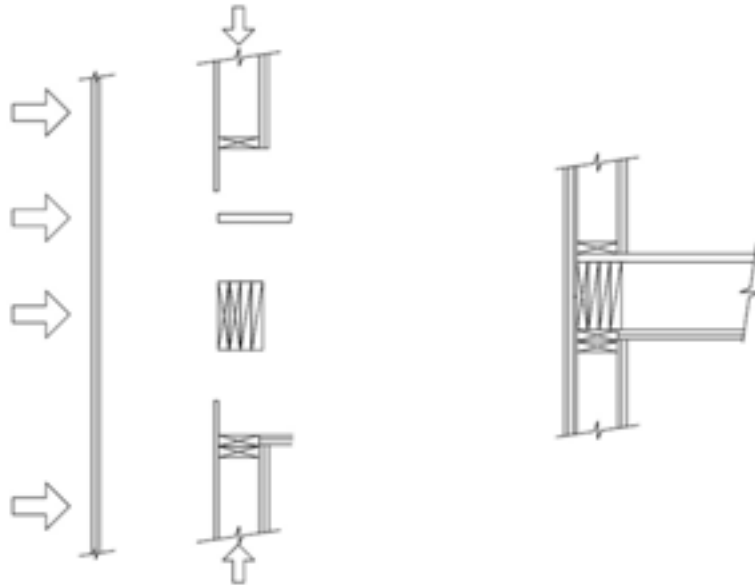


101

Fire Barrier



Fire Barrier



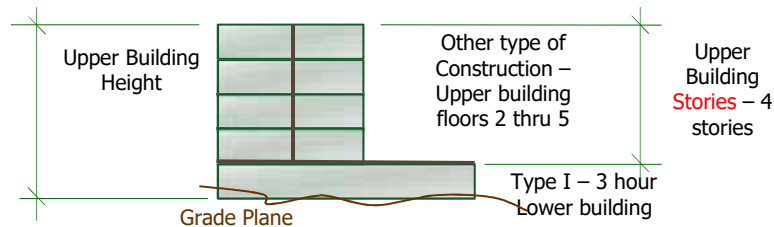
FRR wall types and floor intersections: 706 Fire Wall

- **Fire Walls divide a building into separate buildings by providing complete separation:**
 1. Continuous with no horizontal offsets from foundation to roof. Allowed to stop at horizontal 3 hour Type IA podium (IBC 510.2). Parapet required with some exceptions at roof.
 2. Continuous horizontally from exterior wall to exterior wall with specific termination conditions.
 3. Required to be structurally stable after collapse of either side or constructed per NFPA 221.
- **Always extends through concealed space of horizontal assembly**
- **Noncombustible except for Type V**

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Fire wall in a podium: 510.2

- Building Height – in feet
 - Upper building height (feet) is measured from grade plane
- Building Height – stories
 - Upper building height (stories) – measured from top of lower building
- **Fire Walls not required to extend beyond 3 hour separation.**



706.2 – FS22- public comment

706.2 Structural stability. Fire walls shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall for the duration of time indicated by the required *fire-resistance rating* or shall be constructed as double fire walls in accordance with NFPA 221.

Old language



706.2 Structural stability. *Fire walls* shall be designed and constructed to allow collapse of the structure on either side without collapse of the wall under fire conditions. *Fire walls* designed and constructed in accordance with NFPA 221 shall be deemed to comply with this section.

New language



IBC Fire Wall Assemblies



TABLE 706.4
FIRE WALL FIRE-RESISTANCE RATINGS

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 ^a
F-1, H-3 ^b , H-5, M, S-1	3
H-1, H-2	4 ^b
F-2, S-2, R-3, R-4	2

a. In Type II or V construction, walls shall be permitted to have a 2-hour *fire-resistance rating*.

b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.7 and 415.8.

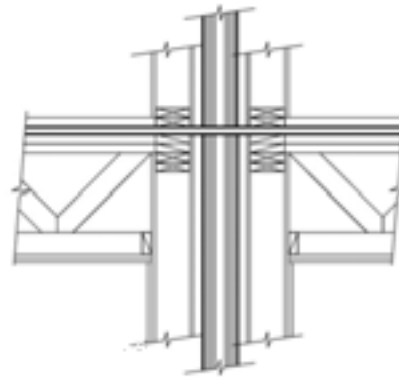
IBC 706.3 – Fire walls shall be of any approved non-combustible materials.

Exception: Buildings of Type V construction

FRR wall types and floor intersections: 706 Fire Wall

• Fire Wall Type III

Is this an issue to have structural floor sheathing going through the noncombustible fire wall?



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FRR wall types and floor intersections: 706 Fire Wall

• Fire Wall Type III

Q: Can I have a wood beam going through a noncombustible fire wall? **A:** Yes ! but

706.7 Combustible framing in fire walls. Adjacent combustible members entering into a concrete or masonry fire wall from opposite sides shall not have less than a 4-inch (102 mm) distance between embedded ends. Where combustible members frame into hollow walls or walls of hollow units, hollow spaces shall be solidly filled for the full thickness of the wall and for a distance not less than 4 inches (102 mm) above, below and between the structural members, with noncombustible materials approved for fire-blocking.

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Fire Walls - 706



SEAOSC LIGHT-FRAMING CONSTRUCTION COMMITTEE STRUCTURAL ENGINEERS ASSOCIATION OF SOUTHERN CALIFORNIA SEISMOLOGY OPINION

DATE: March 21, 2008

Continuity of Plywood Diaphragm Sheathing in 2 hr and 3hr Fire Walls:

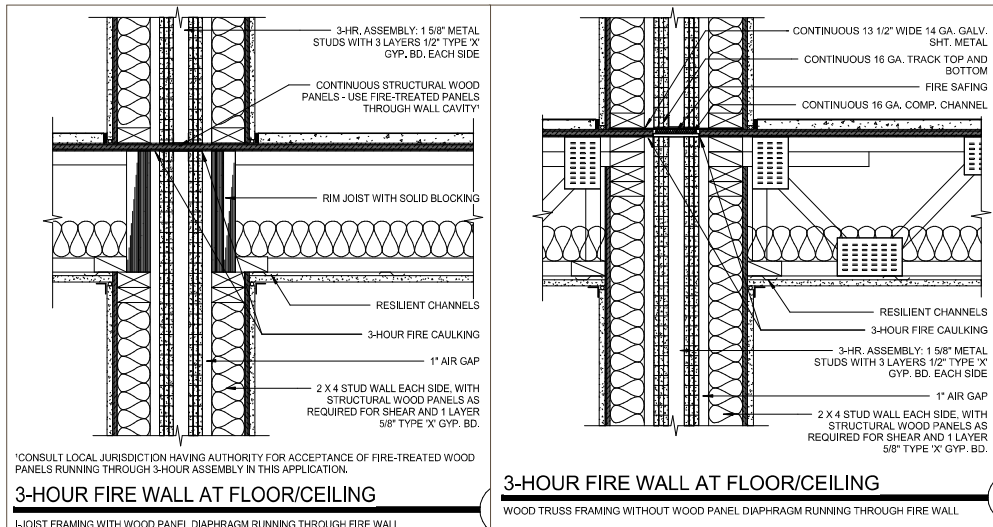
Opinion: The continuity of plywood diaphragm sheathing should be maintained across the air gap commonly encountered in double stud firewalls of 2 or 3 hour construction. The intent is to ensure that structural continuity is not significantly reduced in the roof and floor diaphragms.

Commentary:

This opinion is prepared to address the issue of diaphragm continuity as it relates to recent changes in 2007 CBC and 2006 IBC model code. Specifically the outgoing UBC provisions for Area Separation walls have more or less been replaced by the Fire wall provisions of the IBC. Such walls are encountered in light-frame multifamily or mixed-use construction and are often constructed as a double studwall when occurring at partywall locations. The double stud walls are typically separated by an airspace of a one to four inches.

The IBC has introduced language [IBC 705.4] that states fire walls must have "sufficient structural stability" under fire conditions to allow collapse of either side. Previous commentary to the UBC topic of Area Separation

Fire wall Detailing



CAD & Revit Details: www.woodworks.org

2018 IBC FS 29-15 AMPC1

- FS 29-15 for 2018 IBC:
Approved as modified by public comment 1



2015 International Building Code **AMPC1-OGCV**

706.2 Structural stability. Fire walls shall be designed and constructed to allow collapse of the structure on either side without collapse of the wall under fire conditions. Fire walls designed and constructed in accordance with NFPA 221 shall be deemed to comply with this section.

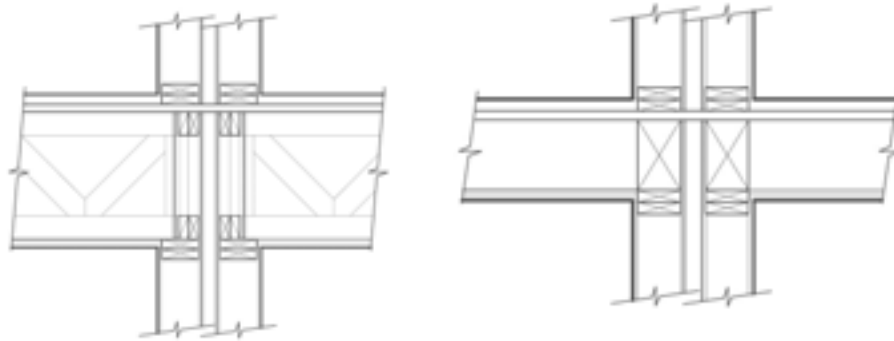
Exception: In SDC D through F, where double fire walls are used in accordance with NFPA 221, floor and roof sheathing not exceeding 3/4 inch (19.05 mm) thickness shall be permitted to be continuous through the wall assemblies of light frame construction.

Commenter's Reason: There is widely accepted interpretation by many building departments and structural engineers that the roof and floor diaphragms must be continuous to properly perform its function. The sheathing which comprises these diaphragms in light frame construction is generally wood structural panels between 7/16 inches to 23/32 inches thickness. These panels represent a very small risk of causing failure of the wall on the unaffected side of a double fire wall assembly. The benefit of performing the seismic function as a diaphragm is generally regarded as well worth any very small risk caused by fire exposure from one side of a double fire wall. The following link is to a Structural Engineers of Southern California recommendation to carry the floor sheathing through these fire walls.
http://www.icclabc.org/uploads/Opinion_from_SEAOSC_on_Firewall_Final.pdf

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FRR wall types and floor intersections: 706 Fire Wall

- **Fire Walls, Type V**



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Sheathing for Type III Fire Walls?

**What is being enforced in your
Jurisdiction?**



Ch 7: Interior FRR Walls:

Fire wall (IBC 706)

- Divides structure into separate buildings
- Continuous from foundation (or top of three hour podium) to or through roof
- Structural stability required to allow collapse on either side from fire w/o causing wall collapse
- Special requirements at roof and intersection with exterior walls at horizontal projecting elements and between stepped buildings
- Required to be of non-combustible construction except in type V
- 2 to 4 hour rated

Fire Barrier (IBC 707)

- Fire resistive wall designed to restrict the spread of fire with continuity through the building
- Divides structure into fire areas, and fire barriers are required for various purposes such as shaft enclosures, exit enclosures, atrium separation, occupancy separations, and control or incidental use areas.
- Supported by construction of equal fire resistance-rating (except for incidental use areas in type IIB, IIIB and VB construction)
- 1 to 4 hour rated

Fire Partition (IBC 708)

- Separates dwelling units, sleeping areas, corridors, and tenant spaces.
- May terminate at the lower side of a fire – resistance rated floor/ceiling/roof assembly
- In most instances fire partitions are not required to be supported by fire resistance-rated construction in type IIB, IIIB and VB construction (section 708.4)
- Rated not less than 1 hour (IBC section 708.3)

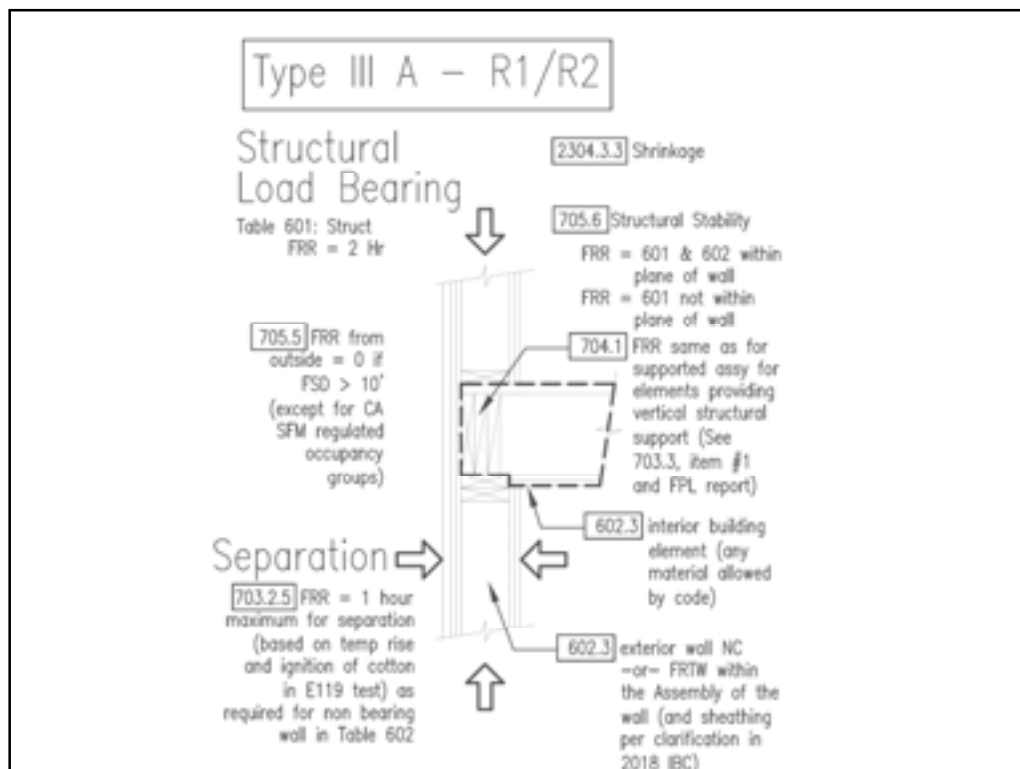
Fire-Retardant-Treated - Type III Exterior Walls



FRR wall types and floor intersections: 705 Exterior Wall

- **Walls enclosing the building (that is not a fire wall) with a slope greater than 60 degrees from horizontal.**
 1. Fire performance (including elements in the plane of the wall) from top (sometimes a parapet) to supporting construction or roof transitions is specified in IBC 703.2.5 based on structural FRR in Table 601 and separation FRR based on FSD and Table 602 for specific occupancy groups (IBC 704.1, 705.5 and 705.6)
 2. Elements supporting exterior wall to have the same structural FRR as the wall (IBC 704.1)
- **Type III noncombustible (walls up to 2 hour FRR permitted to be FRTW within the wall assembly).**

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Exterior Walls (IBC 705)

705.5 Fire-resistance ratings. *Exterior walls shall be fire-resistance rated in accordance with Tables 601 and 602 and this section. The required fire-resistance rating of exterior walls with a fire separation distance of greater than 10 feet (3048 mm) shall be rated for exposure to fire from the inside. The required fire-resistance rating of exterior walls with a fire separation distance of less than or equal to 10 feet (3048 mm) shall be rated for exposure to fire from both sides.*

Exterior Walls (IBC 705)

Exterior walls have to be rated to which ever is greater of Table 601 and 602....

- Table 601: The fire-resistance rating required to maintain vertical structural support and is based on
 - the type of construction
 - whether or not the wall is load bearing (see section 703.2.5 for exterior bearing walls)
 - see Table 602 for non-bearing walls

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		A	B
Primary structural frame ¹ (see Section 202)	2 ^h	2 ^h	1	0	1	0	1H	1	0
Bearing walls									
Exterior ¹	3	2	1	0	2	2	2	1	0
Interior	2 ^h	2 ^h	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions									
Exterior	See Table 602								

Exterior Walls (IBC 705)

Exterior walls have to be rated to which ever is greater of Table 601 and 602

- Table 602: The fire-resistance rating required to prevent spread of fire from the inside to the outside (or outside to inside) and is based on
 - type of construction
 - occupancy group
 - fire separation distance (FSD) associated with the exposure of the exterior wall

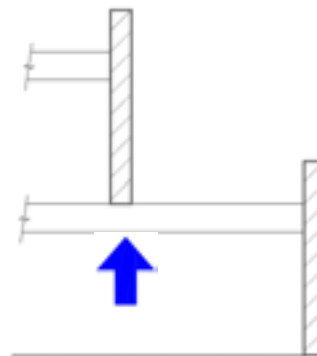
TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE^{a, b, c}

FIRE SEPARATION DISTANCE = X (ft/m)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP 1 ^d	OCCUPANCY GROUP F-1, M, S-1 ^e	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U
X < 5 ^f	All	3	2	1
5 ≤ X < 10	IA Others	3 2	2 1	1 1
10 ≤ X < 30	IA, IB IIB, VB Others	2 1 1	1 0 1	1 ^g 0 1 ^g
X ≥ 30	All	0	0	0

Exterior Walls (IBC 705)

An exterior wall is defined as a wall that is used as an enclosing wall of a building other than a fire wall. There is no requirement for an exterior wall to extend to the foundation in a stepped building.

Posts, beams or walls, that support a rated exterior wall must be fire – resistance rated not less than the rating of the supported wall (IBC 704.1)



Exterior bearing wall fire performance

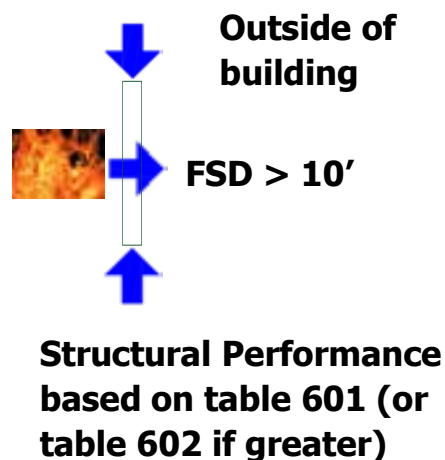
Exterior bearing wall requirement in CBC 703.2.5

703.2.5 Exterior bearing walls. In determining the fire-resistance rating of exterior bearing walls, compliance with the ASTM E119 or UL 263 criteria for unexposed surface temperature rise and ignition of cotton waste due to passage of flame or gases is required only for a period of time corresponding to the required fire-resistance rating of an exterior nonbearing wall with the same fire separation distance, and in a building of the same group. Where the fire-resistance rating determined in accordance with this exception exceeds the fire-resistance rating determined in accordance with ASTM E119 or UL 263, the fire exposure time period, water pressure and application duration criteria for the hose stream test of ASTM E119 or UL 263 shall be based on the fire-resistance rating determined in accordance with this section.

Ext wall fire performance and FSD

Exterior bearing wall exception to IBC 703.2.5:

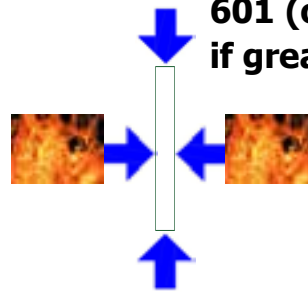
**Separation from inside to
outside based on table 602
for non-bearing wall with
same FSD and occupancy**



Ext wall fire performance and FSD

Exterior bearing wall exception to IBC 703.2.5:

Separation between
inside and outside (from
either direction_ based
on table 602 for non-
bearing wall with same
FSD and occupancy



Structural
Performance
based on table
601 (or table 602
if greater)

FSD < or = 10'

IBC Section 2304.3.3

Shrinkage must be accounted
for in platform construction:

2304.3.3 Shrinkage. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

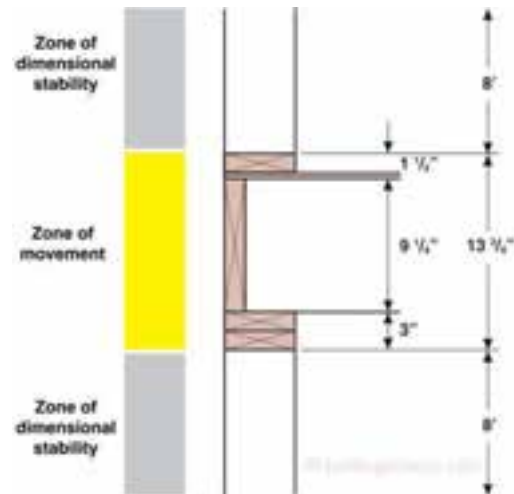
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Zone of Movement

Shrinkage occurs primarily in horizontal members

- wall plates
- Floors

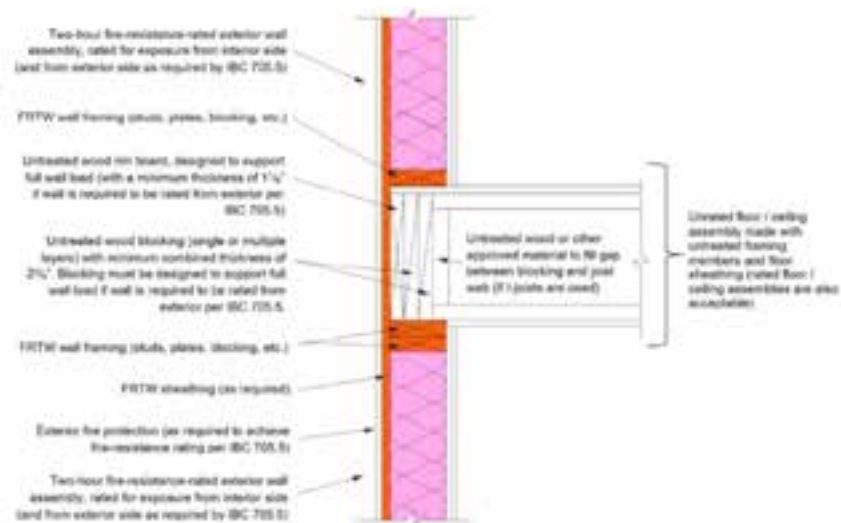
Be aware of accumulation of shrinkage in multi floor buildings. See IBC 2304.3.3.



Slide courtesy of Wood Works

fire-resistance rating in the code – 1. Approved Source:

AWC DCA 3



fire-resistance rating in the code – 1. Approved Source:

AWC DCA 3

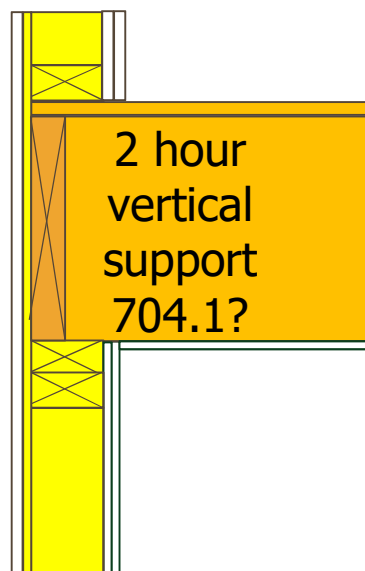
Figure 2: Example detail for Type III-B exterior wall-floor intersection with rim board and blocking

Methodology:

Fire-resistance for exposure from interior side: One or two layers of blocking with a minimum combined thickness of 2¹/₄ inches provides 2 hours of protection to the rim board based on the NDS-calculated time for the char depth to reach the rim board / blocking interface. Additional protection from the ceiling membrane (if any) is neglected. (Continuous rim board may be used in lieu of the blocking depicted in this example, provided it meets the minimum thickness requirement and the minimum bearing length requirements of the joists are met.) The wood rim board must be designed to support the load from the wall above.

Fire-resistance for exposure from exterior side (where required per IBC Section 705.5): A combination of exterior fire protection, FRTW sheathing, and minimum 1¹/₄-inch-thick rim board is used to provide two hours of protection to the wood blocking. Layers to the exterior of the rim board (e.g., exterior fire protection, FRTW sheathing, etc.) must be sufficient to provide at least 80 minutes of protection to the rim board. The wood blocking must be designed to support the load from the wall above.

Type III Construction – 704.1 ????



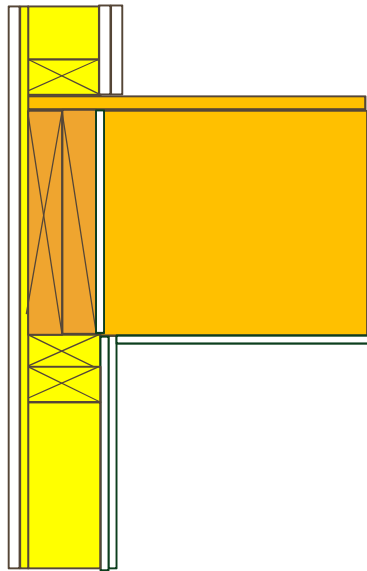
- 5/8" Type X GWB
- 1 layer for 1hr rating
- 2 layers for 2hr rating

- Fire Retardant Treated
- Wall studs, plates and sheathing

- Untreated Lumber
- Floor framing (solid sawn or engineered)
- Floor sheathing

Slide courtesy of Wood Works

Type III Construction

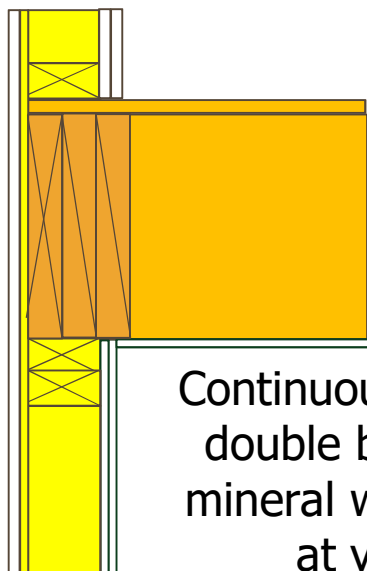


- 5/8" Type X GWB
- 1 layer for 1hr rating
- 2 layers for 2hr rating

- Fire Retardant Treated
- Wall studs, plates and sheathing

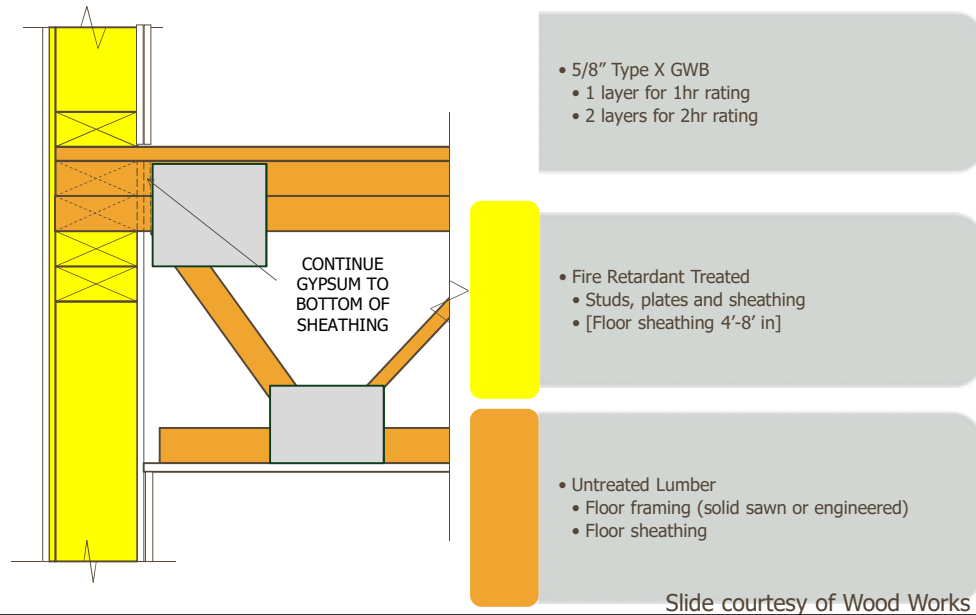
- Untreated Lumber
- Floor framing (solid sawn or engineered)
- Floor sheathing
- See alt means letter w/ safing

Type III Construction



Continuous rim with
double block with
mineral wool safing
at voids.

Type III Construction Detail



FRTW at exterior walls floors?

What is being enforced in your Jurisdiction?



Precautions during construction

www.constructionfiresafety.org



Fire-Resistant Design for Wood Construction

QUESTIONS?

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Thankyou!

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