



## **Code Compliant Fire Resistance Design for Wood Construction**

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Participants may download  
the presentation here:  
<http://www.awc.org/education/resources>

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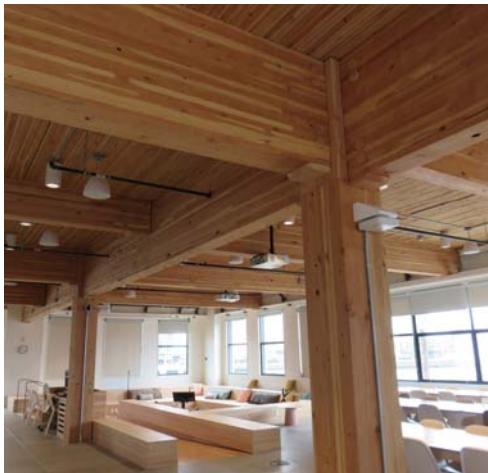
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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.

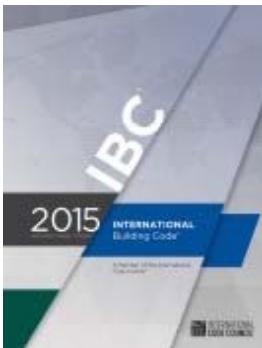
3

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.

# 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**

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## Code Official Connections

[www.awc.org/codeconnections](http://www.awc.org/codeconnections)  
[membership@awc.org](mailto:membership@awc.org)

Fire-Resistant Design for Wood Construction

Free to Qualified Officials  
Free Standard  
Pubs Discounts  
*WoodPost* Newsletter  
WoodWorks Software



# Design Professional Membership

[www.awc.org/membership](http://www.awc.org/membership)  
[education@awc.org](mailto:education@awc.org)

Fire-Resistant Design for Wood Construction

Professional Directory  
Pubs Discounts  
*IMPACT* Newsletter  
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*Wood Design Focus*  
*Wood Design & Building*



## **Outline: principles of FRR design course**

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

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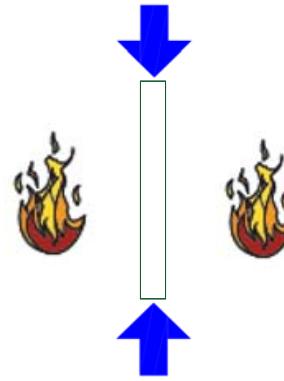
## fire-resistance rating in the code



**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**

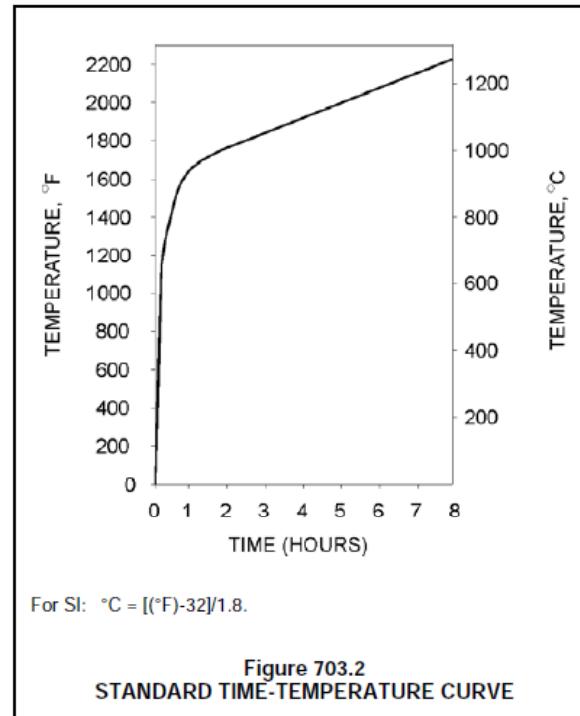


**Structural Performance**

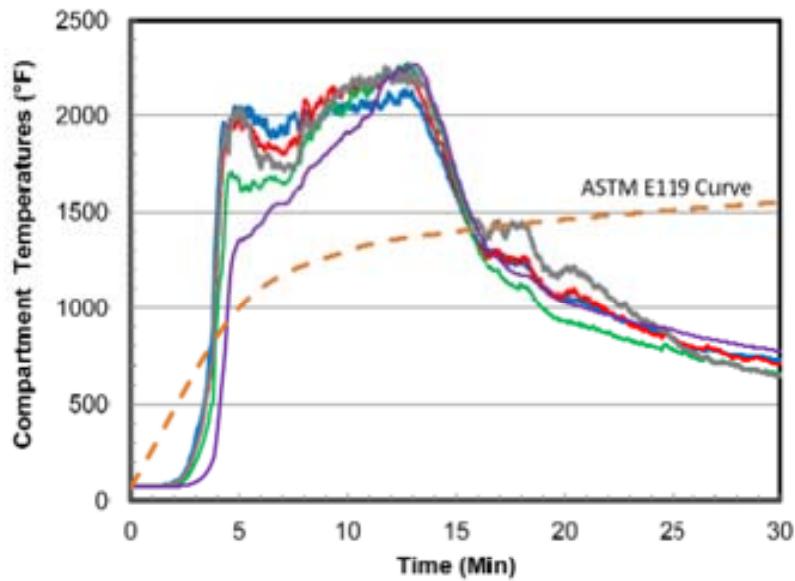
## fire-resistance rating in the code

- **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)

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## "Non-Standard Fire" not in the code



**Compartment Temperature**  
**Typical “non-standard” TT curve**

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## fire-resistance rating in the code



- **E 119 or UL 263 Test considerations:**
  - Material specific criteria: Steel beam, column or component temperature rise within an assembly vs. continued load resistance.
  - % of maximum structural load
  - Is the assembly restrained?
  - Test modifications for connections?
  - Non-symmetrical assembly
  - Structural vs. Barrier, Exterior bearing wall?

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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**



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## CLT Test Report WP-1950



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## 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

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**Design for Code Acceptance**

**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 currently 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. Most model building codes and some model building codes allow wood-frame, wood-sided walls to be tested for exposure to fire from the inside only. Ratings for both interior and exterior fire exposure is only required when exterior walls are 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 Method 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 Underwriters Laboratories (UL) Fire Resistance Division, 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 3 for two-hour rated wall assemblies.

**Conclusions**

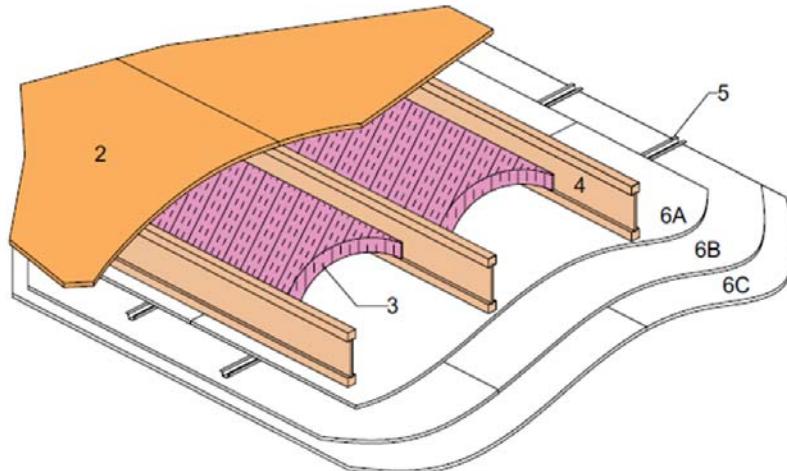
Wood-frame assemblies are used in architectural designs because of their adaptability to style preferences, ease and economics of construction, and energy-saving performance.

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## fire-resistance rating in the code – options:

### WIJ-2.1 Two-Hour Fire-Resistive Ceiling Assembly

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



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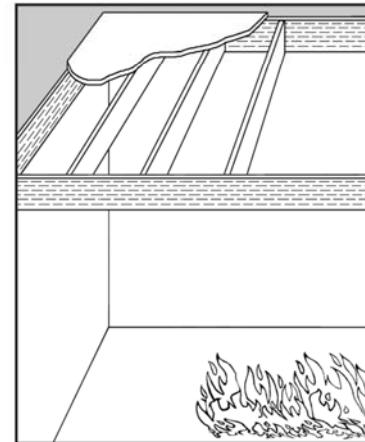
## fire-resistance rating in the code – options:

- 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



### Fire Resistance of Engineered Wood Rim Board Products

Robert H. White



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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(3)—continued  
MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a,b</sup>

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-joint (minimum I-joint depth $9\frac{1}{2}$ " with a minimum flange depth of $1\frac{1}{2}$ " and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of $\frac{1}{4}$ ") @ 24" o.c. Unfaced fiberglass insulation or mineral wool insulation is installed between the I-joints supported on the upper surface of the flange by stay wires spaced 12" o.c.	28-1.1									

13. Double wood floor over wood joists spaced 16" on center. <sup>m,a</sup>	13-1.1	Gypsum plaster over $\frac{1}{8}$ " Type X gypsum lath. Lath initially applied with no less than four $1\frac{1}{8}$ " by No. 13 gage by $\frac{1}{16}$ " head plasterboard blued nails per bearing. Continuous stripping over lath along all joist lines. Stripping consists of 3" wide strips of metal lath attached by $1\frac{1}{2}$ " by No. 11 gage by $\frac{1}{8}$ " head roofing nails spaced 6" on center. Alternate stripping consists of 3" wide 0.049" diameter wire stripping weighing 1 pound per square yard and attached by No. 16 gage by $1\frac{1}{8}$ " by $\frac{1}{16}$ " crown width staples, spaced 4" on center. Where alternate stripping is used, the lath nailing may consist of two nails at each end and one nail at each intermediate bearing. Plaster mixed 1:2 by weight, gypsum-to-sand aggregate.									
	13-1.2	Cement or gypsum plaster on metal lath. Lath fastened with $1\frac{1}{8}$ " by No. 11 gage by $\frac{1}{8}$ " head barbed shank roofing nails spaced 5" on center. Plaster mixed 1:2 for scratch coat and 1:3 for brown coat, by weight, cement to sand aggregate.									

Fire-Resistant Design for Wood Construction

# Calculated fire-resistance rating in the code – CBC 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



**Code Acceptance**

**Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Resistance**

Wood-frame walls and floors offer designers a unique opportunity to provide structures with greater safety and performance. When these assemblies are required by the building codes to achieve a minimum fire resistance rating, a wide range of options for design exists.

**Building Code Requirements**

For both new and existing construction, many building codes require structural elements such as exterior walls and bearing floor and roof assemblies and roofs to achieve a minimum fire resistance rating. Historically, these assemblies have been tested with the UL E119 Standard Test Method for Fire Tests of Building Construction and Materials or UL 281 Standard for Fire Tests of Building Construction and Materials, and assigned an hourly rating based on their measured fire-resistance performance. Many sources are available for obtaining information on the fire resistance of assemblies. In 2013, the International Code Council adopted IBC 722, the American Wood Council's Fire Rated Wood Floor and Wall Assemblies (DC), Gryphon Associates' Fire-Rated Floors, Decking, Gypsum and Underlayment Literature, UL's *Ultimate Fire Rated*, to name a few.

Building codes include both wood assemblies as well as methods for calculating fire resistance, de-

veloped from conducting a series of fire resistance tests. The Component Additive Method (CAM) provides for calculating the fire resistance of light bearing and non-load bearing floor, wall, ceiling and roof assemblies. The minimum fire resistance provisions under Section 22.6 of the International Building Code® (IBC) were developed using CAM.



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# Calculated fire-resistance rating in the code – CBC 722.6:

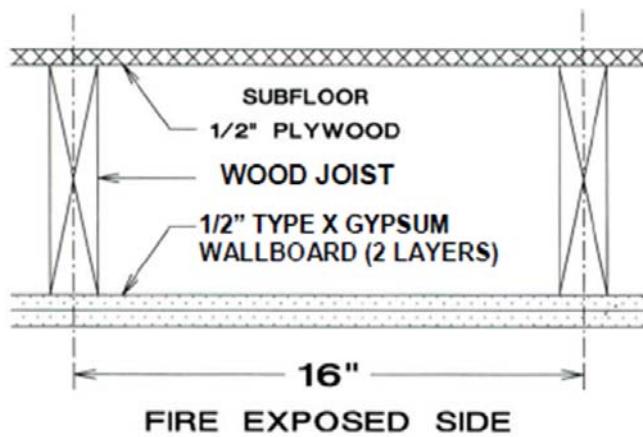
**TABLE 722.6.2(1)**  
**TIME ASSIGNED TO WALLBOARD MEMBRANES<sup>a, b, c, d</sup>**



DESCRIPTION OF FINISH	TIME*(minutes)
3/8-inch wood structural panel bonded with exterior glue	5
15/32-inch wood structural panel bonded with exterior glue	10
19/32-inch wood structural panel bonded with exterior glue	15
3/8-inch gypsum wallboard	10
1/2-inch gypsum wallboard	15
5/8-inch gypsum wallboard	30
1/2-inch Type X gypsum wallboard	25
5/8-inch Type X gypsum wallboard	40
Double 3/8-inch gypsum wallboard	25
1/2-inch + 3/8-inch gypsum wallboard	35
Double 1/2-inch gypsum wallboard	40

Fire-Resistant Design for Wood Construction

## Calculated fire-resistance rating in the code – CBC 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**

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## Calculated fire-resistance rating in the code – CBC 722.6:

TABLE 722.6.2(4)  
FLOORING OR ROOFING OVER WOOD FRAMING<sup>a</sup>



ASSEMBLY	STRUCTURAL MEMBERS	SUBFLOOR OR ROOF DECK	FINISHED FLOORING OR ROOFING
Floor	Wood	$\frac{15}{32}$ -inch wood structural panels or $\frac{11}{16}$ -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 $\frac{3}{8}$ -inch-thick panel-type underlayment Ceramic tile on $1\frac{1}{4}$ -inch mortar bed
Roof	Wood	$\frac{15}{32}$ -inch wood structural panels or $\frac{11}{16}$ -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.

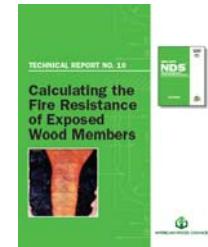
**Similar to  
“Double  
wood floor”  
required by  
footnote m  
in table  
721.1 (3)**

Fire-Resistant Design for Wood Construction

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

### Structural FRR up to *two hours*

- Columns
- Beams
- Tension Members
- ASD only



### Products

- Lumber
- Glulam
- SCL
- Decking
- CLT

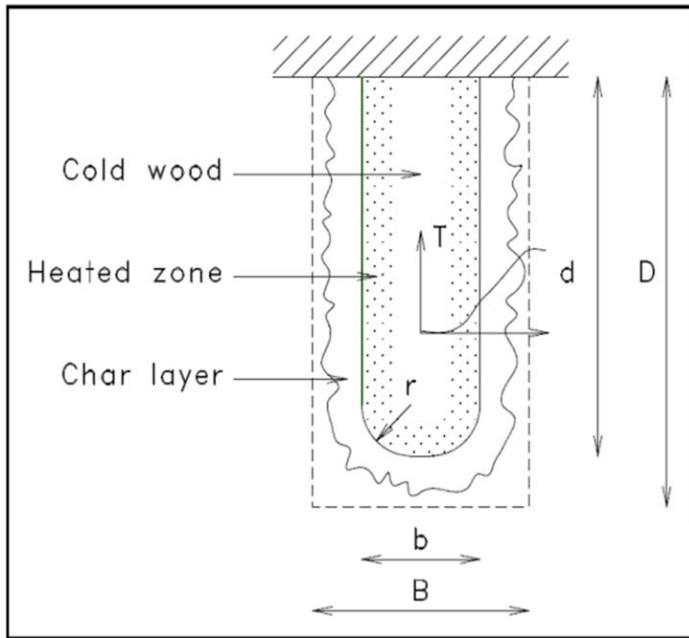


### SECTION 722 CALCULATED FIRE RESISTANCE

**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/AF&PA *National Design Specification for Wood Construction (NDS)*.

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



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

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

Required Fire Endurance (hr.)	Effective Char Rate, $\beta_{eff}$ (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



Fire-Resistant Design for Wood Construction

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

**Table 16.2.2 Adjustment Factors for Fire Design<sup>1</sup>**

			ASD					
			Design Stress to Member Strength Factor	Size Factor <sup>2</sup>	Volume Factor <sup>2</sup>	Flat Use Factor <sup>2</sup>	Beam Stability Factor <sup>3</sup>	Column Stability Factor <sup>3</sup>
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.

## 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.

## Special Provisions NDS 16.2.4

### Glued-laminated Timber Tension Lam Provisions – unbalanced

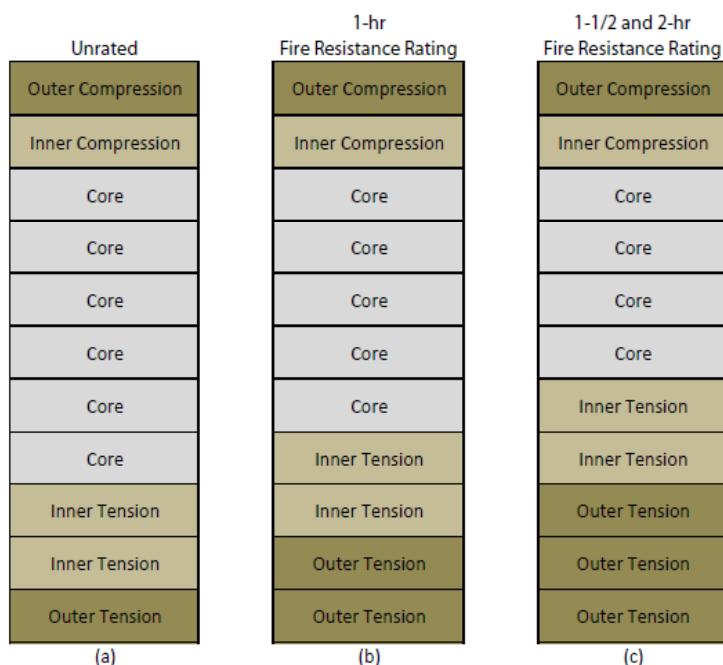
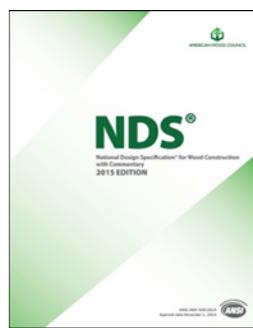
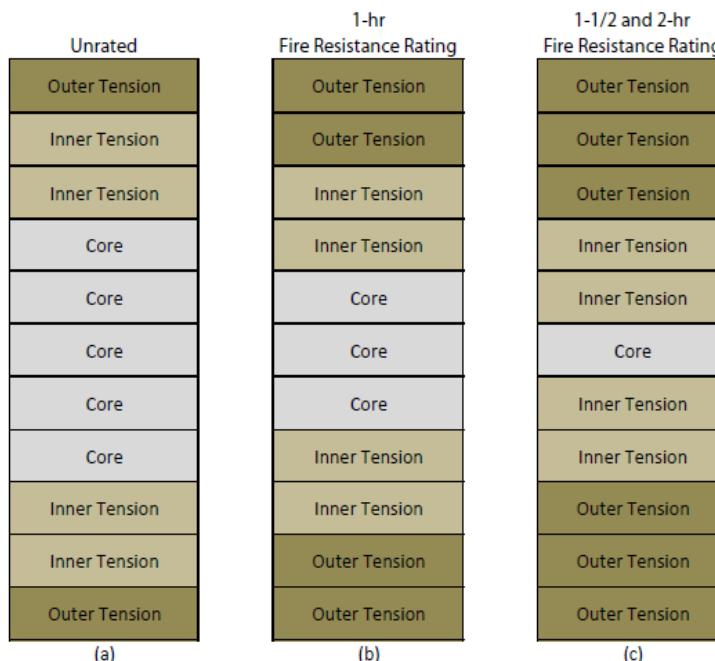
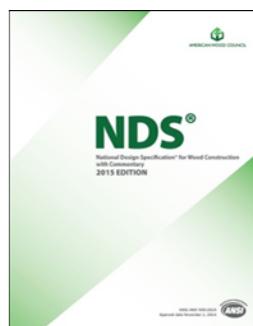


Figure 3-1 Typical glulam unbalanced beam layups

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## **Special Provisions NDS 16.2.4**

# **Glued-laminated Timber Tension Lam Provisions – balanced**



**Figure 3-2** Typical glulam balanced beam layups

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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  $\beta_n=1.5\text{in./hr.}$ )**

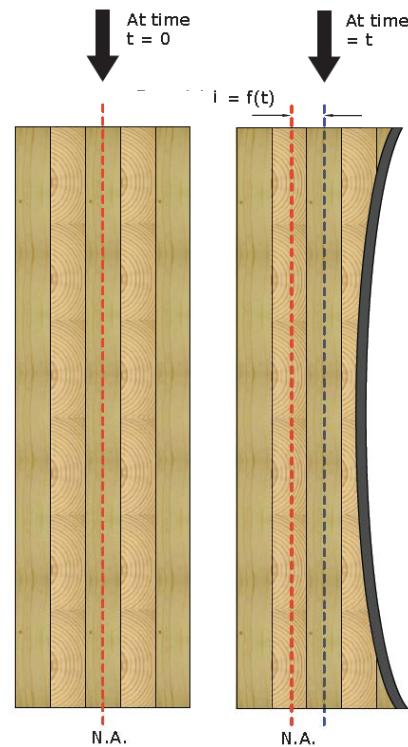
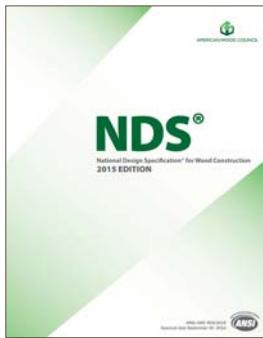
Required Fire Endurance (hr.)	Effective Char Depths, $a_{\text{char}}$ (in.)								
	lamination thicknesses, $h_{\text{lam}}$ (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6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



Fire-Resistant Design for Wood Construction

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

- Chapter 16 NDS
  - Charring Rate and Char Depth
  - Modified char depth model
  - Step-wise approach

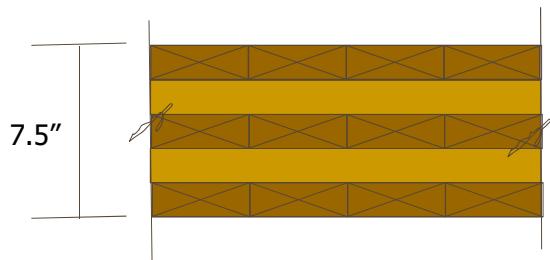
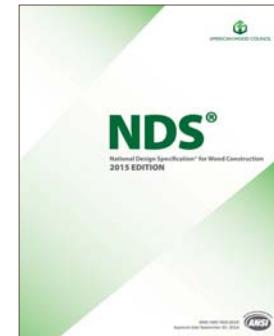


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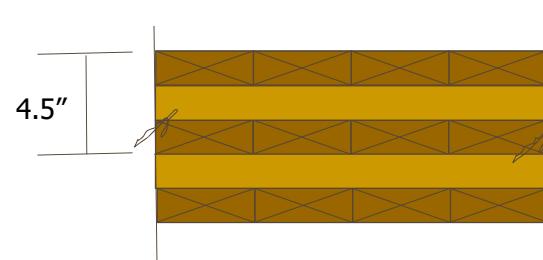
## Example CLT Floor Calculation: NDS Chapter 16

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



Typical one foot section



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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

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

### Technical Report No. 10 (TR10)

- contains background and examples for the method

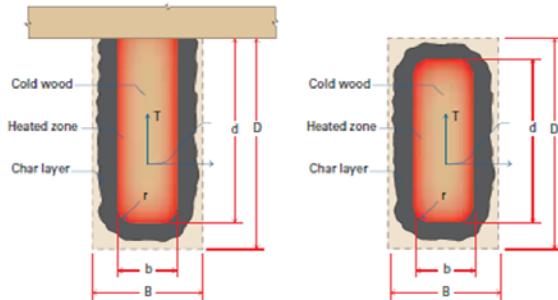
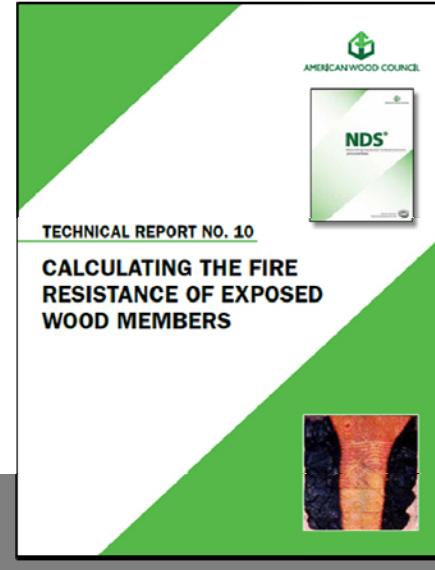


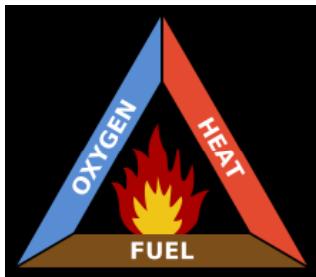
Figure 1-1 Reduction in member breadth and depth over time,  $t$



Fire-Resistant Design for Wood Construction

## Behavior of Fire and Materials

- Fire needs three things:
  - Heat
  - Oxygen
  - Fuel



Source: AWC Staff

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## Behavior of Fire and Materials

- Phases of Fire
  - Ignition
  - Growth
  - Fully Developed
  - Decay



Source: AWC Staff



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## Behavior of Fire and Materials

- Primary Materials
  - Reinforced Concrete / Masonry
  - Steel
  - Wood



Photo Courtesy of CREE

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## Behavior of Fire and Materials

### August 2014 *Structure Magazine*

<http://www.structuremag.org/wp-content/uploads/2014/07/C-StrucForensics-Marxhausen-Aug141.pdf>

Reprinted with permission, STRUCTURE magazine, August 2014.



Figure 1. View showing the widespread damage that occurred through this suburban neighborhood following the Waldo Canyon fire.



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## 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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## Behavior of Fire and Materials

- **Desirable Fire Characteristics?**
  - Dimensionally stable at high temperatures
  - Little or no loss of strength/stiffness with high temperatures
  - Does not burn and contribute to the fire
  - Can be easily repaired after fire exposure
- **What additional construction features can address these?**

Fire-Resistant Design for Wood Construction

## 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!

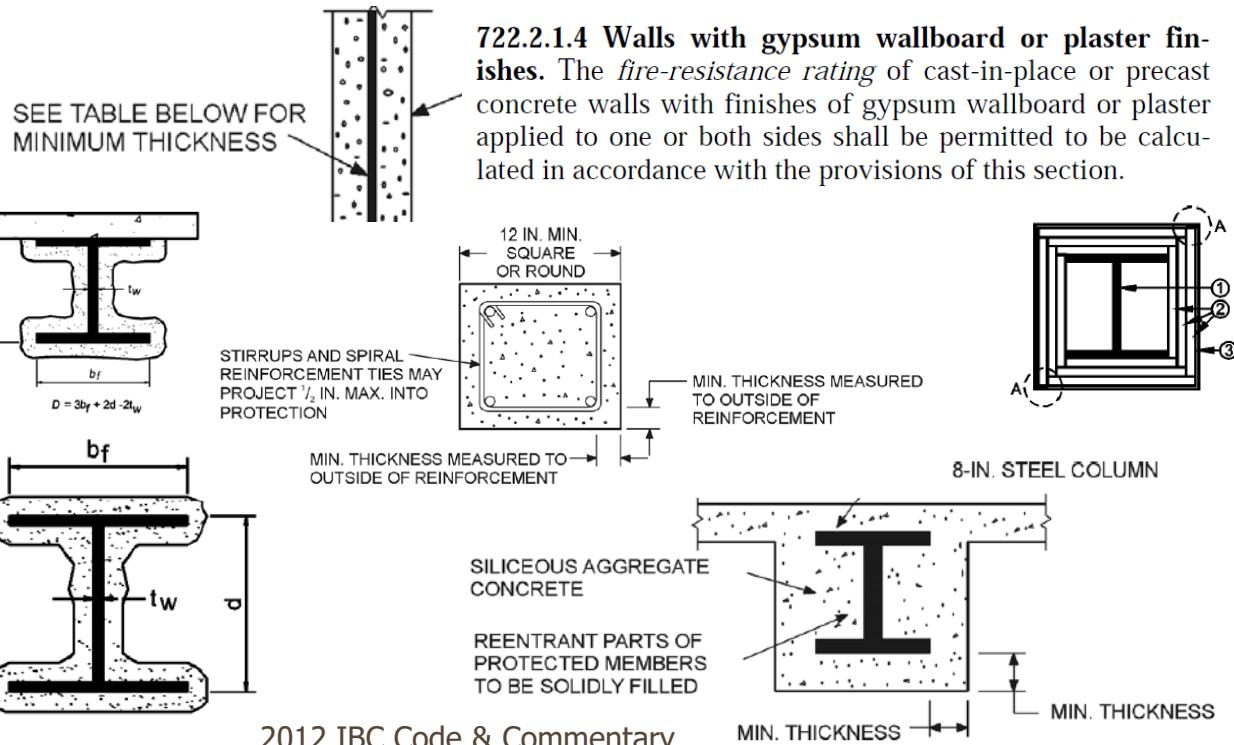
	NFPA 13	NFPA 13R	NFPA 13D
Extent of protection	Equip throughout (Section 903.3.1.1)	Occupied spaces (Section 903.3.1.2)	Occupied spaces (Section 903.3.1.3)
Scope	All occupancies	Low-rise residential	One- and two-family dwellings
Sprinkler design	Density/area concept	4-head design	2-head design
Sprinklers	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

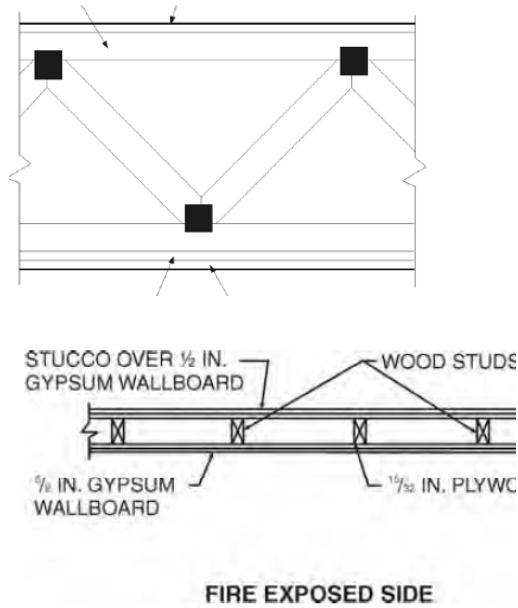
## Behavior of Fire and Materials

### Protection of type I construction:



## Behavior of Fire and Materials

### Protection of light frame construction.



For SI: 1 inch = 25.4 mm.

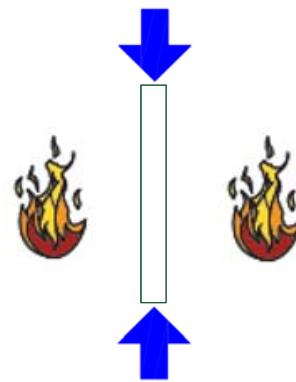
Figure 722.6  
EXAMPLE—WOOD STUD WALL WITH W/

2-HOUR AND STC 50 TO 54 PER GA FILE NO. WP 3910

2-HOUR STAGGERED STUD PARTITION

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 <sup>d</sup>	B
Primary structural frame <sup>f</sup> (see Section 202)	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls									
Exterior <sup>e,f</sup>	3	2	1	0	2	2	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions									
Exterior	See Table 602								
Nonbearing walls and partitions									
Interior <sup>d</sup>	0	0	0	0	0	0	See Section 602.4.6	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)	1 <sup>b</sup> / <sub>2</sub>	1 <sup>b,c</sup>	1 <sup>b,c</sup>	0 <sup>e</sup>	1 <sup>b,c</sup>	0	HT	1 <sup>b,c</sup>	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.**

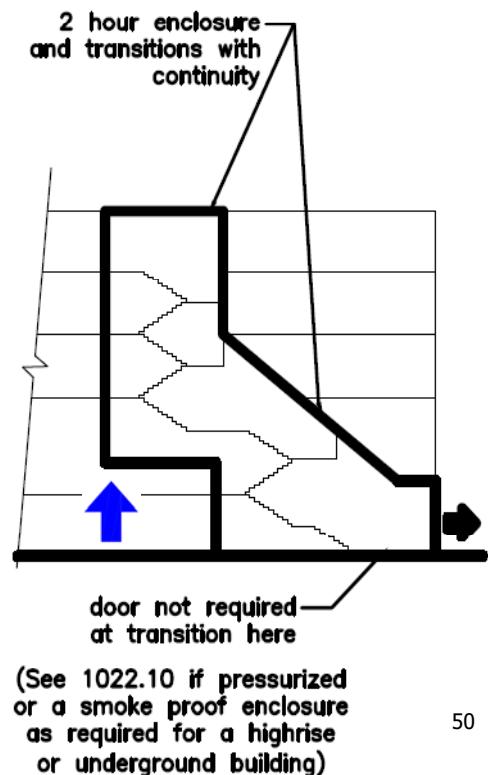
## Review of code... Know the reason for FRR:



- **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

## Example: of reason for 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)

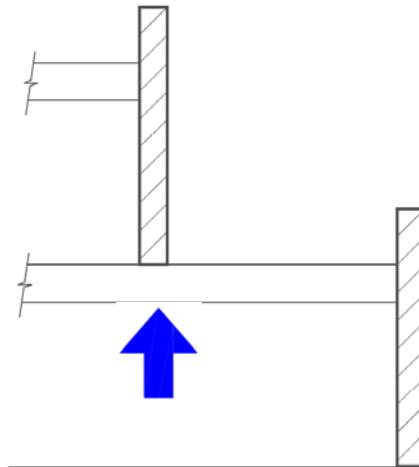


50

## Example: of reason for FRR:



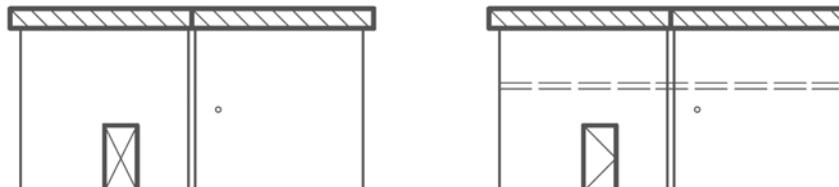
- Two-hour exterior wall is supported by a beam and column system:
- The supporting members of the two-hour exterior wall (that are not part of the enclosure) must have a two-hour structural fire resistance rating (CBC 704.1)



51

## Example: of reason for FRR:

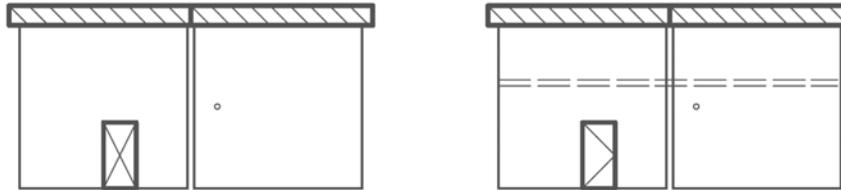
- Existing: Three hour bearing wall in Type IA building with unprotected joints, doors and penetrations.
- Through remodel wall is now part of a 1 hour exit passageway.



**Now what is the required protection of joints, doors and penetrations?**

52

## Example: of reason for FRR:



## Now what is the required protection of joints, doors and penetrations?

**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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## **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**

54

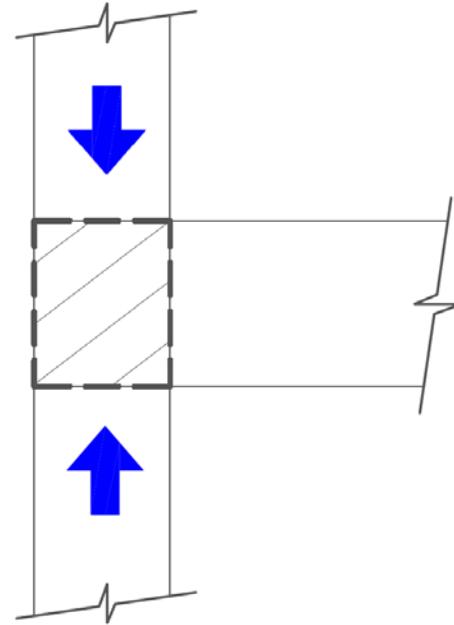
## **Platform floor construction and structural FRR variables:**

- **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

55

## Platform floor construction and structural FRR variables:

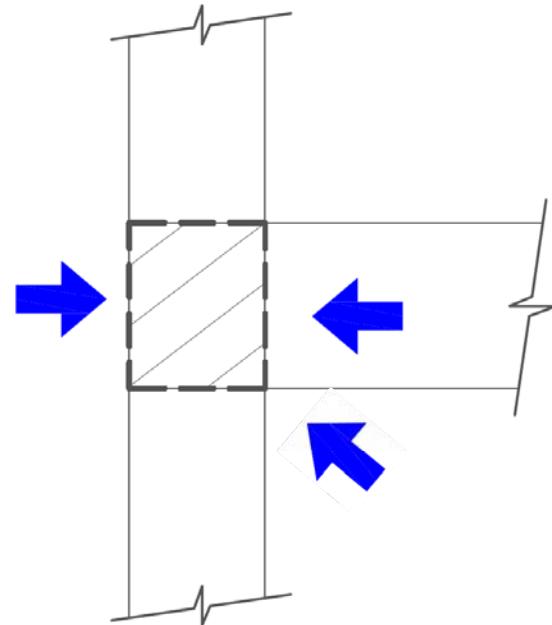
- **Typically questions occur at the intersection between walls and floor assemblies... “in the plane of the wall”**



56

## Platform floor construction and structural FRR variables:

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



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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

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## Platform floor construction and FRR requirements: IBC 202



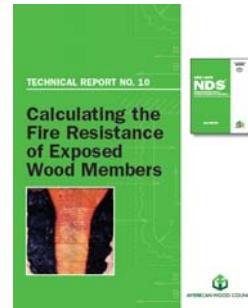
59

## Ch 7: Fire, Smoke Protect Features

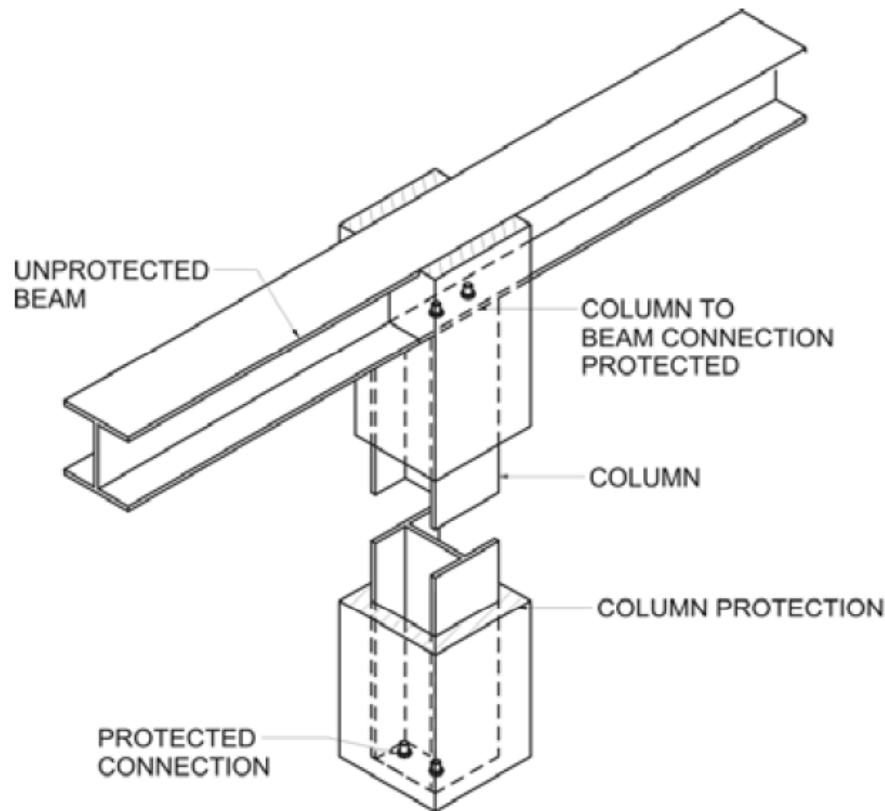


**704.2 Column protection.** Where columns are required to have protection to achieve a fire-resistance rating, the entire column shall be provided individual encasement protection by protecting it on all sides for the full column height, including connections to other structural members, with materials 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.

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.**

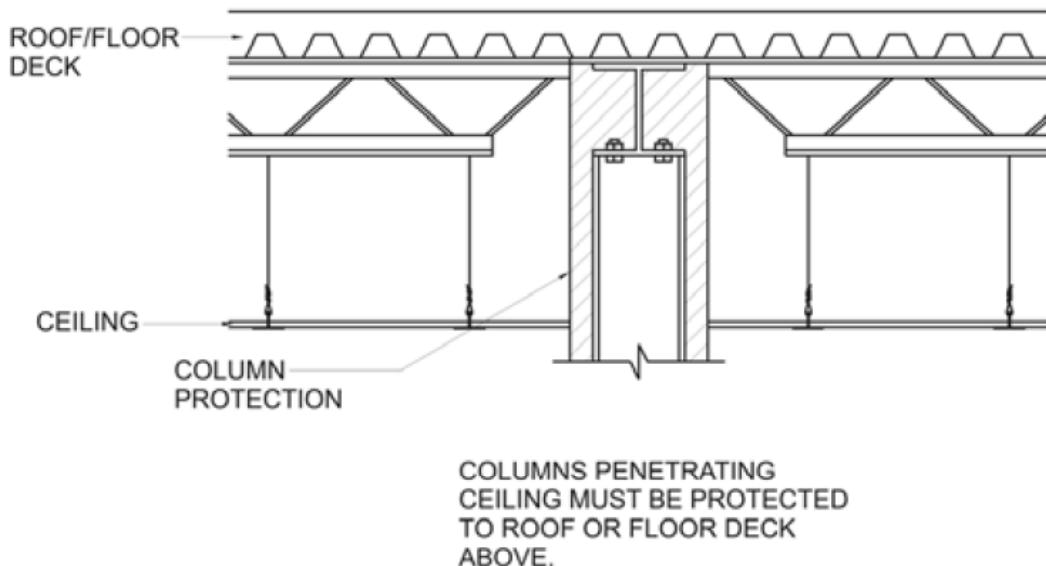


## Ch 7: Fire, Smoke Protect Features



2012 IBC Code & Commentary

## Ch 7: Fire, Smoke Protect Features



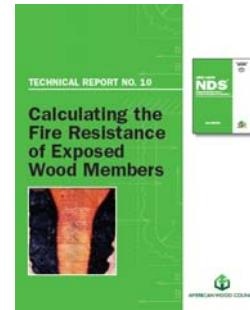
2012 IBC Code & Commentary

## 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



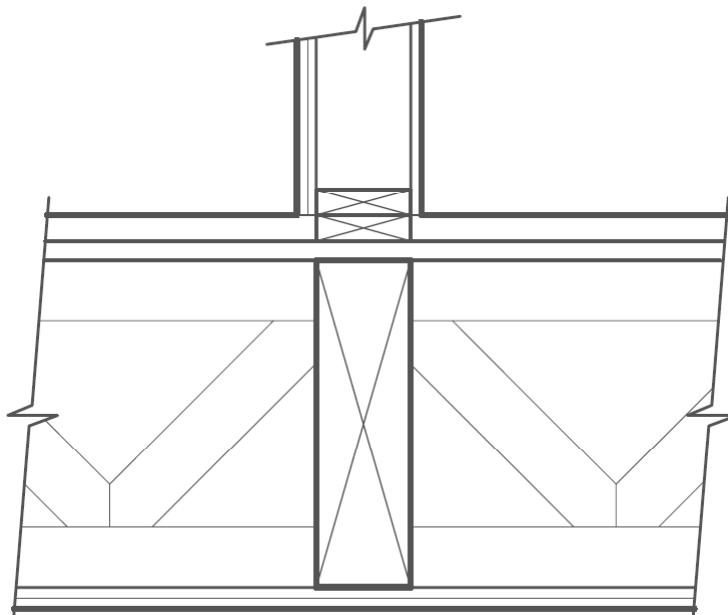
## Platform floor construction and FRR requirements: IBC 202



**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.

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



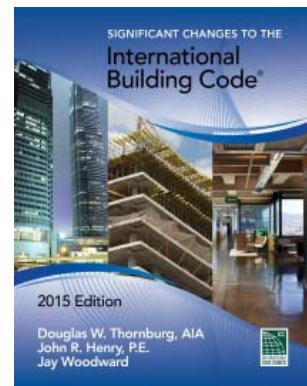
65

## 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.

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.

Old  
language



## 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.

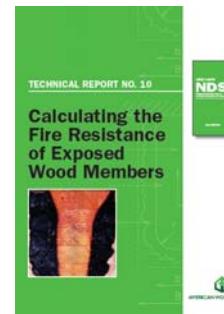
Note: The word “king” from king studs was also removed from the 2012 IBC language now in 704.4.1, also see 2018 IBC change:

## Structural FRR of secondary wood beam in floor assembly

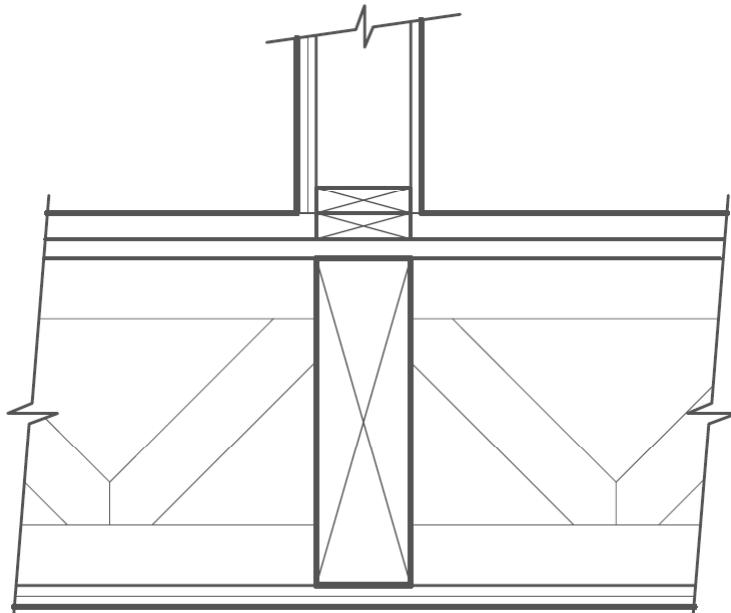
What about a glued-laminated or SCL beam within an I joist assembly protected with two layers of 5/8" type X gyp board?

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?

21. Wood joists, wood I-joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" wood structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with 8d nails. The wood structural panel thickness shall not be less than nominal 1/2" nor less than required by Chapter 23.	21-1.1	Base layer 5/8" Type X gypsum wallboard applied at right angles to joist or truss 24" o.c. with 1 1/4" Type S or Type W drywall screws 24" o.c. Face layer 5/8" Type X gypsum wallboard or veneer base applied at right angles to joist or truss through base layer with 1 1/8" Type S or Type W drywall screws 12" o.c. at joints and intermediate joist or truss. Face layer Type G drywall screws placed 2" back on either side of face layer end joints, 12" o.c.	—	—	—	Varies	—	—	—	—	1 1/4
---	--------	---	---	---	---	--------	---	---	---	---	-------



## 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**

## 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"



1. 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.
2. The fire endurance of a construction does not decrease with the addition of further layers.
3. 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.
4. 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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## 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 easement 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.

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AM-  
OGCV

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

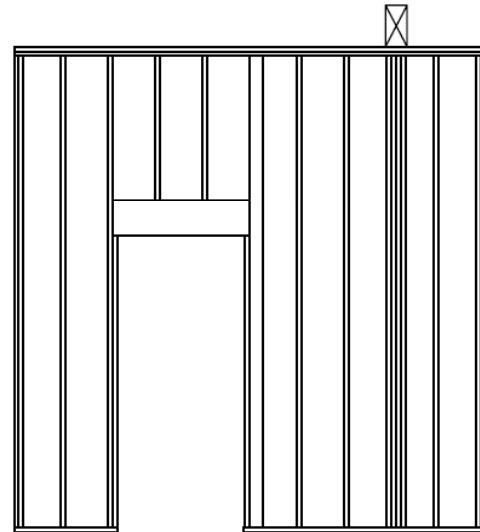
- New language in 2018 IBC:

**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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## 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)



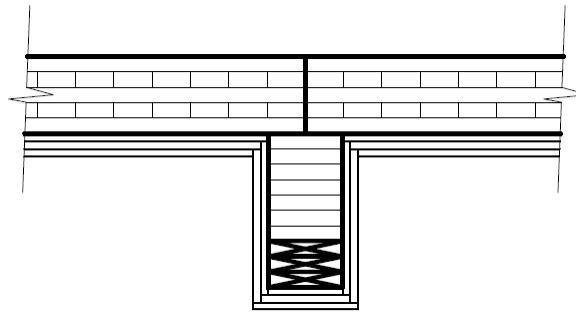
## 2-hour Exposed Glulam Beam/Column



Photos Courtesy of Arup

76

## 2021 Draft IBC Mass Timber CAM

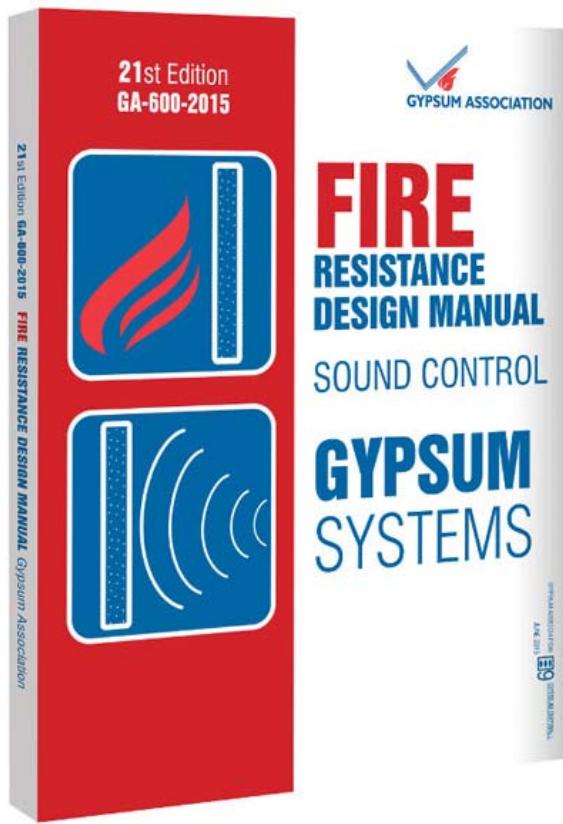


- Proposed CAM method in the 2021 IBC
- FRR of Element = FRR of Wood + FRR of Added Gypsum

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## Fire Resistance Design Manual

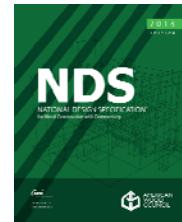
- 21<sup>st</sup> Edition (2015)
- See Page 17 for Protection of Wood Column and Beam CAM (very, very conservative but useful)
- Allowed under Section 703.3, items 1 and 3



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# 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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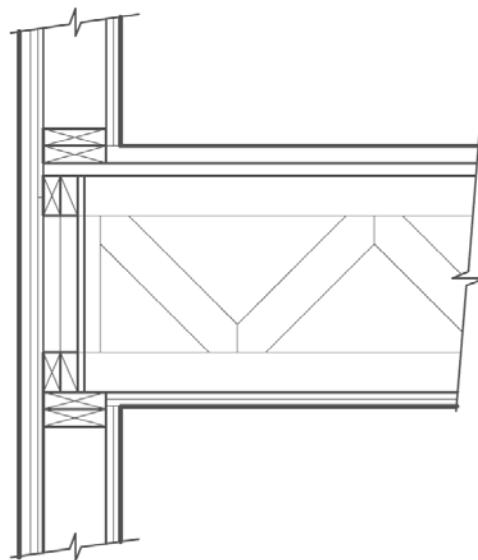
## **Platform floor construction and structural FRR variables:**

- **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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## Platform floor construction and structural FRR variables:

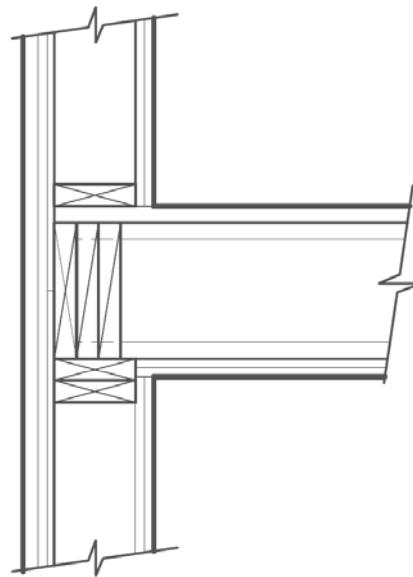
- **Open web truss construction:**



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## Platform floor construction and structural FRR variables:

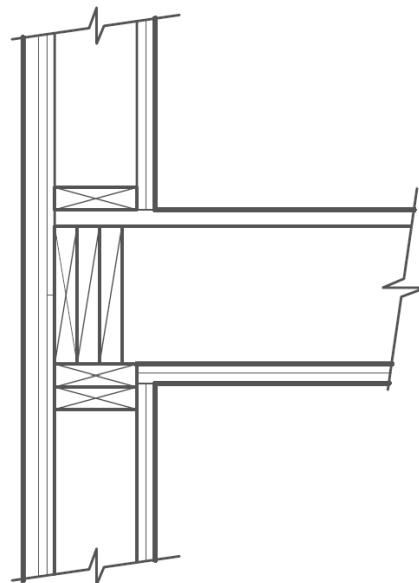
- **Engineered I joist construction:**



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## Platform floor construction and structural FRR variables:

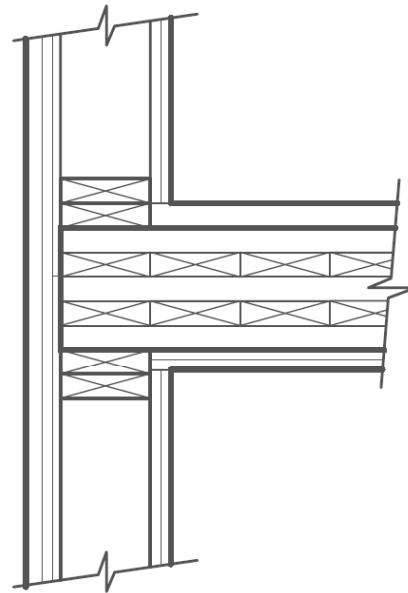
- **Solid wood joist construction:**



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## Platform floor construction and structural FRR variables:

- **Solid panel construction:**



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## 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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## FRR wall types and floor intersections: 708 Fire Partition



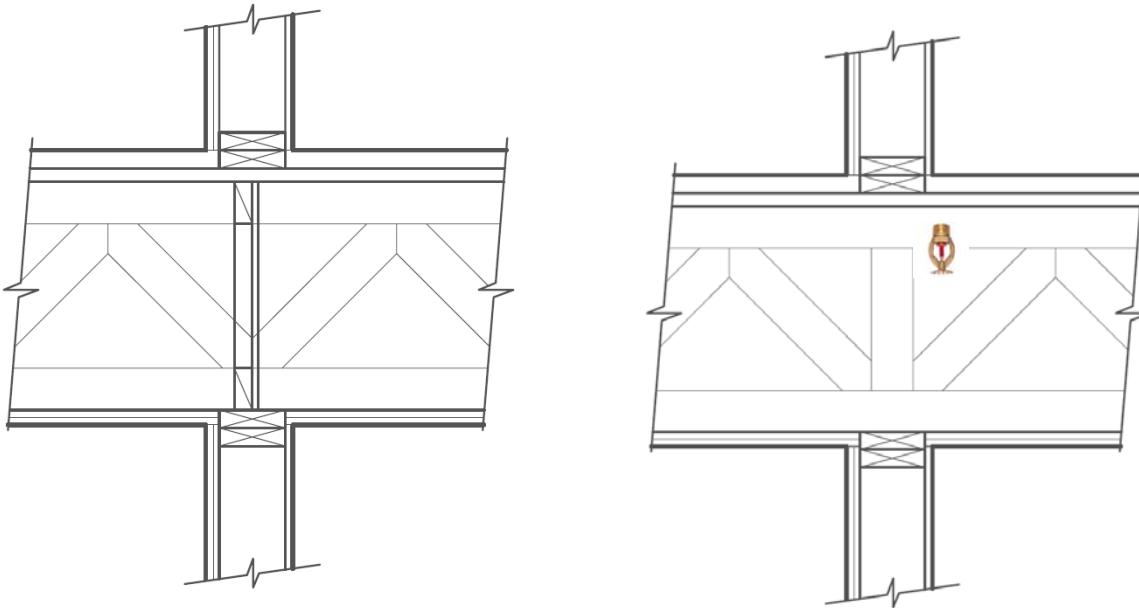
- **Fire Partitions separate:**
  1. Tenants in malls
  2. Dwelling unit and sleeping units from each other and other uses
  3. Corridor walls
  4. Elevator lobbies
  5. Egress balconies
- **May stop if securely attached to bottom of rated horiz. assembly**
- **Exceptions for support in IIB, IIIB and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

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## FRR wall types and floor intersections: 708 Fire Partition



- **Fire Partition construction:**



## Fire Partitions – IBC 708



**CONTINUITY OF FIRE PARTITIONS**

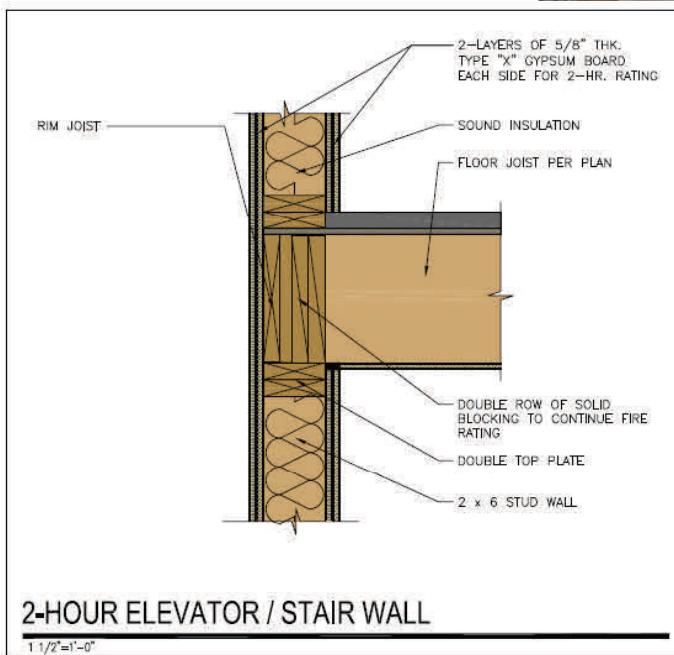
## FRR wall types and floor intersections: 707 Fire Barrier



- **Fire Barriers separate:**
  1. Shafts
  2. Exit enclosures
  3. Exit passageways
  4. Horizontal exits
  5. Incidental uses
  6. Atriums
  7. Fire areas
- **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

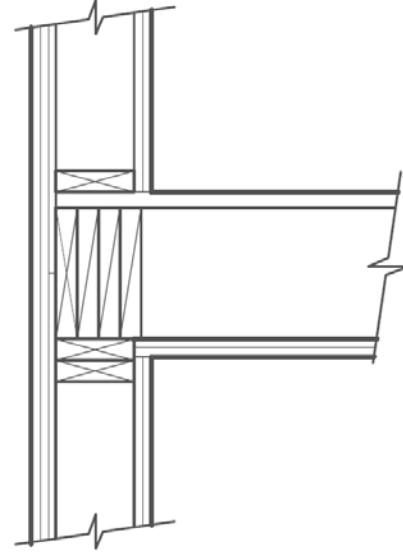
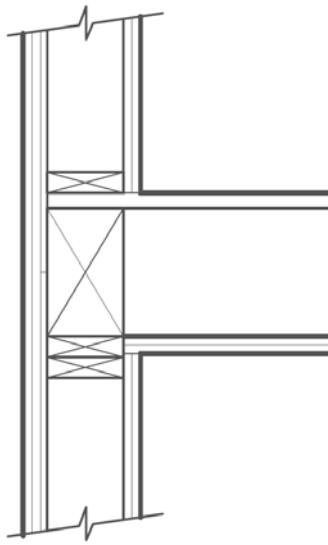


Slide courtesy of Wood Works

## FRR wall types and floor intersections: 707 Fire Barrier



- **Fire Barrier construction:**

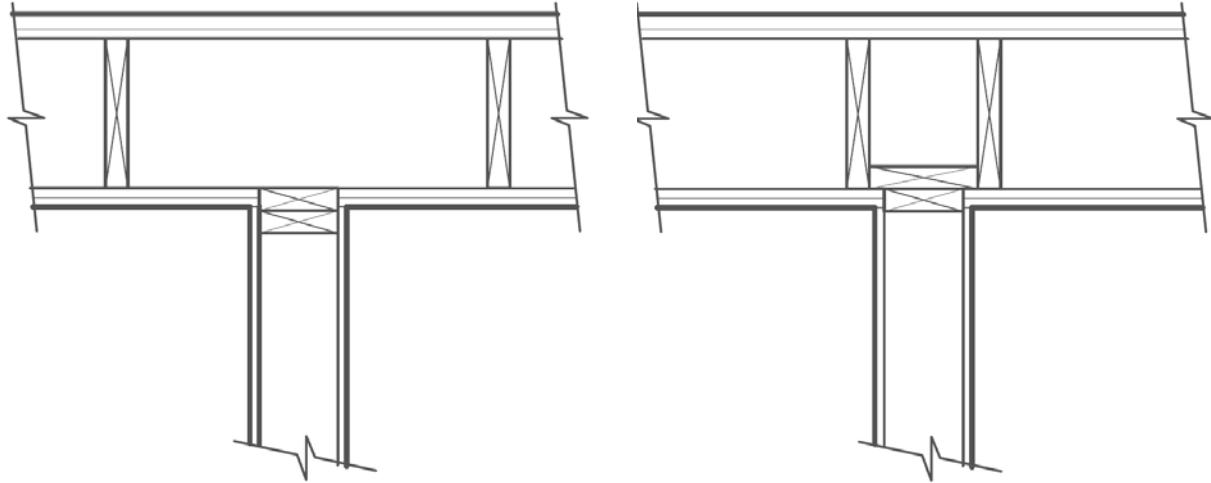


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## FRR wall types and floor intersections: 707 Fire Barrier



- **CBC 714.4.2 Exception 7**

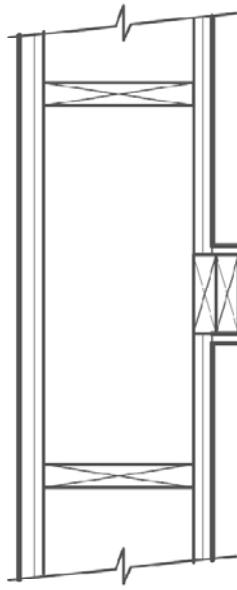


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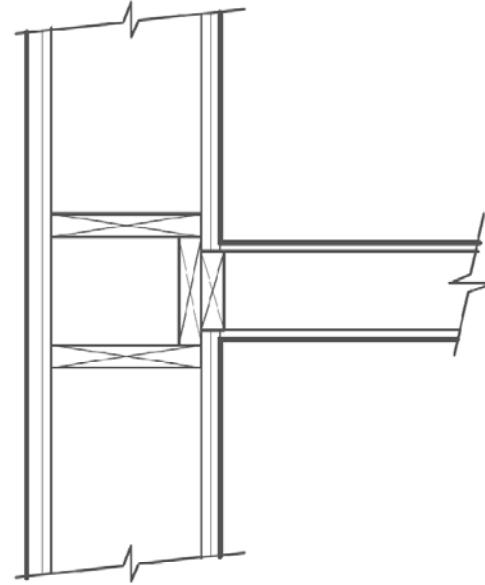
## FRR wall types and floor intersections: 707 Fire Barrier



- **CBC 714.4.2 Exception 7**



**Rotated**



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## FRR wall types and floor intersections: 706 Fire Wall



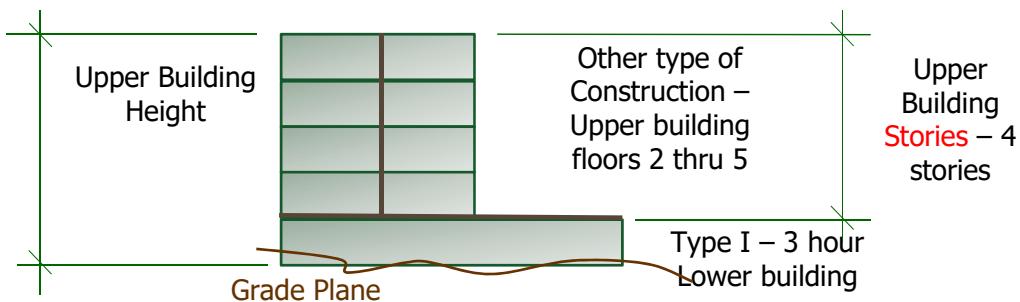
- **Fire Walls divide a building into separate buildings by providing complete separation:**
  1. Continuous with no horizontal offsets from foundation to roof. Allowed to stop at horizontal 3 hour Type IA podium (IBC 510.2). Parapet required with some exceptions at roof.
  2. Continuous horizontally 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**

95

## Fire wall in a podium: 510.2



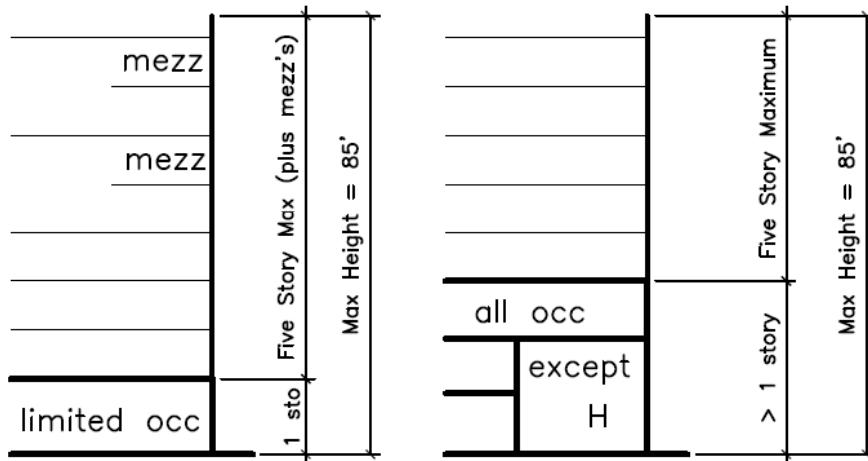
- Building Height – in feet
  - Upper building height (feet) is measured from grade plane
- Building Height – stories
  - Upper building height (stories) – measured from top of lower building
- **Fire Walls not required to extend beyond 3 hour separation.**



## 510.2, R2: Over 3 Hr FRR Podium



G133-12; G134-12; 2015 IBC



R2 occ – type IIIA or IV-HT (story increase NFPA 13 spr)  
over type I podium – IBC 510.2



2012 IBC

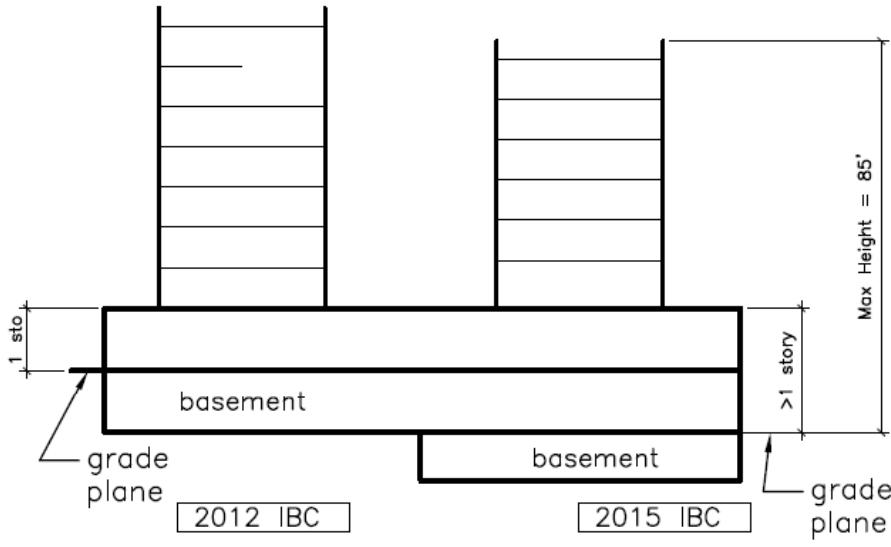
2015 IBC



## 510.9 Mult Bldgs Over 3 Hr Podium



IBC 510.9 Multiple Buildings



## 705.6 – FS22- public comment



### Old language

**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.



### New 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.



## CBC 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 <sup>a</sup>
F-1, H-3 <sup>b</sup> , H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
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.

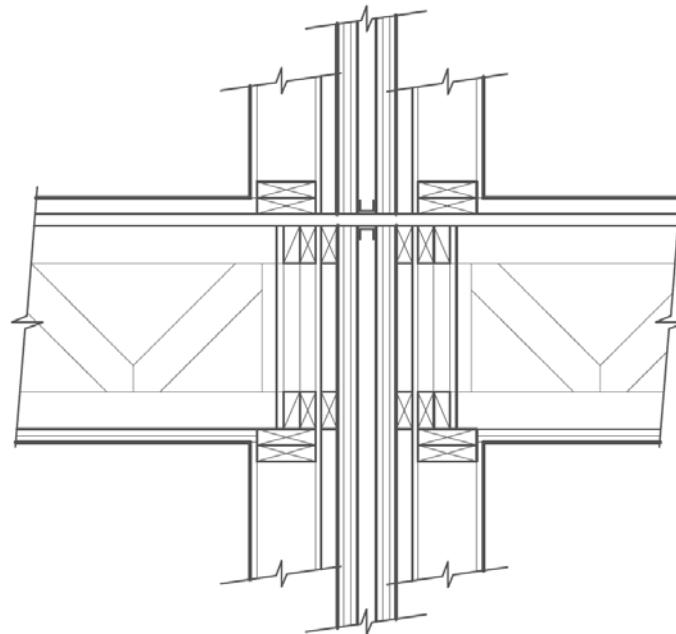
**IBC 706.3 –** Fire walls shall be of any approved non-combustible materials.

**Exception:** Buildings of Type V construction

## FRR wall types and floor intersections: 706 Fire Wall



- **Fire Wall Type III**



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# Fire Walls - 706



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

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**DATE:** March 21, 2008

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

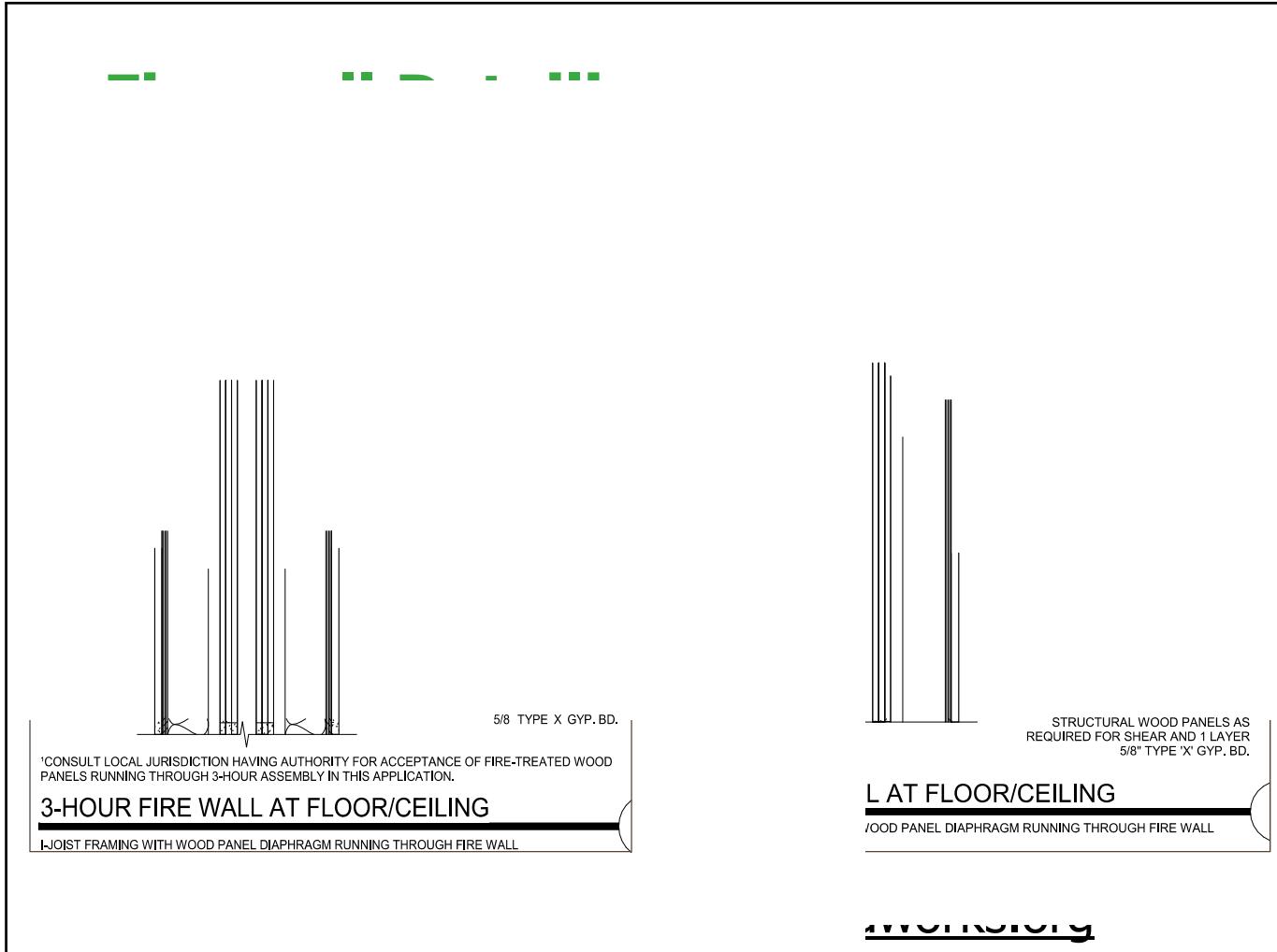
**Opinion:** The continuity of plywood diaphragm sheathing should be maintained across the air gap commonly encountered in double stud Firewalls of 2 or 3 hour construction. The intent is to ensure that structural continuity is not significantly reduced in the roof and floor diaphragms.

---

**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



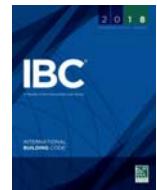
## **Sheathing for Type III Fire Walls?**

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



## 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.

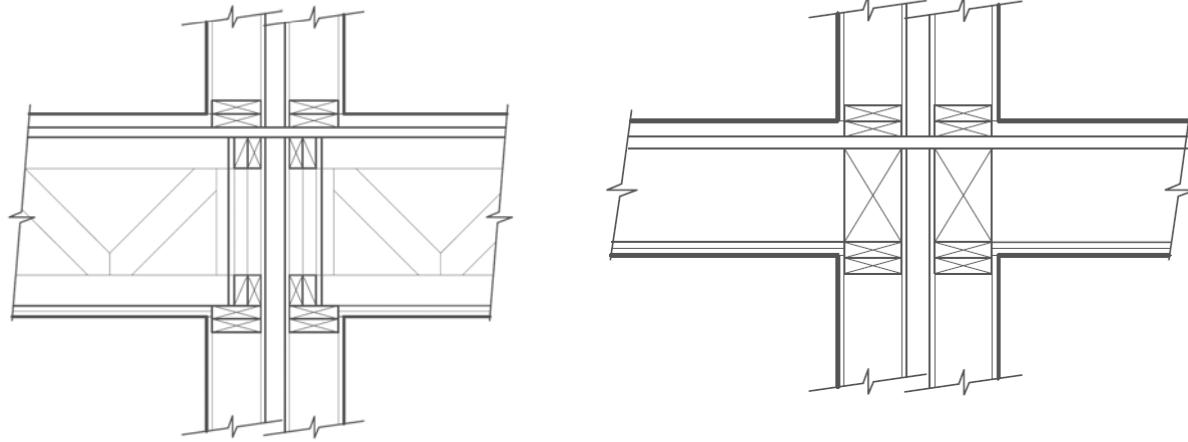
**Commenter's Reason:** There is widely accepted interpretation by many building departments and structural engineers that the roof and floor diaphragms must be continuous to properly perform its function. The sheathing which comprises these diaphragms in light frame construction is generally wood structural 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](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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## 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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## Type III A – R1/R2

### Structural Load Bearing

Table 601: Struct  
FRR = 2 Hr

705.5 FRR from outside = 0 if FSD > 10' (except for CA SFM regulated occupancy groups)

### Separation ➡

703.2.5 FRR = 1 hour maximum for separation (based on temp rise and ignition of cotton in E119 test) as required for non bearing wall in Table 602

2304.3.3 Shrinkage



705.6 Structural Stability

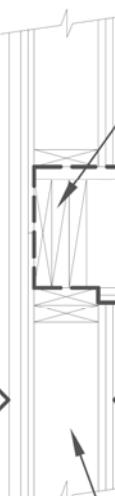
FRR = 601 & 602 within plane of wall

FRR = 601 not within plane of wall

704.1 FRR same as for supported assy for elements providing vertical structural support (See 703.3, item #1 and FPL report)

602.3 interior building element (any material allowed by code)

602.3 exterior wall NC –or– FRTW within the Assembly of the wall (and sheathing per clarification in 2018 IBC)



## 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 <sup>f</sup> (see Section 202)	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls Exterior <sup>e,f</sup> Interior	3 3 <sup>a</sup>	2 2 <sup>a</sup>	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 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<sup>a, d, g</sup>

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H <sup>e</sup>	OCCUPANCY GROUP F-1, M, S-1 <sup>f</sup>	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U
X < 5 <sup>b</sup>	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 <sup>c</sup> 0 1 <sup>c</sup>
X ≥ 30	All	0	0	0

## Exterior Walls (IBC 705)



**705.11 Parapets.** Parapets shall be provided on *exterior walls* of buildings.

Parapets are required on exterior walls with six exceptions.

**705.11.1 Parapet construction.** Parapets shall have the same *fire-resistance rating* as that required for the supporting wall, and on any side adjacent to a roof surface, shall have non-combustible faces for the uppermost 18 inches (457 mm), including counterflashing and coping materials. The height of the parapet shall not be less than 30 inches (762 mm) above the point where the roof surface and the wall intersect. Where the roof slopes toward a parapet at a slope greater than two units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a *fire separation distance* where protection of wall openings is required, but in no case shall the height be less than 30 inches (762 mm).

## Wall Projections (Table 705.2)



**705.2 Projections.** Cornices, eave overhangs, exterior balconies and similar projections extending beyond the exterior wall shall conform to the requirements of this section and Section 1406. Exterior egress balconies and exterior exit stairways and ramps shall comply with Sections 1021 and 1027, respectively. Projections shall not extend any closer to the line used to determine the fire separation distance than shown in Table 705.2.

**TABLE 705.2  
MINIMUM DISTANCE OF PROJECTION**

FIRE SEPARATION DISTANCE (FSD)	MINIMUM DISTANCE FROM LINE USED TO DETERMINE FSD
0 feet to 2 feet	Projections not permitted
Greater than 2 feet to 3 feet	24 inches
Greater than 3 feet to less than 30 feet	24 inches plus 8 inches for every foot of FSD beyond 3 feet or fraction thereof

## Wall Projections FS13-15 AS (2018 IBC)



**TABLE 705.2  
MINIMUM DISTANCE OF PROJECTION**

FIRE SEPARATION DISTANCE - FSD (FSD feet)	MINIMUM DISTANCE FROM LINE USED TO DETERMINE FSD
0 feet to less than 2 feet	Projections not permitted
Greater than 2 feet to less than 3 feet	24 inches
Greater than 3 feet to less than 30 5 feet	24 inches plus 8 inches for every foot of FSD beyond 3 feet or fraction thereof
30 feet 5 or greater	20 feet 40 inches

## Exterior Walls (IBC 705.2.3)



**705.2.3 Combustible projections.** Combustible projections extending to within 5 feet (1524 mm) of the line used to determine the fire separation distance shall be of not less than 1-hour fire-resistance-rated construction, Type IV construction, fire-retardant-treated wood or as required by Section 1406.3.

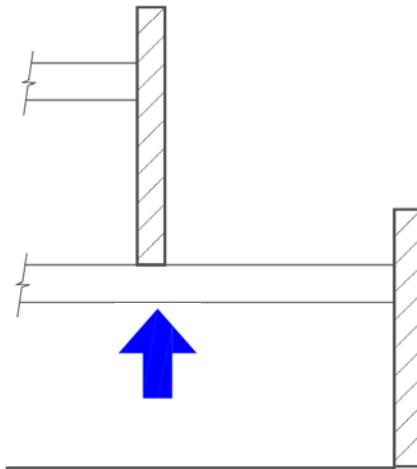
**Exception:** Type VB construction shall be allowed for combustible projections in Group R-3 and U occupancies with a fire separation distance greater than or equal to 5 feet (1524 mm).

This section has been simplified with only one threshold based on distance from line used determine FSD instead of prior criteria based on opening protection and location:

## 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.

## Exterior Walls (CBC 705)



**705.5 Fire-resistance ratings.** *For other than Group A, E, H, I, L and R occupancies, high-rise buildings, and other applications listed in Section 1.11 regulated by the Office of the State Fire Marshal, 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.*

*For Group A, E, H, I, L and R occupancies, high-rise buildings, and other applications listed in Section 1.11 regulated by the Office of the State Fire Marshal, 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 shall be rated for exposure to fire from both sides.*

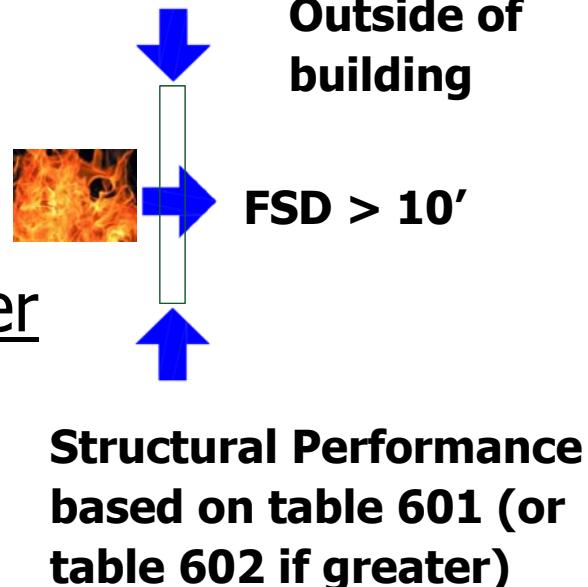
## CA ext wall fire performance and FSD



### 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**

- This slide for other than SFM regulated occupancy



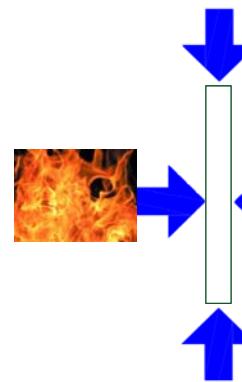
## CA ext wall fire performance and FSD



### 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**

- This slide < 10' or any SFM regulated occupancy

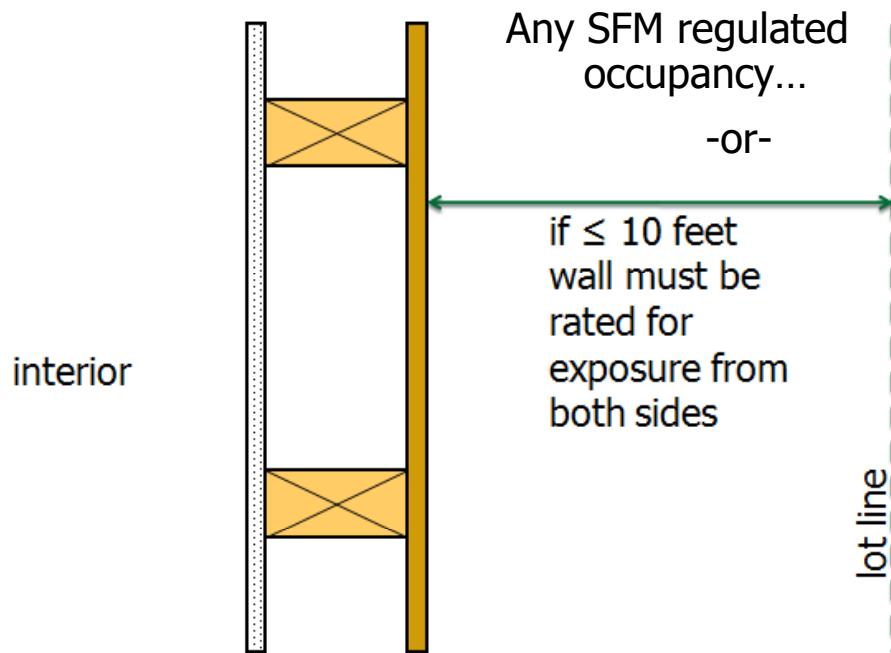


**Structural Performance based on table 601 (or table 602 if greater)**

SFM regulated occupancy, **or:**

**FSD < or = 10'**  
Non-SFM regulated occ

## CA ext wall fire performance and FSD



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## 705.6 – FS22- public comment



**705.6 Structural stability.** The wall shall extend to the height required by Section 705.11 and shall have sufficient structural stability such that it will remain in place for the duration of time indicated by the required *fire-resistance rating*. Where exterior walls have a minimum *fire separation distance* of not less than 30 feet (9144 mm), interior structural elements which brace the exterior wall but which are not located within the plane of the exterior wall shall have the minimum *fire-resistance rating* required in Table 601 for that structural element. Structural elements which brace the exterior wall but are located outside of the exterior wall or within the plane of the exterior wall shall have the minimum *fire-resistance rating* required in Tables 601 and 602 for the exterior wall.

### Old language



**705.6 Structural stability.** *Exterior walls* shall extend to the height required by Section 705.11. Interior structural elements that brace the exterior wall but that are not located within the plane of the exterior wall shall have the minimum *fire-resistance rating* required in Table 601 for that structural element. Structural elements that brace the exterior wall but are located outside of the exterior wall or within the plane of the exterior wall shall have the minimum *fire-resistance rating* required in Tables 601 and 602 for the exterior wall.

### New language



## 705.6 – 2012 code / commentary

ers (Section 707.5.1), fire partitions (Section 708.4), smoke barriers (Section 709.4) and horizontal assemblies (Section 711.4). This section on structural integrity for exterior walls does not require that the wall remains in place when the structure collapses. That language is only used for fire wall structural integrity.

The ability of the exterior wall to remain in place for the required duration of time will require that the supporting elements also be fire-resistance rated for the same duration of time as the wall. In light-frame plat-



this section does not require that the entire floor system be of fire-resistance-rated construction. To state otherwise would prohibit Type IIB and VB buildings with an FSD of less than 10 feet (3048 mm). Only the structural element within the floor system that supports the vertical load of the wall must be of fire-resistance-rated construction.

For exterior walls, this section requires the required fire-resistance-rated construction to extend to the roof construction or to the top of the parapet if a parapet is required (see Section 705.11). This begs the ques-

2012 IBC Code & Commentary

## Adding lateral resistance

### 4.7 Fire-resistive Construction:

As an alternate to plywood of the same thickness, structural-use panels may be used in one-hour fire-resistant floor-ceiling or roof-ceiling assemblies permitted by the applicable code. In lieu of  $\frac{15}{32}$ -inch-thick (11.9 mm) or  $\frac{1}{2}$ -inch-thick (12.7 mm) plywood, two-layer assemblies are permitted to be constructed with  $\frac{7}{16}$ -inch-thick (11.1 mm), nonveneer rated sheathing (span-rated 24/16).

The  $\frac{15}{32}$ -inch- or  $1\frac{1}{8}$ -inch-thick (27.8 mm or 28.6 mm) Sturd-I-Floor (rated 48 oc) panels may be substituted for the double-wood floor for one-hour wood-floor construction.

Structural-use panels may be installed between the fire protection and the wood studs on either the interior or exterior side of fire-resistance-rated wood frame wall and partition assemblies described in the applicable code, provided the length of fasteners is adjusted for the added thickness of the panel.

Tongue-and-groove structural-use panels that are either  $\frac{15}{32}$  inch or  $1\frac{1}{8}$  inch (27.8 mm or 28.6 mm) thick, with exterior glue, may be substituted for the plywood permitted in the code for heavy timber roof decks in Type IV construction.

### Common issues with tested assemblies:

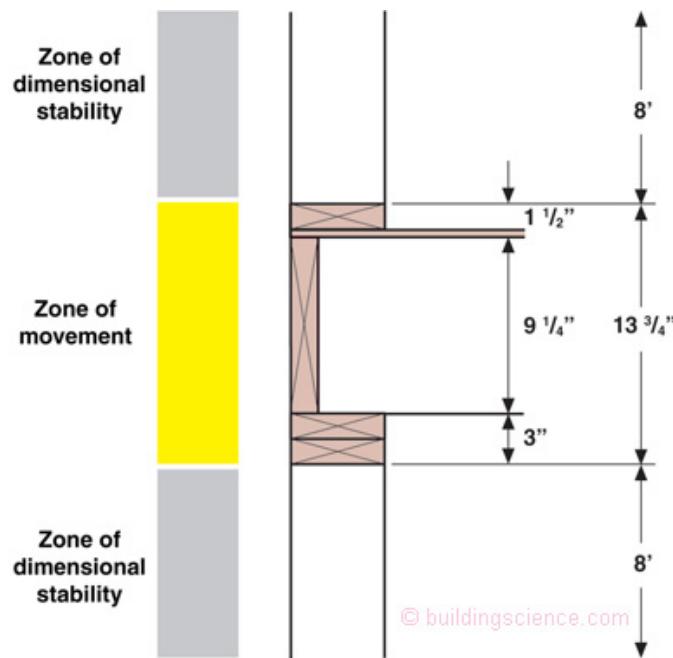
- Inclusion of wood structural panel – ESR2586
- FRT may also be substituted for untreated wood

## Zone of Movement

Shrinkage occurs primarily in horizontal members

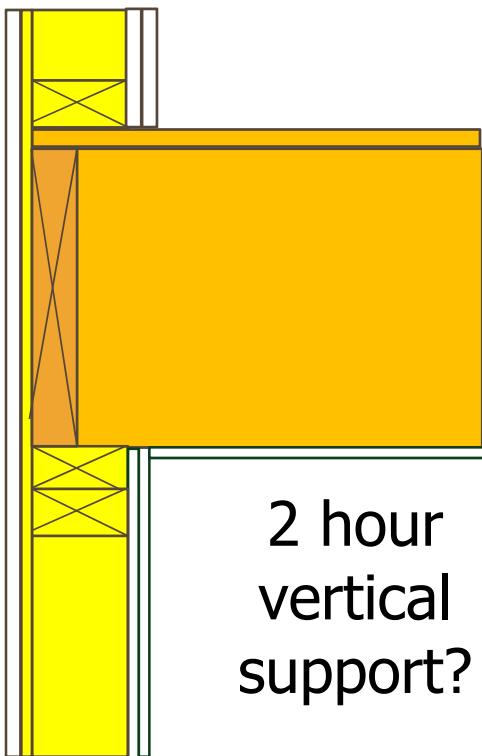
- wall plates
- Floors

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



Slide courtesy of Wood Works

## Type III Construction



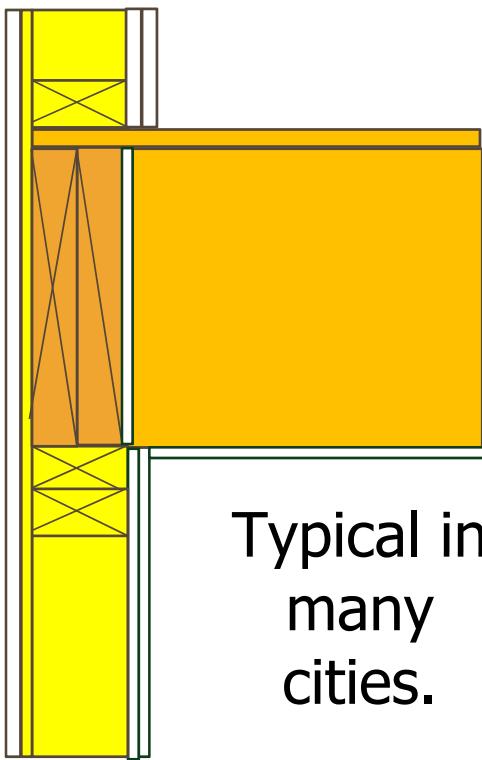
- 5/8" Type X GWB
  - 1 layer for 1hr rating
  - 2 layers for 2hr rating

- Fire Retardant Treated
  - Wall studs, plates and sheathing

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

Slide courtesy of Wood Works

## Type III Construction



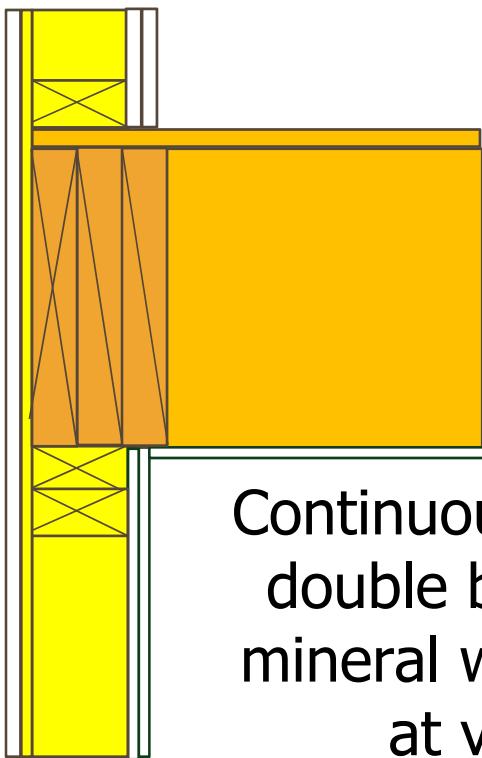
Typical in  
many  
cities.

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

- Fire Retardant Treated
  - Wall studs, plates and sheathing

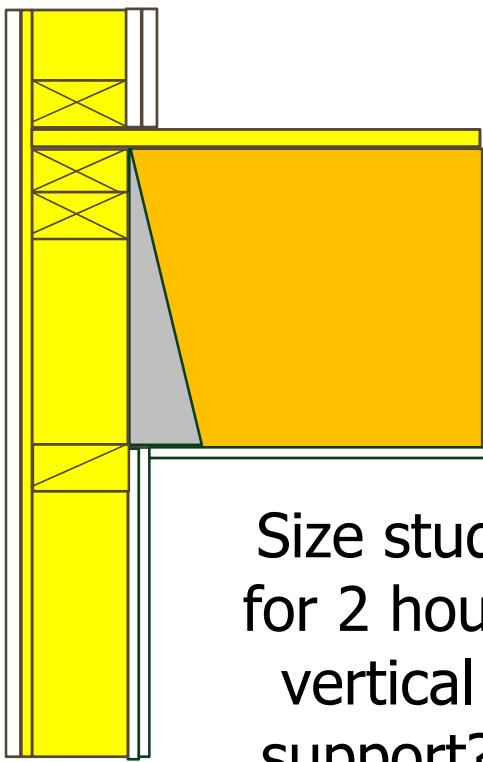
- Untreated Lumber
  - Floor framing (solid sawn or engineered)
  - Floor sheathing
  - See alt means letter w/ safing

## Type III Construction - Alt Means



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

## Continuity of FRT ?????



- 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

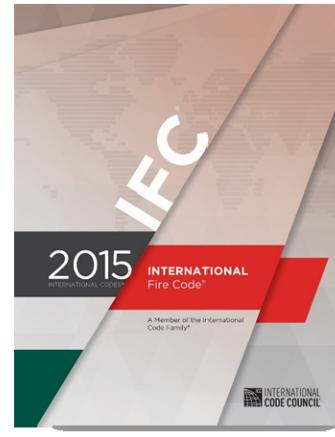
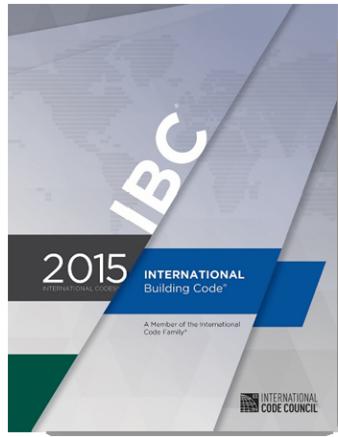
## **FRTW at exterior walls floors?**

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



## Precautions during construction



Fire-Resistant Design for Wood Construction

## 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)



Fire-Resistant Design for Wood Construction

## Precautions during construction

**[www.constructionfiresafety.org](http://www.constructionfiresafety.org)**



Fire-Resistant Design for Wood Construction

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