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Introduction to Wood: Architectural Considerations

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WoodWorks

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

AIA Approved Continuing Education

Course Description

This presentation will provide an introductory review of architectural considerations associated with wood framing. Fire protection and sprinklers, construction types, acoustics, and building envelopes in wood-frame structures will be reviewed, with an emphasis on cost-effective, code-compliant options for different building configurations.

Learning Objectives

1. Review wood's role and allowable uses under current building codes.
2. Highlight code provisions specific to allowable wood-frame building sizes, including sprinklers and construction types.
3. Explore the variety of details and assemblies available for fire- and acoustically-tested wood-frame walls, floors and roofs.
4. Discuss building enclosure design fundamentals and the role that each control layer has on durability of exterior assemblies.

Outline

- Construction Types
- Building Size
  - Heights & Areas Allowances
  - Sprinklers
  - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

Outline

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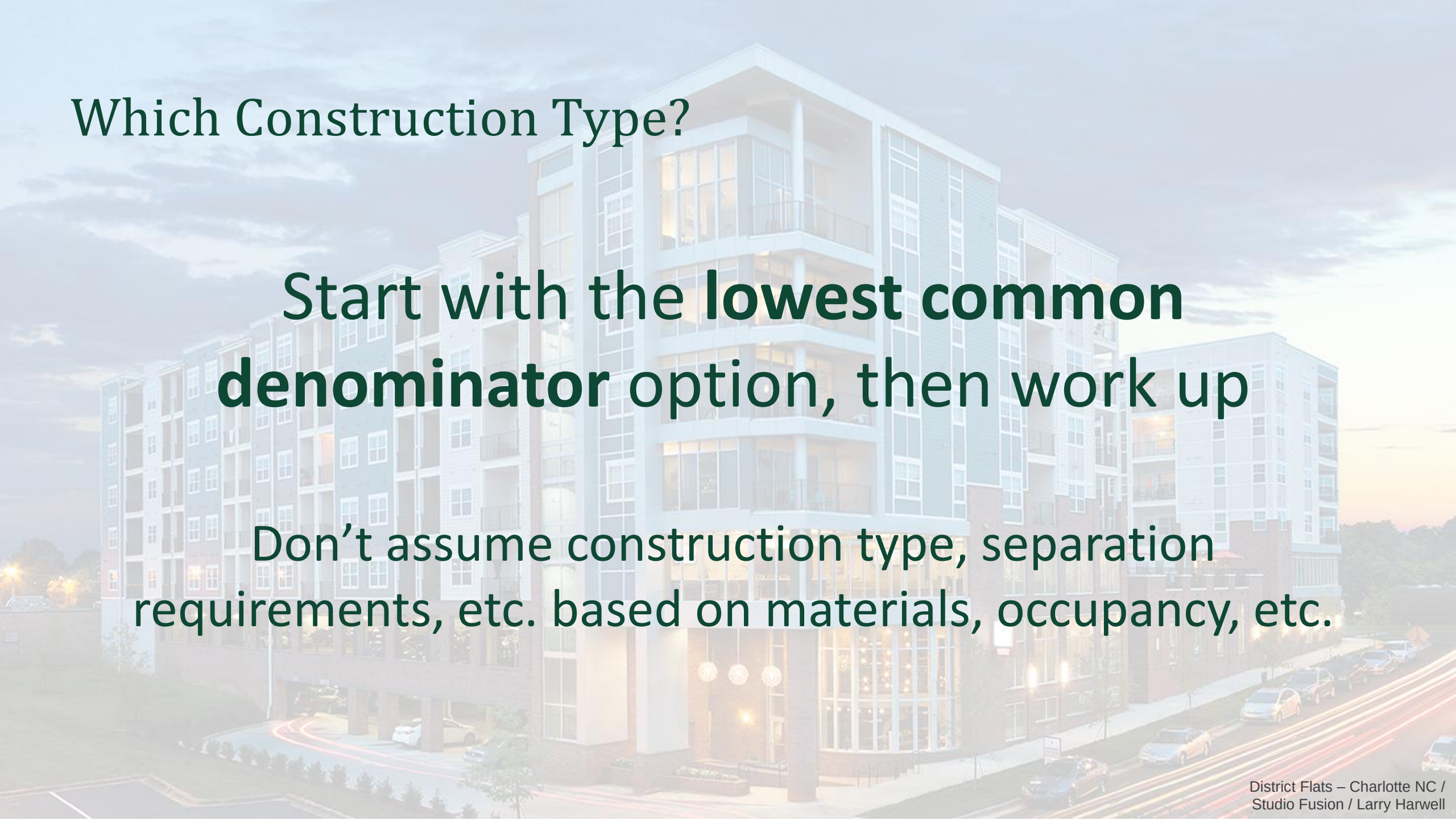
  - Acoustics
  - Building Envelope
  - Resources

Which Construction Type?

Start with the **lowest common denominator** option, then work up

Don’t assume construction type, separation requirements, etc. based on materials, occupancy, etc.



District Flats – Charlotte NC / Studio Fusion / Larry Harwell

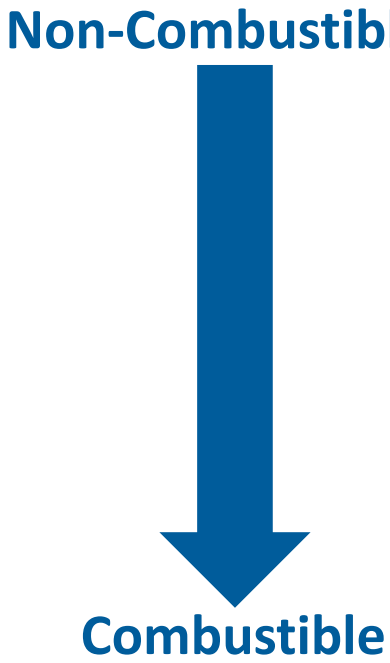
Which Construction Type?

Many buildings use higher construction types than necessary

- Traditional practice
- Cost impacts
  - Fire ratings
  - Material requirements

Crescent Terminus / Crescent Communities / Lor Aeck Sargent / SCA Consulting Engineers / Richar Lubrant

IBC 602: Construction Types



Type I: Non-Combustible Fire-Resistance Rated Structure

Type II: Non-Combustible Structure

Type III: Non-Combustible Exterior

Type IV: Heavy Timber Construction

Type V: Combustible Construction

IBC 602: Construction Types

	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Exterior Wall Material	Non-combustible		Non-combustible		Non-combustible, FRTW (LF, MT)		CLT (protected)			FRTW (LF, MT), CLT (protected)	Any materials permitted by code	
Interior Elements	Non-combustible		Non-combustible		Any materials permitted by code		Heavy Timber			Heavy Timber, LF (1-hour)	Any materials permitted by code	

IBC 602: Construction Types

Which construction types permit wood as the structural system?

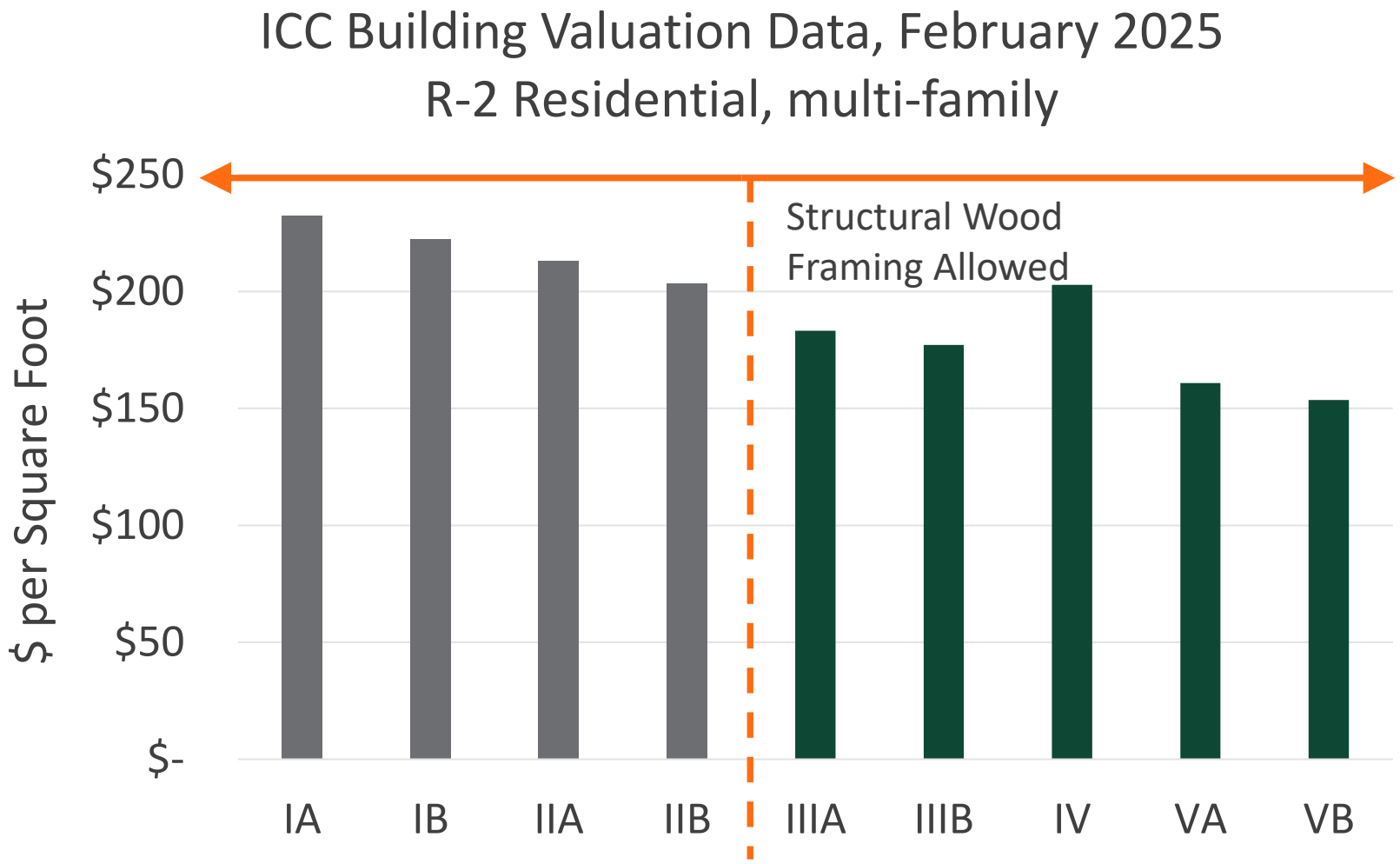
	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Exterior Wall Material	Non-combustible		Non-combustible		Non-combustible, FRTW (LF, MT)		CLT (protected)			FRTW (LF, MT), CLT (protected)	Any materials permitted by code	
Interior Elements	Non-combustible		Non-combustible		Any materials permitted by code		Heavy Timber			Heavy Timber, LF (1-hour)	Any materials permitted by code	

Allowances for wood per IBC Chapter 6

IBC Light-Frame Construction Type Differences

	TYPE III		TYPE V	
	A	B	A	B
Exterior Wall Material (Chapter 6)	Non-combustible, FRTW (LF, MT)	Non-combustible, FRTW (LF, MT)	Any materials permitted by code	Any materials permitted by code
Interior Elements (Chapter 6)	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code

ICC Building Valuation Data



Outline

- Construction Types
- Building Size
  - Height & Area Allowances
    - Sprinklers
    - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

IBC Table 504.3: Height Allowances in Feet

TABLE 504.3
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE[a]

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	270	180	85	85	70	60
R[h]	NS[d]	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

NS = Buildings not equipped throughout with an automatic sprinkler system

S = Buildings equipped throughout with an NFPA 13 automatic sprinkler system

S13D = Buildings equipped throughout with an NFPA 13D automatic sprinkler system

S13R = Buildings equipped throughout with an NFPA 13R automatic sprinkler system

IBC Table 504.4: Height Allowances in Stories

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[a, b]

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	3	3	3	2	1
	S	UL	6	4	3	4	3	9	6	4	4	3	2
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	18	12	9	6	4	3
M	NS	UL	11	4	2	4	2	4	4	4	4	3	1
	S	UL	12	5	3	5	3	12	8	6	5	4	2
R-2[h]	NS[d]	UL	11	4	4	4	4	4	4	4	4	3	2
	S13R	4	4	4								4	3
	S	UL	12	5	5	5	5	18	12	8	5	4	3

NS = Buildings not equipped throughout with an automatic sprinkler system

S = Buildings equipped throughout with an NFPA 13 automatic sprinkler system

S13R = Buildings equipped throughout with an NFPA 13R automatic sprinkler system

IBC Table 506.2: Allowable Area Factor

TABLE 506.2
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET[a, b]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	45,000	30,000	18,750	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	180,000	120,000	75,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	135,000	90,000	56,250	45,000	34,500	16,500
B	NS	UL	UL	37,500	23,000	28,500	19,000	108,000	72,000	45,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	432,000	288,000	180,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	324,000	216,000	135,000	108,000	54,000	27,000
M	NS	UL	UL	21,500	12,500	18,500	12,500	61,500	41,000	26,625	20,500	14,000	9,000
	S1	UL	UL	86,000	50,000	74,000	50,000	246,000	164,000	102,500	82,000	56,000	36,000
	SM	UL	UL	64,500	37,500	55,500	37,500	184,500	123,000	76,875	61,500	42,000	27,000
R-2[h]	NS[d]	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S13R												
	S1	UL	UL	96,000	64,000	96,000	64,000	246,000	164,000	102,500	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	184,500	123,000	76,875	61,500	36,000	21,000

NS = Buildings not equipped throughout with an automatic sprinkler system

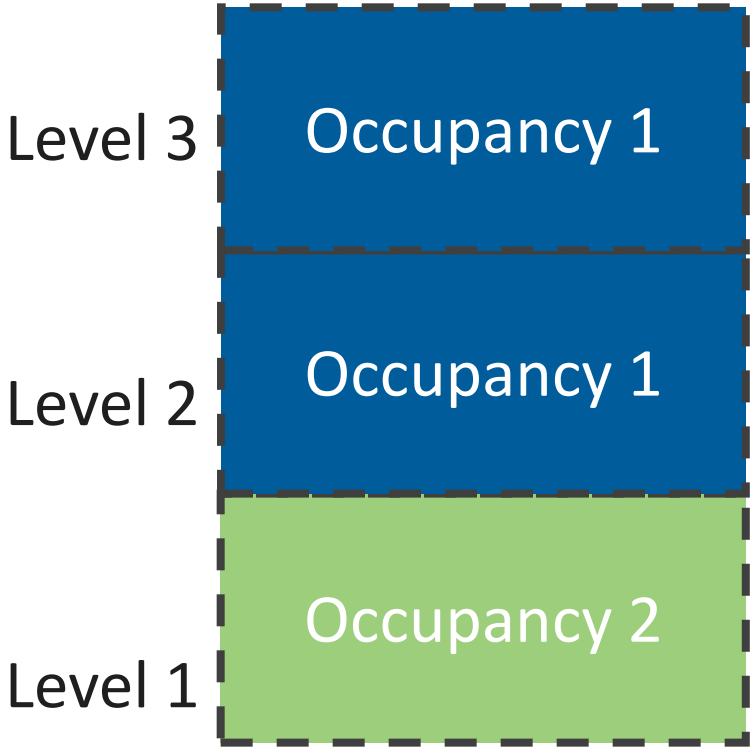
S1 = Buildings a maximum of one *story above grade plane* equipped throughout with an NFPA 13 automatic sprinkler system

SM = Buildings two or more stories above grade plane equipped throughout with an NFPA 13 automatic sprinkler system

S13R = Buildings equipped throughout with an NFPA 13R automatic sprinkler system

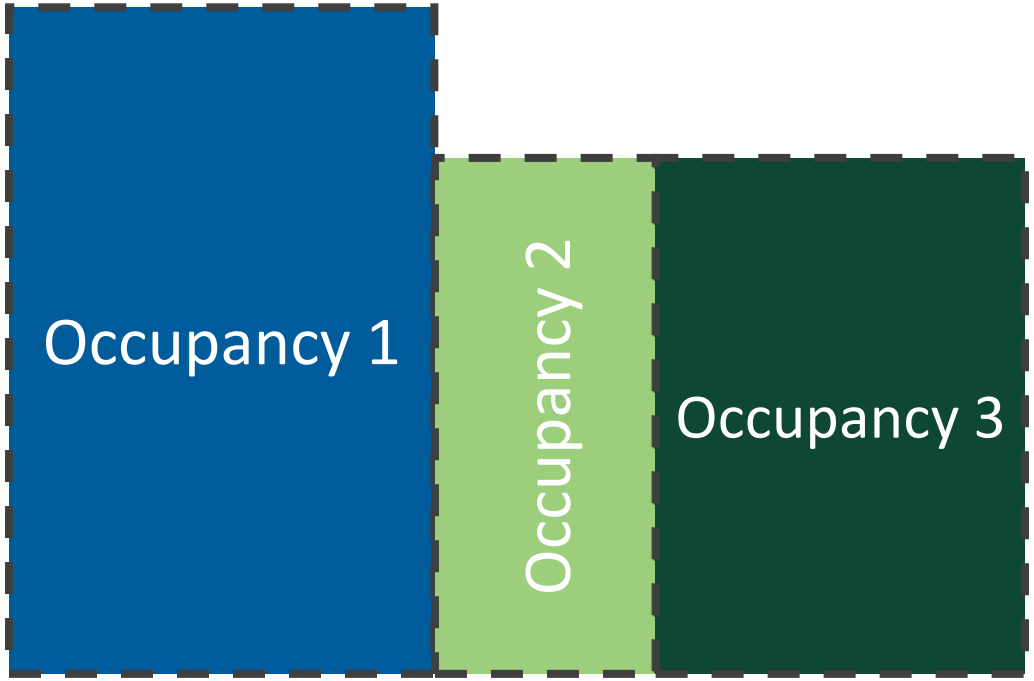
IBC 508: Mixed Use and Occupancy

» Different occupancies on **different** levels:



Elevation view

» Different occupancies on **same** level:



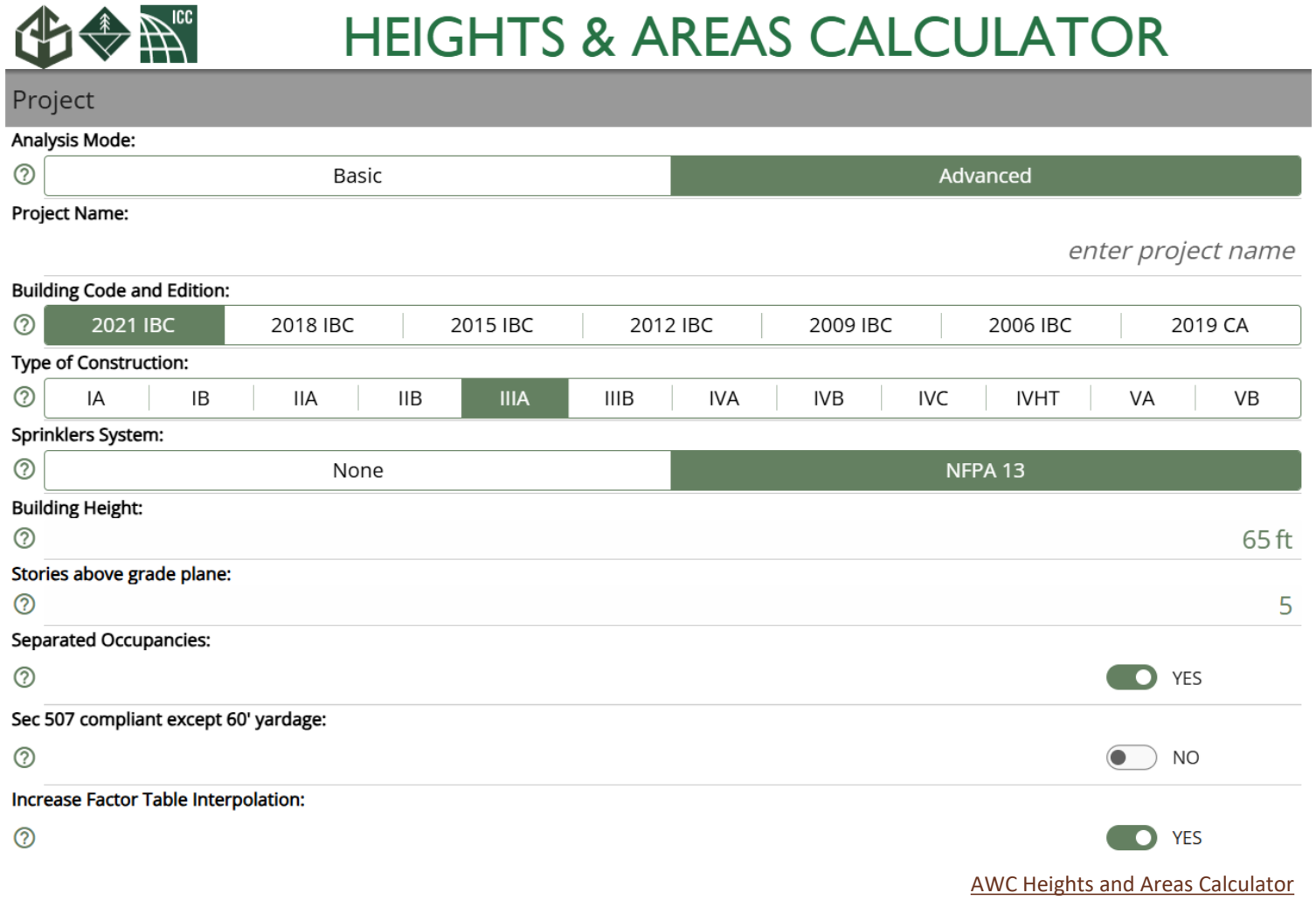
Plan View

Heights and Areas Calculator—free tool

Calculates:
Maximum heights and areas

Code Editions:
2006 to 2021 IBC

Inputs:
- Building geometry
- Site conditions (e.g., open frontage)
- Type of construction
- Single and Mixed-Use Occupancy



AWC Heights and Areas Calculator

Outline

- Construction Types
- Building Size
  - Height & Area Allowances
  - Sprinklers
    - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

IBC 903.2: Automatic Sprinkler Systems

In some cases, sprinklers are required by code depending on occupancy per IBC 903.2

- Examples include most new Group H, I, R fire areas (IBC 903.2.5, 903.2.6, 903.2.8)
- Group E fire areas greater than 12,000 sf (IBC 903.2.3)

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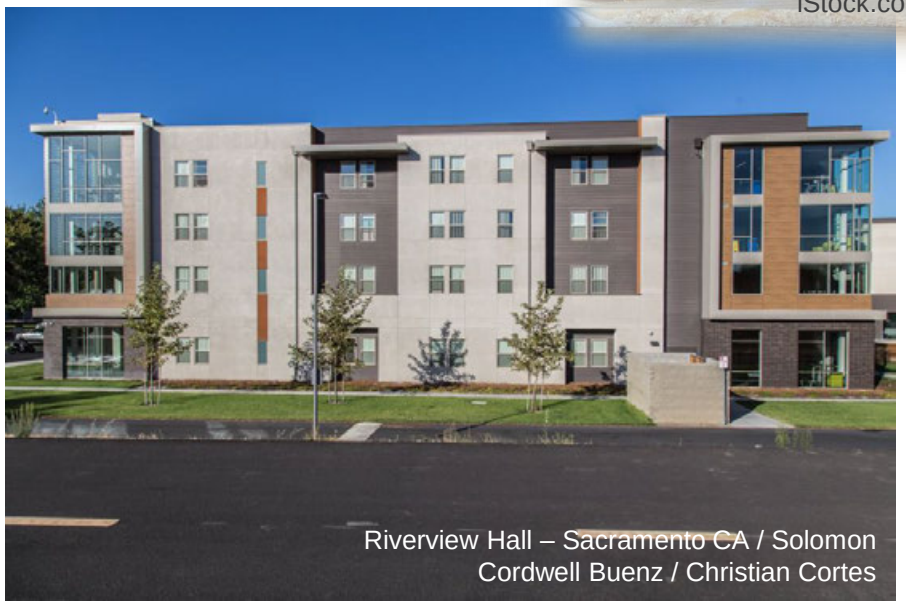
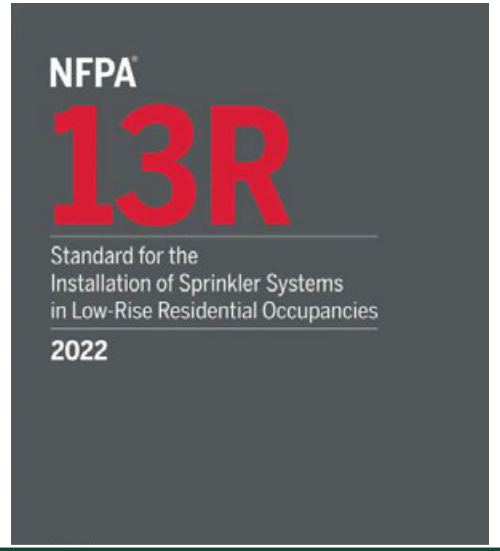


Riverview Hall – Sacramento CA / Solomon Cordwell Buenz / Christian Cortes

Sprinkler System Standards



NFPA 13	NFPA 13R
Goal: Life safety and property protection	Goal: Life safety
Fully sprinklered system throughout entire building (including unoccupied spaces)	Partially sprinklered system; unoccupied spaces often not sprinklered
Can cost more	Lower water discharge levels, shorter water supply time; can result in smaller pipes, reduced storage and pumps
Permitted for many occupancies, buildings of many sizes, allows greater building size increases	Limited applications, mainly multi-family up to 4 stories, 60 feet

IBC Building Size Limits

Residential (R1, R2, and R4) Occupancies

IBC 2021 Table 504.3 , 504.4, 506.2 : Type IIIA Construction

Sprinklers Allowable Limit	NS	NFPA 13R	NFPA 13	Frontage Increase**
Stories	4	**4**	5	5
Height (ft)	65	**60**	85	85
Building Area/Story (ft^2)	24k	**24k**	72k	90k
Total Building Area* (ft^2)	72k	**96k**	216k	270k

* Assuming max stories built

** Maximum allowable frontage increase

IBC Building Size Limits

Residential (R1, R2, and R4) Occupancies

IBC 2021 Table 504.3 , 504.4, 506.2 : Type IIIA Construction

Sprinklers / Allowable Limit	NS	NFPA 13R	NFPA 13	Frontage Increase**
Stories	4	4 →	**5**	5
Height (ft)	65	60 →	**85**	85
Building Area/Story (ft^2)	24k	24k →	**72k**	90k
Total Building Area* (ft^2)	72k	96k →	**216k**	270k

* Assuming max stories built

** Maximum allowable frontage increase

IBC Building Size Limits

Residential (R1, R2, and R4) Occupancies

IBC 2021 Table 504.3 , 504.4, 506.2 : Type IIIA Construction

Sprinklers Allowable Limit	NS	NFPA 13R	NFPA 13	Frontage Increase**
Stories	4	4	5 →	**5**
Height (ft)	65	60	85 →	**85**
Building Area/Story (ft^2)	24k	24k	72k →	**90k**
Total Building Area* (ft^2)	72k	96k	216k →	**270k**

* Assuming max stories built

** Maximum allowable frontage increase

IBC Light-Frame Construction Type Differences

	TYPE III		TYPE V	
	A	B	A	B
Exterior Wall Material (Chapter 6)	Non-combustible, FRTW (LF, MT)	Non-combustible, FRTW (LF, MT)	Any materials permitted by code	Any materials permitted by code
Interior Elements (Chapter 6)	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code
Allowable Stories (Table 504.4)	5	5	4	3
Allowable Height (Table 504.3)	85’	75’	70’	60’
Allowable Area per Story (Table 506.2)	72,000 ft^2	48,000 ft^2	36,000 ft^2	21,000 ft^2
Allowable Total Building Area*	216,000 ft^2	144,000 ft^2	108,000 ft^2	63,000 ft^2

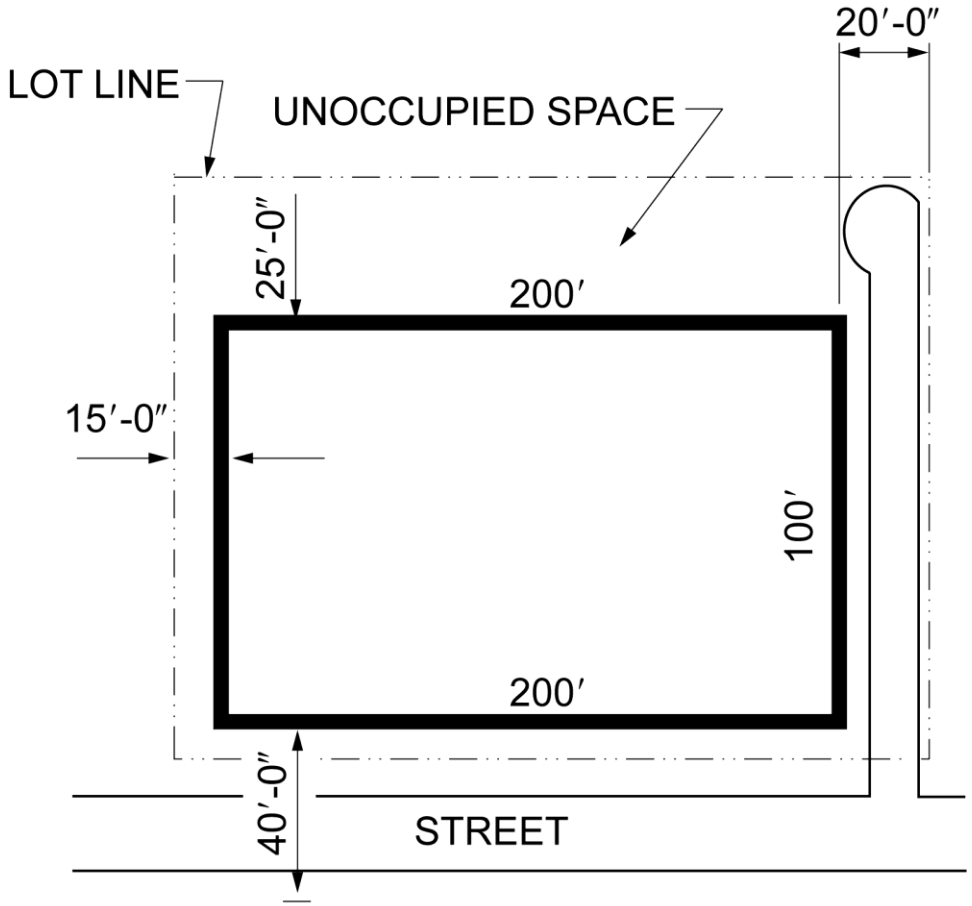
Residential (R-2) occupancy with NFPA 13 sprinklers without further increases. *Assuming max stories built.

Outline

- Construction Types
- Building Size
  - Height & Area Allowances
  - Sprinklers
  - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

IBC 506.3: Frontage Increase for Area Modification

- Allowable area increase for frontage on:
  - Streets (public ways)
  - Open Spaces
- Frontage provides:
  - Access by fire service personnel
  - Temporary refuge for occupants
  - Reduced exposure to/from adjacent structures



2021 IBC Code and Commentary – Volume 1, Commentary Figure 506.3.2

IBC 506.3: Frontage Increase for Area Modification

- Minimum Qualifications:
  - Minimum 25% of building perimeter is on a public way or open space with a minimum distance of 20’ measured perpendicular from building face to:
    - Closest interior lot line
    - Entire width of street, alley, or public way
    - Exterior face of adjacent building on the same lot
- Open space shall be:
  - On the same lot or dedicated for public use
  - Accessed from a street or approved fire lane
- Exceptions:
  - Buildings meeting the requirements of IBC 507: Unlimited Area Building

IBC 506.3: Frontage Increase for Area Modification

I_f = Frontage Increase Factor

$I_{f,\ max} = 0.75$

TABLE 506.3.3
FRONTAGE INCREASE FACTOR[a]

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (feet)			
	0 to less than 20	20 to less than 25	25 to less than 30	30 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

a. Interpolation is permitted.

IBC 506.2.1: Single-Occupancy Buildings

Calculate total allowable building area ***per story***

$$A_a = A_t + (NS \times I_f)$$

(Equation 5-1)

A_a = Allowable area per story (ft^2)

A_t = Tabular allowable area per story per Table 506.2 for NS, S1, S13R or S13D (ft^2)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Frontage Increase Factor per IBC 506.3, $I_{f,\ max} = 0.75$

IBC 506.2.1: Single-Occupancy Buildings

Calculate total allowable building area *(<u>not</u> per story)*

$$A_a = [A_t + (NS \times I_f)] \times S_a$$

(Equation 5-2)

A_a = Total allowable building area (ft^2)

A_t = Tabular allowable area per story per Table 506.2 for NS, S13R, S13D, or SM (ft^2)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Frontage Increase Factor per IBC 506.3, $I_{f,\ max} = 0.75$

S_a = Actual number of building stories above grade plane

- $S_{a,\ max}$ = 3 where the actual number of stories above grade plane exceeds 3
- $S_{a,\ max}$ = 4 where the building is equipped throughout with an NFPA 13R (<u>not</u> NFPA 13) automatic sprinkler system

» ***The actual area of any individual story cannot exceed the allowable area of a one-story building as calculated by Equation 5-1***

IBC 506.2.2: Mixed-Occupancy Buildings

Dependent on Section 508 for accessory occupancies, nonseparated occupancies, and separated occupancies

Story Area: $\sum \frac{A_i}{A_{a,i}} \leq 1.0$ Total Building Area: $\sum \frac{A_i}{A_{a,i}} \leq S_a$

A_i = Actual area of Occupancy *i* at a given story (ft^2)

$A_{a,i}$ = Allowable area per story of Occupancy *i* (ft^2) = $A_{t,i}$ + (NS_i x I_f)

$A_{t,i}$ = Tabular allowable area per story per Table 506.2 for NS, S13R, S13D, or SM (ft^2)

NS_i = Tabular allowable area per story per Table 506.2 for non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase due to frontage per IBC 506.3, $I_{f,\ max}$ = 0.75

S_a = Actual number of building stories above grade plane

$S_{a,\ max}$ = 3 where the actual number of stories above grade plane exceeds 3

$S_{a,\ max}$ = 4 where the building is equipped throughout with an NFPA 13R (not NFPA 13) automatic sprinkler system

IBC 510.2: Horizontal Building Separation

Often called ***Podium provision***:

Considered separate buildings above and below for purposes of area calculations if:

- 3-hour rated horizontal assembly
- Overall height in feet is limited to min. of building above or building below
- Building below, including horizontal assembly, is Type I-A with sprinklers
- Occupancy restrictions above and below

Broadstone Saratoga / Urbal Architecture / Axiom Engineering / Chad Case Photography

IBC 505.2: Mezzanines

- An intermediate level or levels between the floor and ceiling of any story:
  - Provide minimum 7’ clearance above and below the mezzanine floor construction
- Does not count towards building area or number of stories if:
  - Mezzanine floor area ≤ one-third floor area of *room* or *space* where located
  - Special egress provisions
  - Must be open and unobstructed to room in which it’s located (walls ≤ 42” allowed)
  - Several exceptions
  - Slight differences for equipment platforms
  - ***Does count toward fire area with regard to fire protection in Chapter 9***

IBC 506.1.3: Basements

A basement is not included in the total allowable building area if the total area of the basement does not exceed the area permitted for a building that is one-story above grade plane

"Basement" is defined as "not a story above grade plane" and has a finished floor surface of the next floor above:

- Less than 6 feet above grade plane; or
- Less than 12 feet above the finished ground level at any point

626 Dekalb Avenue, Atlanta, GA
Matt Church - Davis Church Structural Engineers

IBC 506.1.3: Basements & Sloping Sites

To qualify as a basement (and therefore not be included in building area):

Outline

- Construction Types
- Building Size
  - Height & Area Allowances
  - Sprinklers
  - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
    - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

IBC Table 601: Fire-Resistance Ratings

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	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	$1\frac{1}{2}$	1	1	HT	1[b,c]	0

IBC Table 705.5: Fire-Resistance Ratings

TABLE 705.5
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a, d, g]

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

IBC Light-Frame Construction Type Differences

	TYPE III		TYPE V	
	A	B	A	B
Exterior Wall Material (Chapter 6)	Non-combustible, FRTW (LF, MT)	Non-combustible, FRTW (LF, MT)	Any materials permitted by code	Any materials permitted by code
Interior Elements (Chapter 6)	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code	Any materials permitted by code
Allowable Stories (Table 504.4)	5	5	4	3
Allowable Height (Table 504.3)	85’	75’	70’	60’
Allowable Area per Story (Table 506.2)	72,000 ft^2	48,000 ft^2	36,000 ft^2	21,000 ft^2
Allowable Total Building Area*	216,000 ft^2	144,000 ft^2	108,000 ft^2	63,000 ft^2
Exterior Bearing Wall Rating (Table 601)	2-hour	2-hour	1-hour	0-hour
All Other Fire Ratings (Table 601)	1-hour	0-hour	1-hour	0-hour

Residential (R-2) occupancy with NFPA 13 sprinklers without further increases. *Assuming max stories built.

Outline

- Construction Types
- Building Size
  - Height & Area Allowances
  - Sprinklers
  - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
- Acoustics
- Building Envelope
- Resources

IBC 703.2: Fire-Resistance Ratings and Fire Tests

Common Tested Assemblies (ASTM E119) per IBC 703.2.1:

- UL Listings
- Gypsum Association GA-600 Design Manual
- Industry Documents such as AWC's DCA3
- Proprietary Manufacturer Tests

Analytical Methods per IBC 703.2.2:

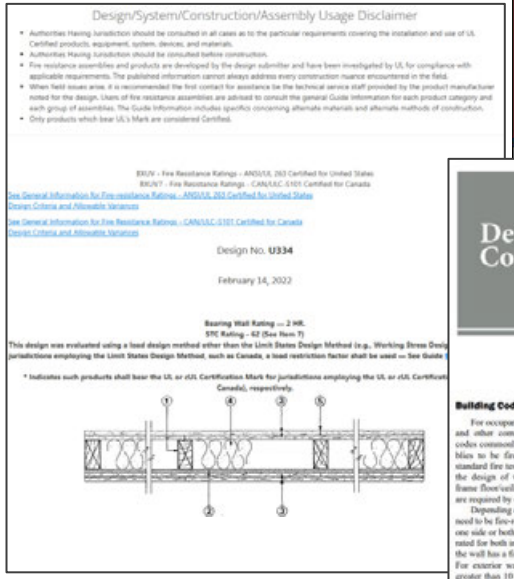
- Fire-resistance designs documented in sources
- Prescriptive designs per IBC 721
- Calculated Fire Resistance per IBC 722
- Engineering analysis based on a comparison
- Fire-resistance designs certified by an approved agency

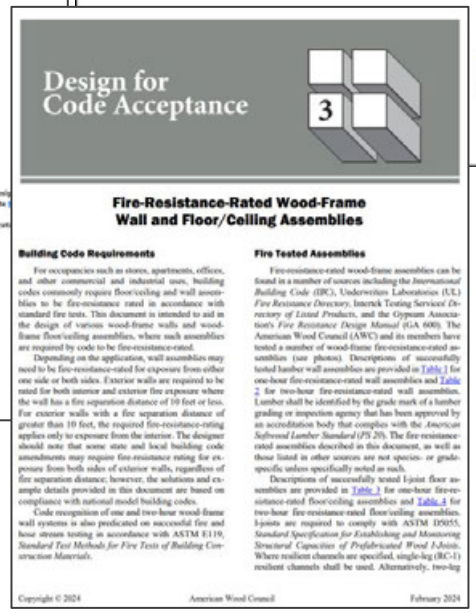
Approved Alternate Methods per IBC 703.2.3:

- Permitted in accordance with IBC 104.11

Gypsum Association. (2024).

Underwriters Laboratories. (2022).





American Wood Council. (2024).

IBC 703.2: Fire-Resistance Ratings and Fire Tests

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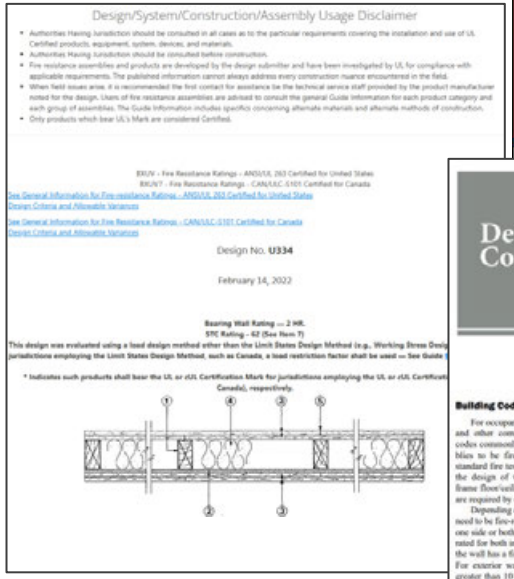
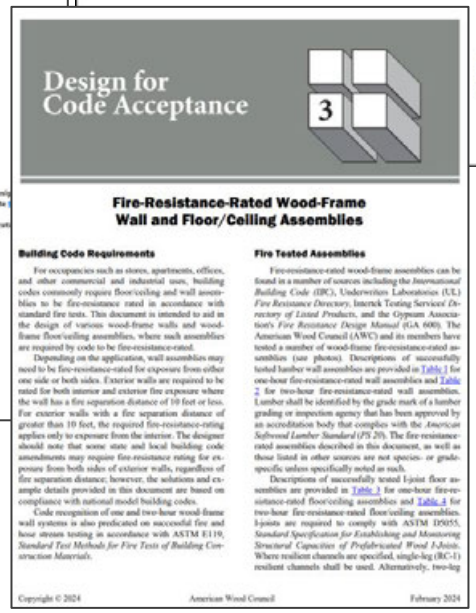
Approved Alternate Methods per IBC 703.2.3:

- Permitted in accordance with IBC 104.2.3

Gypsum Association. (2024).

Underwriters Laboratories. (2022).





American Wood Council. (2024).

IBC 721: Prescriptive Fire Resistance

- **Table 721.1(2):** Rated Fire-Resistance Periods for Walls and Partitions
  - Example: Item 14-1.3 (1-hour FRR): 2x4 wood studs @ 24” O.C. with (1) layer of 5/8” Type-X gypsum wallboard each face
- **Table 721.1(3):** Floor/Ceiling and Roof/Ceiling Assemblies
  - Example: Item 21-1.1 (1-hour FRR): ½” wood structural panel sheathing applied to top of framing, wood joists, I-joists, floor trusses, or flat or pitched roof trusses @ 24” O.C. with (2) layers of 1/2” Type-X gypsum wallboard ceiling

IBC 722.6: Calculated Fire Resistance

- Applies to:
  - Walls
  - Floor/ceiling assemblies
  - Roof/ceiling assemblies
- 1-hour max rating

TABLE 722.6.2(1)
TIME ASSIGNED TO WALLBOARD MEMBRANES[a, b, c, d]

DESCRIPTION OF FINISH	TIME[e] (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

For SI: 1 inch = 25.4 mm.

a. These values apply only where membranes are installed on framing members that are spaced 16 inches o.c. or less.

b. Gypsum wallboard installed over framing or furring shall be installed so that all edges are supported, except 5/8-inch Type X gypsum wallboard shall be permitted to be installed horizontally with the horizontal joints staggered 24 inches each side and unsupported but finished.

c. On wood frame floor/ceiling or roof/ceiling assemblies, gypsum board shall be installed with the long dimension perpendicular to framing members and shall have all joints finished.

d. The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly. Where dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire-resistant (weaker) side.

e. The time assigned is not a finished rating.

TABLE 722.6.2(2)
TIME ASSIGNED FOR CONTRIBUTION OF WOOD FRAME [a, b, c]

DESCRIPTION	TIME ASSIGNED TO FRAME (minutes)
Wood studs 16 inches o.c.	20
Wood floor and roof joists 16 inches o.c.	10

For SI: 1 inch = 25.4 mm.

a. This table does not apply to studs or joists spaced more than 16 inches o.c.

b. All studs shall be nominal 2 × 4 and all joists shall have a nominal thickness of not less than 2 inches.

c. Allowable spans for joists shall be determined in accordance with Sections 2308.4.2.1, 2308.7.1 and 2308.7.2.

2021 International Building Code
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IBC 722.6: Calculated Fire Resistance

- AWC's DCA4: Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Resistance
  - Includes Ten Rules of Fire Endurance Rating

Ten Rules of Fire Endurance (Resistance) Rating

Rule 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 characteristics of the individual layers when exposed separately to fire.*

Where two layers of panel materials, such as gypsum wallboard or plywood, are fastened to studs or joists separately, their combined effect is greater than the sum of their individual contributions to the fire endurance rating of the assembly.

Rule 2. *The fire endurance of a construction does not decrease with the addition of further layers.*

This is a corollary to Rule 1. The fire resistance will not decrease with the addition of layers such as wallboard or other panel materials, regardless of how many layers are added or where they are located within the assembly.

Rule 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.*

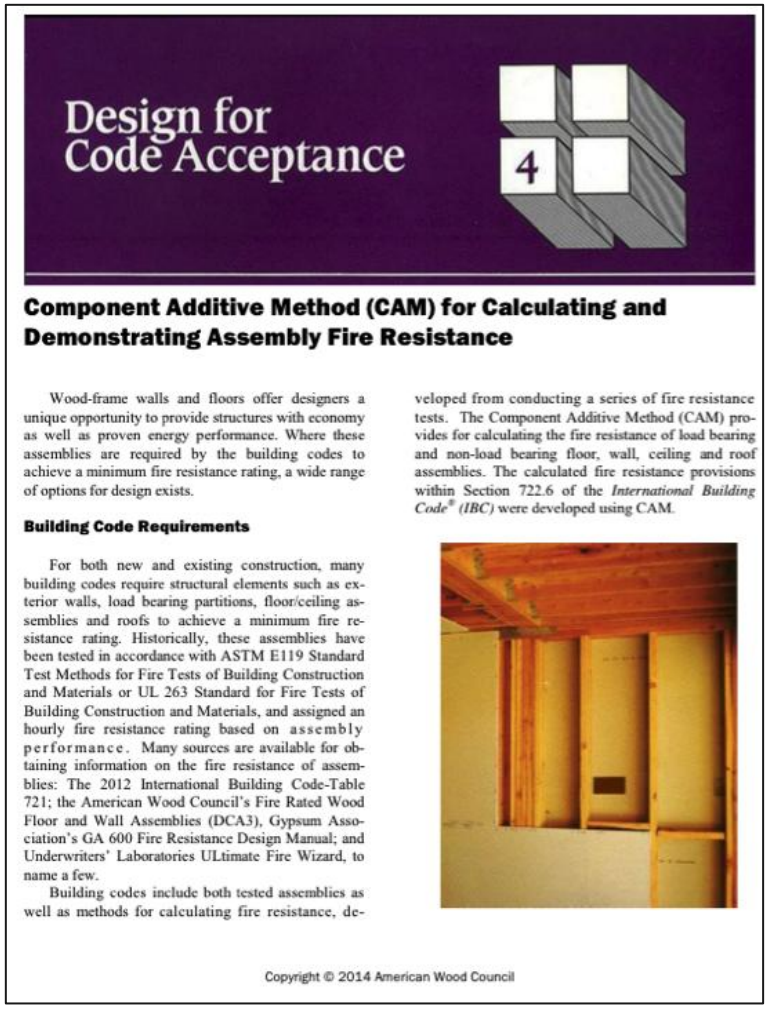
Wall and ceiling cavities formed by studs and joists protected and encased by wall coverings adds to the fire resistance rating of these assemblies.

Rule 4. *The farther an air gap or cavity is located from the exposed surface, the more beneficial its effect on the fire endurance.*

In cases where cavities are formed by joists or studs and protected by 2-inch-thick panel materials against fire exposure, the beneficial effect of such air cavities is greater than if the protection is only 1/2 inch thick.

Rule 5. *The fire endurance of an assembly cannot be increased by increasing the thickness of a completely enclosed air layer.*

An increase in the gap distance between separated layers does not change the fire resistance of an assembly.



American Wood Council. (2014).

IBC 722.1: Calculated Fire Resistance

- Calculated fire resistance of exposed wood members and decking
  - Refers to AWC NDS Chapter 16
  - AWC Technical Report No. 10 is a design aid to NDS Chapter 16
  - WoodWorks Expert Tip: Using Char Methods to Demonstrate Fire Resistance of Exposed Wood Members

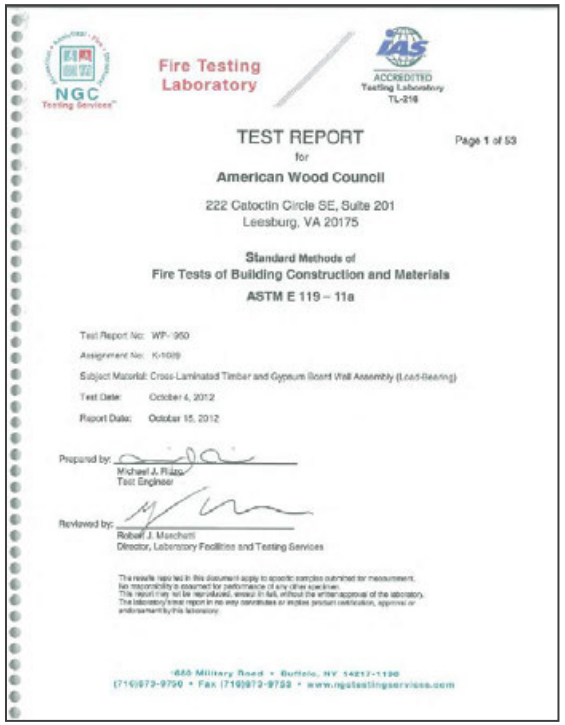
American Wood Council. (2018).

American Wood Council. (2021).

WoodWorks. Using Char Methods to Demonstrate Fire Resistance of Exposed Wood Members.

Other Approved Fire-Resistance Rated Assemblies

- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Fire-resistance designs certified by an approved agency
- Third-Party Test Reports



NGC Testing Services

Fire Testing Laboratory

ACCREDITED Testing Laboratory TL-216

TEST REPORT

Page 1 of 53

for

American Wood Council

222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

Standard Methods of
Fire Tests of Building Construction and Materials
ASTM E 119 – 11a

Test Report No: WP-950

Assignment No: K-1009

Subject Material: Cross-Laminated Timber and Gypsum Board Wall Assembly (Load-Bearing)

Test Date: October 4, 2012

Report Date: October 15, 2012

Prepared by:
Michael J. Ruffo
Test Engineer

Reviewed by:
Robert J. Marchetti
Director, Laboratory Facilities and Testing Services

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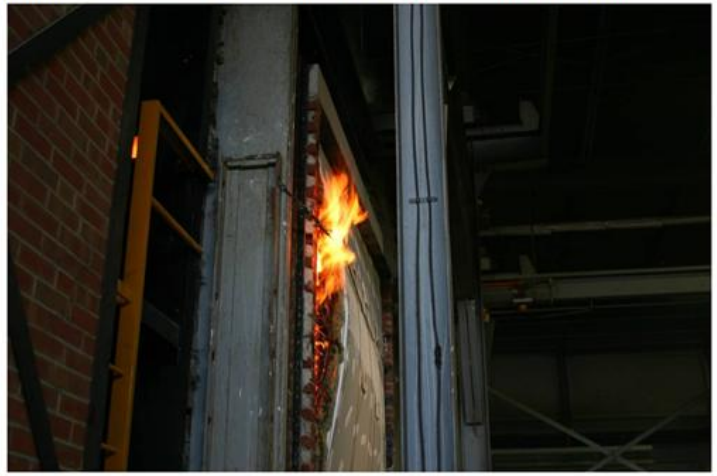
American Wood Council. (2012).

Highly Successful CLT Fire Test

As part of a project to produce a U.S. design manual for cross-laminated timber (CLT), AWC conducted a very successful ASTM E119 fire endurance test on a CLT wall at NGC Testing Services in Buffalo, NY. The wall, consisting of a 5-ply CLT (approximately 7-inches thick), was covered on each side with a single layer of 5/8" Type X gypsum wallboard. The wall was loaded to the maximum attainable by the test equipment, although it remained significantly below the full design strength of the CLT specimen. It was then exposed to a standard fire that reaches over 1800 degrees Fahrenheit in the first 90 minutes of exposure. While only seeking a 2-hour rating, as required by the targeted building code provisions, the test specimen lasted 3 hours 6 minutes. This may open up additional possibilities in a few specialized locations where a 3-hour fire resistance rating might be required. The test culminated nearly a month of intense planning and cooperation by the North American wood products industry to get the test run in advance of the recent ICC hearings where an AWC-proposed code change to specifically recognize CLT was approved.



American Wood Council.

Outline

- Construction Types
- Building Size
  - Height & Area Allowances
  - Sprinklers
  - Allowable Area Increase Options
- Fire Performance
  - Code Requirements
  - Approved Fire-Resistance Rated Assemblies
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IBC 1206.2: Airborne Sound (STC)

Sound Transmission Class (STC)

- Measures how effectively an assembly isolates air-borne sound and reduces the level that passes from one side to the other
- Applies to walls and floor/ceiling assemblies

IBC 1206.3: Structure-borne Sound (IIC)

Impact Insulation Class (IIC)

- Evaluates how effectively an assembly blocks impact sound from passing through it
- Only applies to floor/ceiling assemblies

Source: iStock.com/Saklakova

IBC 1206: Sound Transmission

Code requirements only address residential occupancies:

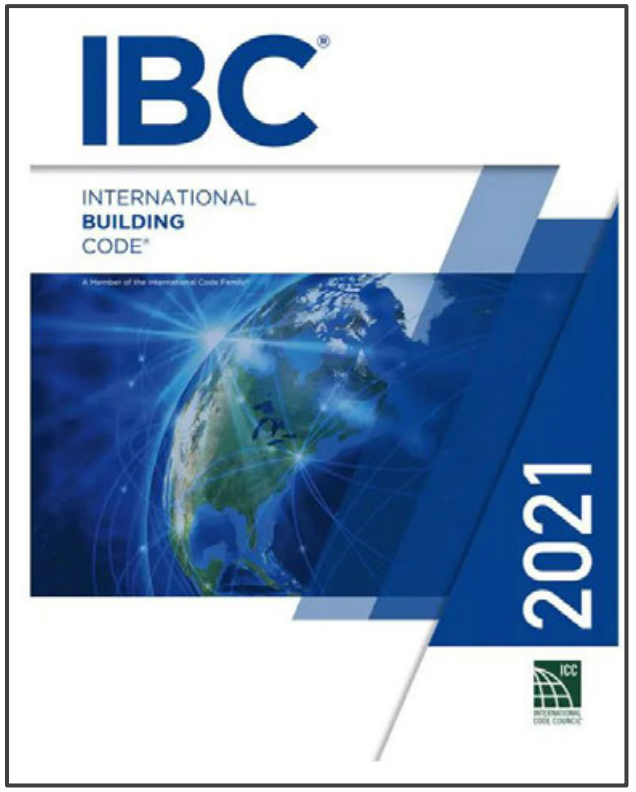
For unit to unit or unit to public or service areas:

Min. STC of 50 (45 if field tested) for:

- Walls, Partitions, and Floor/Ceiling Assemblies

Min. IIC of 50 (45 if field tested) for:

- Floor/Ceiling Assemblies



Acoustical Criteria

American Wood Council. (2018).

Table M16.1-3 Privacy Afforded According to STC Rating

STC Rating	Privacy Afforded
25	Normal speech easily understood
30	Normal speech audible, but not intelligible
35	Loud speech audible and fairly understandable
40	Loud speech barely audible, but not intelligible
45	Loud speech barely audible
50	Shouting barely audible
55	Shouting inaudible

Choosing Acoustically Rated Assemblies

Common tested assemblies:
STC: ASTM E90, per IBC 1206.2
IIC: ASTM E492, per IBC 1206.3

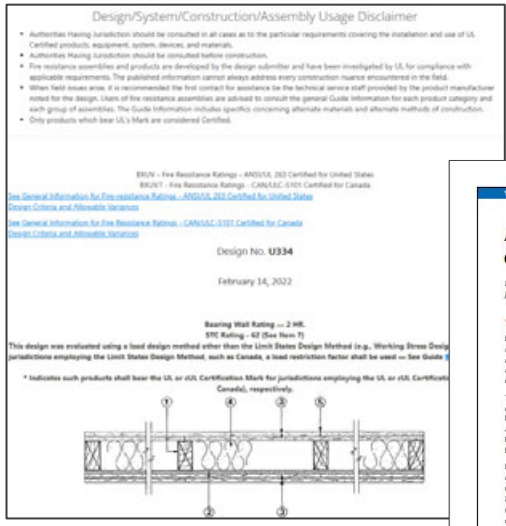
- Manufacturers of gypsum, insulation, acoustical products (proprietary tests)
- UL Listings
- Gypsum Catalog
- Industry associations: AWC, APA, others
- Reach out to **WoodWorks**

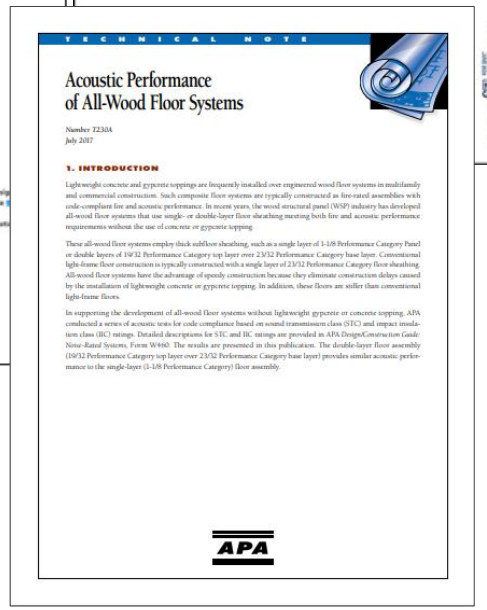
Alternate Method: IBC 1206.2 & 1206.3

- Both STC and IIC may be “established by engineering analysis based on a comparison of floor-ceiling assemblies having [STC/IIC] ratings as determined by the test procedures.”

Gypsum Association. (2024).

Underwriters Laboratories. (2022).

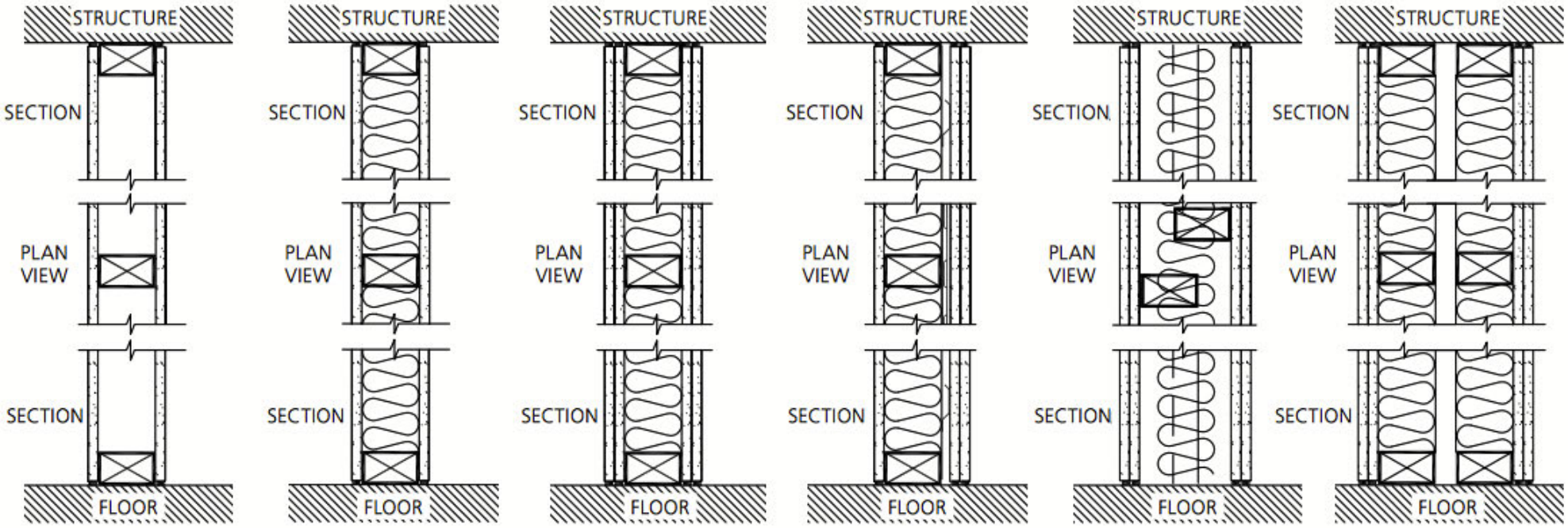




APA – Engineered Wood Association. (2017).

Acoustically Rated Wall Assemblies

Acoustical Progression in Wood-Frame Wall Assemblies (Section & Plan Views)

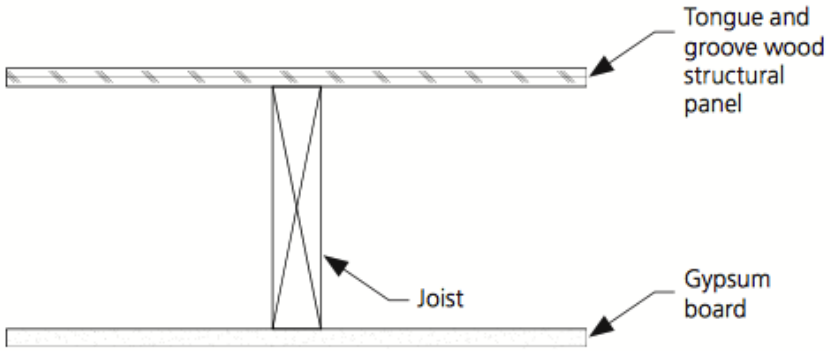


WoodWorks. Acoustical Considerations for Mixed-Use Wood-Frame Buildings.

Acoustically Rated Floor Assemblies

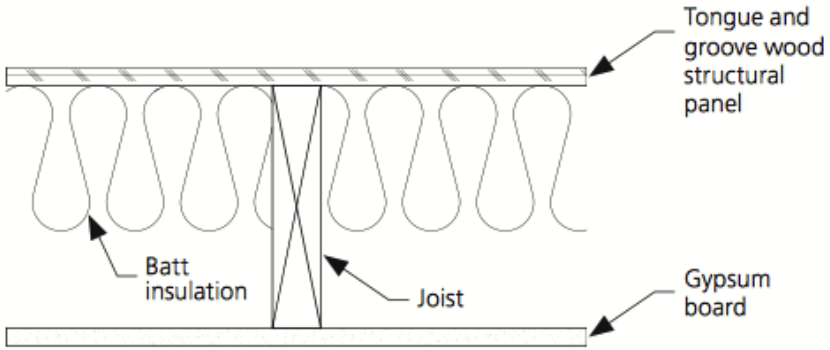
Acoustical Progression in Wood-Frame Floor/Ceiling Assemblies (Section View)

Baseline Assembly



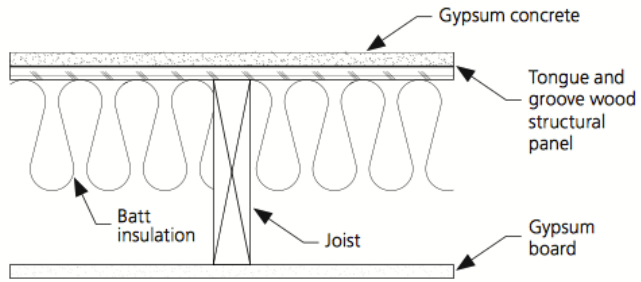
STC 37

Added Insulation



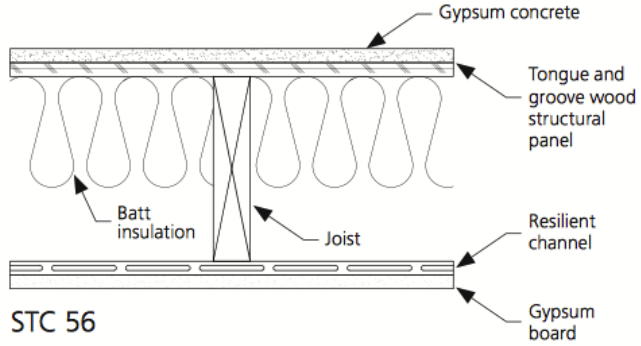
STC 43

Added Poured Topping



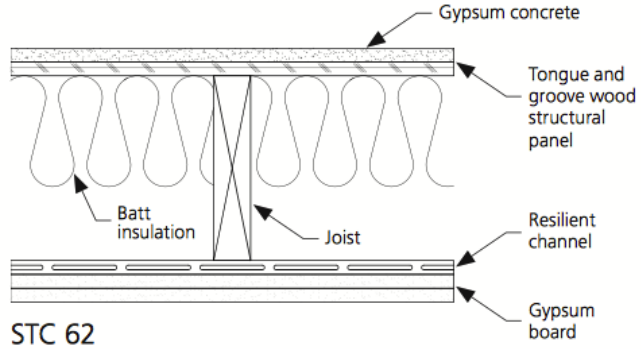
STC 49

Added Resilient Channel



STC 56

Added Additional Gyp. to Ceiling



STC 62

WoodWorks. Acoustical Considerations for Mixed-Use Wood-Frame Buildings.

Acoustical Performance Improvements

- Avoid creating flanking paths
  - Sound can bypass or “flank” sound protections, such as the wall or floor assemblies, by traveling through, around, or over/under the primary partitions

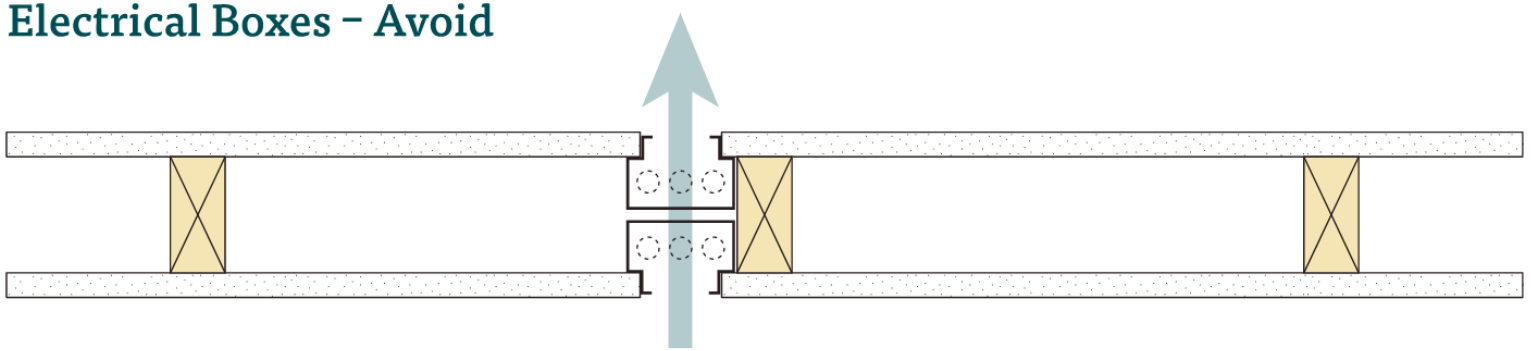
iKoustic.co.uk

Flanking transmission from one house to another

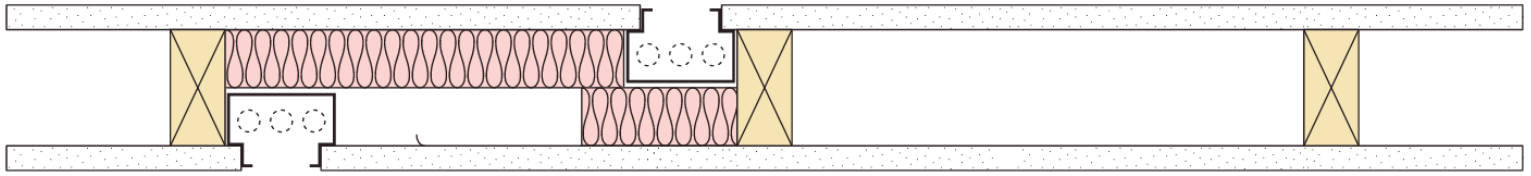
Acoustical Performance Improvements

- Avoid aligning outlets on opposite sides of common walls

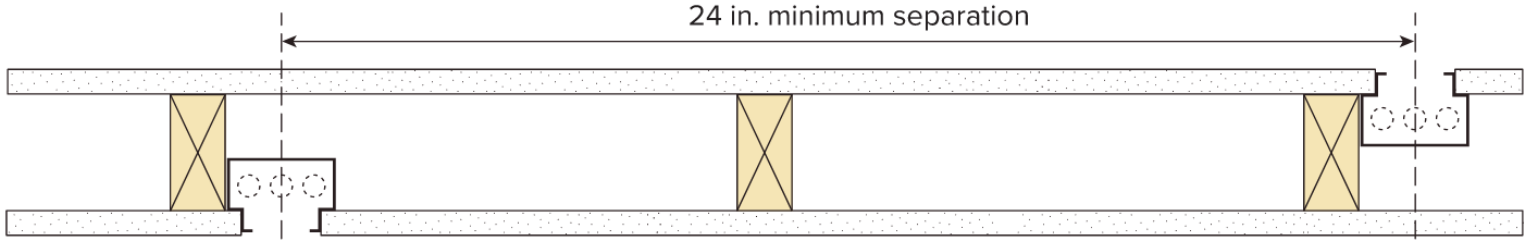
Electrical Boxes – Avoid



Electrical Boxes – Better



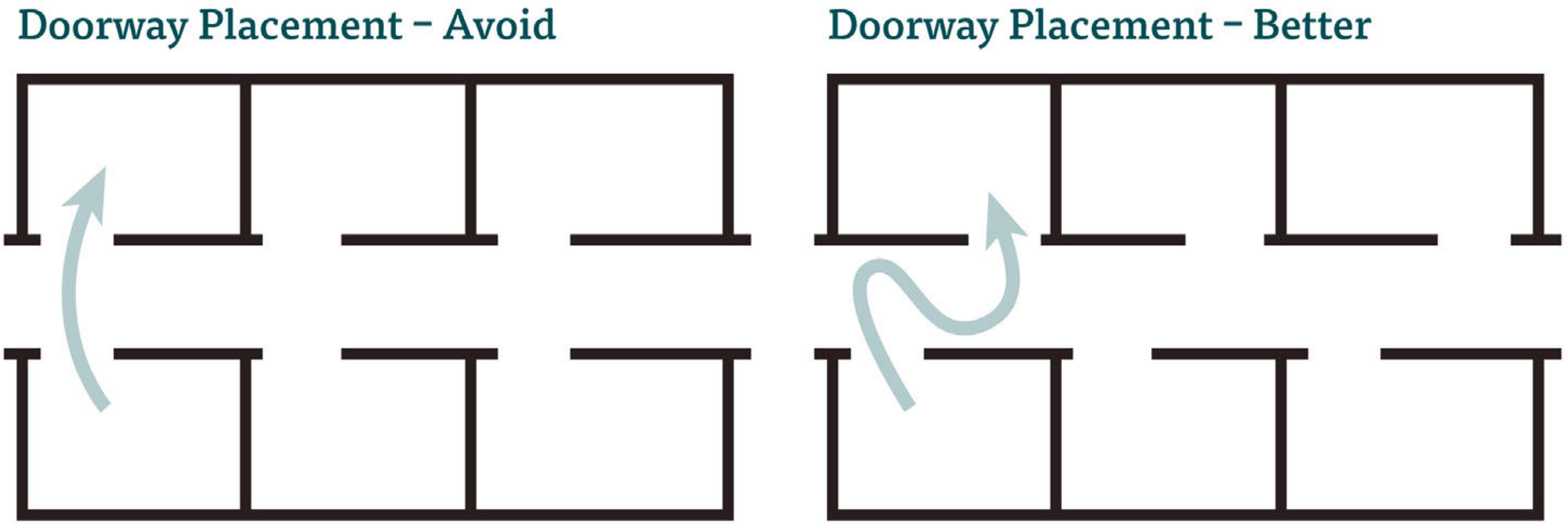
Electrical Boxes – Recommended



WoodWorks. (2025).

Acoustical Performance Improvements

» Avoid aligning doors on opposite sides of common hallways



WoodWorks. (2025).

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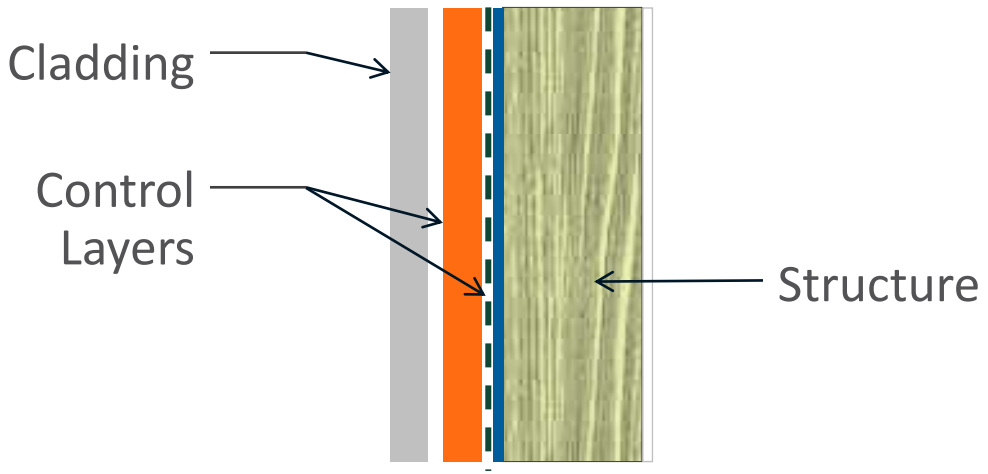
Building Enclosure

Building enclosures protect the structure & interior.

3 main components:

- Cladding: manages bulk water intrusion
- Control layers: manage heat, air, and moisture movement
- Structure: supports building envelope



Building Enclosure: Control Layers

Select products and detail to ensure:

- Continuity (in all directions)
- Compatibility
- Constructability

Water: water resistive barrier

Vapor: vapor barrier (or retarder)

Air: air barrier

Heat transfer: thermal insulation

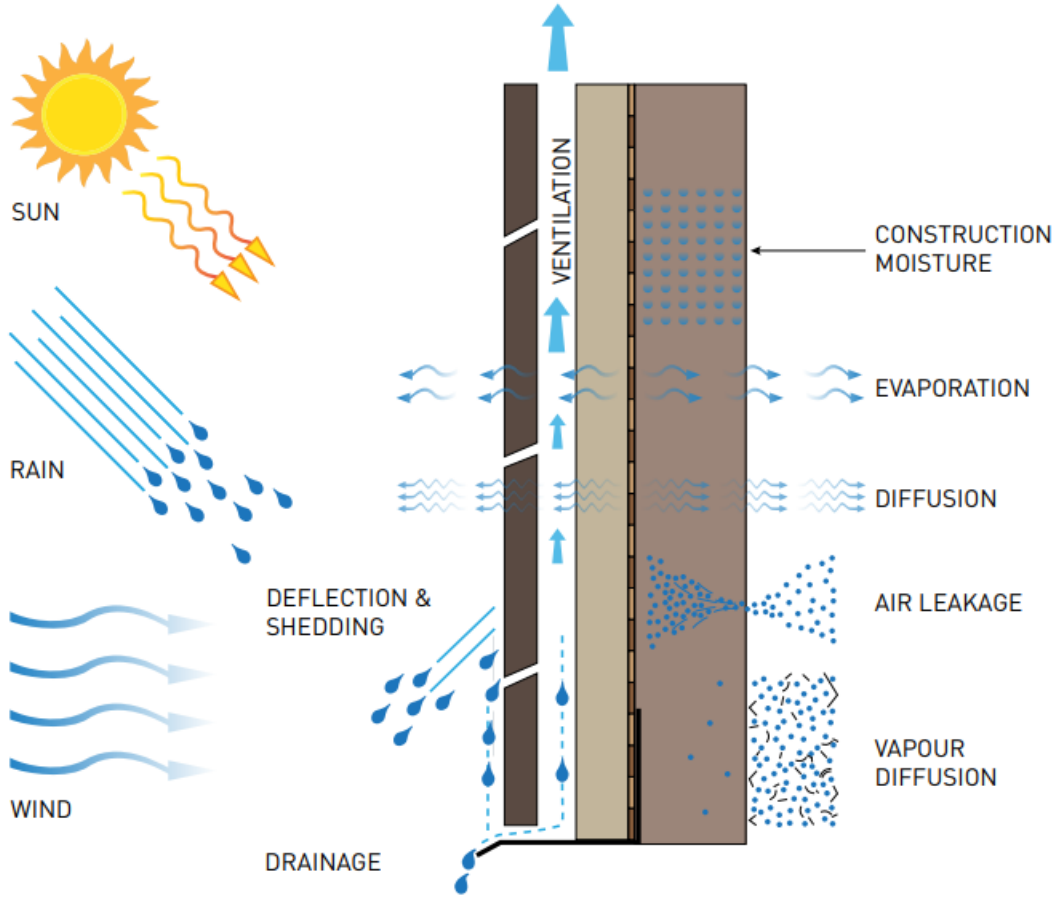
Building Enclosure: Water

Deflection: use overhangs, flashings, & cladding profiles to deflect precipitation and shed water away from the building.

Drainage: provide an adequate airspace to drain the water that may penetrate cladding to the outside.

Drying: properly vent the drainage cavity select and arrange control layer materials to minimize wetting and promote drying by diffusion and evaporation.

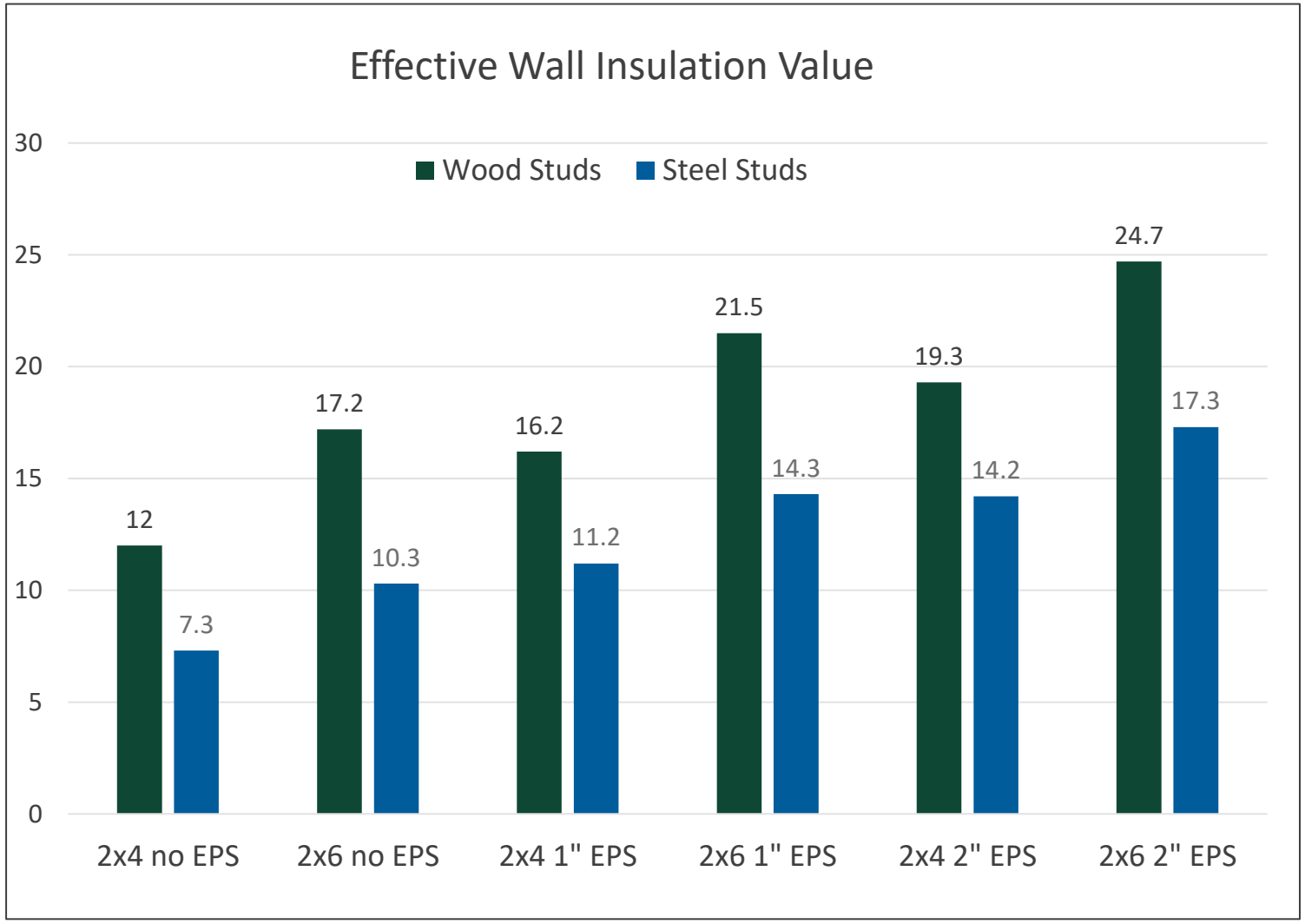
Durability – use durable materials that can tolerate periodic wetting.



The “Perfect Wall”
Source: Mass Timber Building Science Primer
By Mass Timber Institute & RDH

Thermal Performance: Wood vs. Steel Framing

- With the same amount of insulation, wood stud wall performs better thermally
- Alternatively, more insulation is required to achieve equivalent performance with a steel stud wall



Thermal Performance of Light Frame Structures—CWC, Wood Handbook–FPL USDA

Outline

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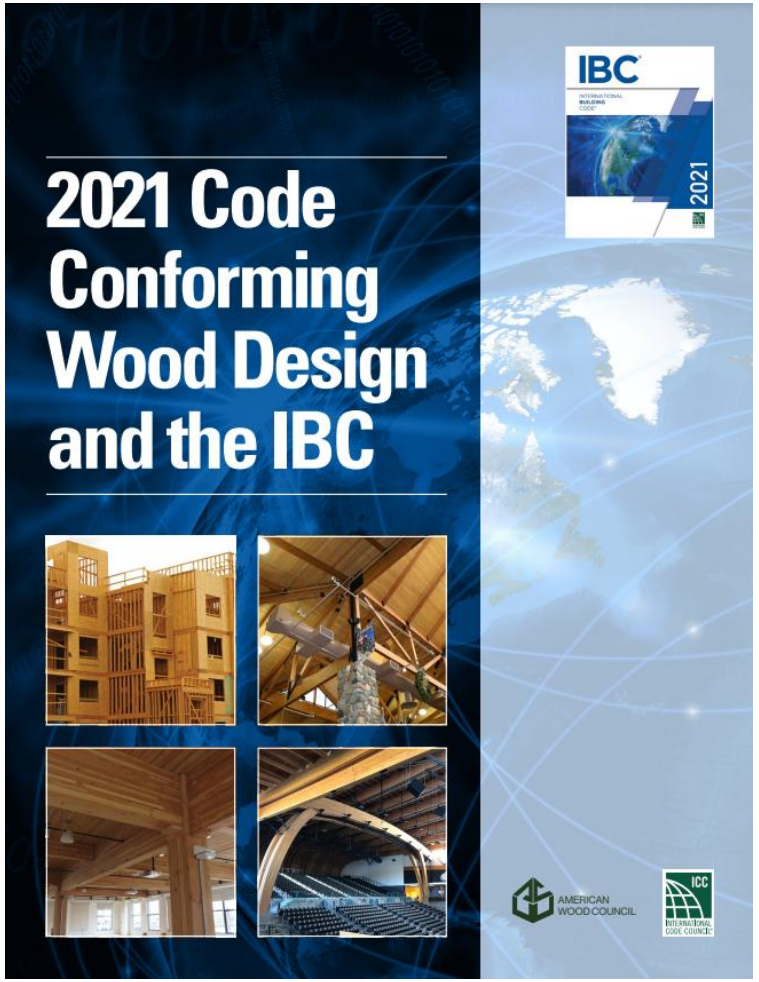
2021 Code Conforming Wood Design and the IBC



Available for Free Download: https://awc.org/

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MULTI-FAMILY/MIXED-USE | EDUCATION | OFFICE | RETAIL | INDUSTRIAL | CIVIC | INSTITUTIONAL

Designing a wood building?

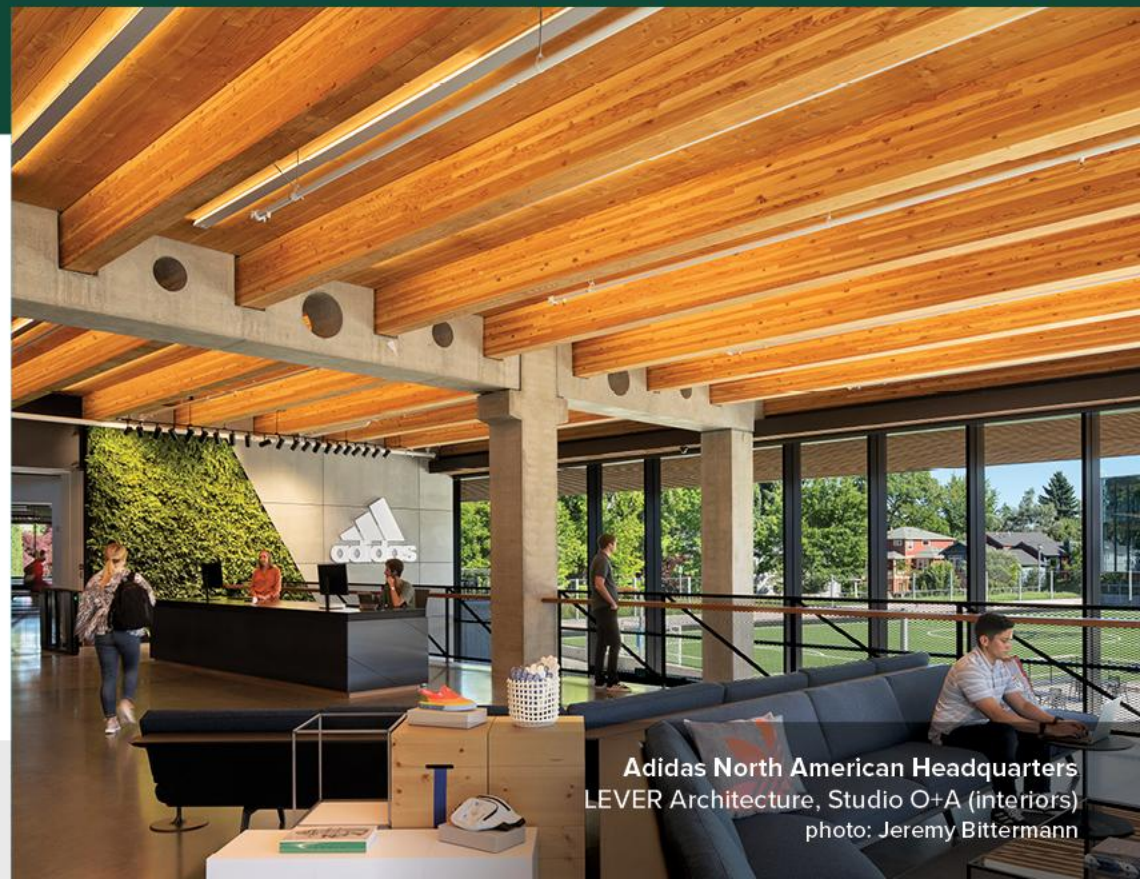
Ask us anything.

FREE PROJECT SUPPORT / EDUCATION / RESOURCES

Nationwide support for the code-compliant design, engineering and construction of non-residential and multi-family wood buildings.

- Allowable Heights/Areas
- Construction Types
- Structural Detailing
- Wood-Framed & Hybrid Systems
- Fire/Acoustic Assemblies
- Lateral System Design
- Alternate Means of Compliance
- Energy-Efficient Detailing
- Building Systems & Technologies

woodworks.org/project-assistance | help@woodworks.org



Adidas North American Headquarters
LEVER Architecture, Studio O+A (interiors)
photo: Jeremy Bittermann

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Emmy Tran, PE

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Funding provided in part by the Softwood Lumber Board