Mid-Rise Design: Optimizing Size, Framing Efficiently with Engineered Wood

Presented by:

Mark Bartlett, PE
Regional Director | TX
WoodWorks

and Aleeta Dene, PE, for

Roy Frederick,
Engineered Wood Specialist
APA – The Engineered Wood Association

August 9, 2022

Resources

New WOOD SOLUTION PAPER

CLT Diaphragm Design for Wind and Seismic Resistance

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New for GCs and installers:

U.S. Mass Timber Construction Manual

PHOTO: MARCUS KAUFFMAN

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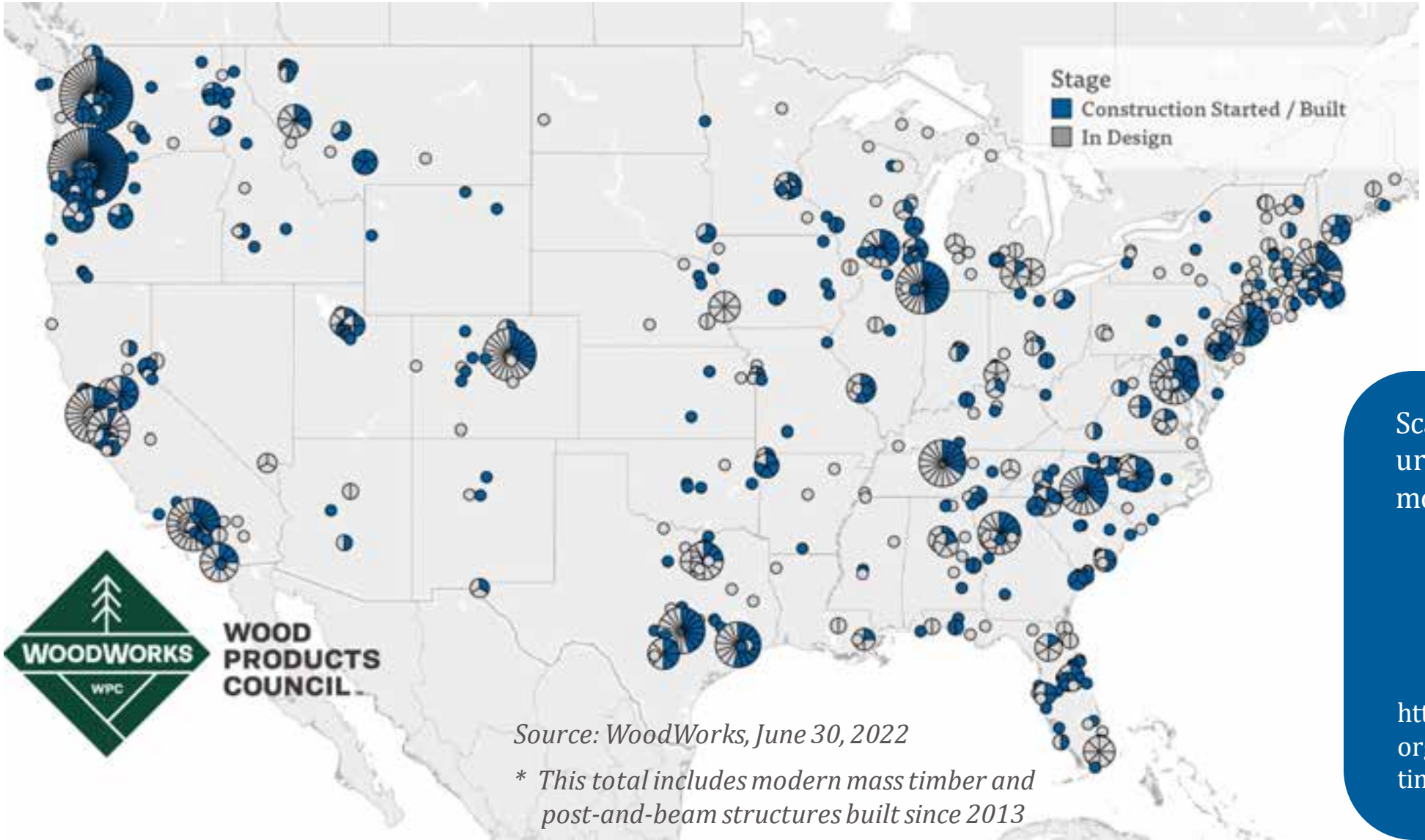
Current State of Mass Timber Projects

As of June 2022, in the US, **1,502** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



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Source: WoodWorks, June 30, 2022

* *This total includes modern mass timber and post-and-beam structures built since 2013*

Scan this code or use the url to find the map and more details online.

https://www.woodworks.org/resources/u-s-mass-timber-projects/

Continuing Education Credits

- Participants will receive a certificate of completion via email
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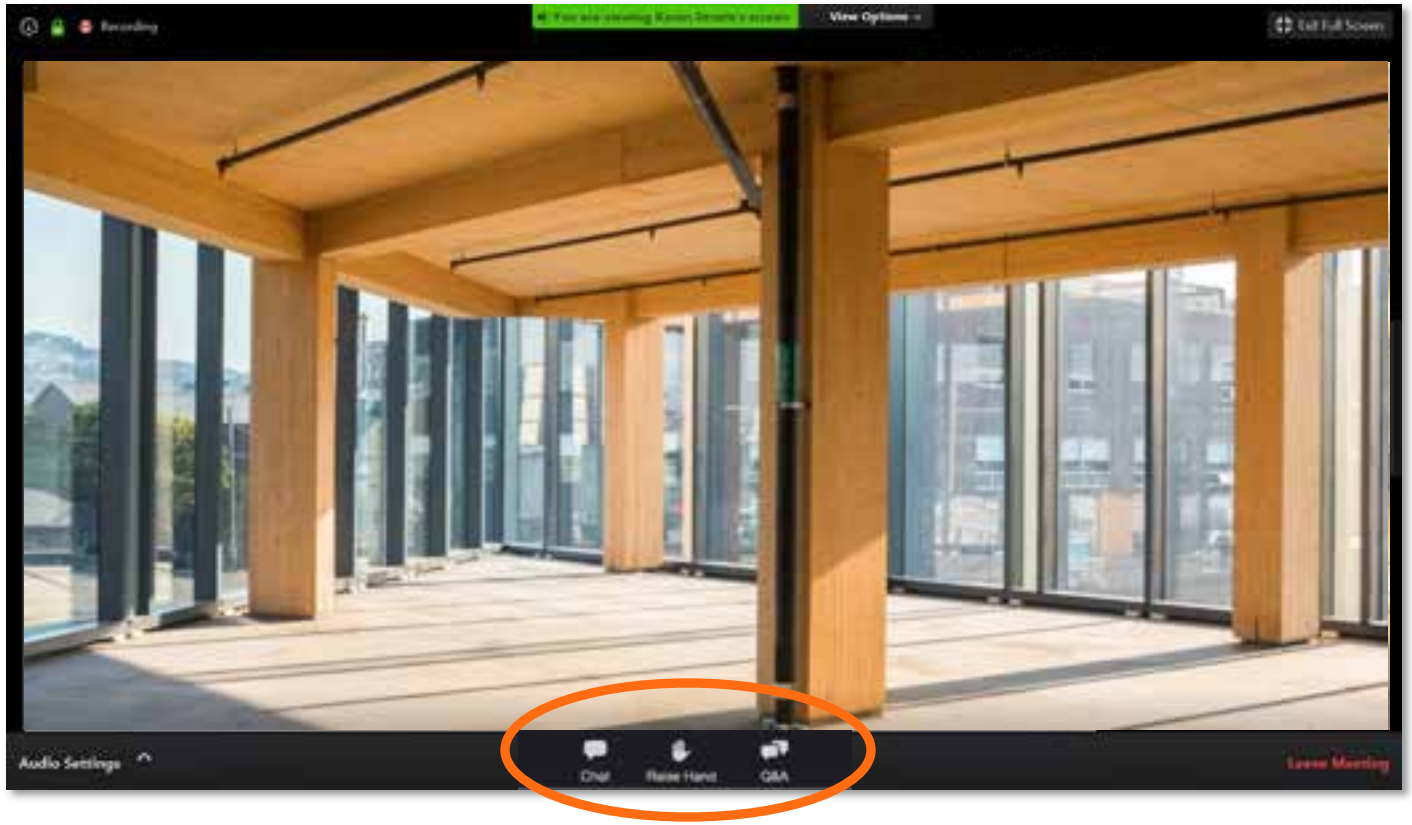
Ask Questions through the Q&A Box

- Submit questions in the **Q&A** box at the bottom of your screen as they come up in the presentations. We will **get to as many questions as possible.**



Allowable Building Size

IBC Chapter 5

Allowable building size a function of:

- Building use (occupancy)
- Construction type
- Fire department access
- Sprinklers

Occupancy Groups

IBC Chapter 3

Mixed use buildings often have 2, 3 or more different occupancy groups. Common examples include:

A: *Assembly*: restaurant, theater, arena, lecture hall
B: *Business*: office building, college, bank
M: *Mercantile*: retail store, sales room
R: *Residential*: apartment, dormitory, hotel
S: *Storage*: parking, bulk material storage

Construction Types

IBC 602

Type III

Exterior walls non-combustible (may be FRTW)
Interior elements any allowed by code

Type V

All building elements are any allowed by code

Types III and V are subdivided into **A** (protected) and **B** (unprotected)

Type IV (Heavy/Mass Timber)

Exterior walls non-combustible (may be FRTW)
Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces)

Construction Types

Allowable Building Height

IBC 2018 Tables 504.3 & 504.4

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	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60

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	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	2	1
	S	UL	6	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
E	NS	UL	5	3	2	3	2	3	1	1
	S	UL	6	4	3	4	3	4	2	2

Construction Types

Allowable Building Area

IBC 2018 Table 506.2

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	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000
E	NS	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	102,000	74,000	38,000
	SM	UL	UL	79,500	43,500	70,500	43,500	76,500	55,500	28,500

Construction Type Differences

	IIIA	IIIB	IV	VA	VB
Ext Wall Material	FRTW	FRTW	FRTW	Any wood	Any wood
Ext Bearing Wall Rating	2 Hr	2 Hr	2 Hr	1 Hr	0 Hr
Interior Elements	Any wood	Any wood	Heavy Timber	Any wood	Any wood
Fire Wall Materials	Non-combustible	Non-combustible	Non-combustible	Any	Any
Building Size	Typ 2nd largest; often same # of stories as IV but smaller area	Comparable to VA, larger in some cases, smaller in others	Typ largest; often same # of stories as IIIA but larger area	Comparable to IIIB; often 1-2 stories less than IIIA and IV	Smallest; often 1 story less than VA and 1/2 to 2/3 area of VA

Fire Department Access

IBC 202

Mid-Rise vs. High-Rise

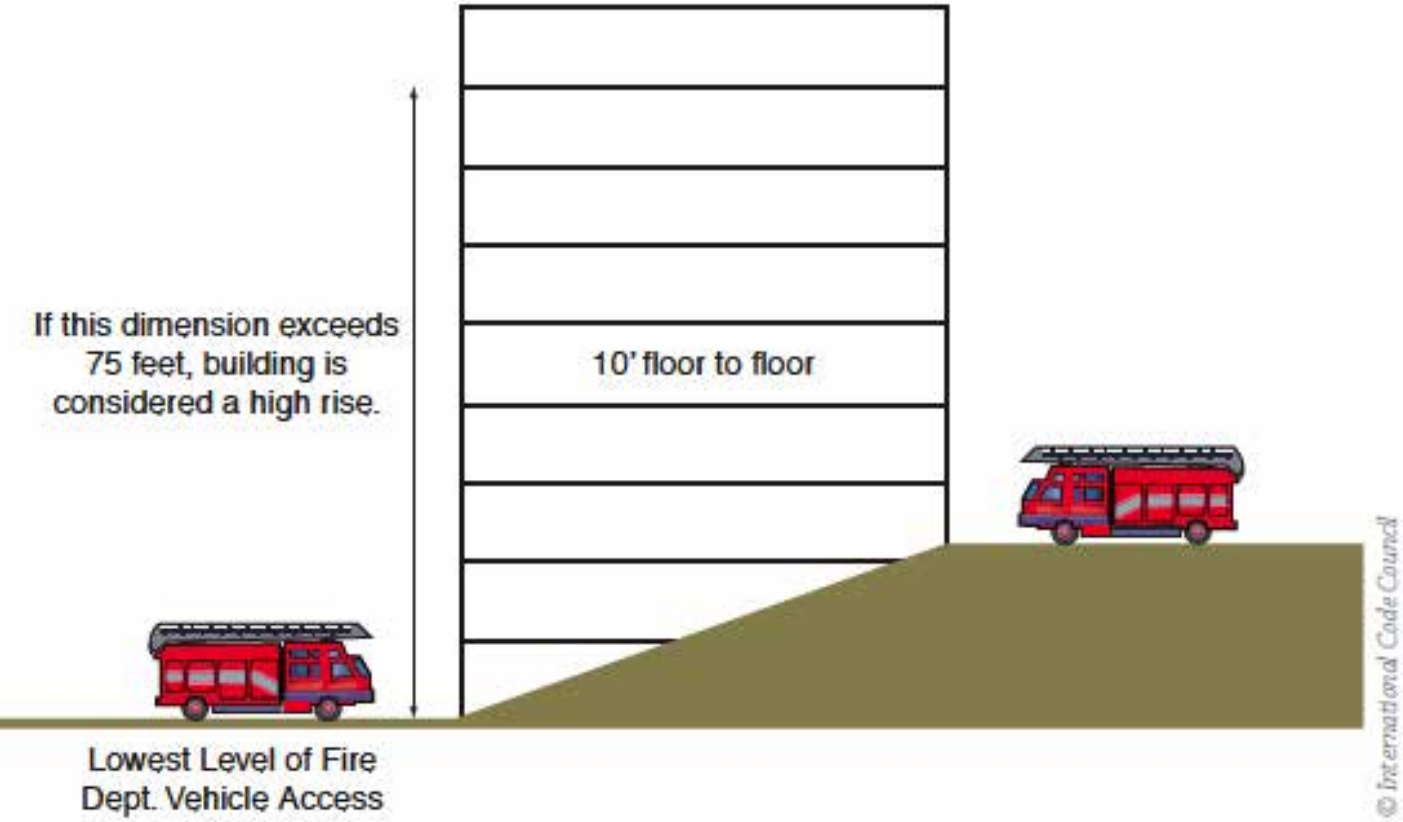


FIGURE 6-6 Determination of high-rise building

High-Rise Building:

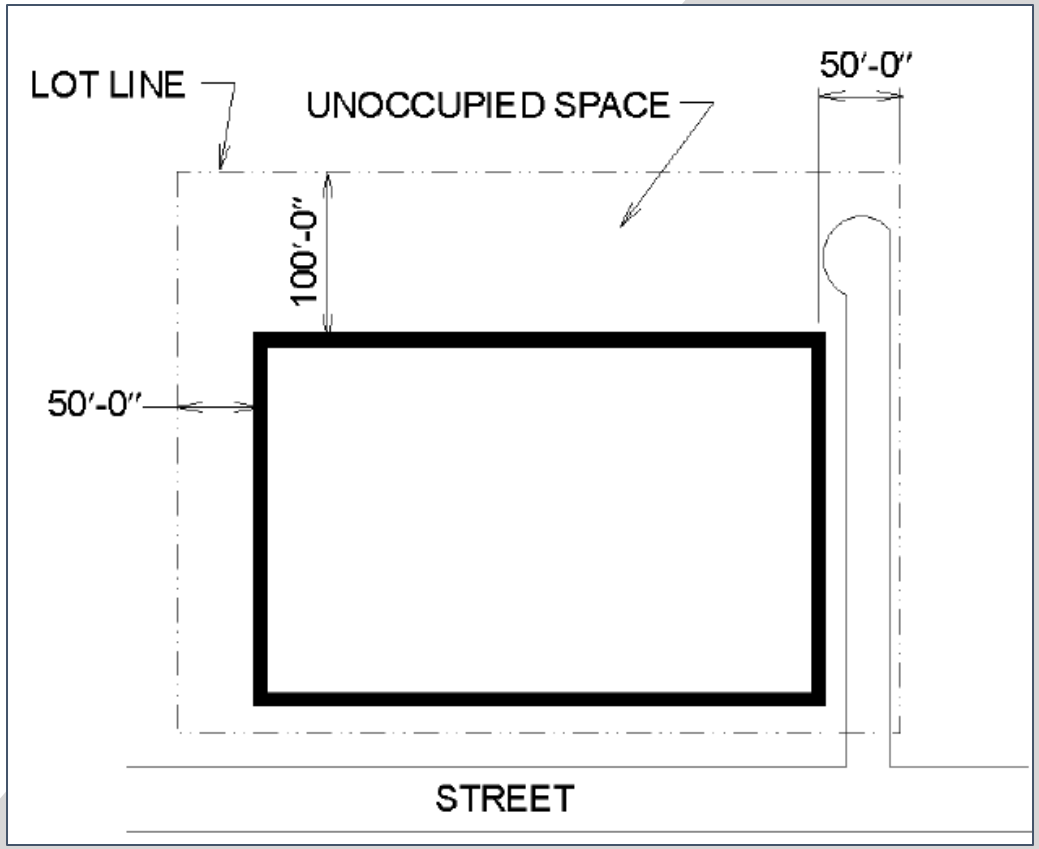
A building with an occupied floor located more than 75 feet above the lowest level of fire department vehicle access.

Fire Department Access

IBC 506

Frontage

Frontage provides access to the structure by fire service personnel, a temporary refuge area for occupants as they leave the building in a fire emergency and a reduced exposure to and from adjacent structures. Larger building area possible with certain amount of frontage



Sprinkler Requirements

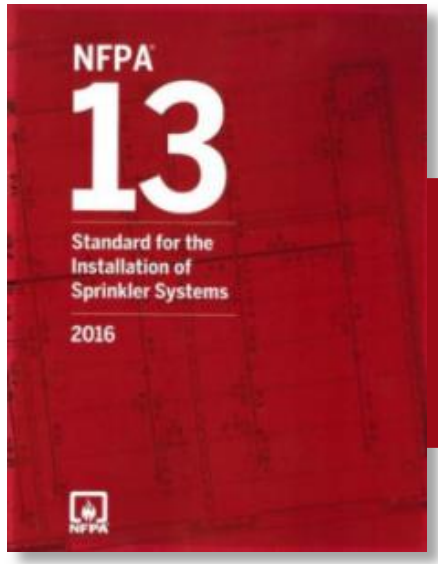
IBC 903.2

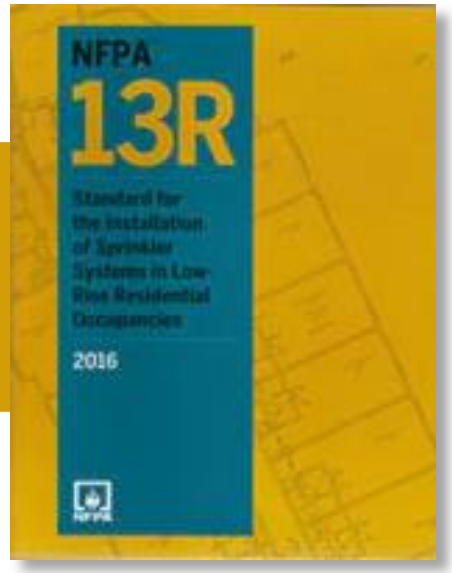
- NFPA 13 or 13R sprinkler system required in all new group R fire areas
- NFPA 13 sprinkler system required in most commercial facilities of any size regardless of construction type or materials used
- Example: Occupancy Group a-2 (restaurant, casino, banquet hall):
  - If Fire Area Exceeds 5,000 sf, or
  - If occupant load is 100 or more

Commercial Sprinkler Systems

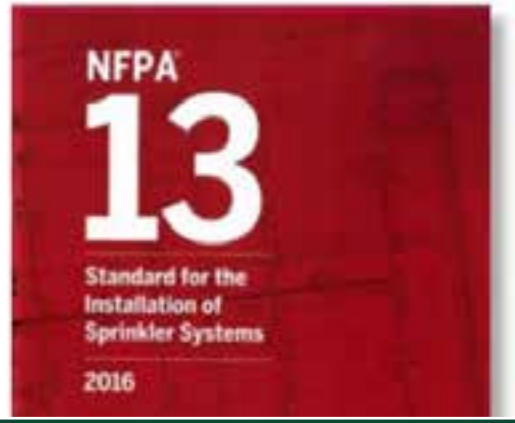
IBC 903.3.1

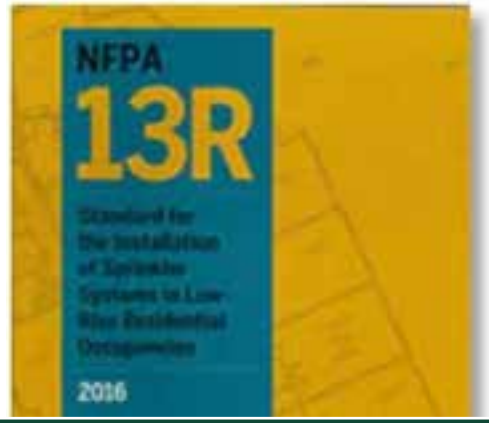
- **NFPA 13**
  Standard for Commercial Construction 903.3.1.1
- **NFPA 13R**
  Residential Occupancies (One- and Two-Family or Low-Rise Multi-Family and Commercial) 903.3.1.2
- **NFPA 13D**
  Standard for One- and Two-Family Residences (but allowed in a few commercial occupancies) 903.3.1.3





Sprinkler Differences





NFPA 13	NFPA 13R
Goal: Provide life safety and property protection	Goal: Provide life safety only
Fully sprinklered system throughout entire building even in unoccupied spaces (closets, attics)	Partially sprinklered system; unoccupied spaces often don't require sprinklers
Can cost more	Lower levels of water discharge, shorter water supply time can result in smaller pipe sizes, reduce need for storage & pumps
Permitted for many occupancies, buildings of many sizes, allows greater building size increases	Limited applications, mainly for multi-family up to 4 stories, 60 feet

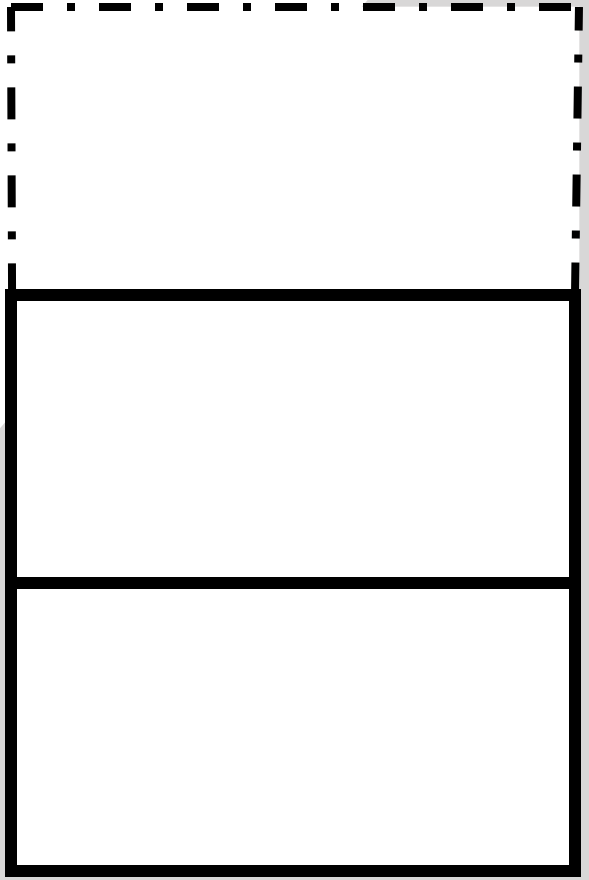
Allowable Building Height

IBC 2018 Tables 504.3 & 504.4

Building Height Increase

Buildings equipped throughout with an NFPA 13 or 13R* sprinkler system are allowed an additional **1 story and 20 ft** over nonsprinklered conditions

*NFPA 13R limited to 60 ft & 4 stories



Allowable Building Height

IBC 2018 Table 504.3

Provides base (non-sprinklered) & increased heights

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

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

NS = Buildings not equipped throughout with an automatic sprinkler system

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

S13D (not shown) = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3 (NFPA 13D)

Allowable Stories

Provides base (non-sprinklered) & increased # of stories

IBC 2018 Table 504.4

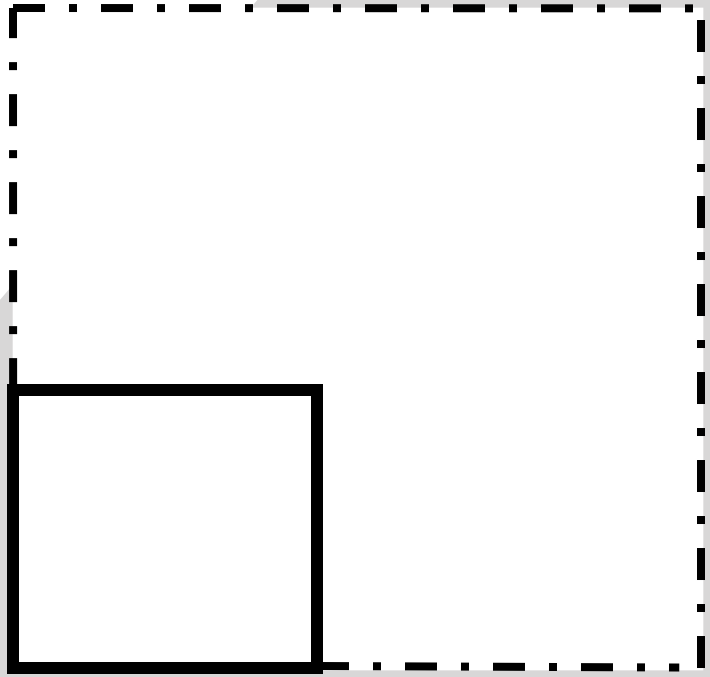
OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4						4	3
	S	UL	12	5	5	5	5	5	4	3
R-2	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4	4					4	3
	S	UL	12	5	5	5	5	5	4	3
S-1	NS	UL	11	4	2	3	2	4	3	1
	S	UL	12	5	3	4	3	5	4	2

Allowable Story Area

IBC 2018 Table 506.2

Floor Area Increase

Buildings equipped throughout with an NFPA 13 sprinkler system can be increased **300% (single story buildings)** or **200% (multi-story buildings)** over nonsprinklered conditions



Allowable Story Area

IBC 2018 Table 506.2

Provides base (non-sprinklered) & increased areas

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

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
R-1	NS[d, h]	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000
	S13R									
	S1	UL	UL	96,000	64,000	96,000	64,000	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	61,500	36,000	21,000

**Can still increase these areas by the Frontage Factor of Section 506.3

NS = Buildings not equipped throughout with an automatic sprinkler system

S1 = Buildings a maximum of one story above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

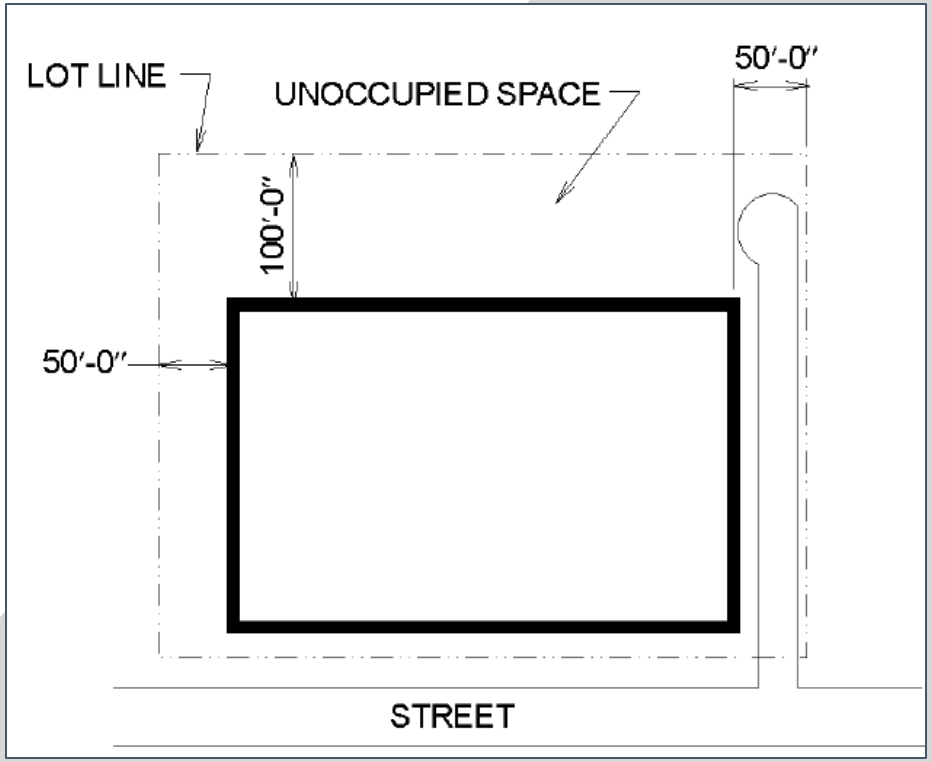
S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

Allowable Story Area

IBC 506.3

Area Frontage Increase

Buildings with minimum levels of open frontage can add **up to 75%** of allowable nonsprinklered area to total floor area



IBC Building Size Limits

IBC Chapter 5

Residential (R1, R2 & R4) Occupancies: Type IIIA Construction

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

* Assuming max stories built

** Maximum allowable frontage increase

Allowable Building Size

2018 IBC Chapter 5

Residential (R1, R2 & R4) Occupancies with NFPA 13 Sprinkler System

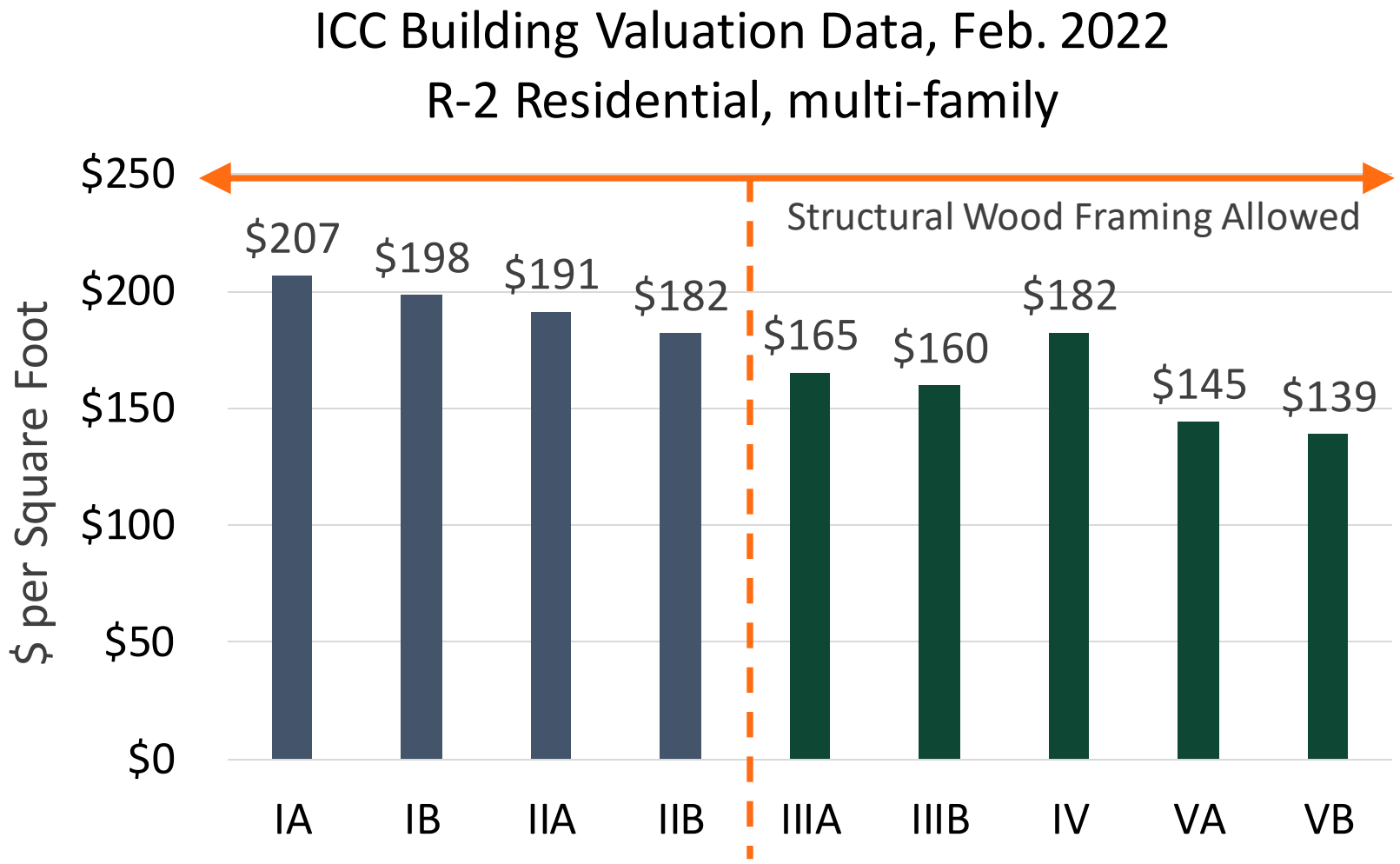
Construction Type / Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	5	5	5	4	3
Height (ft)	85	75	85	70	60
Story Area* (ft^2)	90k	60k	76.9k	45k	26.3k
2 story: Total Bldg Area (ft^2)	180k	120k	153.8k	90k	52.5k
3+ story: Total Bldg Area (ft^2)	270k	180k	230.6k	135k	78.8k

*Assumes full frontage increase

Building Configuration Options

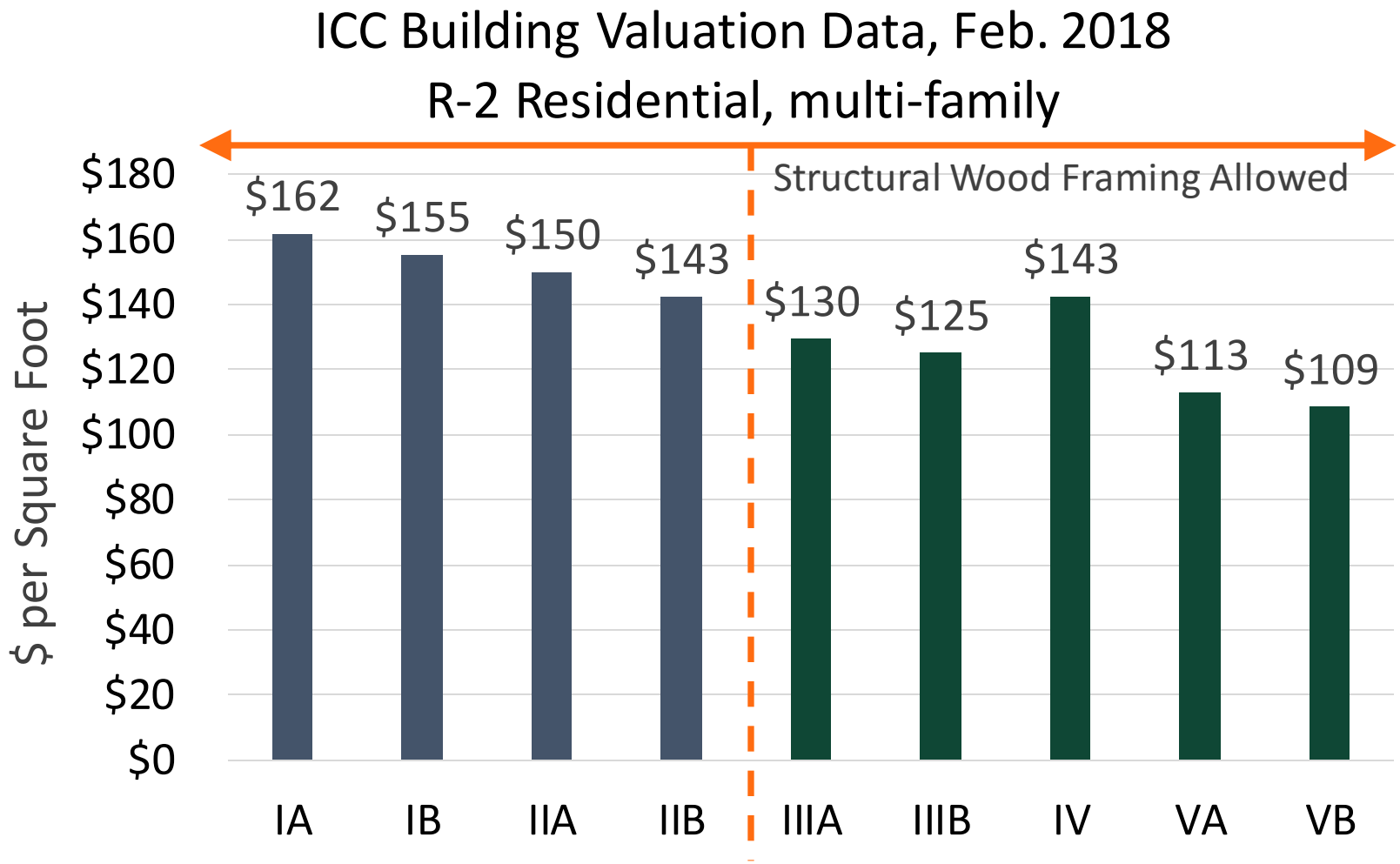
Many buildings utilize a higher construction type than necessary due to traditional practice. This can have an impact on fire ratings, materials and ultimately cost.

ICC Building Valuation Data - 2022



Type VB $43/sf less than Type IIB

ICC Building Valuation Data - 2018



Type VB $34/sf less than Type IIB

Special Provisions

IBC 510

Construction Types

IBC 602.1 requires that each building be classified in one of five construction types.

IBC 510 contains special provisions that in some cases, allow multiple construction types in the same building or multiple “buildings” stacked on top of each other

Photo: Arden Photography

Special Provisions

IBC 510.2

Horizontal Building Separation

Often called ***Podium provision***:

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

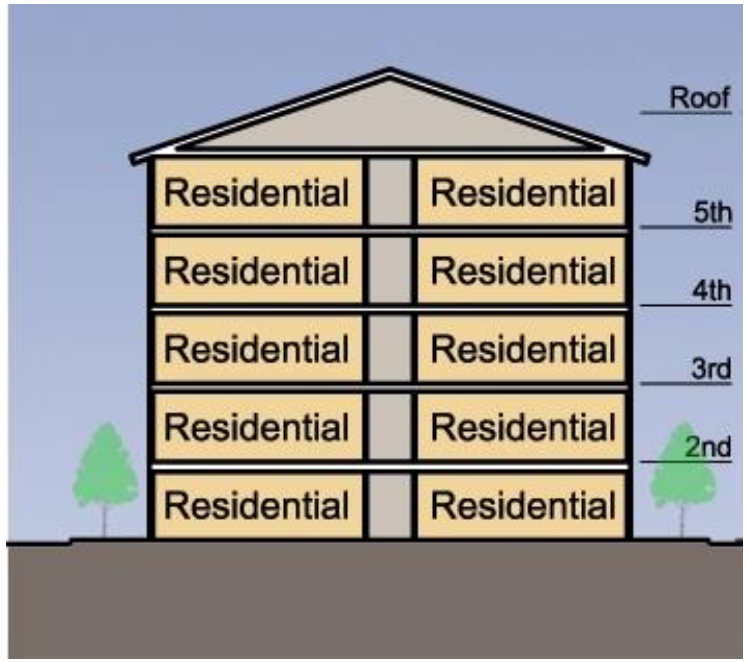
- Overall height in feet is still limited to min of either building
- 3hr rated horizontal assembly
- Building below is Type 1A with sprinklers

Occupancy restrictions above and below

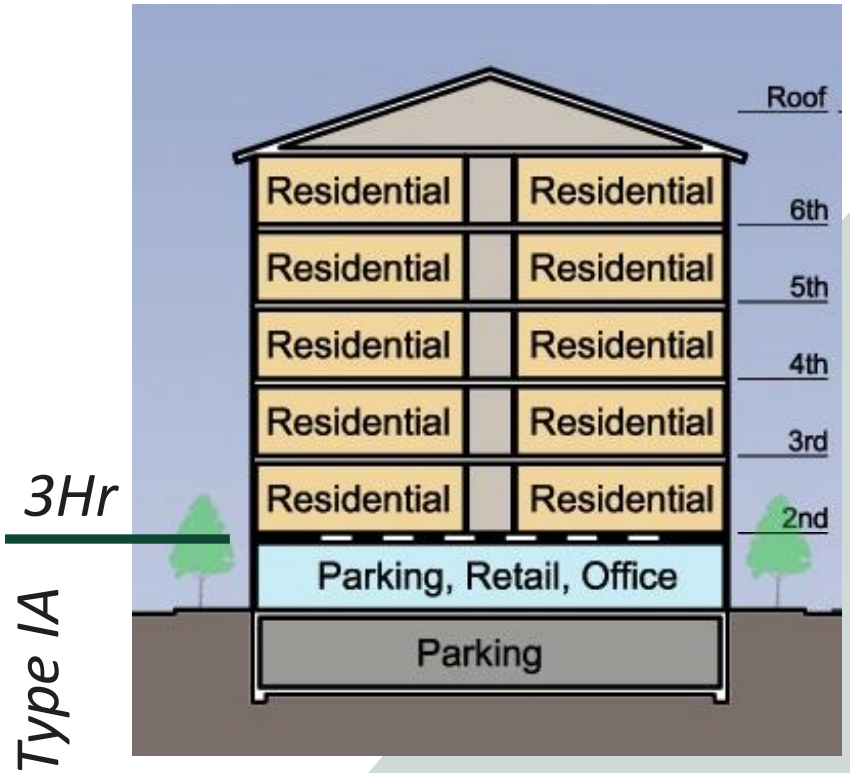
Special Provisions

IBC 510.2

Horizontal building separation



5 story Type III Building

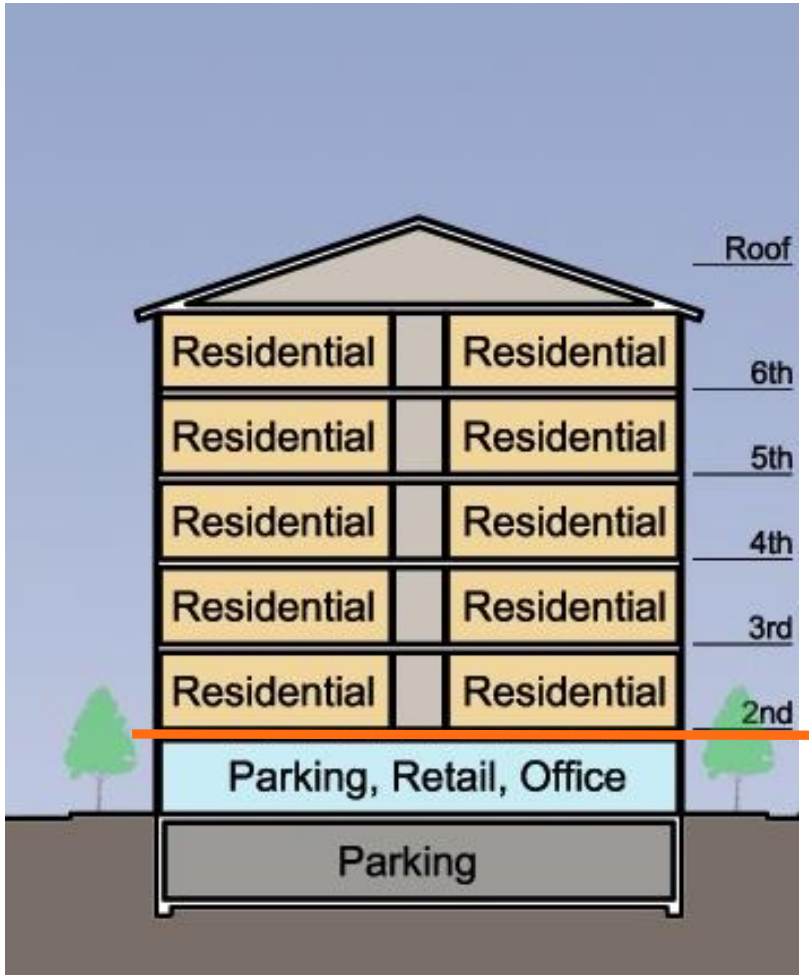


5 story Type III Building
on top of a Type IA Podium

Increases allowable stories… not allowable building height

Special Provisions

IBC 510.2



IBC Provisions for Mixed-Use podium have been evolving.

IBC	2006	2009	2012	2015	2018
Section	509.2	509.2	510.2	510.2	510.2
Upper Occupancy	A, B, M, R or S				
Lower Occupancy	S-2 Parking	A, B, M, R or S-2 Parking		Any Except H	
Podium Height	1 Story		1 Story	No Restriction	

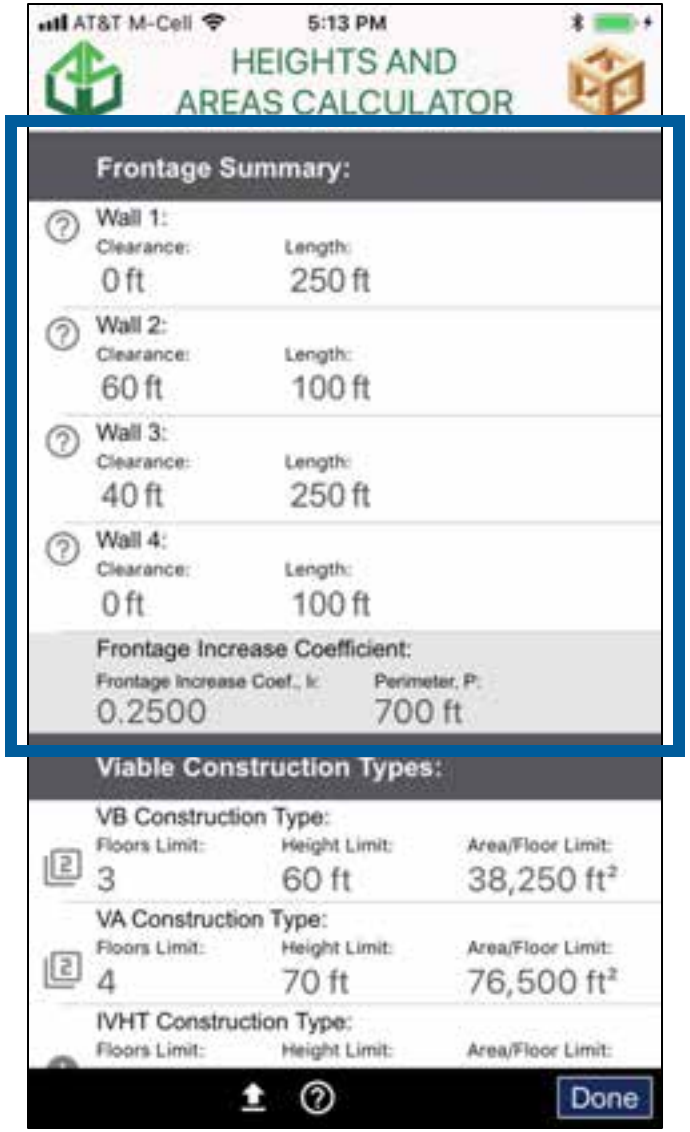
2015 & 2018 IBC allow multiple podium stories above grade

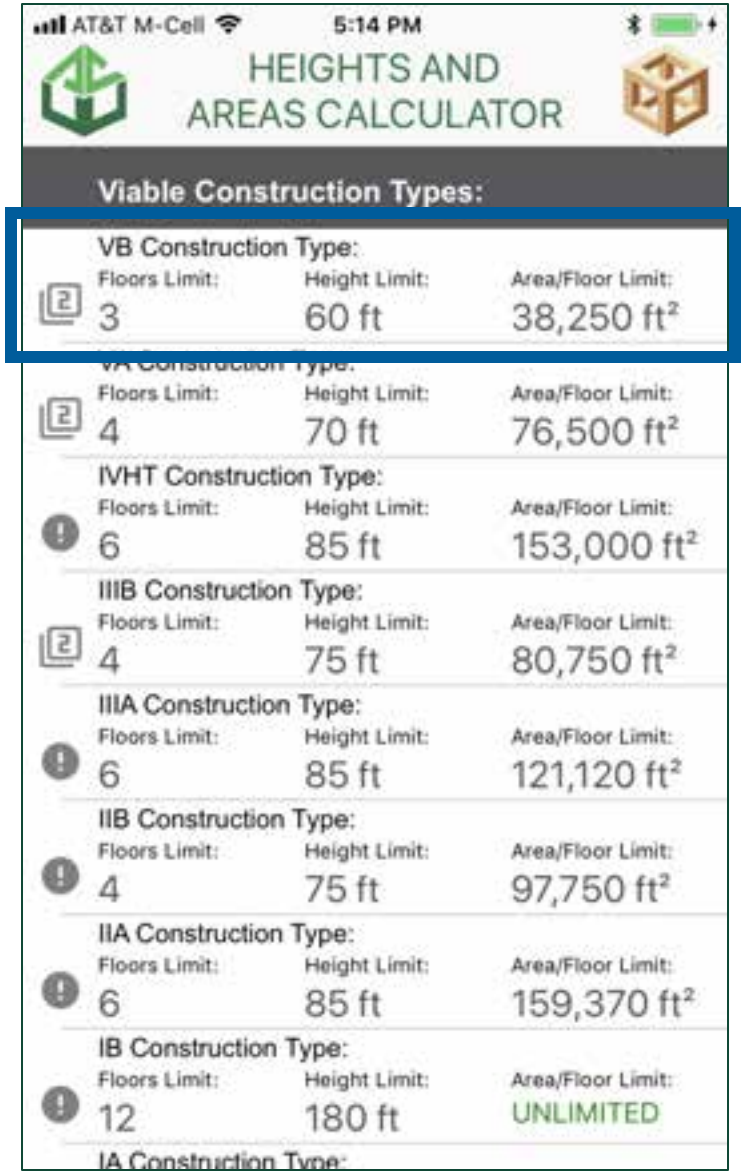
Allowable Building Size

Heights and areas calculator – free tool

http://www.woodworks.org/design-and-tools/design-tools/online-calculators/

Handles Separated & Nonseparated Occupancies (Check “both”)





Questions? Ask us anything.

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901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn

Thank You

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