

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

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Association

August 30, 2022

*Crescent Terminus / Lord Aeck Sargent / photo Richard Lubrant*

# Resources

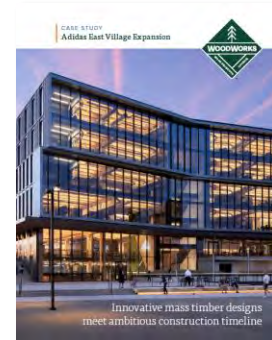
## New WOOD SOLUTION PAPER

### CLT Diaphragm Design for Wind and Seismic Resistance Using SDPWS 2021 and ASCE 7-22



## New CASE STUDIES

### Adidas East Village Expansion Innovative mass timber designs meet ambitious construction timeline



### Thomas Logan

Wood-frame urban podium project fills  
need for affordable downtown housing

Visit [woodworks.org/learn/](https://woodworks.org/learn/)

# Upcoming Events

## Common Challenges in Light Wood-Frame Gravity Structural Design | September 15

1.0 AIA/CES HSW LUs, 1.0 PDH credits, 0.10 ICC credits



Visit [woodworks.org/events](https://woodworks.org/events)





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[www.advancing-mass-timber.com](http://www.advancing-mass-timber.com)



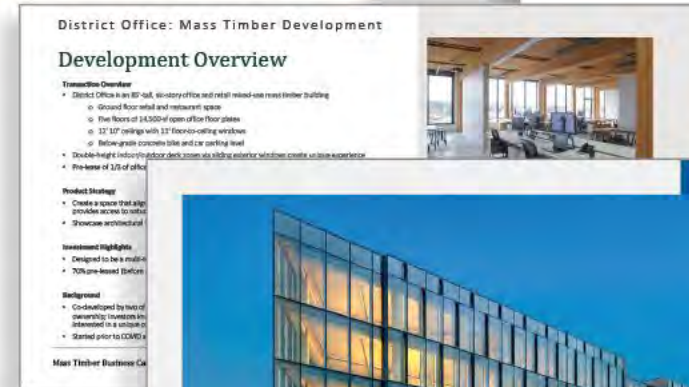
# Mass Timber Business Case Studies

Real financial information on real deals

- Prepared by WoodWorks and Conrad Investment Management
- Include qualitative influences + quantitative data to examine investment success

## PROPERTY SUB-TYPES:

For-Rent Institutional Housing • Institutional Offices •  
Industrial Buildings • Redevelopment/Additions •  
Purpose-Built Owner/Occupied (Student Housing)



« Scan the code to download the current package.

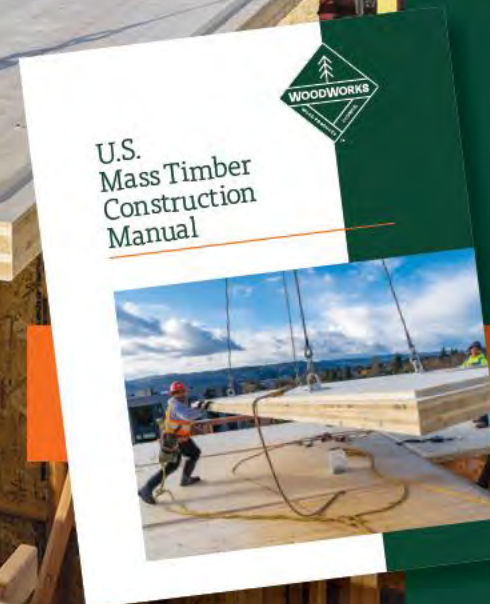




# New for GCs and installers: U.S. Mass Timber Construction Manual



PHOTO: MARCUS KAUFFMAN



Download free at  
[woodworks.org](http://woodworks.org)





# Nominations Open

| Visit [woodworks.org/nominate](https://woodworks.org/nominate)

## 2023 Wood Design Awards

| DEADLINE: OCT. 14, 2022



The Lighthouse | Gensler  
Photo Jason O'Rear



# Design Professionals: One-on-One Support & Assistance

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OPEN POSITION

COMING SOON



David Hanley

OPEN POSITION



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Scott Breneman, PhD, PE, SE



Ashley Cagle, PE, SE



Karen Gesa, PE



Bruce Lindsey



Melissa Kroskey, AIA, SE



Terry Malone, PE, SE



Ricky McLain, PE, SE

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# NOW HIRING

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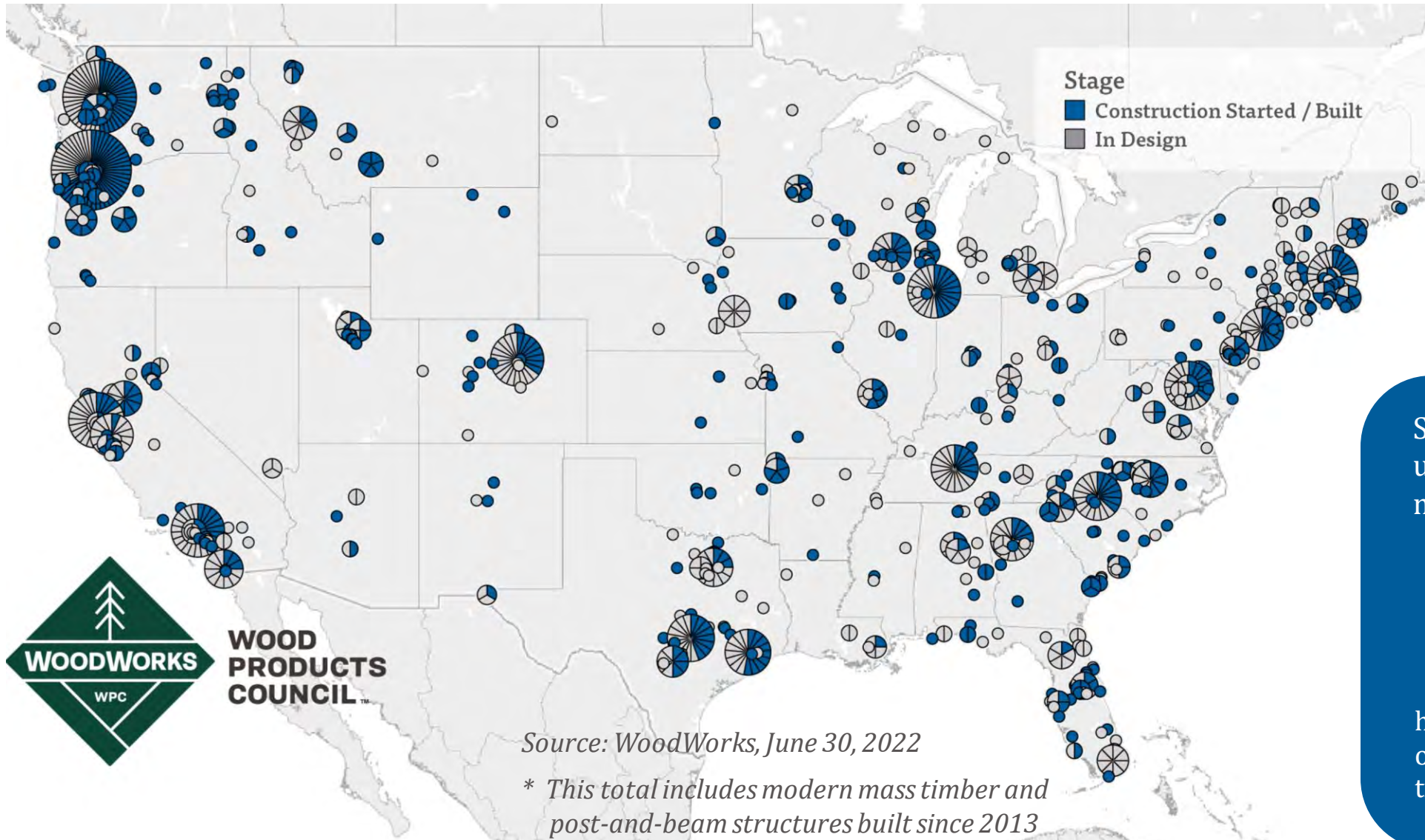
REGIONAL DIRECTOR – SEATTLE, WA  
METRO AREA





# 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.



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

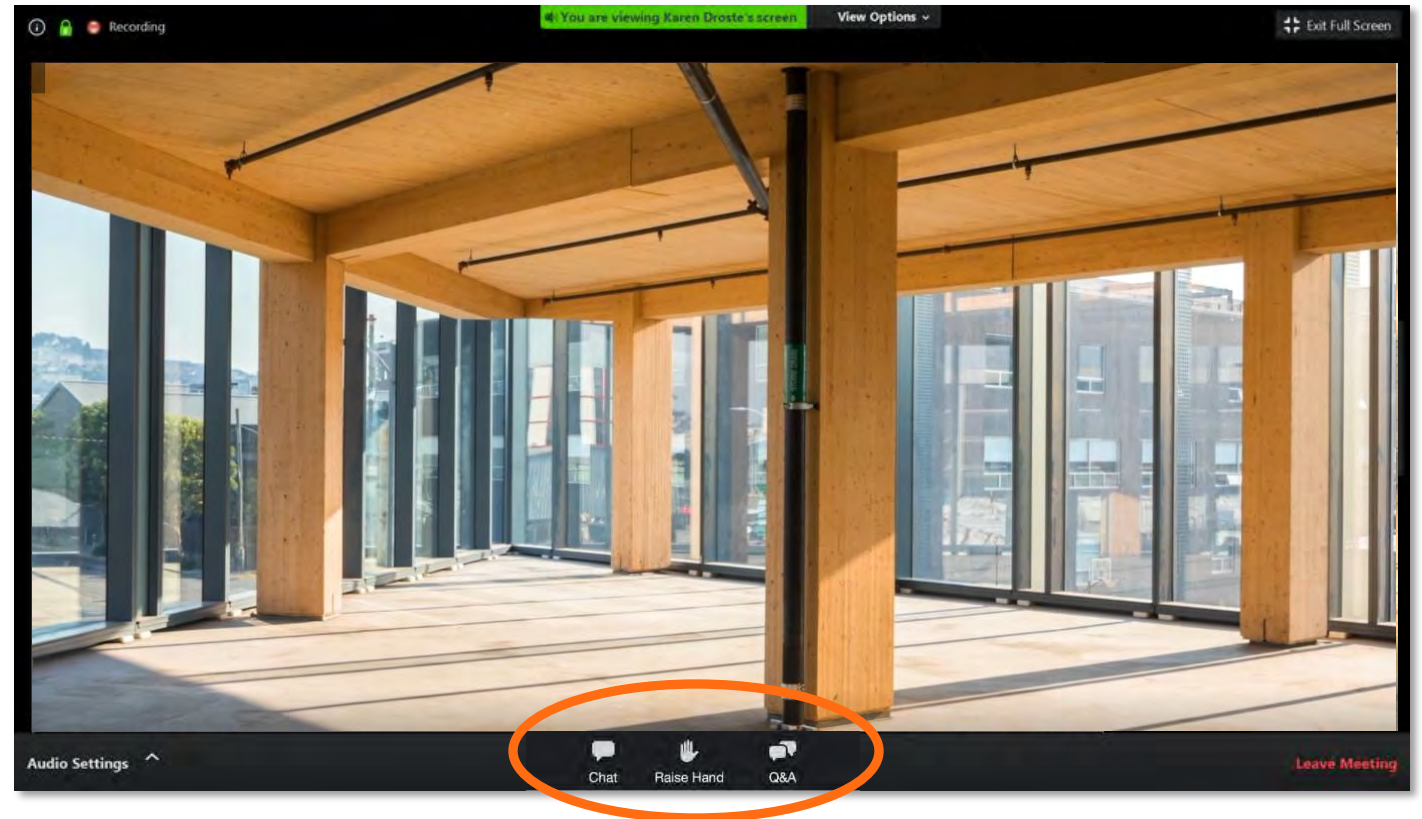
- Participants will receive a certificate of completion via email
  - AIA credits will be processed by WoodWorks
- 
- To receive credit and a certificate, attendees must stay on for the duration of the seminar.



# 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.



“The Wood Products Council” is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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



# Course Description

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As cities seek increased density as a way to address urban population growth, many building designers and developers are looking to mid-rise wood construction as a cost-effective, code-compliant and sustainable solution. This presentation will cover some of the design considerations associated with mid-rise wood-frame buildings, including how to maximize height and area through the use of sprinklers, open frontage, sloping sites, podiums and mezzanines. Construction types will be reviewed, with an emphasis on opportunities for wood use in Type III and V construction. Efficient use of engineered wood products such as wood structural panels, glulam, and structural composite lumber in wall, floor and roof assemblies specific to mid-rise construction will also be discussed, providing attendees with a deeper understanding of when and how to specify these framing systems most efficiently.

# Learning Objectives

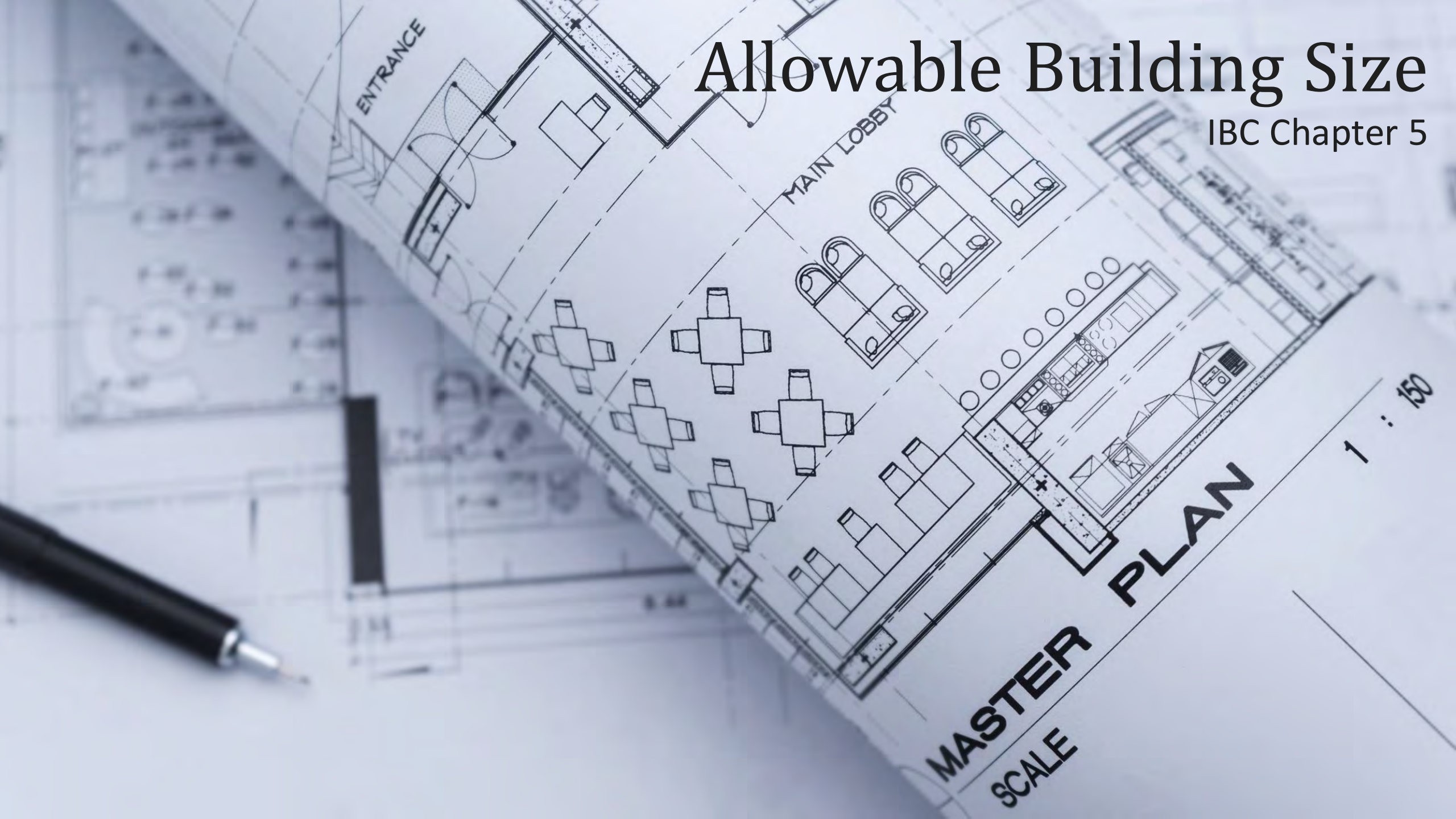
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1. In the context of a shift toward increased urban density, discuss how mid-rise, wood-frame construction meets housing needs while contributing to vibrant and sustainable communities.
2. Discuss allowable construction types, occupancies, building heights and areas for wood-frame mid-rise construction per the International Building Code.
3. Identify potential modifications to the IBC's base tabular heights and areas based on building frontage, sprinklers, sloping sites, podiums and mezzanines.
4. Highlight the use of engineered wood products in code-compliant wall, floor and roof assemblies specific to mid-rise construction.



# Allowable Building Size

IBC Chapter 5



# 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<sup>a</sup>**

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 <sup>b</sup>	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<sup>a, b</sup>**

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

IBC 2018 Table 506.2

## Allowable Building Area

**TABLE 506.2**  
**ALLOWABLE AREA FACTOR ( $A_f$  = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET<sup>a, b</sup>**

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



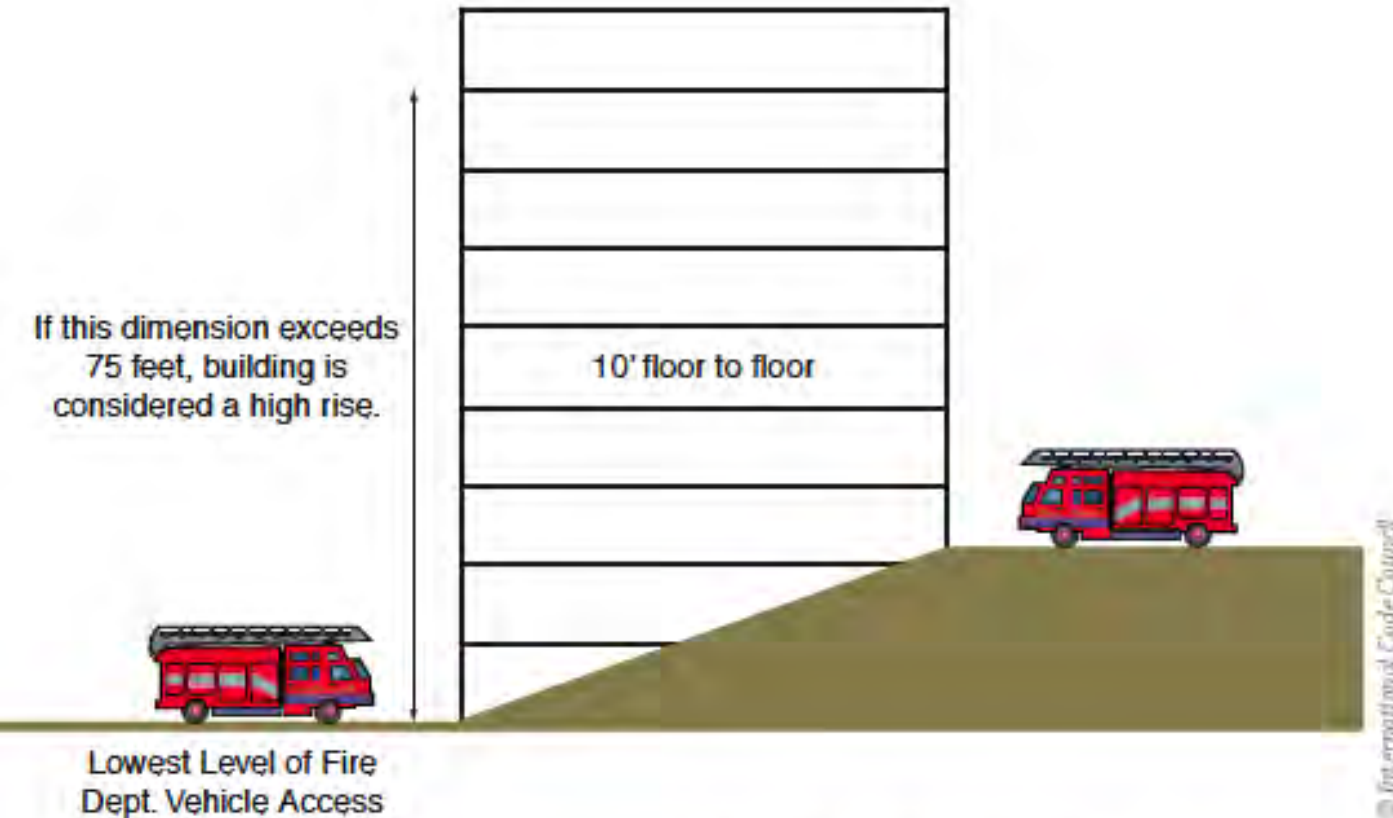
# Construction Type Differences

	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 2 <sup>nd</sup> 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.

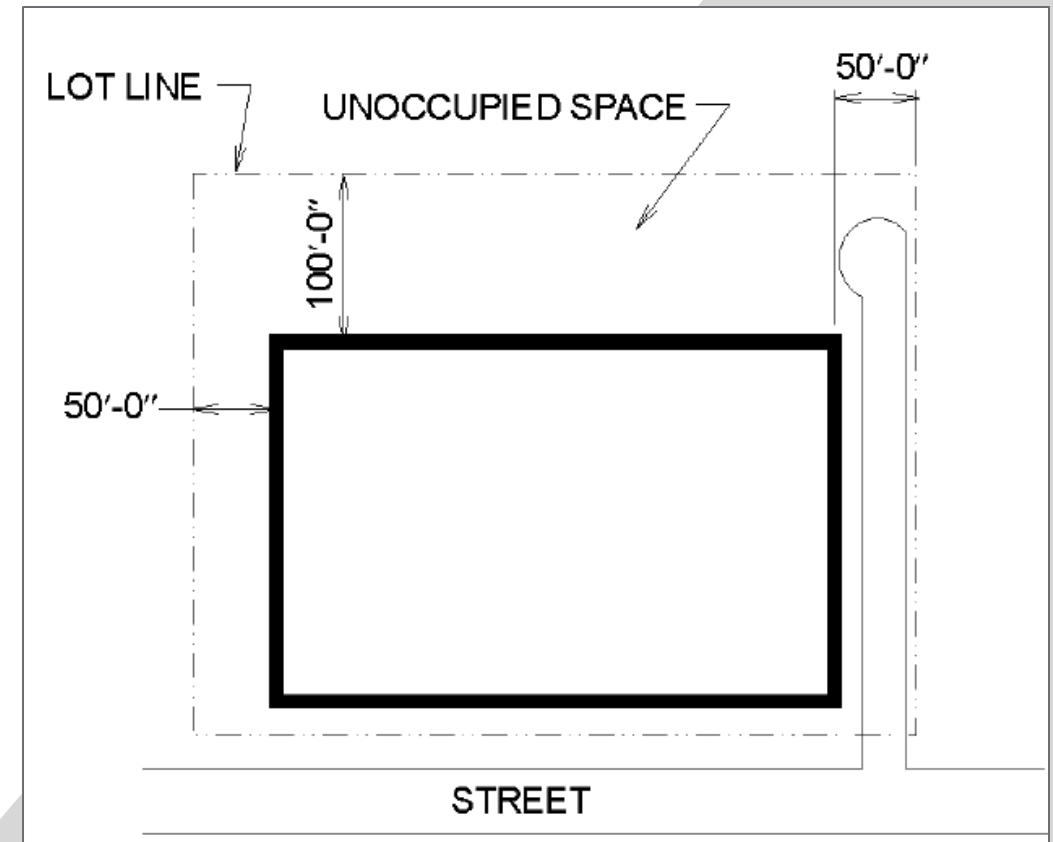


# Fire Department Access

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



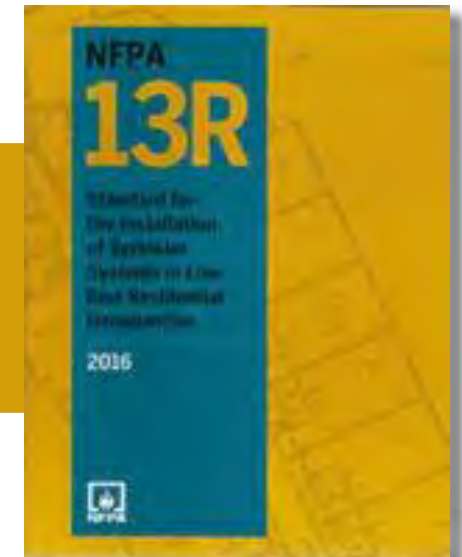
- » NFPA 13 or 13R sprinkler system required in all new group R fire areas
- » NFPA 13 sprinkler system required in most commercial facilities of any size regardless of construction type or materials used
- » Example: Occupancy Group a-2 (restaurant, casino, banquet hall):
  - » If Fire Area Exceeds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

Goal: Provide life safety and property protection

Fully sprinklered system throughout entire building even in unoccupied spaces (closets, attics)

Can cost more

Permitted for many occupancies, buildings of many sizes, allows greater building size increases



## NFPA 13R

Goal: Provide life safety only

Partially sprinklered system; unoccupied spaces often don't require sprinklers

Lower levels of water discharge, shorter water supply time can result in smaller pipe sizes, reduce need for storage & pumps

Limited applications, mainly for multi-family up to 4 stories, 60 feet

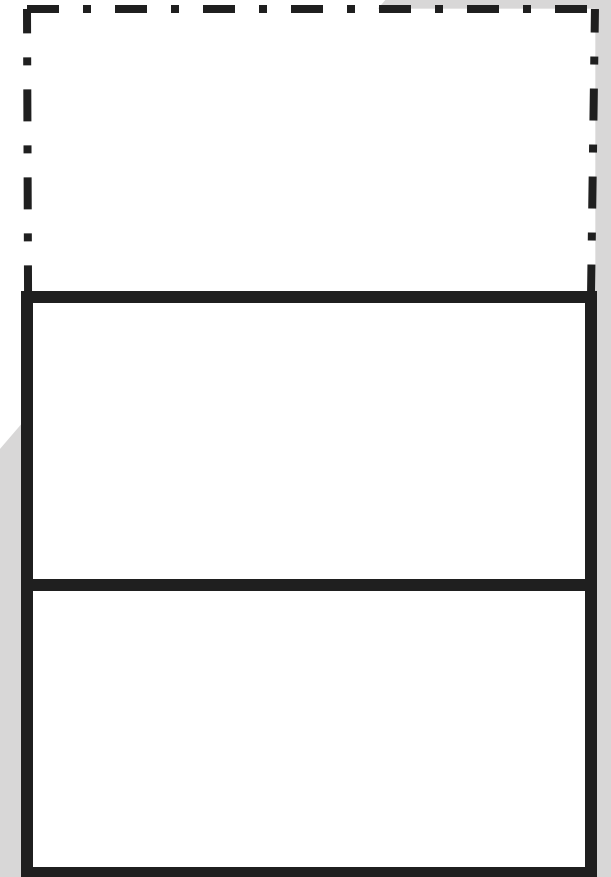
# Allowable Building Height

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<sup>a</sup>**  
**ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE**

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

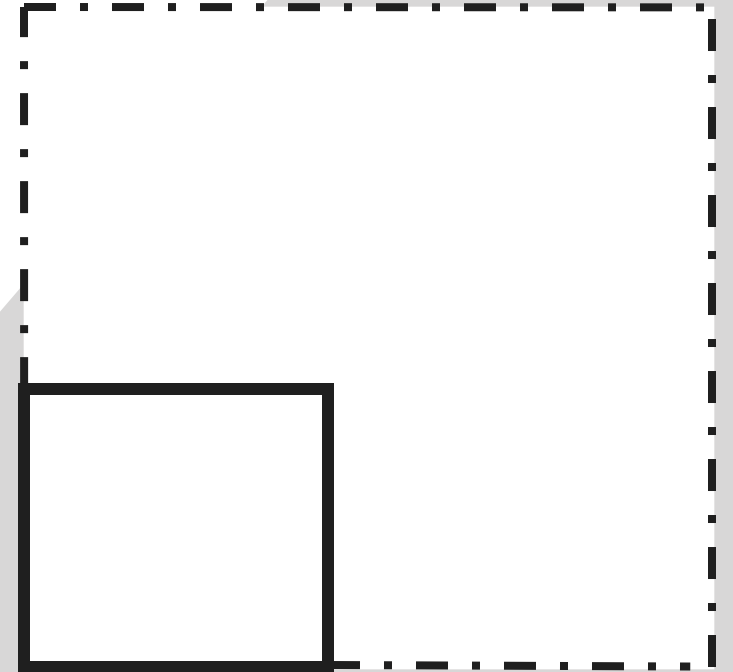
OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1	NS <sup>d, h</sup>	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 <sup>d, h</sup>	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<sup>a, b</sup>**  
**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 <sup>d, h</sup>	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)

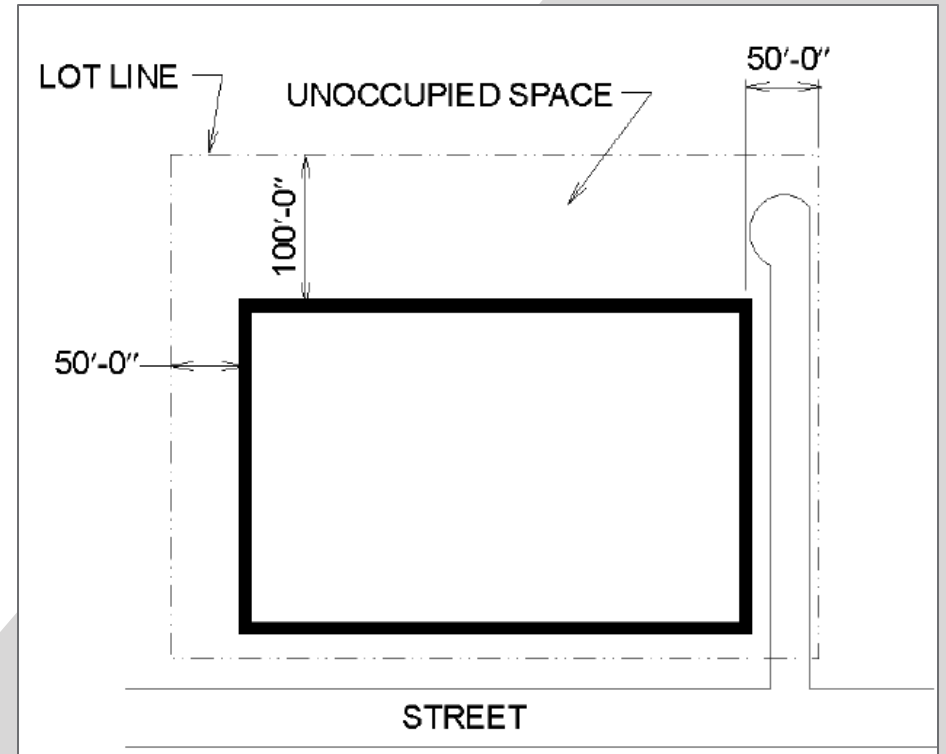
**S13R** = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

# 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 IIA Construction**

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

\* 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* (ft²)	90k	60k	76.9k	45k	26.3k
2 story: Total Bldg Area (ft²)	180k	120k	153.8k	90k	52.5k
3+ story: Total Bldg Area (ft²)	270k	180k	230.6k	135k	78.8k

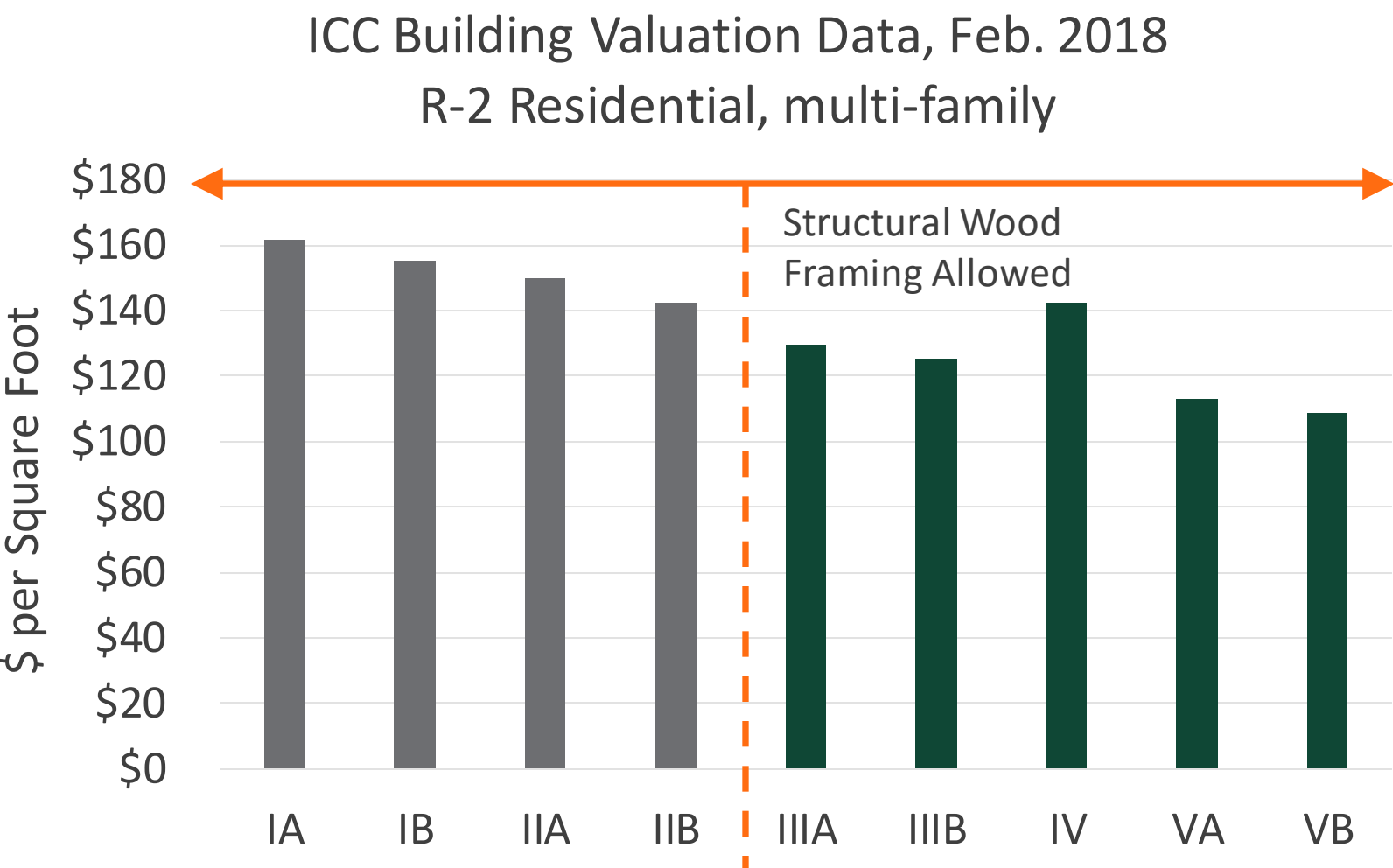
\*Assumes full frontage increase

# 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





# 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

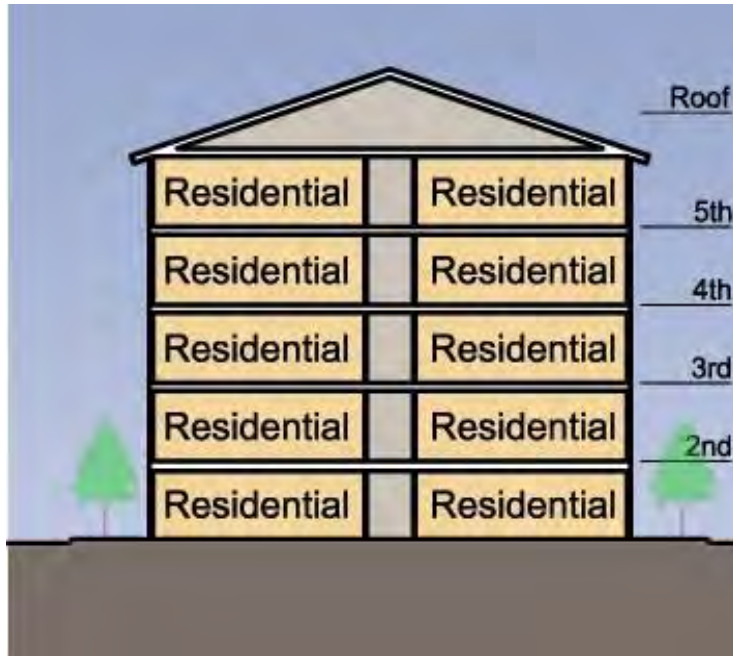




# Special Provisions

IBC 510.2

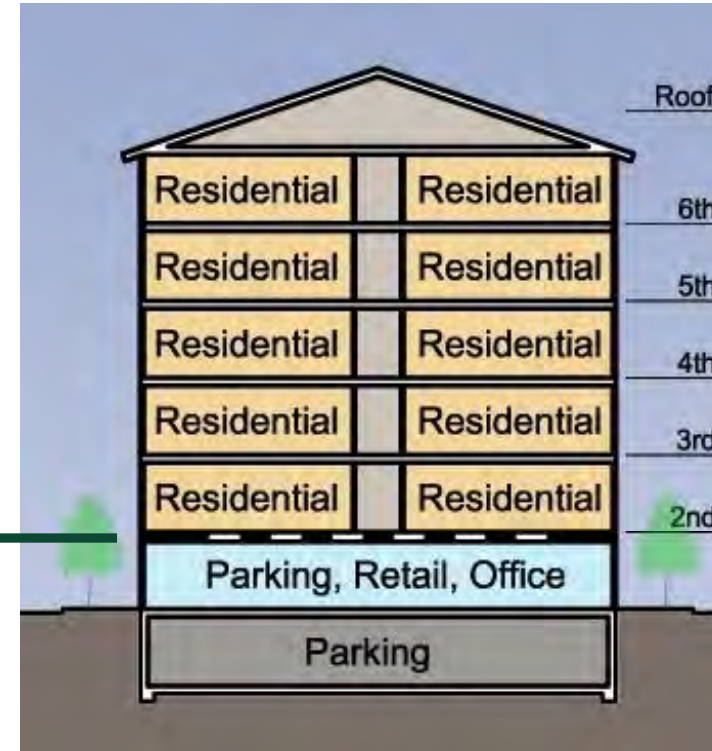
## Horizontal building separation



5 story Type III Building

3Hr

Type IA



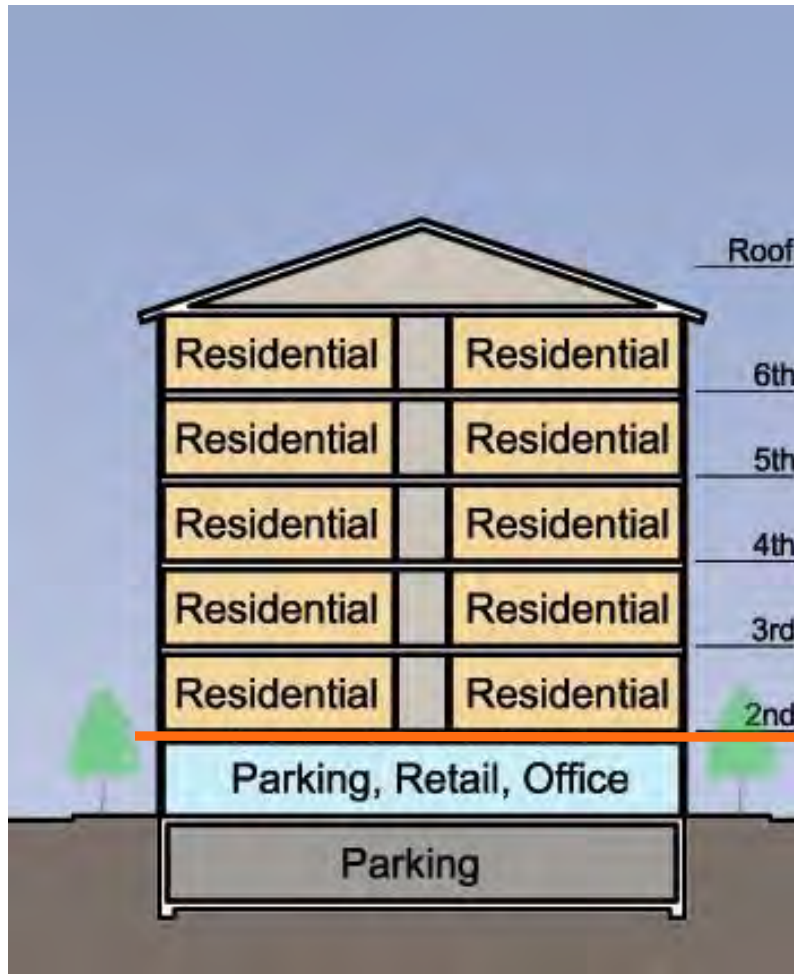
5 story Type III Building  
on top of a Type IA Podium

*Increases allowable stories... not allowable building height*

# Special Provisions

IBC 510.2

IBC Provisions for Mixed-Use podium have been evolving.



3Hr

Type IA

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”)

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**HEIGHTS AND AREAS CALCULATOR**

**Frontage Summary:**

Wall 1:	Clearance:	Length:
	0 ft	250 ft
Wall 2:	Clearance:	Length:
	60 ft	100 ft
Wall 3:	Clearance:	Length:
	40 ft	250 ft
Wall 4:	Clearance:	Length:
	0 ft	100 ft
<b>Frontage Increase Coefficient:</b>		
Frontage Increase Coef., I:	Perimeter, P:	
0.2500	700 ft	

**Viable Construction Types:**

<b>VB Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
3	60 ft	38,250 ft <sup>2</sup>
<b>VA Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
4	70 ft	76,500 ft <sup>2</sup>
<b>IVHT Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:

Done

AT&T M-Cell 5:14 PM

**HEIGHTS AND AREAS CALCULATOR**

**Viable Construction Types:**

<b>VB Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
3	60 ft	38,250 ft <sup>2</sup>
<b>VA Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
4	70 ft	76,500 ft <sup>2</sup>
<b>IVHT Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
6	85 ft	153,000 ft <sup>2</sup>
<b>IIIB Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
4	75 ft	80,750 ft <sup>2</sup>
<b>IIIA Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
6	85 ft	121,120 ft <sup>2</sup>
<b>IIB Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
4	75 ft	97,750 ft <sup>2</sup>
<b>IIA Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
6	85 ft	159,370 ft <sup>2</sup>
<b>IB Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:
12	180 ft	UNLIMITED
<b>IA Construction Type:</b>		
Floors Limit:	Height Limit:	Area/Floor Limit:

# Questions? Ask us anything.



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# Thank You



# Questions? Ask us anything.



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