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The Evolution of Mid-Rise Design: Increasing Opportunities with Wood

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WoodWorks – Wood Products Council


PHOTO CREDIT: ECKERT & ECKERT PHOTOGRAPHY; GBD ARCHITECTS

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Course Description

Increasingly, wood buildings of five, six and more stories are rising up among traditional concrete and steel shells as designers and developers embrace timber's vast potential for lower costs, faster installation, and a significantly lighter carbon footprint. Through the use of project examples, this session will illustrate trends in both residential and commercial mid-rise buildings. Topics will include current code allowances that offer opportunities for taller buildings, design strategies for improved building performance and code-compliant options for meeting fire and life safety requirements.

Learning Objectives

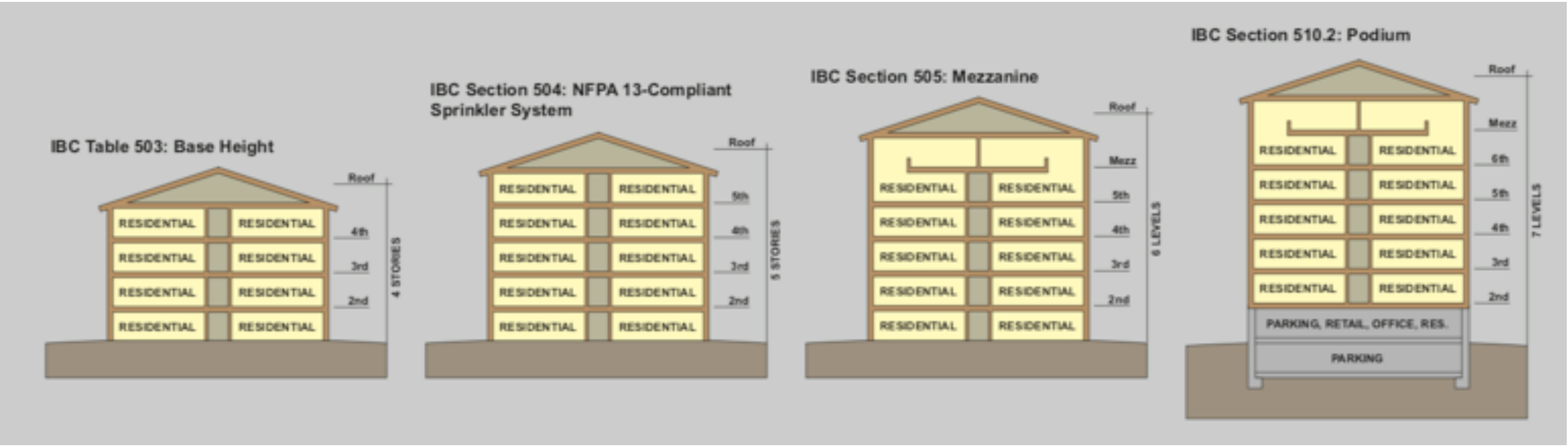
1. Evaluate the code opportunities for cost-effective wood-frame structures in residential mid-rise projects utilizing roofs and basements more effectively.

2. Understand the distinctive design opportunities in mid-rise commercial construction.

3. Learn how using wood even for small building aspects, such as partitions and shaft walls, can add value to projects.

4. Discuss the opportunities for taller mass timber structures

Evolution of Mid-Rise



Evolution of Mid-Rise

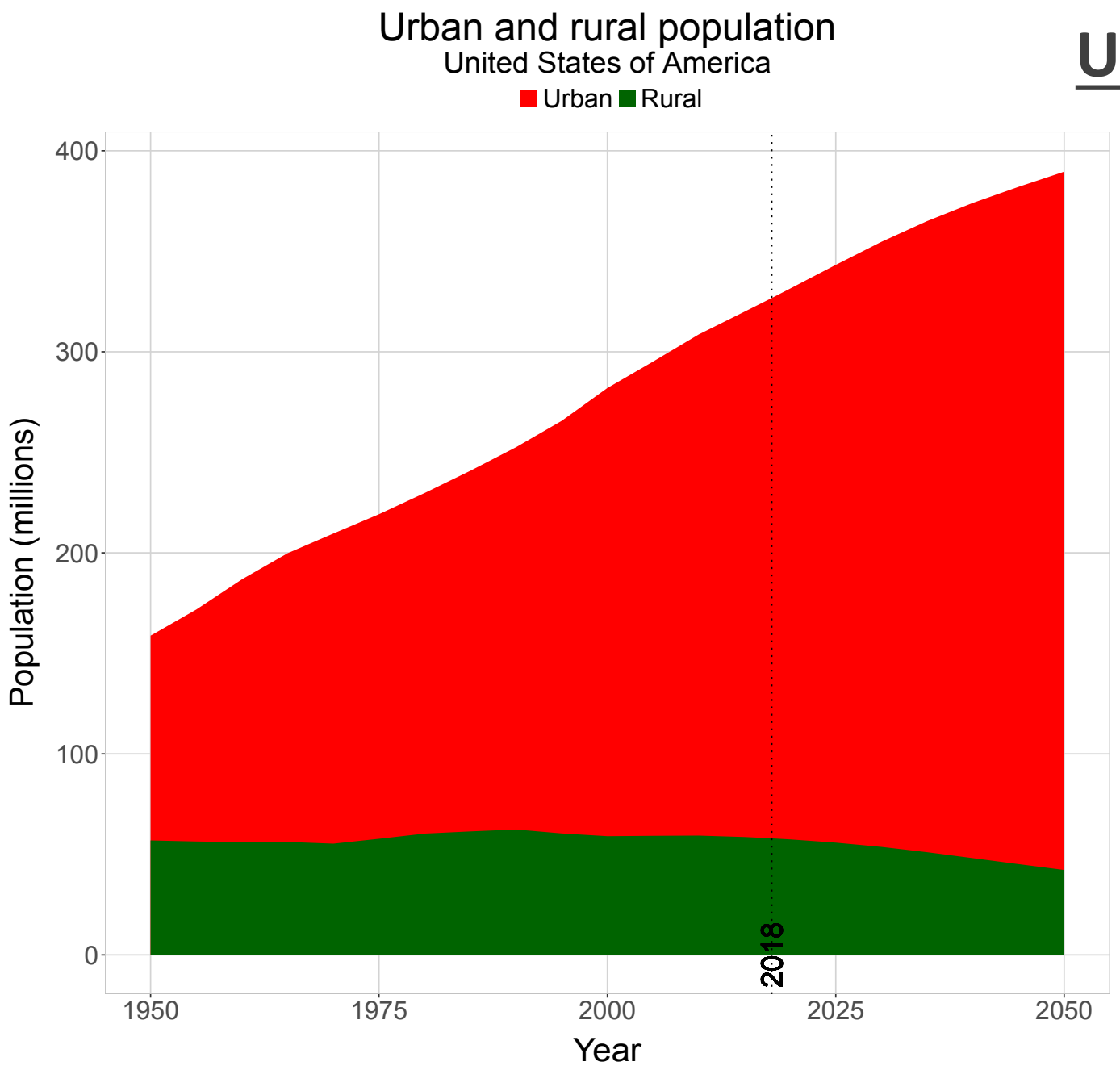
Credit: Susan Jones, atelierjones

GLOBAL POPULATION BOOM

Global Population
7.7 billion now
9.8 billion by 2050
30% increase

Source: United Nations Department of Economic and Social Affairs

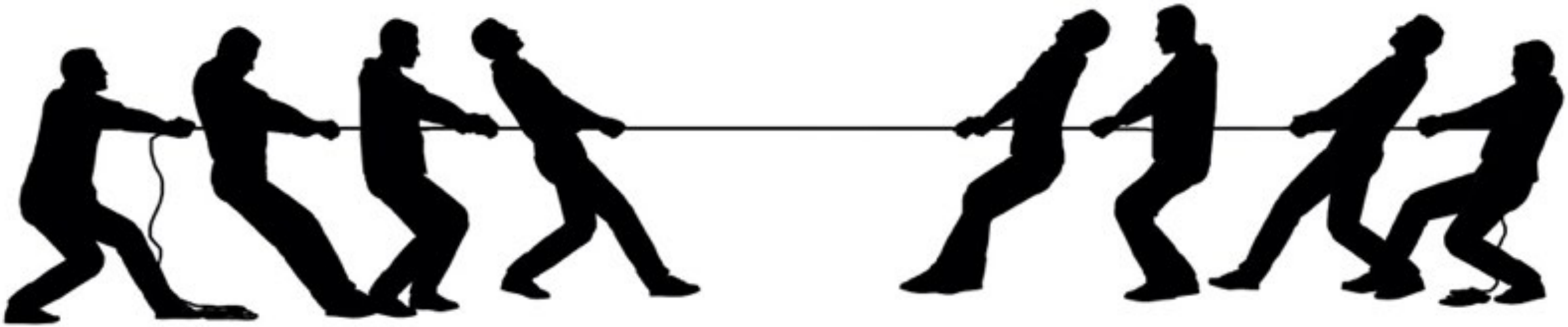
US URBAN POPULATION BOOM



	URBAN	RURAL
2019	271.4 M	57.7 M
2030	301 M	53.7 M
2050	347.3 M	42.2 M

Construction Traffic & Noise
Material Stockpiles
Labor Costs
Labor Availability
Weather Risks

Resiliency
Sustainability
Fire & Life Safety



ESTIMATED ENVIRONMENTAL IMPACT OF WOOD USE

Volume of wood products used:
2,233 cubic meters of CLT and Glulam

U.S. and Canadian forests grow this much wood in:
6 minutes

Carbon stored in the wood:
1,753 metric tons of CO_2

Avoided greenhouse gas emissions:
679 metric tons of CO_2

Total potential carbon benefit:
2,432 metric tons of CO_2

THE ABOVE GHG EMISSIONS ARE EQUIVALENT

511 cars off the road for a year

Energy to operate a home for 222 years

**Estimated by the Wood Carbon Calculator for Buildings, based on research by Sathre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations (this relates to carbon stored and avoided GHG).*

**CO2 in this case study refers to CO2 equivalent*

Source: Naturally:Wood9

Reduced Embodied Carbon

Brock Commons, Vancouver, BC

Photo Credit: UBC

Optimization

Ties together ideas of:

Lower Material Cost

Pre-planning

Less Waste

Shorter Schedule

$

Evolution of Mid-Rise

Type V Construction

Type V Buildings

Multi-family

Restaurants

Retail

Office

Type V-B Height and Area Limits

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	2	60 ft	18,000 SF	36,000 SF
B	3	60 ft	27,000 SF	81,000 SF
M	2	60 ft	27,000 SF	54,000 SF
R-2	3	60 ft	21,000 SF	63,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

1-story retail and restaurants

2 to 3-story residential/office

No fire resistance ratings required*

Type V-A Height and Area Limits

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	70 ft	34,500 SF	103,500 SF
B	4	70 ft	54,000 SF	162,000 SF
M	4	70 ft	42,000 SF	126,000 SF
R-2	4	70 ft	36,000 SF	108,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

3 to 4-story residential/office

1-hour fire resistance rating required for most building elements

Increasing Density, Optimizing Value

Type III Construction

Type III Buildings

Multi-family

K-12/Higher Ed

Hospitality

Office

Type III-B Height and Area Limits

Credit: Lever Architecture

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	75 ft	28,500 SF	85,500 SF
B	4	75 ft	57,000 SF	171,000 SF
M	3	75 ft	37,500 SF	112,500 SF
R-2	5	75 ft	48,000 SF	144,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

4-story office / 5-story residential

2-hour fire resistance rating required for exterior bearing walls only (non combustible or FRT construction)

Type III-A Height and Area Limits

Credit: Christian Columbres

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	42,000 SF	126,000 SF
B	6	85 ft	85,500 SF	256,500 SF
M	5	85 ft	55,500 SF	166,500 SF
R-2	5	85 ft	72,000 SF	216,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

5-story residential / 6-story office

2-hour rating for exterior bearing walls

1-hour rating for other building elements

A nod to Traditional Exposed Timber

Type IV Construction

Type IV Buildings

Mixed-Use

Higher Education

Office

Type IV-HT Height and Area Limits

Credit: John Staments

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	45,000 SF	135,000 SF
B	6	85 ft	108,000 SF	324,000 SF
M	5	85 ft	61,500 SF	184,500 SF
R-2	5	85 ft	61,500 SF	184,500 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

5-story residential / 6-story office

2-hour rating for exterior bearing walls

Interior elements must qualify as Heavy Timber

Heavy Timber
Photo: Benjamin Benschneider

Mass Timber
Photo: John Stamets

Glue Laminated Timber (GLT)

Cross-Laminated Timber (CLT)

Nail-Laminated Timber (NLT)

Photo: Think Wood

Photo: StructureCraft

Photo: LendLease

Photo: Ema Peter

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Mass plywood panels (MPP)

Photo: Freres Lumber

Decking

Photo: StructureCraft

Photo: LEVER Architecture

Photo: Bernard André Photography

Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

Photo: Seagate Structures

STRUCTURAL SOLUTIONS | POST + PLATE

Photo: Lendlease

STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER

Photo: WoodWorks

Photo: Structurlam

STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER

Concealed Connectors

Self Tapping Screws

Photos: Rothoblaas

Beam to Column

Photo: StructureCraft

Photo: Structurlam

Mass Timber Projects In Design and Constructed in the US (December 2019)

Stage	Mass Timber	# of Projects
Construction Started / Built	CLT	125
	NLT	9
	DLT	6
	Heavy Timber Decking	66
	Post & Beam	44
	Total	250
In Design	CLT	266
	NLT	17
	DLT	3
	Heavy Timber Decking	38
	Post & Beam	134
	Total	458
Grand Total		708

State	Stage	
AK	In Design	1
AL	Construction Started / Built	3
	In Design	8
AR	Construction Started / Built	3
	In Design	5
AZ	In Design	3
CA	Construction Started / Built	32
	In Design	68
CO	Construction Started / Built	14
	In Design	11
CT	Construction Started / Built	3
	In Design	6
DC	Construction Started / Built	2
	In Design	5
DE	In Design	2
FL	Construction Started / Built	15
	In Design	18
GA	Construction Started / Built	4
	In Design	13
HI	In Design	3
IA	Construction Started / Built	1
ID	Construction Started / Built	3
	In Design	3
IL	Construction Started / Built	5
	In Design	11
IN	Construction Started / Built	1
	In Design	1
KS	In Design	2
KY	Construction Started / Built	1
	In Design	2
LA	In Design	5
MA	Construction Started / Built	13
	In Design	25
MD	Construction Started / Built	1
	In Design	7
ME	Construction Started / Built	1
	In Design	14
MI	Construction Started / Built	2
	In Design	6
MN	Construction Started / Built	2
	In Design	4
MO	Construction Started / Built	5
	In Design	5

State	Stage	
MS	In Design	4
MT	Construction Started / Built	6
	In Design	5
NC	Construction Started / Built	13
	In Design	22
ND	In Design	1
NE	Construction Started / Built	1
	In Design	3
NH	Construction Started / Built	1
	In Design	1
NJ	Construction Started / Built	1
	In Design	6
NM	Construction Started / Built	1
NV	In Design	2
NY	Construction Started / Built	6
	In Design	24
OH	Construction Started / Built	1
	In Design	5
OK	Construction Started / Built	1
	In Design	2
OR	Construction Started / Built	25
	In Design	23
PA	Construction Started / Built	3
	In Design	5
RI	Construction Started / Built	2
	In Design	1
SC	Construction Started / Built	9
	In Design	11
TN	Construction Started / Built	3
	In Design	4
TX	Construction Started / Built	17
	In Design	37
UT	Construction Started / Built	3
	In Design	3
VA	Construction Started / Built	6
	In Design	7
VT	Construction Started / Built	1
	In Design	8
WA	Construction Started / Built	28
	In Design	44
WI	Construction Started / Built	8
	In Design	12
WV	Construction Started / Built	2
WY	Construction Started / Built	1

Considering mass timber for a project? Ask us anything.

For free project support, contact:
help@woodworks.org
woodworks.org/project-assistance

http://www.woodworks.org/publications-media/building-trends-mass-timber/

Photo: Nordic Structures

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

Photo: ©Albert Vecerka/Esto

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

Photos: Baumberger Studio/PATH Architecture

PRECEDENT PROJECTS | CARBON 12 | PORTLAND, OR

Photos: StructureCraft

Photo: Hartshorne Plunkard Architecture

Photos: Flank

PRECEDENT PROJECTS | 360 WYTHE BROOKYLN, NY

Photos: Michael Elkan | Naturally Wood | UBC

PRECEDENT PROJECTS | BROCK COMMONS

Maximizing Site Value

Podiums

Podium Limits

Credit: Matt Todd & PB Architects

IBC	# of Podium Levels	Podium Occupancy
2009	1	S-2 Parking
2012	1	A, B, M, R or S-2 Parking
2015	Multi-story	A, B, M, R or S-2 Parking
2018	Multi-story	A, B, M, R or S-2 Parking

3-hour building separation

Wood-framed building on top of podium allowed to limits of code allowed heights

MIXED OCCUPANCIES

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.

MIXED OCCUPANCY BUILDINGS

IBC 508

START WITH UNSEPARATED OCCUPANCIES, USING SPECIAL PROVISIONS AND/OR OTHER SPECIAL DESIGN ALLOWANCES AS NEEDED. WORK UP FROM THERE.

MIXED OCCUPANCY BUILDINGS

IBC 508

- INCIDENTAL USES (509)
- ACCESSORY OCCUPANCIES (508.2)
- UNIQUE OCCUPANCY COMBINATIONS (303)
- ROOF TOP OCCUPANCIES (CHPT. 5)
- SPECIAL PROVISIONS (510)
- NON-SEPARATED OCCUPANCIES (508.3)
- SEPARATED OCCUPANCIES (508.4)
- SEPARATE BUILDINGS – FIREWALLS (503.1 & 706)
- COVERED AND OPEN MALLS (402)

CREDIT: BOYE ARCHITECTURE

SMALL ASSEMBLY SPACES

IBC 303.1.1 & 303.1.2

Small Assembly Spaces:

- A building or tenant space used for assembly purposes with an occupant load of less than 50 persons shall be classified as a Group B occupancy.

Example: small cafe

Small Assembly Spaces Accessory to Other Occupancies:

- Occupant load less than 50 persons or less than 750 sf in area - can be classified as a Group B occupancy or as part of main occupancy

Examples:

- Conference room in office building
- Fitness center in hotel

ROOFTOP DECKS

IBC 503.1

Many mixed use buildings, especially apartment buildings, are implementing occupiable roof top decks, either for individual use or as a gathering space

No current code sections clearly discuss this except for basic exit provisions but several design routes have been used

Typically these spaces do not have a roof and therefore aren’t classified as stories per the definition of a story (IBC 202)

ROOFTOP DECKS

IBC 503.1

Occupied Roofs Code Development

2012 IBC section 1021 contains exit provisions for occupied roofs

2015 IBC clarified egress requirements for occupied roofs (IBC 1006.3)

2018 IBC further recognizes occupied roofs. 2018 IBC provisions:

302.1: Occupied roof classified as occupancy it most closely resembles
503.1.4: Permitted to be used as an occupied roof if the occupancy of the roof is an occupancy that is permitted by code for the story immediately below the roof. Area of the occupied roofs is not required to be included in the building area. Further exceptions for sprinklered buildings exist

SHARE

Does an occupied rooftop/roof deck need to be included in allowable building size (height and area) calculations?

Occupied rooftops are becoming common in multi-family and commercial buildings as building designers and owners seek to increase marketability by offering amenities such as roof decks. In most cases, these roof decks are open and uncovered with half height walls/parapets around their perimeter. However, some or all of the roof deck space may also be enclosed by full height walls and a roof covering. In both scenarios, questions that often arise include whether the roof deck needs to be considered as a separate story and how the occupancy and area contribute when evaluating height and area requirements based on a specific construction type.

Code language regarding this topic continues to evolve. Under the 2012 and 2015 IBC, some feel that the relevant code provisions leave room for interpretation. As such, a design team may choose to consult with the Authority Having Jurisdiction (AHJ) regarding what he or she deems acceptable. Code changes set for inclusion in the 2018 IBC further clarify provisions on this topic (see below).

In the meantime, following is a summary of how designers in the U.S. have successfully implemented occupied roof decks in their projects without including them in the tota

http://www.woodworks.org/ask-an-expert/

Roof Decks without Roof Coverings

IBC 2012 Table 503 and IBC 2015 Table 504.4 provide limitations on allowable number of stories in a given building. However, per

View All Expert Tips

Project Assistance

Our technical experts offer free project support from design through construction, on issues ranging from allowable heights and areas to structural design, lateral systems and fire- or acoustical-rated assemblies.

Get Assistance >

Ask an Expert

Q: When is blocking/bracing within wood-frame walls required? What is considered adequate bracing for wood wall studs in their weak axis?

A: Wood studs used in light-frame wall construction may require horizontally-oriented blocking for a number of reasons—including blocking at shear panel edges, fire blocking, and buckling restraint when subject to axial loads. Structural Blocking Purposes Blocking to Reduce Stud Slenderness Ratio Section 3

- Learn More
Have a question? Email Us >

Feature Project

PHOTO CREDIT: ARDEN PHOTOGRAPHY

SPECIAL PROVISIONS

IBC 510

CONSTRUCTION TYPES

IBC 602.1 REQUIRES THAT EACH BUILDING BE CLASSIFIED IN ONE OF FIVE CONSTRUCTION TYPES.

IBC SECTION 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

SPECIAL PROVISIONS

IBC 510.2

Horizontal Building Separation

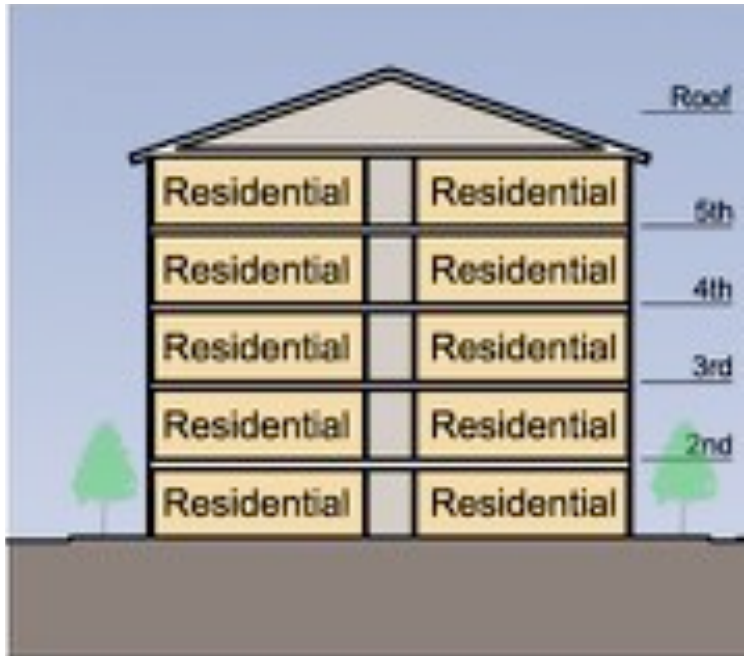
Often called Podium Provision:

- 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

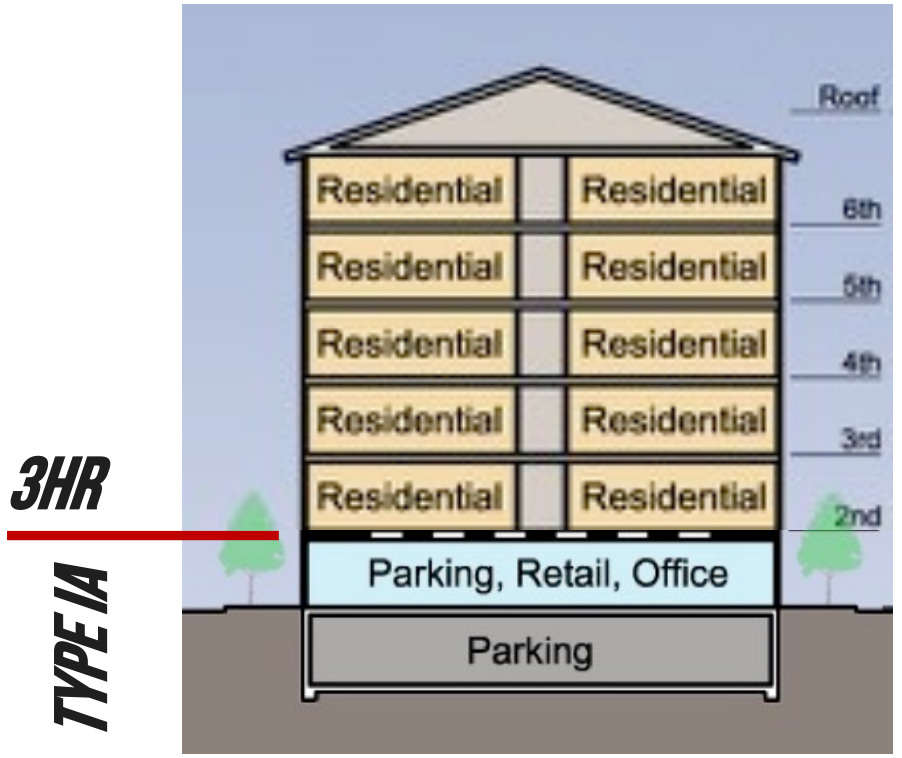
SPECIAL PROVISIONS

HORIZONTAL BUILDING SEPARATION

IBC 510.2



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

5 STORY MIXED-USE POSSIBILITIES

4 STORIES OF TYPE V
OVER 1 STORY PODIUM

PHOTO CREDIT: GABLES RESIDENTIAL

5 STORIES OF TYPE III

SPECIAL PROVISIONS

IBC 510.2

6 & 7 STORY MIXED-USE POSSIBILITIES

5 STORIES OF TYPE III
OVER 1 STORY PODIUM

5 STORIES OF TYPE III
OVER 2 STORY PODIUM

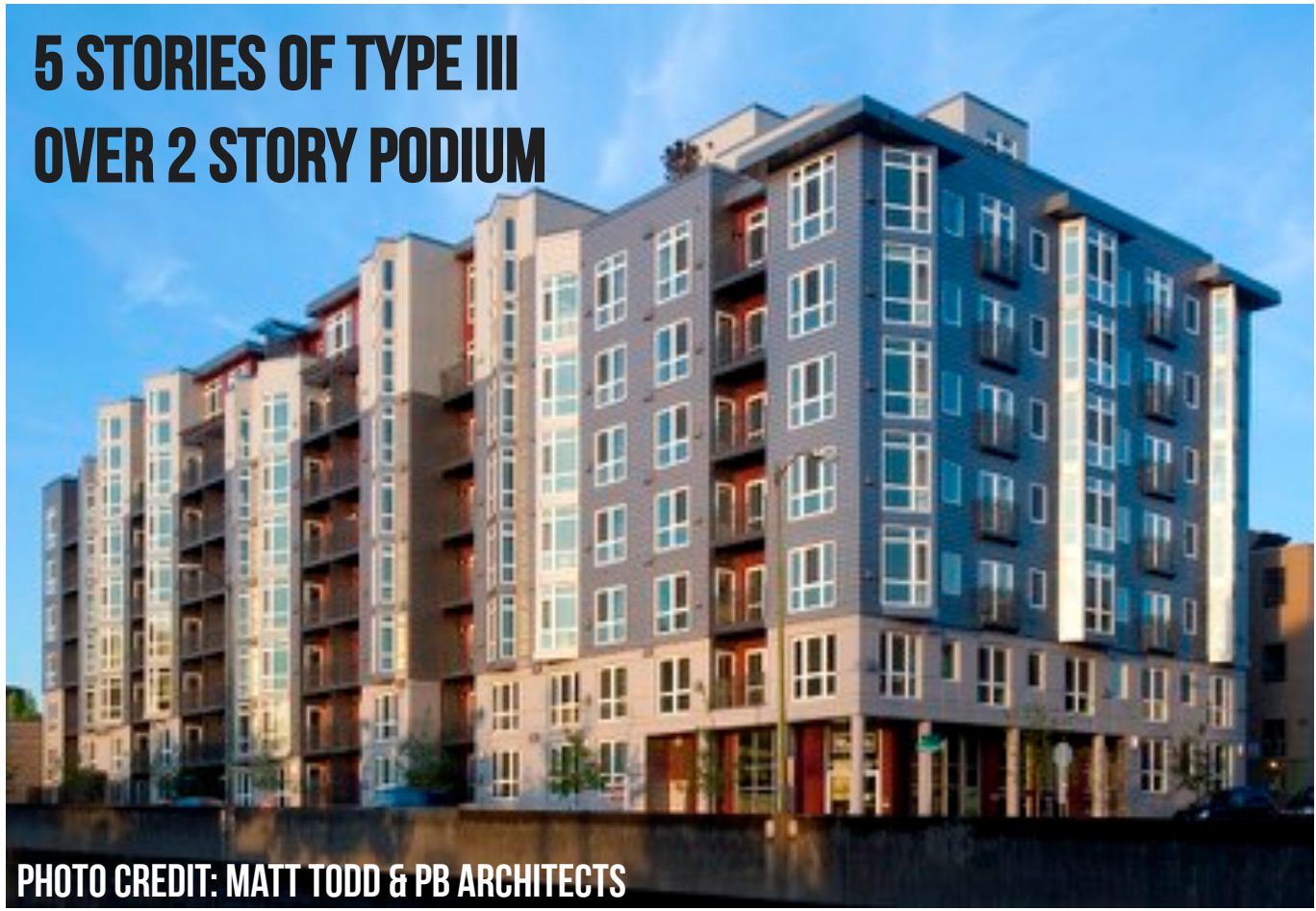


PHOTO CREDIT: MATT TODD & PB ARCHITECTS

SPECIAL PROVISIONS

IBC 510.2

7 STORY MIXED-USE POSSIBILITIES

6 STORIES OF TYPE IIIA OR IV
OVER 1 STORY PODIUM

IMAGE CREDIT: MICHAEL GREEN ARCHITECTS/HINES GROUP

SPECIAL PROVISIONS

IBC 510.4

PARKING BENEATH GROUP R

- UNIQUE APPLICATION SIMILAR TO PODIUM PROVISION BUT MORE FLEXIBILITY

SPECIAL PROVISIONS

IBC 510.4

Parking beneath group R

Single story above grade, S-2 parking:

- Type I (enclosed or open) or
- Type IV (open)
- Group R occupancy above
- # of stories measured from floor above parking
- Floor separating parking & group R:
    - Same construction type as parking hourly rating per Table 508.4 and/or 601

PARKING BENEATH GROUP R

SPECIAL PROVISIONS

IBC 510.4

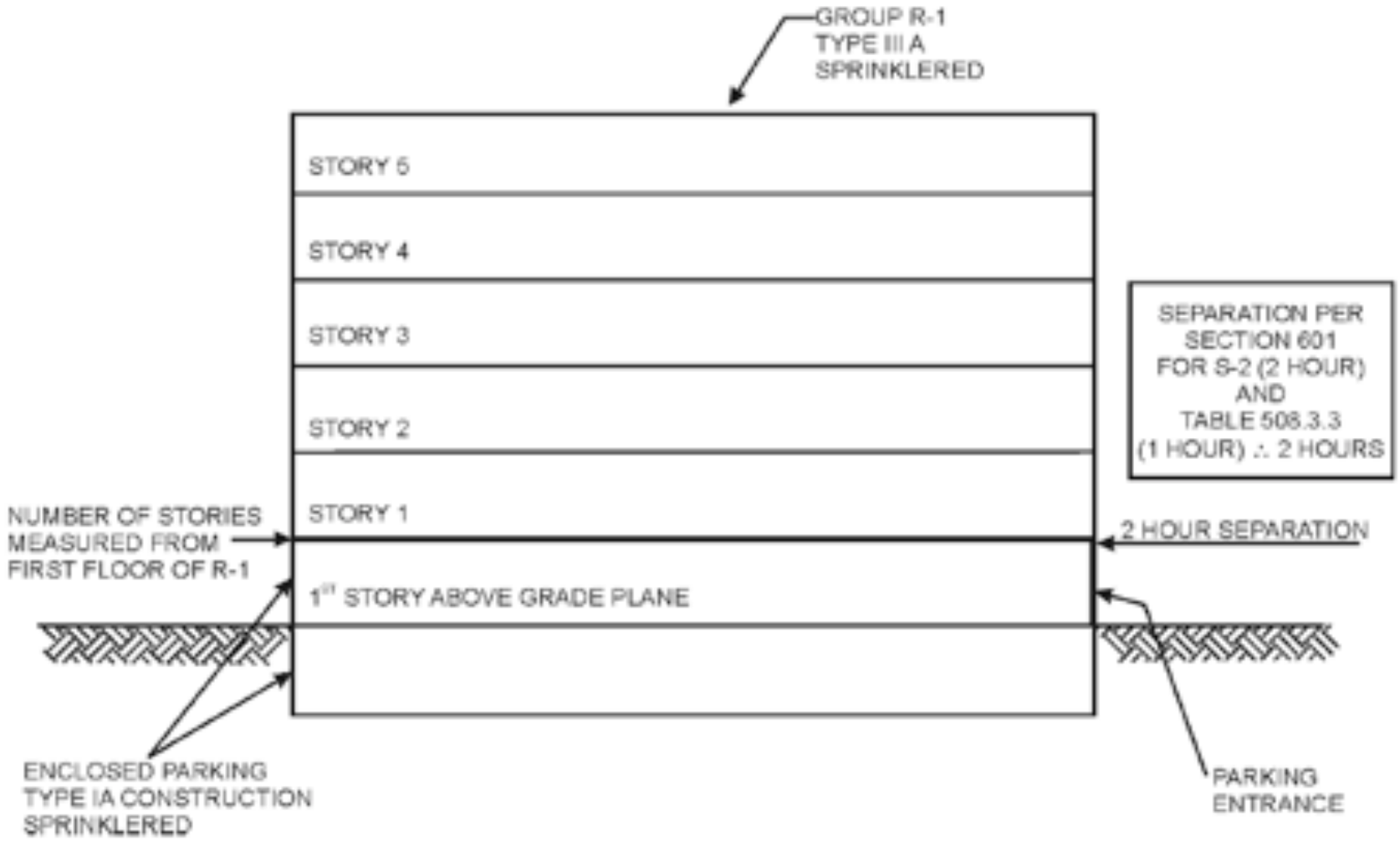


Figure 510.4
EXAMPLE R-1 OVER ENCLOSED PARKING

IMAGE CREDIT: IBC CODE COMMENTARY

Sloped Sites

HEIGHT, BUILDING. The vertical distance from *grade plane* to the average height of the highest roof surface.

GRADE PLANE. A reference plane representing the average of finished ground level adjoining the building at *exterior walls*. Where the finished ground level slopes away from the *exterior walls*, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.

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

Basements

IBC 506.4 & 506.5: A single basement is not included in the total allowable building area if it doesn't exceed the area permitted for a building with no more than one story above grade plane.

Basement is defined as that where the finished surface of the floor next above is:

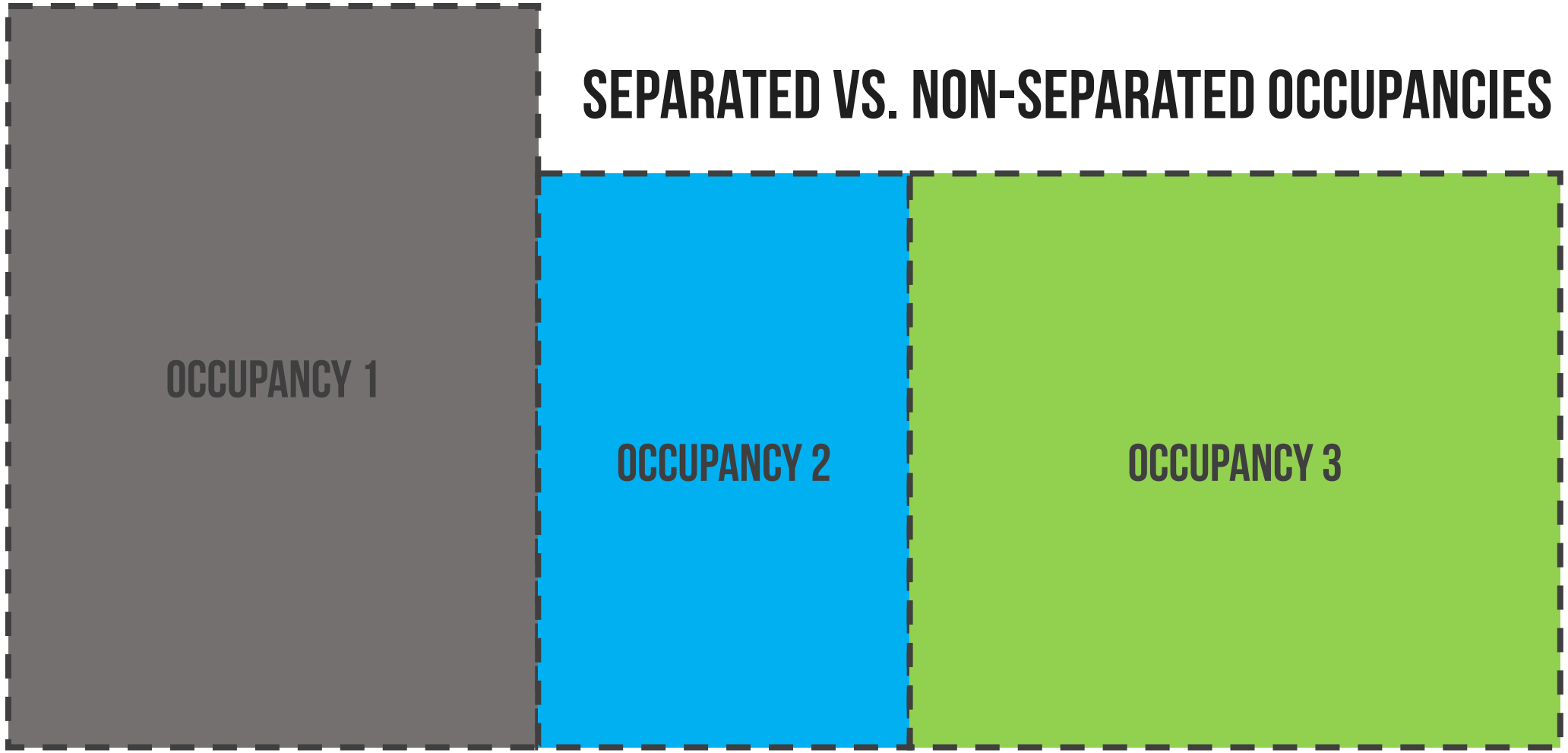
- Less than 6 feet above grade plane or
- Less than 12 feet above the finished ground level at any point

Fashion Valley, CA
AvalonBay Communities

MIXED OCCUPANCY BUILDINGS

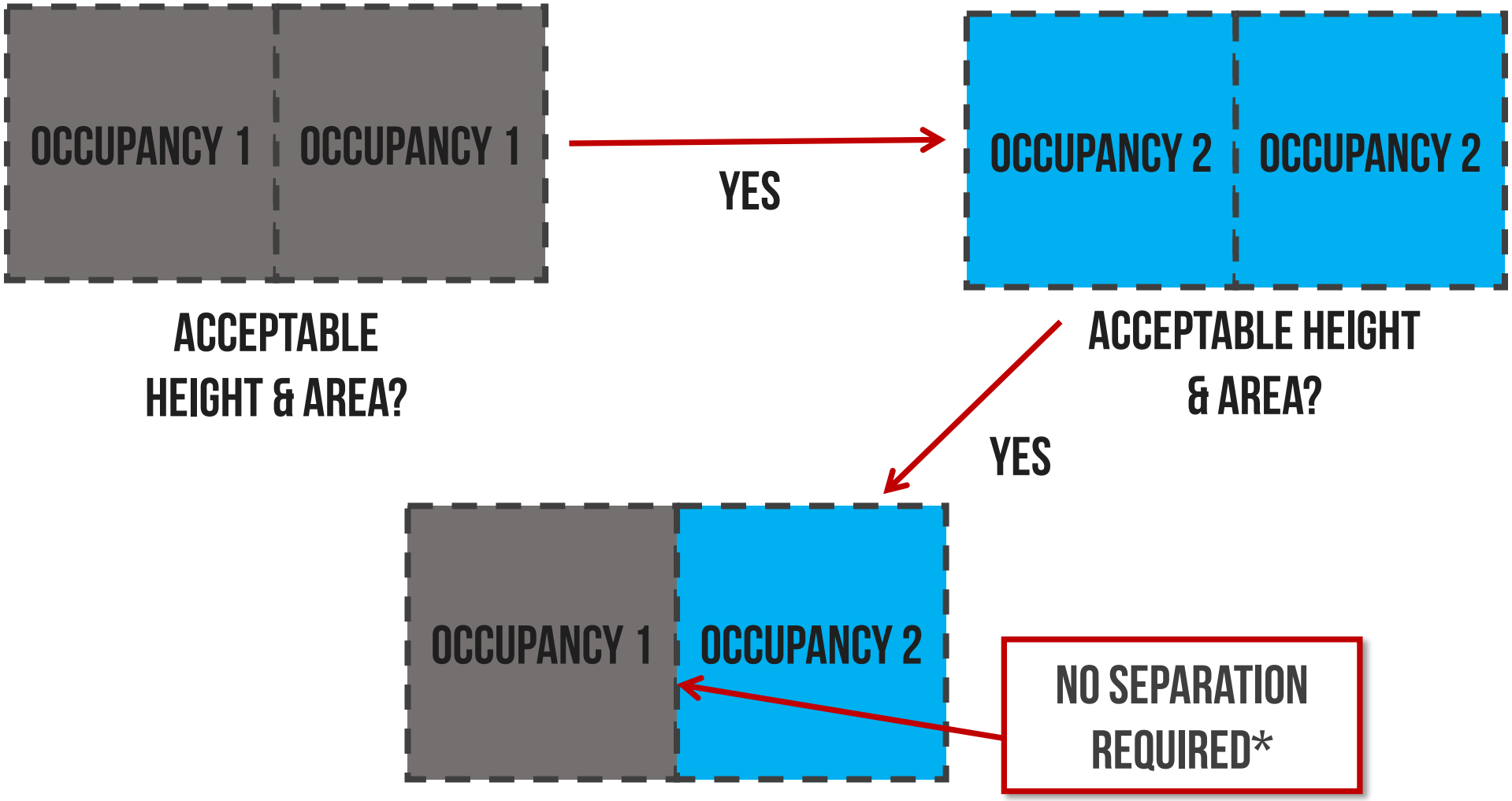
IBC 508

SEPARATED VS. NON-SEPARATED OCCUPANCIES



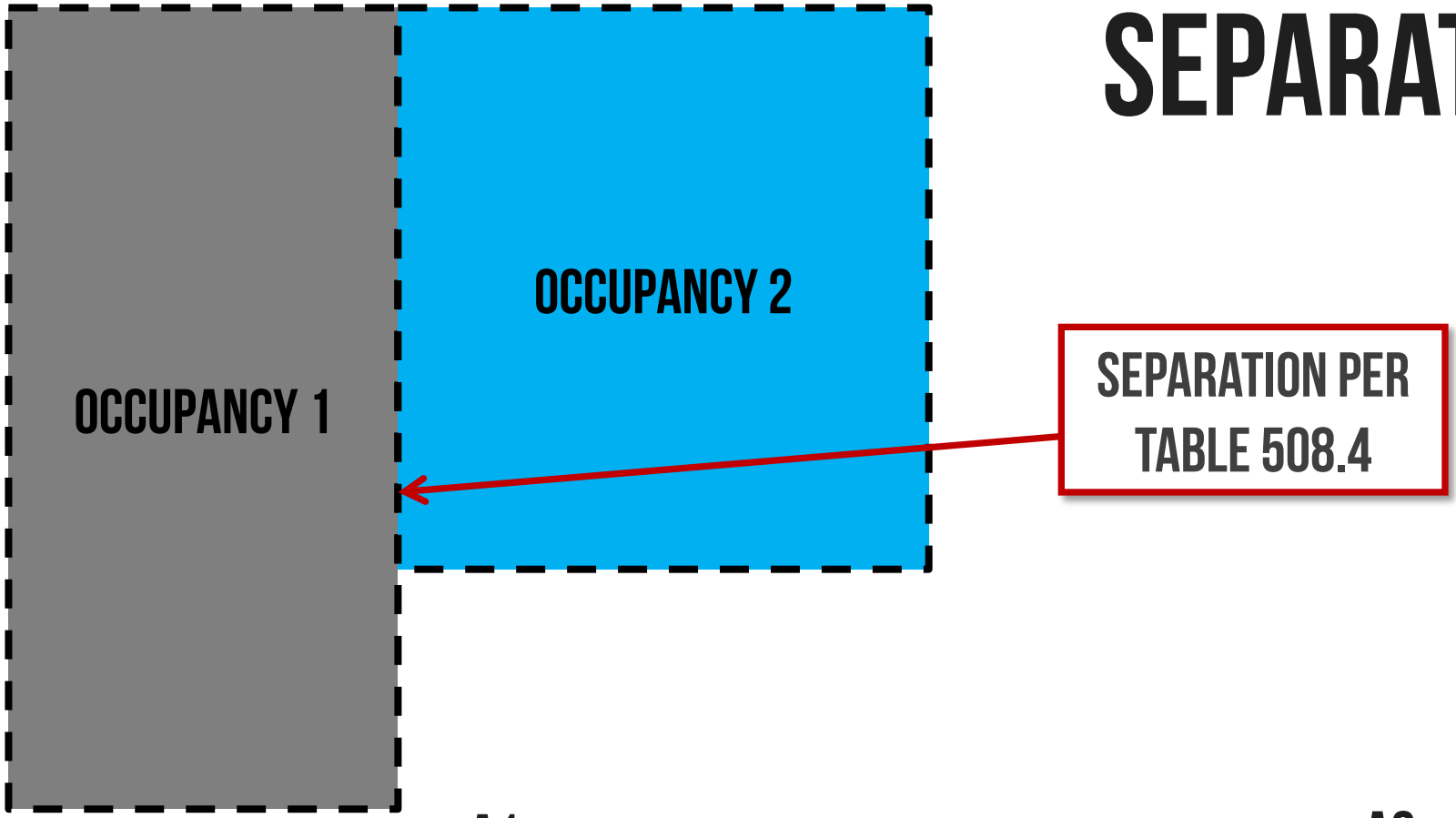
NON-SEPARATED OCCUPANCIES

IBC 508.3



SEPARATED OCCUPANCIES

IBC 508.4



$$\frac{A1}{\text{ALLOWABLE AREA FOR OCCUPANCY 1}} + \frac{A2}{\text{ALLOWABLE AREA FOR OCCUPANCY 2}} < 1.0$$

CHECK PERFORMED FOR EACH STORY.

SEPARATION BY FIRE BARRIERS AND HORIZONTAL ASSEMBLIES

SEPARATED OCCUPANCIES

IBC TABLE 508.4

OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B[c], F-1, M, S-1	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2
F-2, S-2[b], U	—	—	—	—	—	—	—	—	N	N	1	2
B[c], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

NP = NOT PERMITTED,
N = NO SEPARATION REQUIRED

SEPARATION ACCOMPLISHED WITH:
WALLS: FIRE BARRIERS, IBC 707
FLOORS: HORIZONTAL ASSEMBLIES, IBC 711

ALLOWABLE BUILDING SIZE

IBC 508

MULTI-STORY NON-SEPARATED OCCUPANCIES EXAMPLE

IMAGE CREDIT: WARE MALCOMB

3 STORY, COLLEGE CAMPUS BUILDING
20,400 SF PER FLOOR

- TOTAL BUILDING AREA = 61,200 SF
- 1ST FLOOR: (2)-800 SF COFFEE/SNACK BARS, 13,700 SF OF CLASSROOMS, 1,700 SF ADMIN, 3,400 SF OFFICES
- 2ND & 3RD FLOORS: 20,400 SF OF OFFICES
- NFPA 13 SPRINKLER REQUIRED THROUGHOUT BUILDING

ALLOWABLE BUILDING SIZE

IBC 508

MULTI-STORY NON-SEPARATED OCCUPANCIES EXAMPLE

IMAGE CREDIT: WARE MALCOMB

- COFFEE/SNACK BAR: GROUP A-2 OCCUPANCY
  - MAY BE ABLE TO USE SMALL ASSEMBLY PROVISION (IBC 303.1.1) – GROUP B
- CLASSROOMS FOR HIGHER THAN 12TH GRADE: GROUP B OCCUPANCY
- ADMIN & OFFICES: GROUP B OCCUPANCY

ALLOWABLE BUILDING SIZE

IBC 508

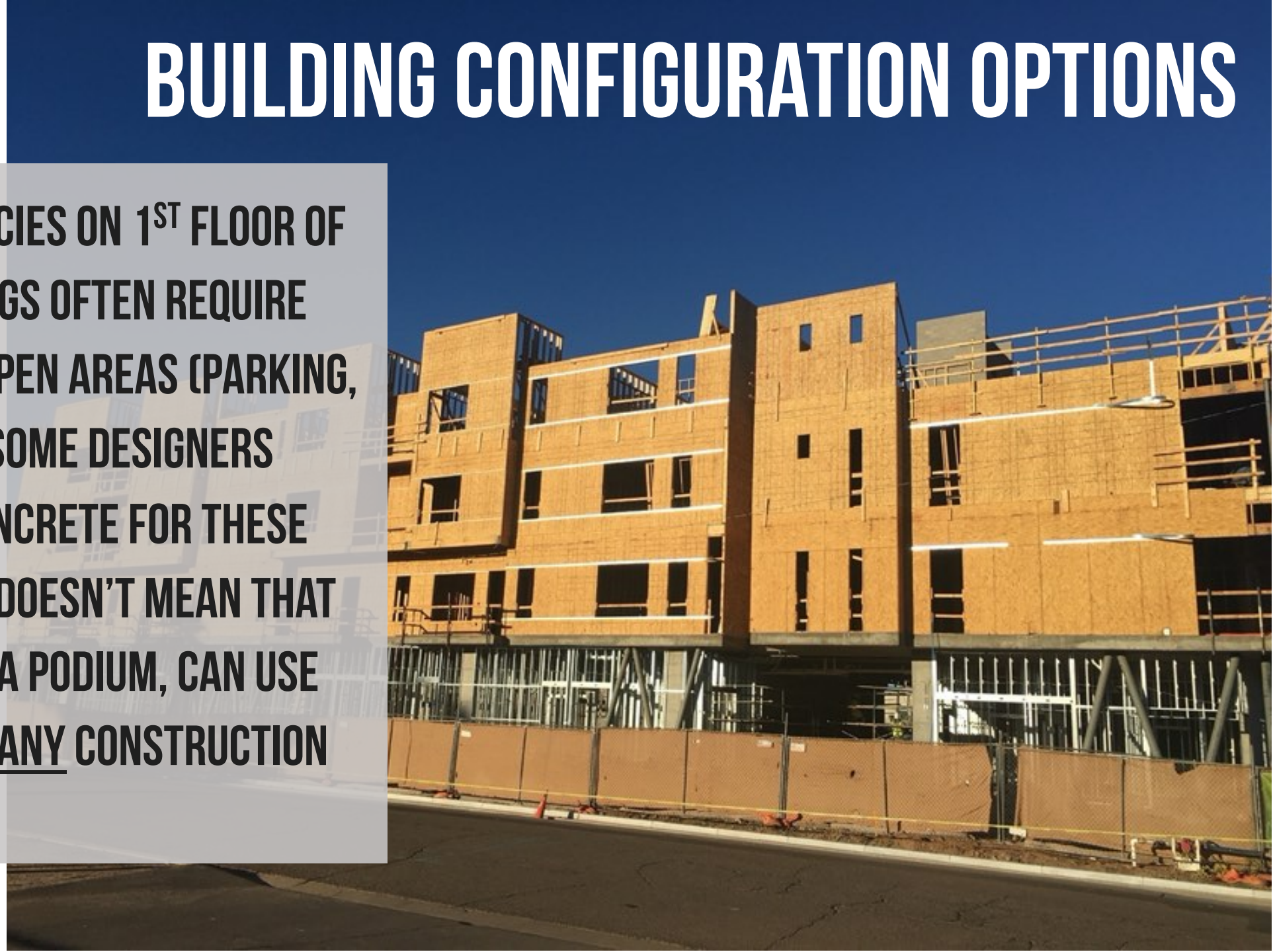
MULTI-STORY NON-SEPARATED OCCUPANCIES EXAMPLE

IMAGE CREDIT: WARE MALCOMB

- If coffee/snack areas meet provisions for small assembly spaces: classify as group B. entire building is group B and can **use Type VB construction**: allowed 3 stories, 60 ft, 27,000 sf per floor, 81,000 sf total area
- If coffee/snack areas don't meet provisions for small assembly spaces: classify them as group A-2. **use non-separated occupancies, type VA construction**: group B ok per above, group A-2 allowed 3 stories, 70 ft, 34,500 sf per floor, 103,500 sf total area
- Could also use separated occupancies, type VB construction

BUILDING CONFIGURATION OPTIONS

MIXED-USE OCCUPANCIES ON 1ST FLOOR OF RESIDENTIAL BUILDINGS OFTEN REQUIRE LONGER SPANS FOR OPEN AREAS (PARKING, RETAIL, ASSEMBLY). SOME DESIGNERS CHOOSE STEEL OR CONCRETE FOR THESE LONGER SPANS. THIS DOESN'T MEAN THAT IT HAS TO BE A TYPE IA PODIUM, CAN USE THESE MATERIALS IN ANY CONSTRUCTION TYPE (IBC 602.1.1)



BUILDING CONFIGURATION OPTIONS

Example:

5 story building

1st floor: mixed-use, retail

2nd-5th floors residential

Options:

4-story, type VA over 1 story type IA (podium provision – IBC 510.2)

5 Stories of type III (A or B), separated occupancies

5 stories of type IIIB with firewall(s), separated occupancies

BUILDING CONFIGURATION OPTIONS

Example:

5 story hotel

1st floor: lobby, restaurant, fitness center, conference rooms, residential

2nd-5th floors residential

BUILDING CONFIGURATION OPTIONS

Option 1:

4-story, type VA over 1 story type IA (podium provision – IBC 510.2)

Mixed-use on 1st floor handled with separated/non-separated occupancies considering that floor only

Option 2:

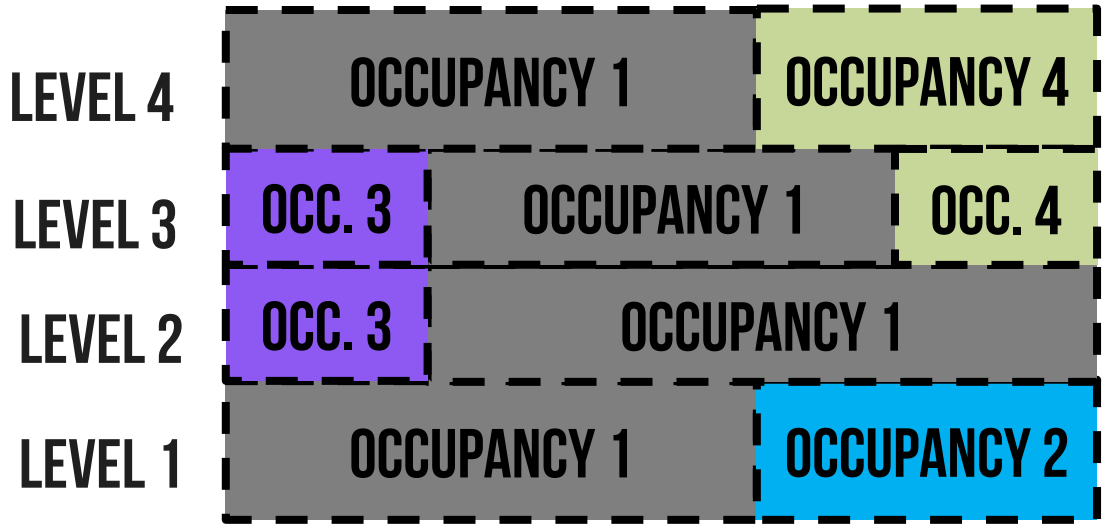
5-story, type III (with or without firewalls for area limitations)

Mixed-use on 1st floor handled with separated/non-separated occupancies considering all floors

SEPARATED OCCUPANCIES

IBC 508.4

MULTI-STORY SEPARATED OCCUPANCY EXAMPLE



ELEVATION VIEW

0.78

0.83

0.85

0.80

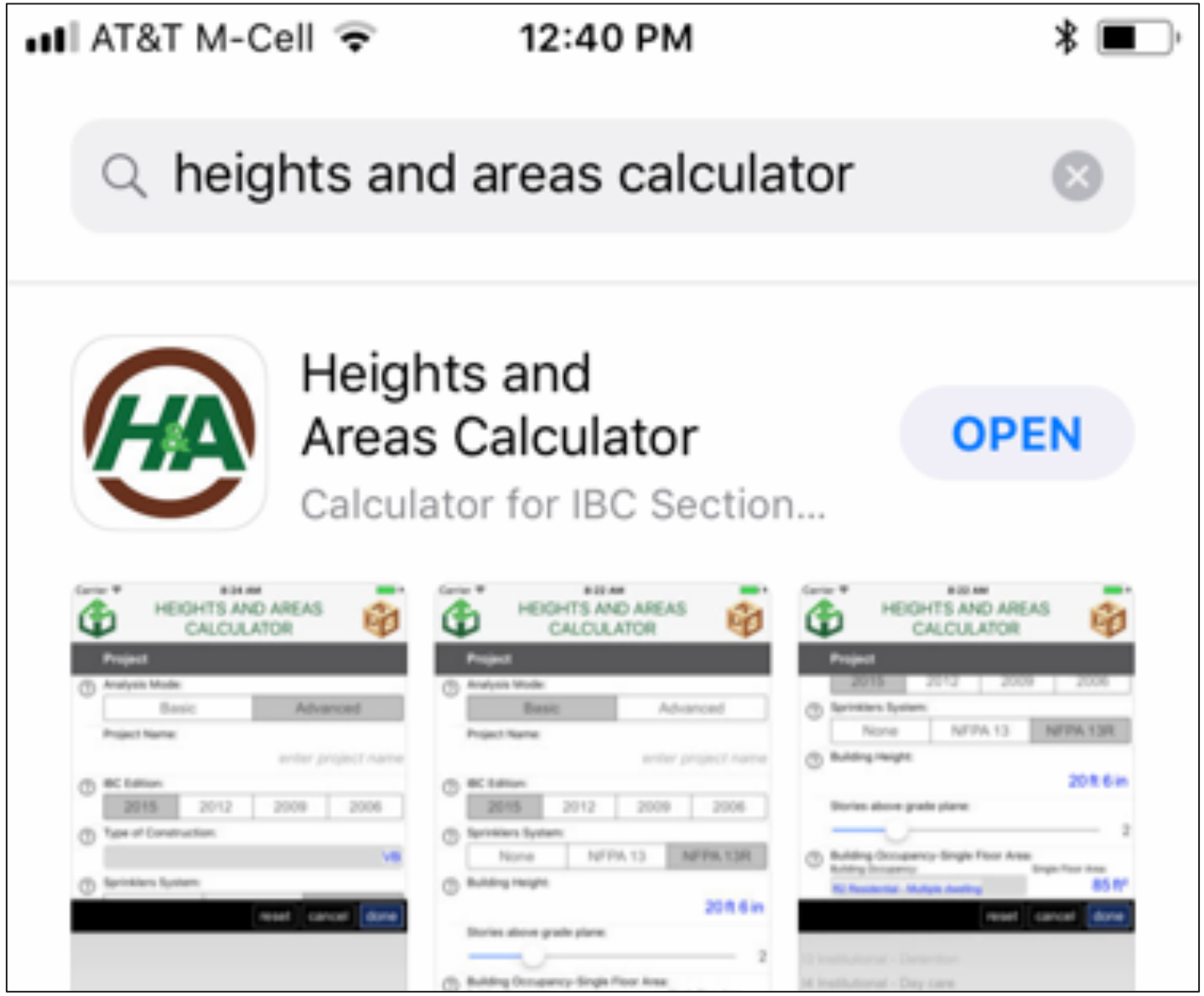
Sum of ratios of actual area/allowable area for all occupancies per floor:

0.78 + 0.83 + 0.85 + 0.80 = 3.26 > 3.0

inadequate; type VA can't be used

Use Type IIIB

WoodWorks/AWC H&A Calculator

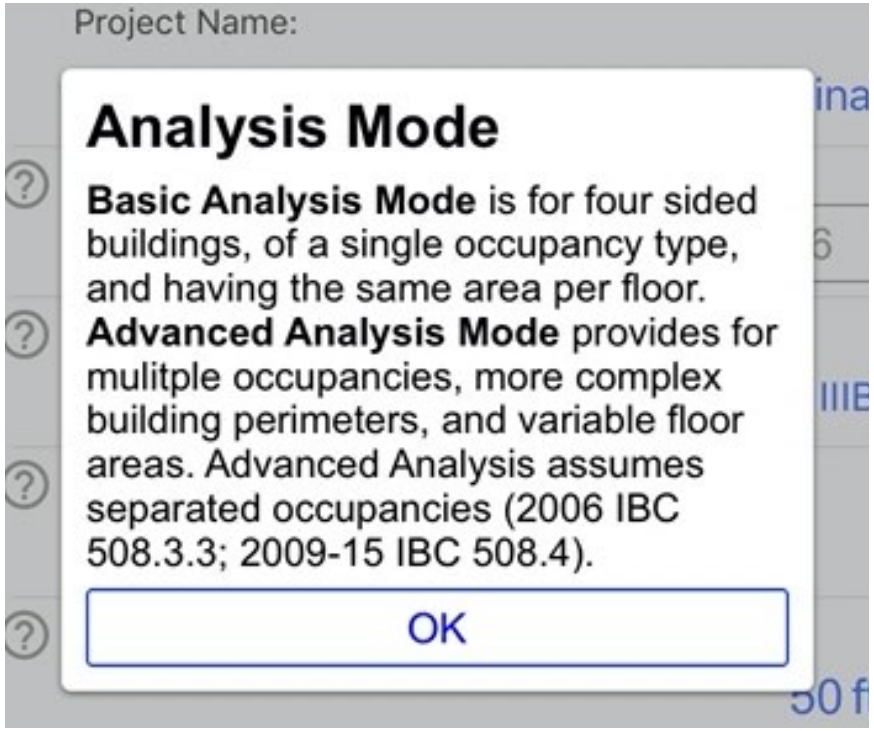


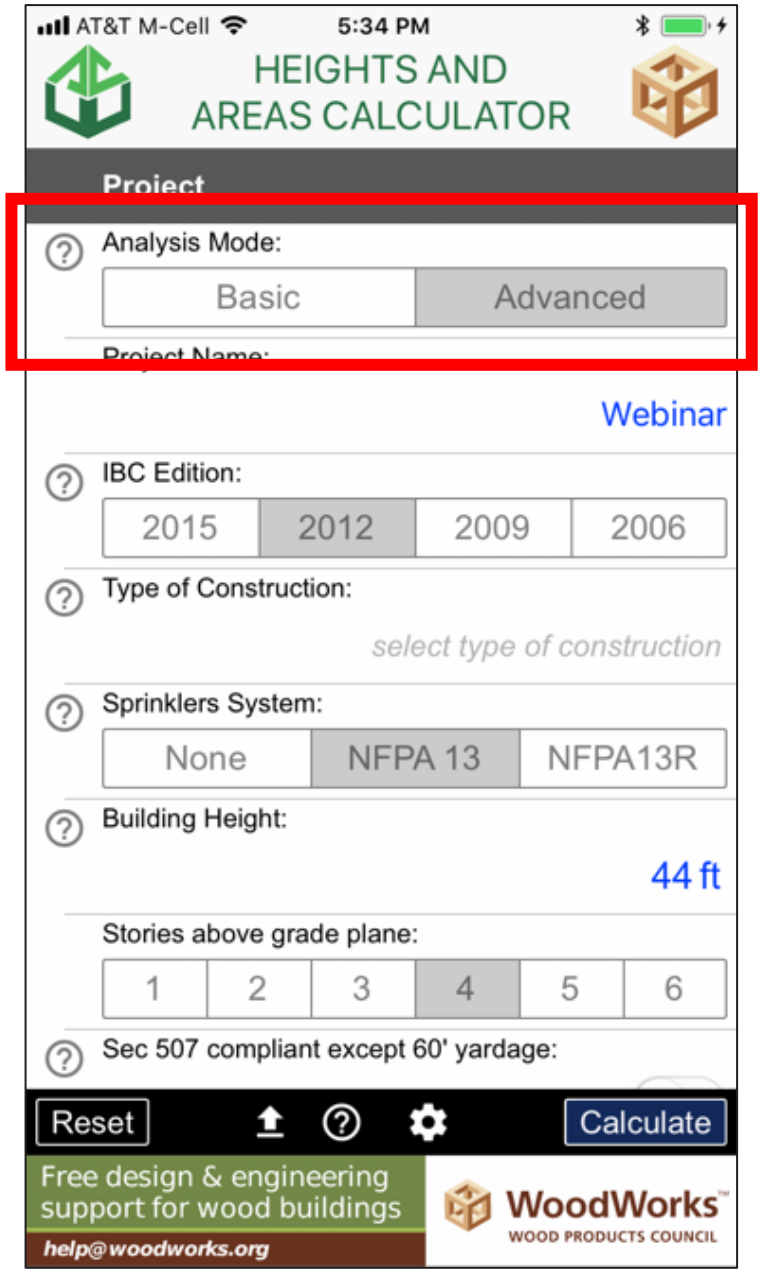
https://www.awc.org/codes-standards/calculators-software/heights-areas

WoodWorks/AWC H&A Calculator

2 Analysis Modes:

- Basic
- Advanced





Savings Can be Found in the Details

Shafts, Partitions & More

Shaft Wall Savings – Case Study

Switch to Wood Framed Shaft Walls Saves Project $176,000

- Gala at Oakcrest, Euless, TX
- 4 Story, 135,000 sf multi-family building
- 2 Elevator Shafts, 3 Stair Shafts, all originally designed in masonry – project was otherwise all wood framed
- Initial estimates were total of $266,000 for all 5 shafts
- Team switched to wood shafts, cut $176,000 from cost and at least 3 weeks from schedule

Source: Gardner Capital Construction, project General Contractor & Developer

Shaft Wall Resource

Code provisions, detailing options, project examples and more for light-frame wood and mass timber shaft walls

Free resource at woodworks.org

WoodWorks
WOOD PRODUCTS COUNCIL

Shaft Wall Solutions
For Wood-Frame Buildings

Richard McLain, MS, PE, SE • Technical Director • WoodWorks

Wood shaft walls can reduce costs and shorten the construction schedule.

It is fairly common for light wood-frame commercial and multi-family buildings to include shaft walls made from other materials. However, with the heavy use of wood structure in mid-rise construction, many designers and contractors have come to realize that wood-frame shaft walls are in fact a code-compliant means of reducing cost and shortening construction schedule.

A shaft is defined in Section 202 of the 2012 International Building Code (IBC) as "*an enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof.*" Therefore, shaft enclosure requirements apply to stairs, elevators, and MEP chases in multi-story buildings. While these applications might be similar in their fire design requirements, they often have different construction constraints and scenarios where assemblies and detailing may also differ.

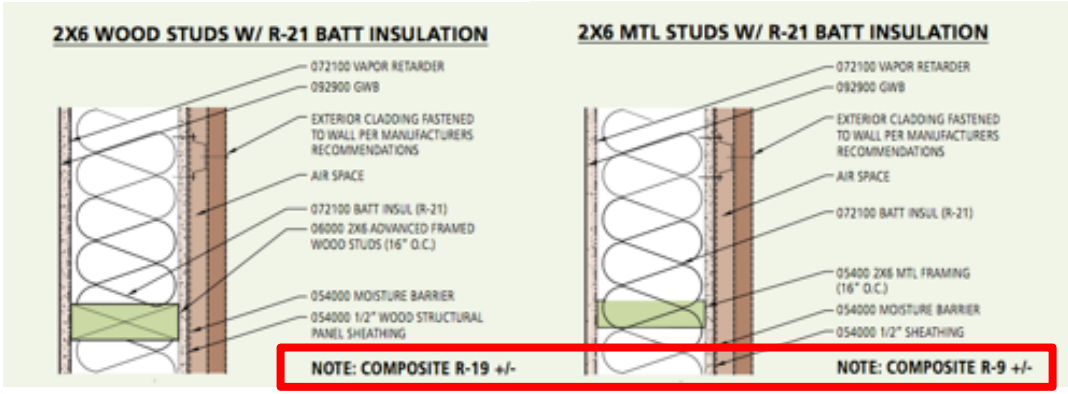
This paper provides an overview of design considerations, requirements, and options for wood-frame shaft walls under the 2012 IBC. While some of the IBC-referenced section numbers may be different in different editions, none of the main shaft wall provisions have been modified in the 2015 IBC.

Wood Within Podium Level(s)

Credit: WoodWorks

FRTW is permitted in non-bearing, non-rated exterior walls in types I & II (IBC 603.1)

Thermal/building envelope benefits, as well as consistent exterior wall detailing



Source: Mahlum Architects

Wood Within Podium Level(s)

Credit: WoodWorks

2021 IBC allows stairs below the podium to be framed with wood if building above podium is type III, IV or V

How is Design Shifting?

Off-Site Construction

Varying Degrees of Automated Equipment

Panelized Construction

Image: Blueprint Robotics

33% Schedule Savings

Woodlands at Harvest Hill, Lebanon, NH
4 Stories, 167k SF

Image: Trumbull-Nelson Construction Company
Source: Wallace Building Products[3]

Prefabricated Construction

Image: Ecocor

MODULAR CONSTRUCTION

Modular Construction

Image: Guerdon Modular

Modular Construction

Image: Guerdon Modular

A new style of panelized construction


NO SITE PARKING
NO SITE PARKING


1 Floor = 3 Days

17 Floors Erected in 9.5 Weeks

Brock Commons, Vancouver, BC
Source: Naturally: Wood[7]

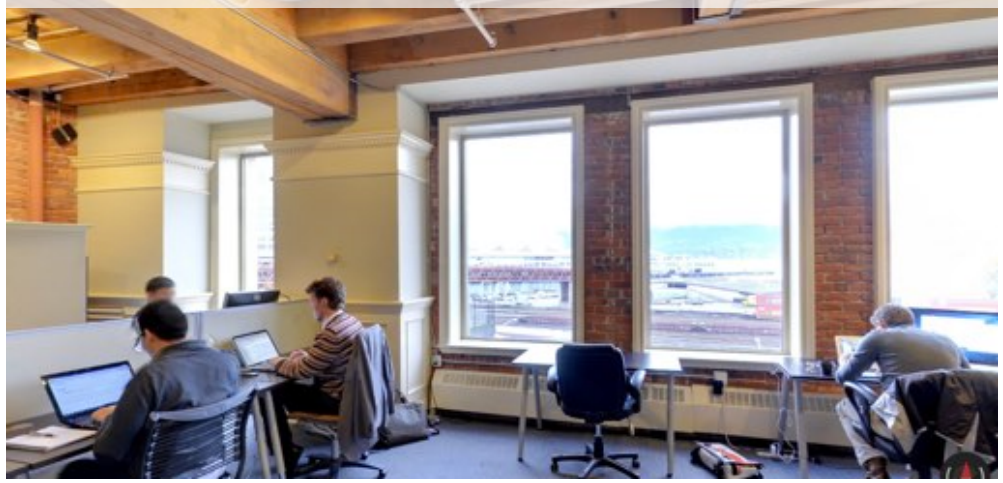
What’s Happening Across The Globe?

Tall Wood

TALL WOOD IN NORTH AMERICA CIRCA 1906

9 STORIES

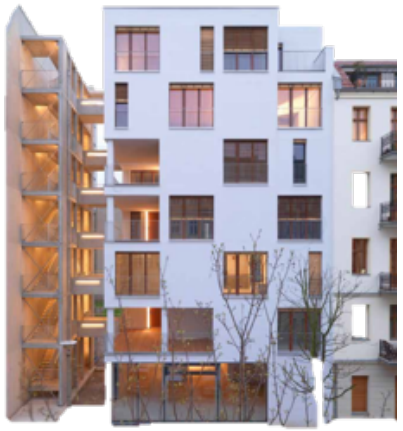
THE LANDING, VANCOUVER



BUTLER SQUARE, MINNEAPOLIS

GLOBAL TALL WOOD CIRCA 2015

7-14 STORIES



GLOBAL TALL WOOD CIRCA 2019

18-24 STORIES

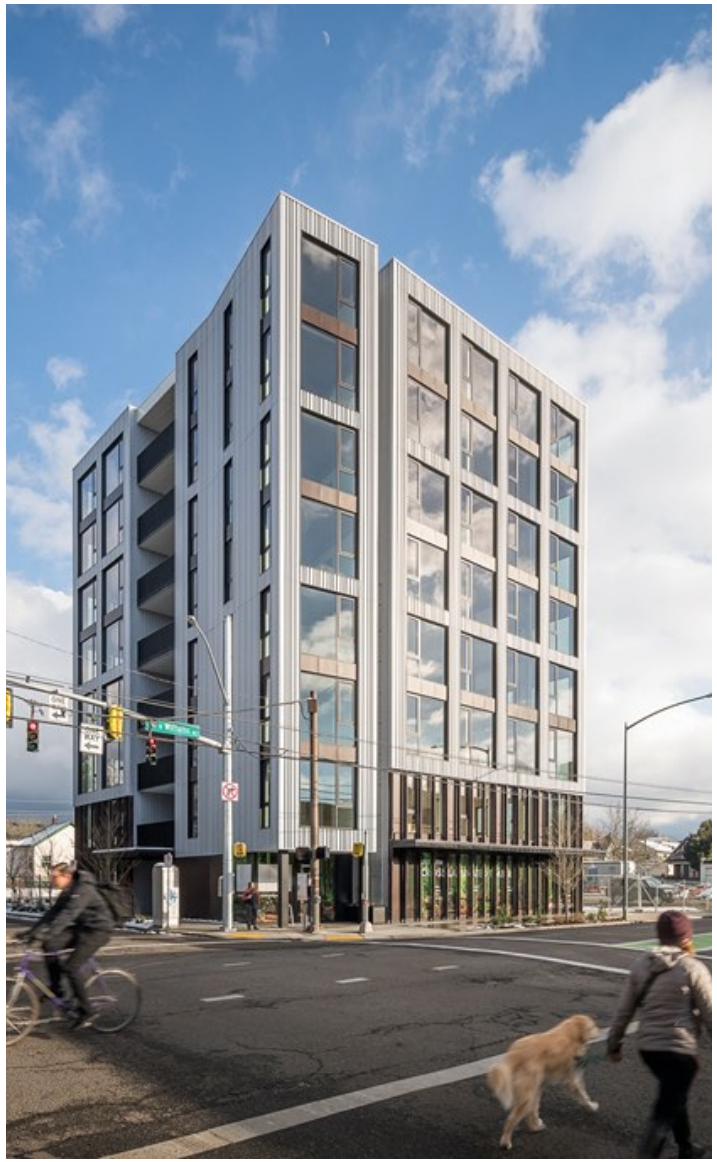

Photo: Moelven Limtre

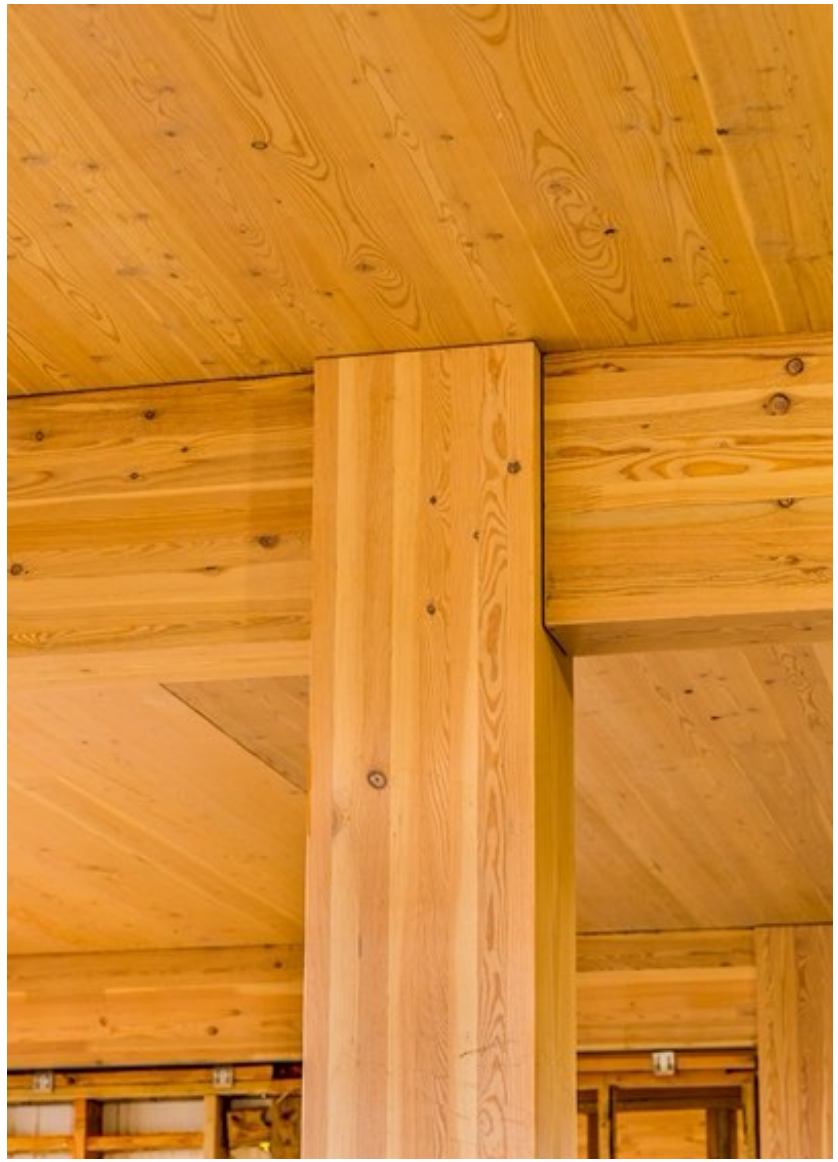

Photo: naturally:wood


Photo: Rudiger Lainer + Partner

TALL WOOD IN THE US CIRCA 2019

8 STORIES





Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: PATH Architecture

What Will The Future Bring?

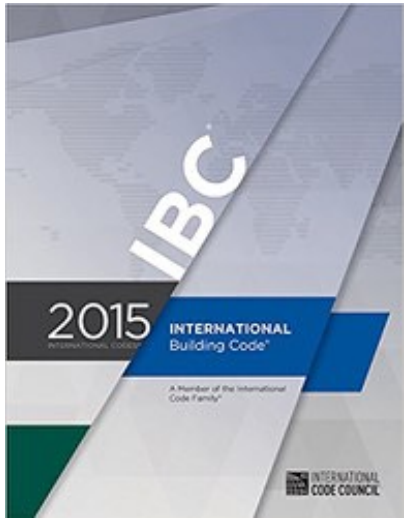
Tall Wood in the US

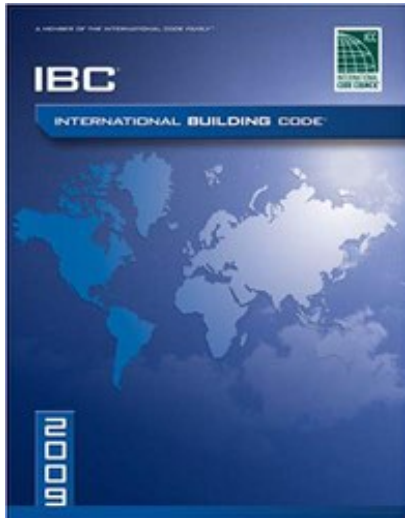
IBC 2021

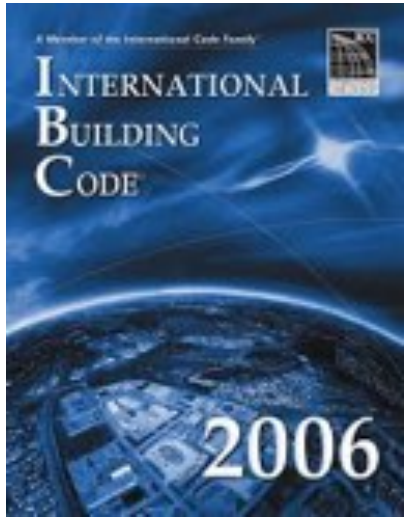
U.S. BUILDING CODE STATUS

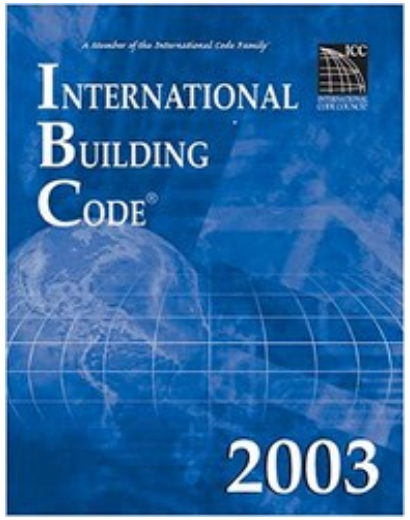
Photo: Ema Peter

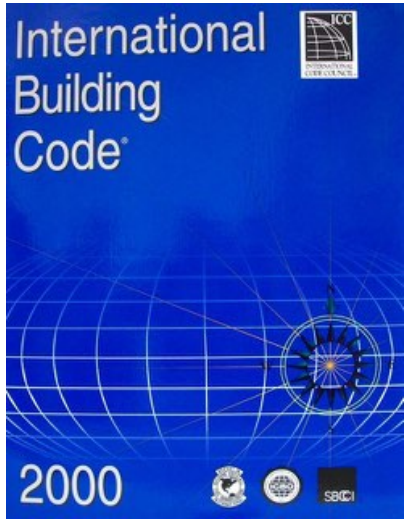
3 YEAR CODE CYCLE











U.S. TALL WOOD
DEVELOPMENT AND CHANGES

In December 2015, the ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings. Objectives:

1. Explore the building science of tall wood buildings
2. Investigate the feasibility, and
3. Take action on developing code changes for tall wood buildings.

Photo: LendLease

Photo: LendLease

Photo: LendLease

Photo: LendLease

Photo: LendLease

TALL WOOD APPROVED!

Unofficial results posted Dec 19, 2018

Final votes ratified Jan 31, 2019

AWC: Tall Mass Timber code changes get final approval

Dec 19, 2018

LEESBURG, VA. – The International Code Council (ICC) has released the unofficial voting results on code change proposals considered in 2018, including passage of the entire package of 14 tall mass timber code change proposals. The proposals create three new types of construction (Types IV-A, IV-B and IV-C), which set fire safety requirements, and allowable heights, areas and number of stories for tall mass timber buildings. Official results are expected to be announced during the first quarter of 2019. The new provisions will be included in the 2021 *International Building Code* (IBC).

"Mass timber has been capturing the imagination of architects and developers, and the ICC result means they can now turn sketches into reality. ICC's rigorous study, testing and voting process now

2021 IBC Introduces 3 new tall wood construction types:

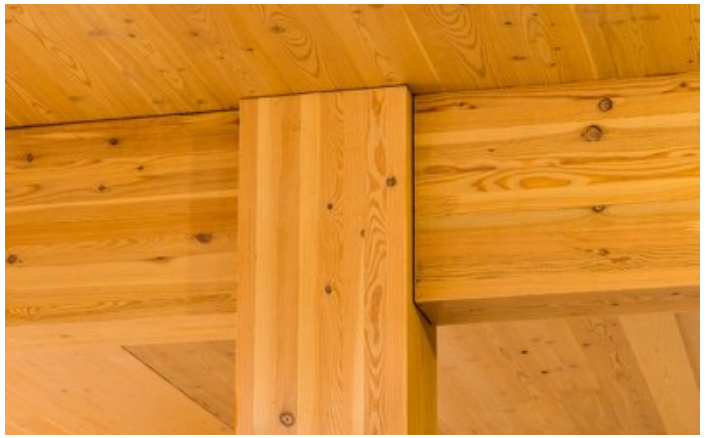
IV-A, IV-B, IV-C

Previous type IV renamed type IV-HT

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B

Type IV-C

Credit: Susan Jones, atelierjones



Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Protection vs. Exposed

IV-C

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path, Ema Peter

All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls

Type IV-C Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
B	9	85 ft	135,000 SF	405,000 SF
M	6	85 ft	76,875 SF	230,625 SF
R-2	8	85 ft	76,875 SF	230,625 SF

Areas exclude potential frontage increase

In most cases, Type IV-C height allowances = Type IV-HT height allowances, but add'l stories permitted due to enhanced FRR

Type IV-C area = 1.25 * Type IV-HT area

Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Protection vs. Exposed

IV-B

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed, see code for requirements

Type IV-B Protection vs. Exposed

IV-B

Credit: AWC

Type IV-B Protection vs. Exposed

IV-B

Credit: AWC

Type IV-B Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
B	12	180 ft	216,000 SF	648,000 SF
M	8	180 ft	123,000 SF	369,000 SF
R-2	12	180 ft	123,000 SF	369,000 SF

Areas exclude potential frontage increase

In most cases, Type IV-B height & story allowances = Type I-B height & story allowances

Type IV-B area = 2 * Type IV-HT area

Type IV-A

18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

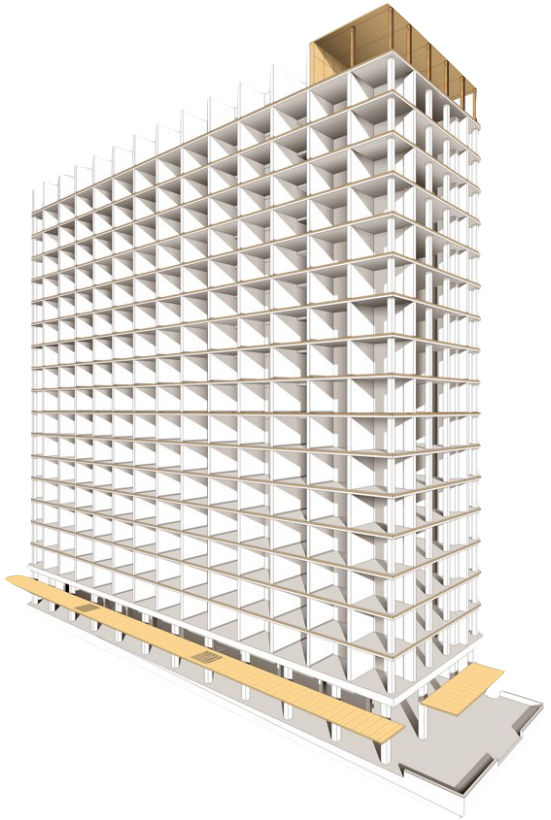
TYPE IV-A

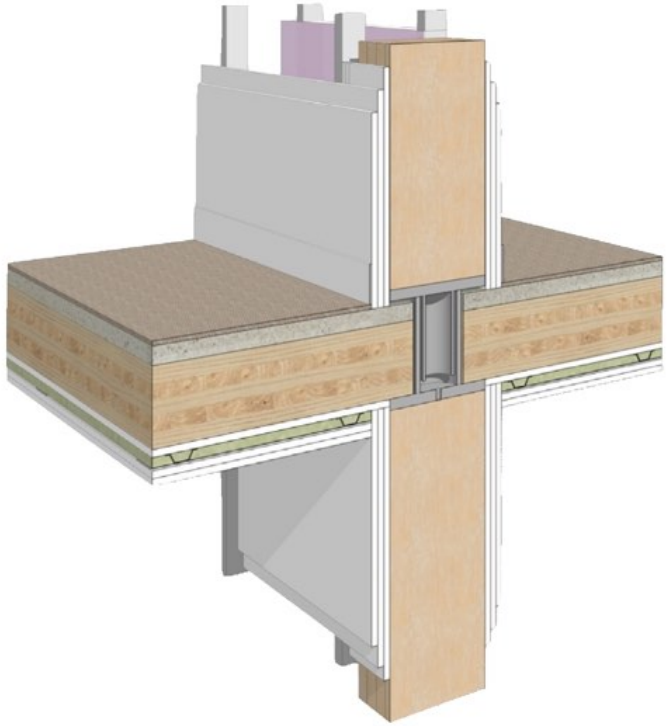
Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp

Type IV-A Protection vs. Exposed

Credit: Susan Jones, atelierjones





Credit: Acton Ostry Architects, Fast + Epp

100% NC protection on all surfaces of Mass Timber

Type IV-A Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
B	18	270 ft	324,000 SF	972,000 SF
M	12	270 ft	184,500 SF	553,500 SF
R-2	18	270 ft	184,500 SF	553,500 SF

Areas exclude potential frontage increase

In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height & story allowances

Type IV-A area = 3 * Type IV-HT area

MID-RISE VS. HIGH-RISE

IBC BASIS: 75 FT TO HIGHEST FLOOR

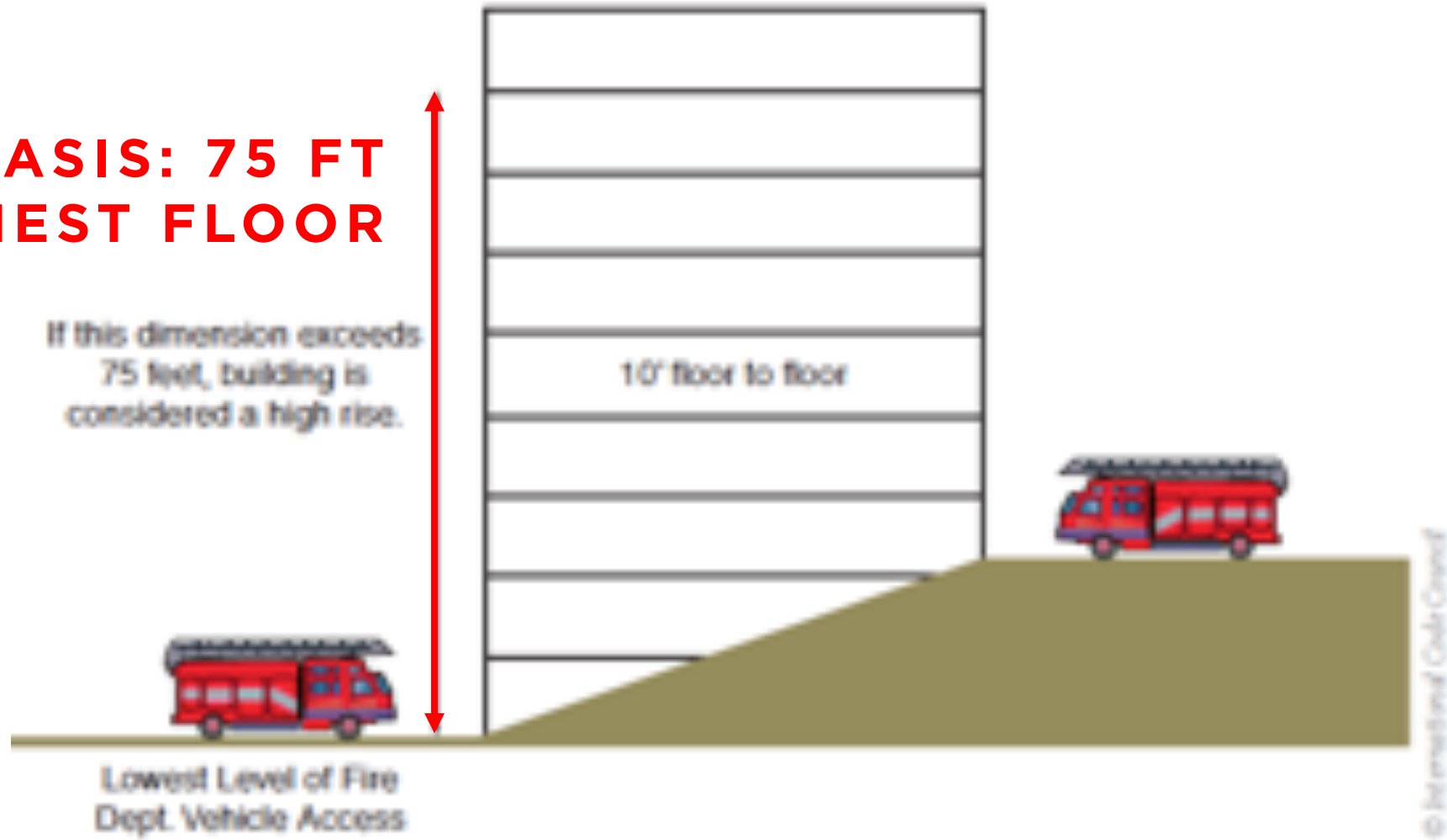


FIGURE 6-6 Determination of high-rise building

THE MID-RISE EVOLUTION

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Ricky McLain, PE, SE

WoodWorks – The Wood Product Council

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