WoodWorks™
WOOD PRODUCTS COUNCIL

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

David Hanley - Regional Director
WoodWorks – Wood Products Council
August 14th, 2019


PHOTO CREDIT: ECKERT & ECKERT PHOTOGRAPHY; GBD ARCHITECTS

"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.

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

Course Description

The expanding use of wood-frame construction for mid-rise projects is allowing architects to creatively achieve multiple, simultaneous objectives. Wood can effectively meet code requirements while adding value and enabling the need for increased density in urban environments. 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

Outline

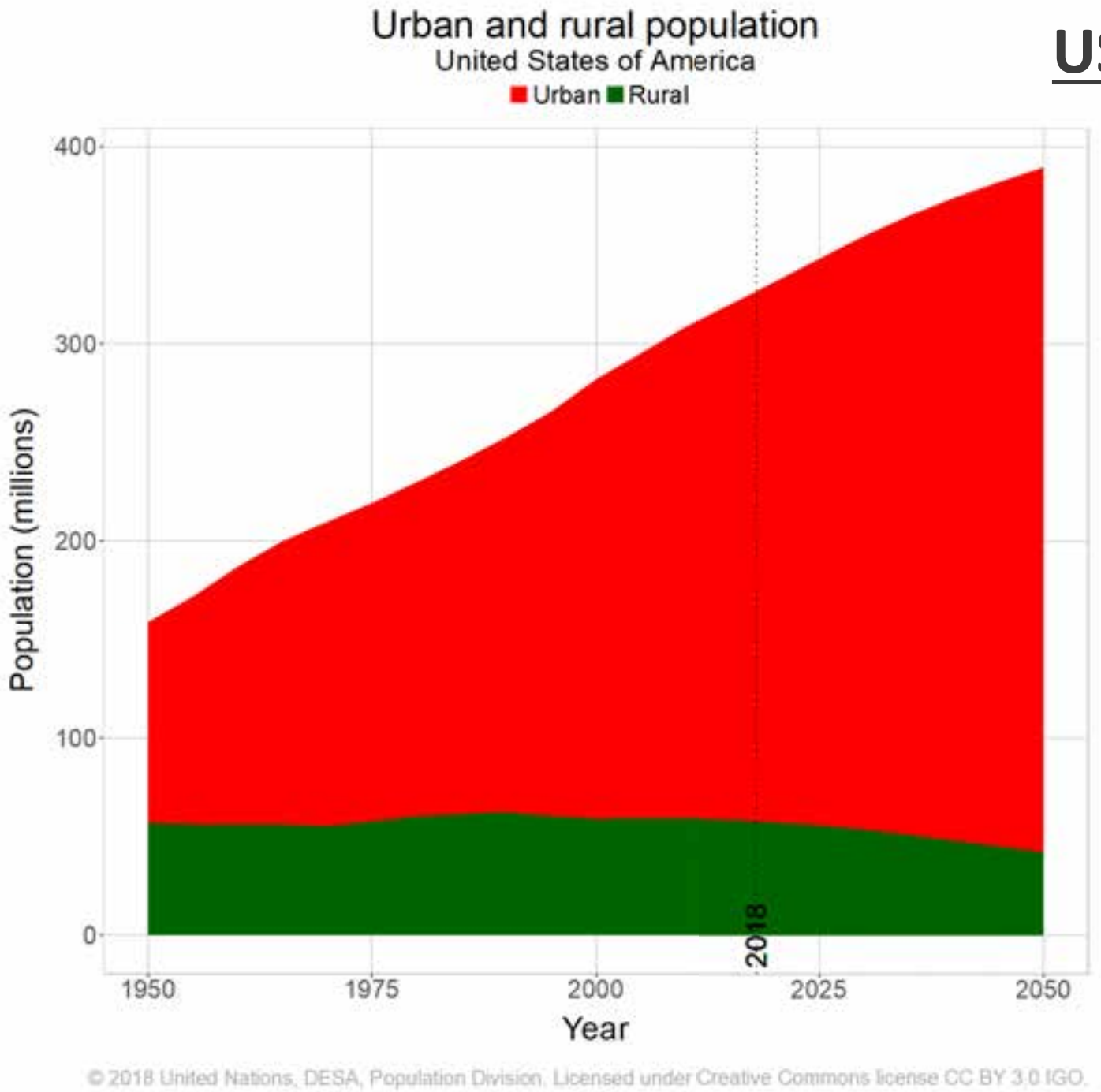
- Need for Wood Construction & Urban Densification
- Building Types/Configurations/Maximizing Height & Area
- Podium Provisions
- New Tall Wood Provisions

GLOBAL POPULATION BOOM

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

Source: United Nations Department of Economic and Social Affairs

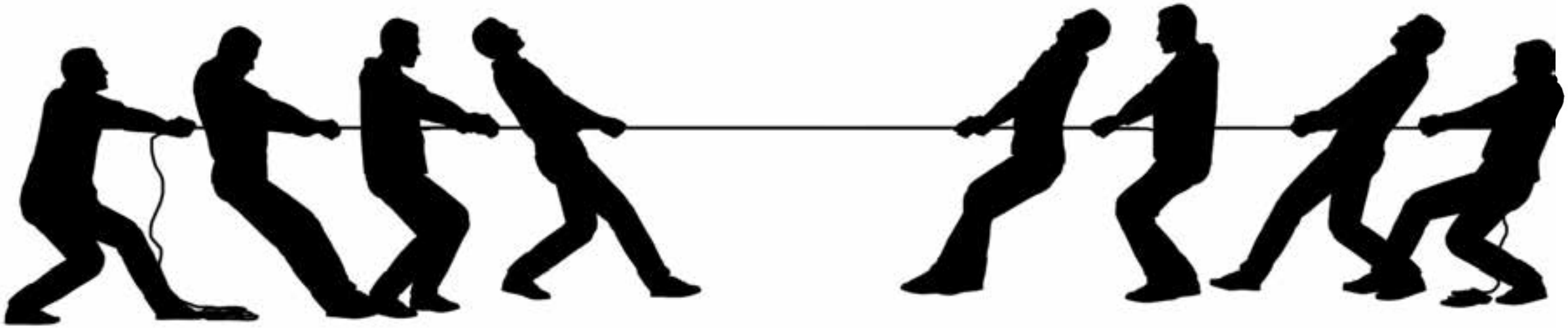
US URBAN POPULATION BOOM



	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

V-B

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

V-A

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

III-B

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

III-A

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

IV-HT

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

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

WHAT ABOUT 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

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

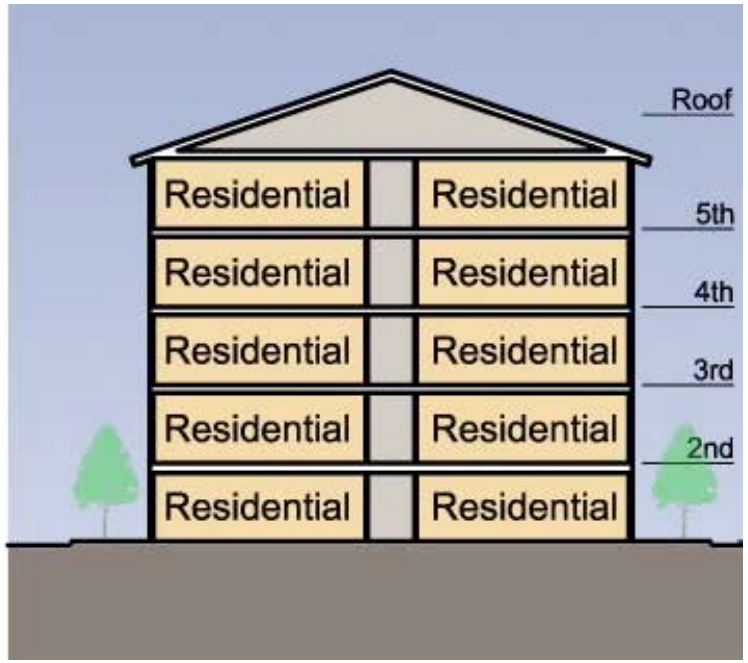
OFTEN CALLED PODIUM PROVISION:

- 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

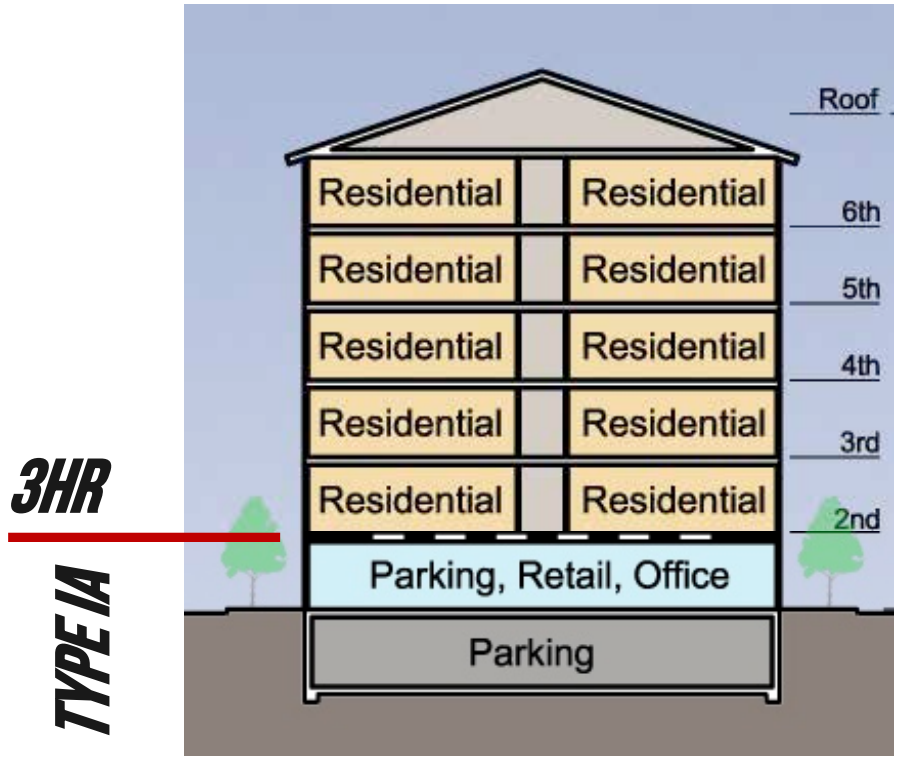
SPECIAL PROVISIONS

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

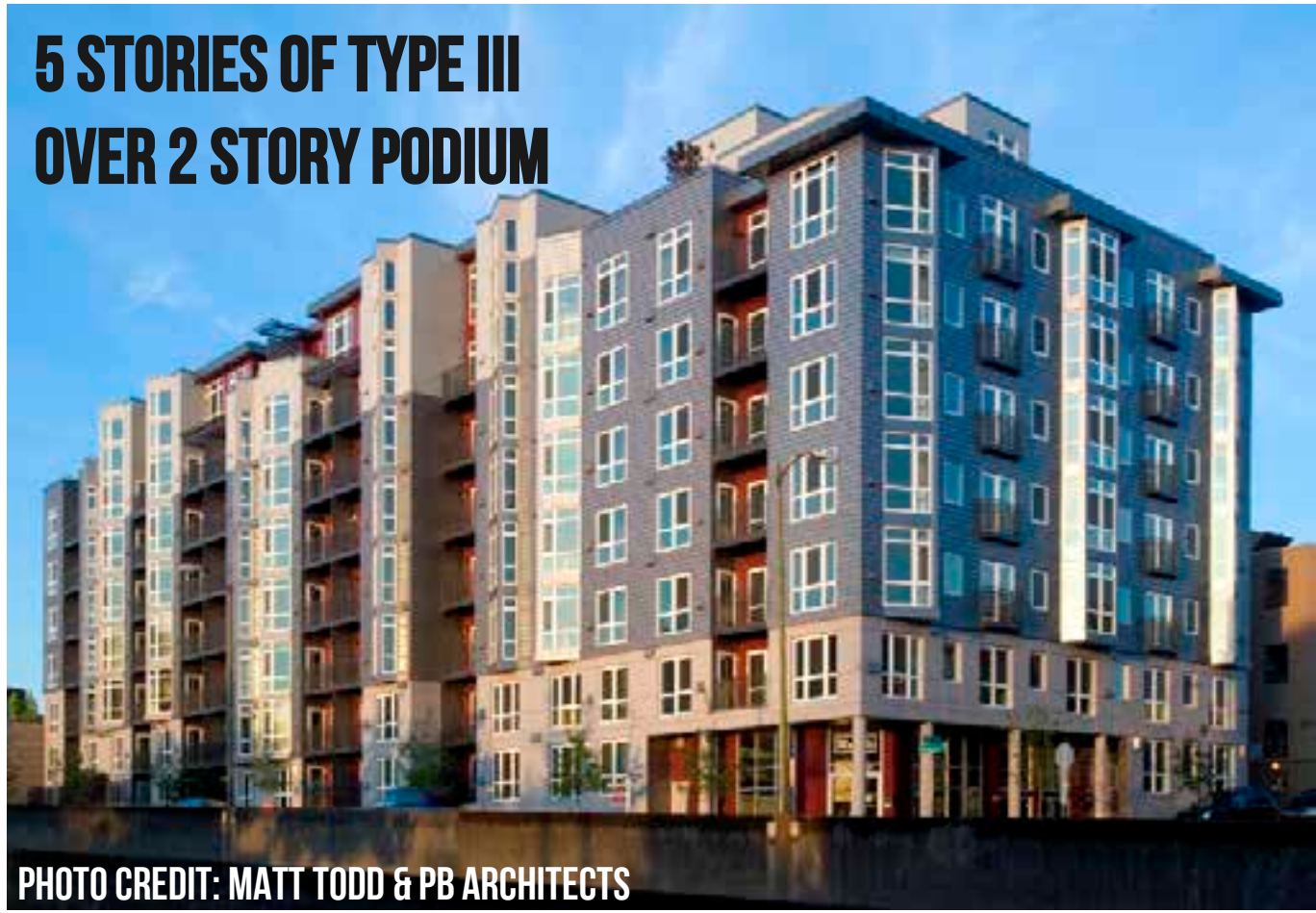


PHOTO CREDIT: MATT TODD & PB ARCHITECTS

SPECIAL PROVISIONS

IBC 510.2

7 STORY MIXED-USE POSSIBILITIES

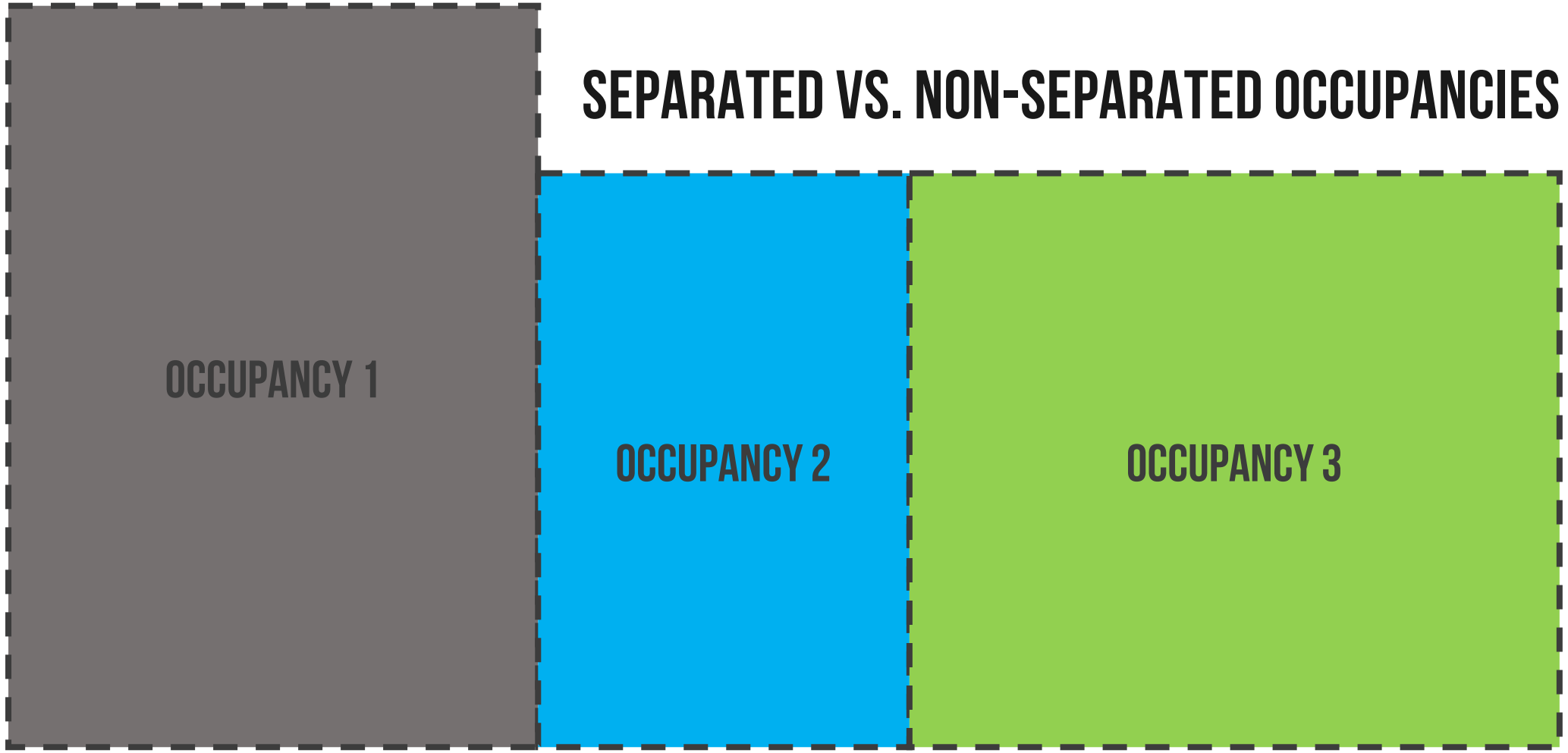
6 STORIES OF TYPE IIIA OR IV
OVER 1 STORY PODIUM

Image Credit: Michael Green Architects/Hines Group

MIXED OCCUPANCY BUILDINGS

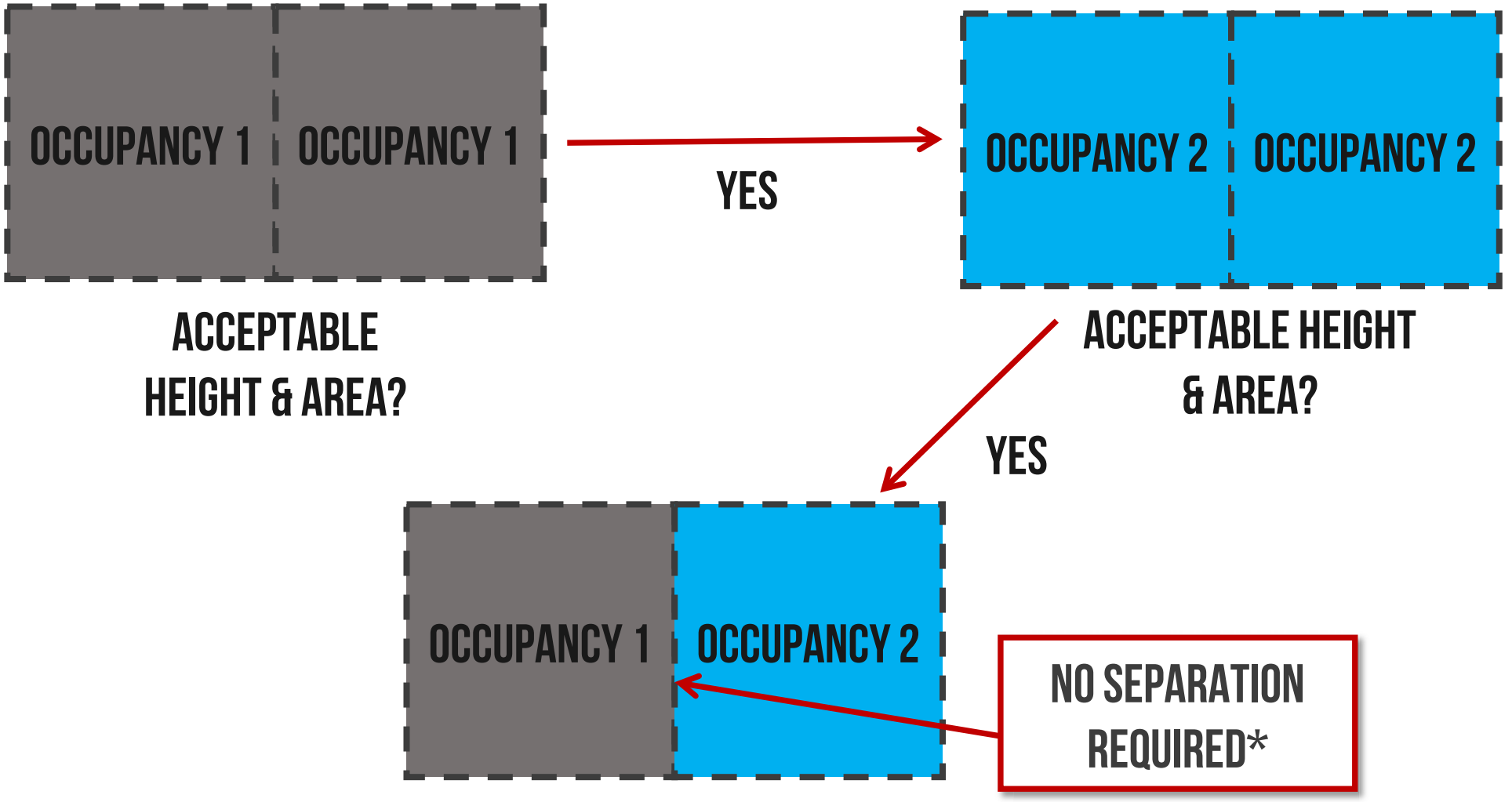
IBC 508

SEPARATED VS. NON-SEPARATED OCCUPANCIES



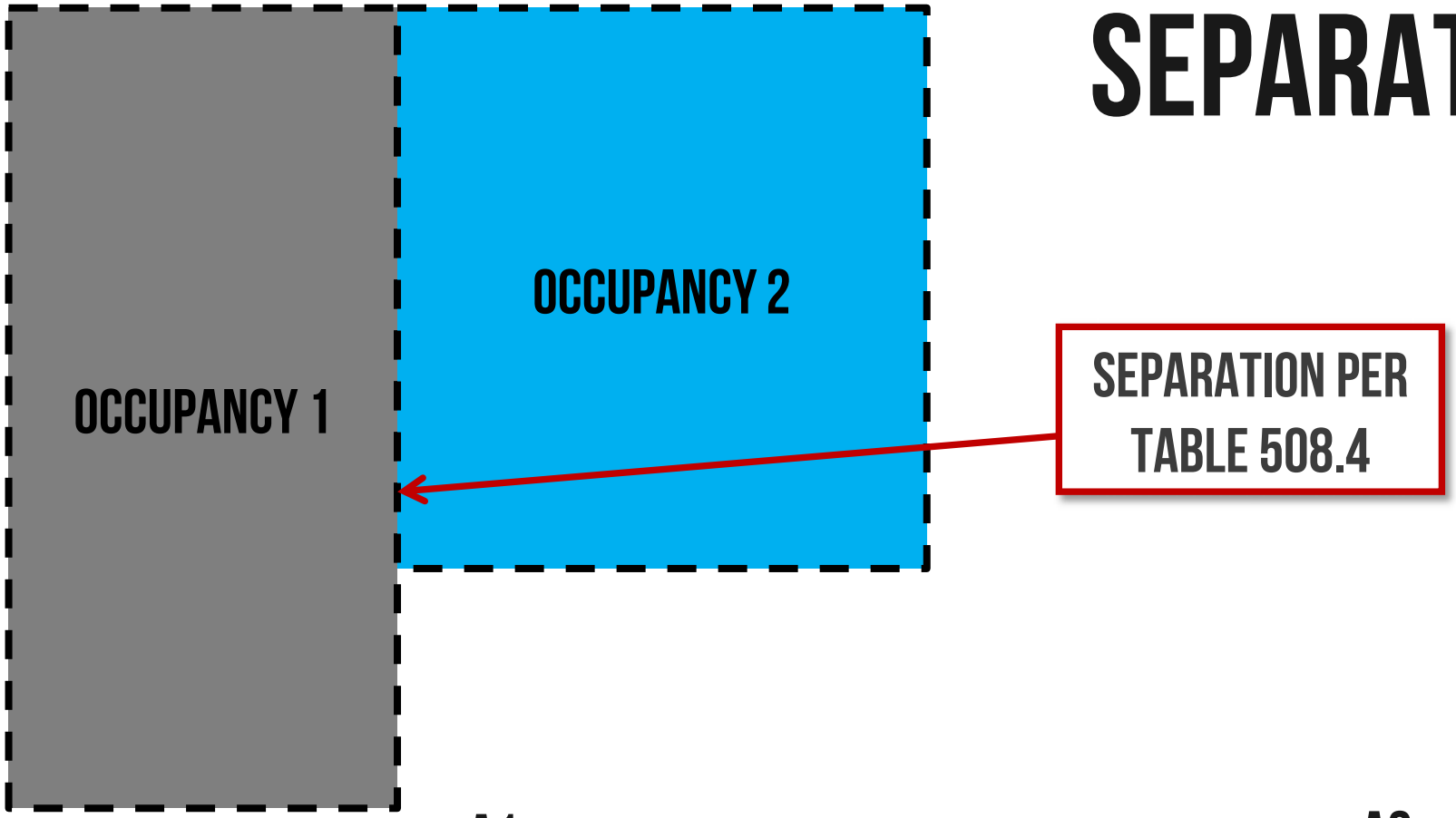
NON-SEPARATED OCCUPANCIES

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

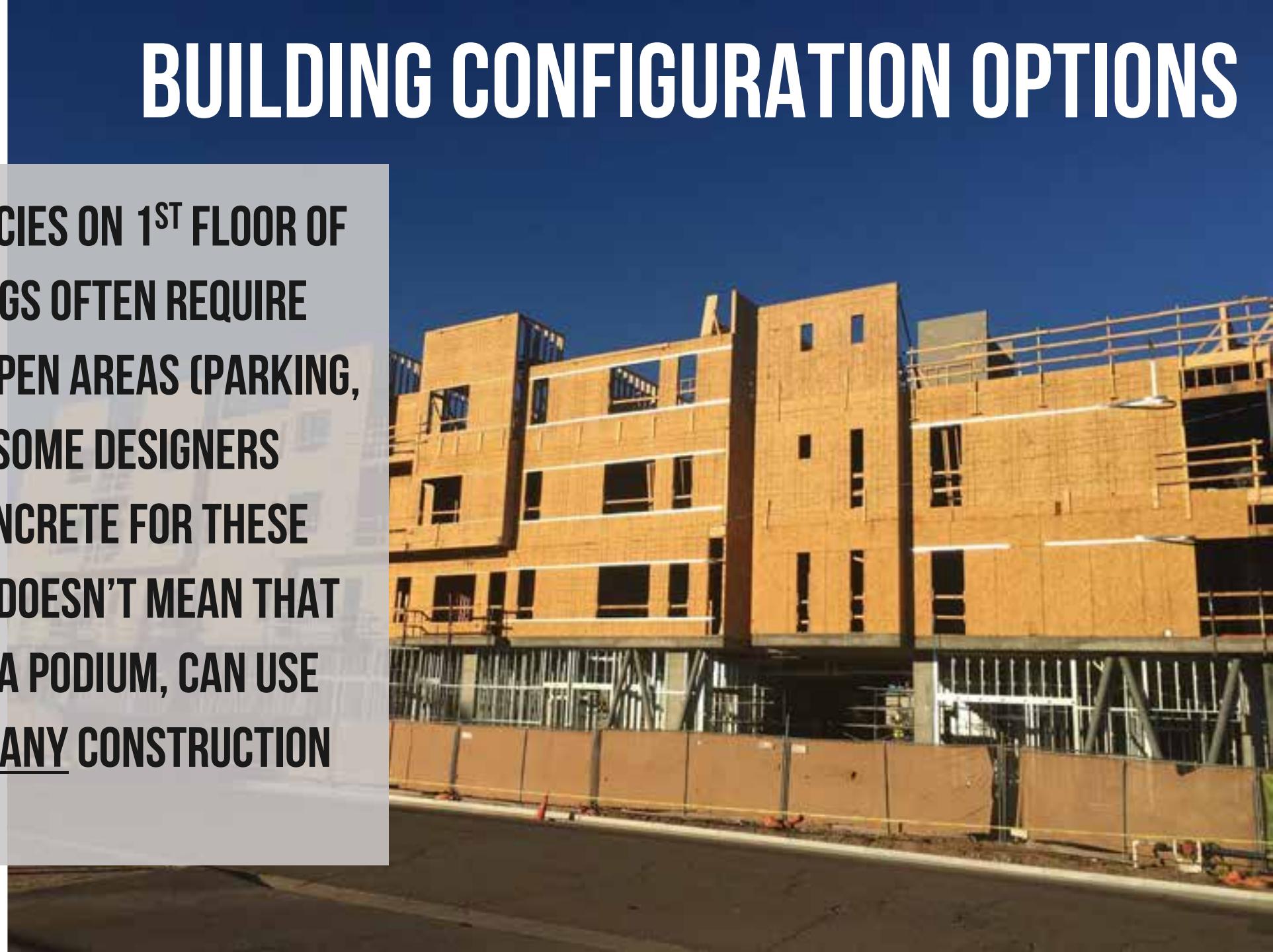
OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B[c], F-1, M, S-1	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2
F-2, S-2[b], U	—	—	—	—	—	—	—	—	N	N	1	2
B[c], F-1, M,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

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


PHOTO CREDIT: BRUCE DAMONTE

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:

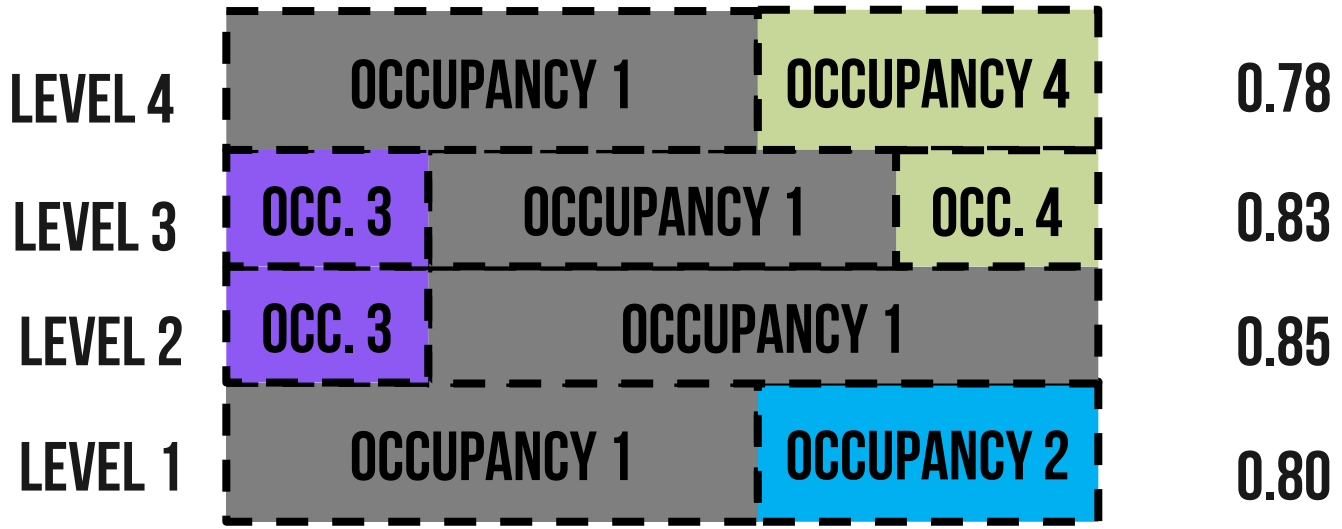
5-story, type III (with or without firewalls for area limitations)

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

SEPARATED OCCUPANCIES

IBC 508.4

MULTI-STORY SEPARATED OCCUPANCY EXAMPLE



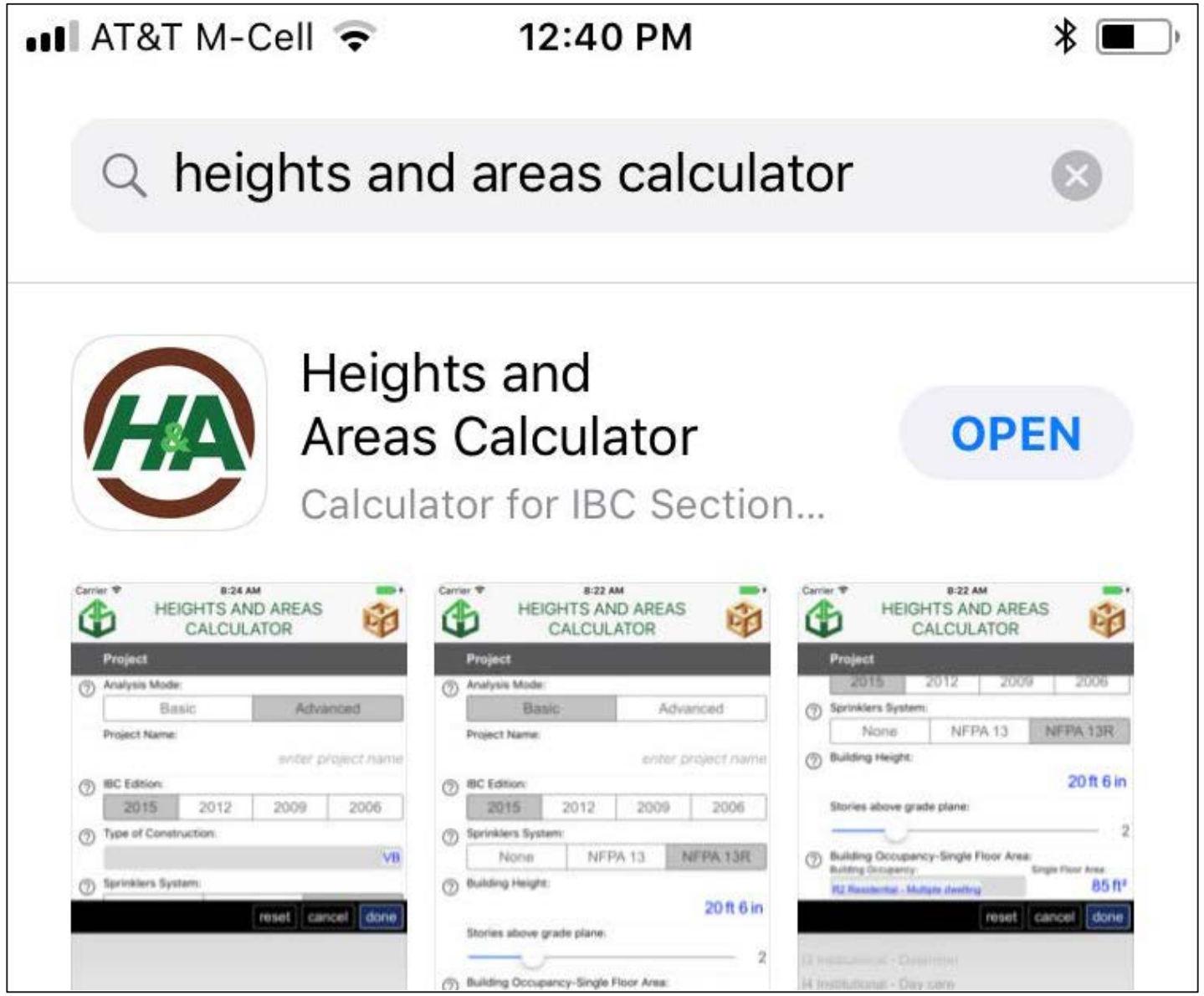
ELEVATION VIEW

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

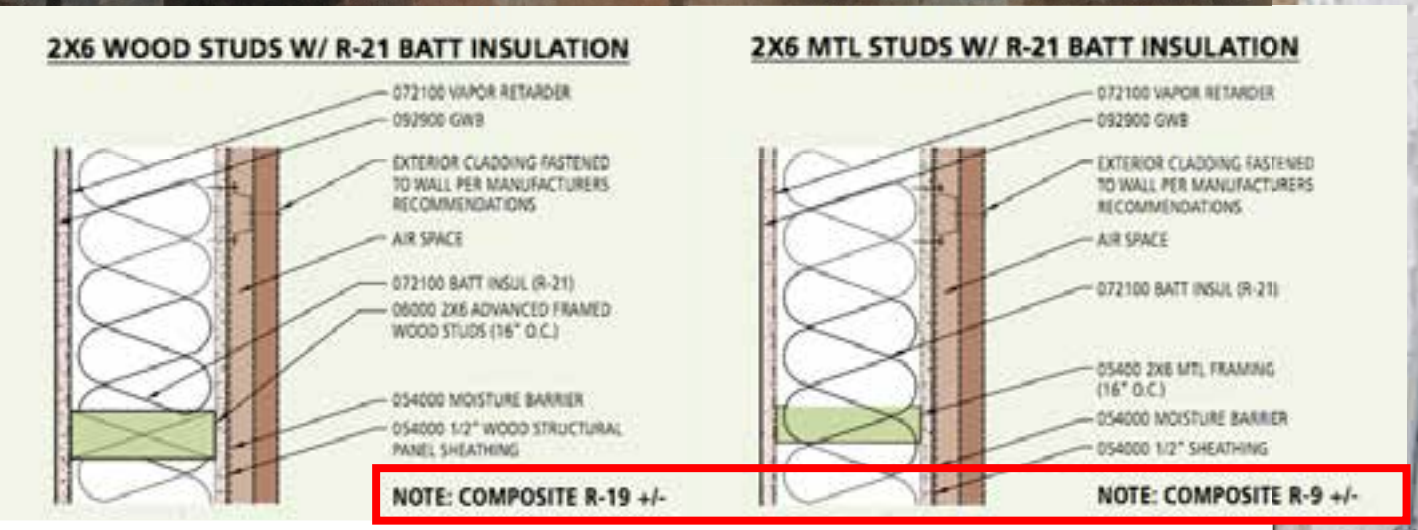
Wood shaft walls can reduce costs and shorten the construction schedule.

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.

- Walls within Podium Levels
- Stair Framing within Podium Levels



SOURCE: MAHLUM ARCHITECTS

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

Image: Guerdon Modular

Modular Construction

Image: Guerdon Modular

Modular Construction

Image: Guerdon Modular

A new style of panelized construction

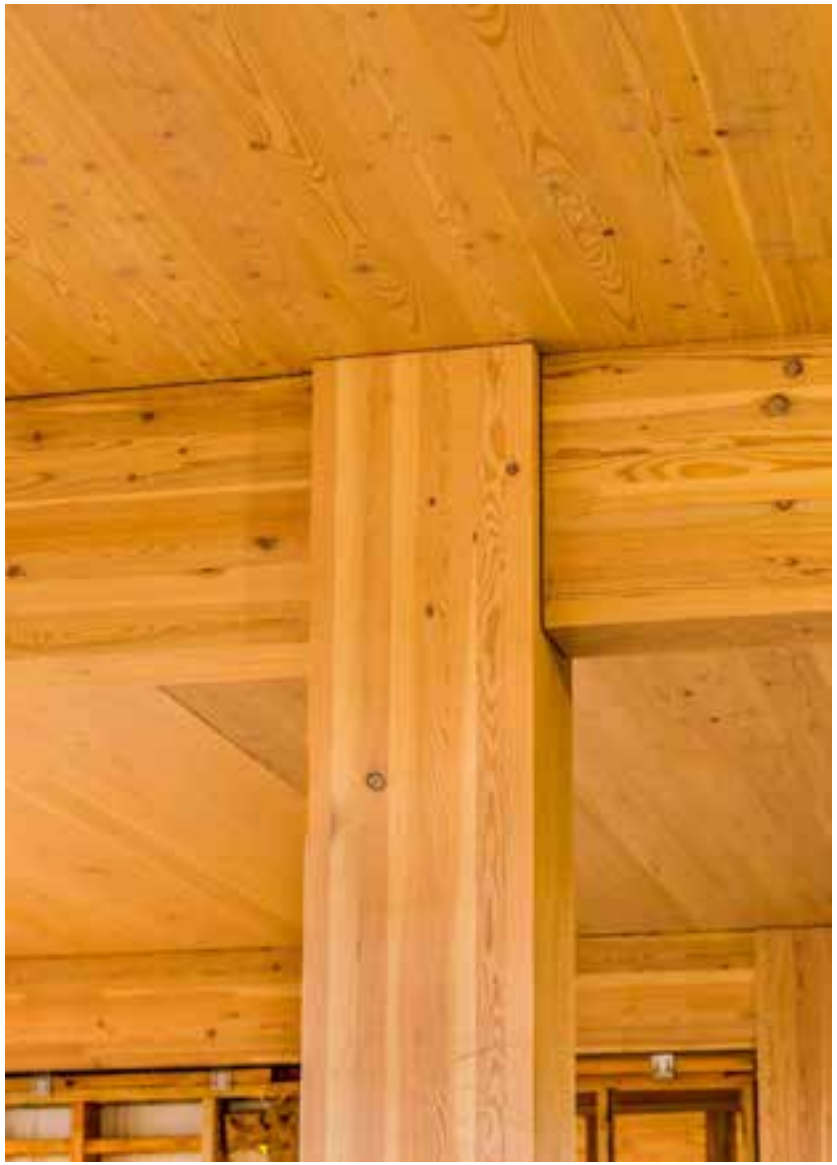
1 Floor = 3 Days

17 Floors Erected in 9.5 Weeks

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

TALL WOOD IN THE US CIRCA 2019

8 STORIES



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

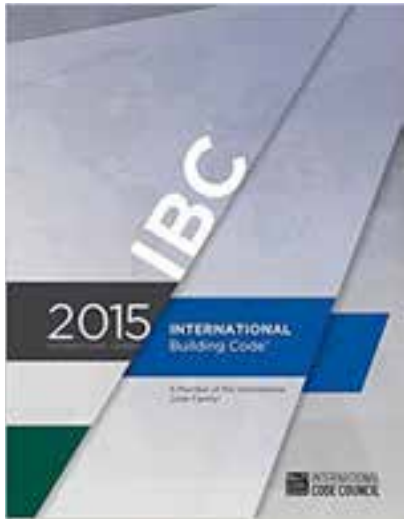
What Will The Future Bring?

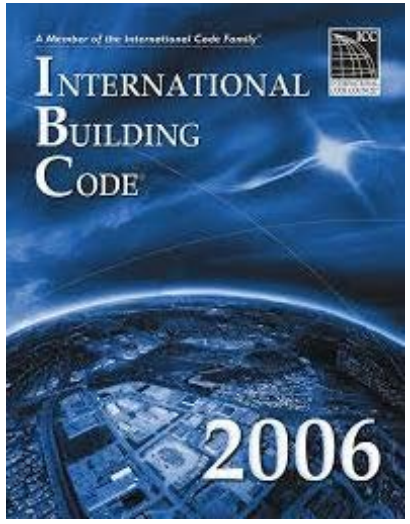
Tall Wood in the US

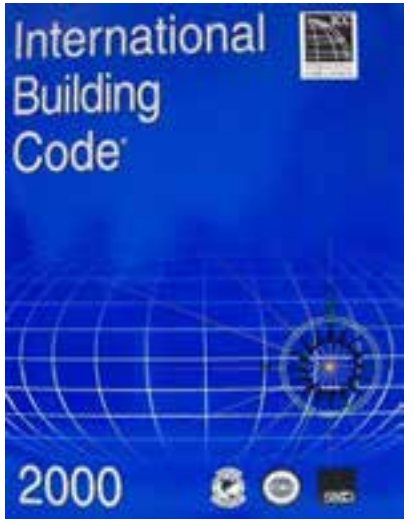
IBC 2021

INTERNATIONAL CODE COUNCIL®

3 YEAR CODE CYCLE







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-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-A

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp

MID-RISE VS. HIGH-RISE

IBC BASIS: 75 FT TO HIGHEST FLOOR

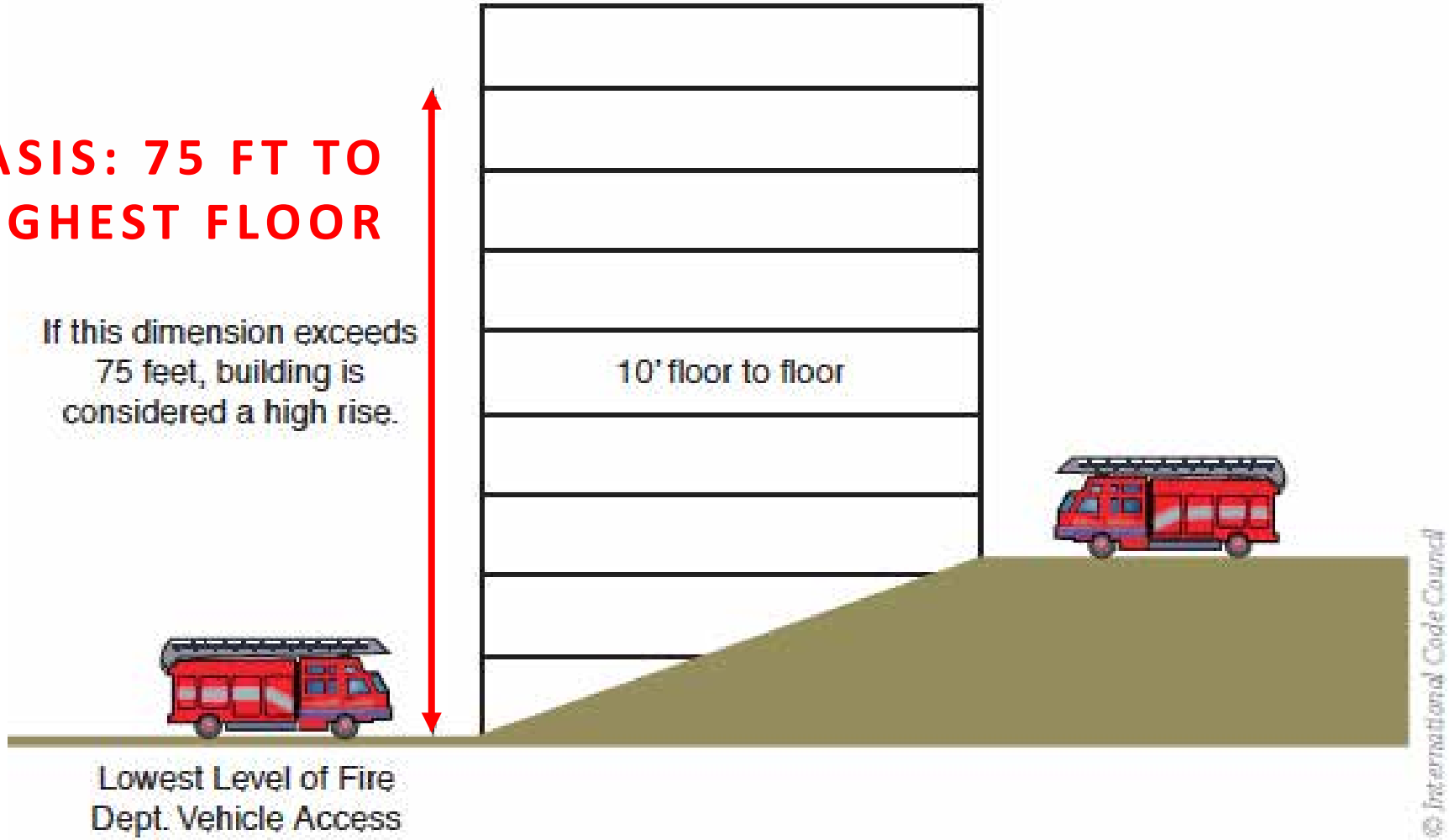


FIGURE 6-6 Determination of high-rise building

THE MID-RISE EVOLUTION

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

David Hanley

WoodWorks – The Wood Product Council

David.Hanley@woodwork.org

Copyright Materials