Taking the Guesswork out of Mixed-Use Building Analysis

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WoodWorks
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The seminar will begin at 8:30 AM EST

The Canyons, Kaiser+Path, photo Jeremy Bittermann

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Course Description

While mixed-use buildings—which combine multiple occupancy types and/or functions in a single structure—are common, determining how to apply their unique mix of code requirements can be a daunting task. To simplify code analysis associated with these buildings, this presentation covers logical, code-compliant steps for a number of topics, including determining allowable building size, separation needs, detailing requirements, and the application of special provisions. With an emphasis on the use of wood framing in Construction Types III, IV and V, examples, calculations, and details will be presented to demonstrate how to navigate the various code requirements associated with mixed-use buildings while maximizing building size and meeting fire and life safety needs.

Learning Objectives

1. Review the basic fire and life safety requirements associated with mixed-use, wood-frame structures.

2. Become familiar with the differences between Construction Types III, IV and V as defined by the International Building Code.

3. Highlight options for determining allowable building size of mixed-use facilities, including separated and non-separated occupancies, incidental uses and podiums.

4. Demonstrate how to achieve separation of occupancies with fire barriers, fire walls and horizontal assemblies.

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November 14 | ACME Tour - New Haven, CT

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UPCOMING EVENTS

What is Mixed Use?

Photo: Nicholas Wrey, courtesy of Applied Architecture, Inc.

Mixed-use development is a type of urban development that blends residential, commercial, cultural, institutional, or industrial uses, where those functions are physically and functionally integrated, and that provides pedestrian connections.

Or, simplistically:

Source: Thrall

A building with more than one occupancy group or intended function

Agenda

- Code history: property and life protection
- Occupancy groups and construction types
- Mixed use buildings
- Building configuration options
- Achieving fire separation (when necessary)

Fire and Life Safety

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Before we get into mixed use code provisions, a brief look at the evolution of fire & life safety

In early years of building code development, main purpose was to provide a reasonable level of **protection to property** from fire.

Concept was that if property was adequately protected from fire, occupants would also be protected.

Fire and Life Safety

IBC

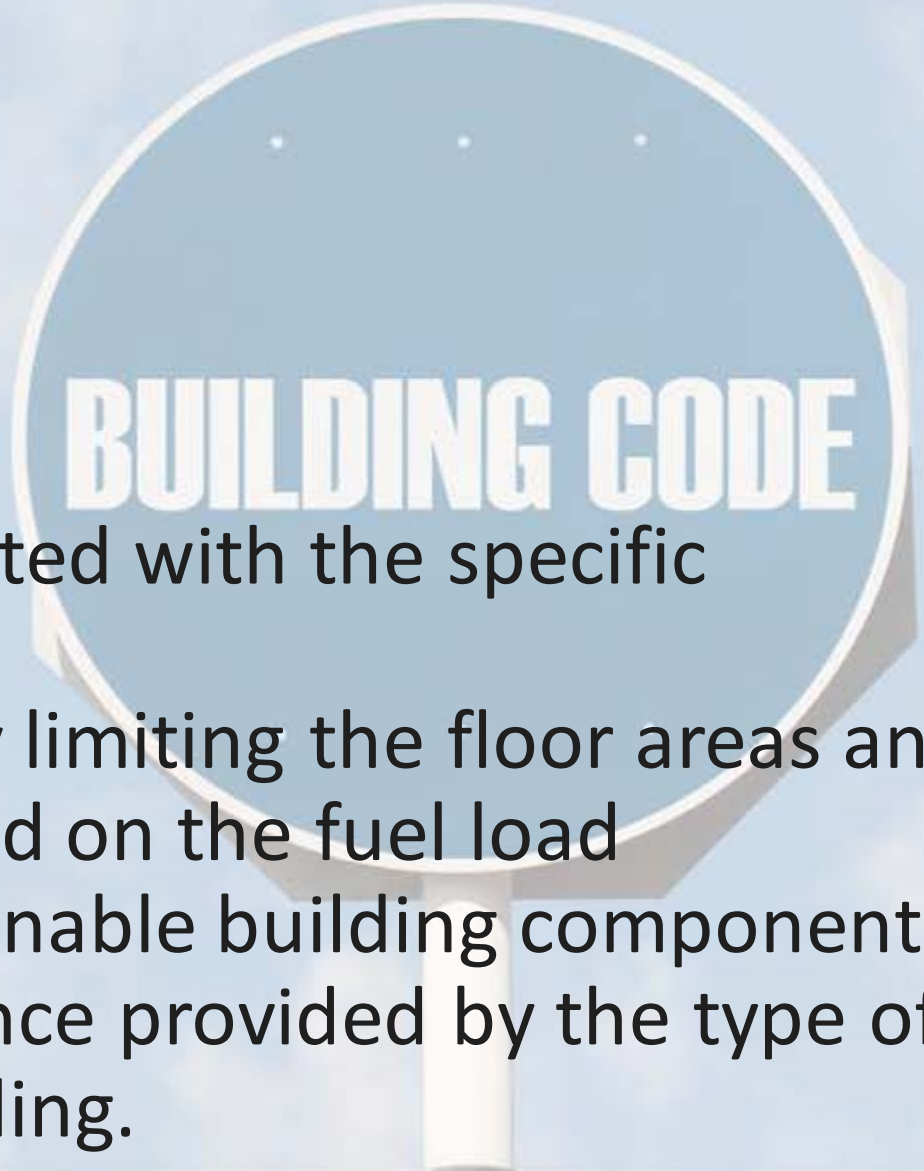
From this outlook on property fire safety, concept of equivalent risk evolved in the code.

Equivalent risk associates an acceptable level of risk against the damages of fire respective to a particular occupancy group by limiting building size according to construction type

Fire and Life Safety

IBC

Equivalent risk involves three interdependent considerations:



1. The level of fire hazard associated with the specific occupancy of the facility
2. The reduction of fire hazard by limiting the floor areas and the height of the building based on the fuel load (combustible contents and burnable building components)
3. The level of overall fire resistance provided by the type of construction used for the building.

Fire and Life Safety

IBC

As a result of extensive research and advancements in fire technology, today's building codes are more comprehensive and complex

While the principle of equivalent risk remains an important component in building codes, perspectives have changed and **life safety** is now the paramount fire issue.

Fire and Life Safety

IBC

Minimum provisions to achieve life safety:

- Fire detection, notification & suppression systems
- Adequate means of egress
- Limitation of fire spread
- Structural fire resistance
- Prevention of smoke migration

Outside scope of presentation

Fire and Life Safety

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- **Fire detection, notification & suppression systems**
  - Detection & notification: smoke & fire alarms
  - Suppression: active fire protection

Fire and Life Safety

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- **Adequate means of egress**
  - Number, sizing, and distance to exits
  - Operation and availability of means of egress components
  - Signage and protection of exit paths
  - Different occupancy groups may require more or less time to exit

Fire and Life Safety

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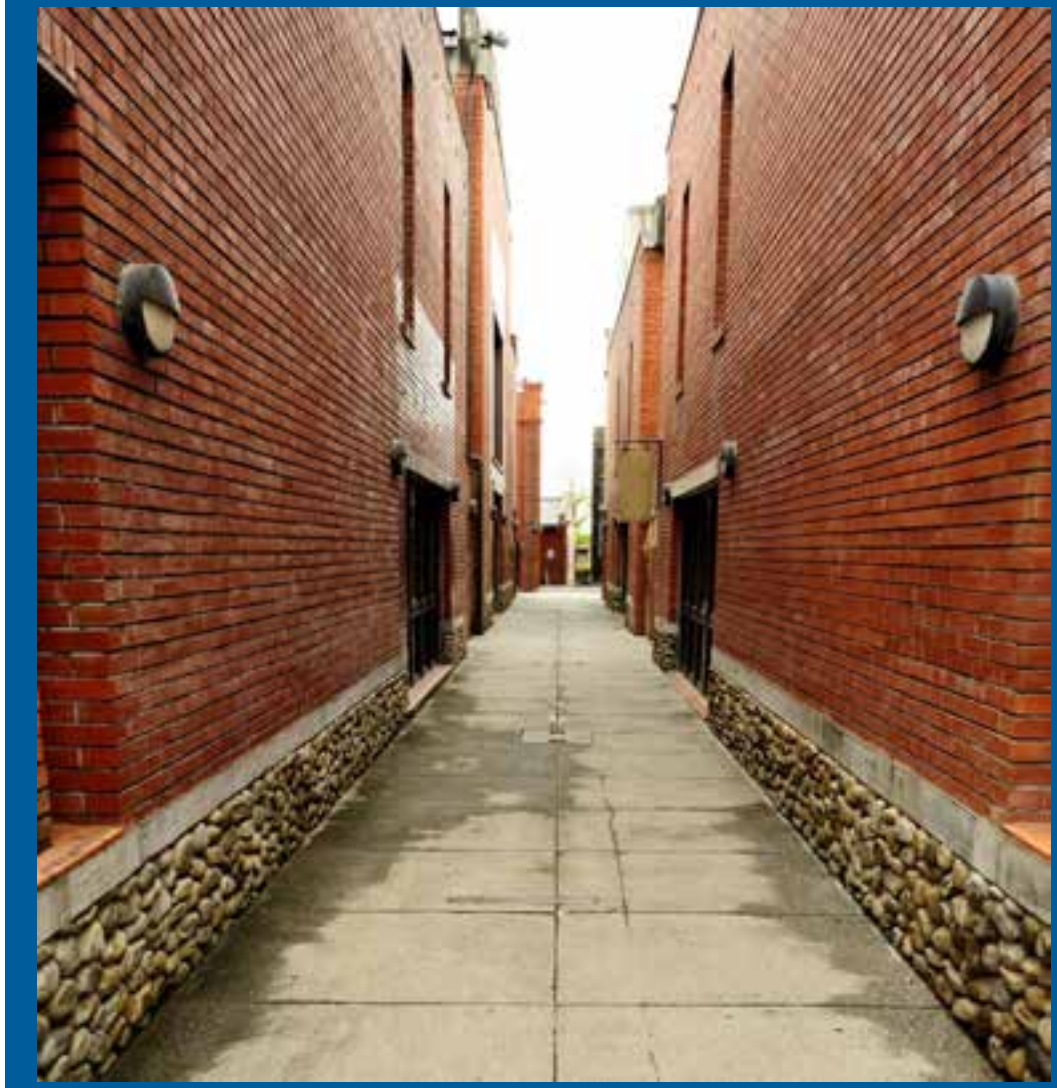
- **Limitation of fire spread**
  - Limit extent of fire spreading throughout building should one occur
- **Radiant heat exposure**
  - Keep fire from spreading to another building –exterior wall requirements



Fire and Life Safety

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- **Structural fire resistance**
  - Maintain structural integrity of building should a fire occur
  - Accounts for the response or participation that a building's structure will have in a fire condition

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[b]	2[b]	1	0	1	0	HT	1	0
Bearing walls Exterior[e,f] Interior	3 3[b]	2 2[b]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1½[b]	1[b,e]	1[b,e]	0[e]	1[b,e]	0	HT	1[b,e]	0

Fire and Life Safety

IBC

The building code:

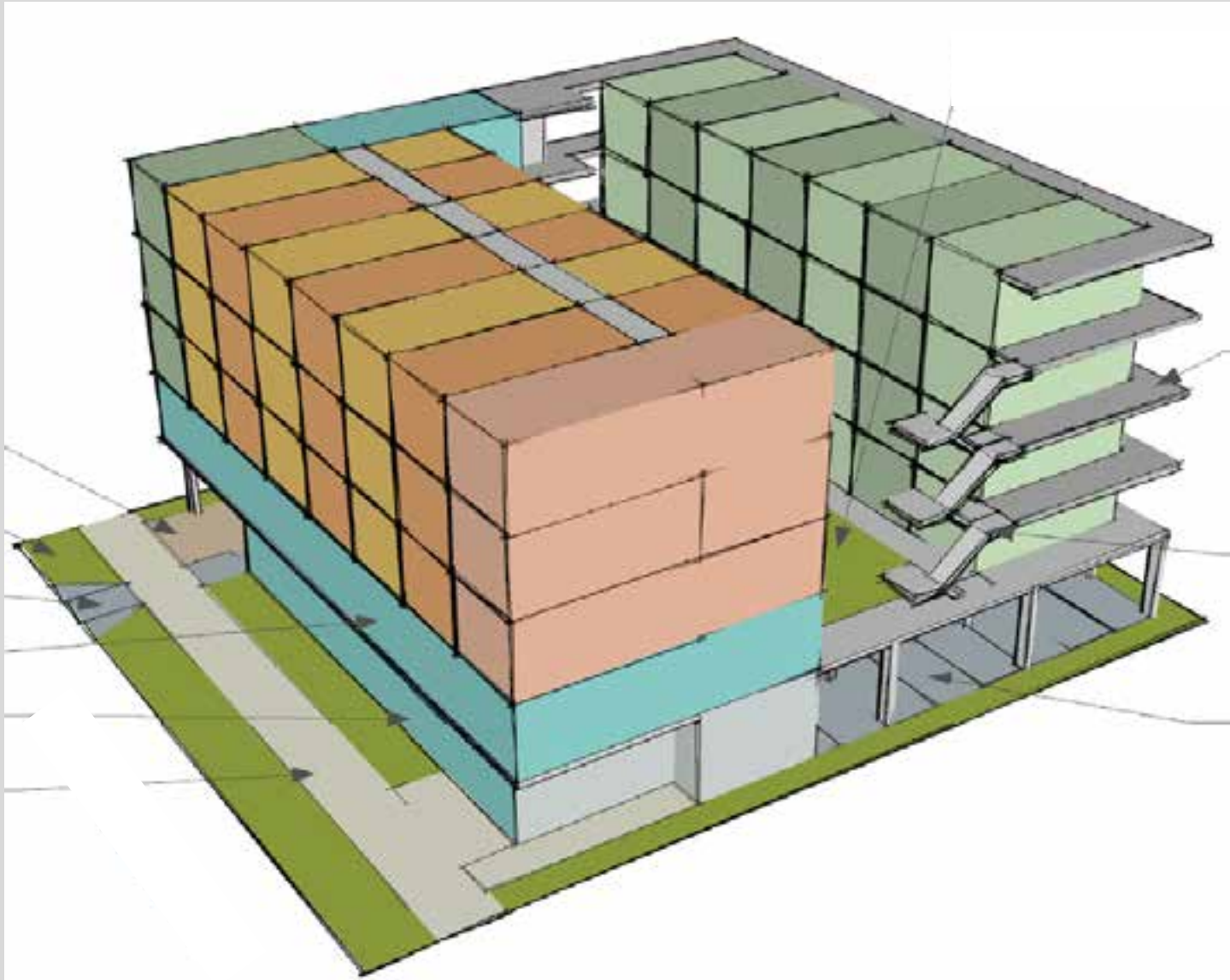
- Controls building size
- Regulates materials used
- Stipulates fire resistance

But…

The code still allows flexibility in building design, configuration, construction type, materials and other choices

Building Configuration Options

There are multiple ways to classify a building. Challenge tradition and consider all options to achieve the most cost-effective solution



Building Configuration Options

Start with the lowest common denominator option and work up. Don’t assume that a certain construction type, occupancy separation, etc. will be required simply based on use of certain materials or presence of certain occupancies.

Image: Neo Studio

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.

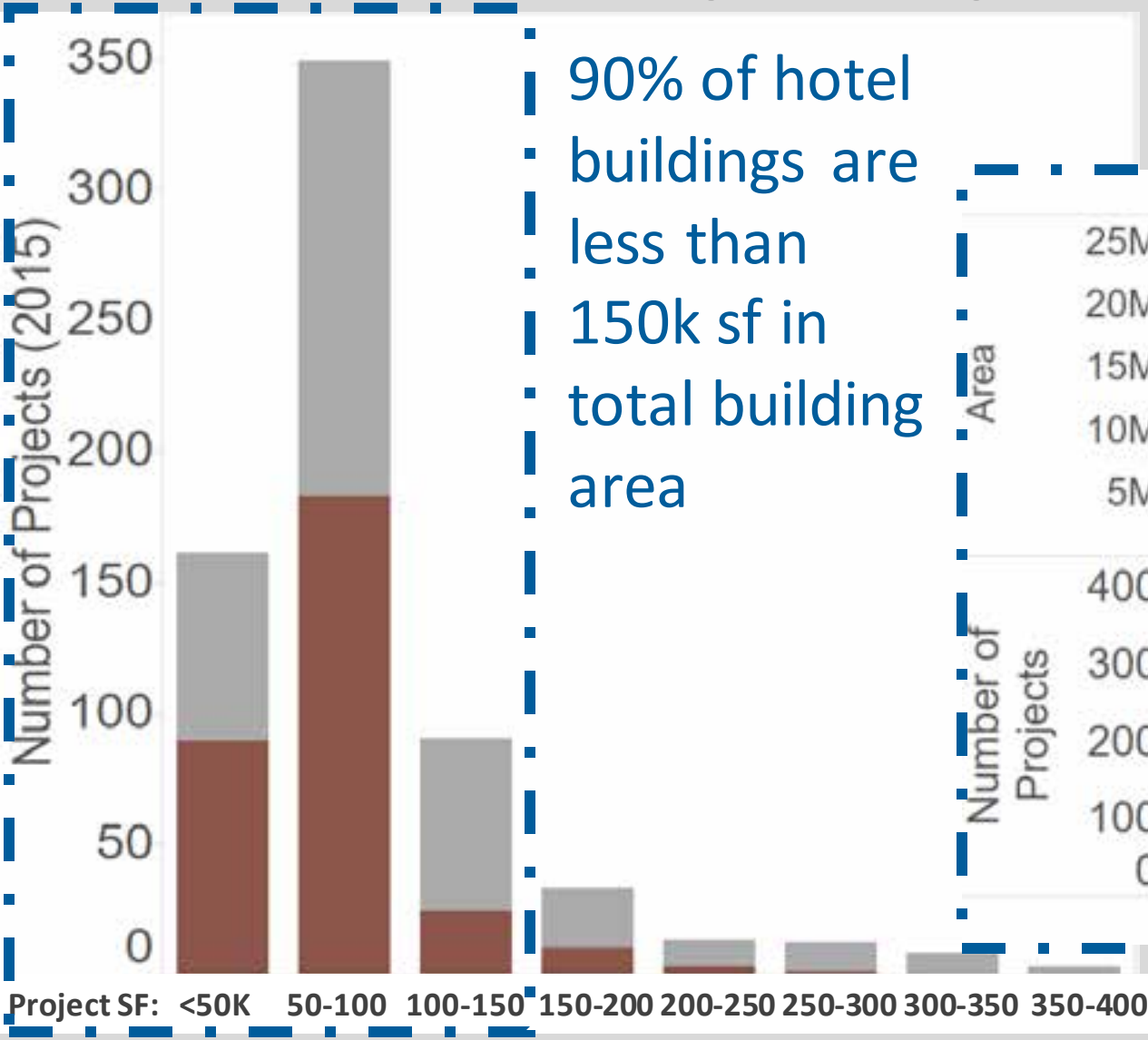
Building Configuration Options

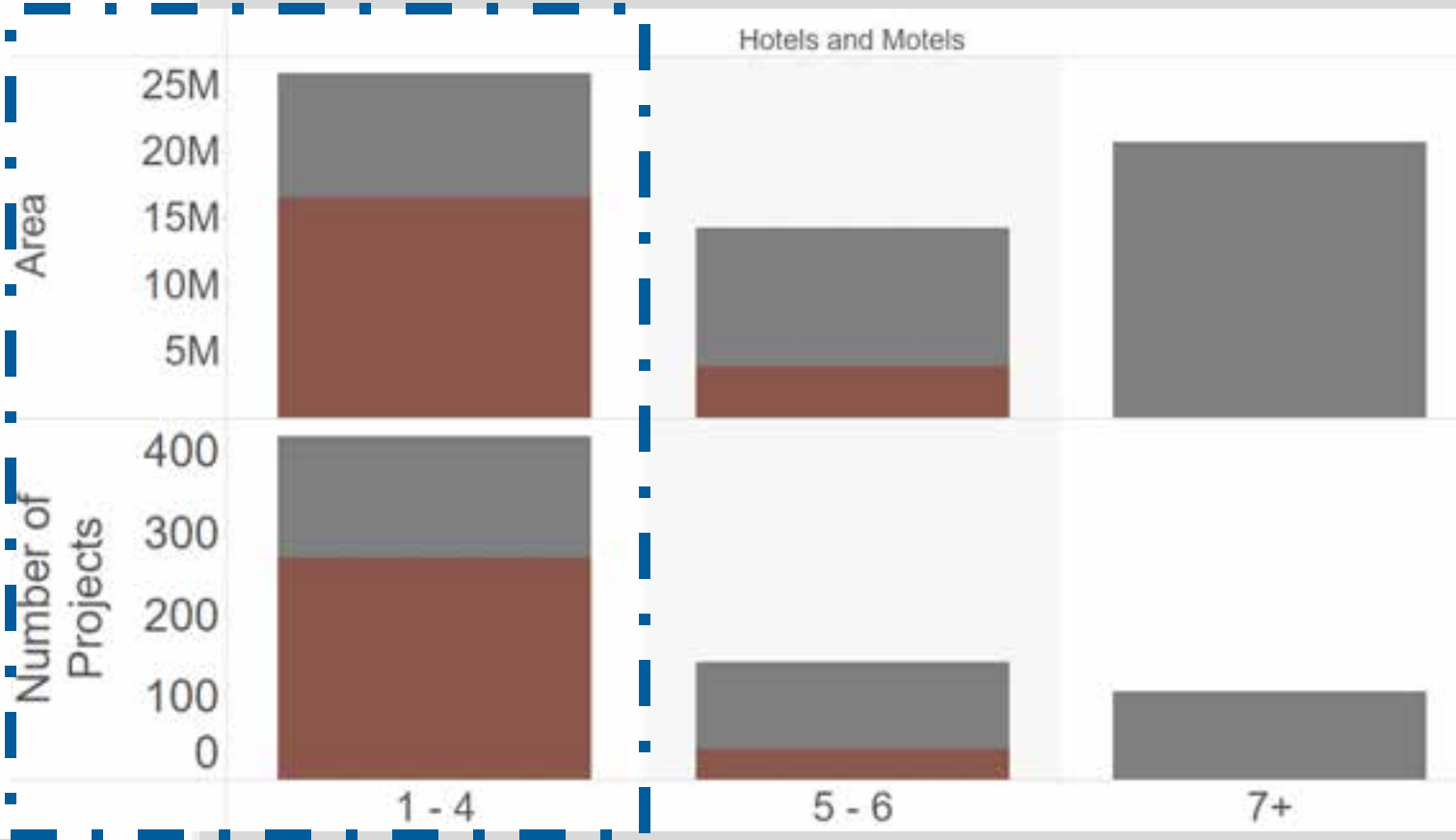
National market data also indicates that many commercial occupancies including hotels, multi-family, office, retail and restaurants can be framed with wood, including in mixed-use applications, when considering building size

Market Data Analysis

Hotels & Motels: Average Building Size

90% of hotel buildings are less than 150k sf in total building area

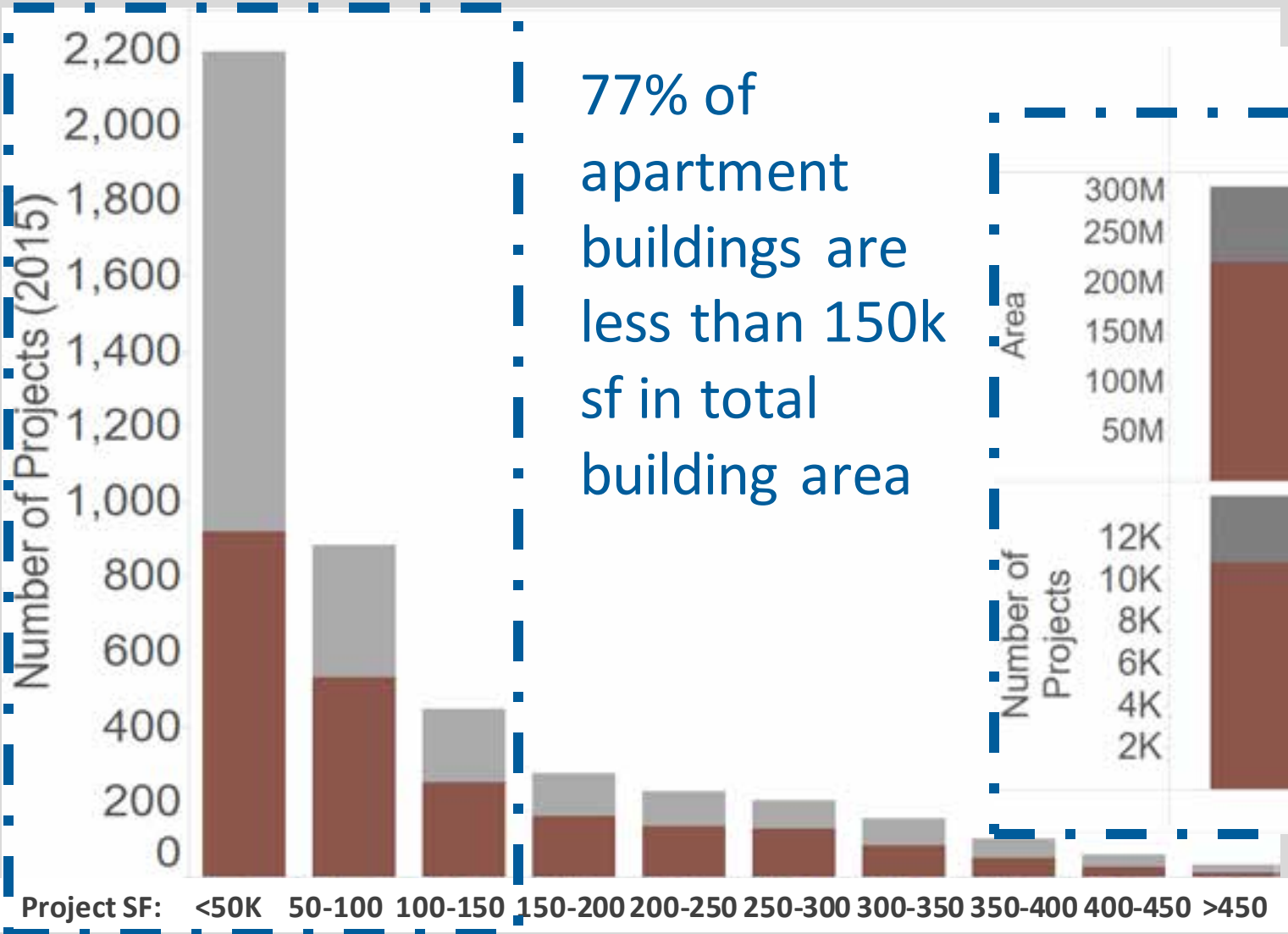




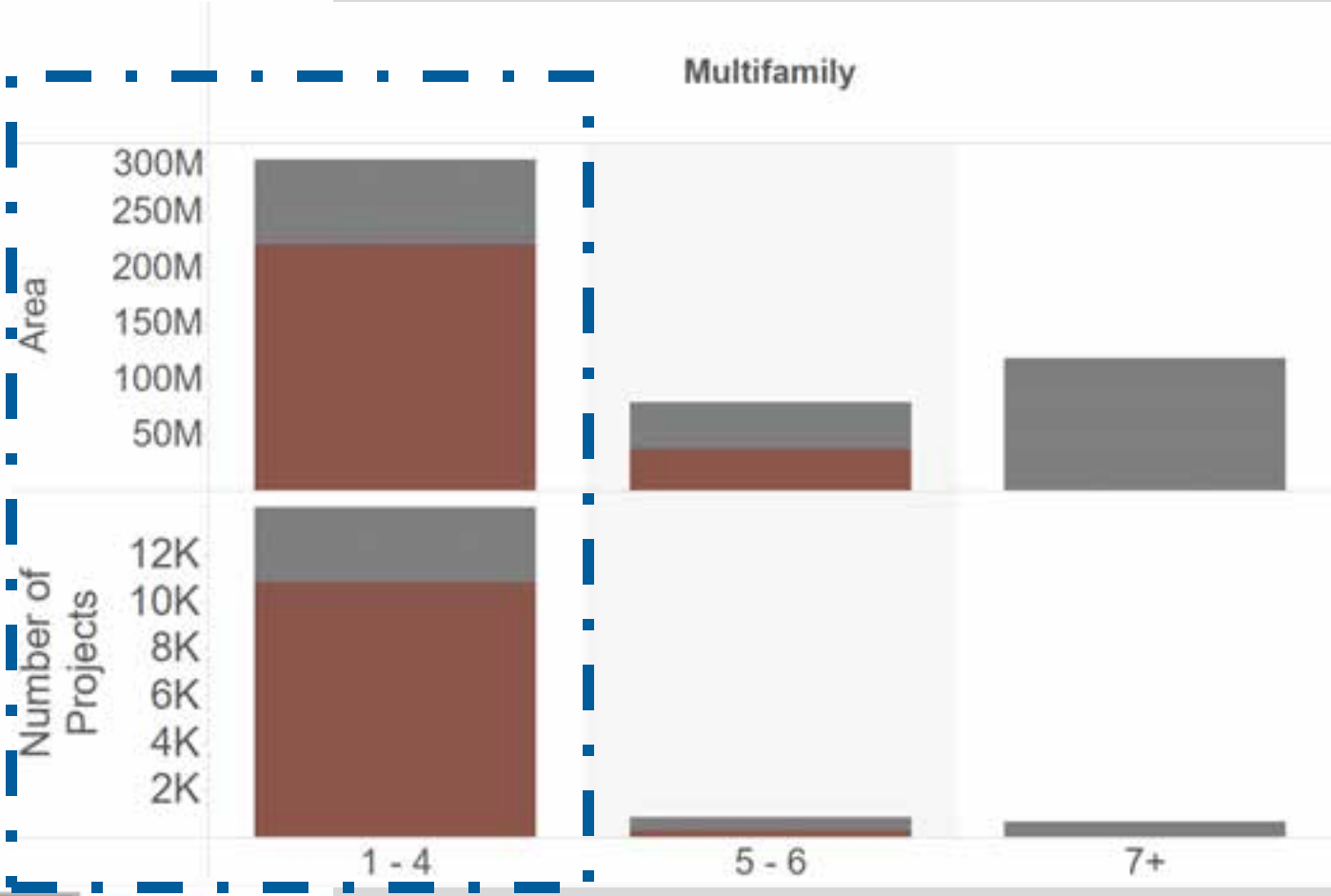
Source: 2015 Dodge Market Data

Market Data Analysis

Apartments: Average Building Size



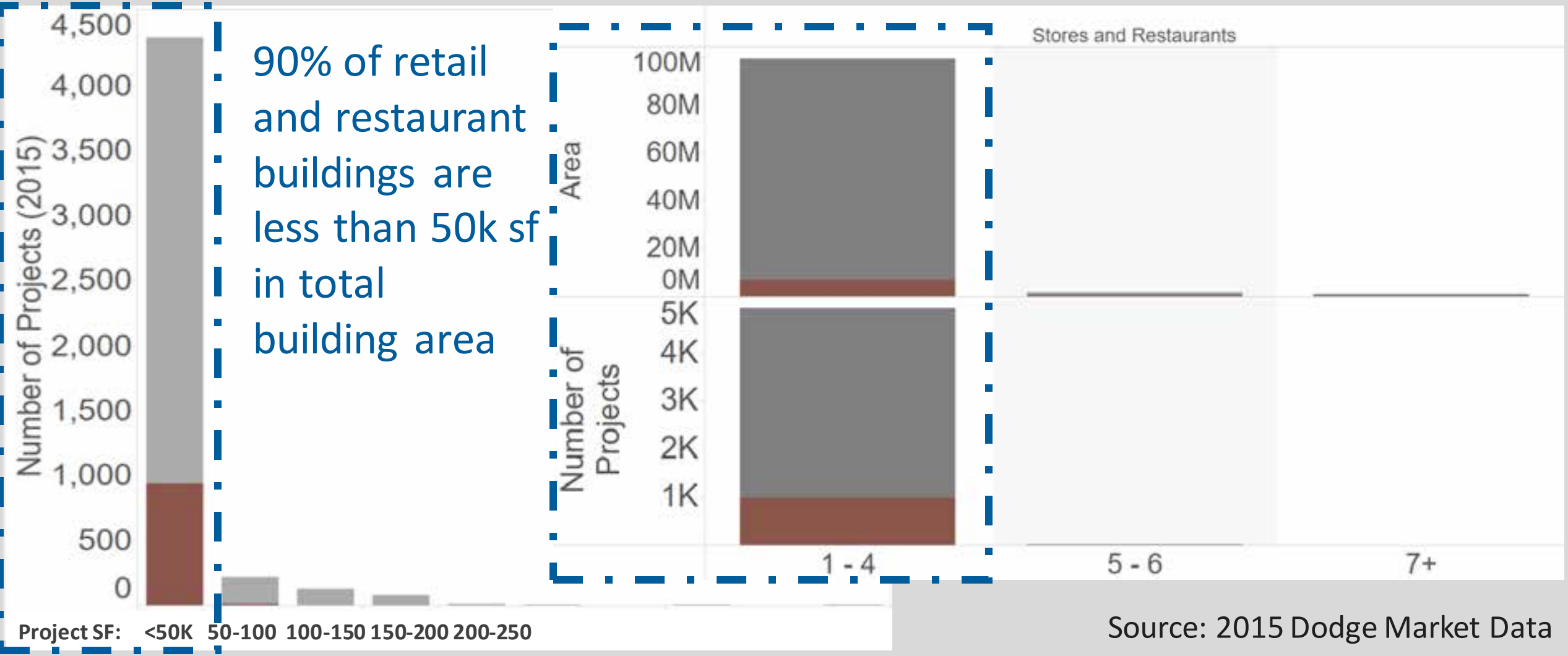
77% of apartment buildings are less than 150k sf in total building area



Source: 2015 Dodge Market Data

Market Data Analysis

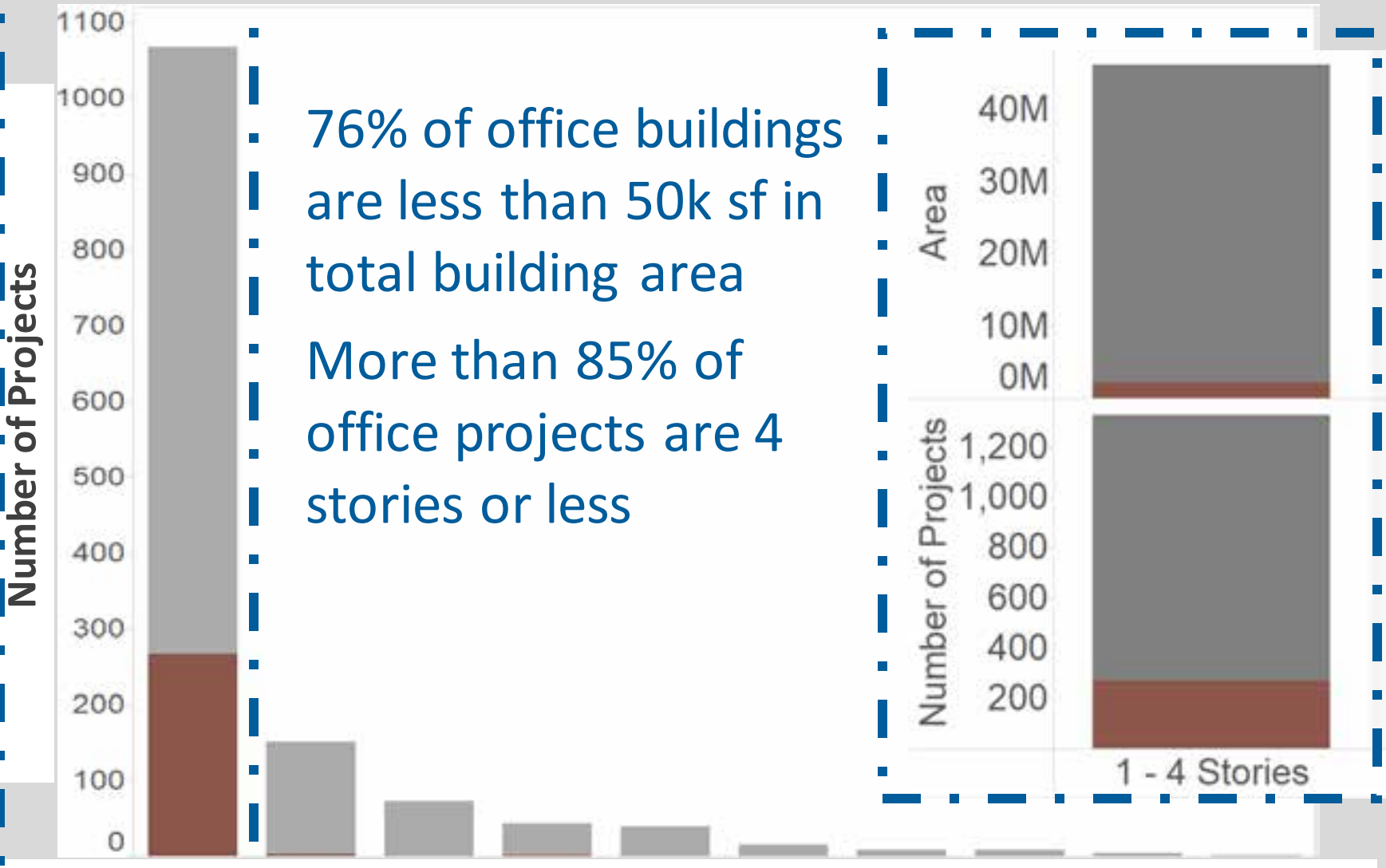
Retail & Restaurants: Average Building Size



Source: 2015 Dodge Market Data

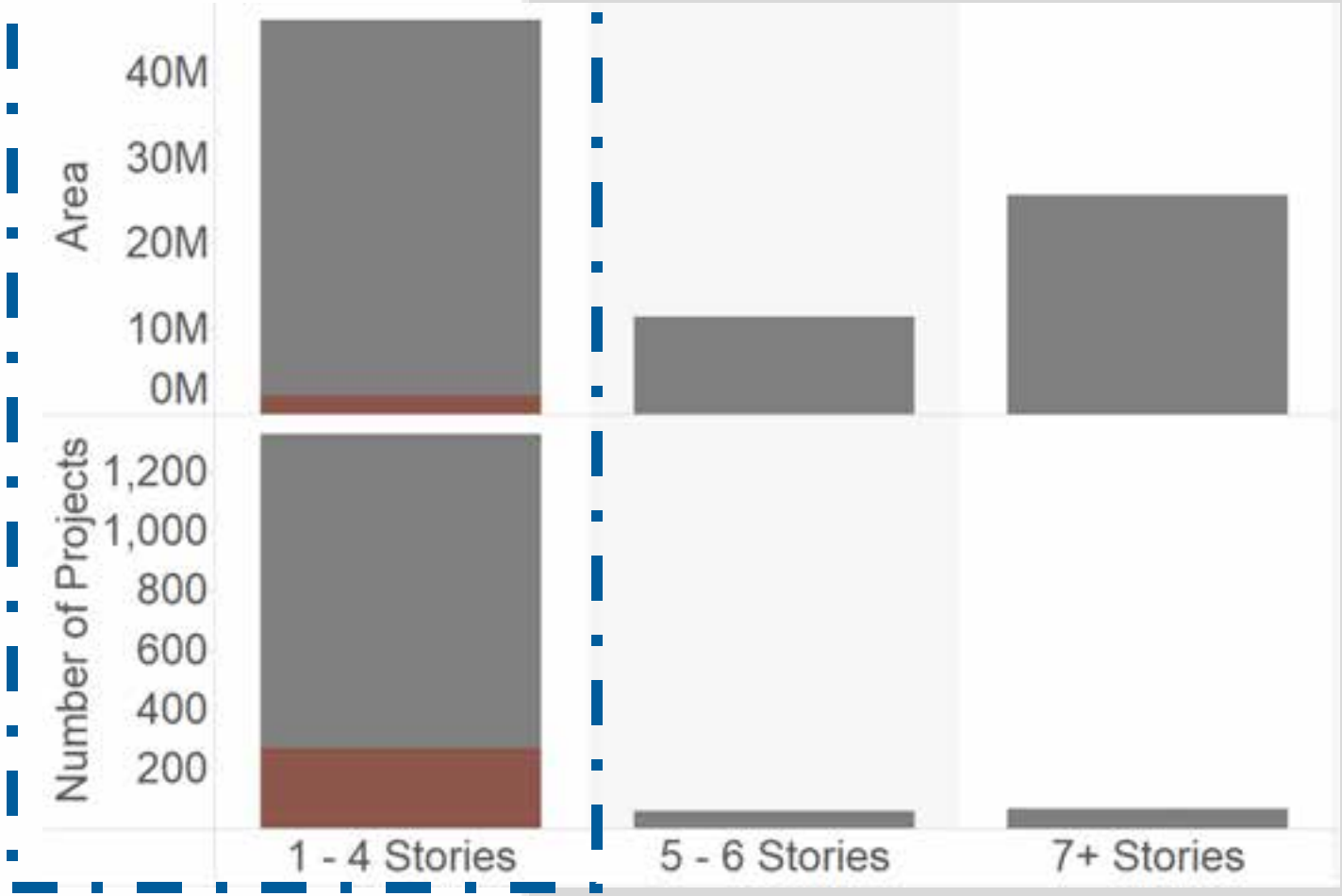
Market Data Analysis

Office Buildings: Average Building Size



76% of office buildings are less than 50k sf in total building area

More than 85% of office projects are 4 stories or less



Source: 2015 Dodge Market Data

Market Data Analysis

What does all this mean?

Wood is being **underutilized** in many commercial occupancy buildings.

	2015 Areas	Of Those Bldgs: % Wood
Hotels	90% < 150 K SF	49% are wood
Apartments	77% < 150K SF	48% are wood
Retail/Restaurant	90% < 50K SF	22% are wood
Offices	76% < 50K SF	25% are wood

These can be framed with **wood**, **type V** construction.

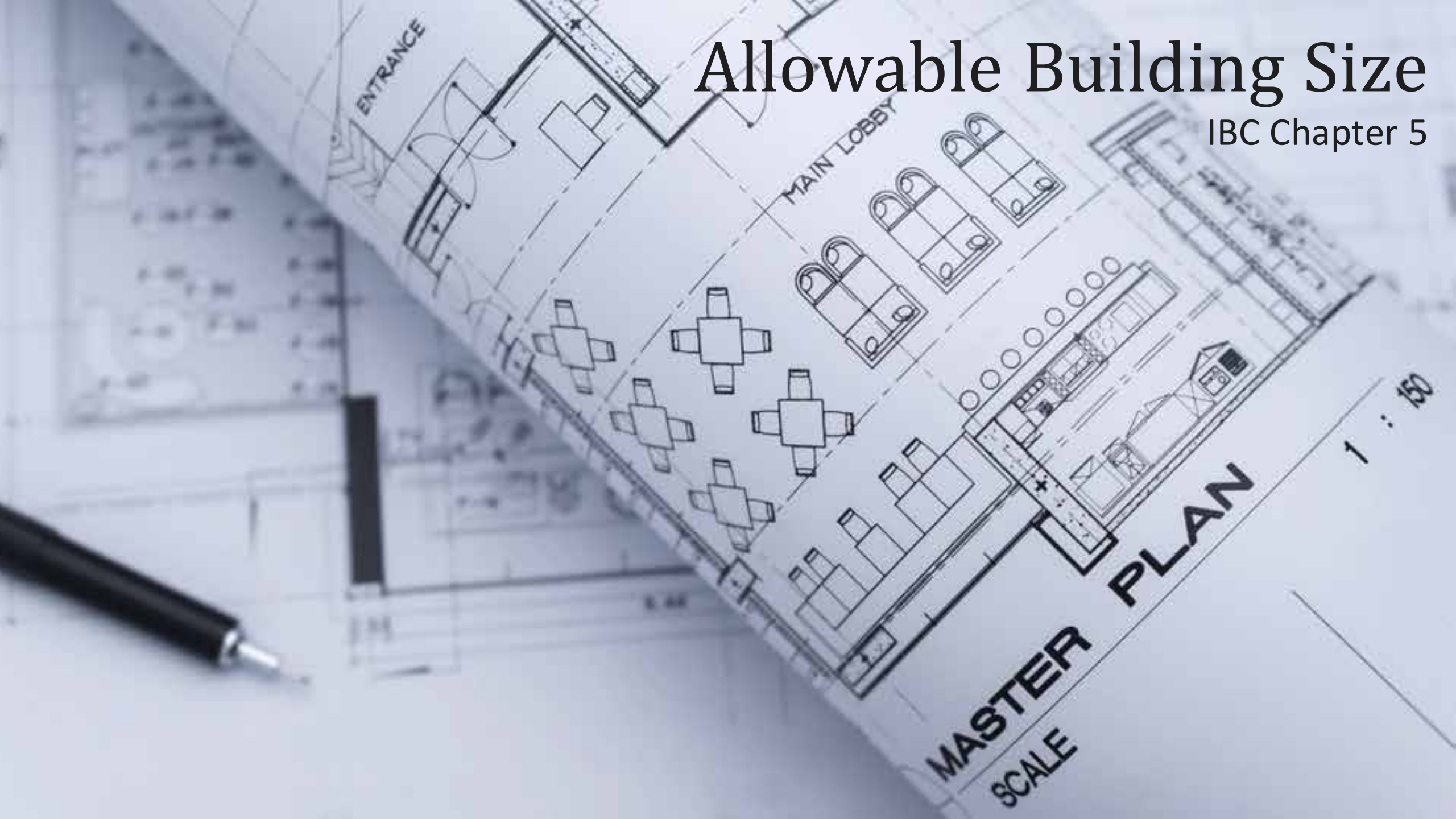
Why is it important to recognize that?

Source: 2015 Dodge Market Data


BUDGET

Allowable Building Size

IBC Chapter 5



Allowable Building Size

IBC Chapter 5

Allowable building size a function of:

- Capability of fire department to access building
- Building use
- Construction type

Fire Department Access

IBC 202

Mid-Rise vs. High-Rise

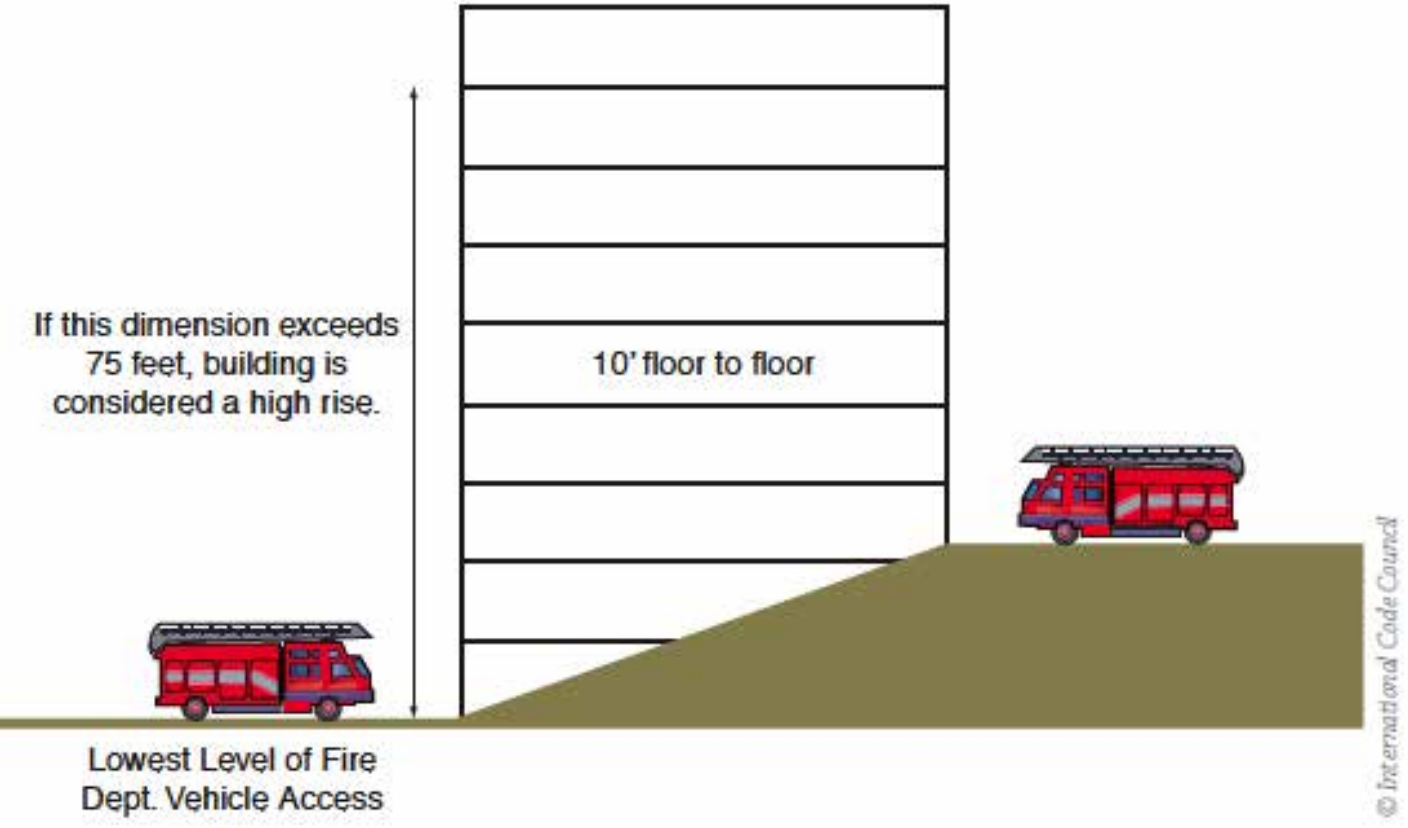


FIGURE 6-6 Determination of high-rise building

High-Rise Building:

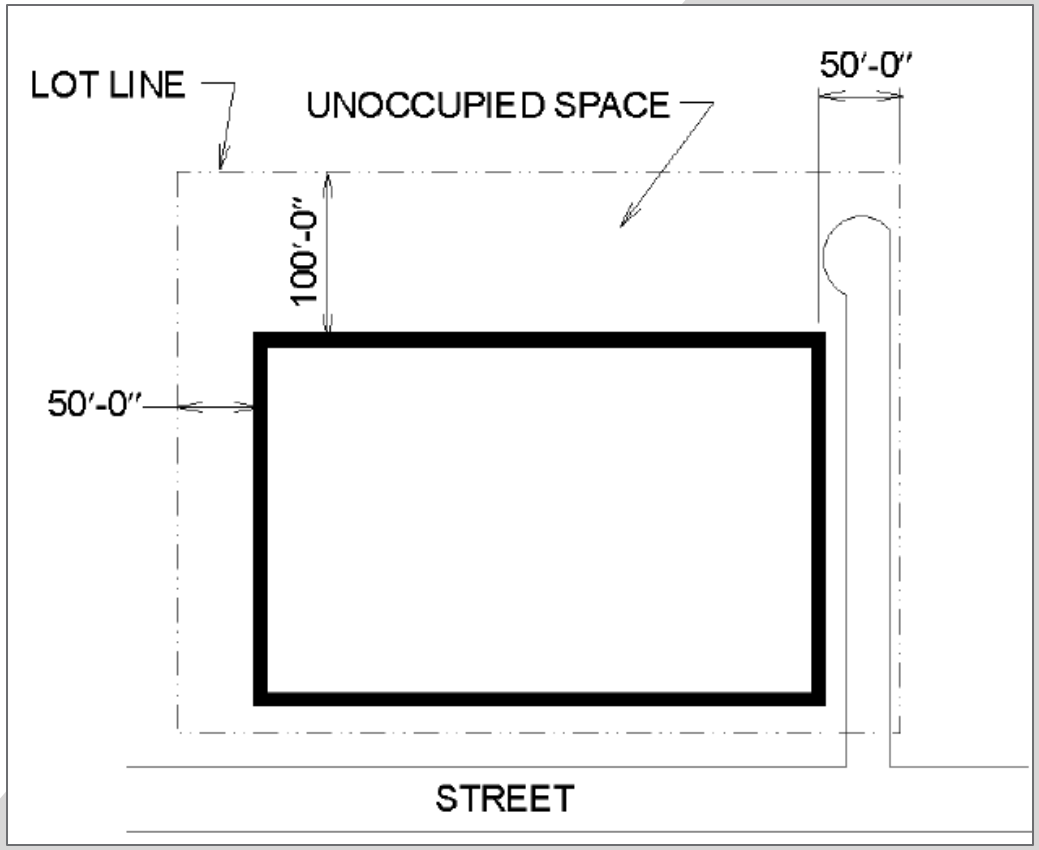
A building with an occupied floor located more than 75 feet above the lowest level of fire department vehicle access.

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



Single Occupancy, 1 Story – 506.2.3

$$A_a = A_t + [NS \times I_f]$$

(Equation 5-1)

A_a = Allowable area per story (sq. ft.)

A_t = Tabular allowable area per story per Table 506.2 for NS, S1 or S13R (sq. ft.)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (sprinklered or not)

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

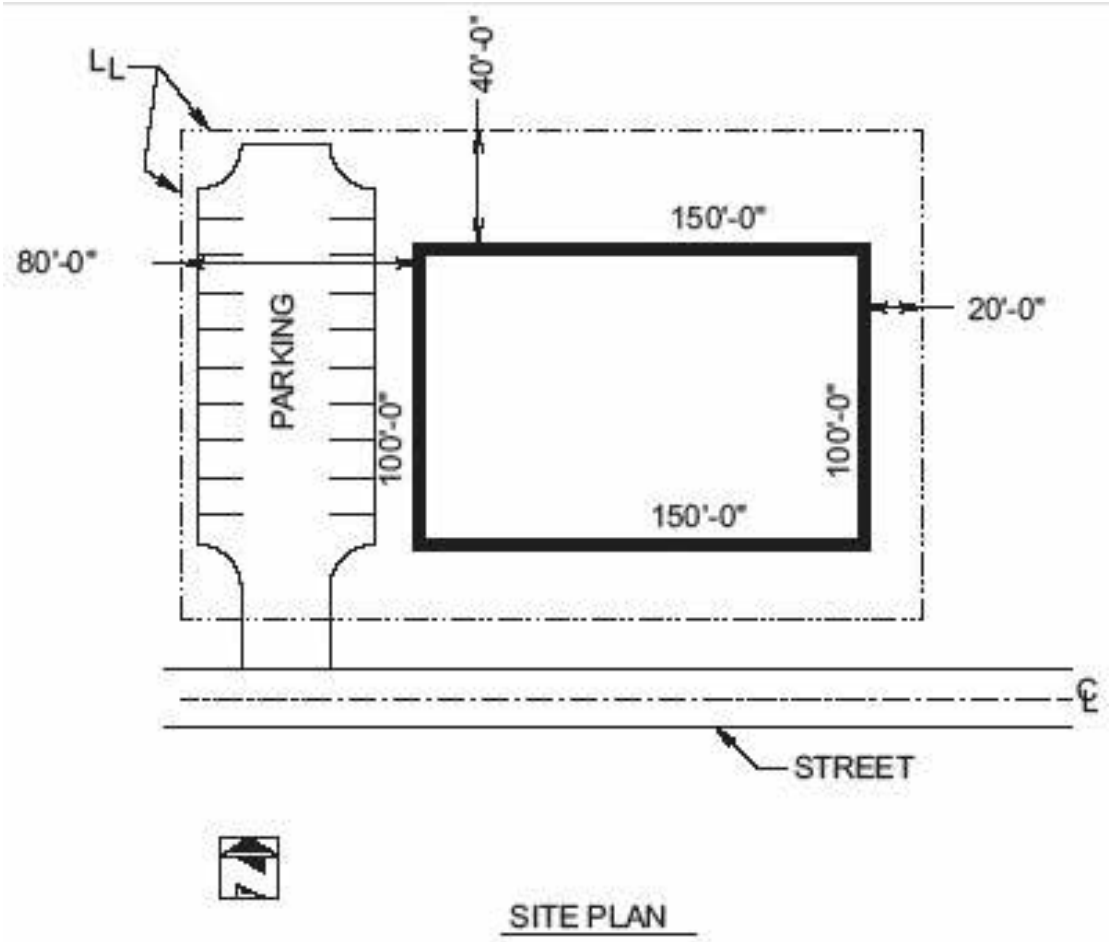
Frontage Increases – IBC 506.3.3

$$I_f = [F/P - 0.25]W/30$$

(IBC Equation 5-5)

WHERE:

- I_f = Area increase due to frontage
- F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width
- P = Perimeter of entire building
- W = Width of public way or open space (feet) in accordance with section 506.3.2



Area Modification – Frontage IBC 506.3

MINIMUM QUALIFICATIONS

25% min of building perimeter is on a public way or open space 20' min distance from building face to:

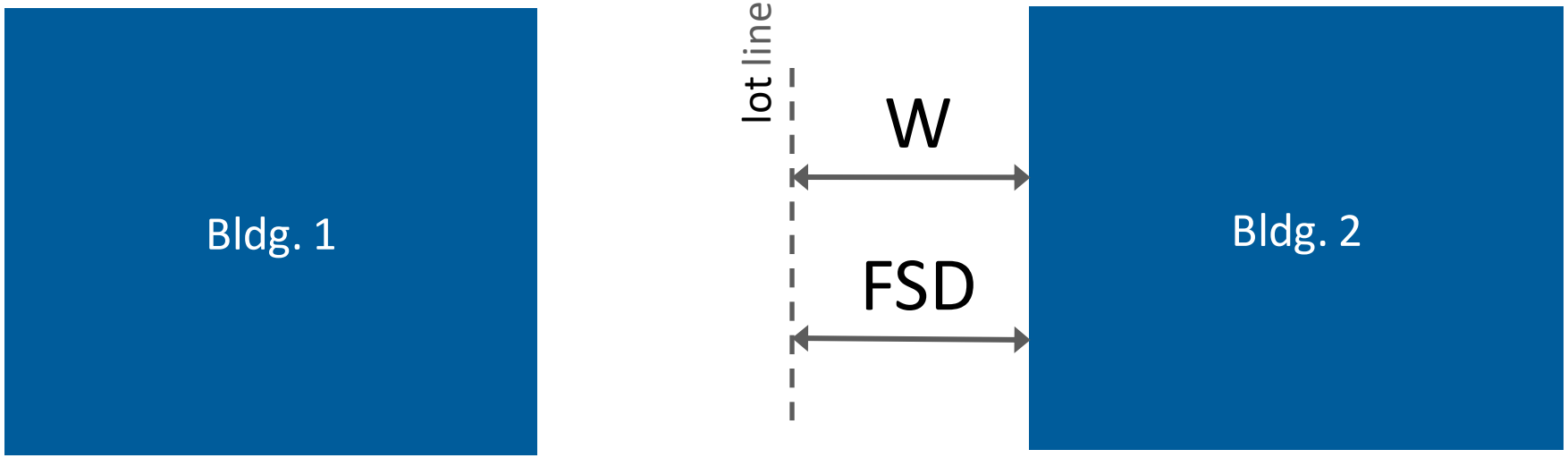
- Closest interior lot line
- Entire width of public way
- Exterior face of adjacent building

Frontage Increases – IBC 506.3.2

"W" for area increases is NOT always the same as Fire Separation Distance for purposes of fire resistance ratings of walls and openings

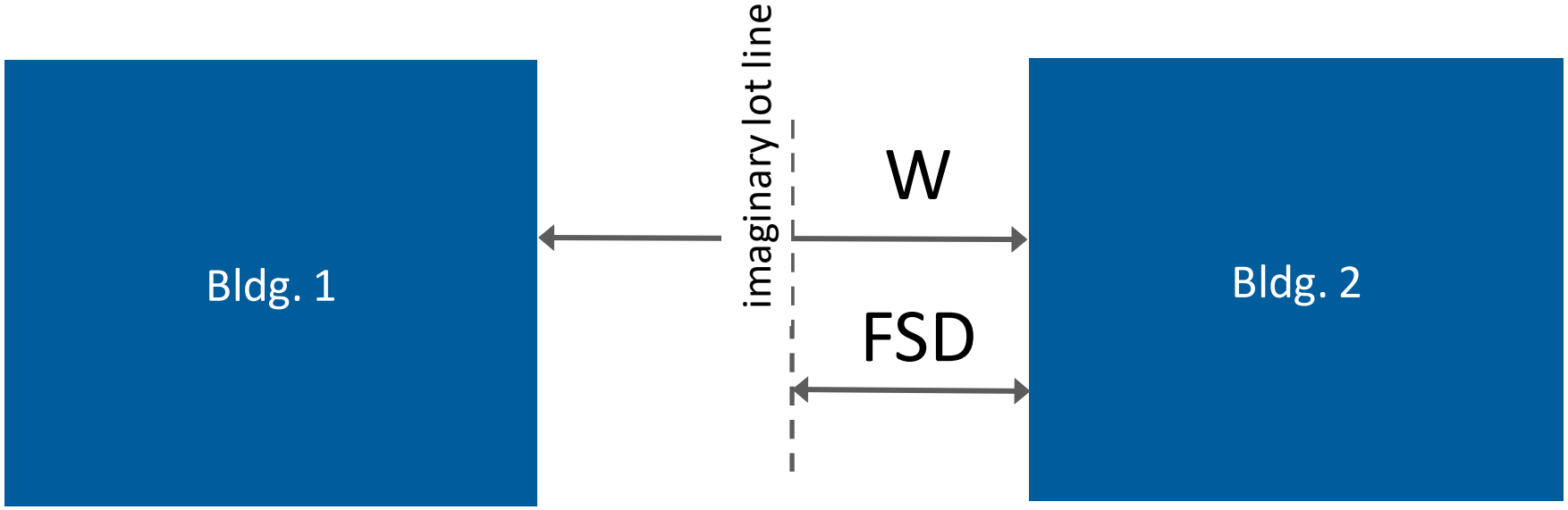
Frontage Increases – IBC 506.3.2

For two buildings on DIFFERENT lots



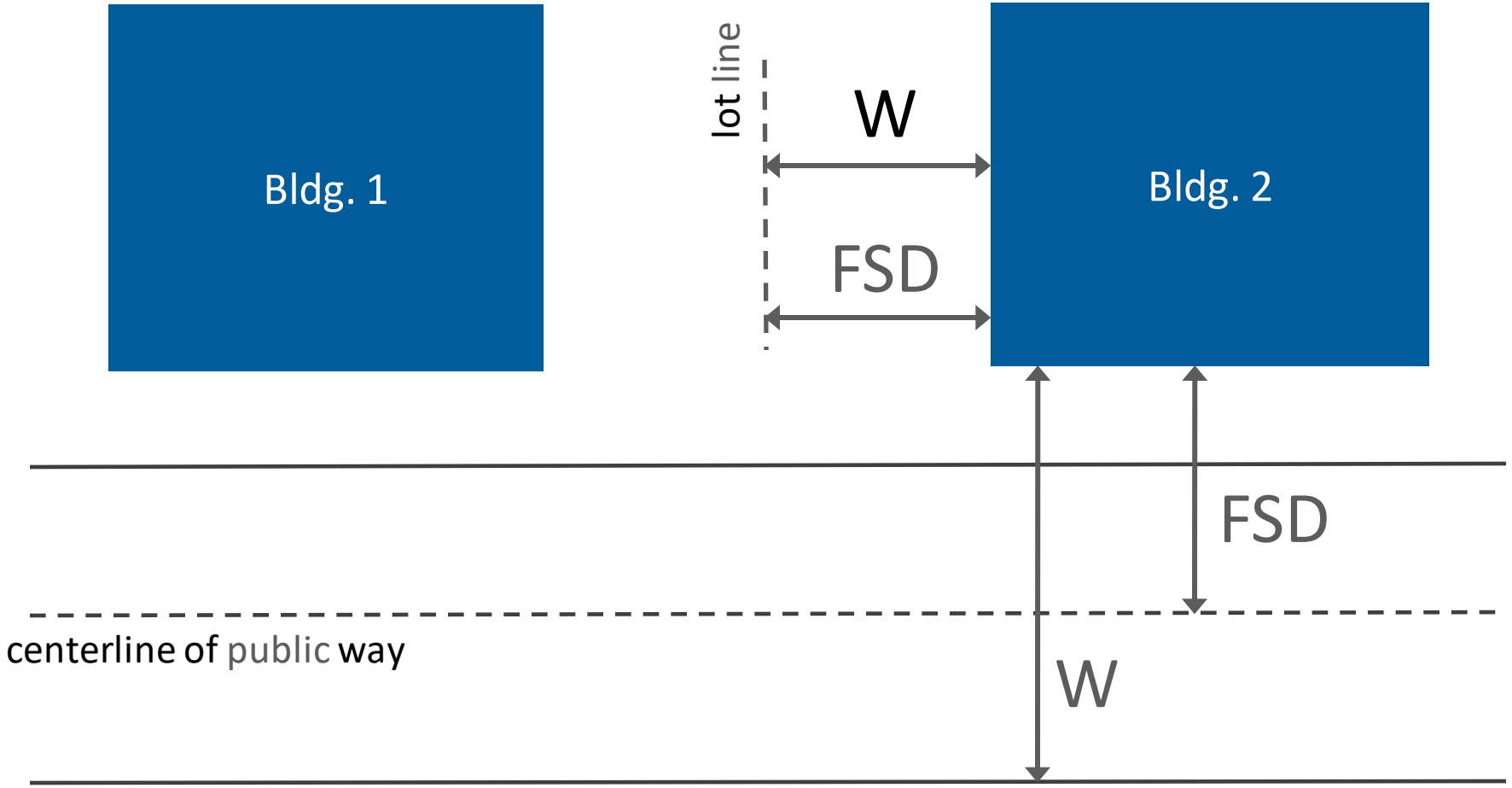
Frontage Increases – IBC 506.3.2

For two buildings on the SAME lots



Frontage Increases – IBC 506.3.2

Buildings near public right of ways:



Frontage Increases – IBC 506.3.3

$$W = [(L_1 \times w_1) + (L_2 \times w_2) + (L_3 \times w_3)....]/F$$

(IBC Equation 5-4)

WHERE:

W = Calculated Width (weighted average) of public way or open space (feet)

$\mathbf{L_n}$ = Length of a portion of the exterior perimeter wall

$\mathbf{w_n}$ = Width (≥ 20 ft) of public way or open space associated with that portion of the exterior perimeter wall

F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width

Total Building Area – 2018 IBC 506.2.3

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

(Equation 5-2)

A_a = Allowable area per story (sq. ft.)

A_t = Tabular allowable area per story per Table 506.2 for NS, S1 or S13R (sq. ft.)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (sprinklered or not)

I_f = Area increase factor due to frontage per 506.3
I_f, max = 0.75

S_a = Actual number of building stories above grade

$S_{a,\,max}$ = 3 for non-sprinklered buildings and those w/ NFPA13

$S_{a,\,max}$ = 4 for buildings w/ NFPA 13R

Fire Department Access

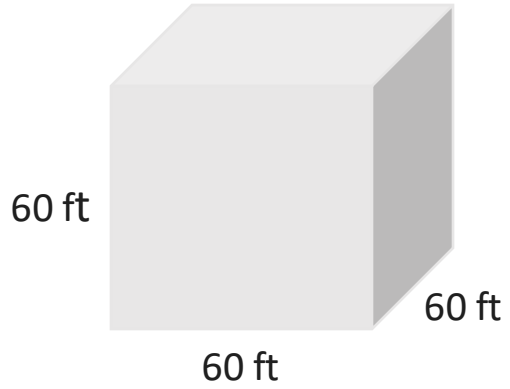
Historical limitations

Many of the current building size limits are based on historical fire department access limitations

1050. What is practically the highest maximum to which water can be thrown with effect by a steam engine?—That is a question which very seldom arises with us, but it can be thrown to 80 or 90 feet, although not with good effect.

1051. What is the extreme height to which fire escapes and ladders can be reasonably carried for the protection of life and the saving of life?—About 50 feet.

1120. What limit, according to you, would be a fair and safe limit to impose?—I should say that the limit applied in Liverpool is about the best for this country; 60 to 65 feet.



With a well organized and properly equipped fire brigade it is found that sixty feet is the greatest height at which a building can be quickly protected, and that the cube of 60, or 216,000 cubic feet, is the largest cubical capacity which can be protected with reasonable hope of success after a fire has once come to a head.

Sources:
E.M. Shaw, Fire surveys 1872: E. Wilson
Great Britain. Parliament. House of Commons, Reports from Committees. 1874.

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 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

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	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

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[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	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

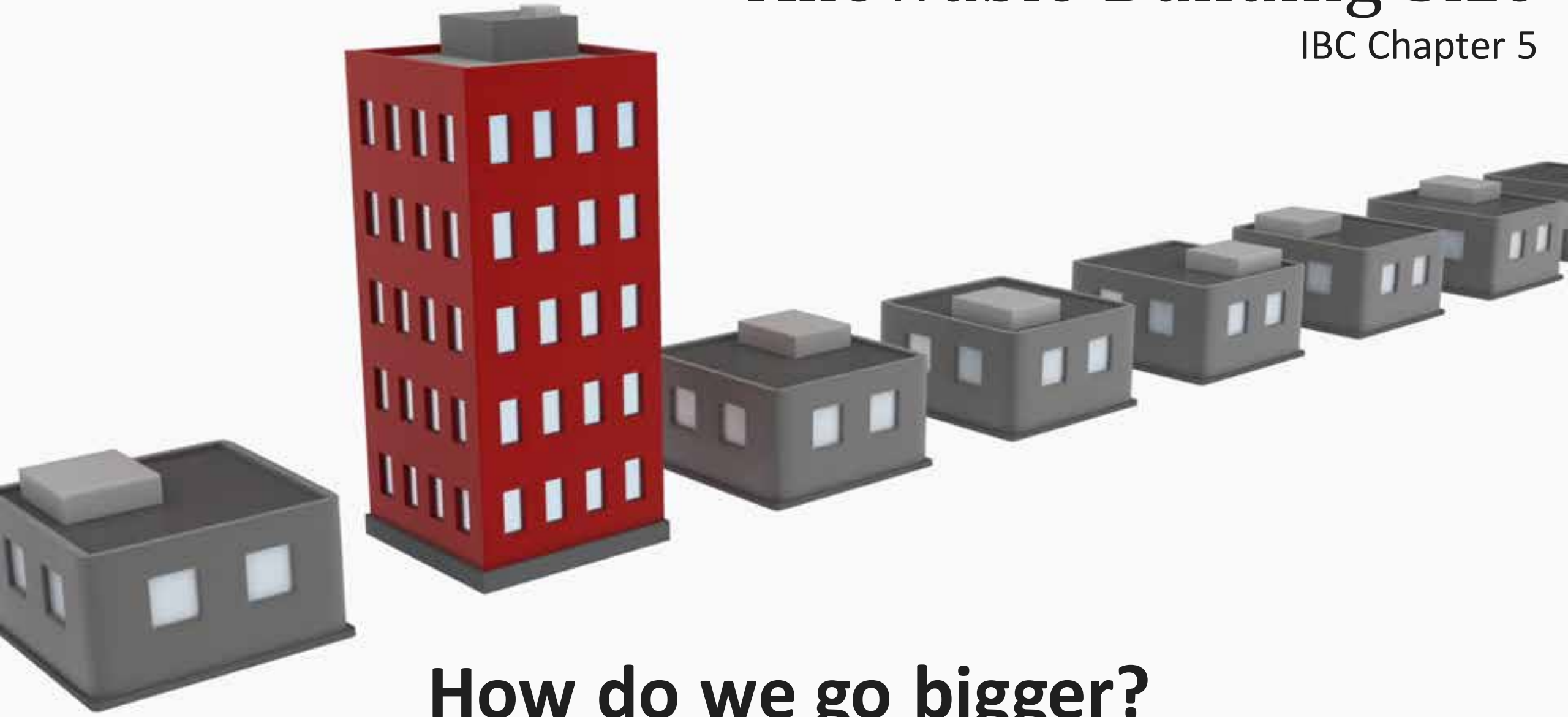
IBC 2018 Table 506.2

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

Allowable Building Size

IBC Chapter 5



How do we go bigger?

Sprinkler Requirements

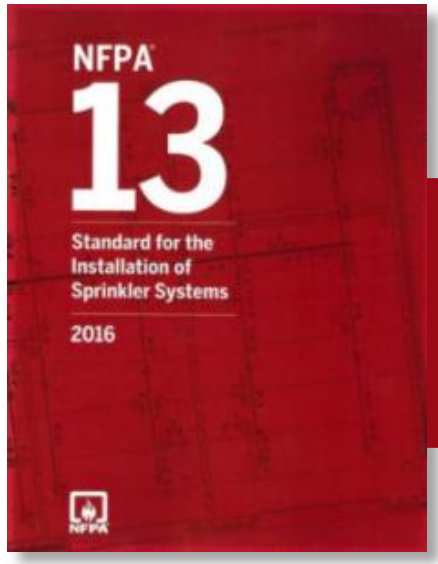
IBC 903.2

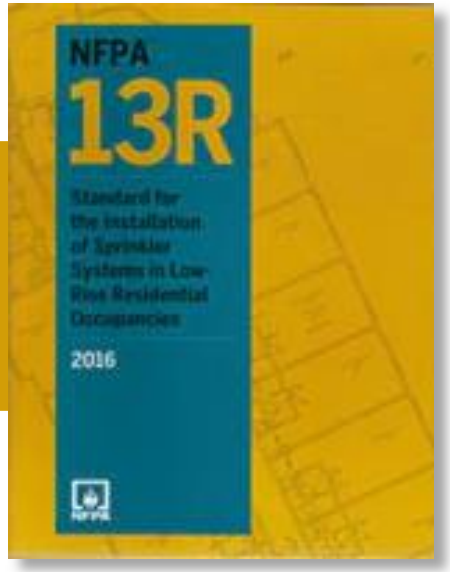
- NFPA 13 or 13R sprinkler system required in all new group R fire areas
- NFPA 13 sprinkler system required in most commercial facilities of any size regardless of construction type or materials used
- Example: Occupancy Group a-2 (restaurant, casino, banquet hall):
  - If Fire Area Exceeds 5,000 sf,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

Commercial Sprinkler Systems

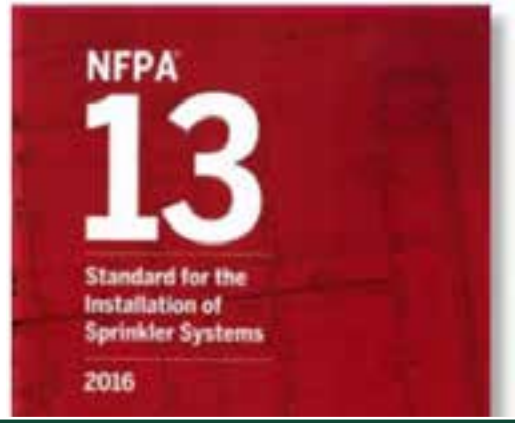
IBC 903.3.1

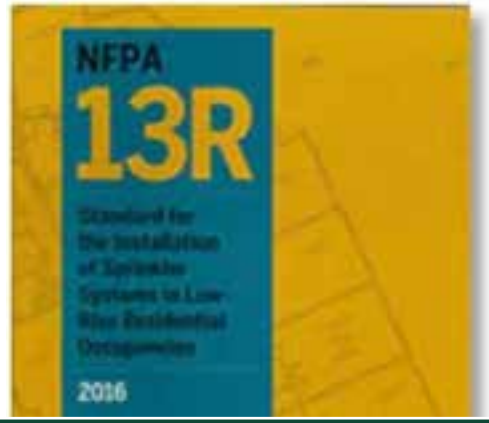
- **NFPA 13**
  Standard for Commercial Construction 903.3.1.1
- **NFPA 13R**
  Residential Occupancies (One- and Two-Family or Low-Rise Multi-Family and Commercial) 903.3.1.2
- **NFPA 13D**
  Standard for One- and Two-Family Residences (but allowed in a few commercial occupancies) 903.3.1.3





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

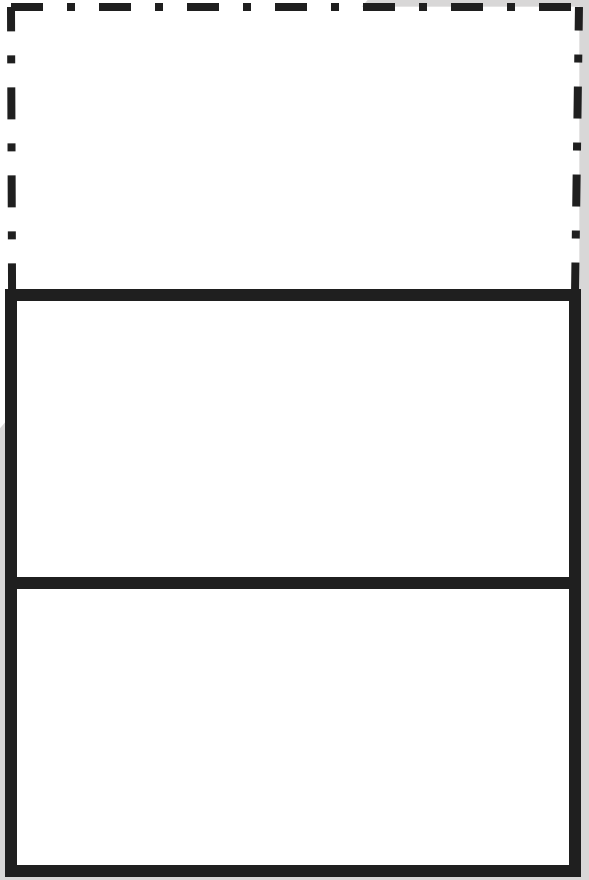
Allowable Building Height

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

IBC 2018 Table 504.4

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

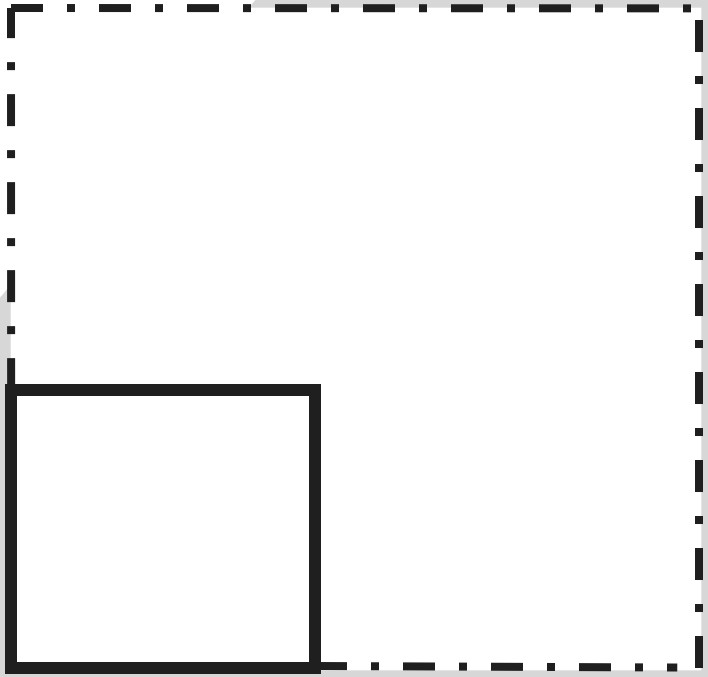
OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1	NS[d, h]	UL	11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

IBC 506.2.3

Total Building Area

Total building allowable area = allowable area per floor times:

2 for 2 story building

3 for 3 or more story buildings

Allowable Building Size

IBC Chapter 5

Business (B) Occupancies with NFPA 13 Sprinkler System

Construction Type Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	6	4	6	4	3
Height (ft)	85	75	85	70	60
Story Area (ft^2)	106.9k	71.3k	135k	67.5k	33.8k
2 story: Total Bldg Area (ft^2)	213.8k	142.5k	270k	135k	67.5k
3+ story: Total Bldg Area (ft^2)	320.6k	213.8k	405k	202.5k	101.3k

Assumes full frontage increase

Allowable Building Size

IBC Chapter 5

Mercantile (M) Occupancies with NFPA 13 Sprinkler System

Construction Type Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	5	3	5	4	2
Height (ft)	85	75	85	70	60
Story Area (ft^2)	69.4k	46.9k	76.9k	52.5k	33.8k
2 story: Total Bldg Area (ft^2)	138.8k	93.8k	153.8k	105k	67.5k
3+ story: Total Bldg Area (ft^2)	208.1k	140.6k	230.6k	157.5k	NP

Assumes full frontage increase

Allowable Building Size

In low- to mid-rise building types, many designers accustomed to steel and concrete default to type II construction

However, nearly identical building sizes can be achieved with wood framing in type IIIA or IIIB

Additionally, market data analysis has shown that majority of commercial & multi-family buildings can be type V construction

Why is the construction type selection so important?

ICC Building Valuation Data, **M occupancies**, February 2022

Cost per SF

Construction Type

ICC Building Valuation Data, **R-1 occupancy**, February 2017

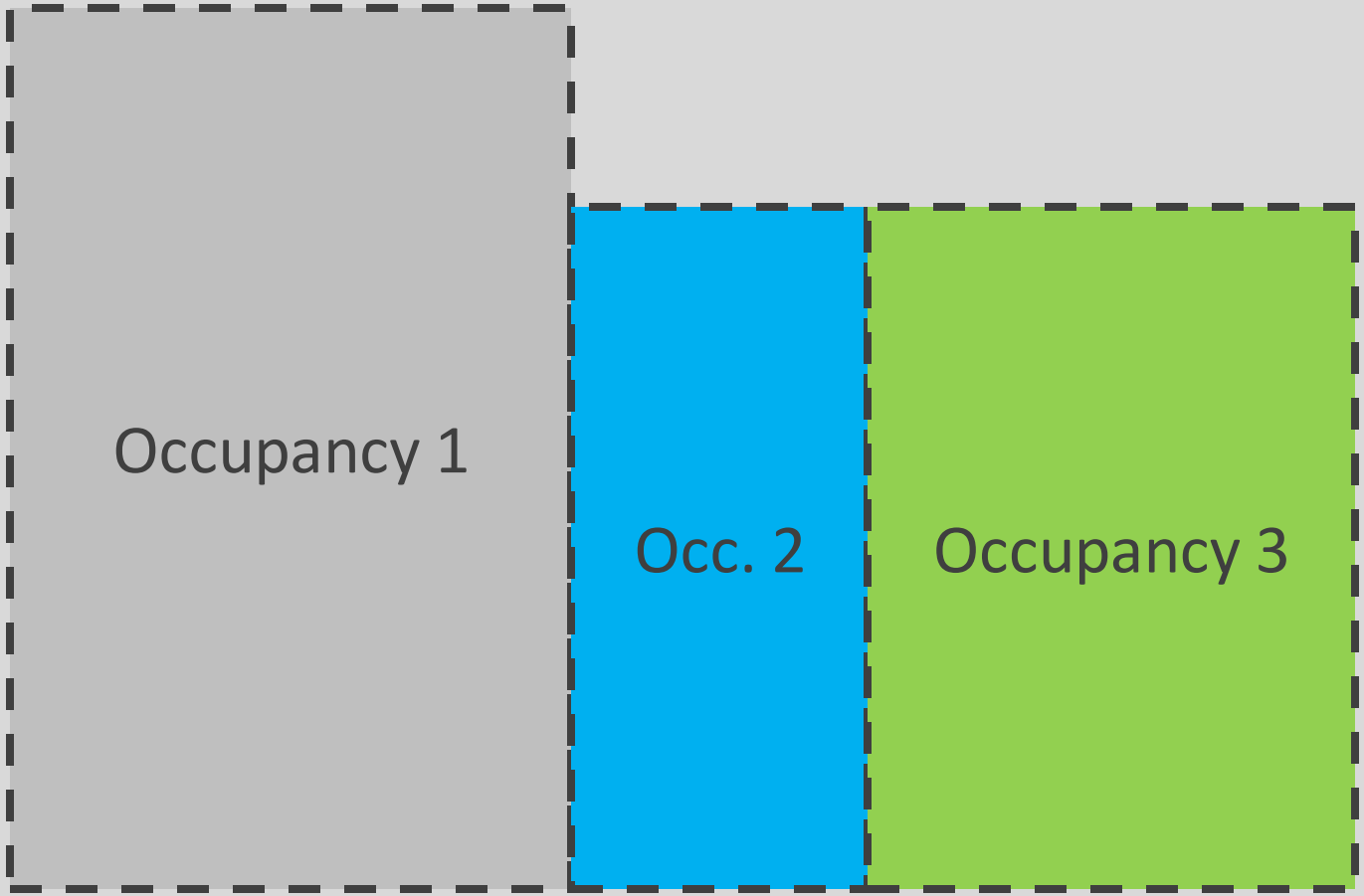
Cost per SF

Construction Type

What about mixed occupancies?

Mixed Occupancy Buildings

IBC 508



Mixed Occupancy Buildings

Start with the lowest common denominator option and work up. Don’t assume that a certain construction type, occupancy separation, etc. will be required simply based on use of certain materials or presence of certain occupancies.

Image: Neo Studio

Mixed Occupancy Buildings

IBC 508

Specifically, start with unseparated occupancies, using special provisions and/or other special design allowances as needed. Work up from there.

Mixed Occupancy Buildings

IBC 508

Example: Urban Infill Project

3 story building

- 1 story below grade: 12,000 sf parking
- 1st floor: 9,500 sf parking, 1,200 sf insurance agency, 1,300 sf print shop
- 2nd floor: 2,400 sf martial arts studio, 9,600 sf apartments
- 3rd floor: 12,000 sf apartments

NFPA 13 sprinkler system throughout building; enclosed parking garage, grade to mean roof height = 38 ft

Mixed Occupancy Buildings

IBC 508

Per IBC 503 & 506, basement does not need to be included in area and story calculations

	Parking (S-2)	Insurance Agency (B)	Print Shop (B)	Martial Arts Studio (B)	Apartments (R-2)
3rd floor	-	-	-	-	12,000 sf
2nd floor	-	-	-	2,400 sf	9,600 sf
1st floor	9,500 sf	1,200 sf	1,300 sf	-	-
Basement	12,000 sf	-	-	-	-

Mixed Occupancy Buildings

IBC 508

Using lowest common denominator, try type VB construction:

	S-2	B	R-2	Actual Building
Allow. # stories	3	3	3	3
Allow. height	60 ft	60 ft	60 ft	38 ft
Allow. area/floor	40,500 sf	27,000 sf	21,000 sf	12,000 sf
Allow. Total area	121,500 sf	81,000 sf	63,000 sf	36,000 sf

Most restrictive occupancy group, R-2 works for whole building.

Use non-separated, type VB construction

Mixed Occupancy Buildings

IBC 508

This 3 story, type VB mixed-use building can be fully framed with wood and can have non-separated occupancies

- No podium is necessary
- No fire resistance rated separation between occupancies is necessary (unless required by other code provisions)
- Even if other materials are used in parts of the building, can still be type VB construction

Mixed Occupancy Buildings

IBC 508

- Incidental Uses (509)
- Accessory Occupancies (508.2)
- Unique Occupancy Combinations (303)
- Roof Top Occupancies (Ch. 5)
- Special Provisions (510)
- Nonseparated Occupancies (508.3)
- Separated Occupancies (508.4)
- Separate Buildings – Firewalls (503.1 & 706)
- Covered and Open Malls (402)

Credit: Boye Architecture

Outside scope of presentation

Incidental Uses

IBC 509

- Ancillary function associated with an occupancy
- Pose GREATER risk than the main occupancy
- Examples:
  - Laundry room over 100 sf
  - Refrigerant machinery room
  - Incinerator room
  - Furnace room
  - Boiler room
  - Vocational shop in a school

Incidental Uses

IBC 509

Limitations:

- Each area not more than 10% of story
- Have fire resistance rated separation (fire barrier or horizontal assembly), smoke separation and/or sprinkler systems per Table 509 and Section 509.4
  - Many permit use of sprinklers in lieu of rated separation
- NOT classified as a different occupancy.
- Allowable area and height per main occupancy

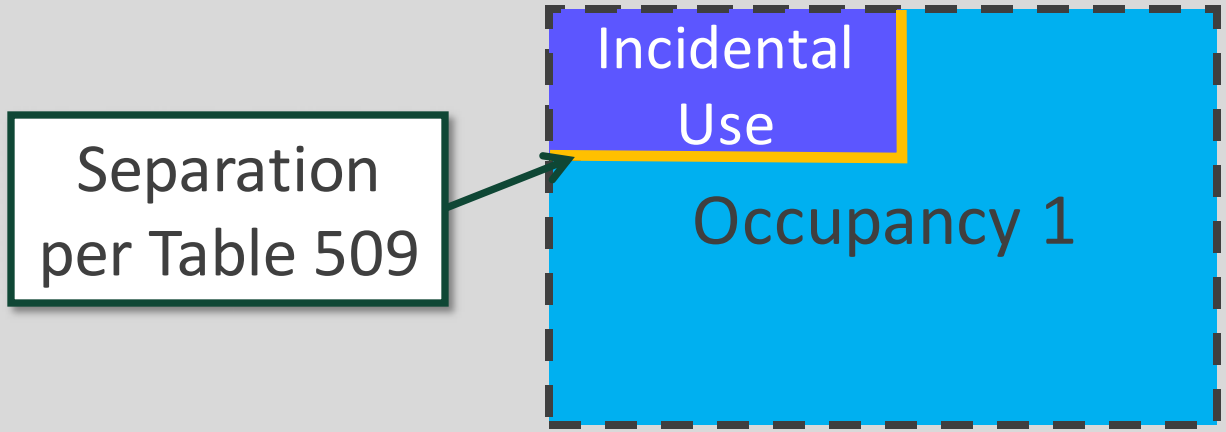


Photo Sean Hackbarth/Flickr

Incidental Uses

IBC 509

Incidental Uses Example:

- NFPA 13 sprinklered, 4 story, type VA building
- Upper 3 floors: 18,000 sf apartments (R-2)
- 1st floor: 16,400 sf apartments plus 800 sf laundry room & 800 sf boiler room
- Total building area = 72,000 sf

- Table 503: allowable building area w/sprinkler increase = 108,000 sf; no floor greater than 36,000 sf: OK

- Allowable incidental use area:
- = 18,000*10% = 1,800 sf > 800 sf
- OK: classify laundry room & boiler room each as R-2
- Table 509: walls and floor separating laundry room & boiler room from R-2: no hourly rating required since bldg is sprinklered, but smoke resistance is required in conjunction with sprinklers per Section 509.4.2

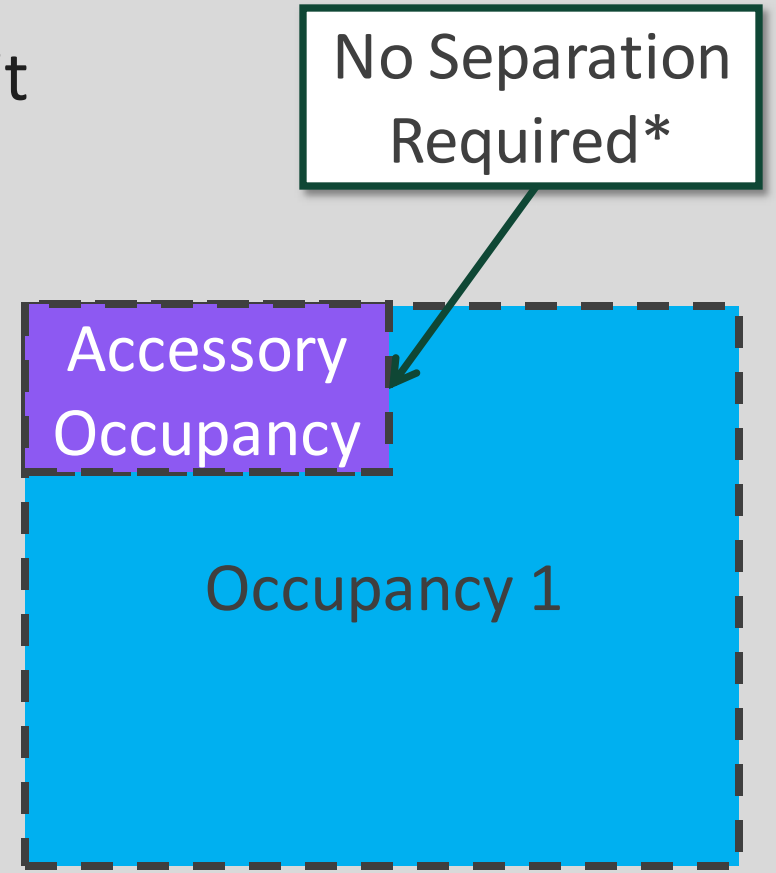
Accessory Occupancies

IBC 508.2

- Ancillary to the main occupancy
- Aggregate accessory area not greater than:
  - 10% of the main occupancy on same floor
  - Table 506.2 non-sprinklered allowable area limit of accessory occupancy
- No separation between occupancies required*
- Allowable building area and height per main occupancy

*Hazardous occupancies require separation

*Residential separations per Section 420 still apply



Accessory Occupancies

IBC 508.2

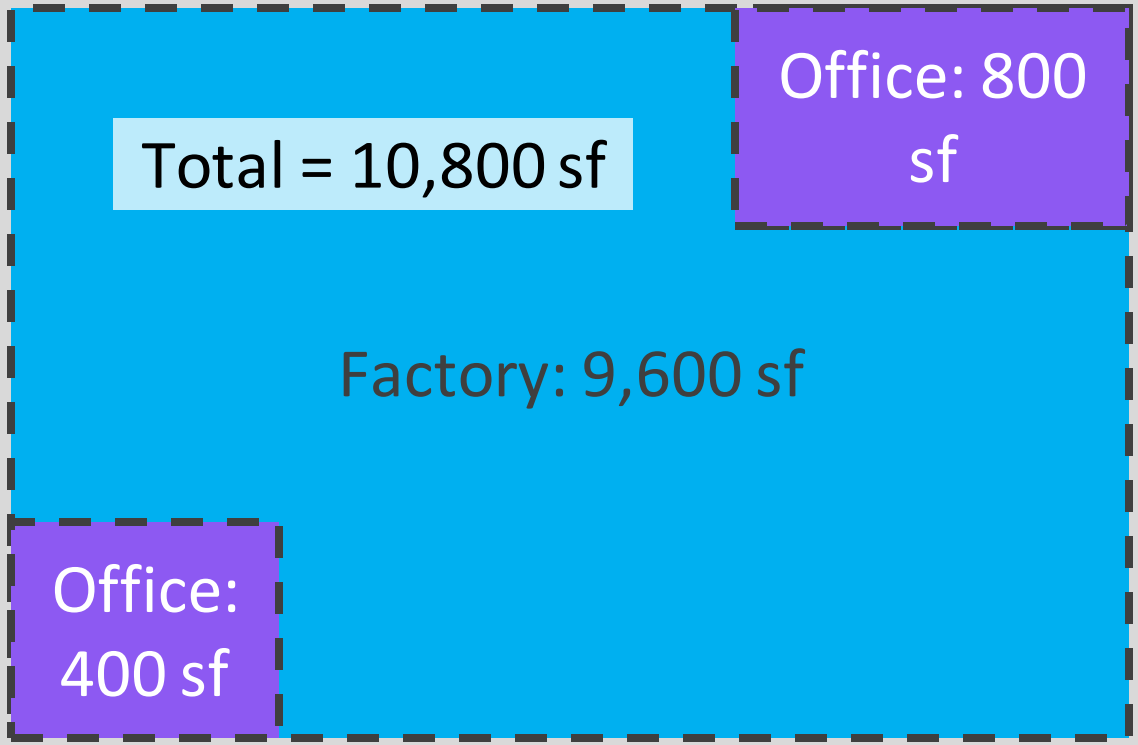
Accessory Occupancies Example:

- Unsprinklered, 1 story, type VA building
- Factory (F-1) 9,600 sf
- Two office (B) spaces: 400 sf and 800 sf

- Table 503: allowable area = 14,000 sf
- Total floor area = 10,800 sf < 14,000 sf ok

- Aggregate Accessory use areas = 1,200 sf
- Max. allowable aggregate accessory use area = 10,800*10% = 1,080 sf

- Does not work as accessory occupancies
- Solution: reduce office area, increase factory area or use mixed-use occupancies



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 café

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*

Assembly Spaces in Educational Facilities

IBC 303.1.3

Educational facilities:

- A room or space used for assembly purposes that is associated with a Group E occupancy is not considered a separate occupancy.

Examples:

- *Gymnasium used for school sports*
- *Cafeteria used for school meals*

Educational Spaces in Places of Worship

IBC 303.1.4

Places of religious worship:

- Accessory religious educational rooms and religious auditoriums with occupant loads of less than 100 per room or space are not considered separate occupancies.

Example: classrooms

St. Martha Catholic Church – Porter, TX

Design Team : Turner Duran Architects, Pinnacle Structural Engineers

Photo Credit: G. Lyon Photography, Inc.

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

Historically, code didn't offer much except for basic exit provisions but several design routes have been used, plus new guidance in 2018.

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

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:

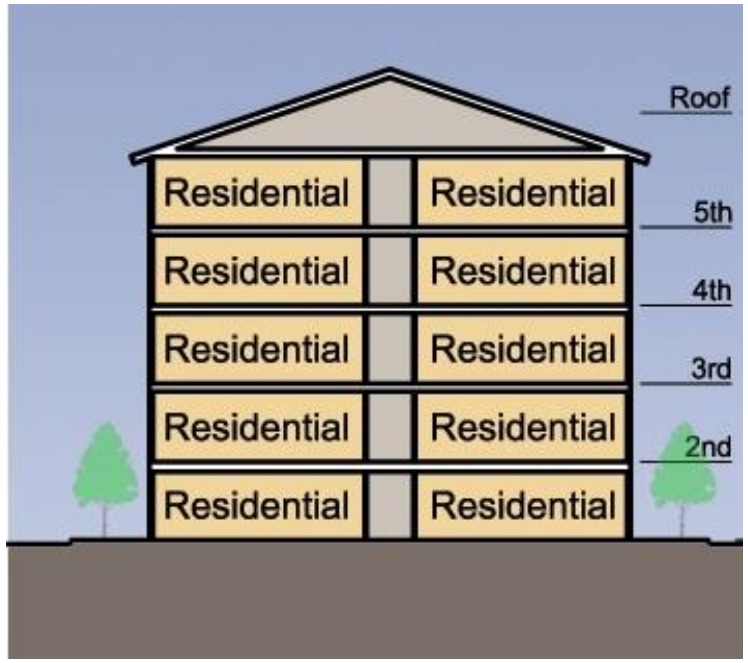
- Overall height in feet is still limited to min of either building
- 3hr rated horizontal assembly
- Building below is Type 1A with sprinklers

Occupancy restrictions above and below

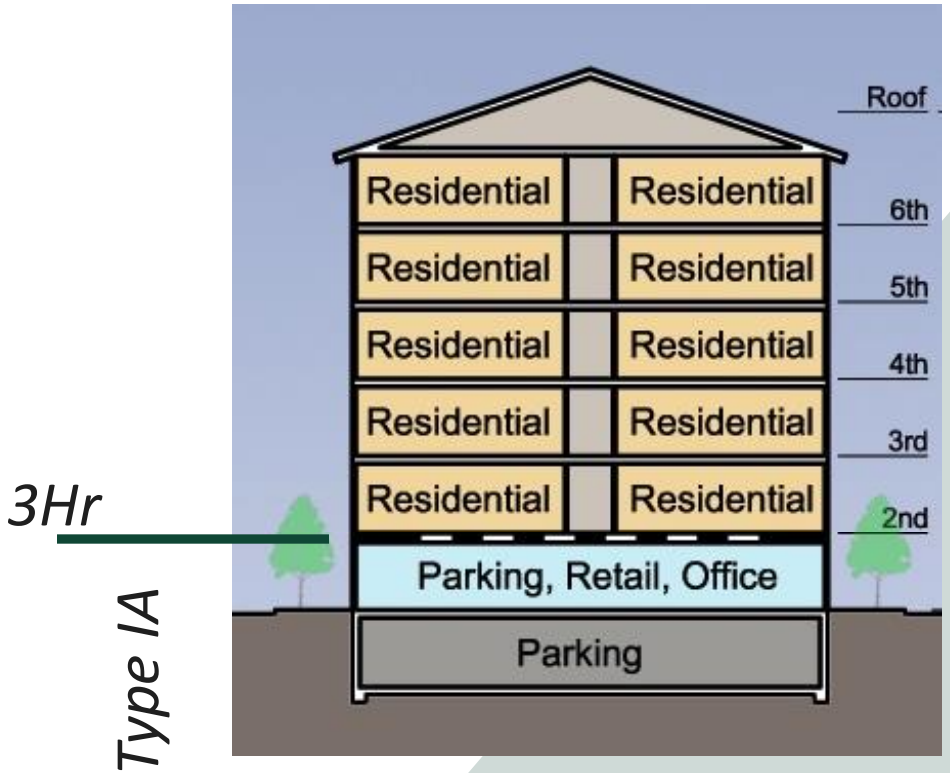
Special Provisions

IBC 510.2

Horizontal building separation



5 story Type III Building

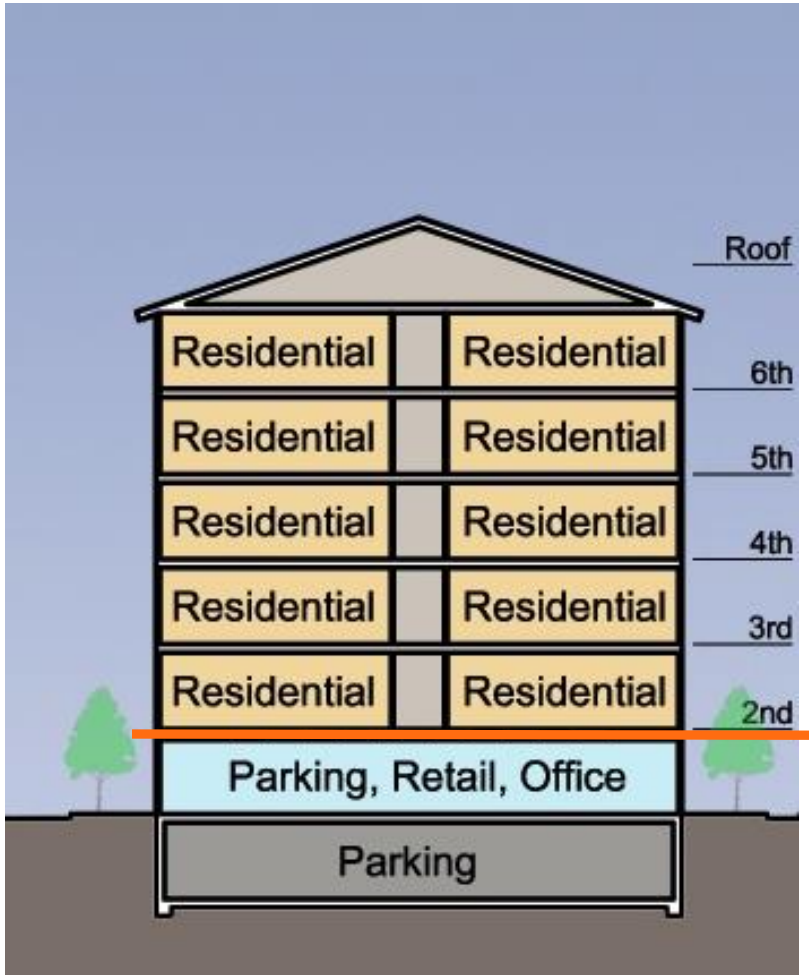


5 story Type III Building
on top of a Type IA Podium

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	

3Hr

Type IA

2015 & 2018 IBC allow multiple podium stories above grade

Special Provisions

IBC 510.2

5-Story Possibilities

4 stories of type V
over 1-story podium

Photo: Gables Residential

5 stories of type III

Special Provisions

IBC 510.2

6- & 7-Story Possibilities

5 stories of type III
over 1-story podium

5 stories of type III
over 2-story podium

Photo: Matt Todd & PB Architects

Special Provisions

IBC 510.2

7-Story Possibilities

6 stories of type IIIA or IV
over 1-story podium

Image: 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

Special Provisions

IBC 510.5

Group R-1 & R-2, Type IIIA Buildings

- Height limitation increased to 6 stories & 75 ft
- First floor assembly above the basement has a fire-resistance rating of not less than 3 hours
- Floor area is subdivided by 2-hour fire- resistance-rated fire walls into areas of not more than 3,000 square feet

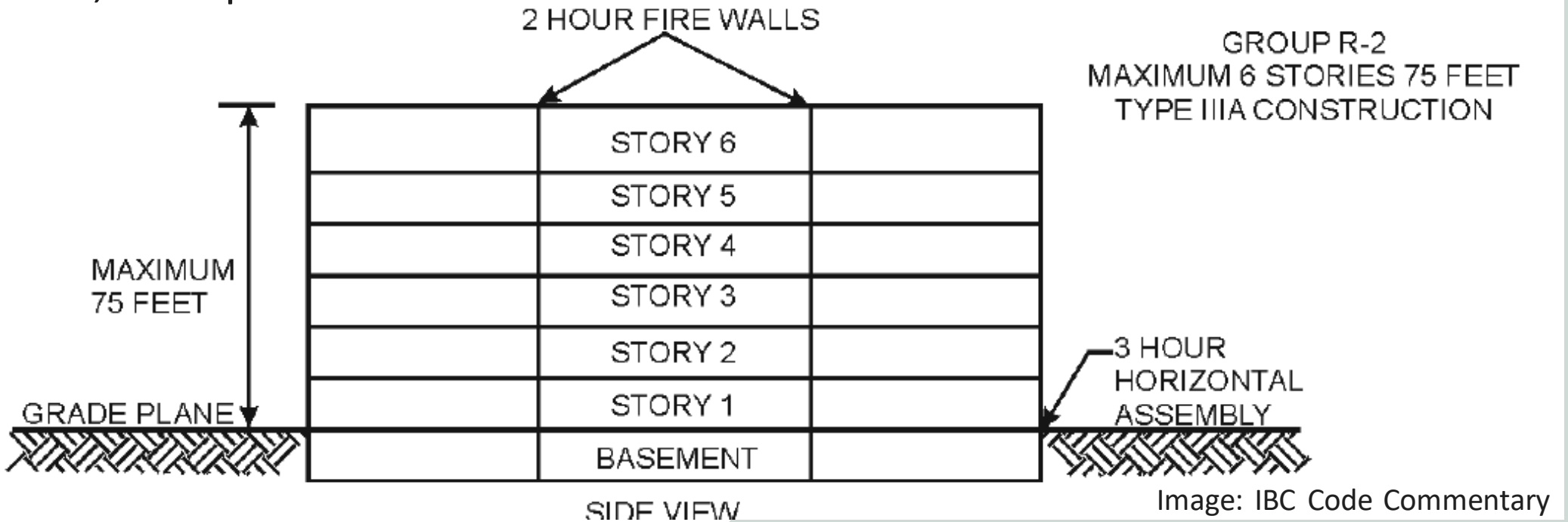
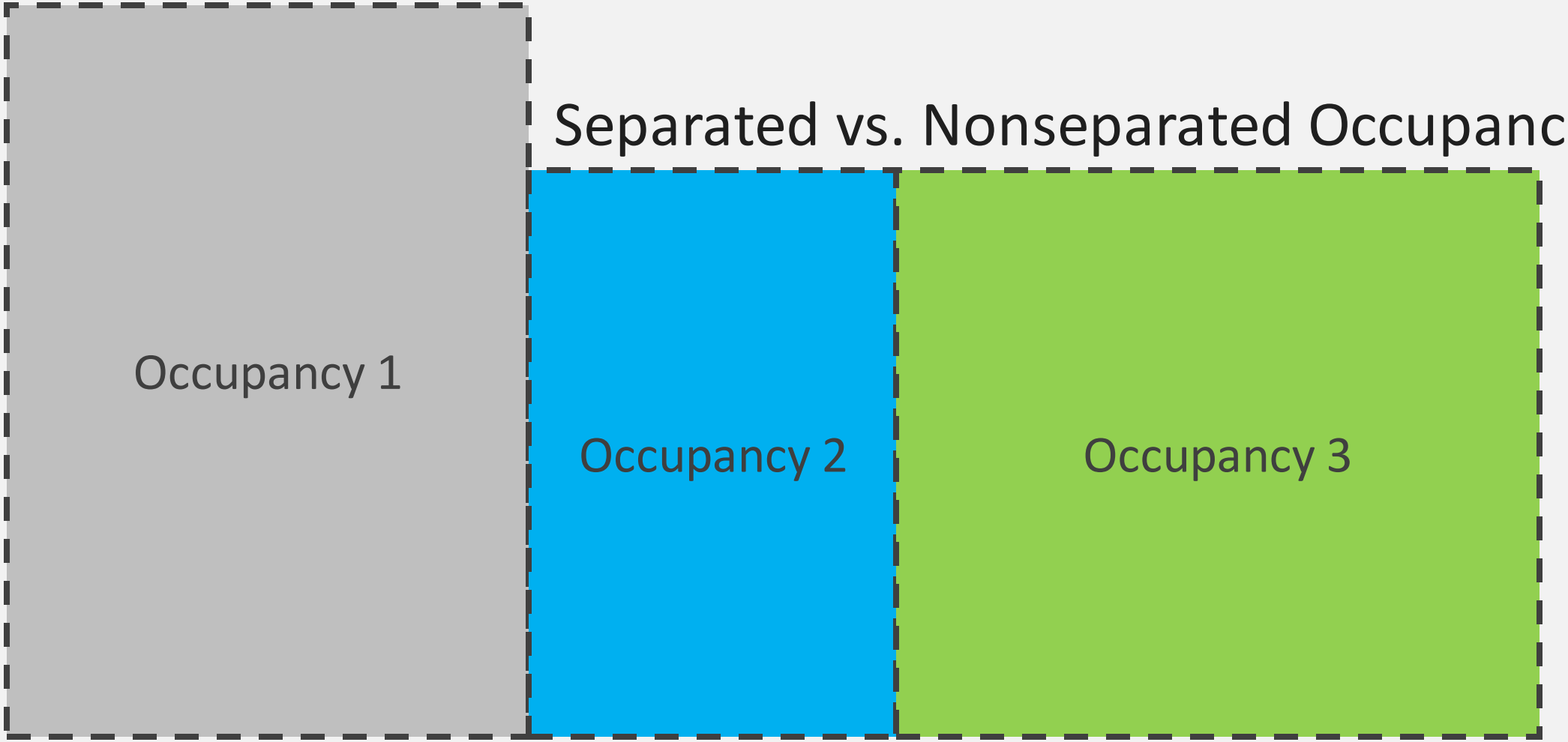


Image: IBC Code Commentary

Mixed Occupancy Buildings

IBC 508

Separated vs. Nonseparated Occupancies



Nonseparated Occupancies

IBC 508.3

Nonseparated Occupancies

IBC 508.3

Nonseparated Occupancies

Most restrictive of all occupancies apply for:

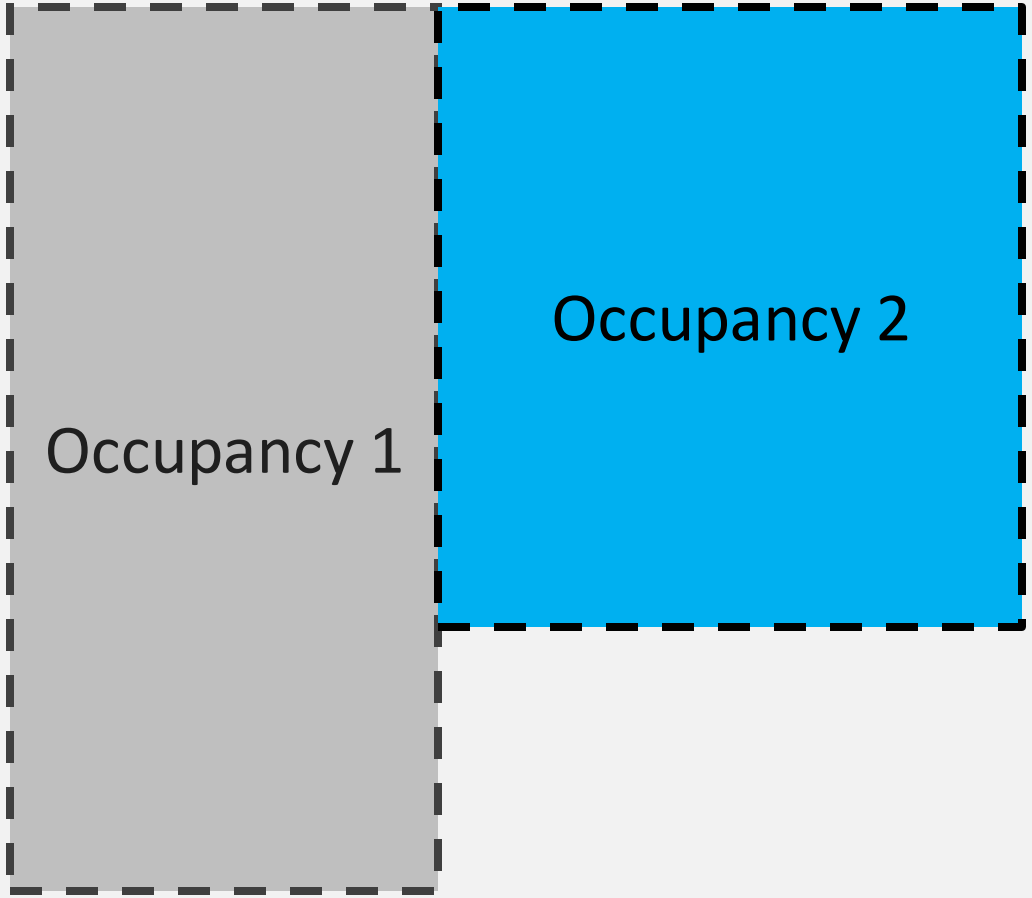
» Fire Protection Systems (Ch. 9)

» Allowable Height and Area (Ch. 5)

Other requirements (i.e. egress, others) based on individual occupancy of each portion

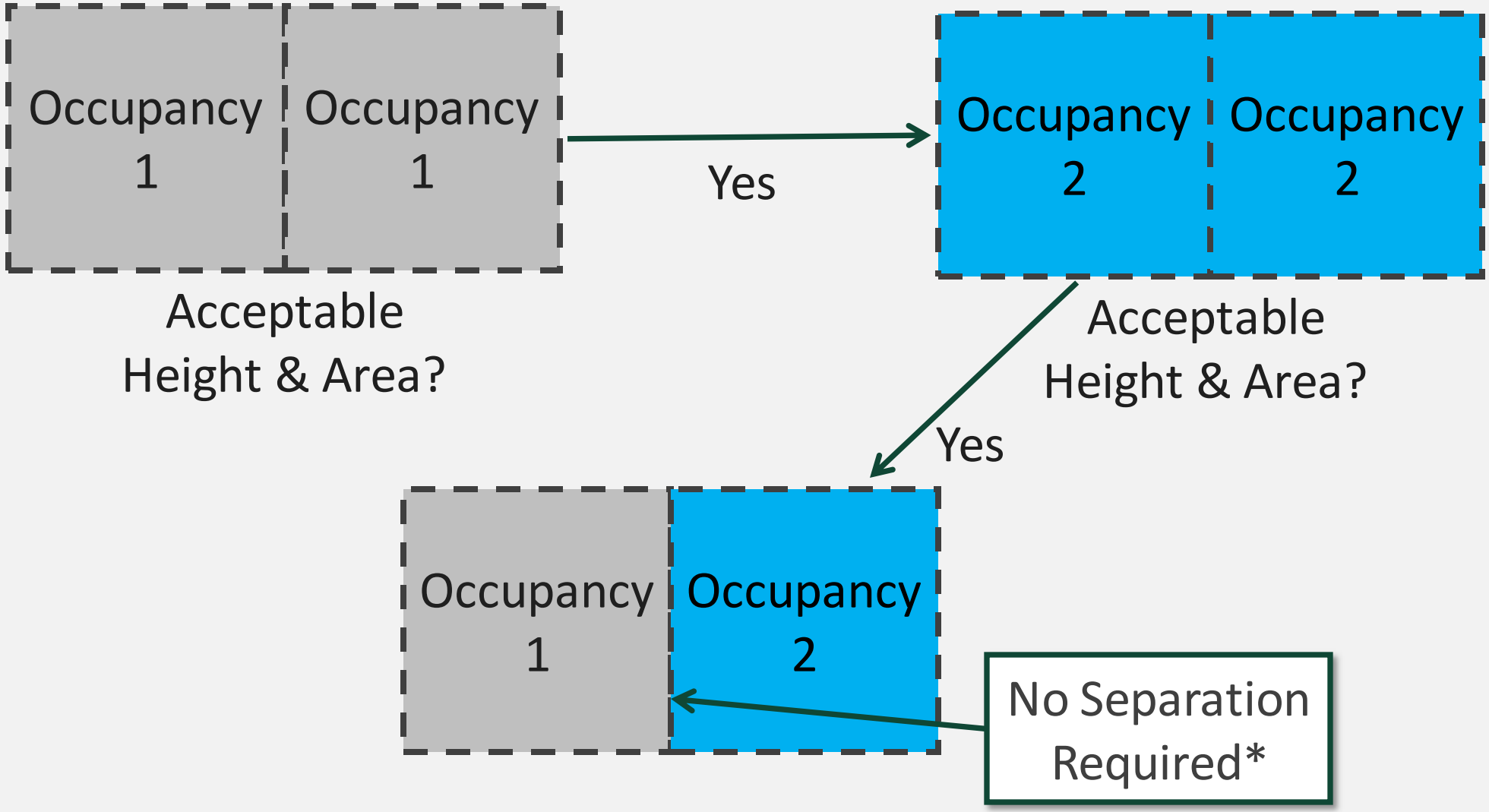
No fire separation between occupancies required*

- *Hazardous occupancies require separation.



Nonseparated Occupancies

IBC 508.3



Nonseparated Occupancies

IBC 508.3

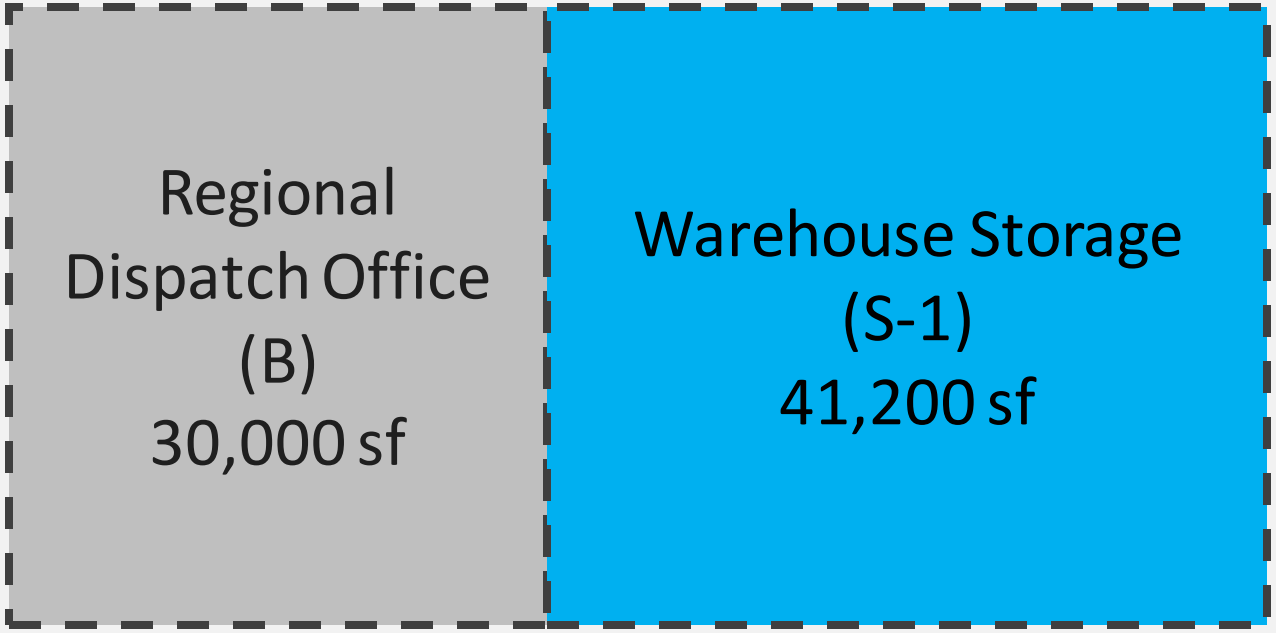
Nonseparated Occupancies Example

» 1 story building

» Total building area = 71,200 sf

» IBC 903 does not require an automatic sprinkler in group B buildings, but it does for S-1 buildings with fire area > 12,000 sf (903.2.9)

» NFPA 13 sprinkler required throughout building



Nonseparated Occupancies

IBC 508.3

Nonseparated Occupancies Example (con't)

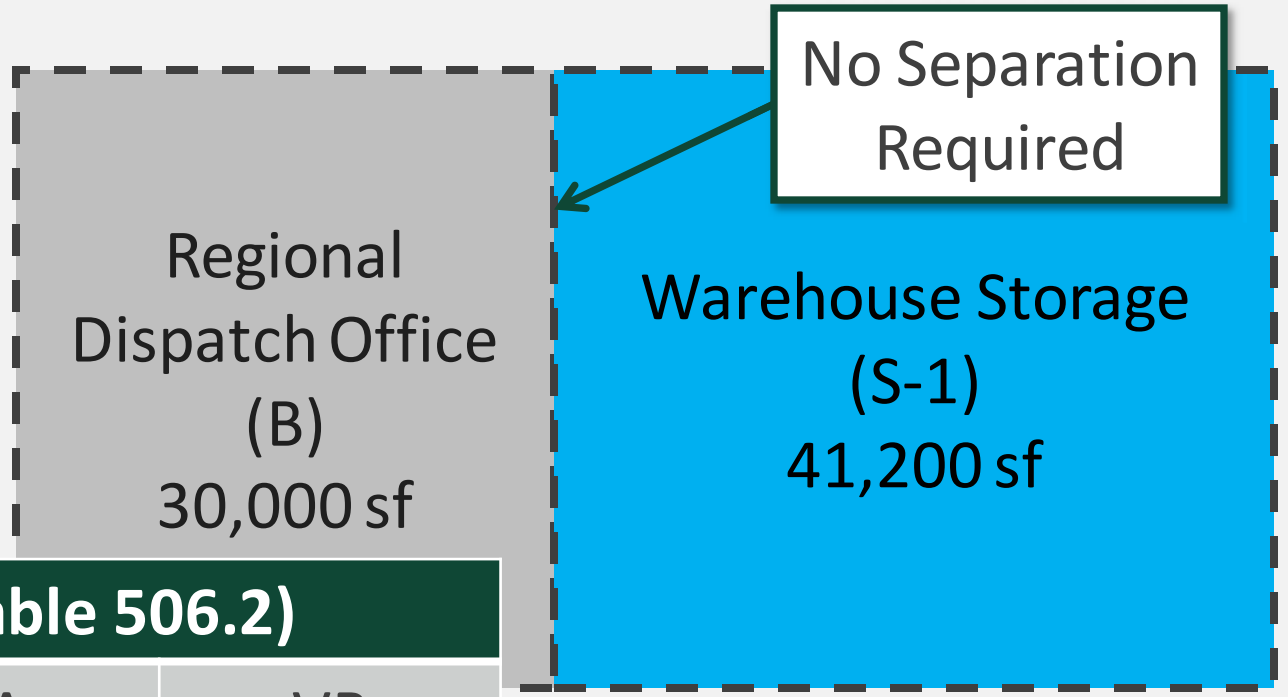
Construction type options:

» VB: inadequate for both

» VA: OK for B, inadequate for S-1

» IIIB: OK for B, inadequate for S-1

» IIIA: works for both: **USE TYPE IIIA**



Allowable 1-Story Building Area (Table 506.2)

	IIIA	IIIB	VA	VB
Group B	114,000 sf	76,000 sf	72,000 sf	~~36,000 sf~~
Group S-1	104,000 sf	~~70,000 sf~~	~~56,000 sf~~	~~36,000 sf~~

Assumptions:
NFPA 13 sprinkler throughout
No frontage increase

Nonseparated Occupancies

IBC 508.3

Multi-story, Nonseparated Occupancy Buildings

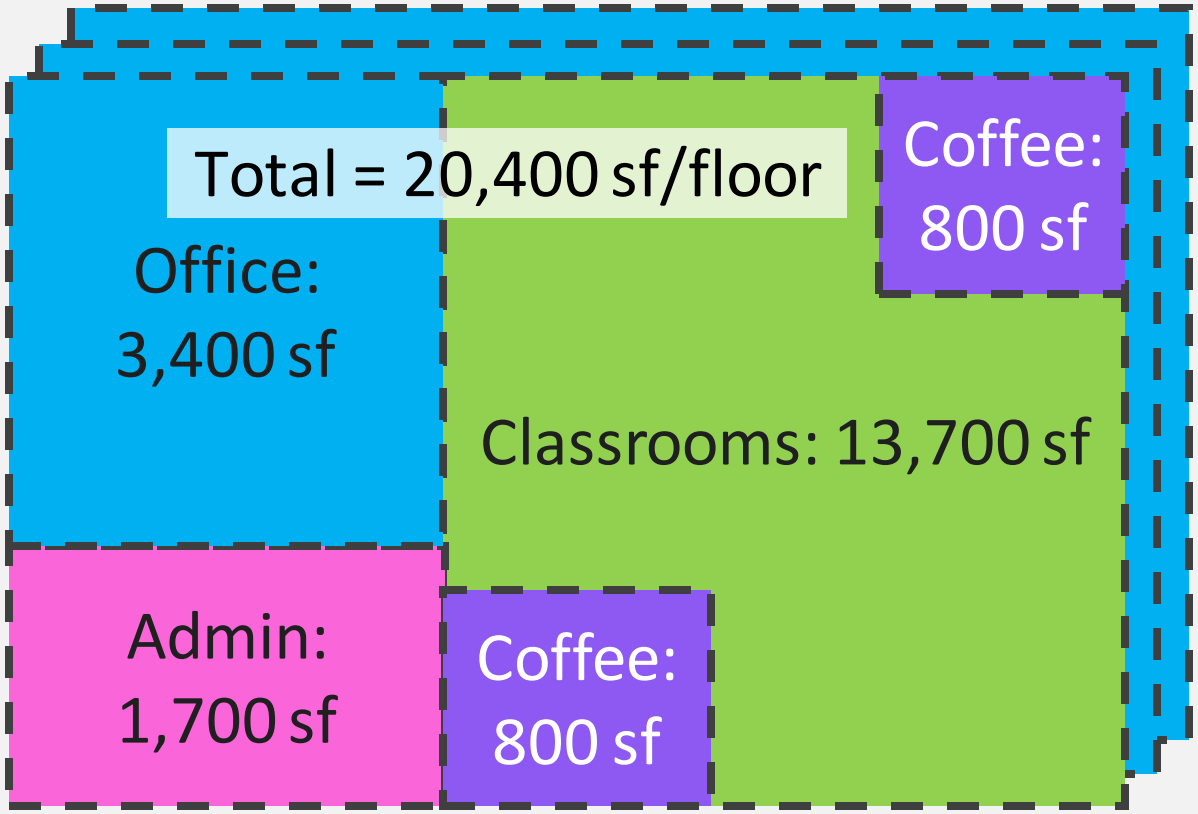
Image: Ware Malcomb

Nonseparated Occupancies

IBC 508.3

Multi-Story Nonseparated Occupancies Example

- 3 story building on college campus
- 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

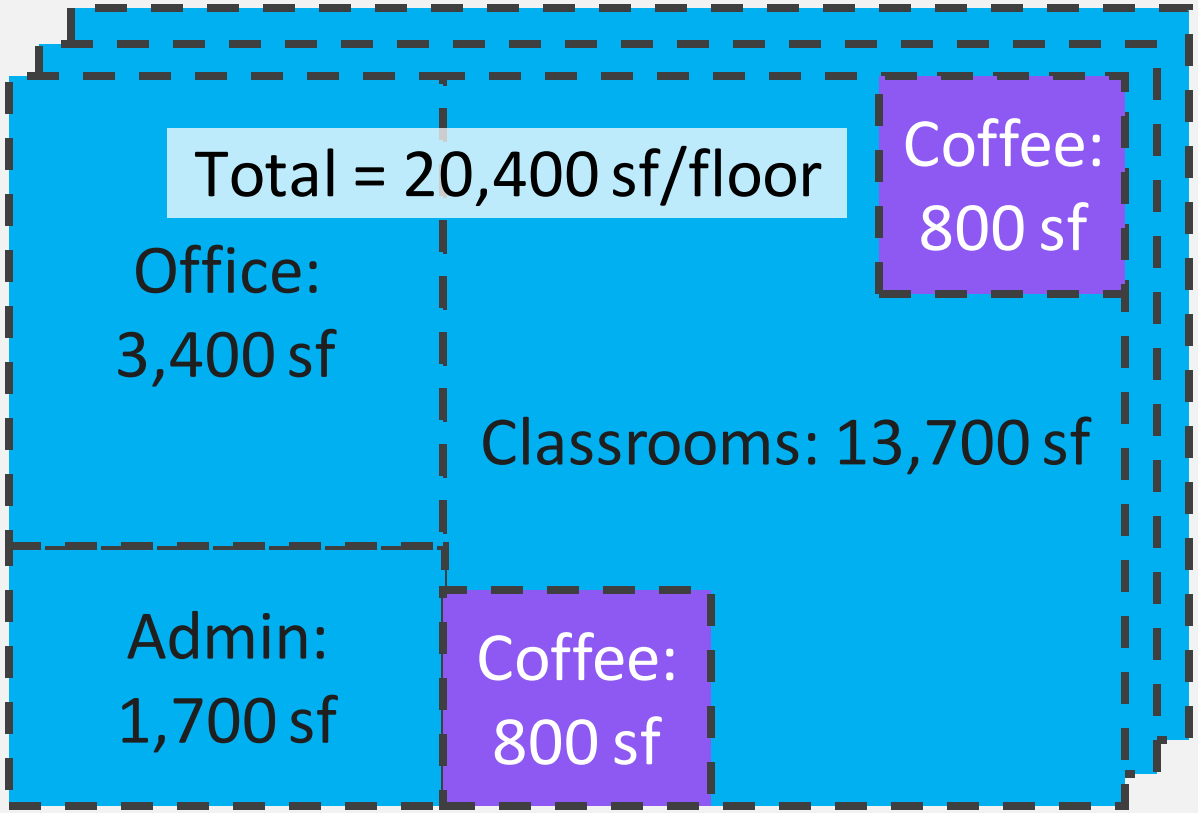


Nonseparated Occupancies

IBC 508.3

Multi-Story Nonseparated Occupancies Example (con't)

- Classrooms for higher than 12th grade: Group B
- Admin & offices: Group B
- Coffee/snack bar: Group A-2
- May be able to use "small assembly" provision (IBC 303.1.1) – Group B
  - Or may be able to call accessory occupancies – Group B

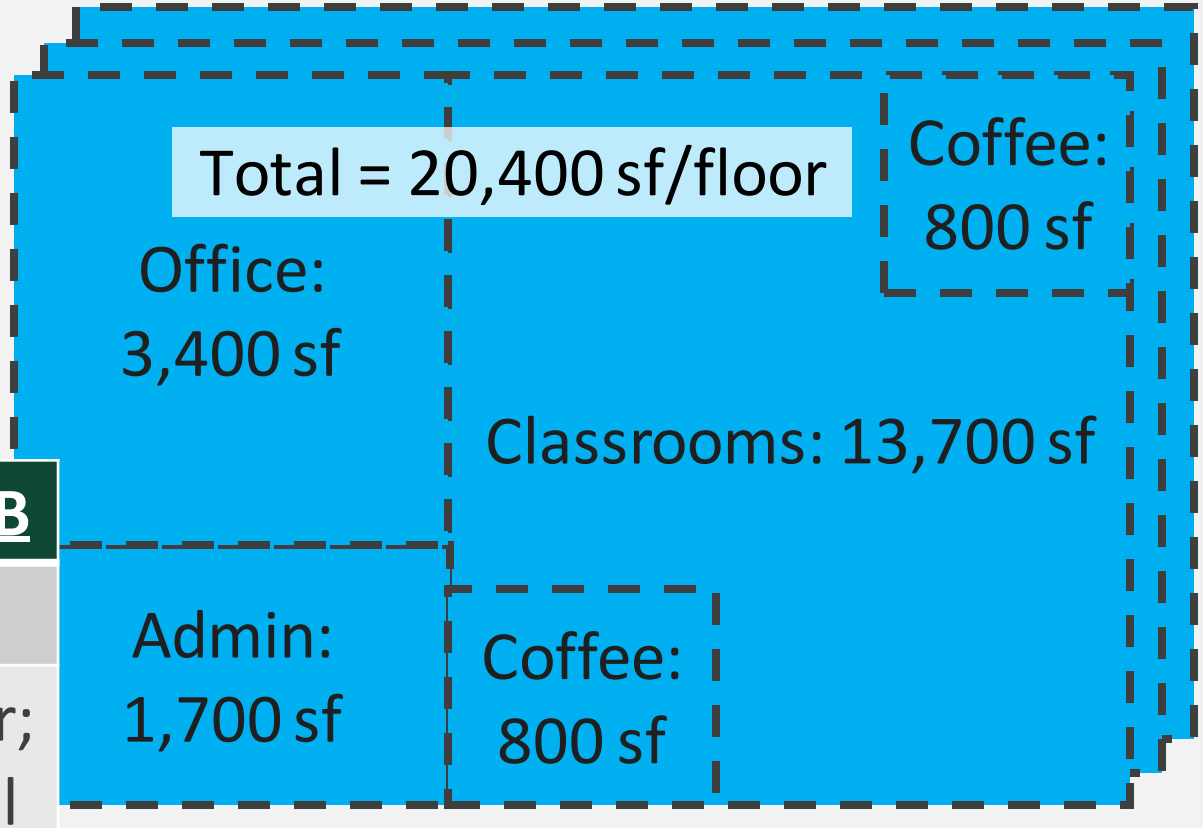


Nonseparated Occupancies

IBC 508.3

Multi-Story Nonseparated Occupancies Example (con't)

» If coffee/snack areas meet provisions for small assembly spaces or accessory occupancy, entire building is group B and can use **Type VB construction**



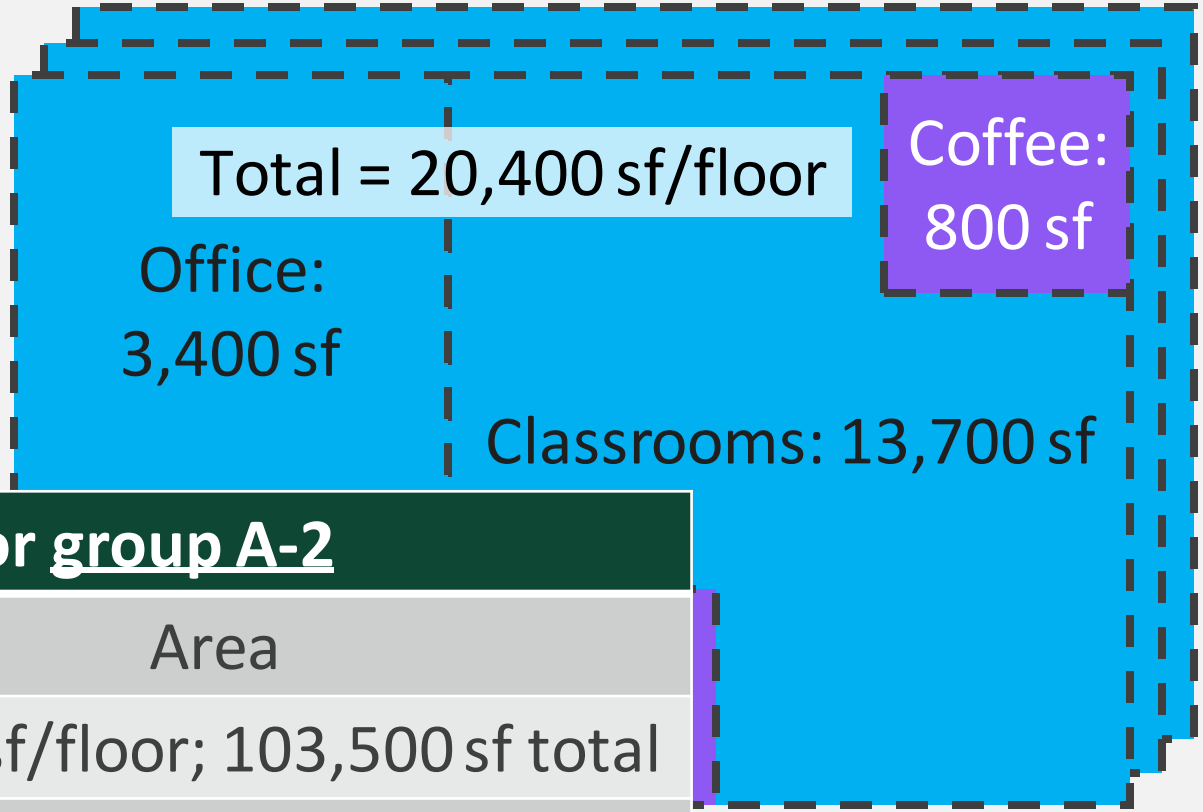
Allowable Heights and Areas for Group B		
	Height	Area
Type VB	3 stories; 60 ft	27,000 sf/floor; 81,000 sf total

Nonseparated Occupancies

IBC 508.3

Multi-Story Nonseparated Occupancies Example (con't)

- If coffee/snack areas don't meet provisions for small assembly spaces, they are group A-2.
- **Use non-separated occupancies, Type VA construction**
- Group B OK per previous
- Group A-2 per below



Allowable Heights and Areas for group A-2		
	Height	Area
Type VA	3 stories; 70 ft	34,500 sf/floor; 103,500 sf total
Type VB	~~2 stories; 60 ft~~	~~18,000 sf/floor; 54,000 sf total~~

Separated Occupancies

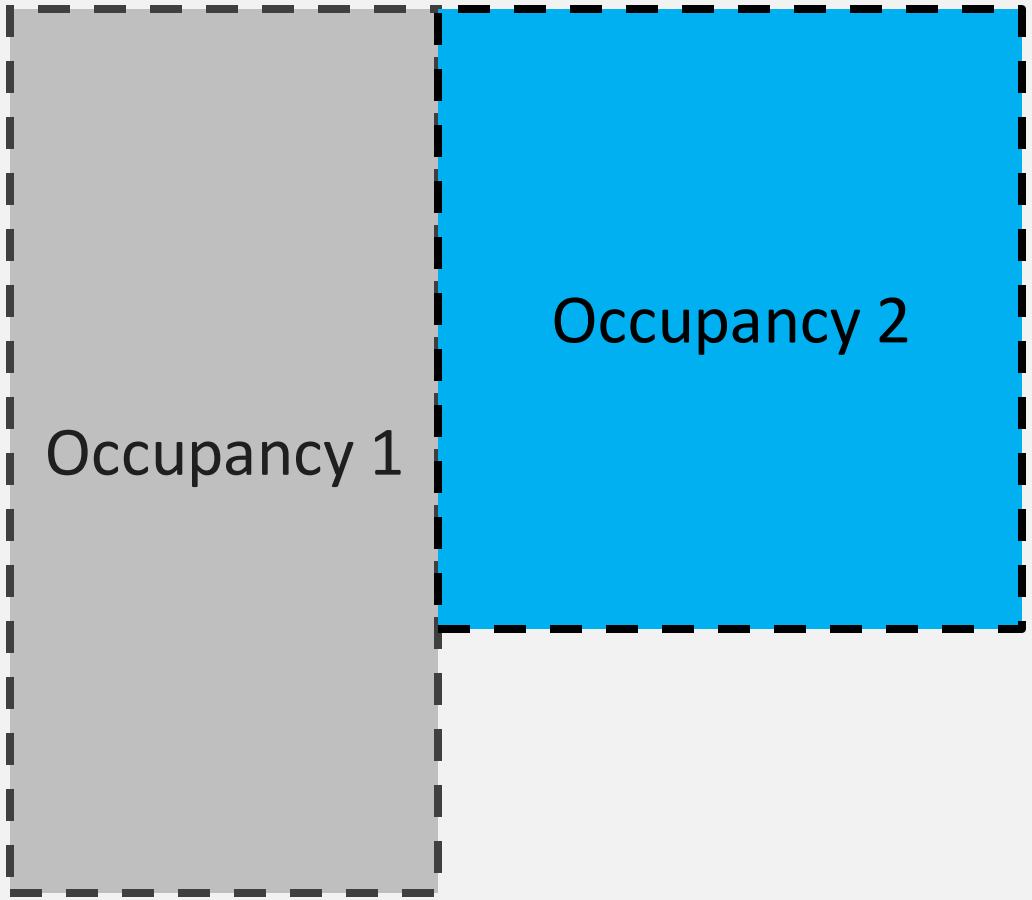
IBC 508.4

Separated Occupancies

IBC 508.4

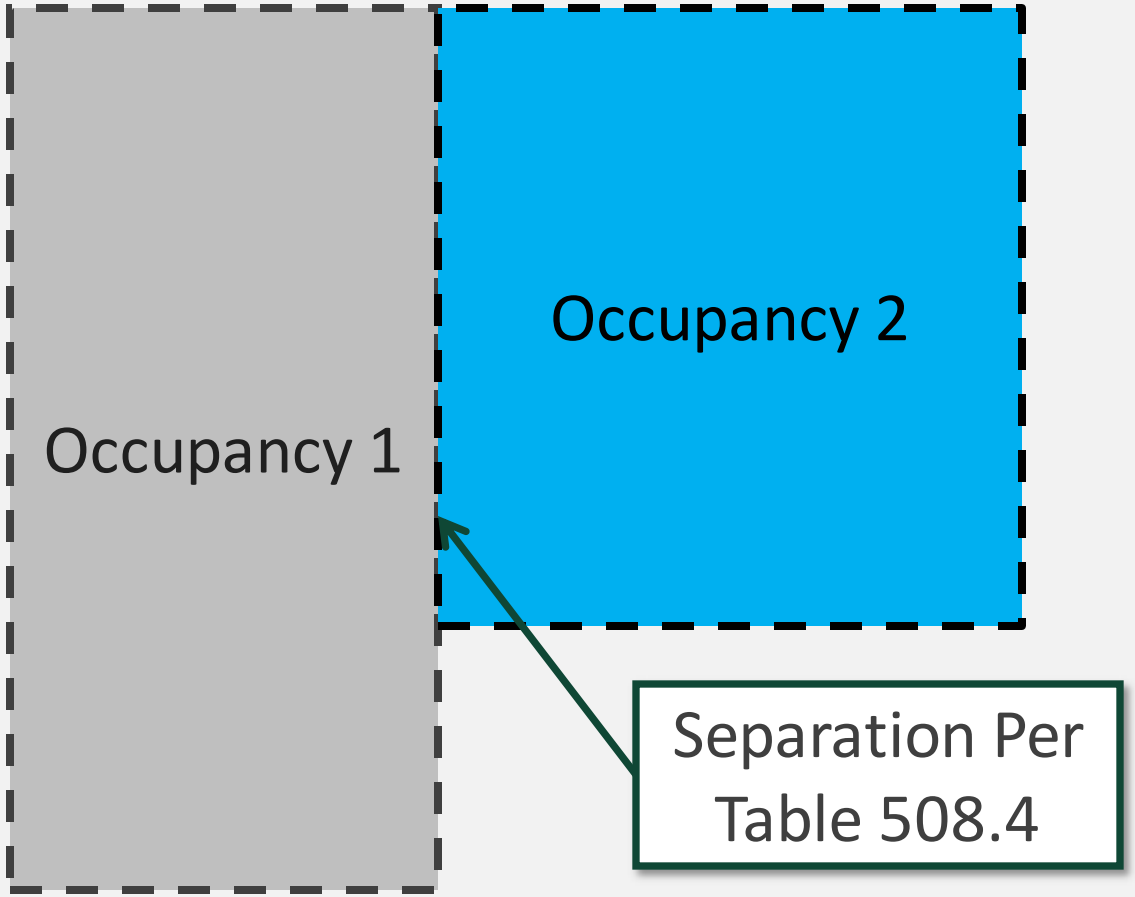
Separated Occupancies

- Requirements of code for each portion based upon occupancy of that portion
- Allowable height of each occupancy based upon construction type and occupancy
- Allowable area of each story
  - Sum of actual area over allowable area of each occupancy ≤ 1.0



Separated Occupancies

IBC 508.4



Check performed for each story. Separation by fire barriers and horizontal assemblies

$$\frac{A1}{\text{Allowable Area for Occupancy 1}} + \frac{A2}{\text{Allowable Area for Occupancy 2}} \leq 1.0$$

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[e], 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[e], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

Separation accomplished with:

- Walls: fire barriers (IBC 707)
- Floors: horizontal assemblies (IBC 711)

S = Sprinklered
NS = No Sprinkler
NP = Not Permitted
N = No Separation Required

Separated Occupancies

IBC 508.4

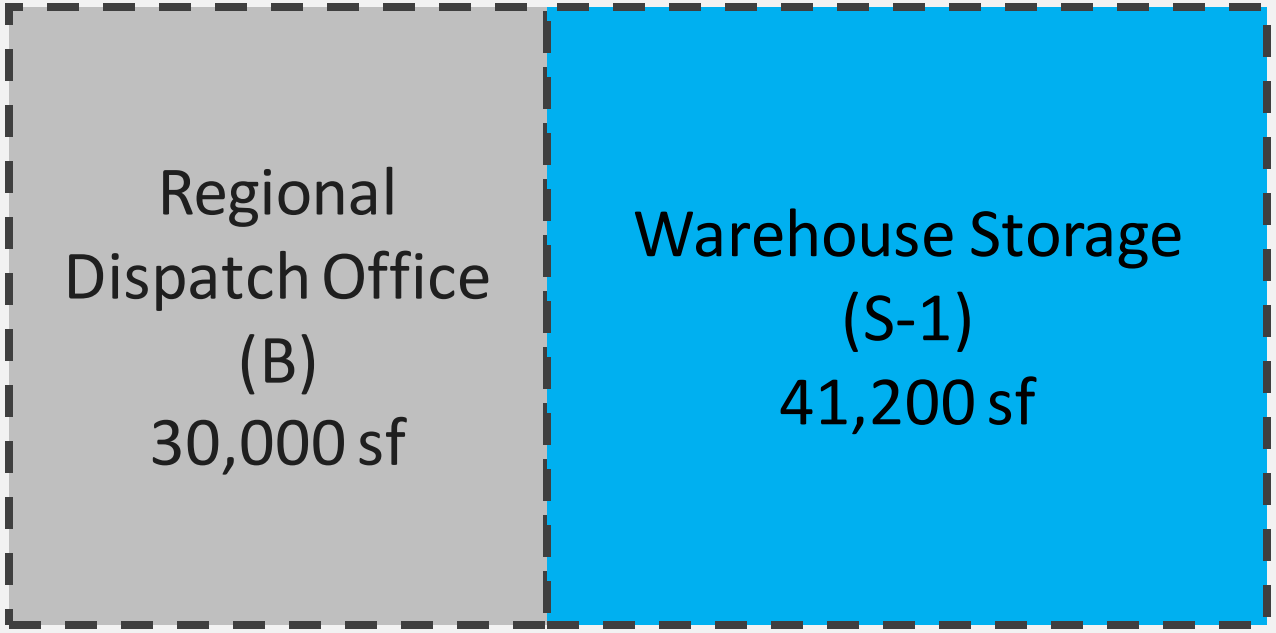
Separated Occupancies Example

» 1 story building

» Total building area = 71,200 sf

» IBC 903 does not require an automatic sprinkler in group B buildings, but it does for S-1 buildings with fire area > 12,000 sf (903.2.9)

» NFPA 13 sprinkler required throughout building



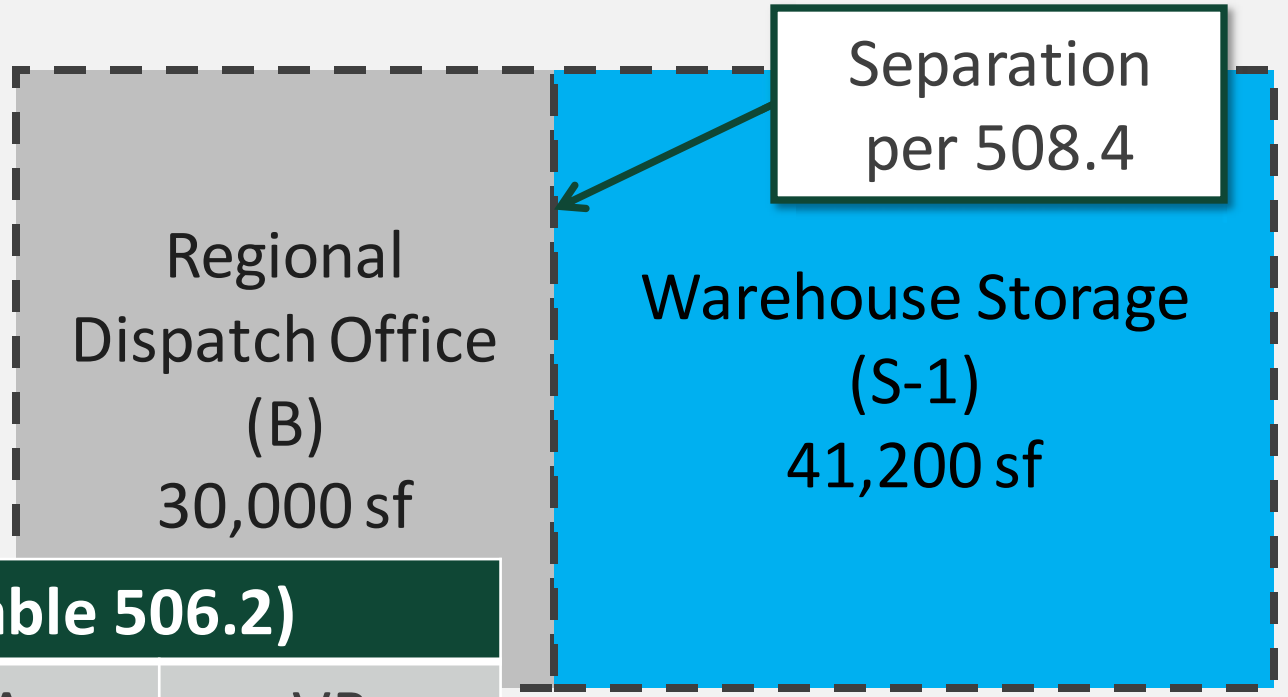
Separated Occupancies

IBC 508.4

Nonseparated Occupancies Example (con't)

Construction type options:

- VB: 30,000/36,000 + 41,000/36,000 = 1.97 > 1.0 *inadequate*
- VA: 30,000/72,000 + 41,000/56,000 = 1.15 > 1.0 *inadequate*
- IIIB: 30,000/76,000 + 41,000/70,000 = 0.98 < 1.0 OK: **USE TYPE IIIB**



Allowable 1-Story Building Area (Table 506.2)

	IIIA	IIIB	VA	VB
Group B	114,000 sf	76,000 sf	72,000 sf	36,000 sf
Group S-1	104,000 sf	70,000 sf	56,000 sf	36,000 sf

Assumptions:
NFPA 13 sprinkler throughout
No frontage increase

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[e], 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[e], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

For this example, no separation required

Separation accomplished with:

- Walls: fire barriers (IBC 707)
- Floors: horizontal assemblies (IBC 711)

S = Sprinklered
NS = No Sprinkler
NP = Not Permitted
N = No Separation Required

Separated Occupancies

IBC 508.4

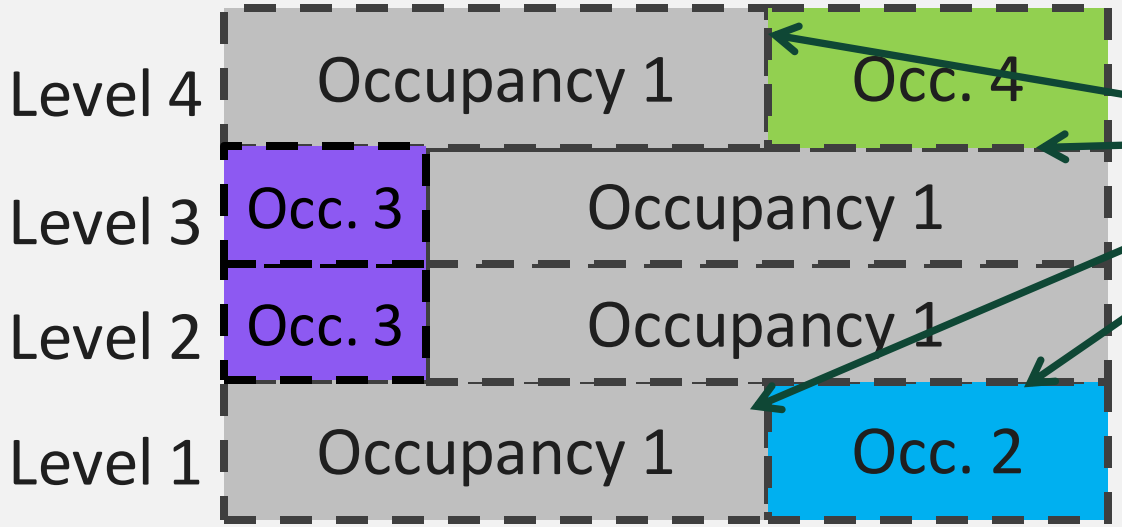
Multi-story, Separated Occupancy Buildings

Image: CUBE 3 Studio LLC & Rixon Photography

Separated Occupancies

IBC 506.2.4 & 508.4

Multi-Story Separated Occupancies



Elevation view

Separation Per Table 508.4

(Also between occ. 1 & occ. 3)

Sum of ratios

actual area/allowable area

for all occupancies per floor:

≤ 1.0 for 1 story building

≤ 2.0 for 2 story building

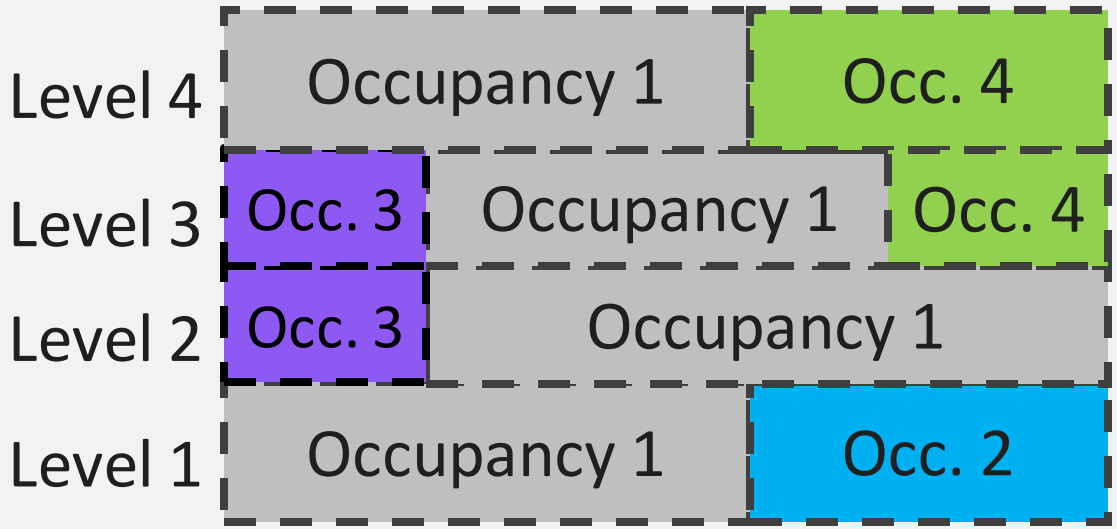
≤ 3.0 for 3+ story building

No floor can have a ratio > 1.0

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example



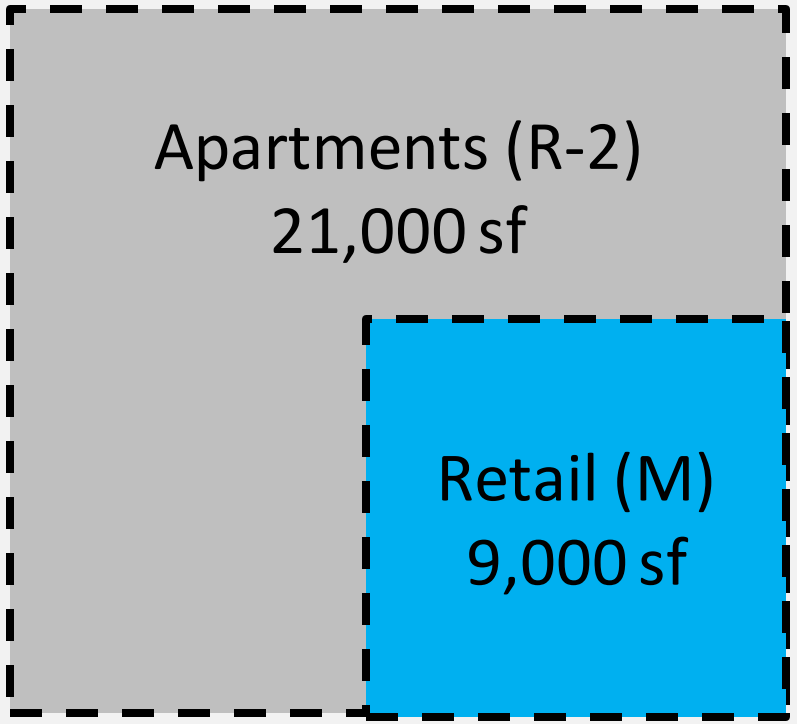
Elevation view

- 4 story building
- Total building area = 120,000 SF
- Occupancy 1 = apartments (R-2)
- Occupancy 2 = retail (M)
- Occupancy 3 = restaurant (A-2)
- Occupancy 4 = professional offices (B)
- IBC section 903.2.8 requires buildings containing group R fire areas to be sprinklered throughout the building
- Provide NFPA 13 sprinkler throughout building

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



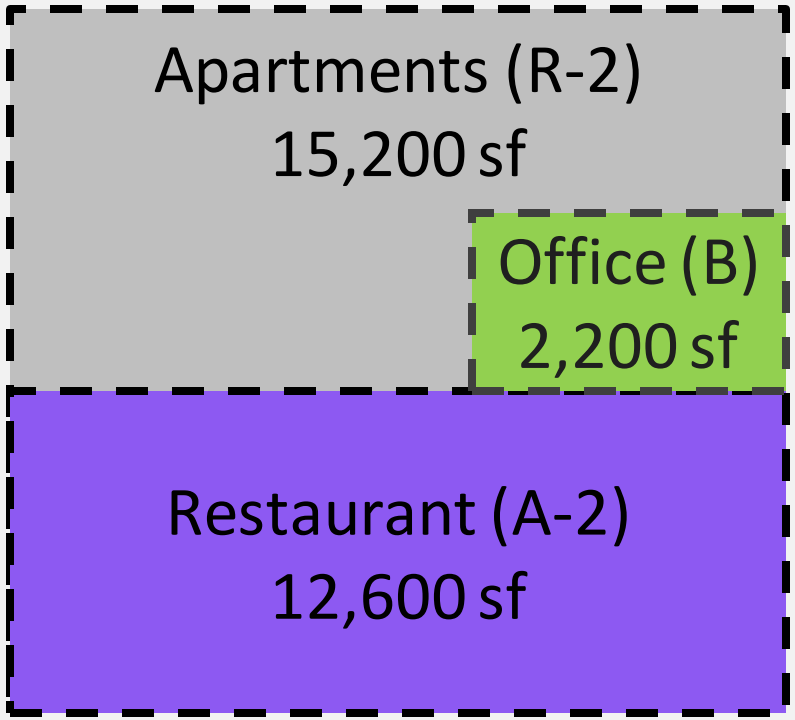
Level 1 Floor Plan

Level 2 Floor Plan

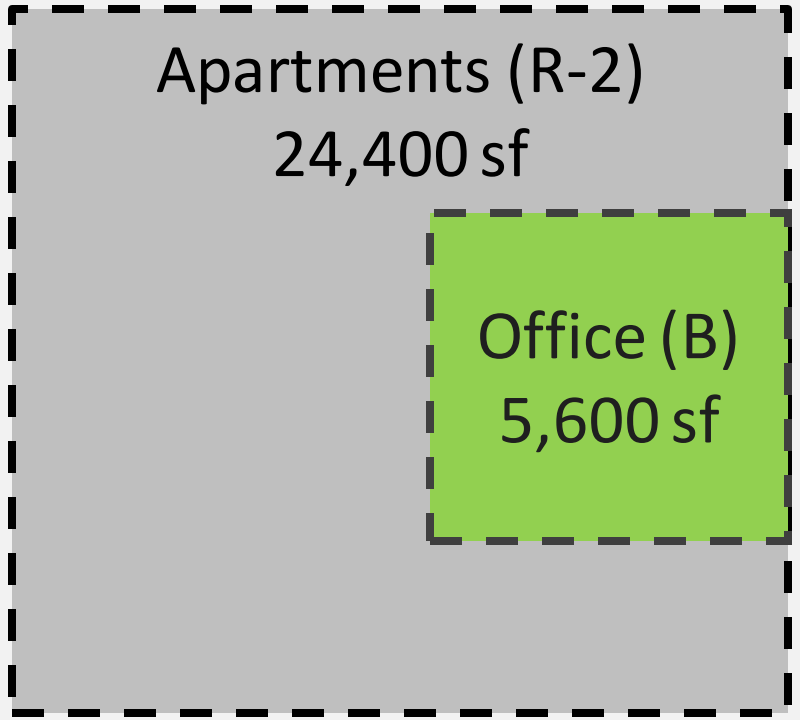
Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



Level 3 Floor Plan



Level 4 Floor Plan

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)

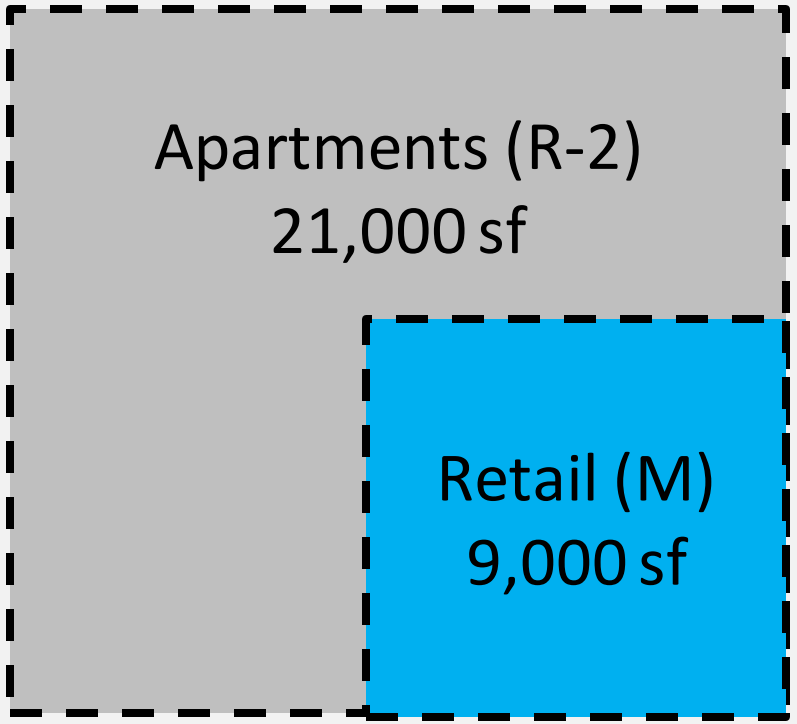
Allowable Floor Area / # of stories (from Tables 504.4 and 506.2)				
	IIIA	IIIB	VA	VB
Group A-2	42,000 sf / 4	28,500 sf / 3	34,500 sf / 3	18,000 sf / 2
Group B	85,500 sf / 6	57,000 sf / 4	54,000 sf / 4	27,000 sf / 3
Group M	55,500 sf / 5	37,500 sf / 3	42,000 sf / 4	27,000 sf / 2
Group R-2	72,000 sf / 5	48,000 sf / 5	36,000 sf / 4	21,000 sf / 3

With full NFPA 13 sprinkler increases but no frontage increase

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



Level 1 Floor Plan

- Try construction type VA:
  21,000/36,000 + 9,000/42,000
  = 0.80 < 1.0: OK

- Allowable height & stories:
  R-2: 70 ft, 4 stories: OK
  M: 70 ft, 4 stories: OK

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)

Level 2 Floor Plan

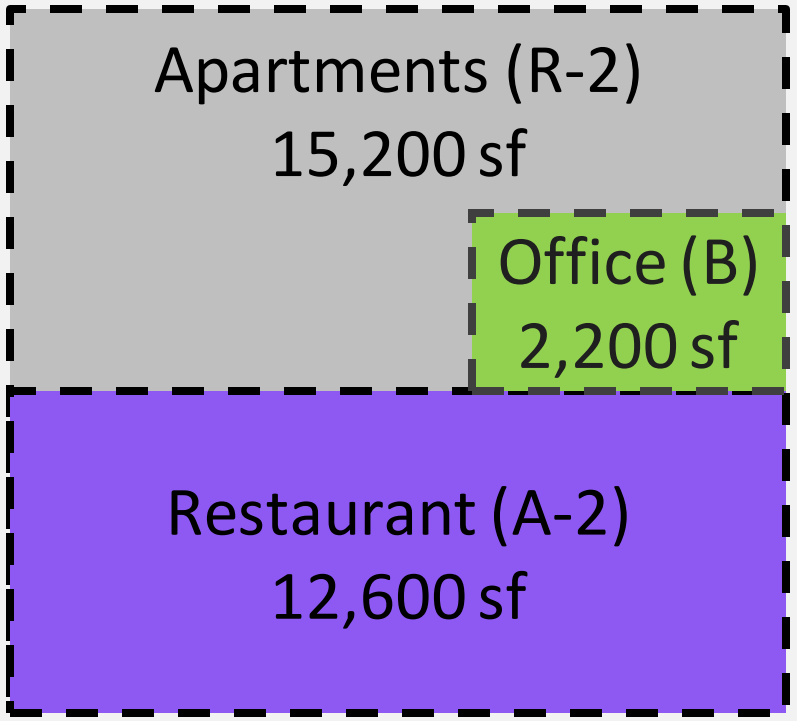
- Try construction type VA:
  17,400/36,000 + 12,600/34,500
  = 0.85 < 1.0: OK

- Allowable height & stories:
  R-2: 70 ft, 4 stories: OK
  A-2: 70 ft, 3 stories: OK

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



Level 3 Floor Plan

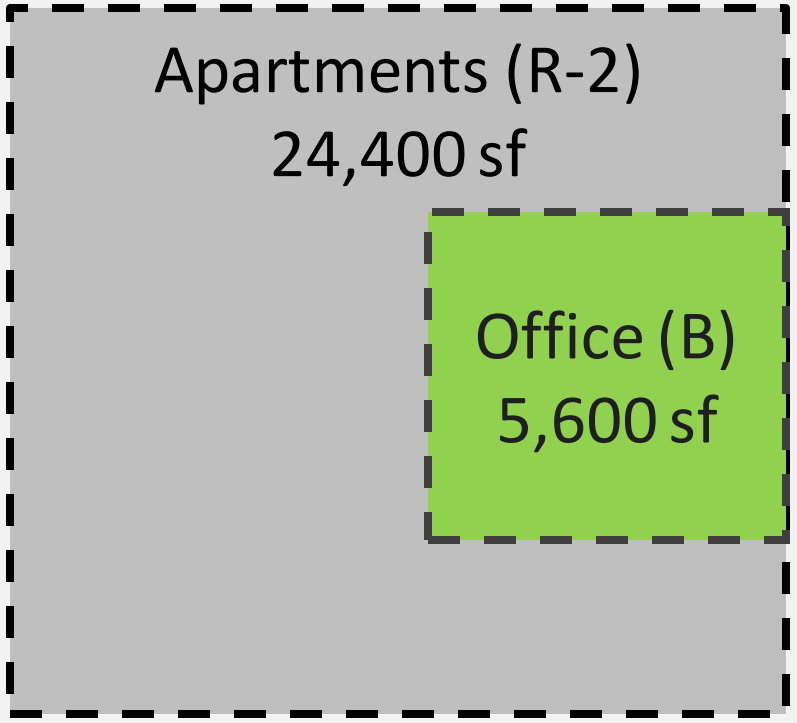
- Try construction type VA:
  15,200/36,000 + 12,600/34,500 +
  2,200/54,000 = 0.83 < 1.0: OK

- Allowable height & stories:
  R-2: 70 ft, 4 stories: OK
  A-2: 70 ft, 3 stories: OK
  B: 70 ft, 4 stories: OK

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



Level 4 Floor Plan

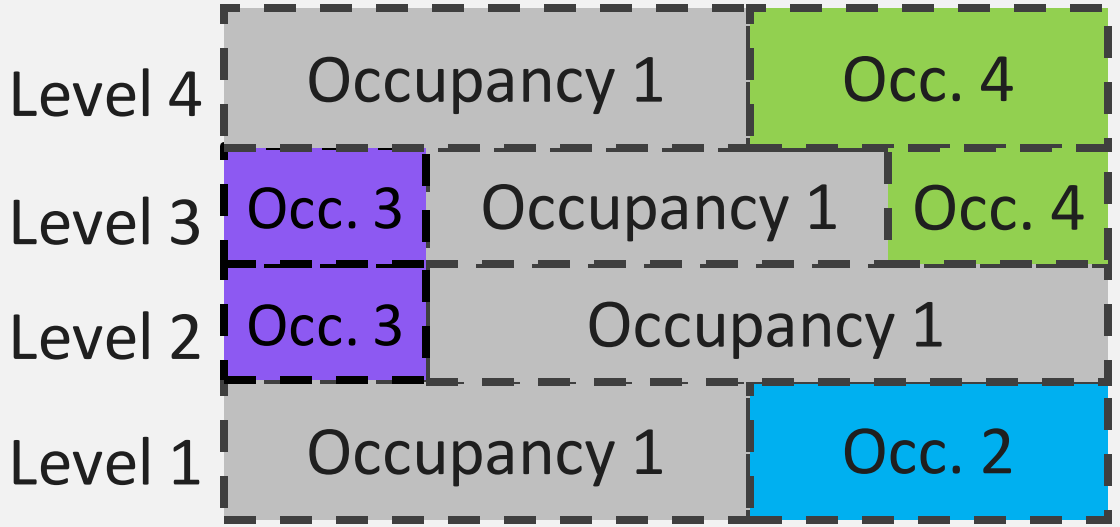
- Try construction type VA:
  24,400/36,000 + 5,600/54,000
  = 0.78 < 1.0: OK

- Allowable height & stories:
  R-2: 70 ft, 4 stories: OK
  B: 70 ft, 4 stories: OK

Separated Occupancies

IBC 508.4

Multi-Story Separated Occupancies Example (con't)



Elevation view

0.78

0.83

0.85

0.80

sum of ratios of
actual area/allowable area
for all occupancies per floor

3.26 > 3.0: *Inadequate*

Type VA can't be used.

Use type IIIB.

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[e], 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[e], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

- R-2 to B, M, A-2: 1-hr walls and floors
- A-2 to M: 1-hr floor

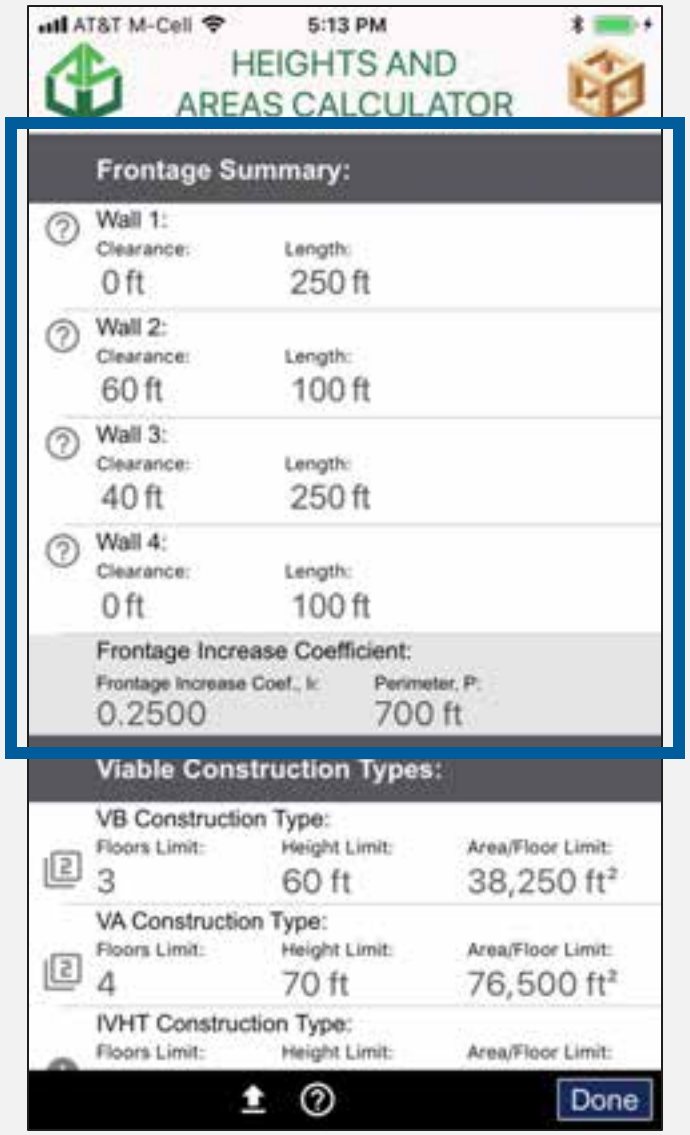
S = Sprinklered
NS = No Sprinkler
NP = Not Permitted
N = No Separation Required

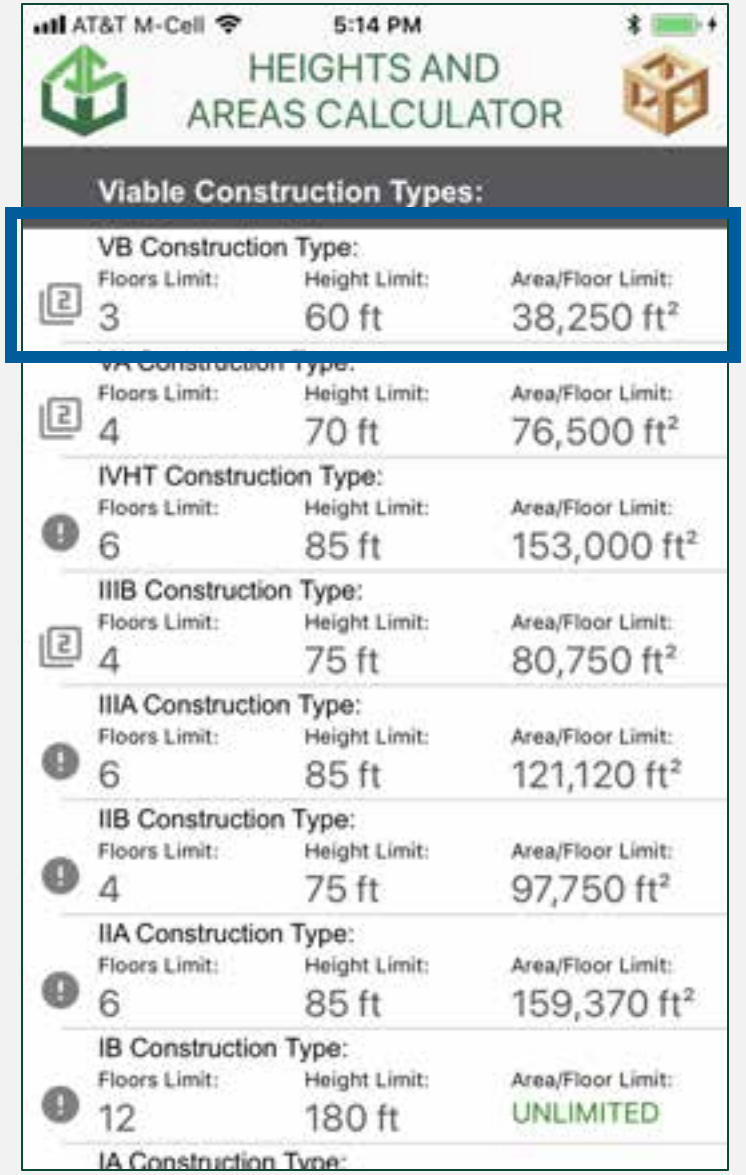
Allowable Building Size

Heights and areas calculator – free tool

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

Handles Separated & Nonseparated Occupancies (Check “both”)





Fire Barriers

IBC 707

What is a fire barrier?

- May be constructed with any materials permitted by the construction type
- Occupancy separation: Fire resistance ratings per IBC Table 508.4
- Required to extend from top of the foundation/floor below to underside of floor/roof sheathing, slab or deck above
- Supporting construction required to have same fire-resistance rating as the fire barrier being supported
- Other requirements for openings, penetrations, joints

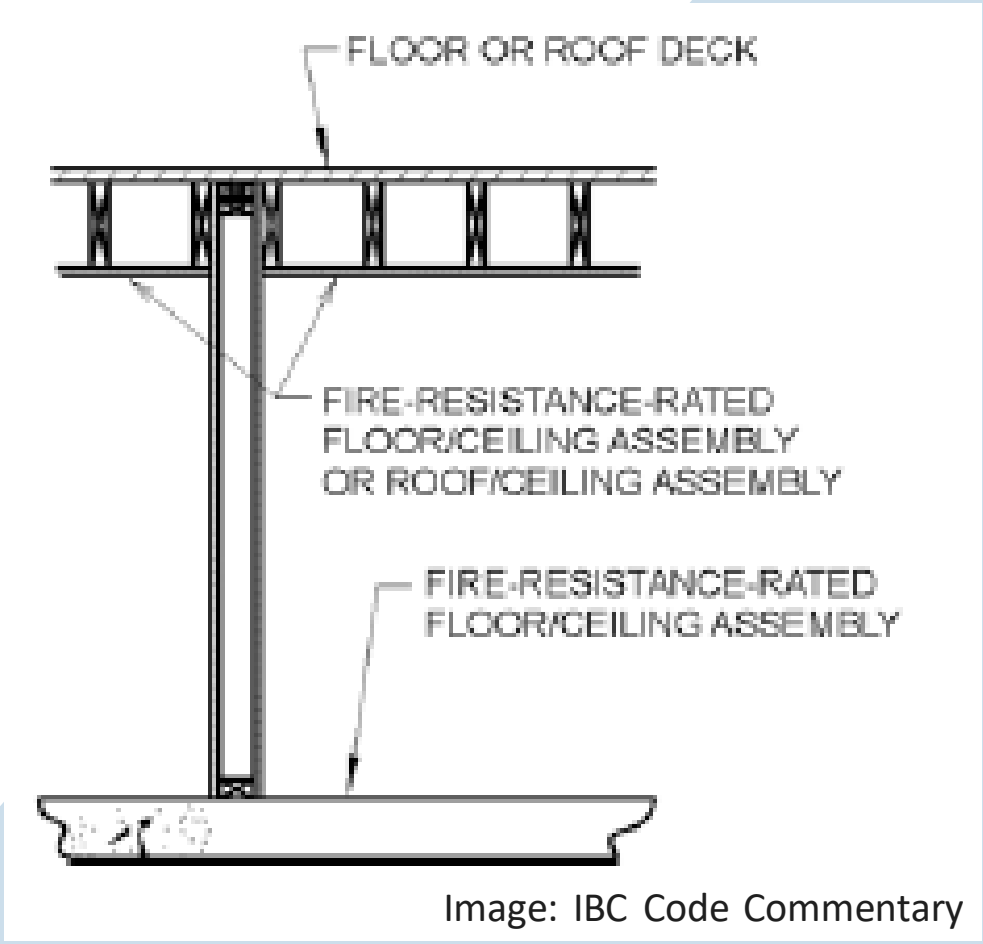


Image: IBC Code Commentary

Fire Barriers

IBC 707

Common detailing method: fire barrier & membrane extend to underside of floor deck above

Fire Barriers

IBC 707

Where else we see fire barriers:

- Shaft enclosures
- Interior exit stairways
- Exit access airway enclosures
- Exist passageways
- Incidental uses
- Compartmentalized fire areas
- Horizontal exits
- Atrium separations
- Hazardous material control areas

Photo: Alex Schreyer

Horizontal Assemblies

IBC 711

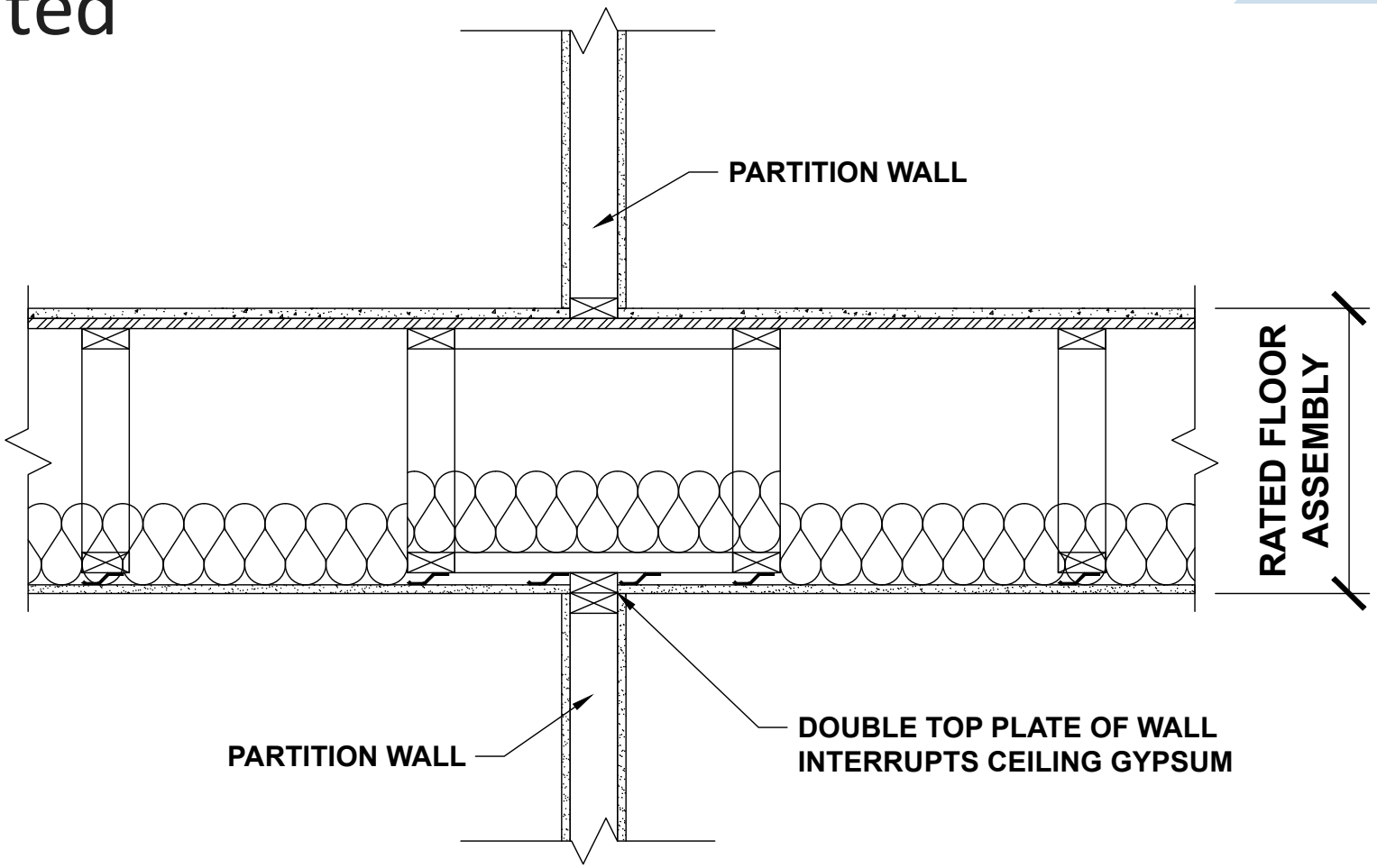
What is a horizontal assembly?

- A floor or roof assembly required to have a fire resistance rating such as for occupancy separations and fire area separations
- May be constructed with any materials permitted by the construction type
- Occupancy separation: Fire resistance ratings per IBC Table 508.4
- Required to be continuous without vertical openings except as permitted in IBC 712
- Supporting construction required to have same fire-resistance rating as the fire barrier being supported (with exceptions per 711.4)
- Other requirements for openings, penetrations, joints

Horizontal Assemblies

IBC 711

Can a wall interrupt the ceiling gypsum of a rated horizontal assembly?



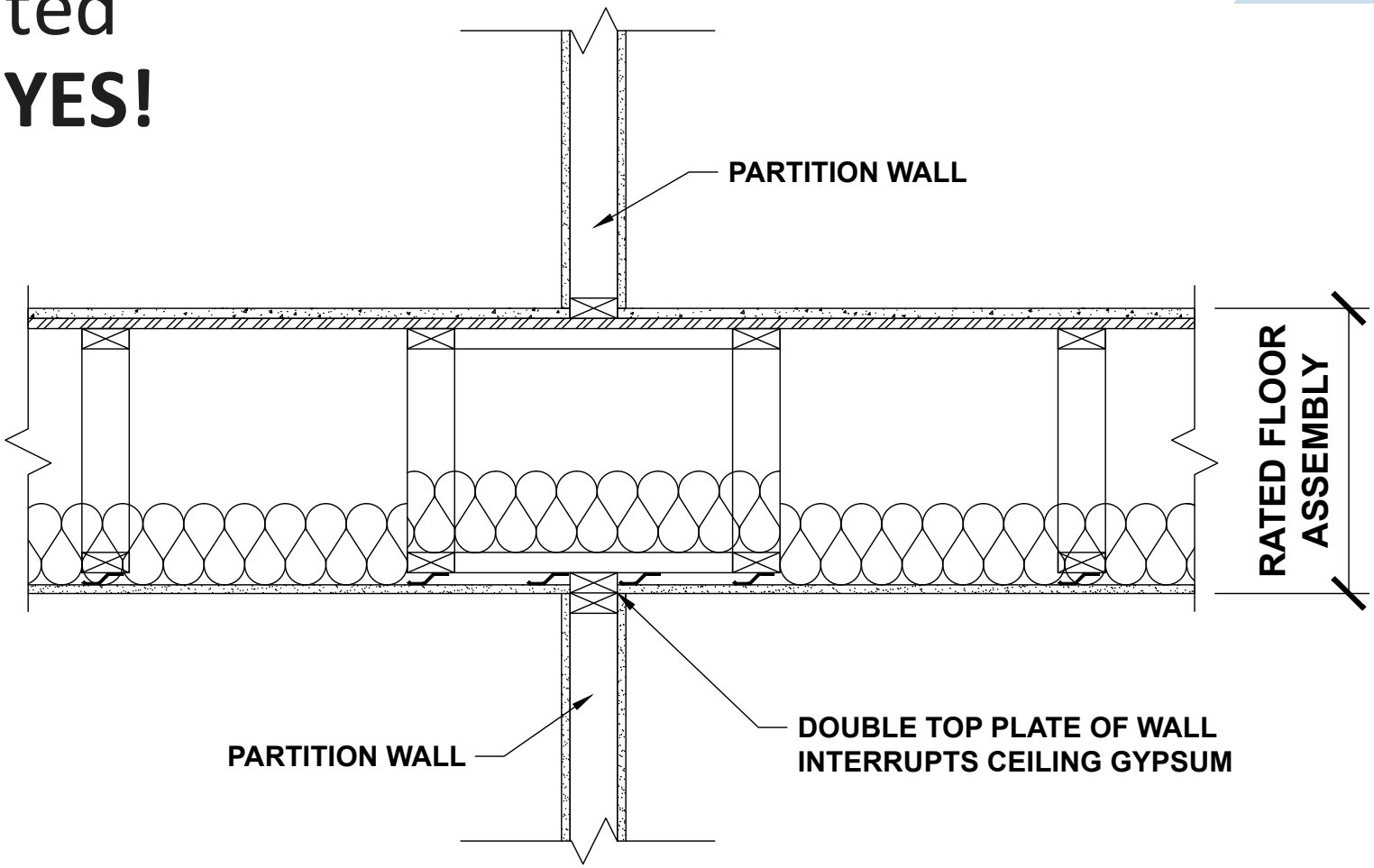
INTERIOR WALL TO FLOOR INTERSECTION

Horizontal Assemblies

IBC 711

Can a wall interrupt the ceiling gypsum of a rated horizontal assembly? **YES!**

- 712.1.4 references 714 for penetrations
- IBC 2012 714.4.1.2, Except. 7: Permitted if wall is rated to match horizontal assembly
- IBC 2015 714.4.2, Except. 7: Permitted if wall is covered with type X gypsum each side



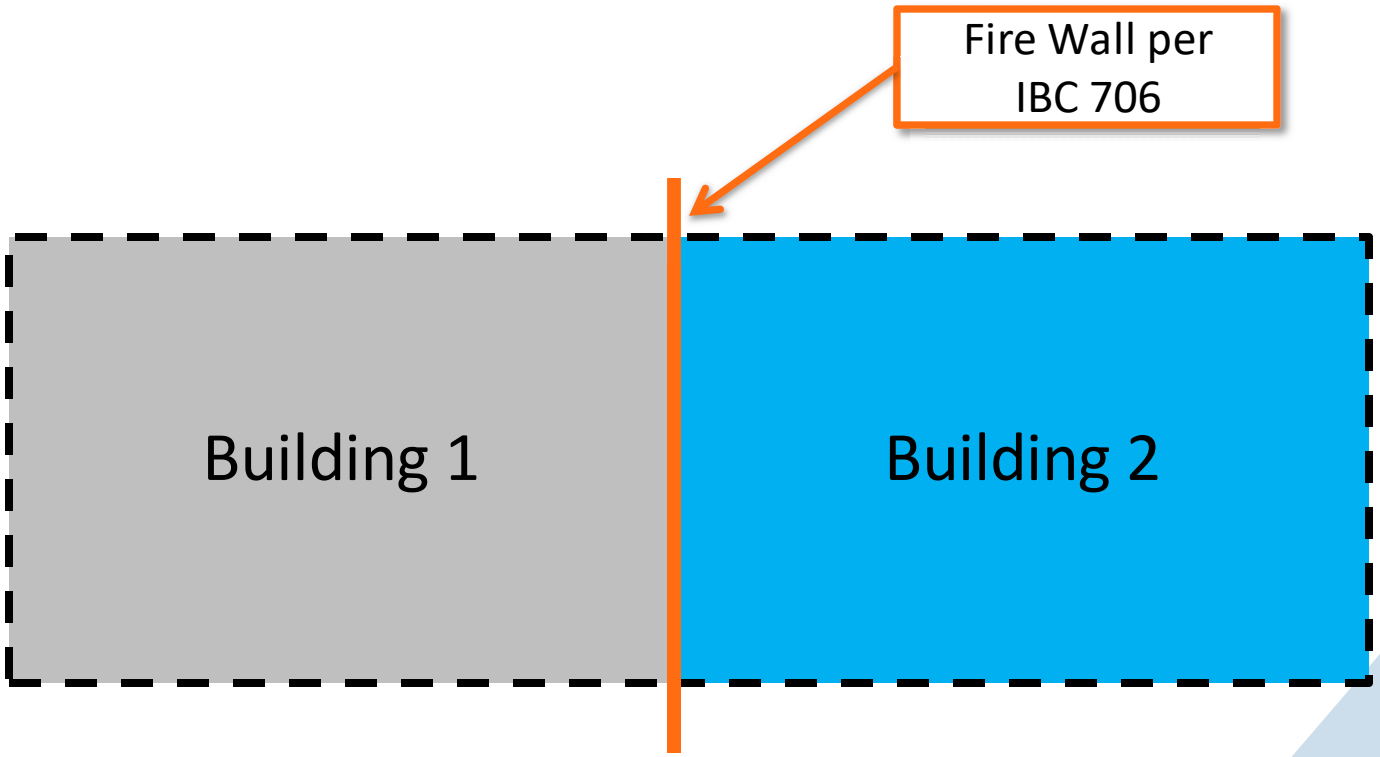
INTERIOR WALL TO FLOOR INTERSECTION

Fire Walls

IBC 706

Separate buildings with fire walls

» Each portion of a building separated by one or more fire walls shall be considered to be a separate building



Fire Walls

IBC 706

- Materials: noncombustible except type V
- Hourly ratings per table 706.4
- Protected openings
- Continuous from foundation to/through roof
- Structural stability
- If fire wall is separating 2 occupancies, use most restrictive fire rating from table:

TABLE 706.4
FIRE WALL FIRE-RESISTANCE RATINGS

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3[a]
F-1, H-3[b], H-5, M, S-1	3
H-1, H-2	4[b]
F-2, S-2, R-3, R-4	2

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.

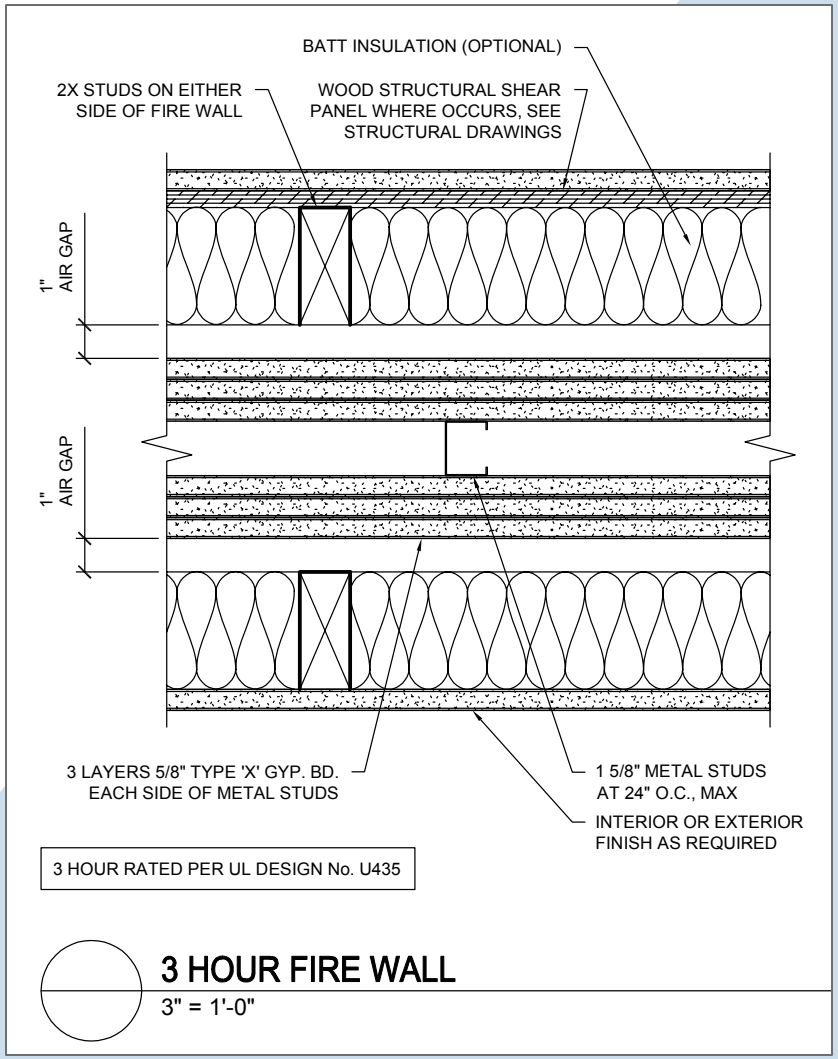
b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.6 and 415.7.

Fire Walls

IBC 706

Structural Stability

- Fire walls are required to be constructed such that in the event of a fire, the floor/roof construction on either side of the wall could collapse without causing the wall and floor/roof construction on the opposite side of the wall to collapse.
- Common options include cantilever walls, laterally tied walls and double walls

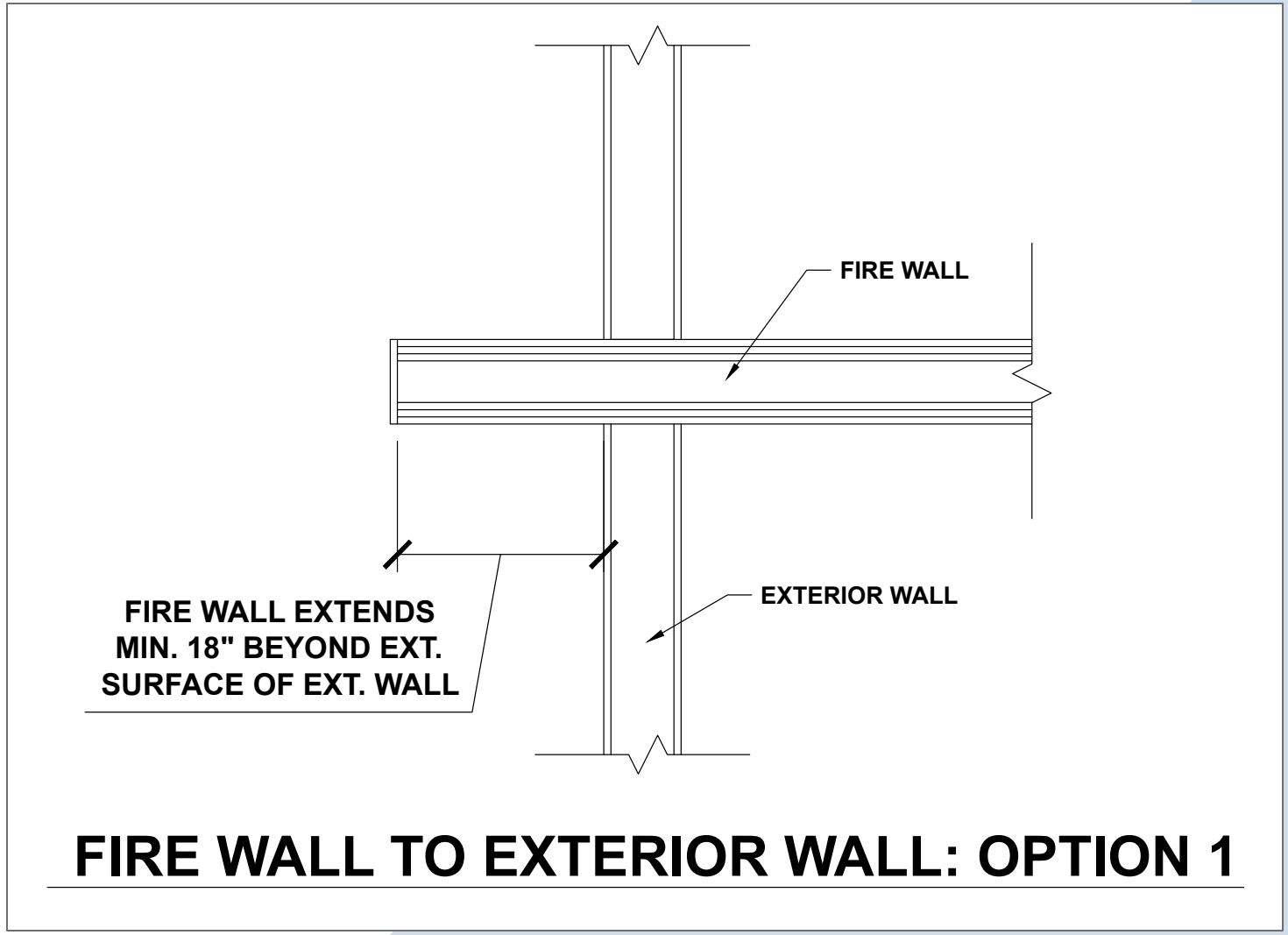


Fire Walls

IBC 706

Horizontal Continuity

- Fire walls are required to be continuous from exterior wall to exterior wall



Fire Walls

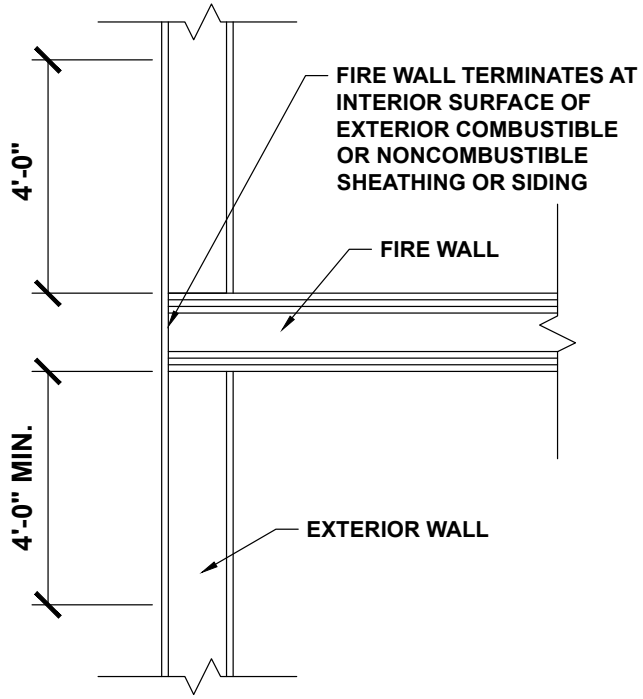
IBC 706

Horizontal Continuity

- Fire walls are required to be continuous from exterior wall to exterior wall

ALTERNATIVES:

1. **EXTERIOR WALL RATED FOR 1 HR MIN. 4FT EACH SIDE (OPENING PROTECTION REQ'D)**
2. **NONCOMBUSTIBLE SHEATHING/SIDING EXTENDS MIN. 4FT EACH SIDE**
3. **BUILDING ON EACH SIDE OF THE FIRE WALL IS EQUIPPED THROUGHOUT WITH AN NFPA OR NFPA 13 SPRINKLER SYSTEM**



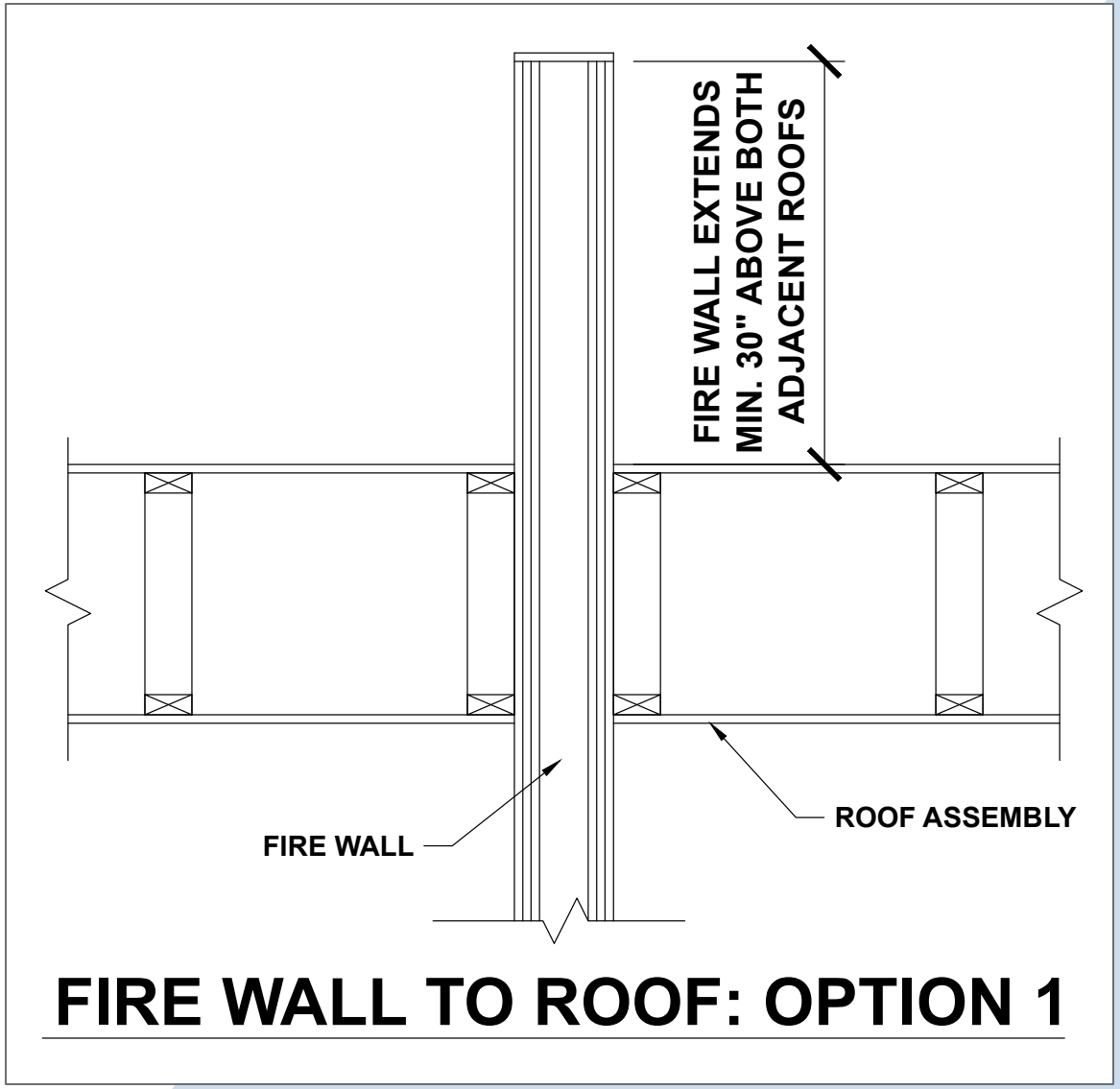
FIRE WALL TO EXTERIOR WALL: OPTION 2

Fire Walls

IBC 706

Vertical Continuity

- Fire walls are required to be continuous from foundation to roof



Fire Walls

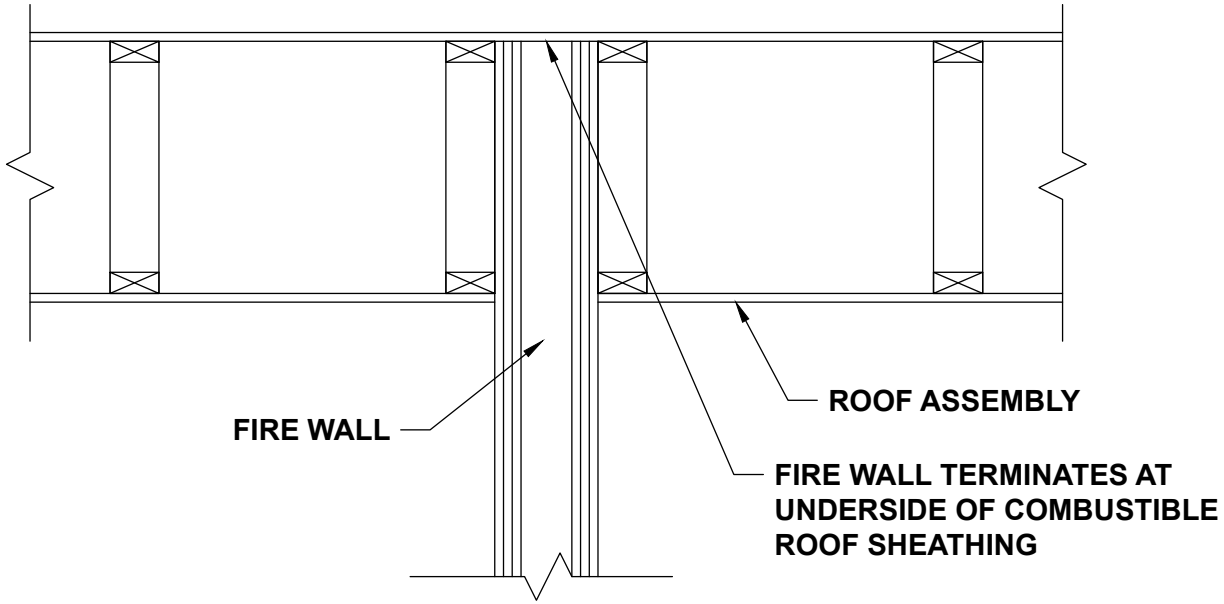
IBC 706

Vertical Continuity

- Fire walls are required to be continuous from foundation to roof

IN CONSTRUCTION TYPES III, IV OR V

- **NO OPENINGS IN ROOF WITHIN 4FT OF FIRE WALL**
- **MIN. CLASS B ROOF COVERING**
- **ROOF SHEATHING/DECK MIN. 4FT EACH SIDE OF WALL IS FRT OR UNDERSIDE OF SHEATHING IS COVERED WITH $\frac{5}{8}$" TYPE X GYPSUM**



FIRE WALL TO ROOF: OPTION 2

Fire Walls

IBC 706

Opportunity for Wood Framed Fire Walls:

- Permitted in type V construction
- Fire Walls in type III and IV construction are required to be constructed of non-combustible materials
- Opportunity for wood frame bearing walls on each side of fire wall to meet structural stability requirements

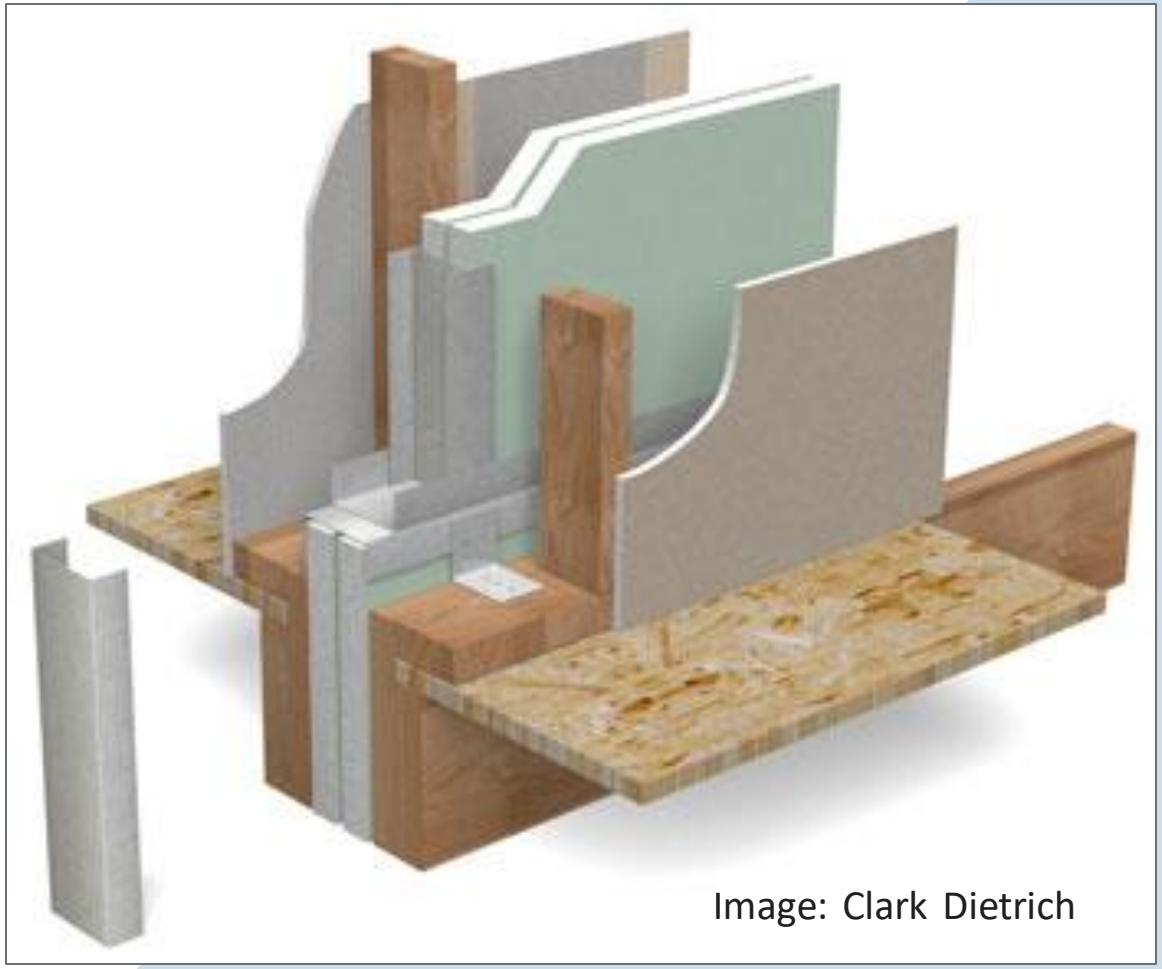
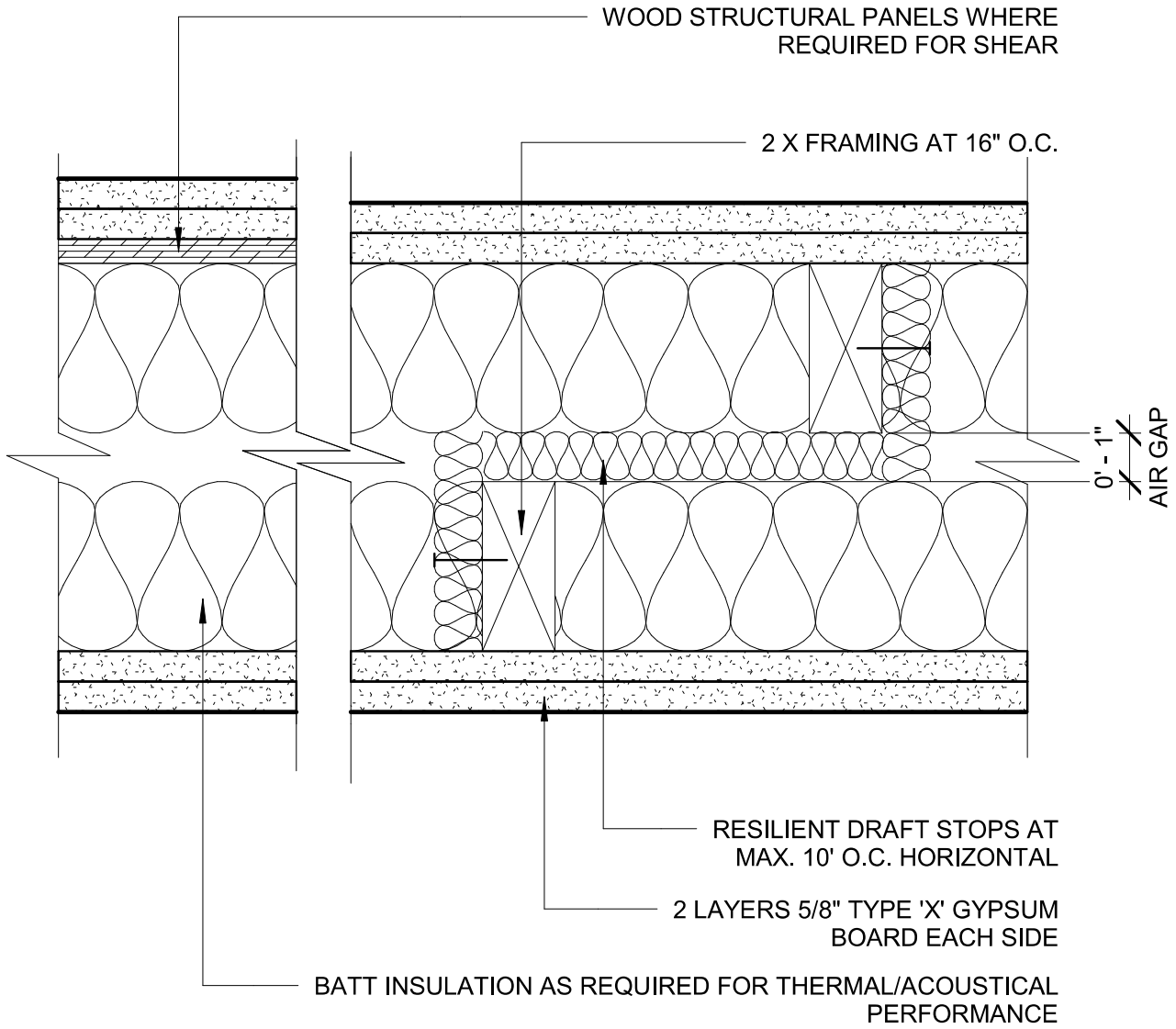


Image: Clark Dietrich

Fire Walls

IBC 706



2-HOUR RATING PER GA FILE NO. WP 3820

2-HOUR DOUBLE STUD WALL

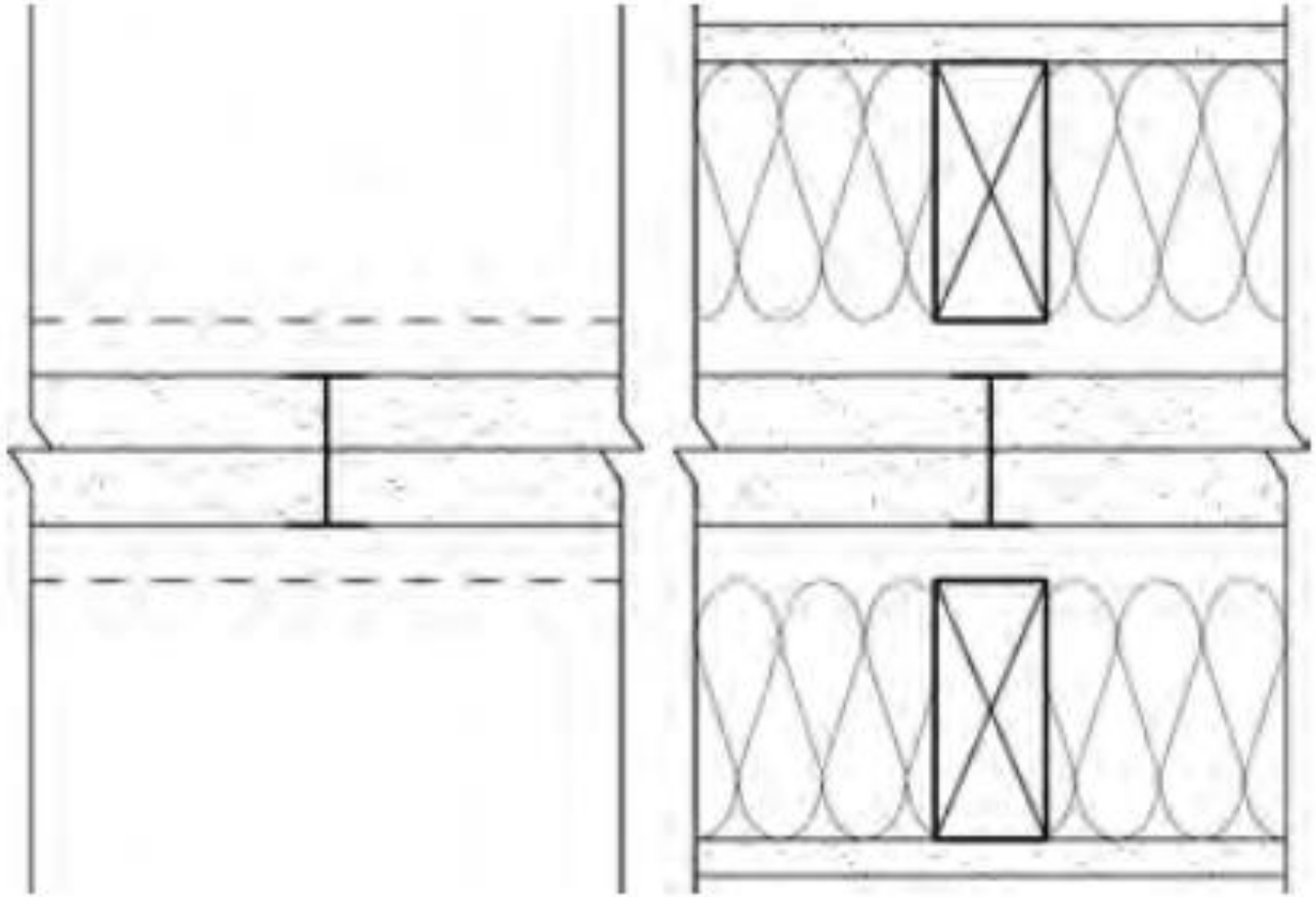
Construction Type: V

Fire Walls

IBC 706

GA FILE NO. ASW 1000

2 HOUR FIRE	60 to 64 STC SOUND

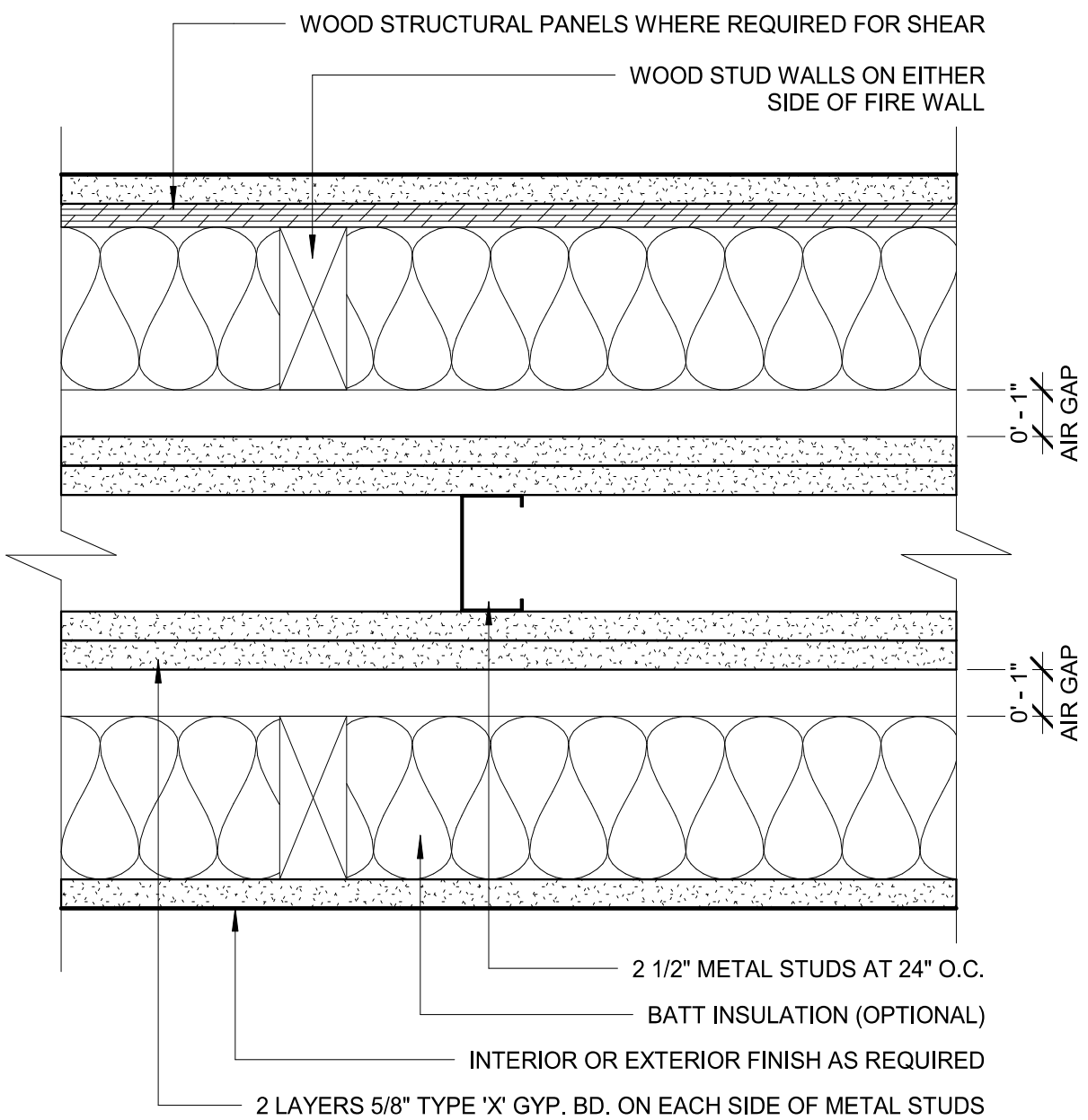


Construction Types: III, IV, or V

Also see: UL U336

Fire Walls

IBC 706



2-HOUR RATING PER GA FILE NO. WP 1548

2-HOUR FIRE WALL ASSEMBLY

Construction Types: III, IV, or V

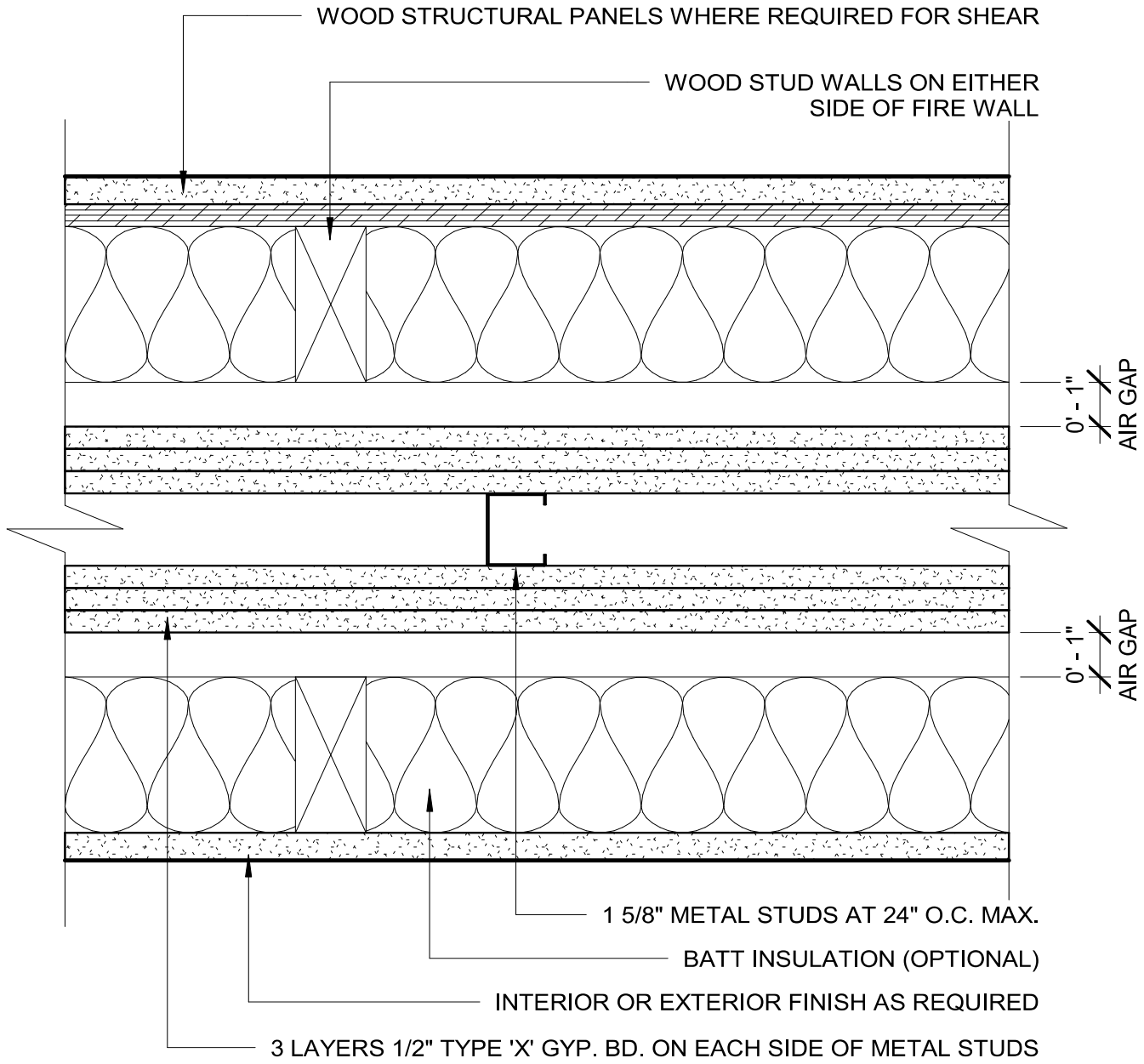
Also see: GA WP 1548, UL U411

CAD & Revit Details:

www.woodworks.org

Fire Walls

IBC 706



3 HOURS PER UL DESIGN NO. U435

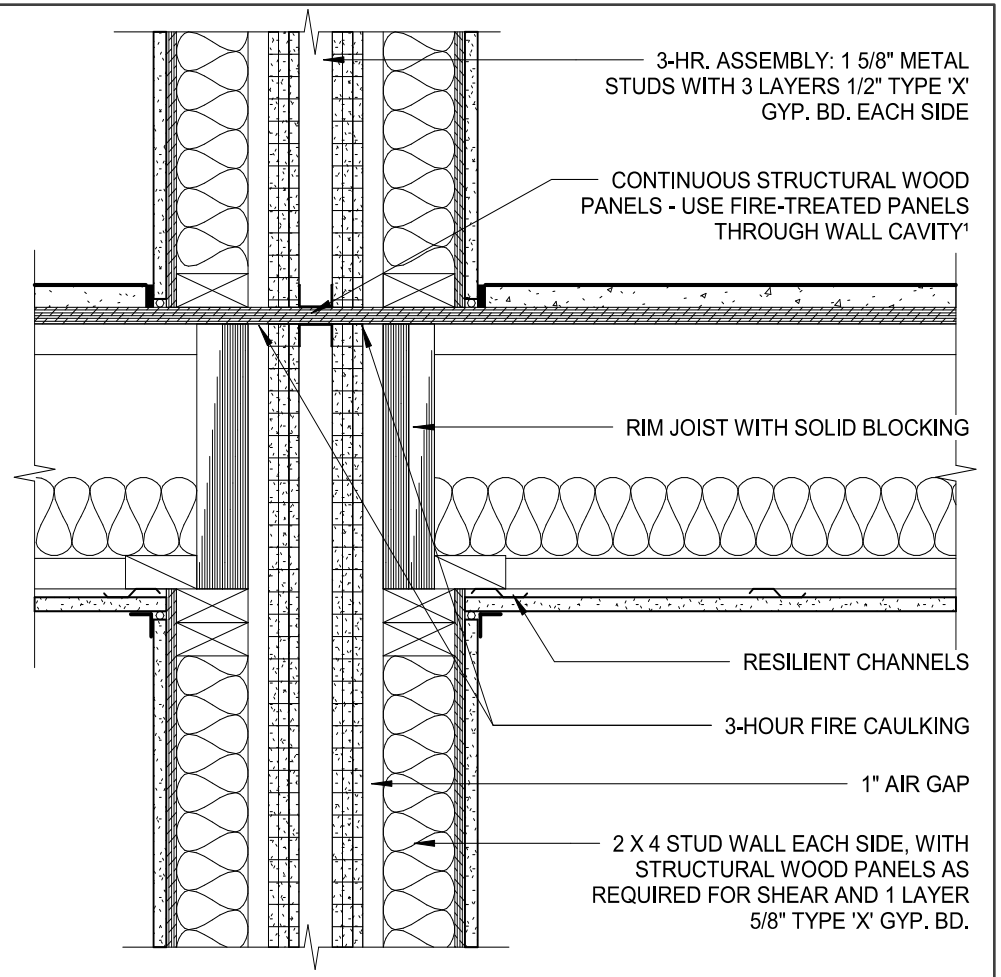
3-HOUR FIRE WALL ASSEMBLY

Construction Types: III, IV, or V

Fire Walls

IBC 706

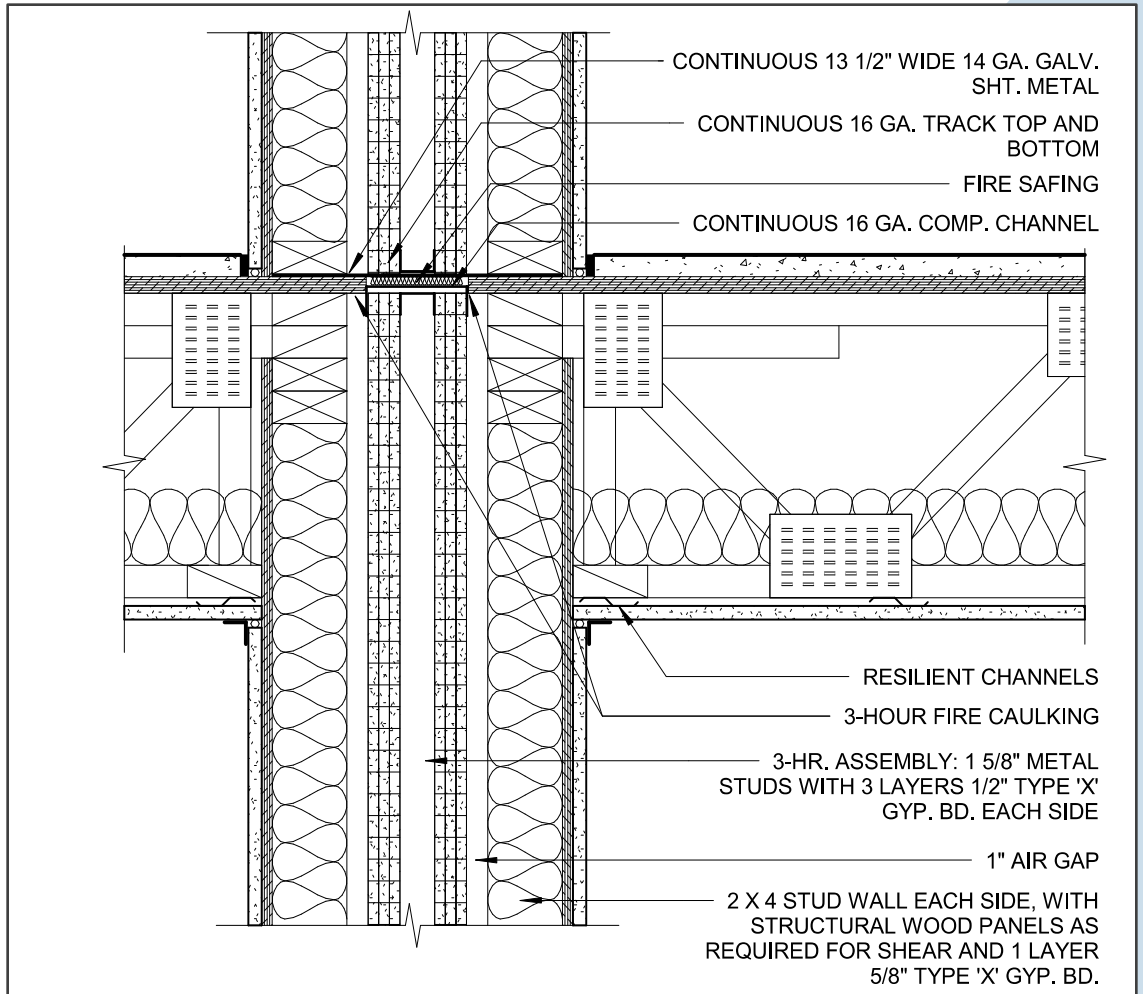
Seismic Diaphragm Continuity



[1]CONSULT LOCAL JURISDICTION HAVING AUTHORITY FOR ACCEPTANCE OF FIRE-TREATED WOOD PANELS RUNNING THROUGH 3-HOUR ASSEMBLY IN THIS APPLICATION.

3-HOUR FIRE WALL AT FLOOR/CEILING

I-JOIST FRAMING WITH WOOD PANEL DIAPHRAGM RUNNING THROUGH FIRE WALL



3-HOUR FIRE WALL AT FLOOR/CEILING

WOOD TRUSS FRAMING WITHOUT WOOD PANEL DIAPHRAGM RUNNING THROUGH FIRE WALL

Fire Walls

IBC 706

Seismic Diaphragm Continuity

SEAoSC LIGHT-FRAMING CONSTRUCTION COMMITTEE
STRUCTURAL ENGINEERS ASSOCIATION OF SOUTHERN CALIFORNIA
SEISMOLOGY OPINION

SEAOSC

DATE: **March 21, 2008**

Continuity of Plywood Diaphragm Sheathing in 2 hr and 3hr Fire Walls:

Opinion: The continuity of plywood diaphragm sheathing should be maintained across the air gap commonly encountered in double stud Firewalls of 2 or 3 hour construction. The intent is to ensure that structural continuity is not significantly reduced in the roof and floor diaphragms.

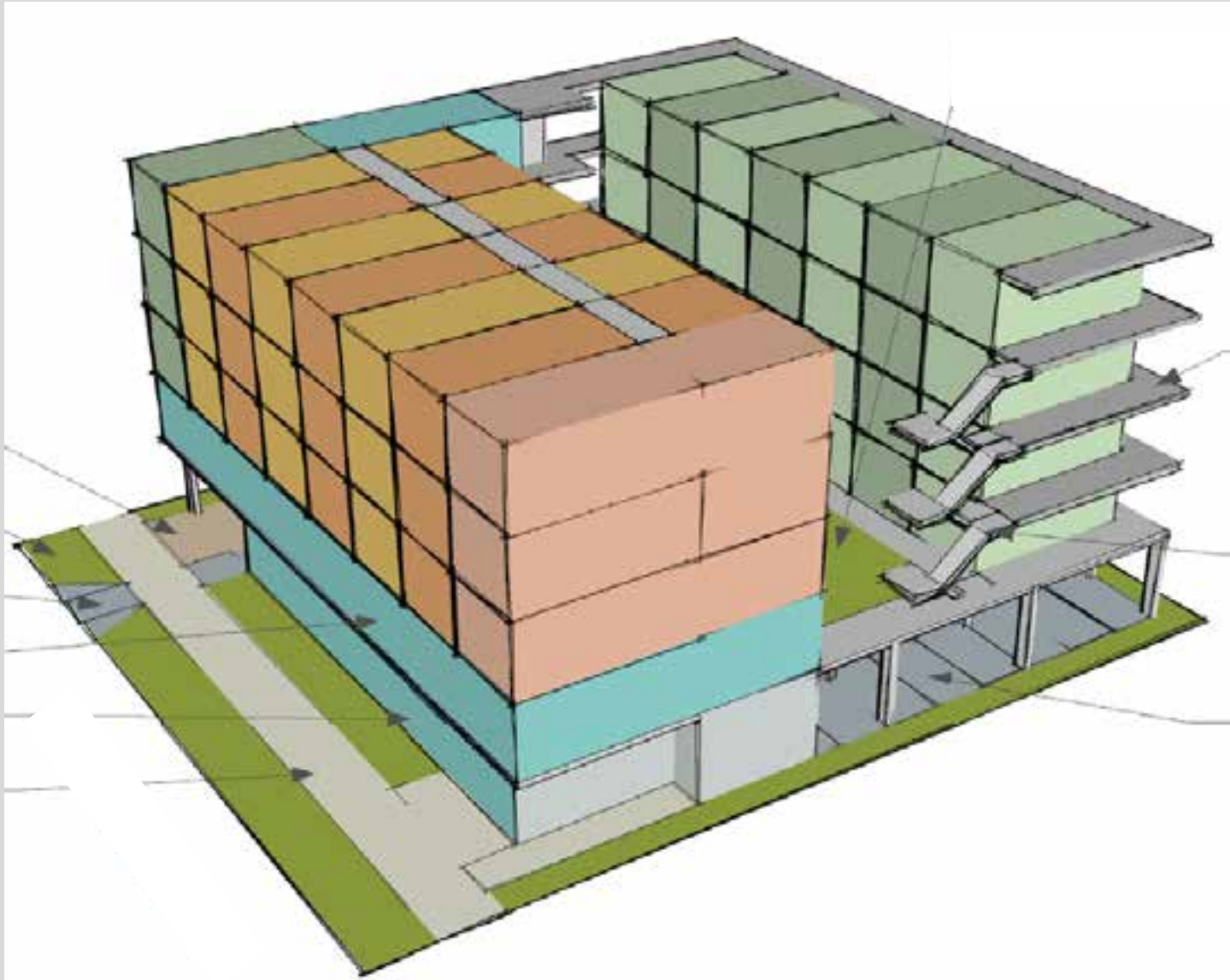
Commentary:

This opinion is prepared to address the issue of diaphragm continuity as it relates to recent changes in 2007 CBC and 2006 IBC model code. Specifically the outgoing UBC provisions for Area-Separation walls have more or less been replaced by the Fire wall provisions of the IBC. Such walls are encountered in light-frame multifamily or mixed-use construction and are often constructed as a double studwall when occurring at partywall locations. The double stud walls are typically separated by an airspace of a one to four inches.

The IBC has introduced language [IBC 705.4] that states fire walls must have "sufficient structural stability" under fire conditions to allow collapse of either side. Previous commentary to the UBC topic of Area Separation

Building Configuration Options

There are multiple ways to classify a building. Challenge tradition and consider all options to achieve the most cost-effective solution



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

Building Configuration Options


Image: Stratos

Example:

» 5 story building
» 1st floor: parking
» 2nd-5th floors residential

Options:

» 4-story, type VA over 1 story type IA (podium provision – IBC 510.2)
» 4-story, type VA over 1 story type IV (open) or type I (IBC 510.4) no ”podium” req’d
» 5 stories of type III (enclosed parking only) sep. or nonsep. occupancies

Building Configuration Options


Image: Mahlum

Example:

» 7 story building (6 above grade)
» Basement: parking
» 1st-6th floors: residential

Options:

» 5-story, type III over 1 story type IA (podium provision – IBC 510.2)
» 4-story, type VA over 2 story podium (podium provision 2015 IBC 510.2)
» 6-story type IIIA (IBC 510.5 – requires 3000 ft^2 max areas & other limitations)

Building Configuration Options

Example:

- 4 story building
- 1st floor: parking
- 2nd-4th floors residential

Options:

- 3-story, type VB over 1 story type IA (podium provision – IBC 510.2)
- 3-story, type VB over 1 story type IV (open) or type I (IBC 510.4) no ”podium” req’d
- 4 stories of type VA (enclosed parking only) sep. or nonsep. occupancies

Building Configuration Options

Example:

- 5 story hotel
- 1st floor:
  - lobby
  - restaurant
  - fitness center
  - conference rooms
  - residential
- 2nd-5th floors residential

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

Building Configuration Options

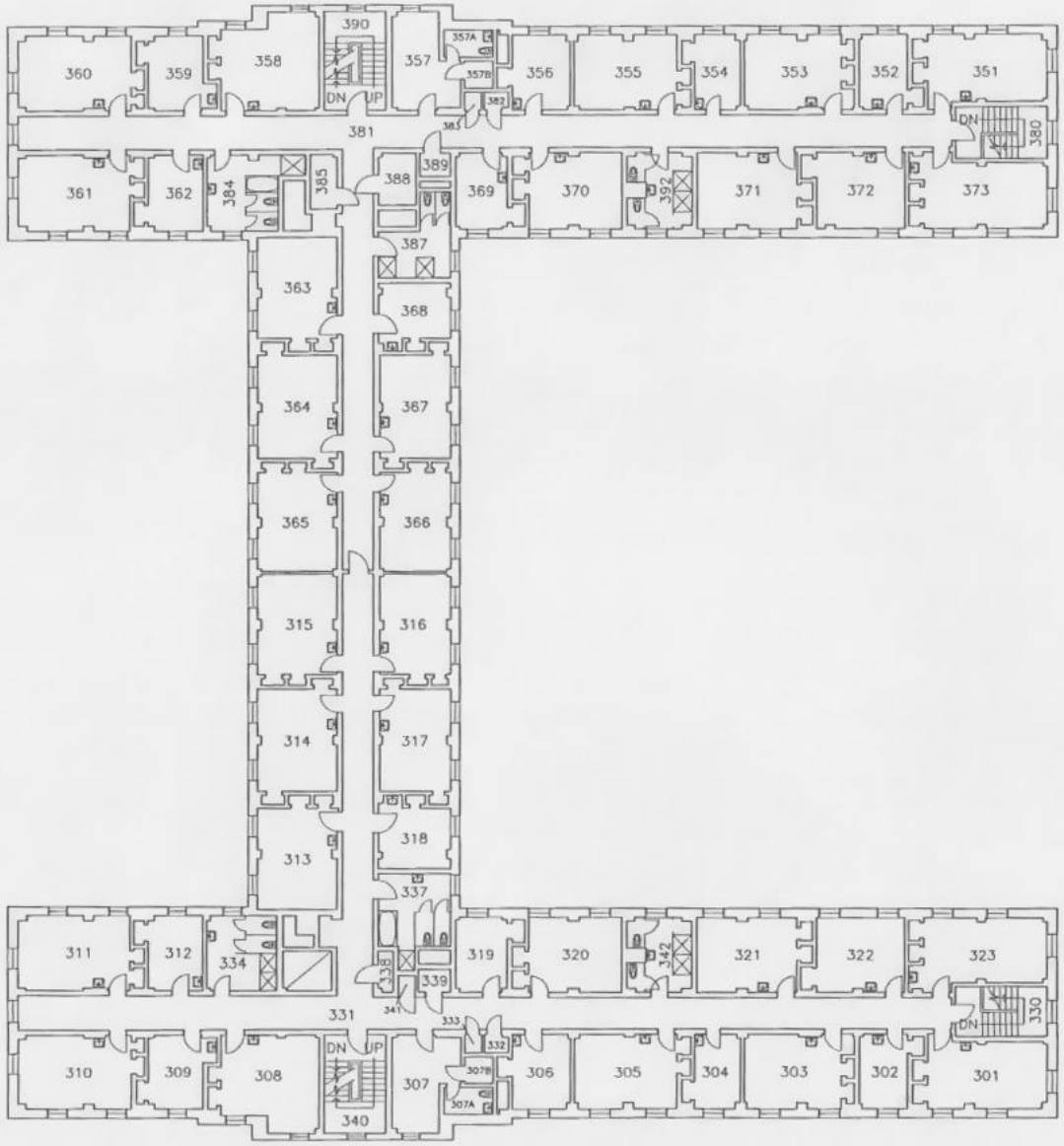
Example:

- 5 story hotel
- 1st floor:
  - lobby
  - restaurant
  - fitness center
  - conference rooms
  - residential
- 2nd-5th floors residential

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

Building Configuration Options

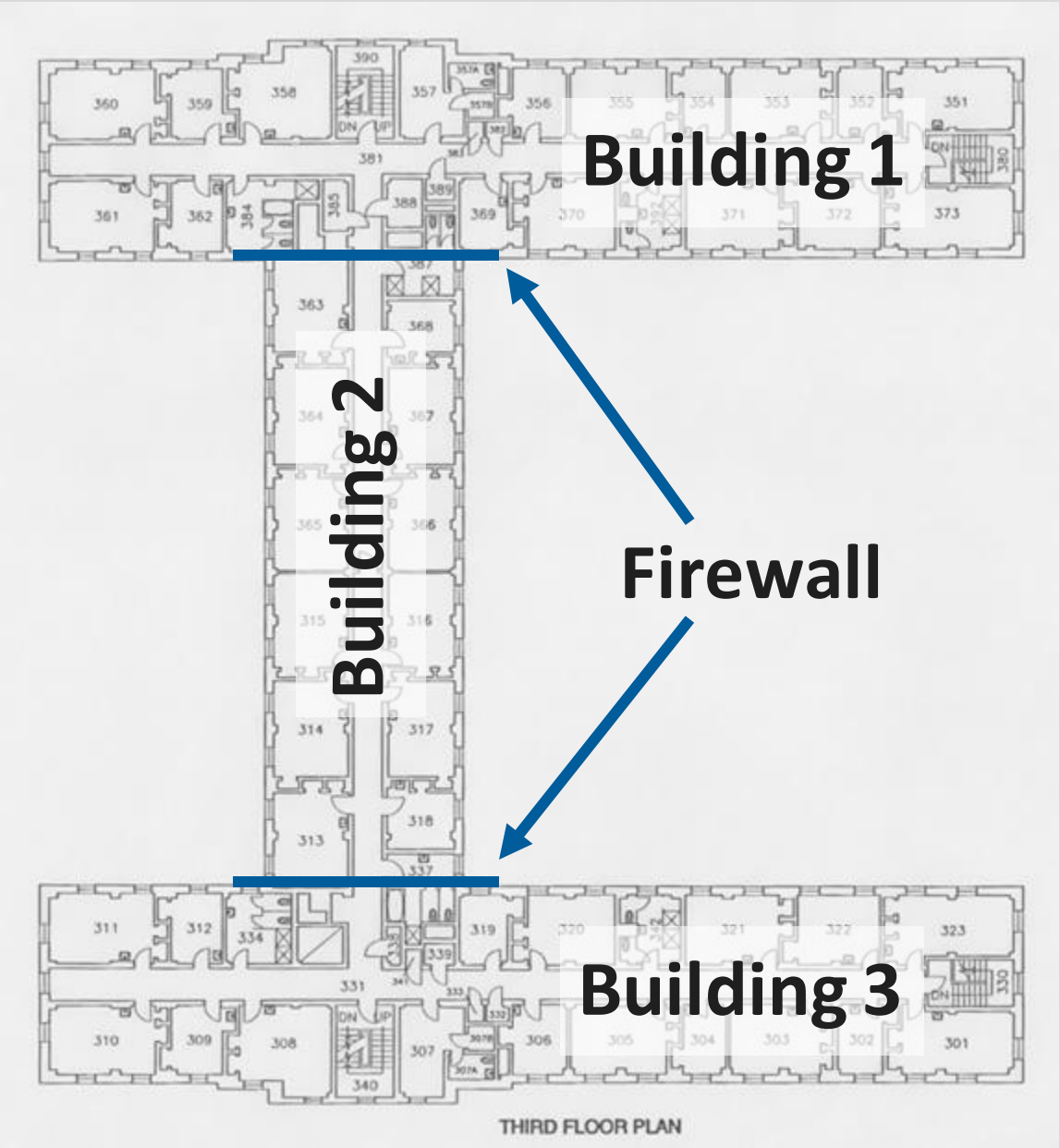


THIRD FLOOR PLAN

Example:

T- and L-shaped buildings:
common in hotels,
often with large floor areas

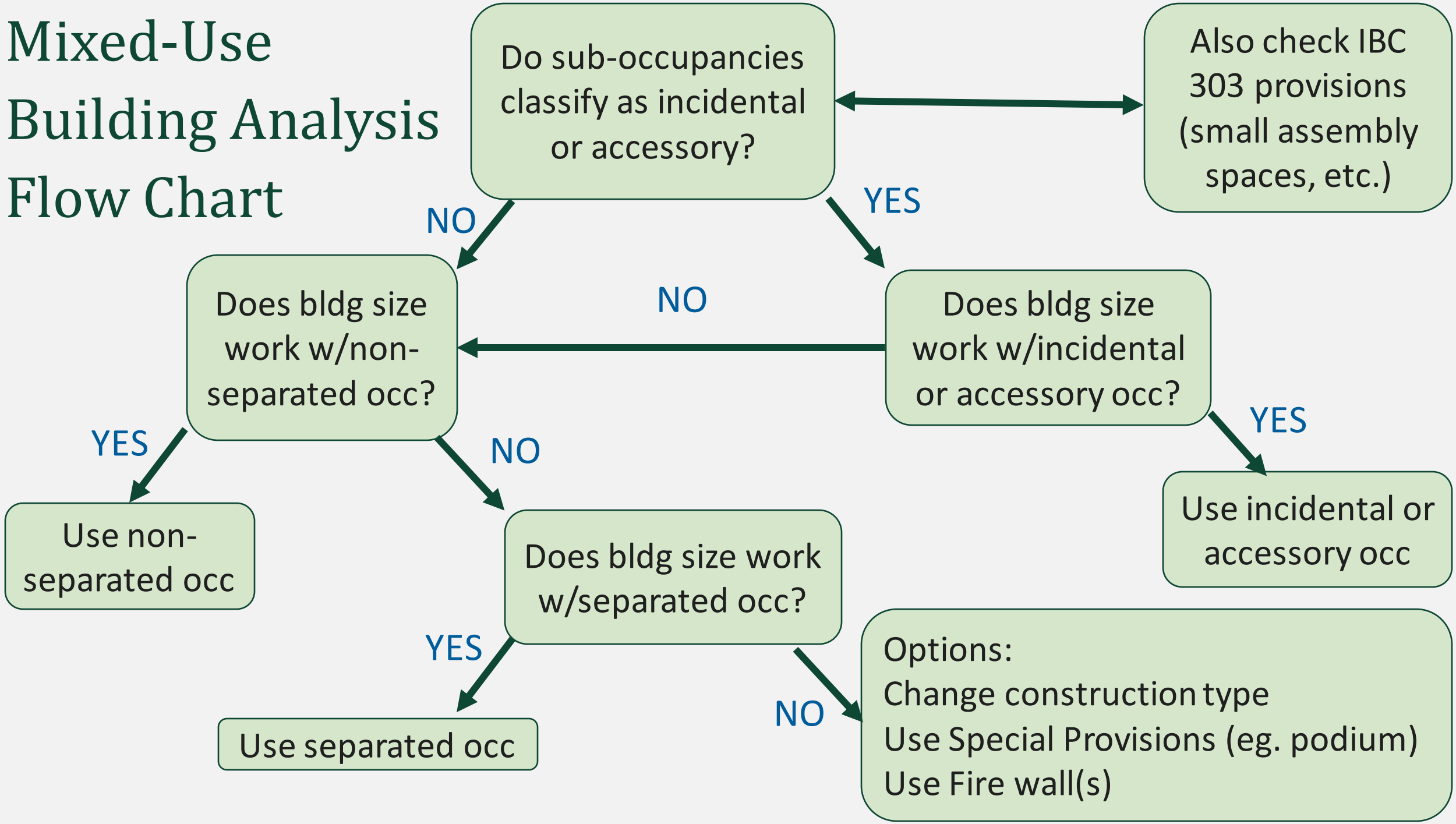
Building Configuration Options



These building configurations may lend themselves well to use of firewalls at building intersections.

Minimize length/impact of firewall while maximizing allowable building area may allow lower construction type (i.e. type IIIB instead of IIIA)

Mixed-Use Building Analysis Flow Chart



QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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