AIA25

Commercial Joining: Installation Efficiency and Performance

CJIEP24B

June 5th, 4-5pm

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AIA25 Conference on Architecture & Design

Keep space clear for closed captioning

AIA25 Conference on Architecture & Design

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AIA25 Conference on Architecture & Design

Course / Learning Objectives

- Describe the **historic evolution of connecting windows** in buildings and how **joining systems today** are improved, including improvements related to the health, safety, and wellbeing of laborers, craftspeople, and occupants
- Name **important performance considerations** for joined combinations in buildings, including performance considerations related to the health, safety and wellbeing of occupants
- Compare **options for getting the job done,** including implications for the safety and wellbeing of laborers and craftspeople
- Identify the **best type of joined combination solution for a given commercial project scenario**

Introductions

Presenter

Kelly Ryan

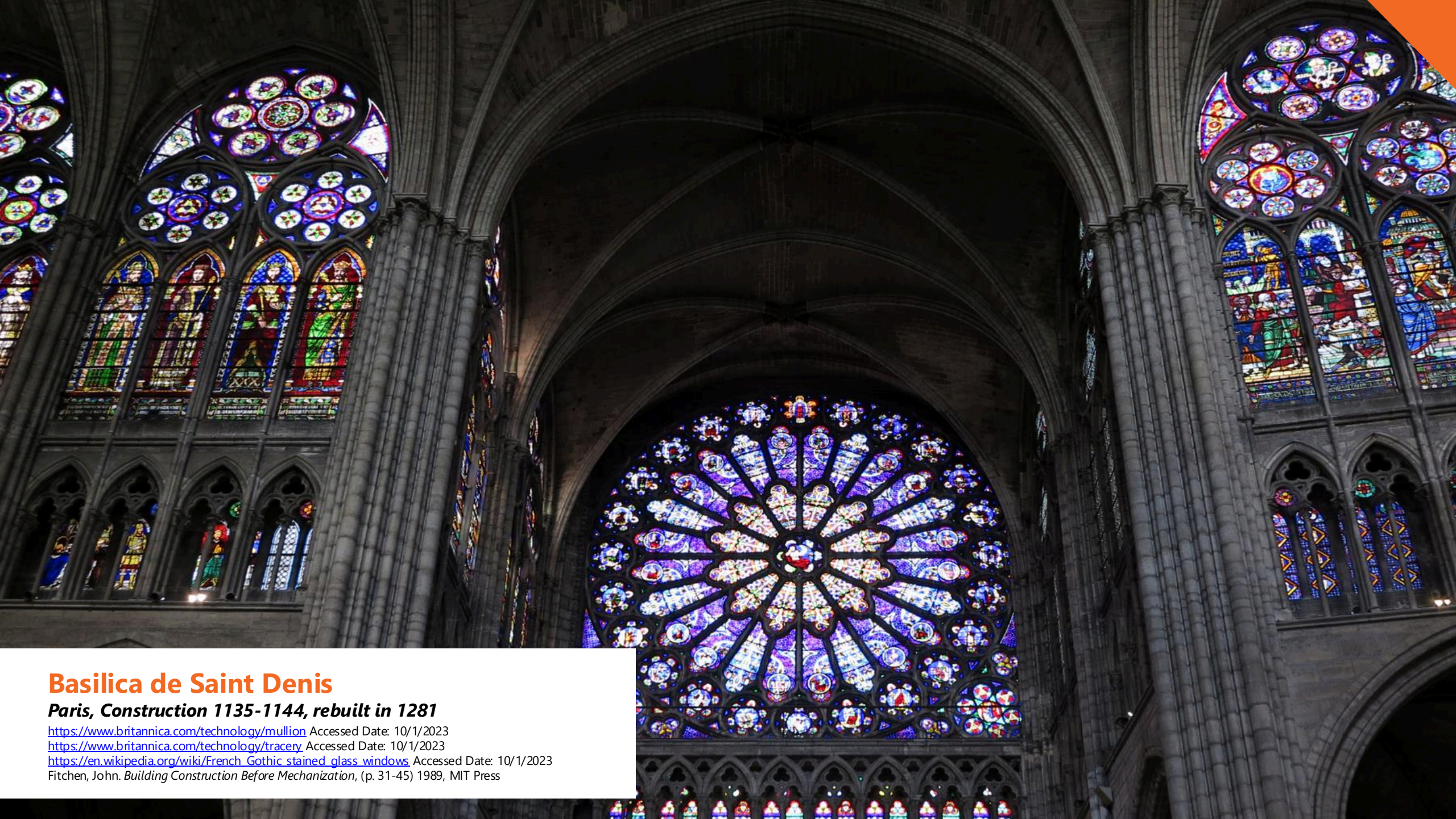
Architectural Consultant

Kelly has worked in the building materials industry for 10 years, and with the Architect & Design community for over 5 years. She started with Andersen 3 years ago and is currently based in Cincinnati, OH. She loves seeing the creative process of design come to life and being a partner along the way!

ANDERSEN® WINDOWS & DOORS

Section 1

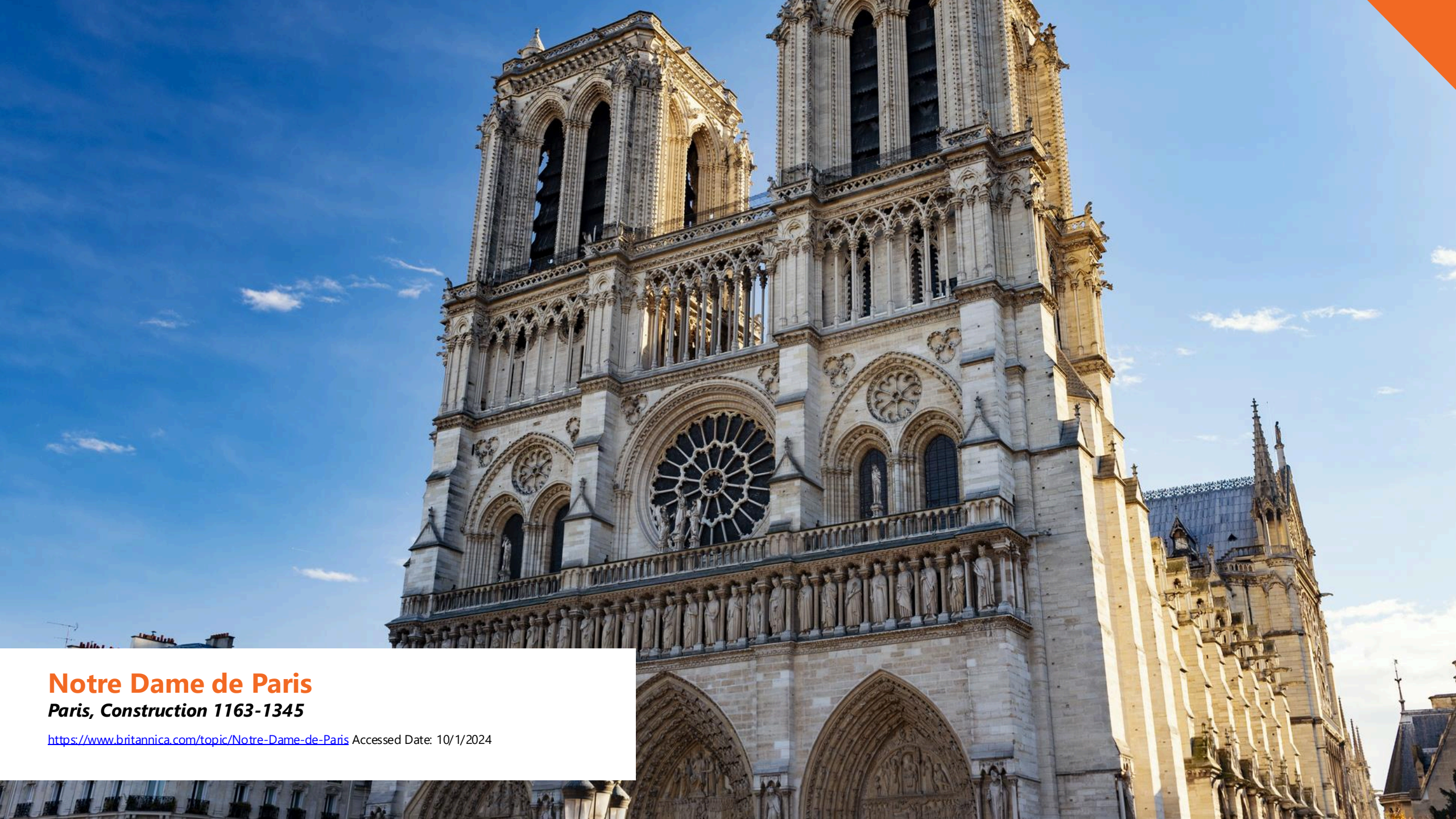
The Evolution of Connecting Windows



Basilica de Saint Denis

Paris, Construction 1135-1144, rebuilt in 1281

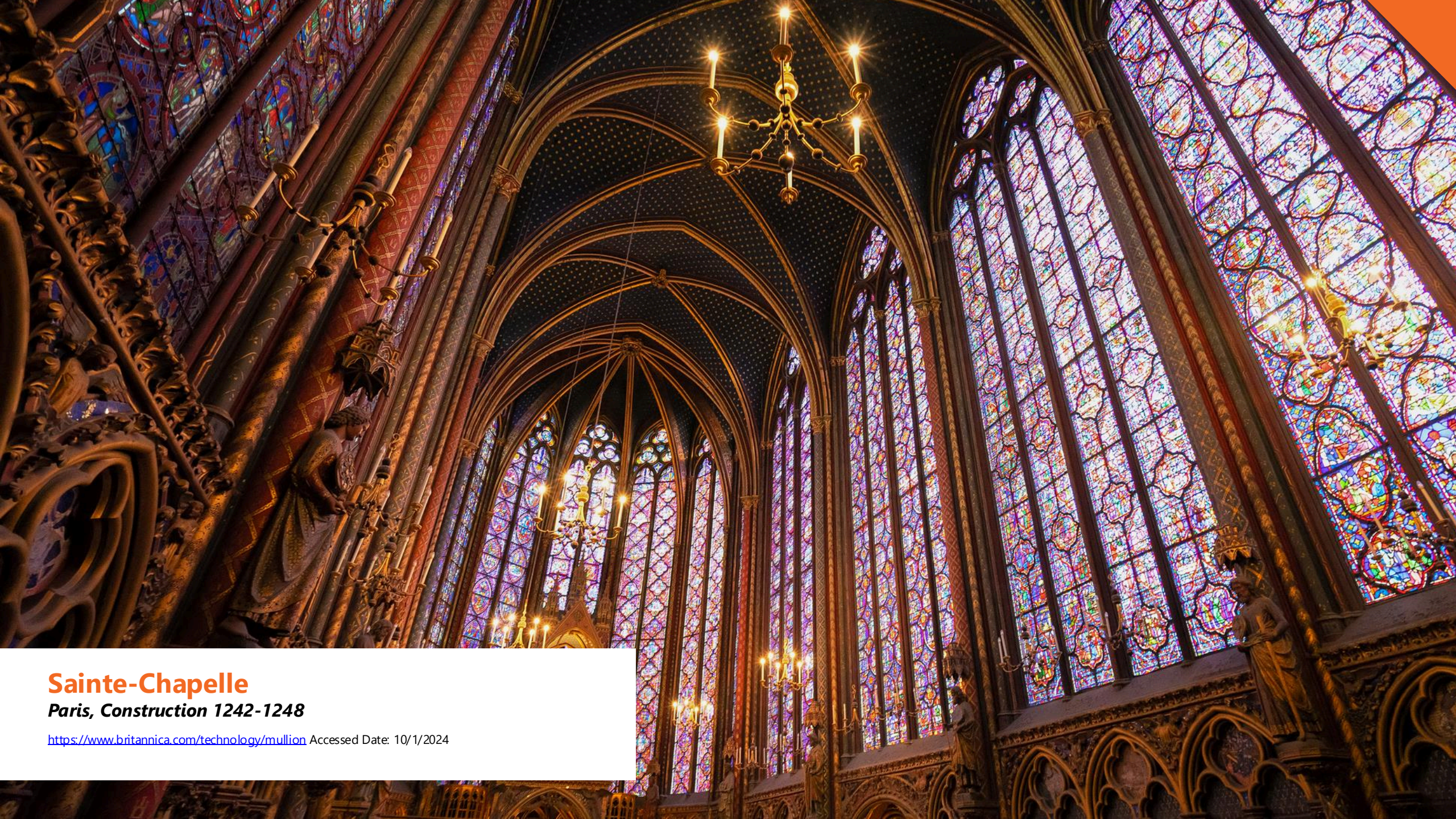
https://www.britannica.com/technology/mullion Accessed Date: 10/1/2023
https://www.britannica.com/technology/tracery Accessed Date: 10/1/2023
https://en.wikipedia.org/wiki/French_Gothic_stained_glass_windows Accessed Date: 10/1/2023
Fitchen, John. *Building Construction Before Mechanization*, (p. 31-45) 1989, MIT Press



Notre Dame de Paris

Paris, Construction 1163-1345

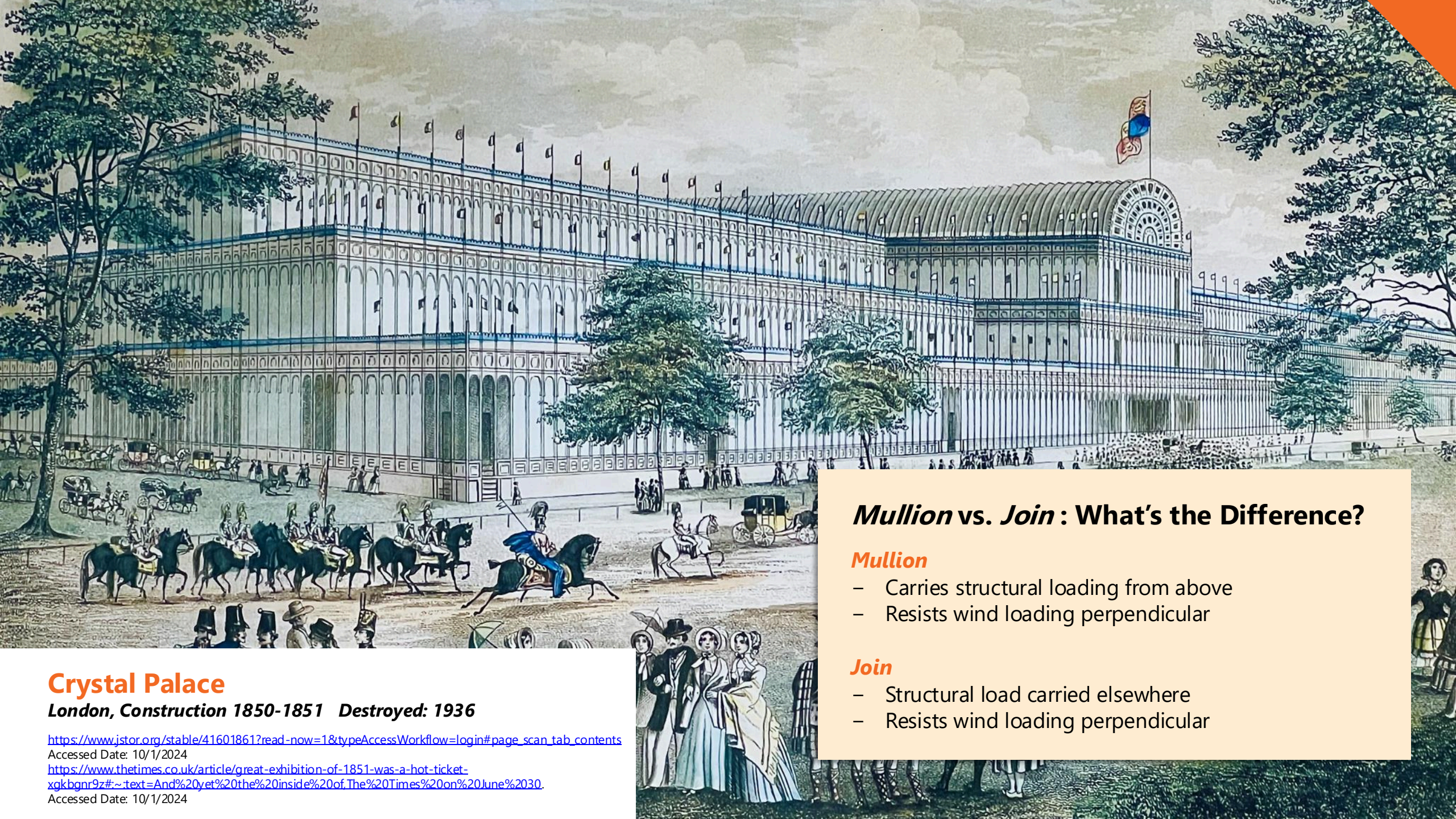
https://www.britannica.com/topic/Notre-Dame-de-Paris Accessed Date: 10/1/2024



Sainte-Chapelle

Paris, Construction 1242-1248

https://www.britannica.com/technology/mullion Accessed Date: 10/1/2024



Crystal Palace

London, Construction 1850-1851 Destroyed: 1936

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Accessed Date: 10/1/2024
https://www.thetimes.co.uk/article/great-exhibition-of-1851-was-a-hot-ticket-xgkbgnr9z#:~:text=And%20yet%20the%20inside%20of,The%20Times%20on%20June%2030.
Accessed Date: 10/1/2024

Mullion vs. *Join* : What's the Difference?

Mullion

- Carries structural loading from above
- Resists wind loading perpendicular

Join

- Structural load carried elsewhere
- Resists wind loading perpendicular

Dessau Bauhaus

Dessau, Construction 1925-1926

https://www.jstor.org/stable/41601861?read-now=1&typeAccessWorkflow=login#page_scan_tab_contents
Accessed Date: 10/1/2024

West End Flats

Media, PA, Construction 2019

Section 2

Performance Considerations for Joined Combinations

Windows and Performance

STRUCTURAL PERFORMANCE (RESISTANCE TO DESIGN WIND LOADS)

RESISTANCE TO WATER PENETRATION

RESISTANCE TO AIR LEAKAGE

RESISTANCE TO FORCED ENTRY

The North American Fenestration Standard/Specification for Windows, Doors and Skylights [NAFS]

- AAMA/WDMA/CSA 101/I.S.2/A440
  - Standard/Specification is applicable for use in testing and rating fenestration products

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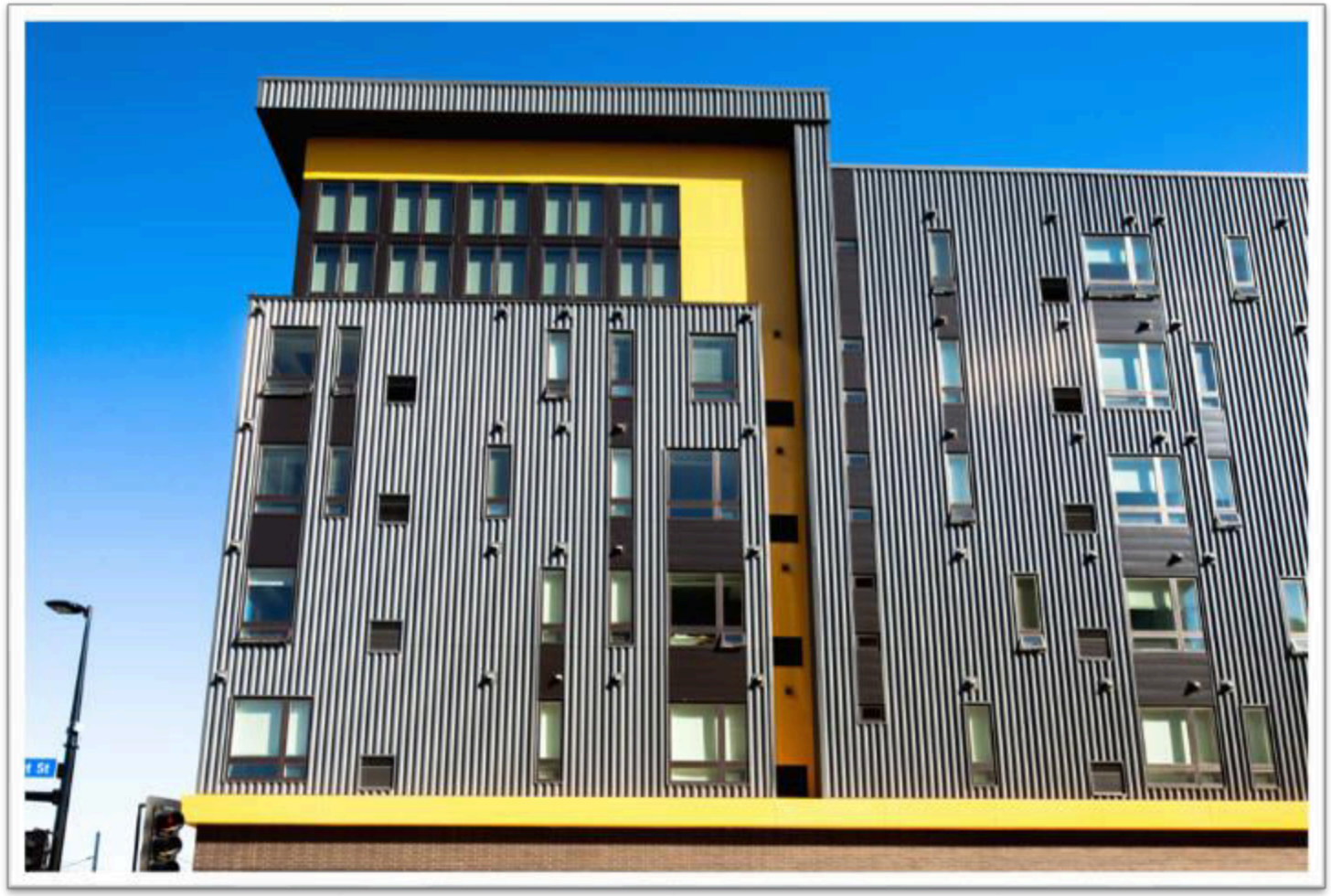
Window Performance

To achieve a numeric Performance Grade (PG) rating:

- Operating force
- Air leakage resistance
- Water penetration resistance
- Uniform load deflection test
- Uniform load structural test
- Forced entry resistance



Design Pressure (DP)

DP rating refers only to the product's capacity to withstand uniform loads caused by:

- Wind, using the uniform load deflection test or
- Snow, using the uniform load structural test (for skylights and roof windows)

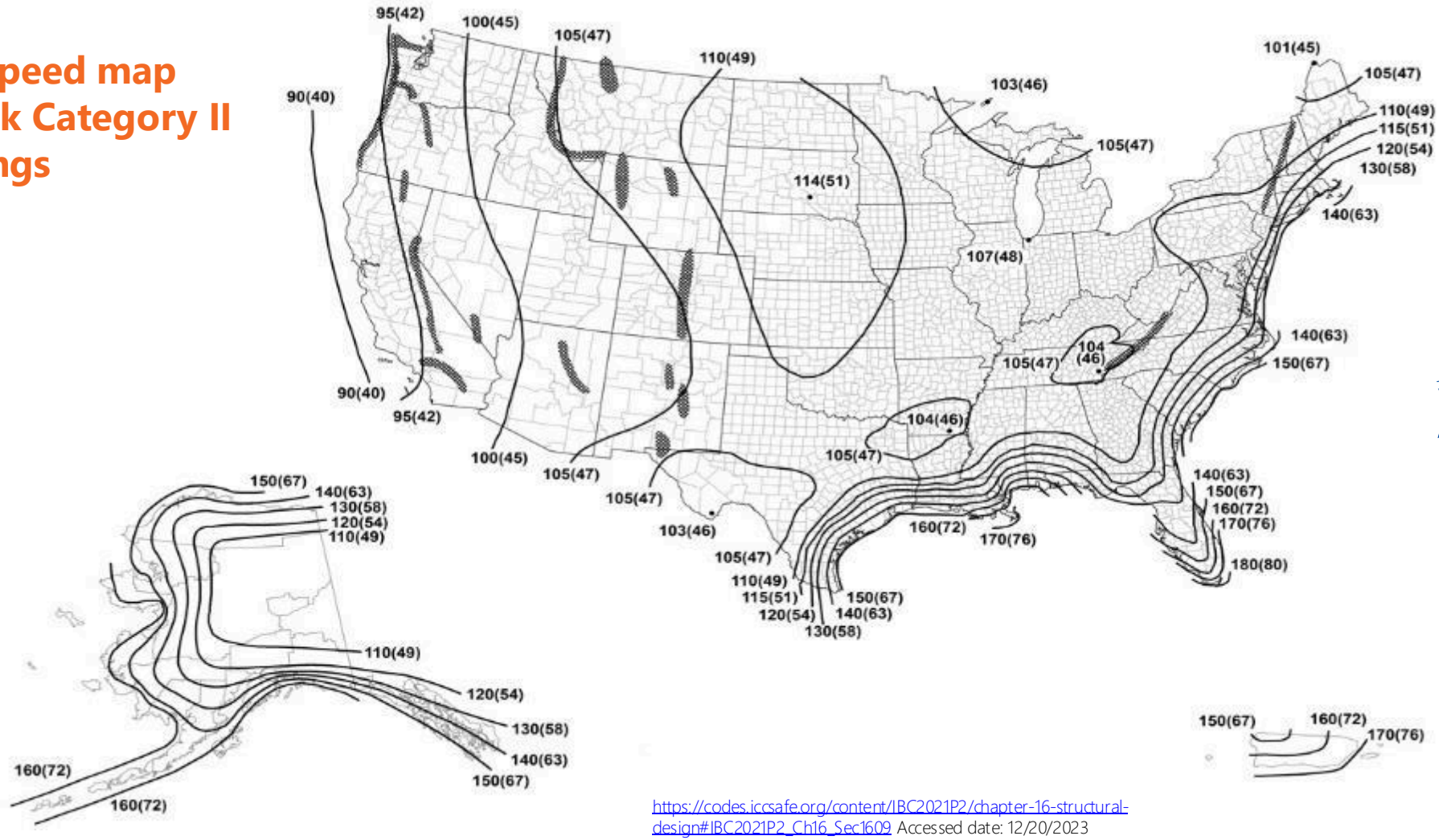
Performance Grade vs. Design Pressure

- For a product to achieve **Performance Grade** rating it must comply with:
  - Structural loading requirement
  - Air infiltration resistance
  - Water penetration resistance
  - Ease of operation
  - Resistance to forced entry

- **Design Pressure** rating describes a product that has only been tested for structural loading (i.e. no other performance tests listed above)

ASCE-7 Design Wind Loads

Windspeed map for Risk Category II buildings



ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

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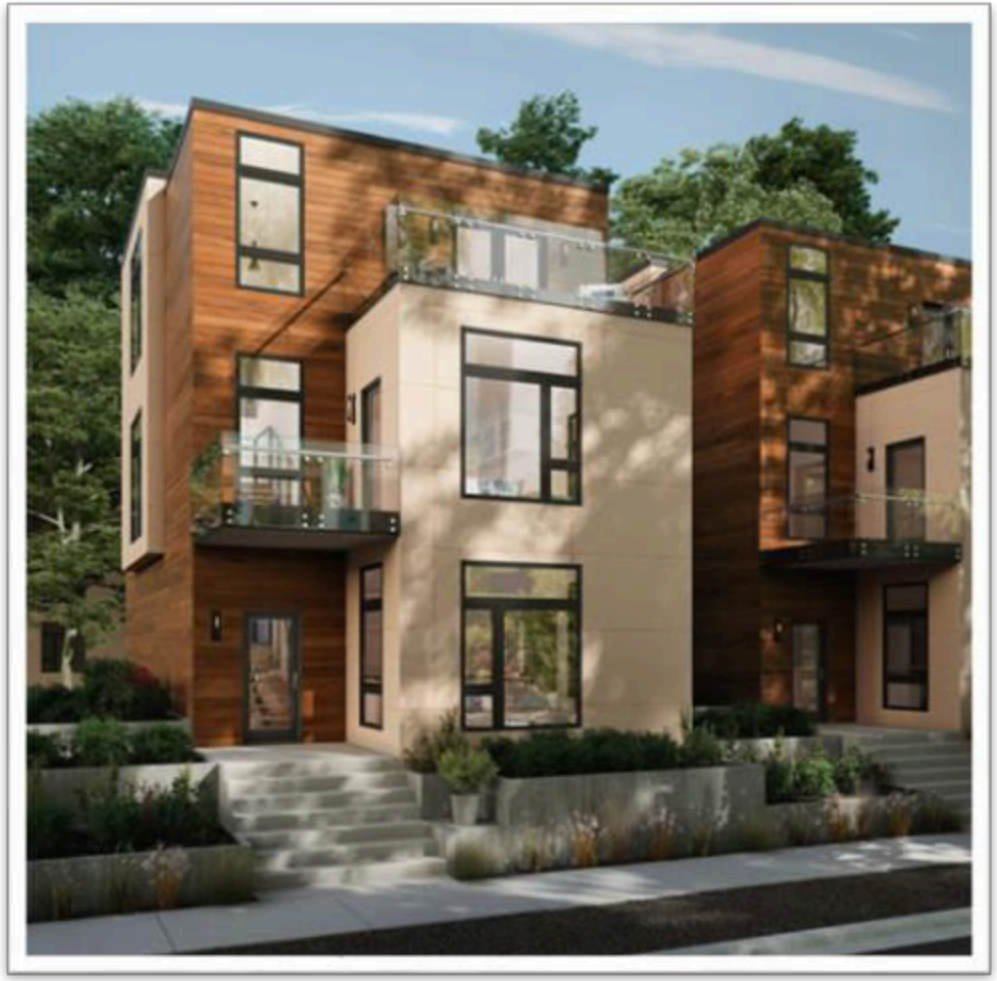
https://codes.iccsafe.org/content/IBC2021P2/chapter-16-structural-design#IBC2021P2_Ch16_Sec1609 Accessed date: 12/20/2023

Performance Classes

Requirements are defined in four performance classes:

- **R: one- and two-family dwellings**
  - PG of at least 15
- **LC: low- and mid-rise multifamily dwellings**
- PG of at least 25
- **CW: low- and mid-rise buildings with higher loading requirements**
  - PG of at least 30
- **AW: mid- and high-rise buildings with higher loading requirements**
  - PG of at least 40



Minimum Thresholds for Each Performance Class

Product Performance Class	Performance Grade (PG)	Design Pressure (DP)		Structural Test Pressure (STP)		Water Penetration Test Pressure (WTP)	
		Pa	~psf	Pa	~psf	Pa	~psf
R	15	720	(15.04)	1080	(22.56)	140	(2.92)
LC	25	1200	(25.06)	1800	(37.59)	180	(3.76)
CW	30	1440	(30.08)	2160	(45.11)	220	(4.59)
AW	40	1920	(40.10)	2880	(60.15)	290	(6.06)

	PG20	PG25	PG30	PG35	PG40	PG45	PG50	PG55	PG60
WTP	3.13	3.76	4.59	5.43	6.06	6.89	7.52	8.35	9.19
DP	20	25	30	35	40	45	50	55	60
STP	30.08	37.59	45.11	52.63	60.15	67.67	75.19	82.71	90.23
Air	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Window and Door Manufacturers Association

Hallmark Certification Program

Designed to provide a way to easily identify products that have been manufactured according to performance standards

- 3rd party inspectors audit quality control procedures and processes and conduct reviews
- Periodic testing is required
- Manufacturers can use WDMA Hallmark logo to identify certified products once requirements are met

Hallmark Certification Labels include:

- Performance Class
- Performance Grade
- Design Pressure
- Size of the tested product

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Test Standards Used in Performance Grade Rating

- **Operating force:** Varies by product type, but ASTM E2028 is used for all sliding products
- **Air leakage resistance:** ASTM E283
- **Water penetration resistance:** ASTM E547 (R, LC, and CW) or ASTM E331 (AW)
  - R, LC, and CW are a 5-minute cyclical test
  - AW is constant
- **Uniform load deflection test and uniform load structural test :** ASTM E330 (positive and negative pressure)
- **Forced-entry resistance:** ASTM F588 (Windows), F476 (Swinging Doors) and F842 (Sliding Doors) at a performance level 10 rating

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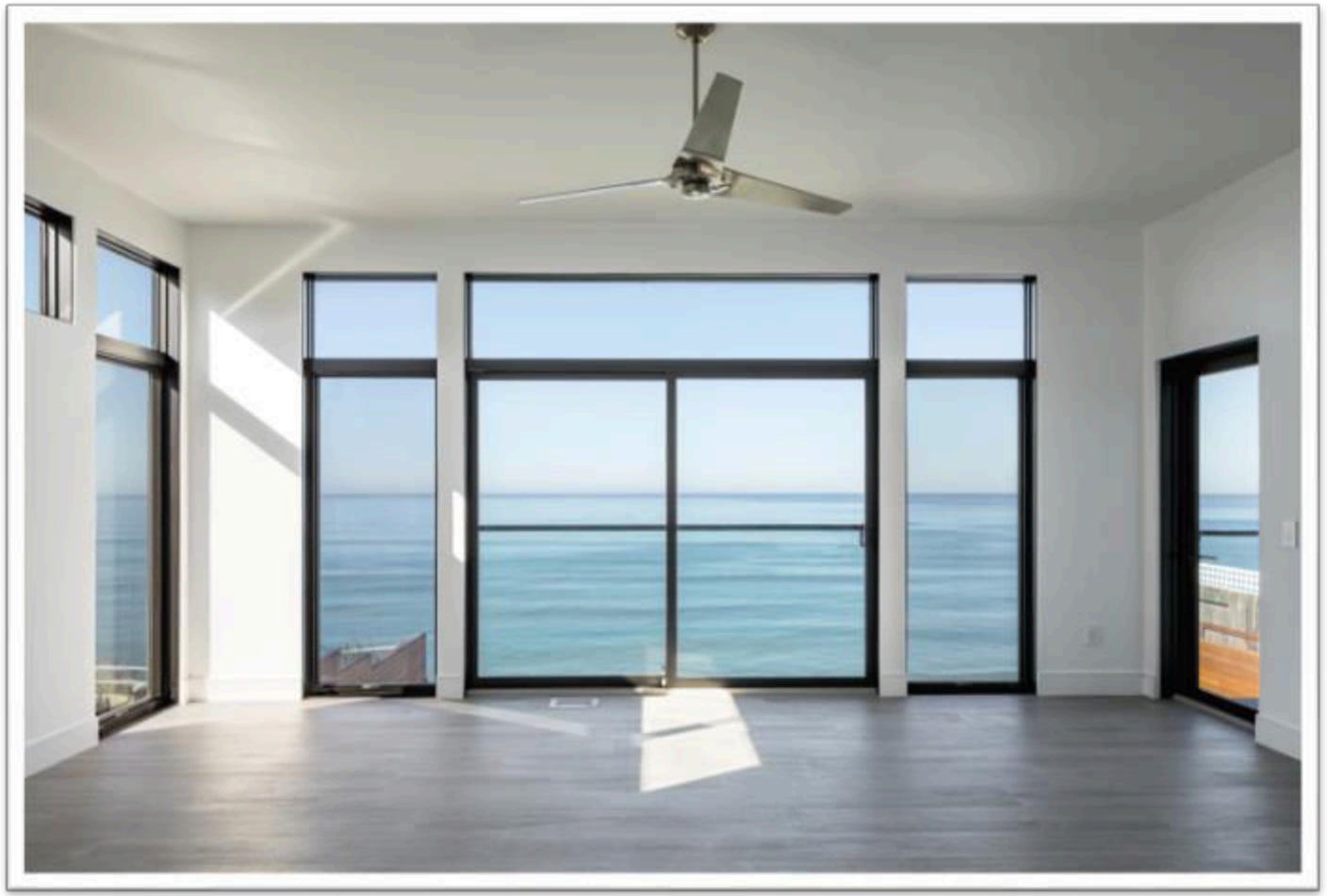
Coastal Zone Requirements

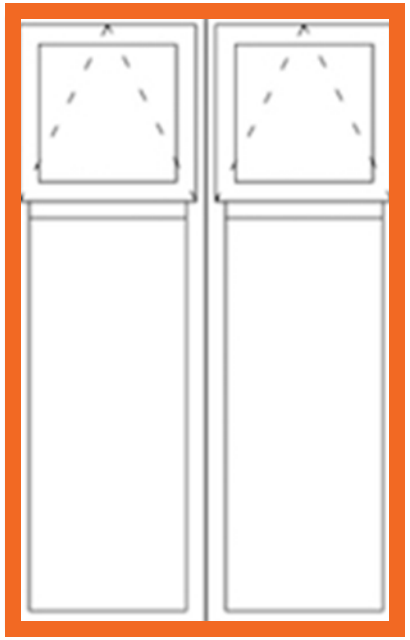
- Higher wind loads are common in some coastal areas
- Higher PG ratings are required when there are higher wind loads
- The Florida Building Code is the most stringent in the US:
  - Defines High Velocity Hurricane Zones
  - Defines area that require wind-borne debris protection (shutters or impact-resistant products)



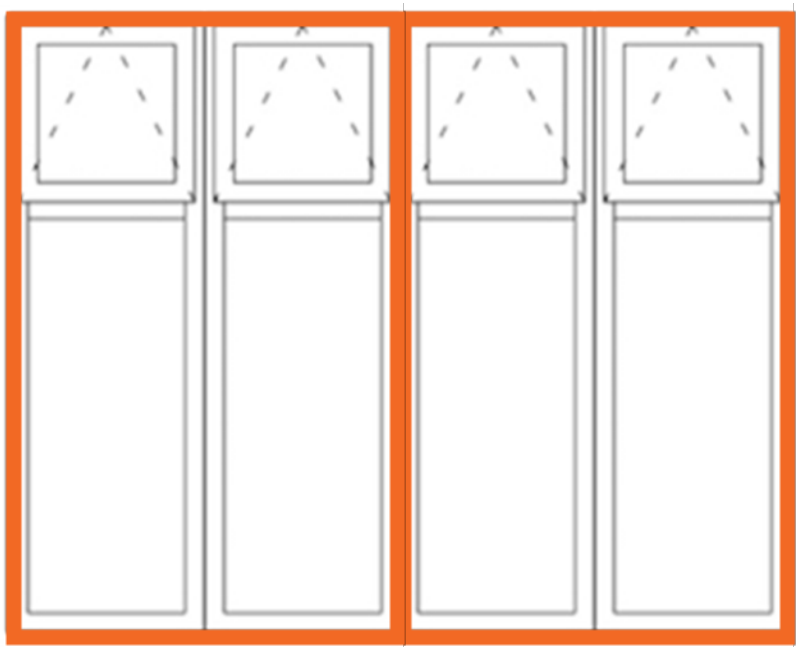
Section 3

Terminology

Composite vs. Combination Assemblies



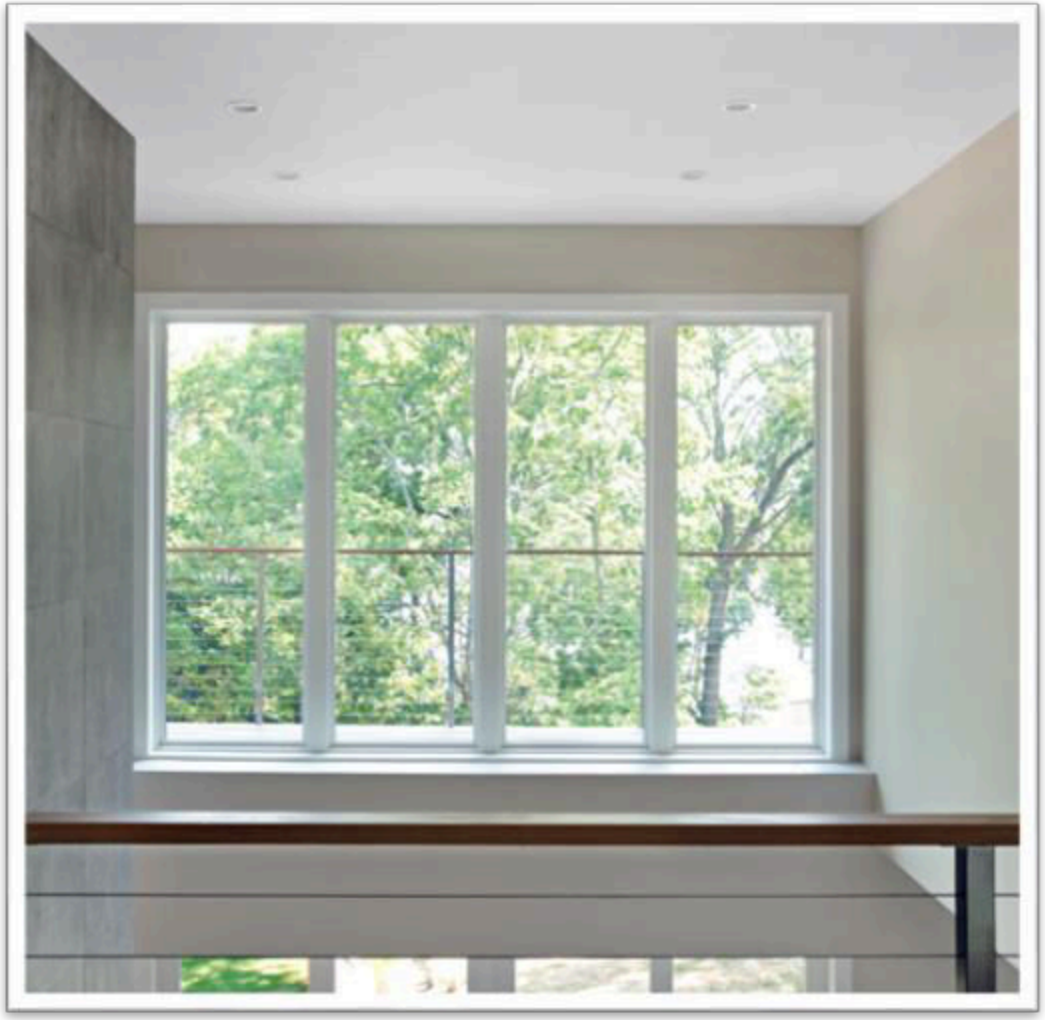
Composite Assembly
One frame divided by one or more integral join



Combination Assembly
Two or more individual units joined together horizontally, vertically, or in both directions

Joining Terminology

- One-way join
  - Ribbon: Joined units in a horizontal configuration
  - Stack: Joined units in a vertical configuration
- Two-way join: Multiple Ribbons and Stacks joined together
- **Join Width:** space between units occupied by joining plate (i.e., join material)
- **Join Depth:** distance a joining plate extends from exterior to interior



Section 4

Options for Getting the Job Done

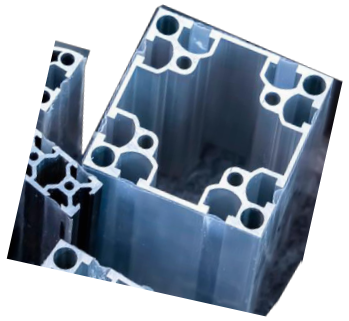
Joining Terminology

- **Joining plate/strip:** connects units, provides lateral strength
- **Gusset plate:** connects units to rough opening (RO)
- **Exterior trim strip:** covers join, creates space for sealant
- **End plugs**: contain and direct flow of sealant
- **Interior trim strip:** covers join, considered final trim detail

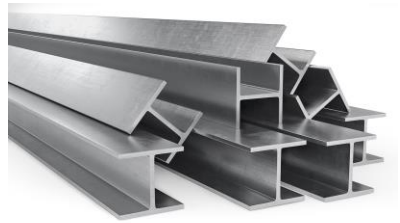
Common Joining Materials

SOLID WOOD

LAMINATED VENEER LUMBER (LVL)



ALUMINUM



STEEL

FIBERGLASS

High Performance vs. Standard Performance Joins

- **High Performance = Reinforced Join**
  - Use for high pressure requirements or larger combinations
  - High performance join is required for two-way combinations
- **Standard Performance = Non-Reinforced Join**
  - Not designed for high pressure requirements
  - Standard performance join is used mostly for smaller one-way combinations

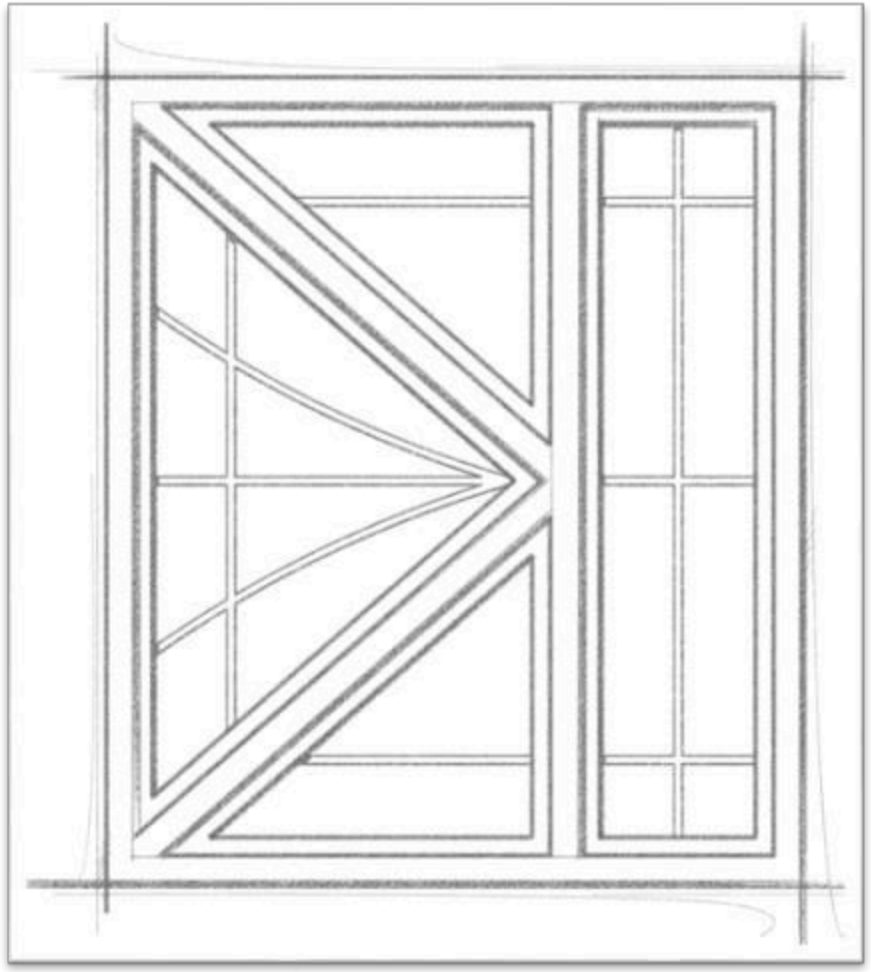
When to Use Reinforced Joins

- Where joined units are subjected to high wind speed pressures
- Where required by building code
- Larger combinations: when non-reinforced materials can't provide required structural strength
- Two-way combinations beyond the capabilities of non-reinforced joining
- Coastal impact regions

When to Use Non-reinforced Joins

- Typically constructed of:
  - Jamb-to-jamb (zero join)
  - Solid Wood
  - Thin LVL
  - Thin Aluminum
- Used in slower/lower wind speed pressures
- Lower mean roof heights
- Smaller combinations

Note: Structural rating of the joined combination **is the same or less than the individual unit.**



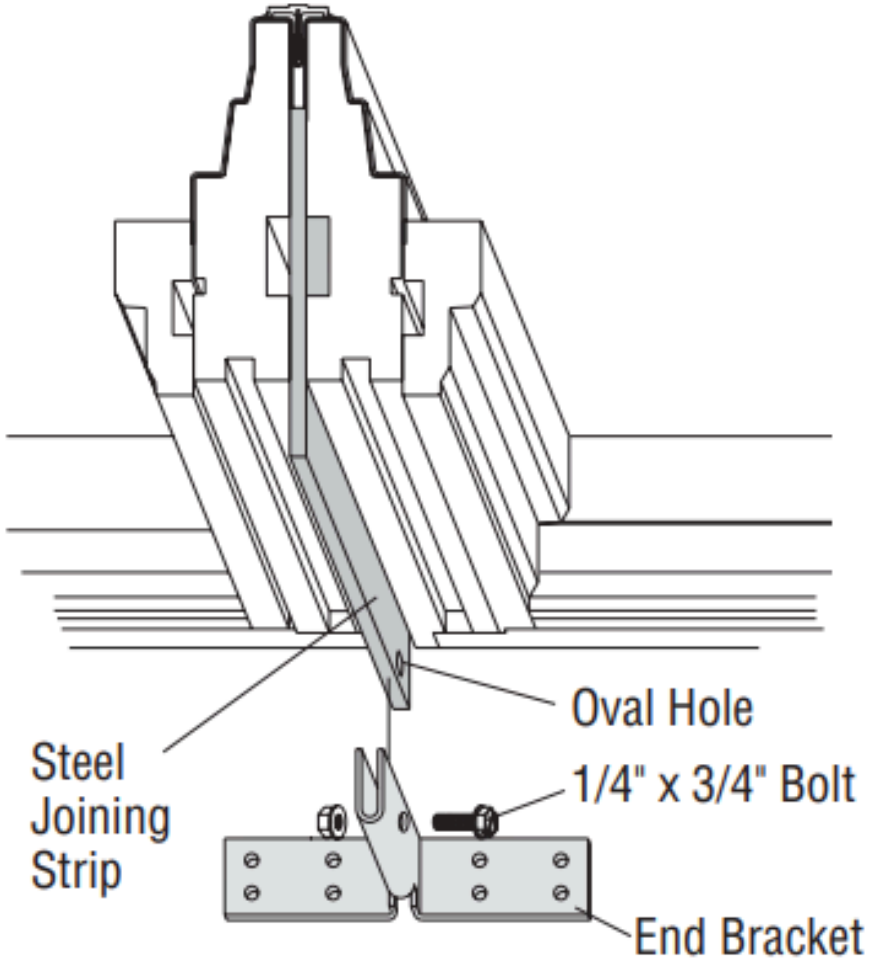
Anchored Joins

- Join materials fastened (clipped) directly to structural framing members
- Structural wind pressure is transferred to framing members
  - Gusset plate or bracket typically used
  - Anchor plates fastened to framing
- Stepped or knee walls: use metal strapping or “L”-shaped half gusset plates

Note: Structural rating of the joined combination **is the same or less than the individual unit.**

Advantages of Anchored Joins

- Higher design pressures can be achieved
- Greater design flexibility

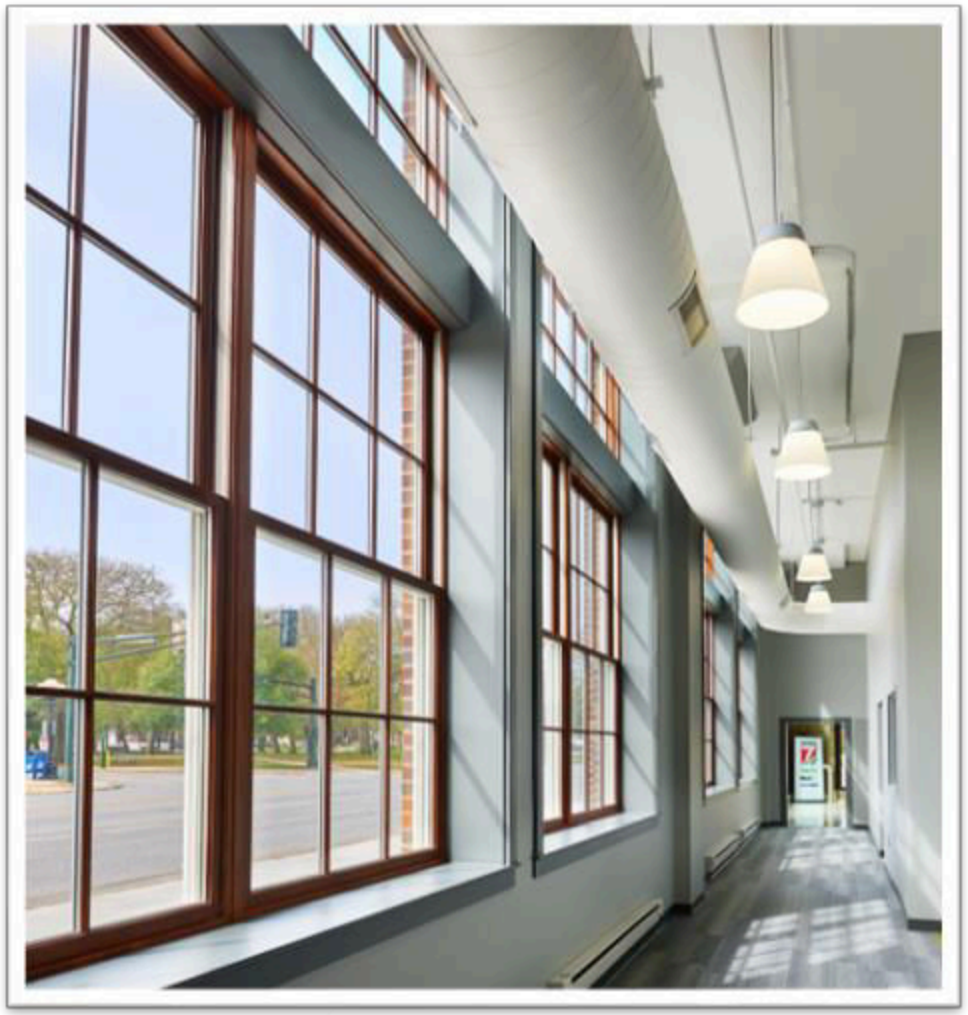


Interior View

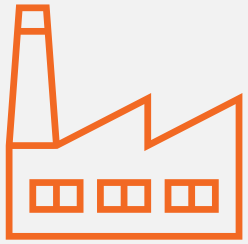
Jamb-to-Jamb Joins

- Joined unit-to-unit
- No additional material between frames

Note: Structural rating of the joined combination **is the same or less than the individual unit.**

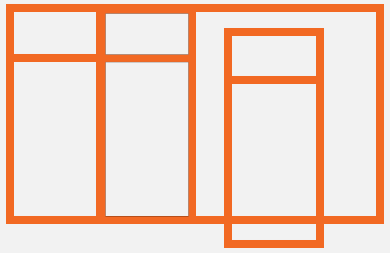


Where Joins Can Be Assembled



IN THE FACTORY

ON THE JOBSITE



IN THE ROUGH OPENING

Factory-Joined Combinations

What they are:

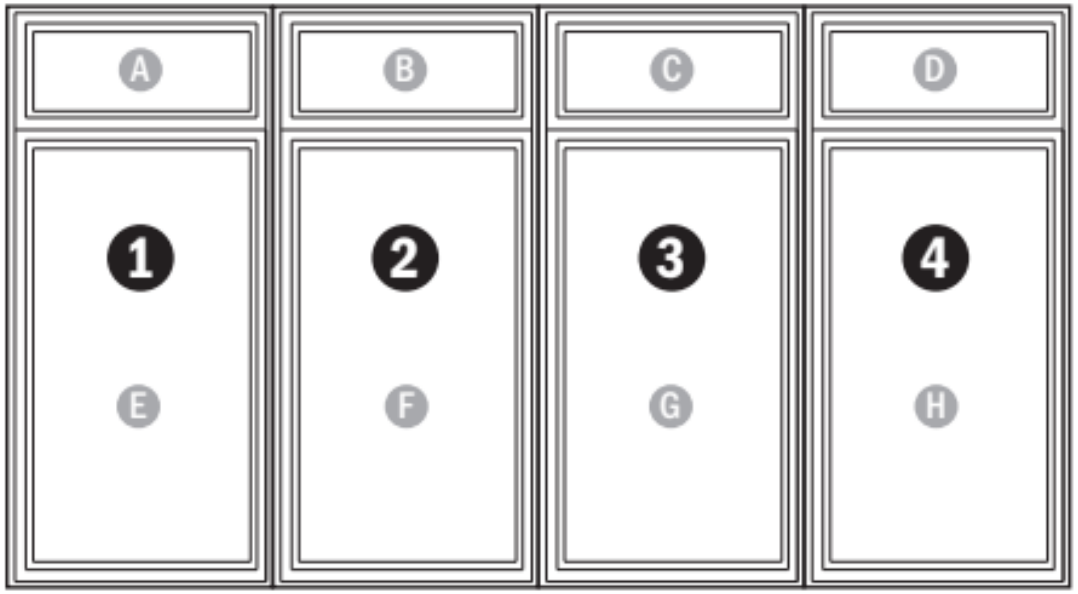
Set of individual units joined in a controlled environment in the factory*

Affordances:

- No pre-installation assembly labor required*
- Can go directly into the rough opening*
- Some proprietary joining systems are PG certified following manufacturer's installation instructions*

Limits:

- Size typically limited to 12' x 8' or smaller
- Door combinations not usually factory joined



*This is only applicable to select products.

Factory-Prepped Combinations

What they are

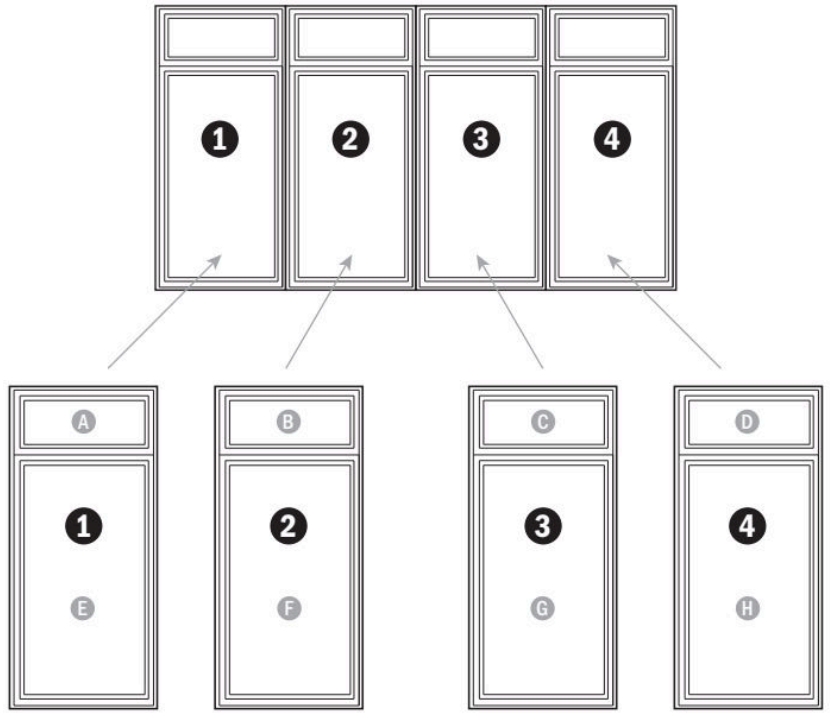
- Individual units assembled into combinations in the rough opening
- Partially assembled sub-combinations used to join units

Affordances

- Allows for assembly in rough opening*
- Requires significantly less labor for installation*
- May reduce the need for lifts for placement *
- Few combination size limitations (unlimited width)*
- Some proprietary joining systems are PG certified following manufacturer's installation instructions*

Limits

- 12 feet high*



**This is only applicable to select products. 69% of 156 builders/general contractors in a 2018 survey said they could reduce the number of installers by half using the Proprietary Joining System when comparing the installation of a 12' wide x 8' high pre-assembled window combination unit with four (4) 3' wide x 8' high window combination units.*

Field-Joined Combinations

What they are:

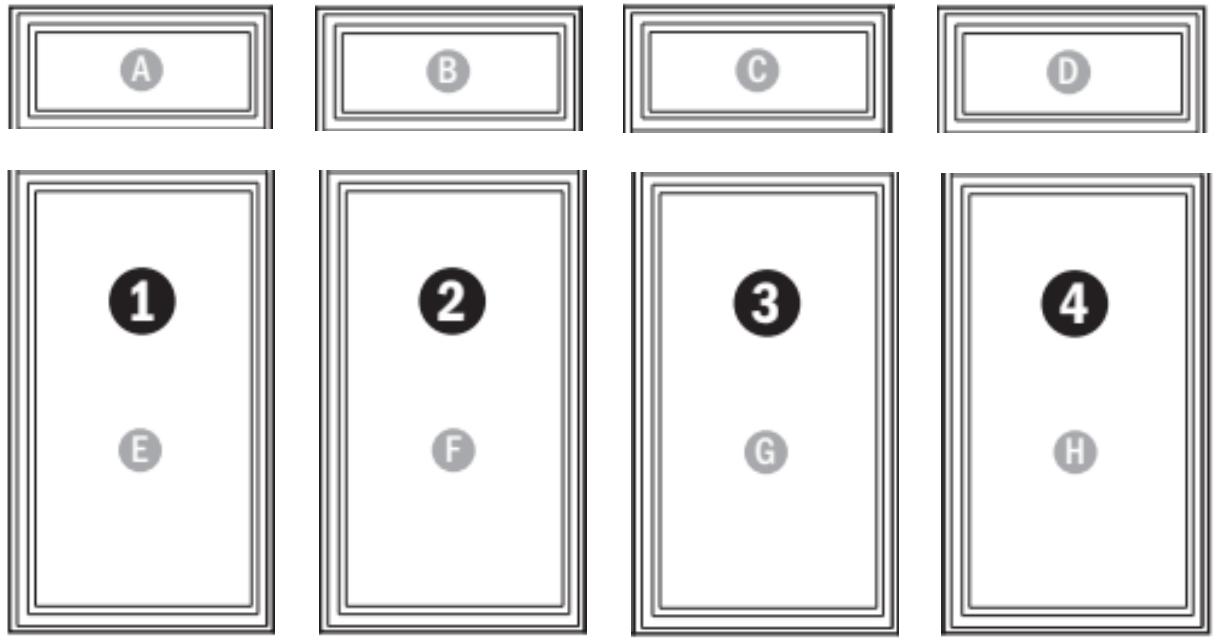
- Individual units assembled into combinations at jobsite or supplier location

Affordances:

- Few size and shape restrictions
- Very customized

Limits:

- More labor and time is needed to transport and assemble on site vs. other options



Definition: *Field kit*
The parts/pieces needed to assemble joined units.

Section 5

Project Scenarios

Condominium Near Seattle, WA

- Low-rise condominium (LC)
- Need to maximize waterfront views
- Tight budget for labor
- Location on the edge of a steep cliff:
  - Difficult for lifts to place windows
  - Access from back of building
  - Scaffold for finishing the install
- Construction site is wet and muddy

What option would you choose for this project?

FACTORY-JOINED OR **FACTORY-PREPPED*** OR **FIELD-JOINED** **?**

Type your answer in the chat .

Condominium Near Seattle, WA

- Low-rise condominium (LC)
- Need to maximize waterfront views
- Tight budget for labor
- Location on the edge of a steep cliff:
  - Difficult for lifts to place windows
  - Access from back of building
  - Scaffold for finishing the install
- Construction site is wet and muddy

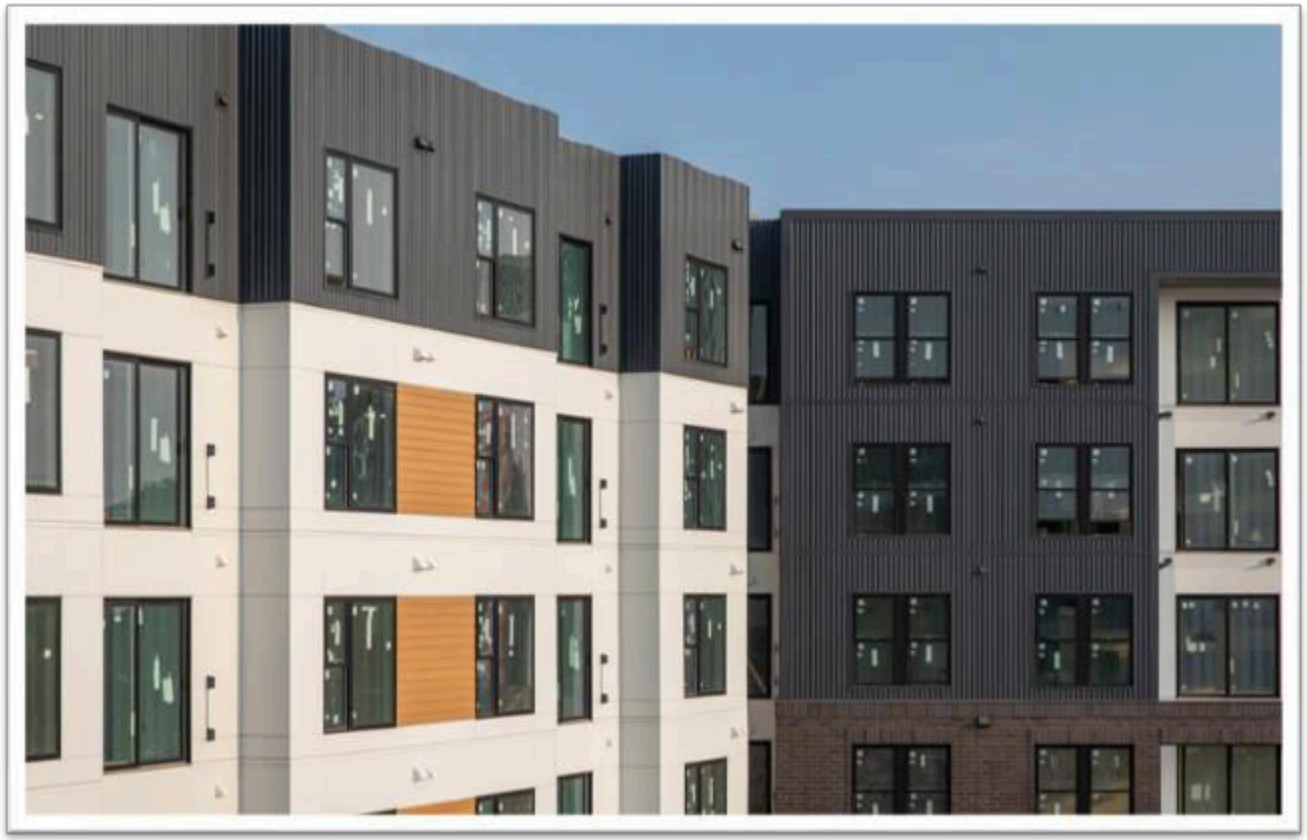
What option would you choose for this project?

FACTORY-PREPPED* → **Assembled in rough opening, lifts may not be needed for placement*, can minimize assembly labor.***

** These statements would applicable only to select products.*

Affordable Multi-Family Housing in Minneapolis

- Apartment building of 180 units (LC)
- 3 uniform window opening sizes throughout, 8 X 8, 6 X 8, 8 X 6.
- Fast-track construction project, small window of opportunity to complete the project in winter
- Flat site conditions make it easy for lifts to operate



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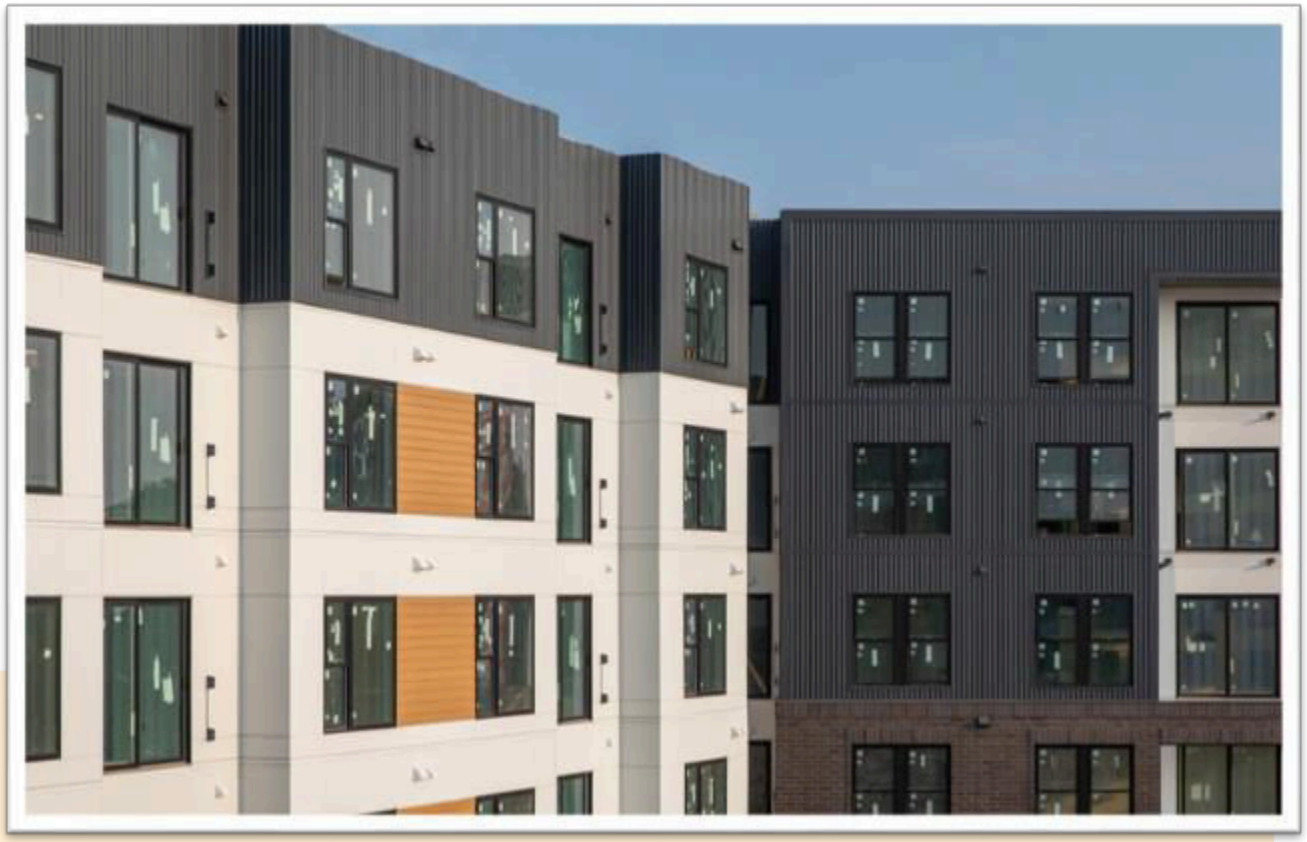


What option would you choose for this project?

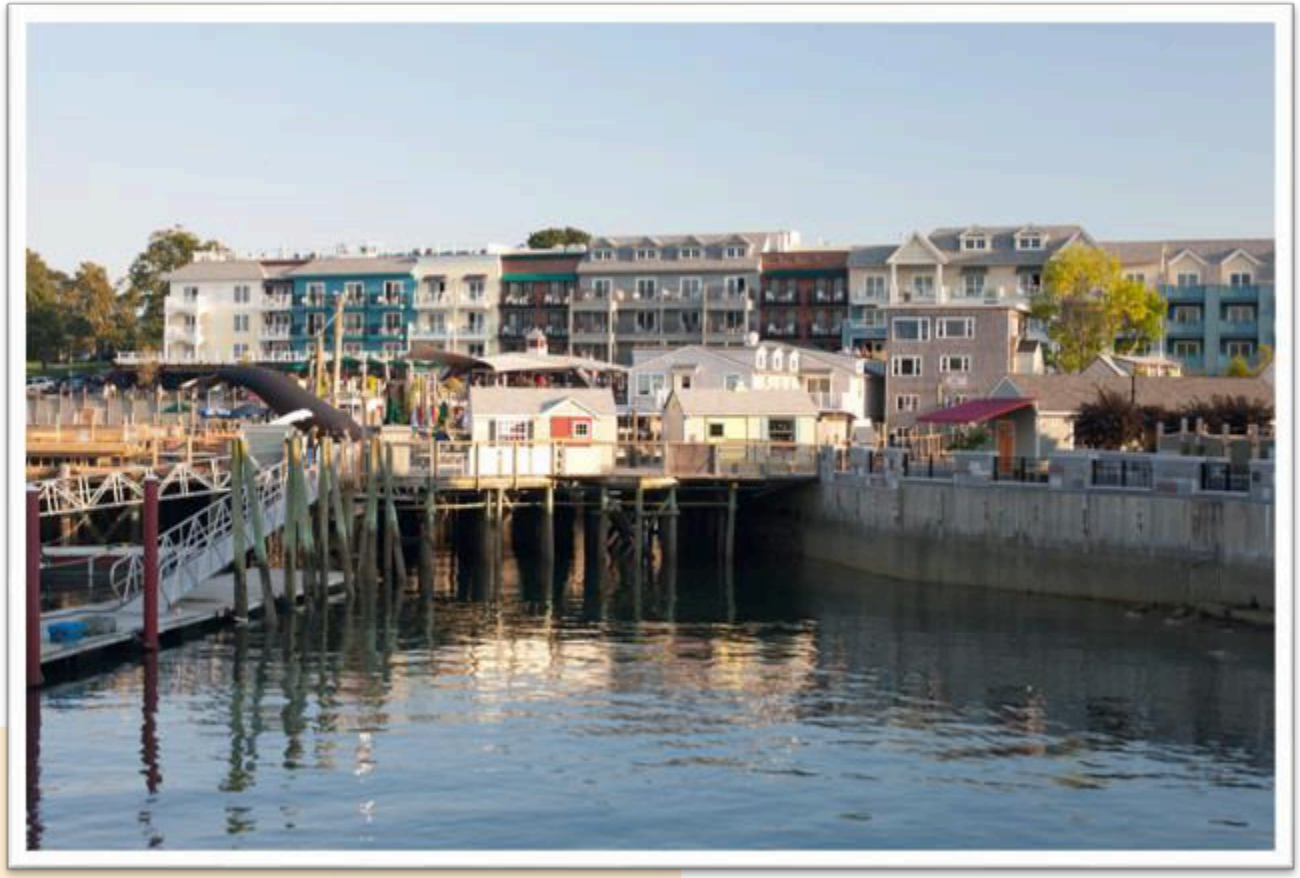
FACTORY-JOINED* → **Pre-joined and PG certified**, many can be installed in a single day, eliminates assembly labor.**

** These statements are applicable only to select products.*

***Some proprietary joining systems are PG certified following manufacturer's installation instructions.*

Dockside Hotel in Bar Harbor, Maine

- Low-rise hotel
- Bay views
- Wide variety of window sizes and combinations in the design, some over 12 ft wide
- ASCE-7 Wind Speed of 110 mph, severe storms and hurricanes are possible
- Fast-track construction project



What option(s) would you choose for this project?

FACTORY-JOINED OR **FACTORY-PREPPED** OR **FIELD-JOINED** **?**

Type your answer in the chat .

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- Bay views
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- ASCE-7 Wind Speed of 110 mph, severe storms and hurricanes are possible
- Fast-track construction project

What option(s) would you choose for this project?

FACTORY-PREPPED* & FACTORY-JOINED* → **Combination can be PG certified**, variety of sizes, efficient, significantly reduces assembly labor.***

** These statements are applicable only to select products.*

***Some proprietary joining systems are PG certified following manufacturer's installation instructions.*

Religious Building in Wheaton , IL

- Place of worship
- Design emphasizes the natural beauty of wood
- Maximize glass area
- Sky / prairie views
- Custom window combinations
- Normal construction timeframe and budget

What option would you choose for this project?

FACTORY-JOINED OR **FACTORY-PREPPED** OR **FIELD-JOINED ?**

Type your answer in the chat .

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- Place of worship
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What option would you choose for this project?

FIELD-JOINED → **Requires more labor and time, allows for customized designs.**

Conclusion

- Advances in joining technology make it possible to meet the demands of fast-paced projects by **reducing on-site labor and time significantly***
- Joining systems can help you feel confident that **performance**** **and design are not compromised** when speed is important to your project
- When **labor and budget numbers** are critical, joining systems can help you reach your goal*
- Your **window manufacturer will help you choose joining systems** that are adequately reinforced and meet requirements

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THANK YOU!