



Innovation in the Built-Environment Through Off-Site Construction and Prefabrication

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Credits:

1 AIA CEU / HSW



Learning Objectives

By the end of this course, Attendees will be able to:

1. Define off-site construction and pre-fabrication benefits
2. Discuss project team roles and stake holder impact
3. Evaluate the off-site process from design stage to installation
4. Analyze existing and in-process case studies

Off-Site Construction: Terminology



Off-site Construction

- An alternative construction method that sources components manufactured in a factory, transported to a project site and then assembled to form or become part of a building structure.





Modular and Prefabricated Construction

- Modular:
 - Larger components that form the building structure
- Prefabricated:
 - Smaller components that fit onto the building structure

Save Money and Stay on Schedule

- Increased specialty expertise
- More accommodating working conditions
- Greater wage transparency
- More opportunities for collaboration
- Diverse workforce
- Enables better control
- Continues rain or shine
- Produces less waste – 40% on average
- Addresses the labor shortage
- Improves safety (McGraw Hill – 34% improved safety and 49% safety is the driver for moving to off-site construction)
- Savings (McGraw Hill surveyed 800 architects – 66% report schedule decrease, 65% report budget decrease, 77% report construct site decrease?)



How off-site construction can contribute to a more diverse workforce



WORKFORCE

Understanding America's Labor Shortage: The Most Impacted States

By Lindsay Cates

Off-Site And Modular Construction Explained

by Ryan E. Smith, University of Utah

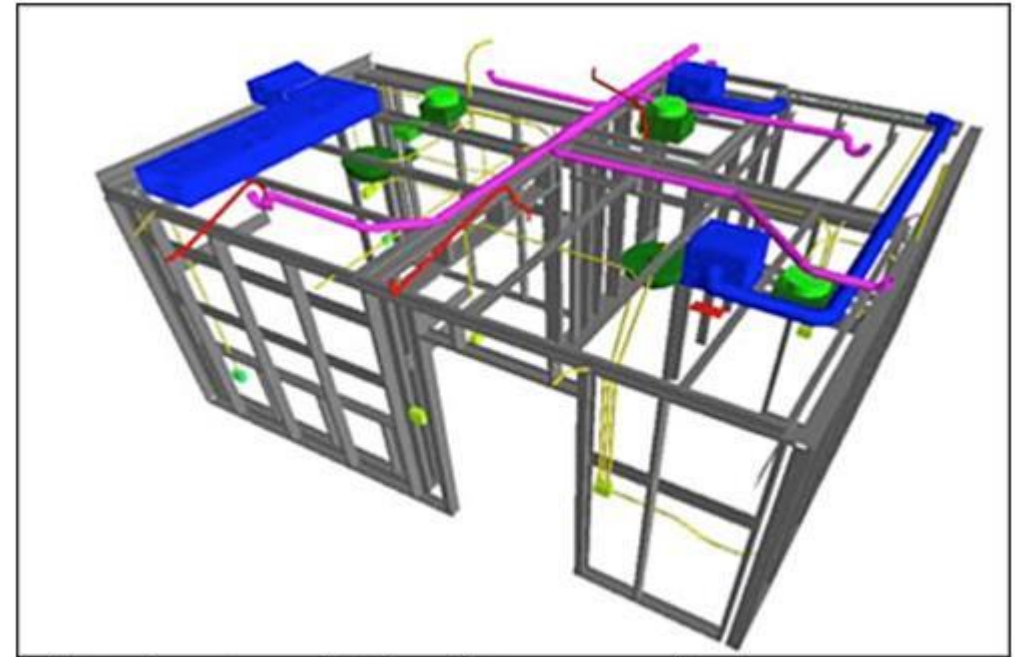
Chair, *Off-Site Construction Council, National Institute of Building Sciences*

Updated: 08-09-2016

Competing performance goals:

1. Cost
2. Schedule
3. Labor
4. Scope
5. Quality
6. Risk

Off-site construction can provide a balance



Building information model of an off-site constructed hotel room.

Photo courtesy of Whiting Turner

How Off-Site Construction Impacts Stakeholders

Contractor

- Differentiation during the bid process and potentially win more projects.
- Job site can be safer when the primary elements have already been constructed elsewhere.
- The speed of installation and QA/QC process
- Can complete more projects faster without compromising building performance or integrity.

Architect

- Design team meetings during the production process to review ongoing work
- Make any necessary changes before early
- Collaborative approach, the manufacturer, fabricator and architect should clearly define their roles and responsibilities at the onset of the project to minimize any miscommunications or ambiguities.

Installers

- Responsibilities depend on whether the project has 2D panels, 3D units or both.
- Scope of work may be completed in the factory by another party
- Field installers are critical to the on-site assembly and connection of the various systems.
- Coordination between off-site and field installed components such as balconies, parking decks, etc

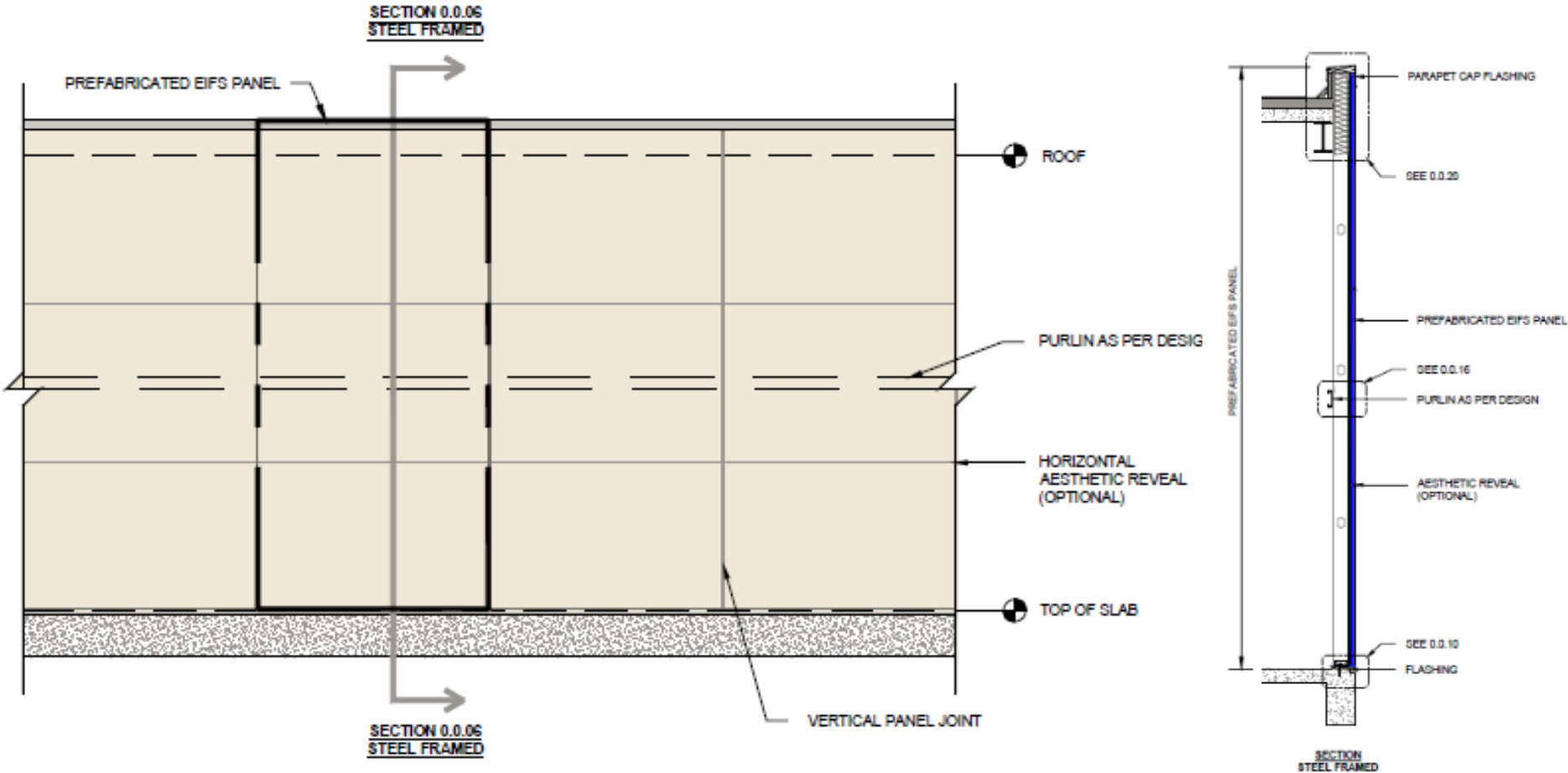
Building Owners

- Large cost and time savings
- Need to make key decisions early in the process
- Understand the design flexibility is early and before the fabrication process begins
- Exterior finishes, textures and colors, as well as space planning, interior finishing details finalized in the initial stages of planning

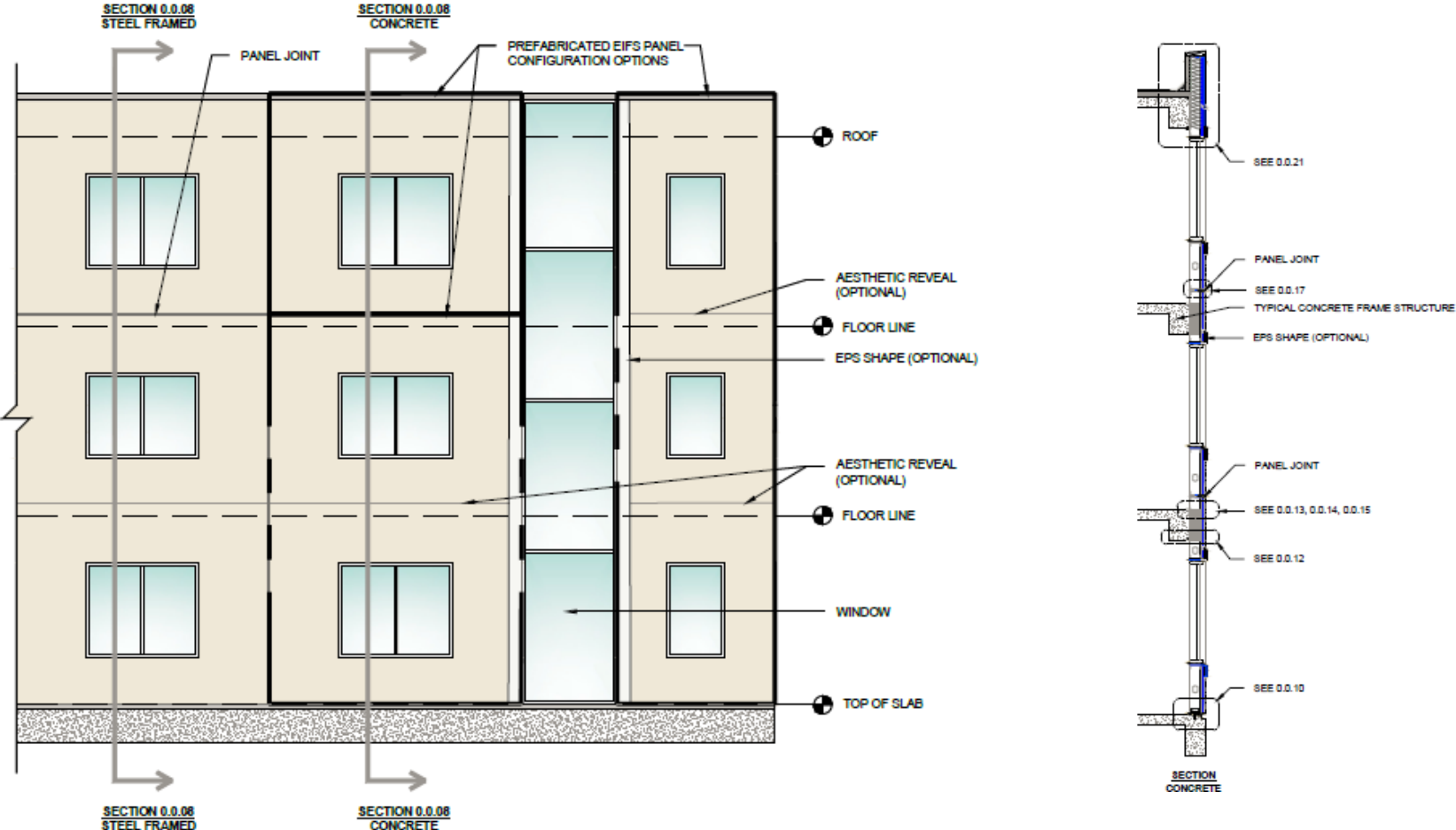
Layouts, Connections, Joints



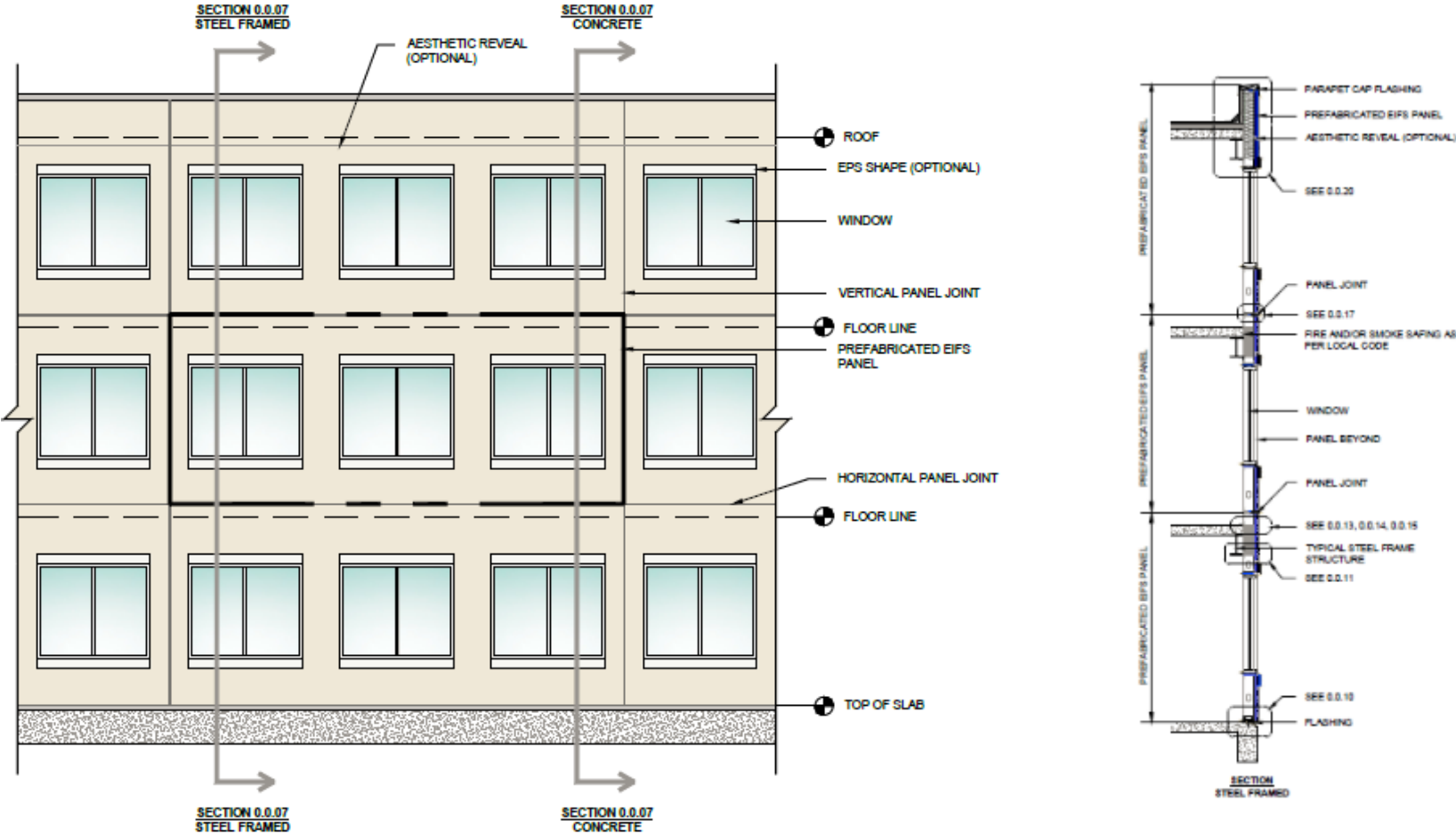
Panel Layout: Vertical, Full Wall Height



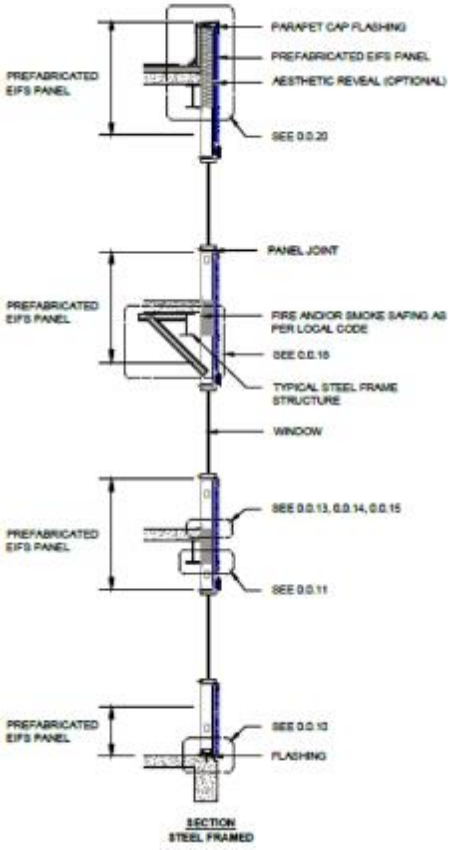
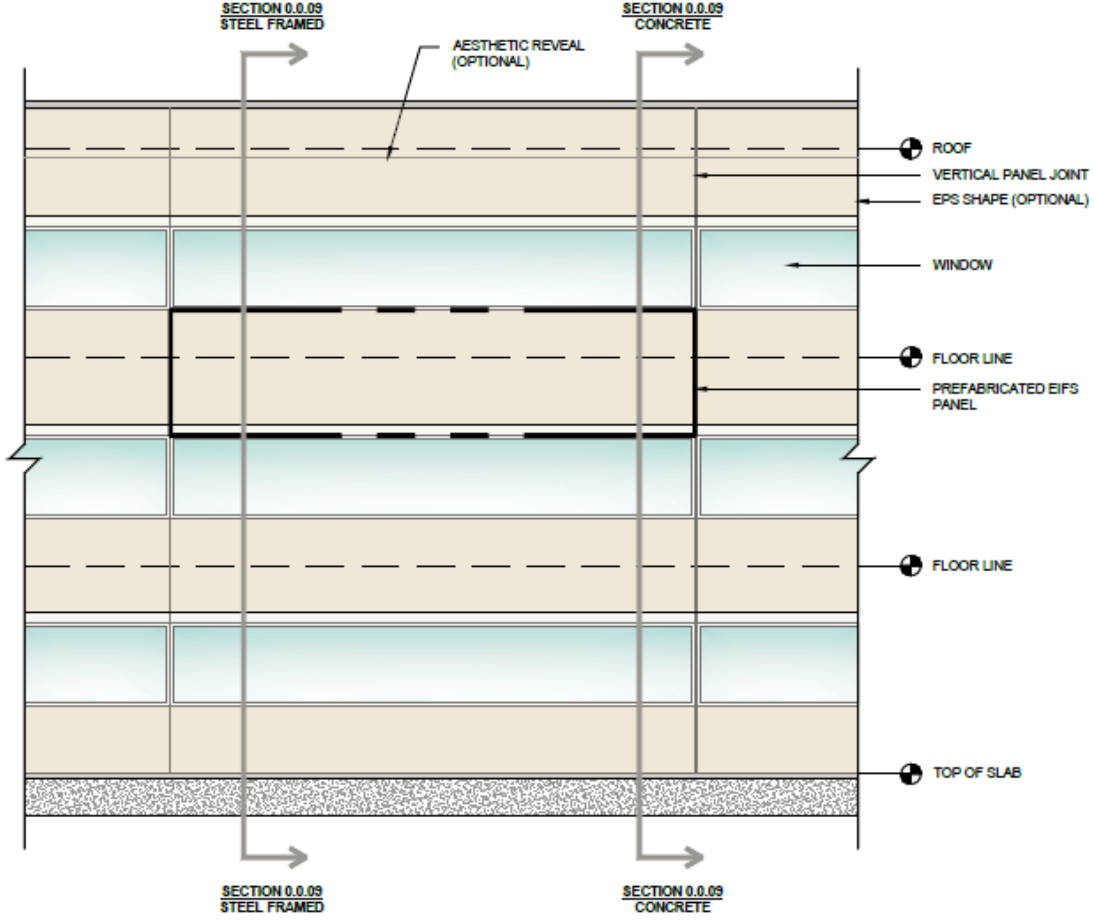
Panel Layout: Vertical, Punched Opening



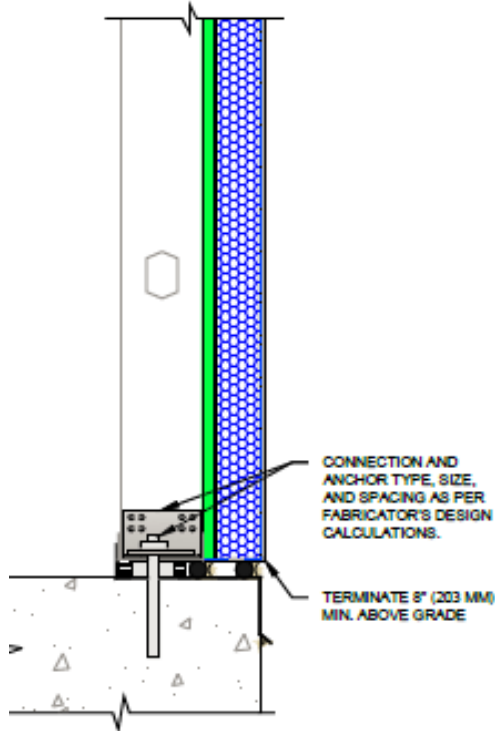
Panel Layout: Horizontal, Punched Opening



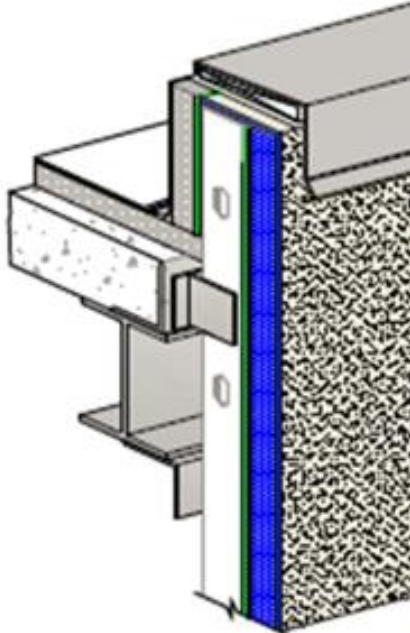
Panel Layout: Horizontal, Spandrel/Ribbon



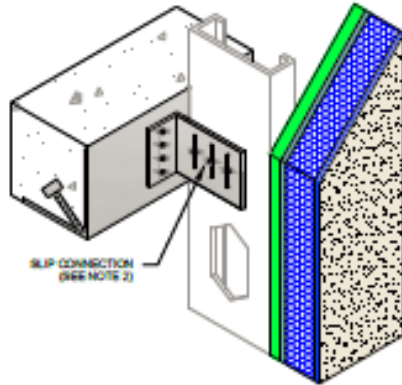
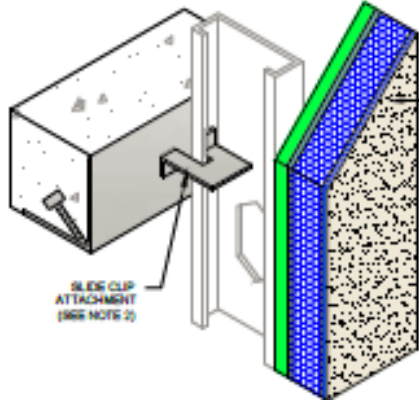
Panel Connections



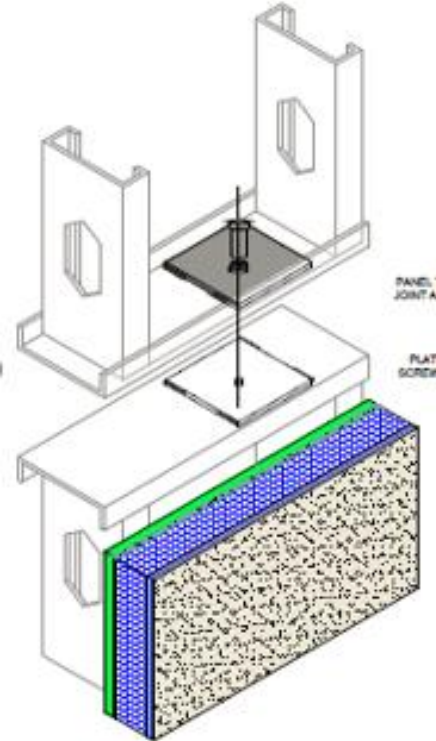
Fixed Pin
Grade Bearing



Bent Plate
Welded

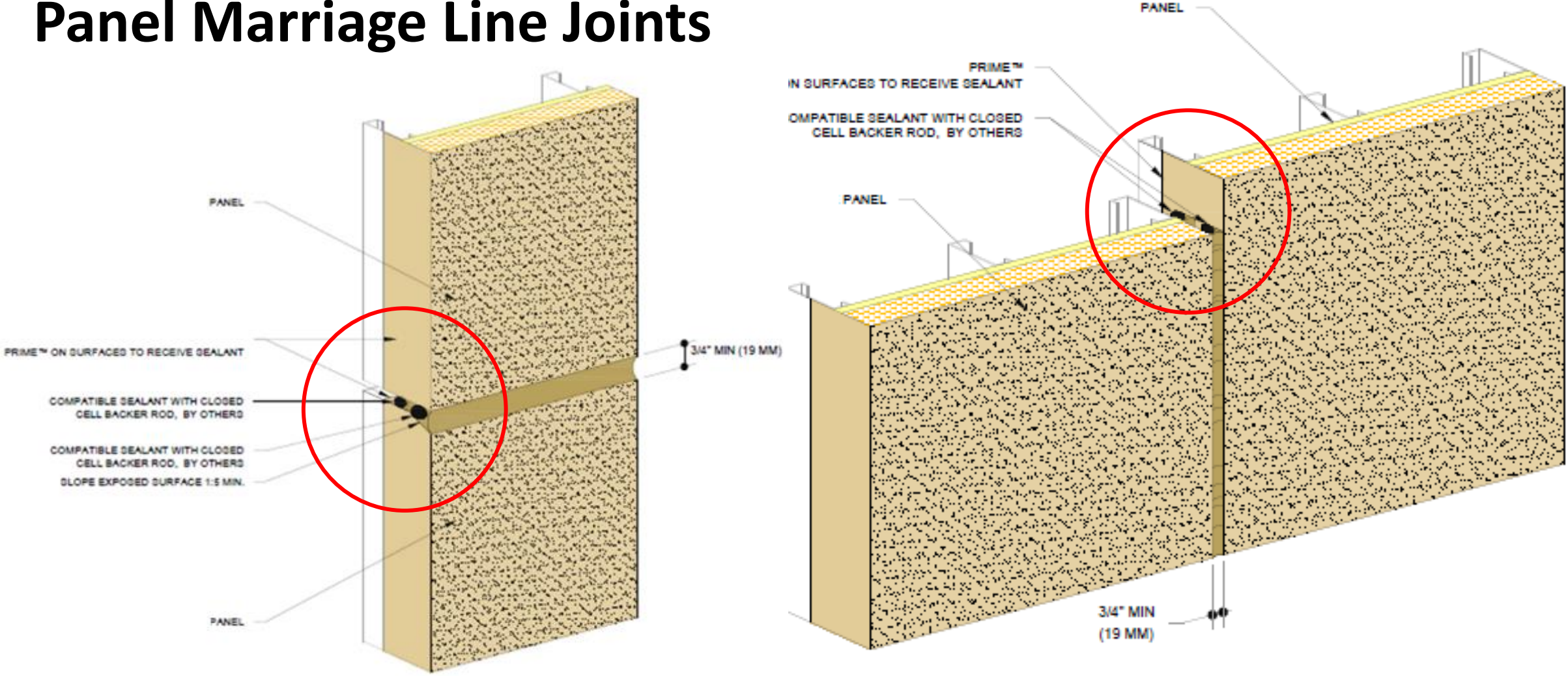


Embed Plate
Slip Clip



Panel to Panel
Fixed Pin

Panel Marriage Line Joints



Prefabricated EIFS-Clad Wall Assemblies



Field-applied EIFS: Challenges



Hand applied layers
and curing periods



Weather impacts and
weather protection



Scaffolding and
worker safety

Prefabricated EIFS-Clad Walls: Features and Benefits

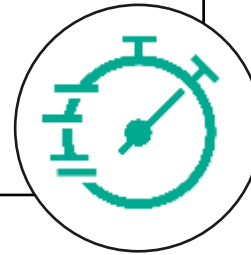
- Better insulated
- Leading edge sustainability
- Lightweight - reduces structural requirements

Greener



- Faster construction time
- Avoid labor shortage problems and delays
- Increased productivity

Faster



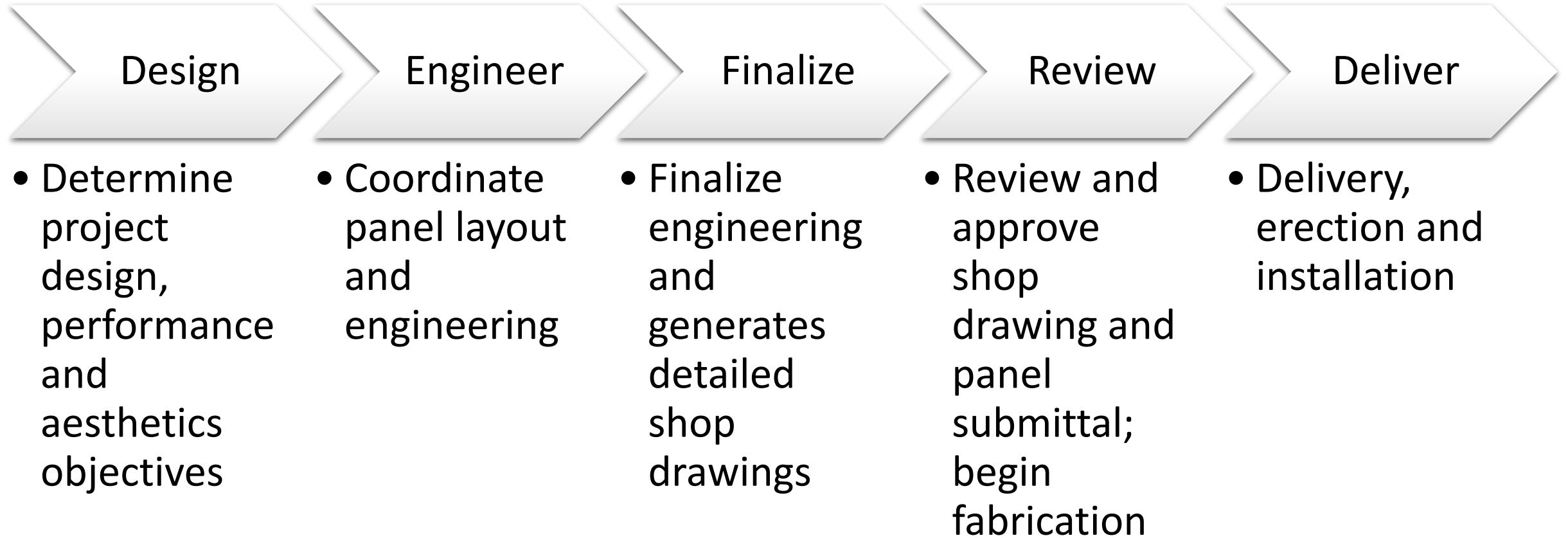
- Stronger and more resilient
- Cost-effective for the long term
- One point of contact
- Any look you want

Smarter



Design Stage to Installation

Prefabricated Design and Engineering Process: Integrated Design Process



Benefits of Design Process: Quality Control

Fabrication

- Environmentally managed, controlled off-site location

Protection

- Wrapped, secured and safeguarded

Shipment

- Coordinated and delivered 'as needed'

Owner, Architect, Engineer, Consultant, General Contractor can inspect, monitor, and observe fabrication process

Transportation: Trailer Configuration

Maximum Legal Dimensions:

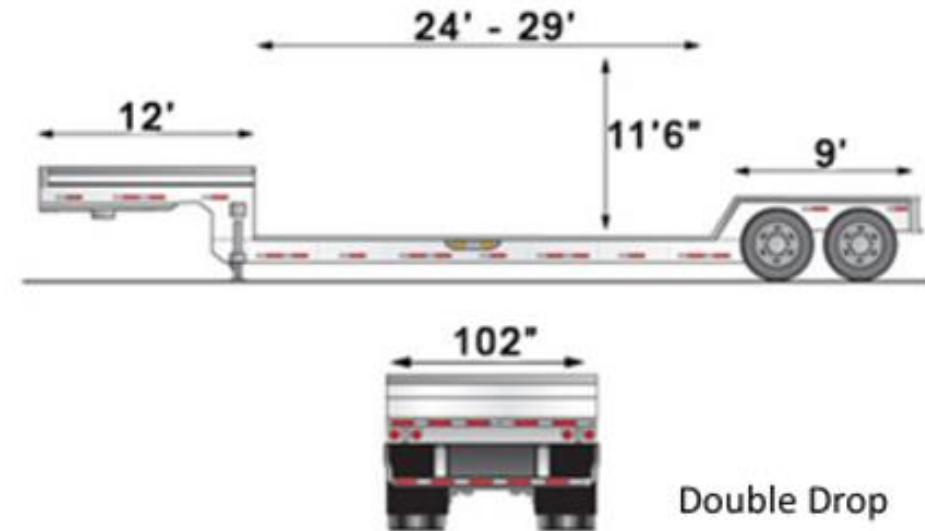
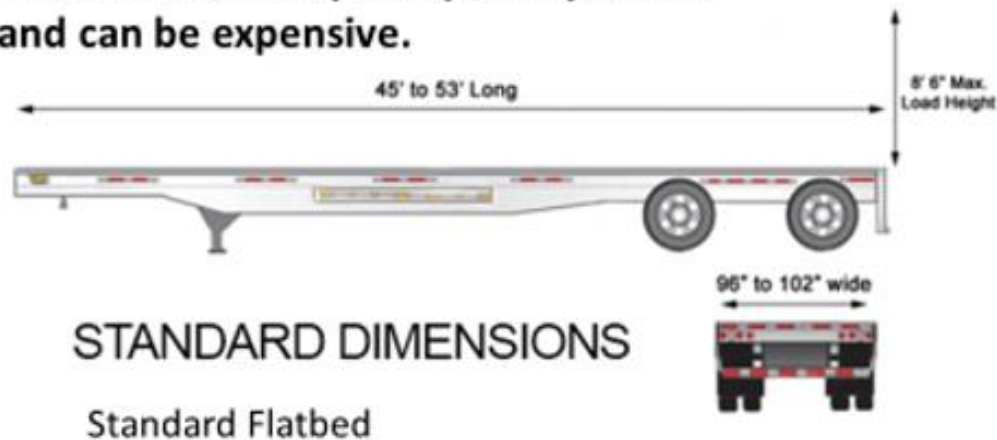
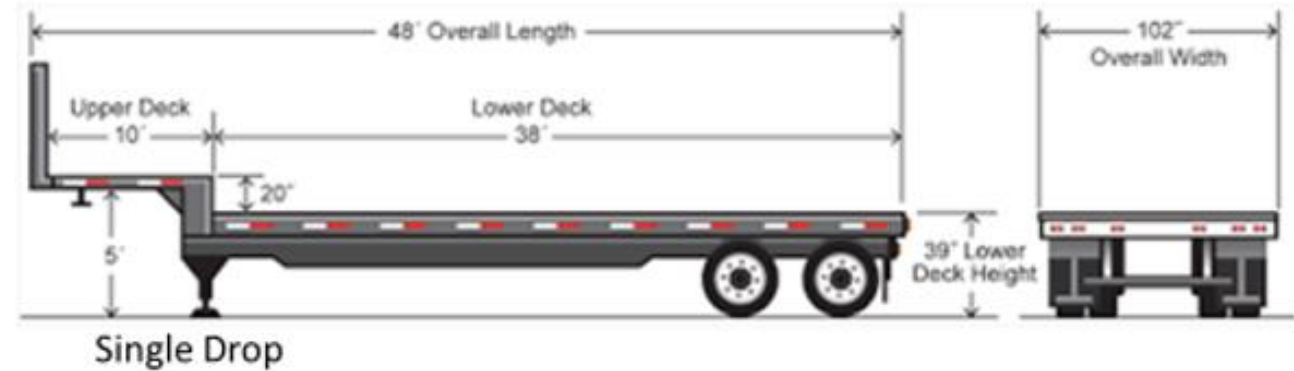
Length: Combined overall is 65 feet.

Trailer length: 48 to 53 feet

Width: 8 feet and 6 inches

Height: 13 feet and 6 inches, Height may vary by location.

Oversize loads require special permits and can be expensive.



Transportation: Site Logistics



- Storage and Staging
 - Limited storage on project site
 - Managed by coordinated shipment and delivery



- Panel Erection
 - Crane lifted into place from truck
 - Can utilize crane onsite and install at night

Cost-Effective for the Long Term

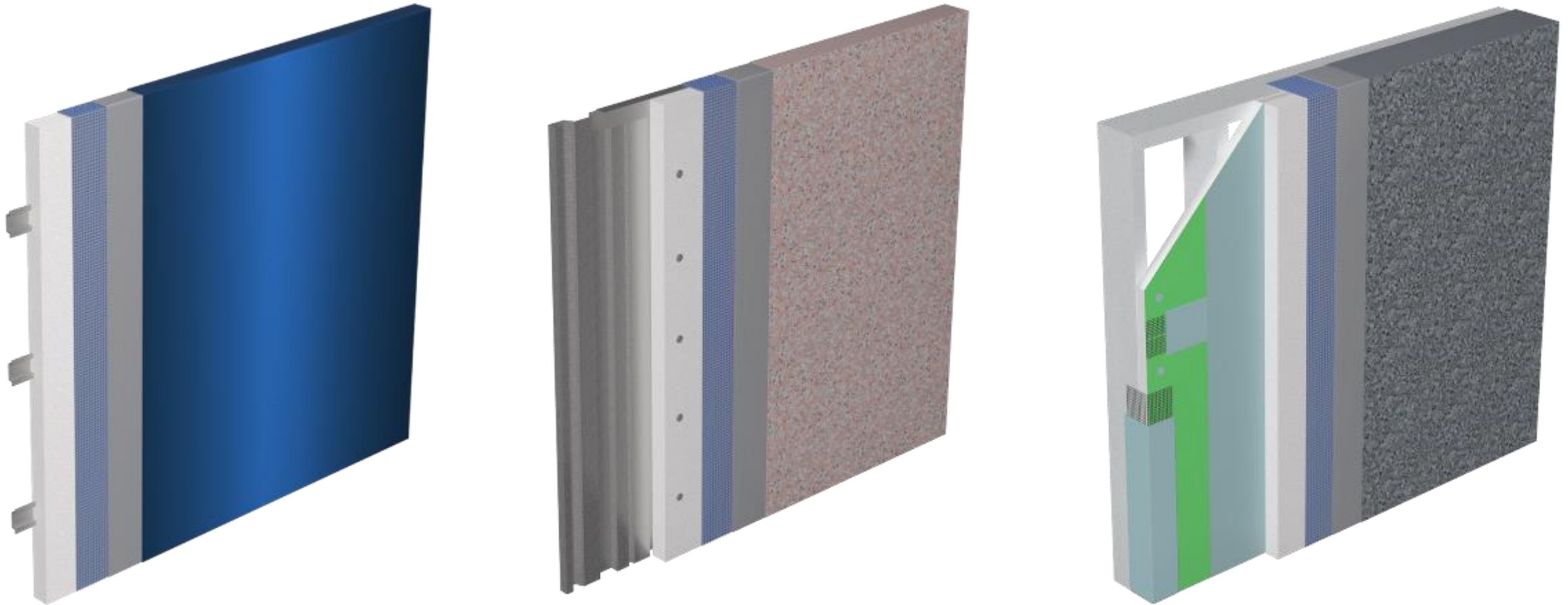
- Enhances Construction Process / Compresses Construction Schedule
- Encloses Building Envelope more quickly
- Extends Construction Season
- Eliminates cost of scaffolding, tenting and heating
- Addresses skilled labor shortages
- Assures Quality Control and Performance



Prefabricated Panels Configurations

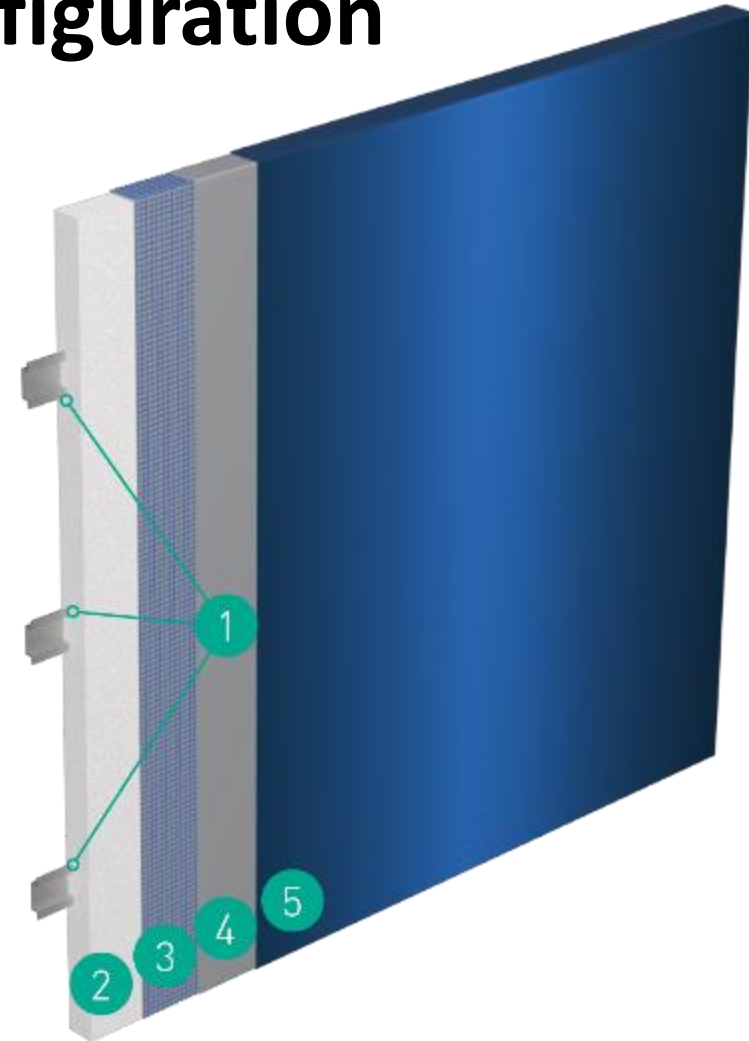


Prefabricated EIFS-Clad Panel Configurations



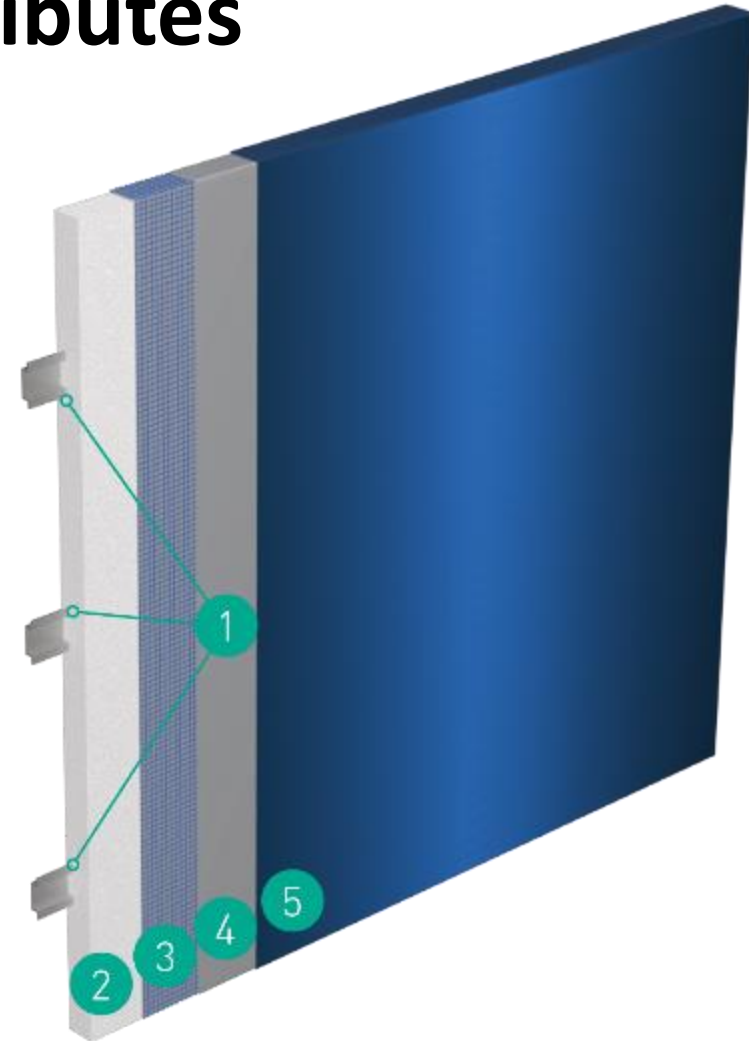
Reinforced Structural Channel: Configuration

1. Reinforcing Channels
2. Expanded Polystyrene (EPS)
3. Reinforcing Mesh
4. Base Coat
5. Finish Coat

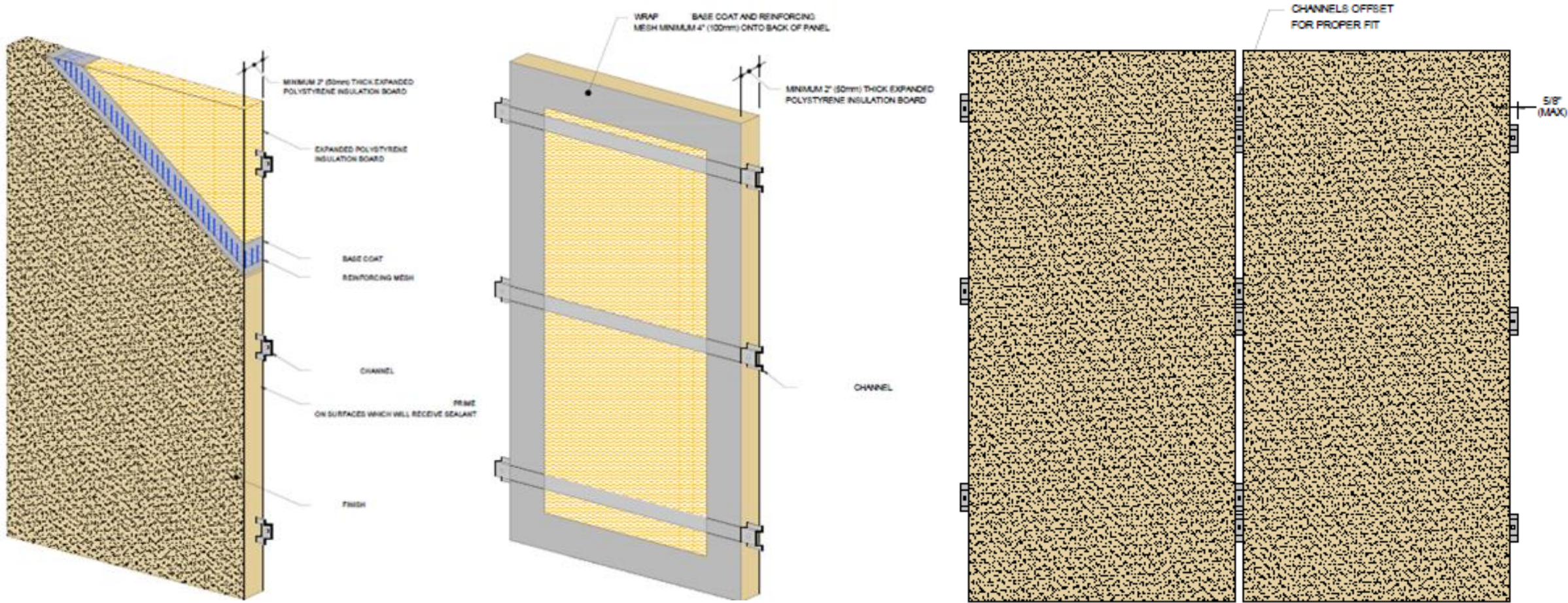


Reinforced Structural Channel: Attributes

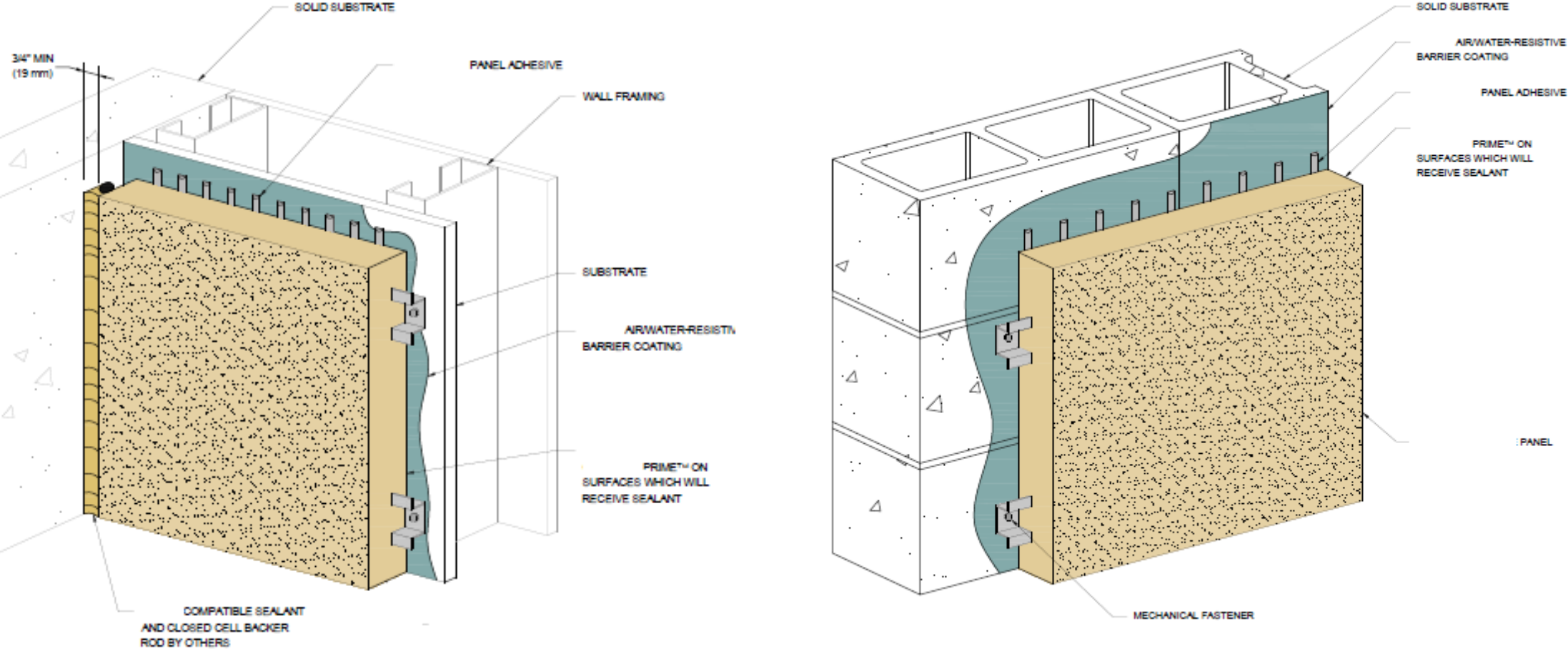
- Ultra-lightweight: 2.5 lbs./sf
- Can be used in new or retrofit constructions
- Embedded reinforcing channels provide strength
- Allows for cold weather installs
- Reduces in-field installation labor
- Can incorporate drainage capacity



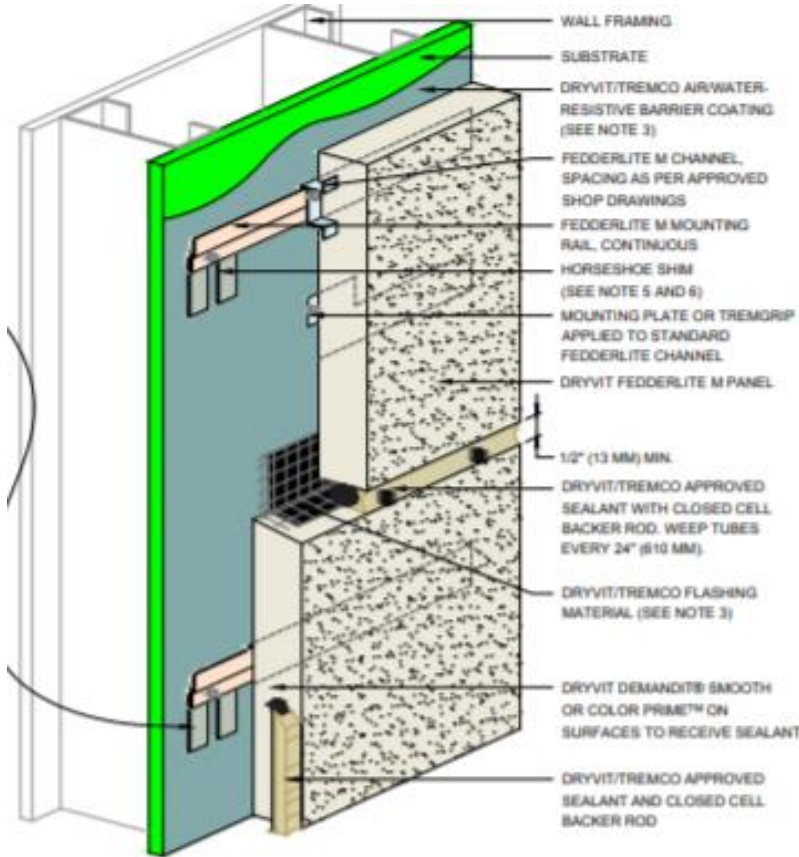
Reinforced Structural Channel: Detailed View



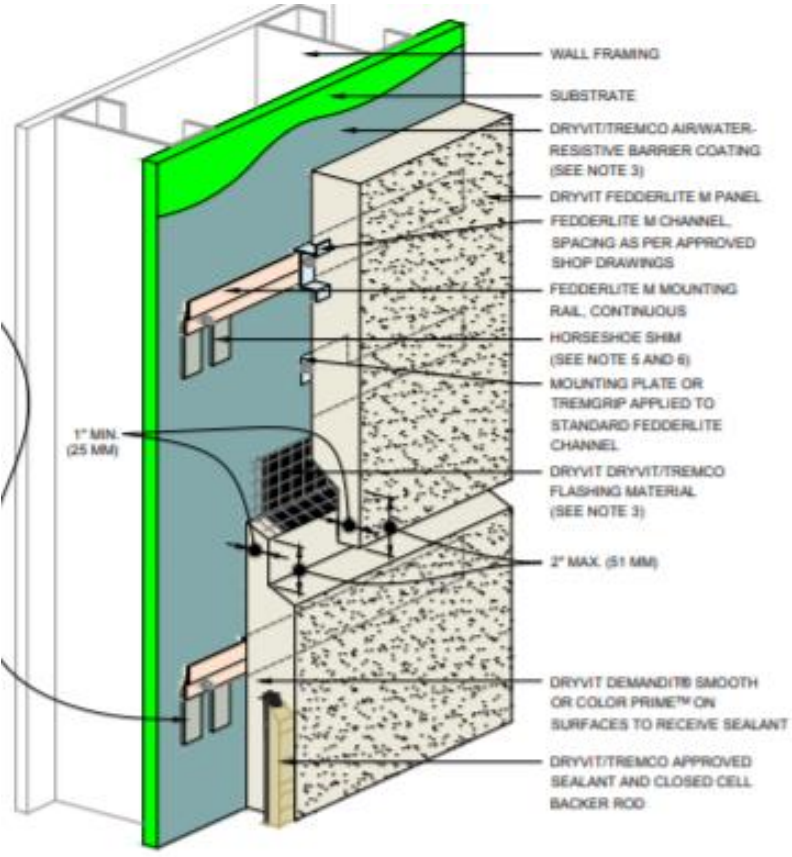
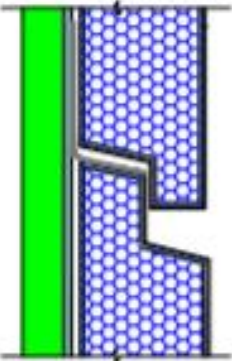
Reinforced Structural Channel: Assembly Options



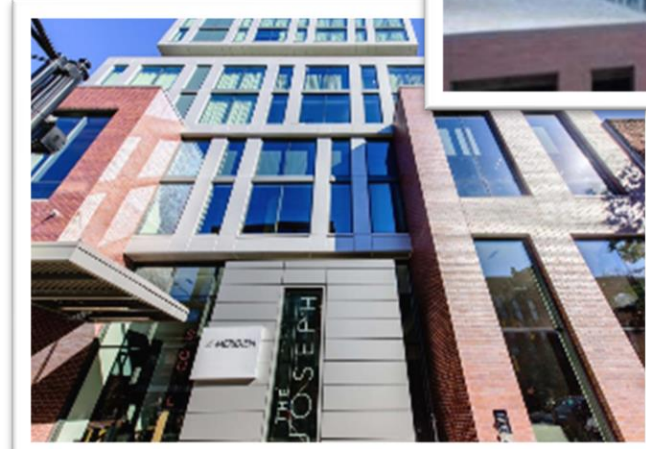
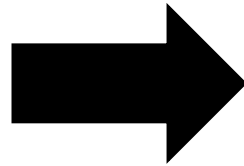
Reinforced Structural Channel: Drainage Option



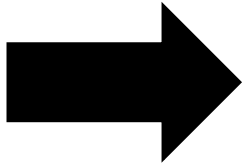
HORSESHOE SHIM
(SEE NOTE 5 AND 6)



New Construction: Le Meridien Hotel, Columbus, OH

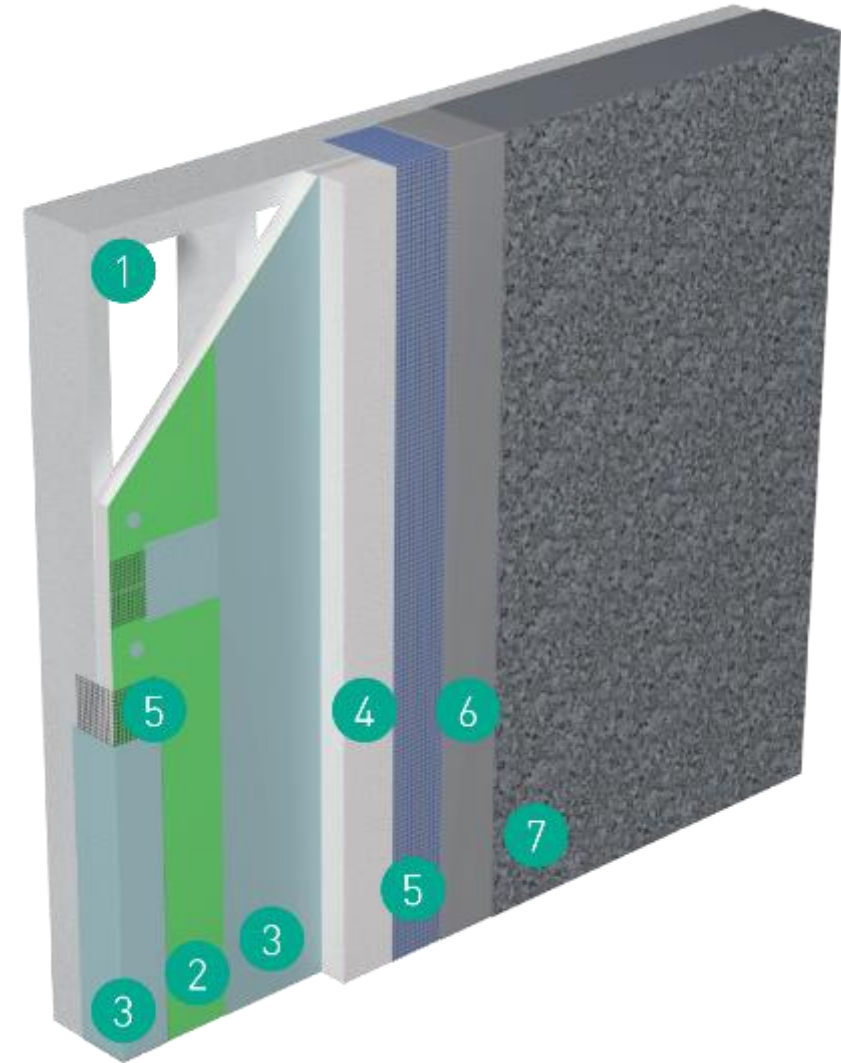


Renovation Construction: Pacific Avenue, Bremerton, WA



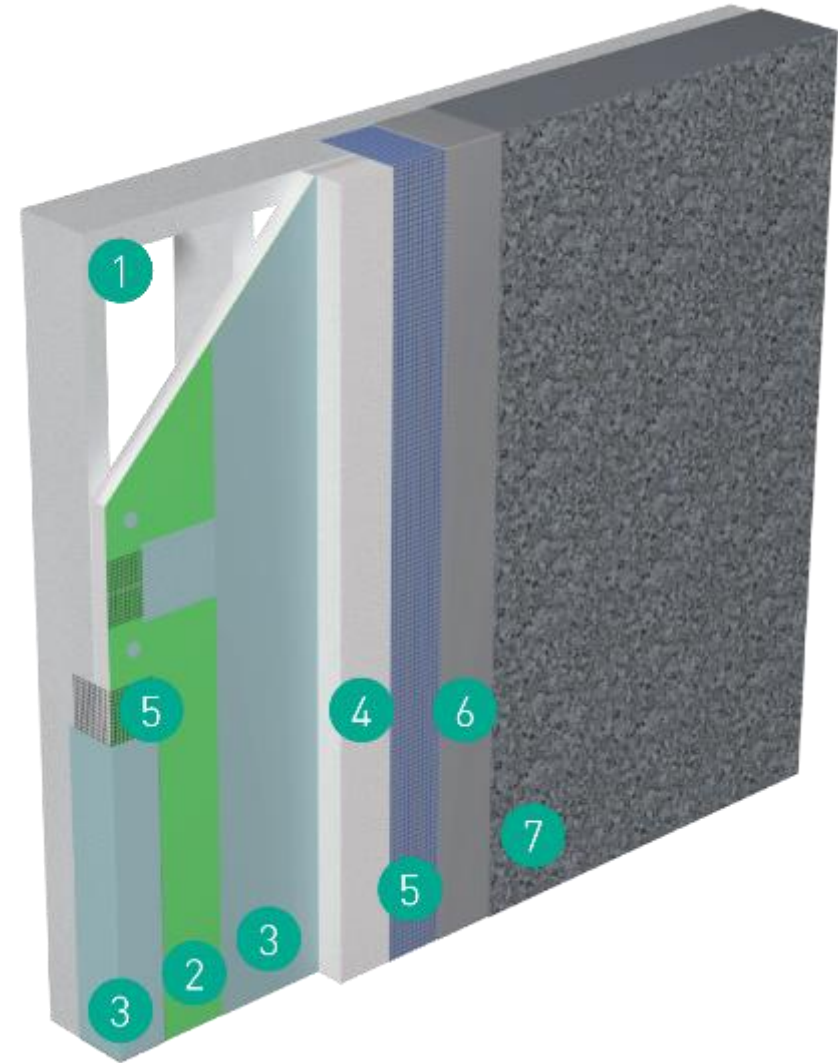
Full Composite Framed

1. Light Gauge Steel Framing
2. Approved Sheathing
3. Air/Water-Resistive Barrier Coating
4. Expanded Polystyrene Insulation (EPS)
5. Reinforcing Mesh
6. Base Coat
7. Finish



Full Composite Framed: Attributes

- Typical weight 7 lbs./sf (approx.)
- Most versatile panel system
- Designed for structural framing, connections and building code requirements through Panel Fabricator Engineer/Shop Drawings
- Deflections are limited to $L/240$
- Lightweight alternative to conventional systems
- AWRB – Integrated component
- Drainage capacity may be incorporated



Full Composite Framed: Assembly Steps



Cold
Formed
Steel
Framing



Sheathing



Air and
Water-
Resistive
Barrier



Rough
Opening
Preparation

Prefabricated EIFS-Clad Panels Full Composite Framed

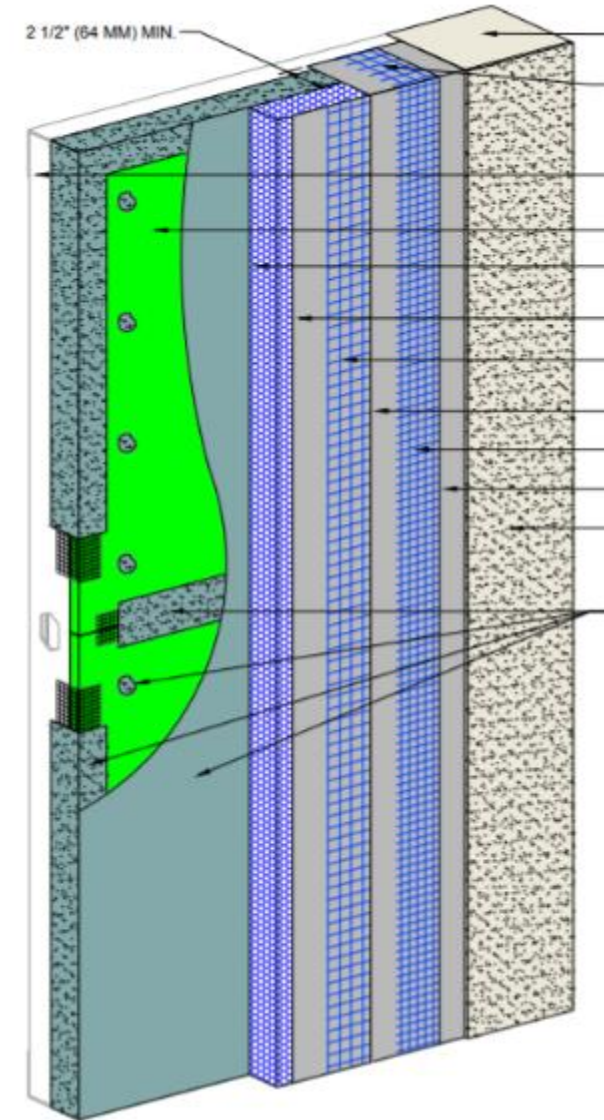


Options for Enhanced Durability and Performance



Enhanced Durability: Impact Resistance

- Impact Resistance through reinforced mesh
- Ultra-High Impact Reinforcing Mesh (**10x the impact resistance of a standard panel face**)
 - Reinforcing mesh installed in 2 individual layers
 - 4.3 oz. / sy reinforcing mesh installed over 20 oz. / sy reinforcing mesh



Enhanced Performance: Hydrophobic

- Available in both textured finish and paint coatings
 - Beads and repels water
 - Reduces dirt pick-up
 - Lends to cleaner surface



Enhanced Performance: High UV Fade Resistance Colorant



Enhanced fade
resistance



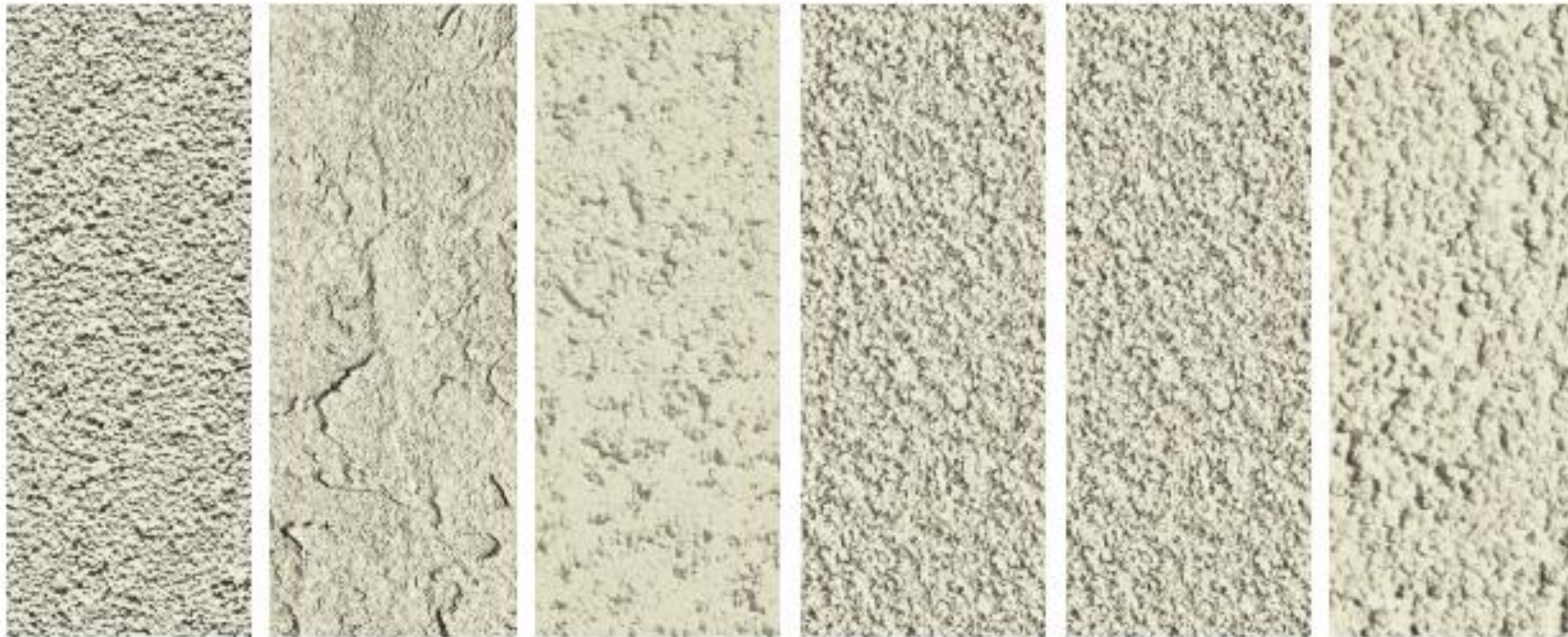
Enabling high profile,
brand imaging colors

Freedom for Architectural Style and Aesthetics



EIF System Acrylic Finishes – Textures

STANDARD TEXTURES



SPECIALTY TEXTURES



Limitless Color

Colorfast:

- Enhanced UV Resistance through High Performance Colorants

Performance

Enhancements:

- Dirt Pick-Up Resistance, Elastomeric, Hydrophobic, Lightweight

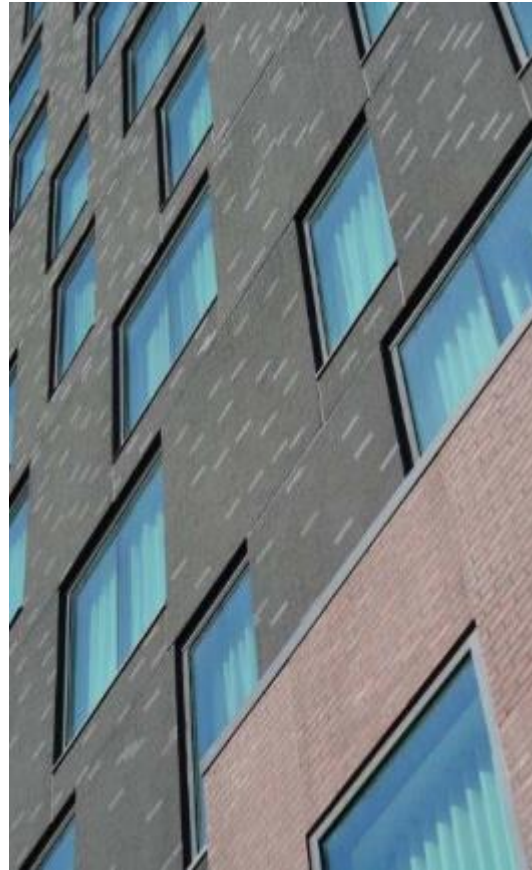
Textures and Coatings



Unlimited Options for Aesthetic Appearance



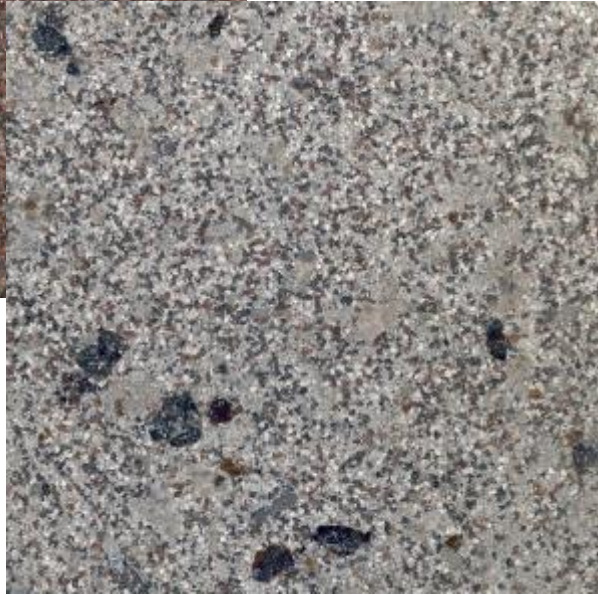
Unlimited Aesthetic Options: Template Brick



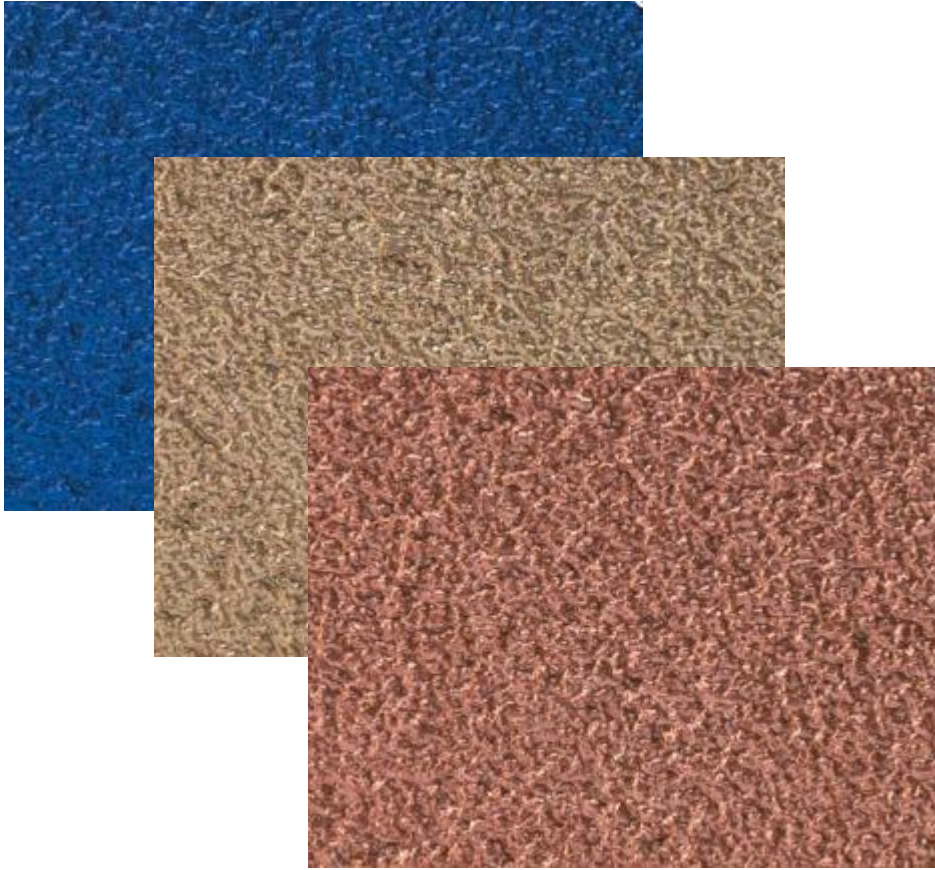
Unlimited Aesthetic Options: Limestone Texture



Unlimited Aesthetic Options: Polished Granite



Unlimited Aesthetic Options: Pearlescent/Metallic



Unlimited Aesthetic Options: Weathered Steel



Unlimited Options for Aesthetic Appearance



Case Studies



CHALLENGING CONVENTIONAL CONSTRUCTION

Our Approach



An Industrialized Approach...

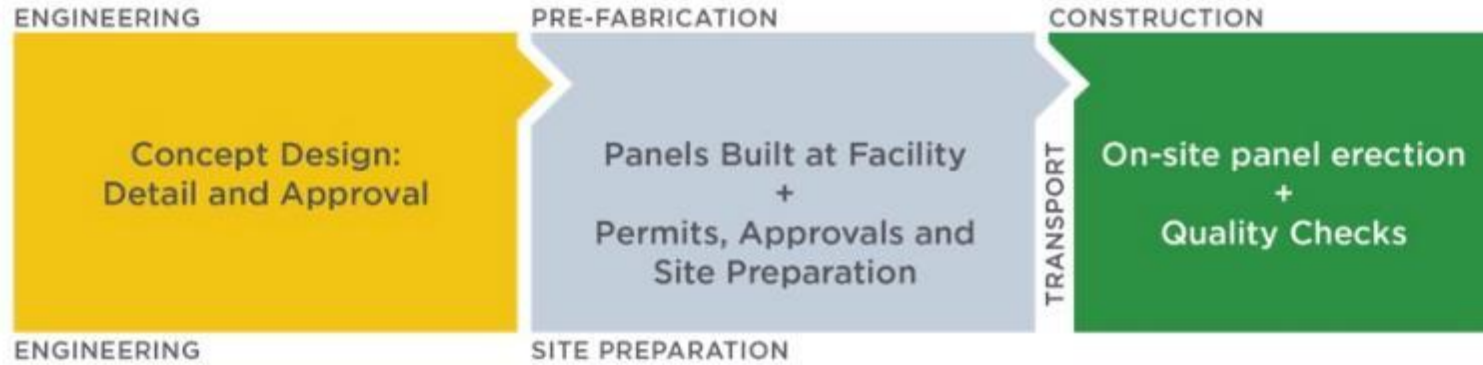
Up Right

Introducing...Up Right!

A new line of video content produced by the C&S Team; designed to bring you into the world of panelized construction while keeping you updated on all of C&S's projects by bringing the action to you!

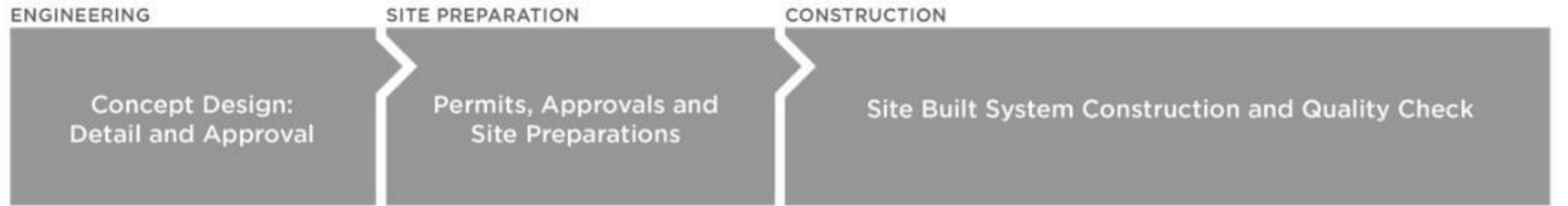
Up Right will tackle everything from conversations about exciting construction innovations, walk-throughs of construction sites, drone fly-overs, and even some exclusive content from right here in the factory!

OFF-SITE BUILD



START ————— FINISH

ON-SITE BUILD



Neenah - Mixed Use

The Neenah, WI - Mixed Use Building is a prime example of how industrialized construction is becoming the future of building. This project in Neenah, Wisconsin faces more weather challenges than we would here in the Midwest; however, C&S's controlled factory environment allows our shop team to perform the tasks of multiple trades under one roof, consistently controlling the quality of the build and helping to maintain the fast paced project schedule. Installation credit goes out to SMA Construction Services out of Green Bay, WI. It was a pleasure working for them on this project.





Hub at Cincinnati

- 14-story student housing tower
- Part of the \$500 million District at Clifton Heights



System Evaluation



**BUILDING
SCIENCE
LABORATORY**

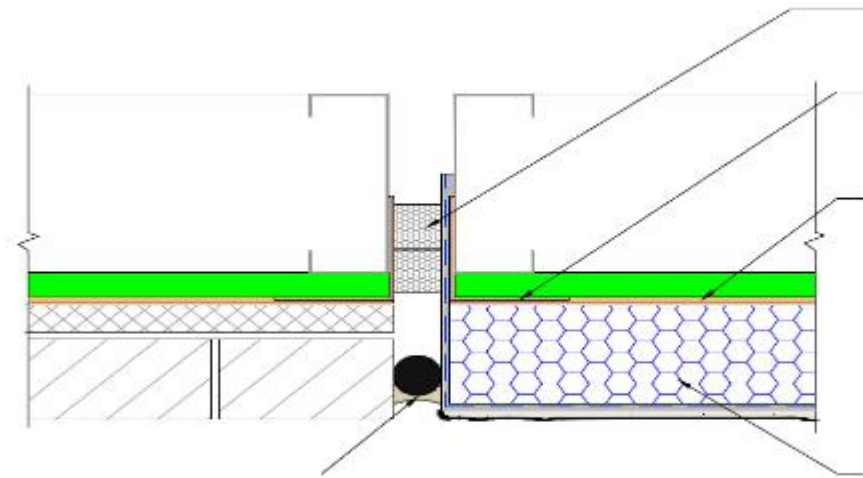


CORE & SHELL
BUILDING CO.
UP RIGHT.



Test Results

Test Standard	Duration (minutes)	Result
ASTM E283	n/a	Pass
ASTM E331 @ 2.86psf	15	Pass
ASTM E331 @ 6.2psf	120	Pass
ASTM E331 @ 9psf	15	Pass
ASTM E331 @ 12psf	15	Pass
ASTM E331 @ 15psf	15	Pass
ASTM E331 @ 18psf	15	Pass
ASTM E331 @ 21psf	15	Pass
ASTM E331 @ 25psf	15	Pass
ASTM E331 @ 52psf	15	Pass





PF100



Summary and Review

1. Recognized offsite construction and pre-fabrication terminology and benefits
2. Understand the roles of the project team and stake holders and need to meet as early as possible in the construction planning and process
3. Review of the off-site process to maximize impact
4. Lessons learned from the case studies





Construction Products Group

