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Senior Architect / Senior Associate





Colton Howard, CEI

Senior Facilities Professional





Trevor Brown, LEED AP

Regional Quality Director



Prefabricated Exterior Wall Assemblies: Herding Cats in Hard Hats

Prefabrication of exterior wall assemblies has been explored since the 1920s and 1930s, so the concept of their use is nothing new to the built environment. However, consideration of the effects on the air, water, and thermal boundaries of buildings are the concerns of the construction industry for the 21st century. No matter if the wall assembly is constructed in the field or in a shop, it must have continuity in their air, water, and thermal barriers. Prefabricated exterior wall assemblies are designed and constructed to meet these requirements. In this presentation, our goal will be to introduce two perspectives on the use of prefabricated exterior wall assemblies. One is the General Contractor's experience with prefabricated exterior wall assemblies and the delegated design process. The other is the experience of the building enclosure consultant reviewing the design and observing the fabrication and erection of these wall systems. Case studies will be reviewed with respect to code and/or industry association inspection requirements, design and construction reviews, and lessons learned in the coordination of these assemblies with other trades.



Kayla Maines, AIA

7 years with Terracon
17 years in the Architectural industry
Registered Architect in Texas and Oklahoma, Legacy
LEED AP, and Building Enclosure Commissioning
Provider (BECxP) and a Commissioning Authority
+Building Enclosure (CxA+BE). Served on the Austin
AIA BEC, IIBEC, and CSI boards.

Colton Howard, CEI

3 years with Terracon
16 years in the construction industry
performs investigative testing and surveys of roofing
and waterproofing components to identify
deterioration and probable sources of water
infiltration, generates reports of observations and
findings with recommendations and cost estimates,
and design repairs and renovations for building
envelopes. Colton also oversees the different ASTM
and AAMA standard tests or specialized testing.

Trevor Brown, LEED AP

18 years with JE Dunn Construction
25 years in the Construction Quality profession
As an experienced Quality Director, he has a proven
track record in the construction industry, showcasing
his expertise in Building Envelope Design,
Constructability Reviews, Mock-ups, Construction
Processes, Pre-construction Activities, Team
Leadership, Teaching/Training, and Contract
Management.



Learning Objectives

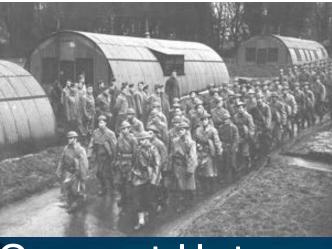
- 1. Describe the history and different types of prefabricated exterior wall panels.
- 2. Contracting and coordinating the delegated design process with the applicable trade partners. Turn-Key, Means & Methods, and discuss who owns the details.
- Applicable codes and standards. Explore how to test and inspect these assemblies.
- Demonstrate the process of designing and construction of the prefabricated exterior wall assembly and how it incorporates the air, thermal and water barriers within it.



Where we have been,
Where we are at,
and
Where we are going



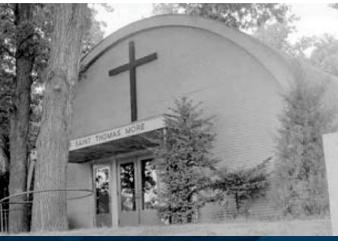




Quonset Huts





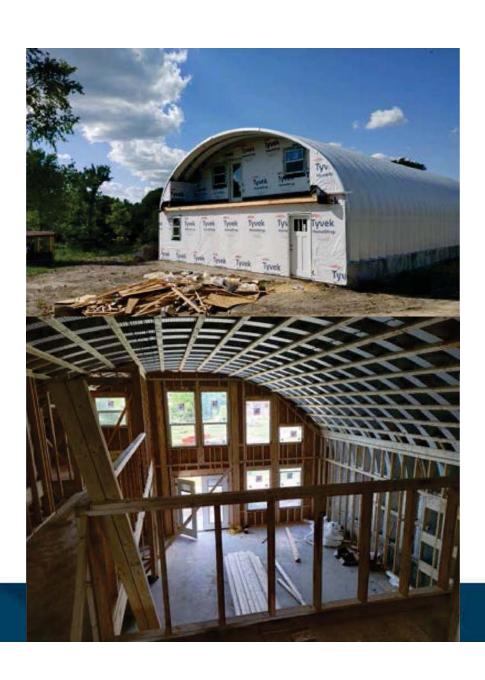




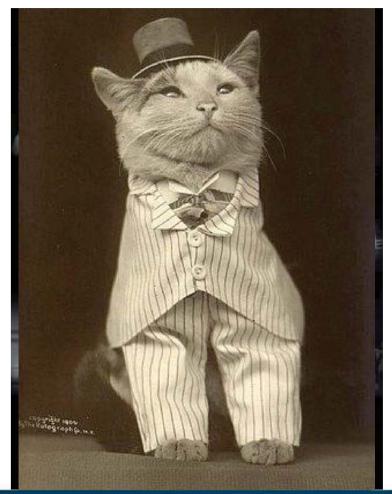




60123 My Friend's House



Carl Strandlund



(Albert) Carl Koch, Jr.



A tale of two Carl's

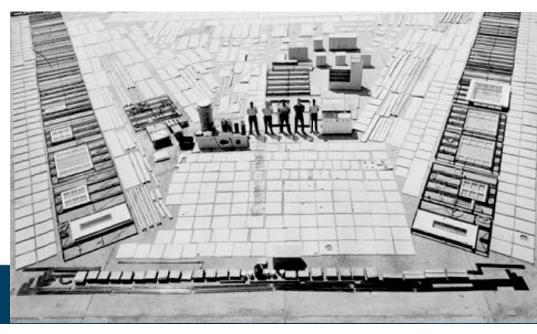


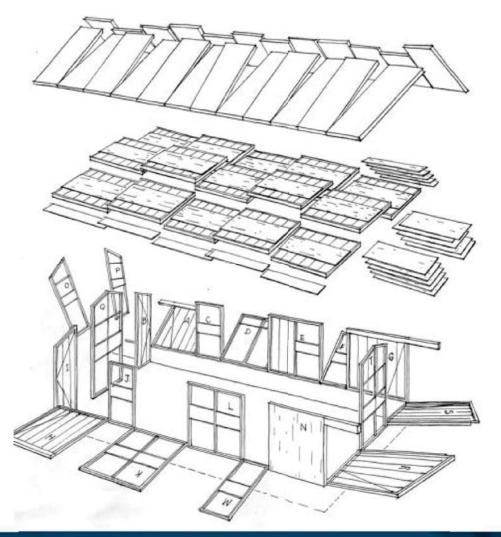








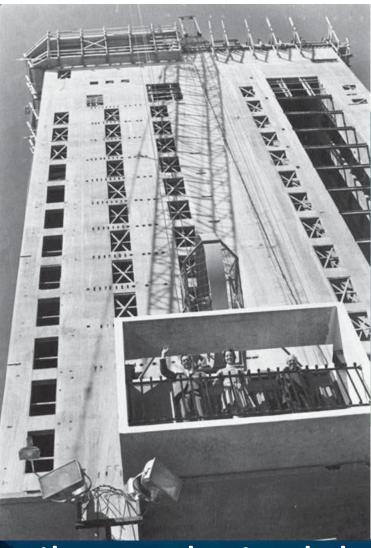








Techbuilt House







Hilton Palacio del Rio







Off-Site Construction Council

Report of the Results of the 2018 Off-Site Construction Industry Survey



An Authoritative Source of Innovative Solutions for the Built Environment

NEW DAY, NEW MINDSET

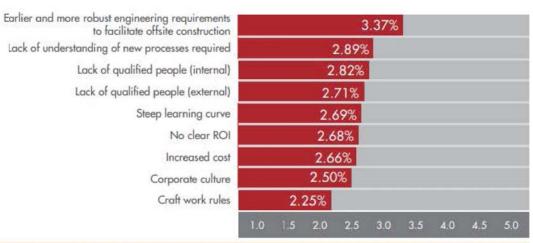
RETHINKING OFFSITE CONSTRUCTION

2018 FMI/CURT/CII Owner Survey

FMI



RANKING OF OFFSITE CONSTRUCTION IMPEDIMENTS THAT ARE MOST IMPORTANT TO PROJECT SUCCESS



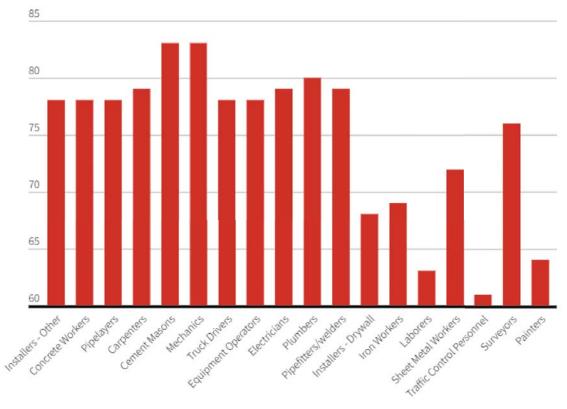
RANKING OF OFFSITE CONSTRUCTION BENEFITS THAT ARE MOST IMPORTANT TO PROJECT SUCCESS



Source: 2018 FMI/CURT/CII Offsite Construction Owner Survey



% of Contractors Having Increased Difficulty Filling Craft Positions



SOURCE:

U.S. Bureau of Labor Statistics

AGC Labor Survey - 2024

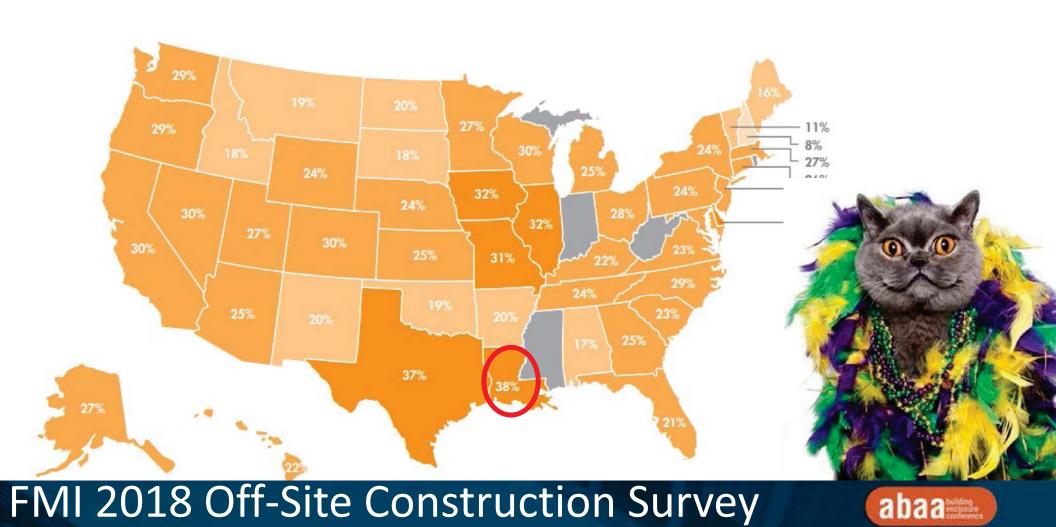


State	Number of Projects in State
Alabama	3
Alaska	2
Arizona	7
Arkansas	2
California	21
Colorado	6
Connecticut	3
Delaware	4
Florida	34
Georgia	5
Hawaii	1
Idaho	6
Illinois	7
Indiana	8
Iowa	5
Kansas	1
Kentucky	2
Louisiana	4
Maine	1
Maryland	10
Massachusetts	10
Michigan	10
Minnesota	2
Mississippi	5
Missouri	6

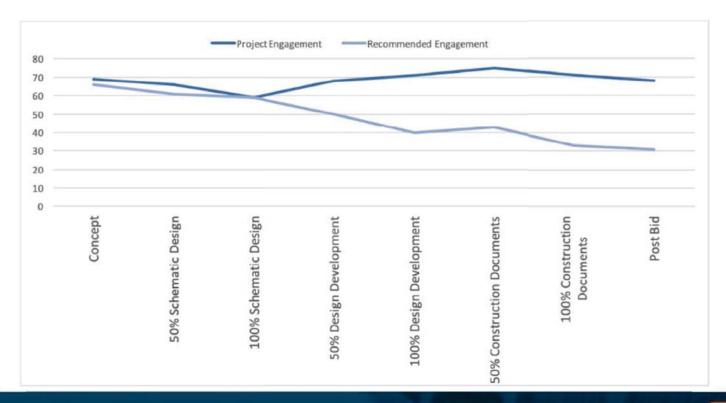
State	Number of Projects in State
Nebraska	3
Nevada	2
New Hampshire	2
New Jersey	12
New Mexico	2
New York	15
North Carolina	9
North Dakota	3
Ohio	18
Oklahoma	4
Oregon	7
Pennsylvania	1
Rhode Island	4
South Carolina	4
South Dakota	1
Tennessee	4
Texas	12
Utah	8
Vermont	1
Virginia	8
Washington	30
West Virginia	2
Wisconsin	4
Wyoming	5
Canada	4

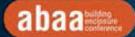
NIBS 2018 Off-Site Construction Survey





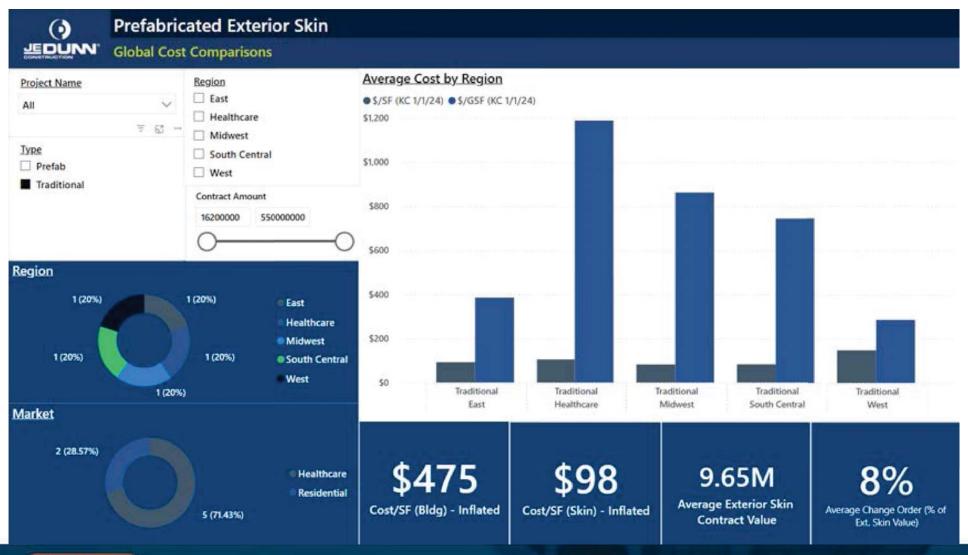
For the considered project, when did you collaborate with the contractor performing the off-site work and, based on your experience, when do you recommend engaging the off-site contractor?









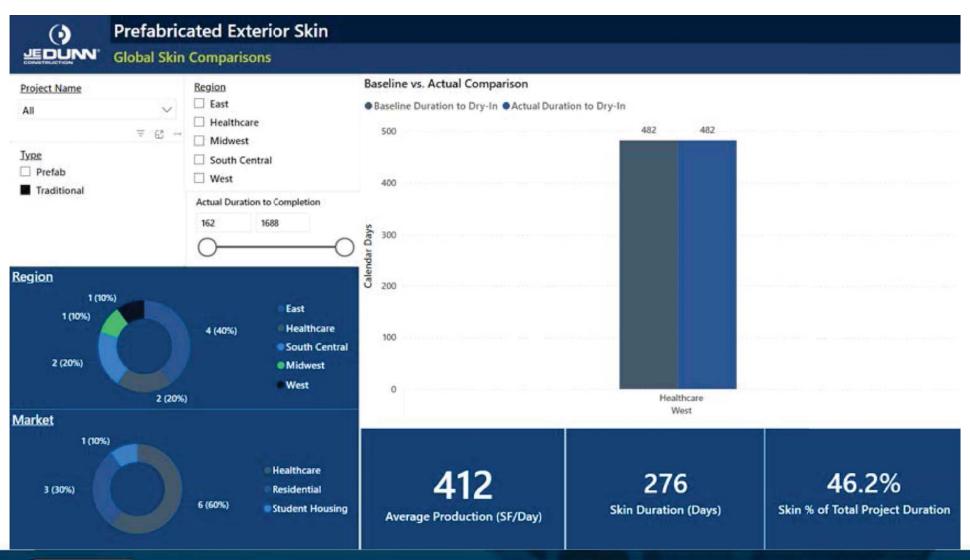
















Contracting and Coordinating

Delegated design process
Turn-Key, Means & Methods,
and
Who owns the details?

Pursue the Project: Discuss prefab in the pursuit strategy.

Note: Early Involvement is Key for success. (Precon agreement.)

Post/ Project Award: Make sure to align client expectations with prefab in the contract.

Set Expectations: Hold meetings to get buy-in on prefab elements.

Preconstruction: Develop Bid Packages/ Schedules for prefab elements for internal and external team members.

Trade Partner Buy Out: Bids should be based on early SD Packages for feasibility. Have a post-bid interview to review the scope. Will you need a mock-up. Buy out turn-key systems.

Prefab Meetings & Design: Trade partners should be included in design assist meetings to enhance coordination and ensure success.

Engineering/ Detailing and Shop Drawings: Get shop drawing approvals prior to fabrication.

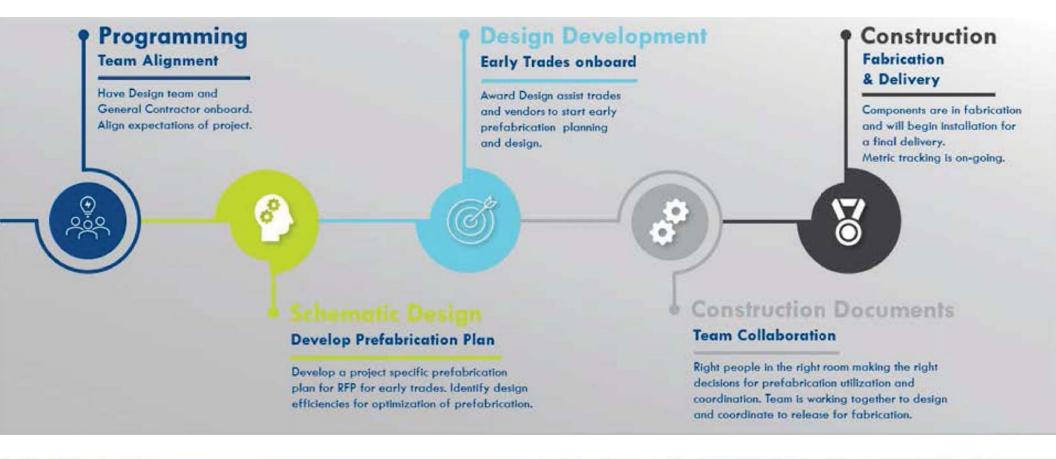
Fabrication & Install: QC the process. Document success/ failures.





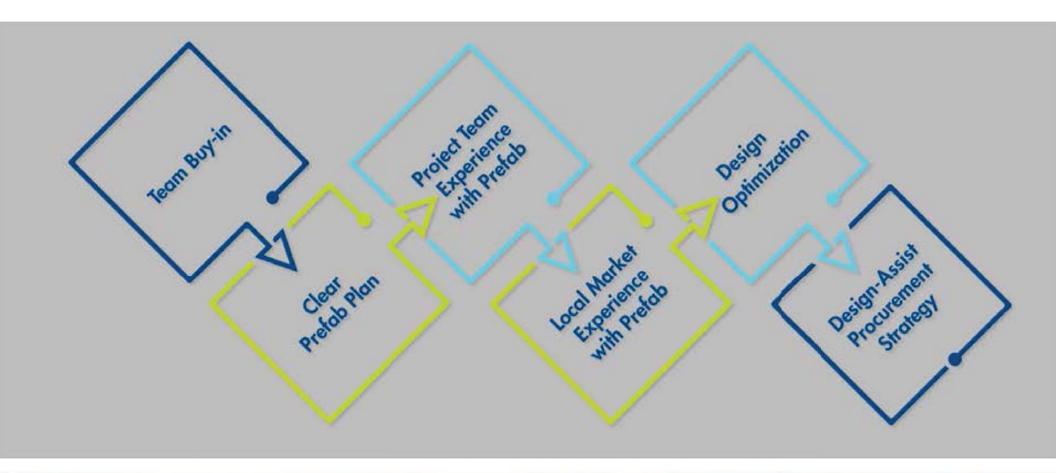
What's the Process?





abaa building enclosure conference

Feasibility



Feasibility





DELEGATED DESIGN: A FORM OF
COLLABORATION BETWEEN A DESIGN
PROFESSIONAL AND CONTRACTOR OR TRADE
PARTNER WHERE THE CONTRACTOR ASSUMES
RESPONSIBILITY FOR AN ELEMENT OR PORTION
OF THE DESIGN.



DEFERRED SUBMITTAL: THE DOCUMENTS
PRODUCED BY THE DELEGATED DESIGN THAT
WERE NOT SUBMITTED AT THE TIME OF PERMIT
APPLICATION. THESE DOCUMENTS MUST BE
REVIEWED BY THE REGISTERED DESIGN
PROFESSIONAL IN RESPONSIBLE CHARGE PRIOR
TO SUBMISSION TO THE BUILDING
DEPARTMENT OR AUTHORITY HAVING
JURISDICTION (AHJ).

DEFERRED STRUCTURAL SUBMITTALS

SOME STRUCTURAL SYSTEMS ARE DEFINED AS VENDOR-DESIGNED COMPONENTS PER THE STRUCTURAL DOCUMENTS. THESE ELEMENTS OF THE DESIGN ARE DEFERRED SUBMITTAL COMPONENTS AND HAVE NOT BEEN PERMITTED UNDER THE BASE BUILDING APPLICATION. THE CONTRACTOR WILL BE REQUIRED TO SUBMIT THE STAMPED COMPONENT SYSTEM DOCUMENTS TO THE BUILDING OFFICIAL FOR APPROVAL.

DOCUMENTS FOR DEFERRED SUBMITTAL ITEMS SHALL BE SUBMITTED TO THE ARCHITECT, WHO SHALL REVIEW THEM FOR GENERAL CONFORMANCE TO THE DESIGN OF THE BUILDING. THE CONTRACTOR SHALL SUBMIT THESE REVIEWED DEFERRED SUBMITTAL DOCUMENTS TO THE BUILDING OFFICIAL. THE DEFERRED SUBMITTAL ITEMS SHALL NOT BE INSTALLED UNTIL THE DESIGN AND SUBMITTAL DOCUMENTS HAVE BEEN APPROVED BY THE BUILDING OFFICIAL.

THE FOLLOWING LIST INCLUDES THE ITEMS THAT ARE DEFINED AS DEFERRED STRUCTURAL SUBMITTAL COMPONENTS. REFER TO THE ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND CIVIL DRAWINGS FOR ADDITIONAL DEFERRED SUBMITTAL COMPONENTS.

DEFERRED STRUCTURAL SUBMITTAL COMPONENTS:

EXTERIOR CLADDING

METAL STUD SYSTEMS

METAL STAIRS AND LANDINGS

BUILDING MAINTENANCE SYSTEMS

PATIENT LIFTS

LOUVER SUPPORTS

MEDICAL EQUIPMENT SUPPORTS

DESIGN-BUILD SHORING WALLS

MEPF SUPPORTS AND BRACING

Delegated Design



Who owns the details?

Designers are legally held to a professional standard of care.

Contractors are legally held to substantially perform their contractual obligations.

Design delegation creates a hybrid of these roles.

Answer: Depends on the State.



Delegated Design



ConsensusDocs' new delegated design provisions recognize that a delegated design must meet the applicable standard of care for design but that such design cannot be relied upon to be perfect. The AIA A201 general conditions document, inadequately addresses delegated design. However, one thing that is clear in AIA contracts is that an architect is protected from inaccuracies in a delegated design because an architect can fully rely upon the accuracy of a delegated design produced by a contractor's design professional. In contrast, an owner can only rely upon the accuracy of its architect's design documents to meet the applicable standard of care, which has been recognized to have an acceptable error rate. These inconsistent standards produced by the AIA contract documents are unfair to an owner and insulate an architect from liability while protecting their authority. The new ConsensusDocs require design coordination between the project's overall design and the delegated design elements. The updates also provide a consistent standard of care for these design elements for delegated design.

The AIA and ConsensusDOCS form agreements both include language relating to the general apportionment of responsibility and the overall process for design delegation between the project participants. *See*, AIA A201-2017, Section 3.1.12.10.1; ConsensusDOCS 200, Section 3.15.

The ConsensusDOCS 200 – Agreement and General Conditions between Owner and Constructor, Section 3.15 (2017) provides:

DESIGN DELEGATION. If the Contract Documents Specify that Constructor is responsible for the design of a particular system or component to be incorporated into the Project, then the Owner shall specific all required performance and design criteria. Constructor shall not be responsible for the adequacy of such performance and design criteria. As required by the Law, Constructor shall procure design services and certifications necessary to satisfactorily complete the Work from a licensed design professional. The signature and seal of Constructor's design professional shall appear on all drawings, calculations, specifications, certifications, shop drawings, and other submittals related to the Work designed or certified by Constructor's design professional.

The AIA General Conditions – AIA A201-2017, Section 3.12.10.1 provides:

If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional.

Delegated Design

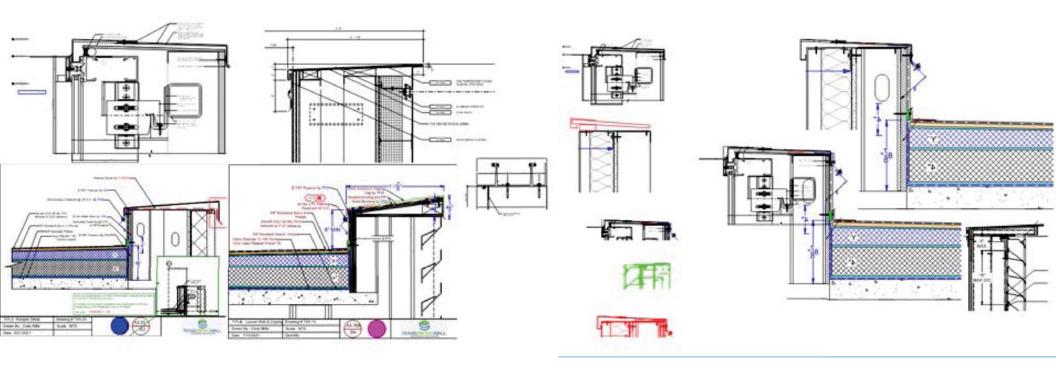




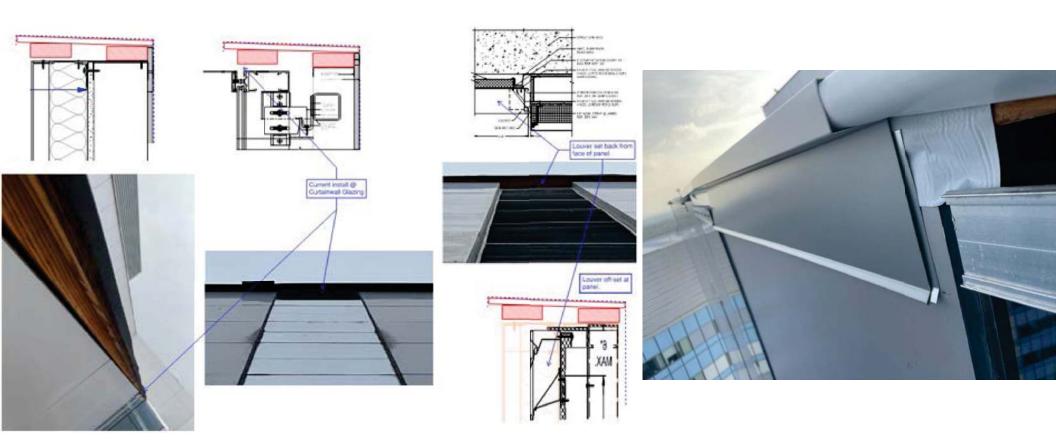


Fully Coordinated Details









Fully Coordinated Details







Fully Coordinated Details



Looking for the (3) Leak Locations:

Change in Plane/Direction or has Movement.

Change in Trade Partner.

Change in Material/Scope of Work.

The Field Verify Evil 3 Locations:

Any location where (3) building components or systems come together.

Think in 3D (height, width, & depth to adjacent materials)

Building Envelope Coordination is all about maintaining continuity of the (4) control layers.

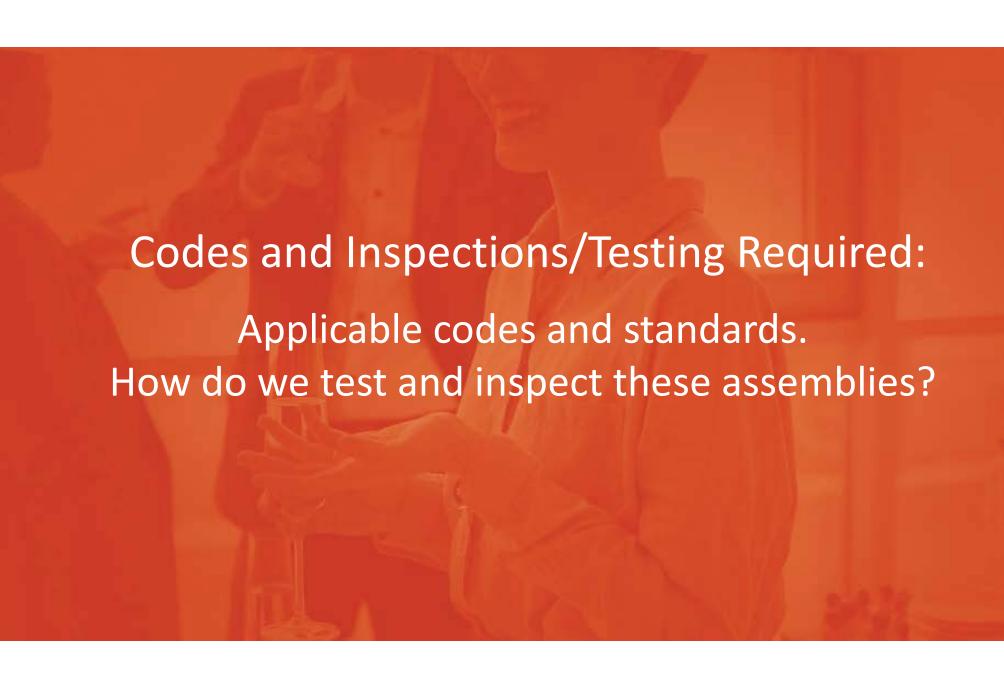
If there are more than (2) details for one element it needs to be coordinated.

Structural/ Architectural Architectural/ Shop Drawing Shop Drawing/ Manufacturer Detail



Fully Coordinated Details





• IBC 2024: 1705.17 Exterior Insulation and Finish System (EIFS)

(around since 2000)

Special inspections shall be required for all EIFS applications.

EXECPTIONS:

- 1. Special inspections shall not be required for EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior.
- 2. Special inspections shall <u>NOT</u> be required for EIFS applications installed over **masonry or concrete walls.**
- 1705.17.1 Water-Resistive Barrier Coating (added in 2009 IBC)

A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a **sheathing substrate**.



Codes



IECC 2021: Building Enclosure

- C402.5 Air Leakage Thermal Envelope:
- 1. The building thermal envelope shall comply with Sections C402.5.1 through C402.5.11.1,
 - a. C402.5.1.5 Requires Performance Verification and C402.2 and C402.3 Requires Testing)
 - b. <u>C402.5.1.2 Exceptions Identifying Zones with the Option of:</u>
 - i. Verification Only
 OR
 - ii. Testing

OR

2. The building thermal envelope shall be tested in accordance with Section C402.5.2 or C402.5.3 (whole building air leakage testing). Where compliance is based on such testing, the building shall also comply with Section C402.5.7, C402.5.8, and C402.5.9.

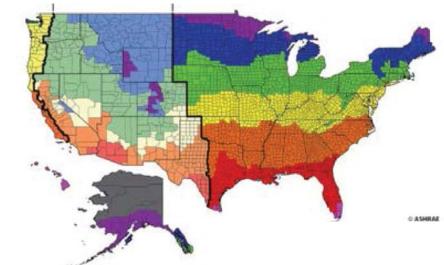


- <u>IECC 2021: C402.5 Air Leakage Thermal Envelope: Performance Verification and Testing Method C402.5.1 through C402.5.11.1</u>
- C402.5.1 Continuous Air Barriers
 - Air Barrier Construction C402.5.1.1, Air Barrier Compliance C402.5.1.2, Air Barrier Materials C402.5.1.3, and Assemblies C402.5.1.4, and Performance Verification C402.5.1.5
- C402.5.2 Dwelling and Sleeping Unit Enclosure Testing
- C402.5.3 Building Thermal Envelop Testing
- C402.5.3 Building Thermal Envelope Testing
- C402.5.4 Air Leakage of Fenestration
 - Refer to Table C402.5.4
- C402.5.5 Rooms Containing Fuel-Burning Appliances
- C402.5.6 Doors and Access Openings to Shafts, Chutes, Stairways and Elevator Lobbies
 - From conditioned space to shaft needs to be gasketed, weather-stripped or sealed
- C402.5.7 Air intakes, Exhaust Openings, Stairways and Shafts
- C402.5.8 Loading Dock Weather Seals
- C402.5.9 Vestibules
- C402.5.10 Recessed Lighting
- C402.5.11 Operable Openings Interlocking

- IECC 2021: C402.5 Air Leakage Thermal Envelope: Air Barrier Compliance C402.5.1.2
- A continuous air barrier for the opaque building envelope shall comply with the following:
 - 1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2 Dwelling and Sleeting Unit Enclosure Testing.
 - Exception: Buildings in Climate Zone 2B Hot dry, 3C Warm Marine, and 5C Cool Marine.
 - 2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of section C402.5.3 **Building Thermal Envelope Testing.**

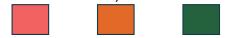
Exceptions:

- 1. Buildings in Climate Zones 2B, 3B, 3C, and 5C.
- 2. Buildings larger than 5,000 sf floor area in Climate Zones 0B, 1, 2A, 4B, and 4C.
- Buildings between 5000 sf and 50,000 sf floor area in Climate Zones OA, 3A, and 5B.
- 3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 materials or C402.5.1.4 assemblies in addition to C402.1.5.5 verification.



Exceptions Zones:

Note 1. 1. 2B Hot Dry, 3C Warm Marine, 5C Cool Marine.



Note 2.1. 2B Hot Dry, 3B Warm Dry, 3C Warm Marine, 5C Cool Marine.









Note 2.2. OB Extremely Hot Dry, Both 1A and B Very Hot Humid and Dry, 2A Hot Humid, 4B Mixed Dry, and 4C Mixed Marine









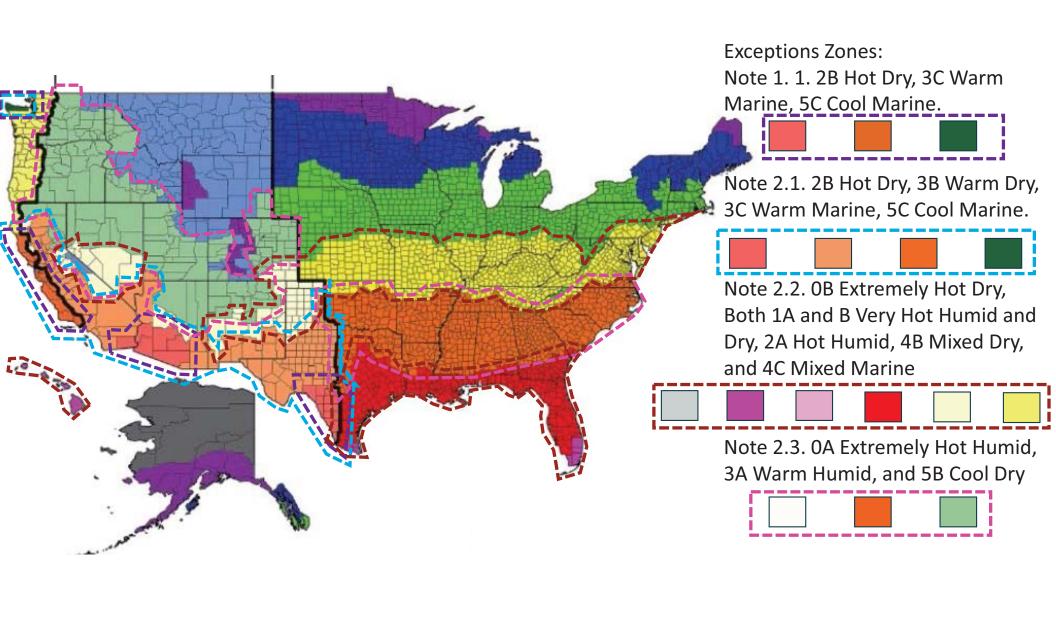


Note 2.3. 0A Extremely Hot Humid, 3A Warm Humid, and 5B Cool Dry









C402.5 Air Leakage – Thermal Envelope: Performance Verification Method C402.5.1.5

- Continuous air barrier shall be verified
 - by the code official, a registered design professional, or approved agency
 - 1. A review of the construction documents and other supporting data shall be conducted to assess compliance with C402.5.1.

Drawings, Specifications, Submittals, Shop Drawings

- 2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with C402.5.1.3 and C402.5.1.4.
- 3. A final commissioning report shall be provided for inspections completed by the registered design professional or approved agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the code official. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.



BECx Process



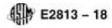
- Drawing & Specification Reviews BECx Specifications
- Functional Performance Checklist
- Product Submittal Reviews
- Preconstruction, Construction, and BECx Meetings
- Construction Monitoring
- Functional Performance Testing
- Owner and Maintenance Manuals and Warranty Review
- 10 Month Post Occupancy Site Observation and Meeting with Owner

Building Enclosure Commissioning (BECx) Standards

- ASHRAE Guideline 0
- NIBS Guideline 3 2012
- ASTM E 2813 Standard Practice for Building Enclosure Commissioning
- ASTM E 2947 Standard Guide for Building Enclosure Commissioning
- LEED v4.0, v4.1, and v5
- IECC 2018, 2021, and 2024

Building Enclosure Commissioning





Property	Standard Designation	Title	Lab	Enhanced		Fundamental	
			System Testing ^A	Field Mockup Testing ⁶	In-Situ Field Testing	Field Mockup Testing [#]	In-Situ Field Testing
		Water Penel	tration				52
Water penetration	ASTM E331	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	(M)		****	***	::00
	ASTM E514/ E514M	Test Method for Water Penetration and Leakage Through Masonry	OL	(OF)	(OF)	(QF)	(OF)
	ASTM C1601	Test Method for Field Determination of Water Pen- etration of Masonry Wall Surfaces	775	(OF)	(OF)	(OF)	(OF)
	ASTM D5957 ^J	Guide for Flood Testing Horizontal Waterproofing Installations	111	(OF)	(All horizontal surfaces)	(OF)	(All horizonta surfaces)
Static water penetration	ASTM E1105	Test Method for Field Determination of Water Pen- etration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference	***	(1X)	(2X)	(1X)	(1X)
Dynamic water penetration	AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure	OL (M)	(OF)	(1X)	(OF)	(OF)
	ASTM E2268*	Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference	OL	(OF)	(OF)	(OF)	(OF)
	AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems		(1X)	(1X)	(1X)	(1X)
-	STORY TO SERVE	Air Infiltra					
Air flow	ASTM E2319	Test Method for Determining Air Flow Through the Face and Sides of Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	OL	***	414	.537	***
Air leakage	ASTM E283	Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	(M)	9.50	***		
	ASTM E779 ^C	Test Method for Determining Air Leakage Rate by Fan Pressurization		+1+	(1X) ^C		(OF)

Recommended Testing Highly recommended you do not try reading this slide. May cause irritation at the presenters. Instead, obtain a copy of ASTM E2813 and refer to Table A2.1.

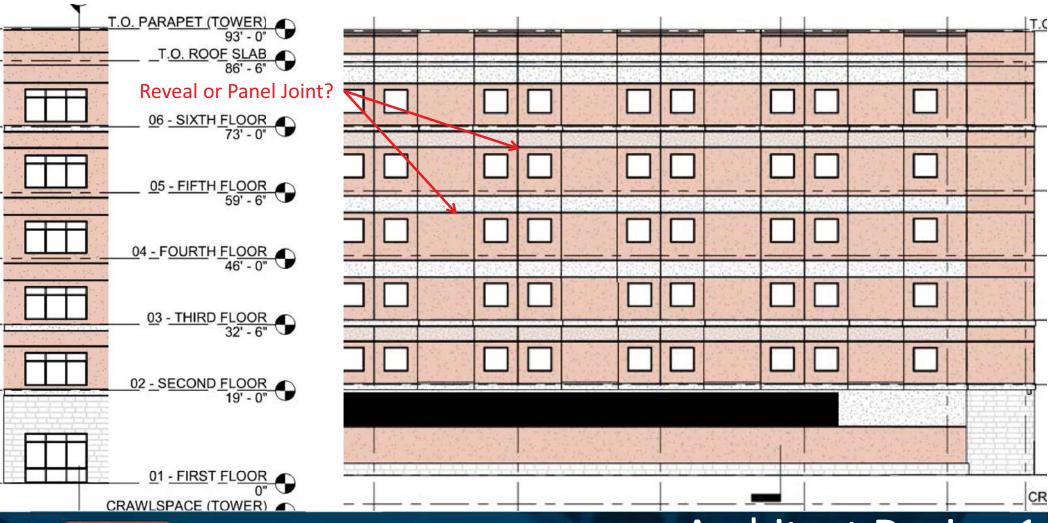
Have a meeting with the local Authority Having Jurisdiction (AHJ) as early as possible.

- Will the AHJ inspectors require any site visits to the prefabrication facility?
- What provisions will they need if the pre-fab facility is not local? Is video/ photo inspection acceptable?
- Will a 3rd Party inspection be required for a portion of the work? (Structural, Seismic, UL, etc.)
- Review the manufacturers certifications with the AHJ and confirm everything is up to date and code compliant.
- Is the facility required to be an approved fabricator in the jurisdiction of the product installation?
- What is the AHJ's process for delegated design? Who has final acceptance of the deferred submittals?
- Make sure the engineer of record for the delegated design is registered in the appropriate states required.
- What is the AHJ's expectations for review of the approved construction documents for deferred submittals?
- Will the AHJ require any testing at the prefab facility?

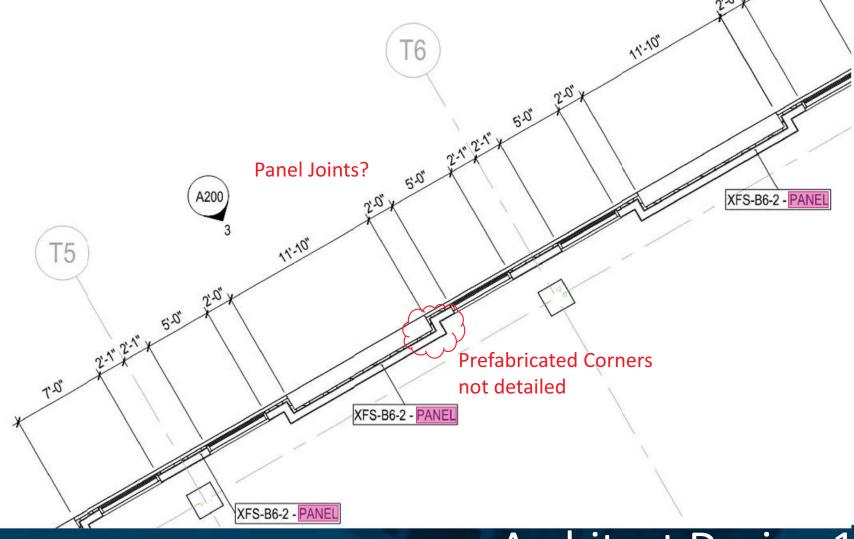


AHJ Coordination

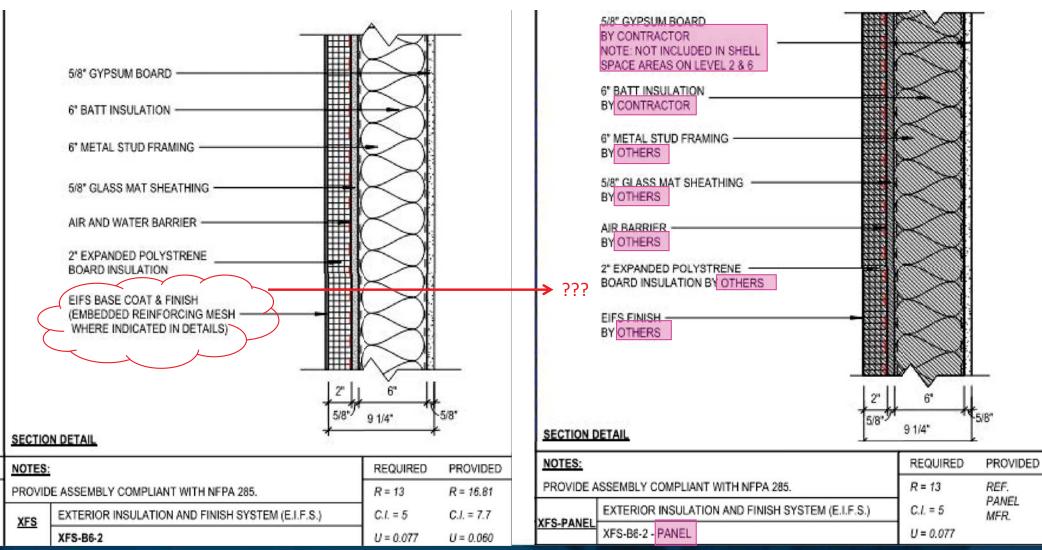




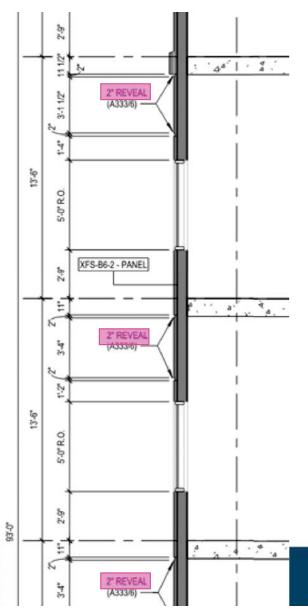
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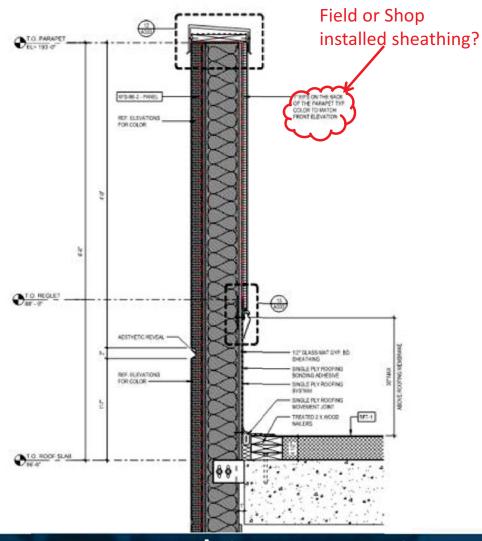




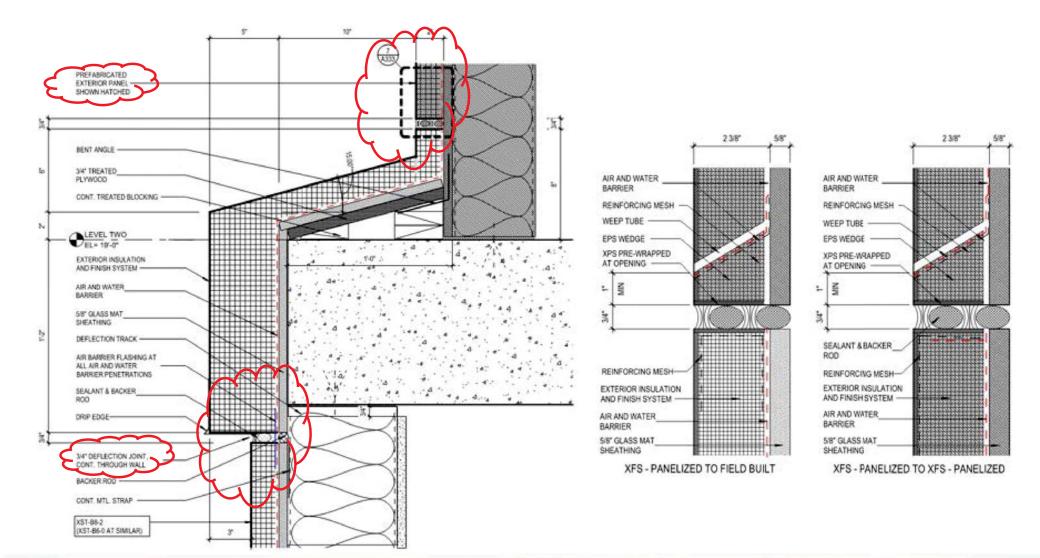




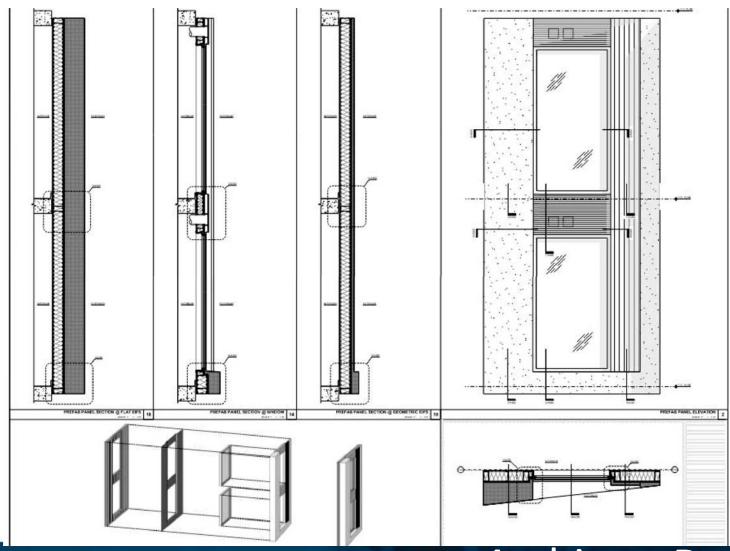




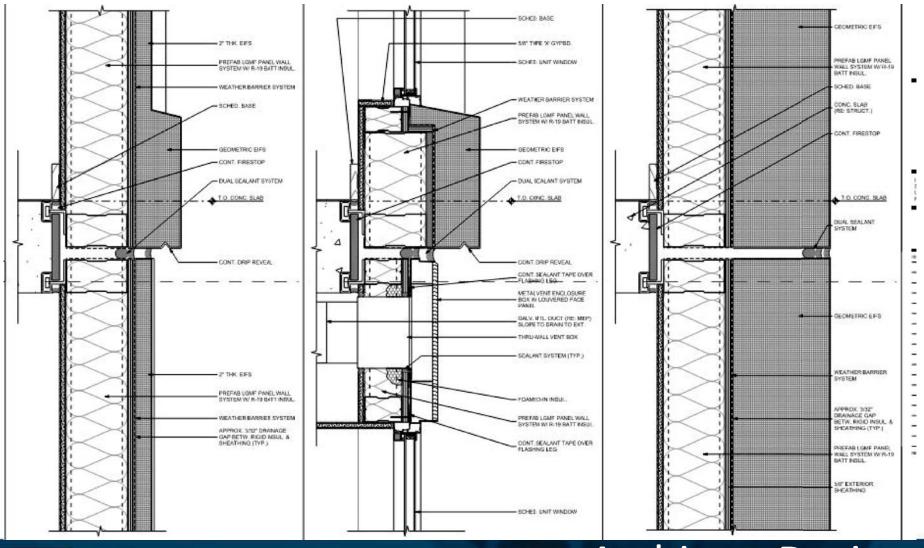
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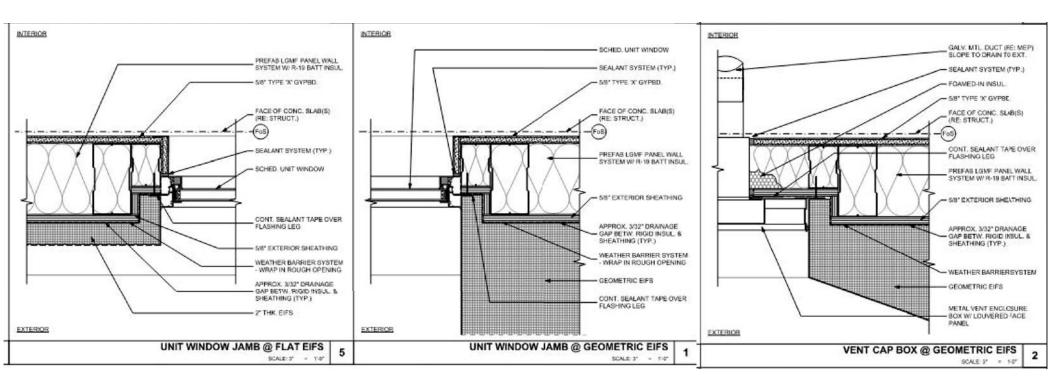




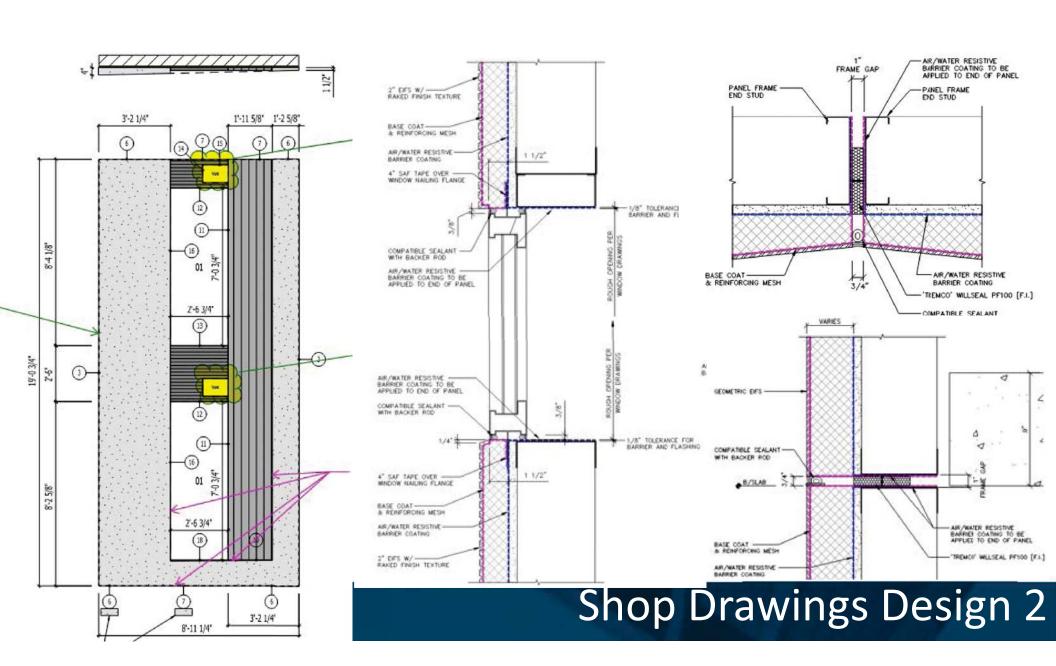




























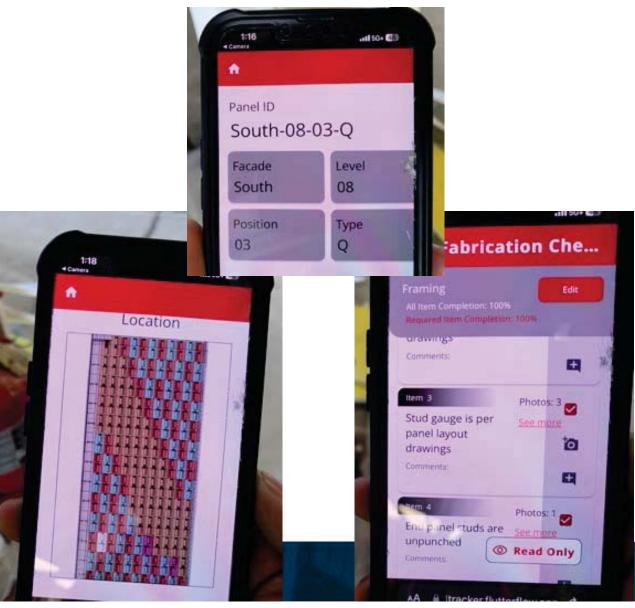


























Unsealed Splice Between Panels 10-04 and 10-05



Unsealed Splice Between Panels 10-11 and 10-12



Unealed Splice Between Panels 10-09 and 10-10



Unealed Splice Between Panels 10-17 and 10-18

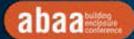








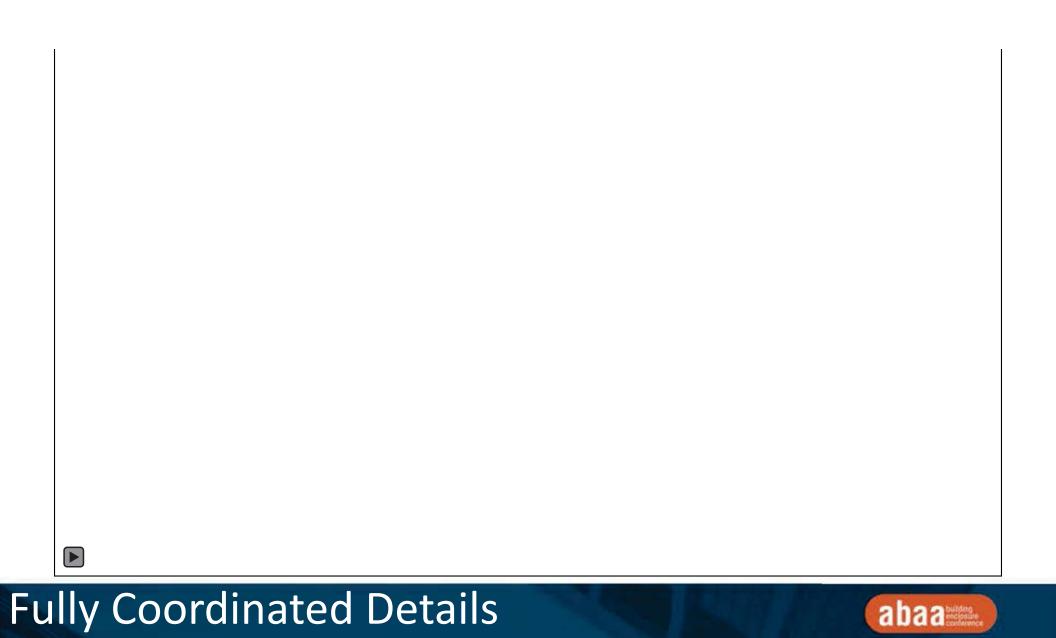
Fully Coordinated Details





Fully Coordinated Details





CAT PERSONALITIES by color



Friendly, affectionate, calm, trainable



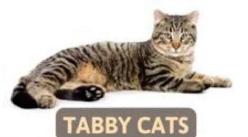
Unpredictable, mysterious, independent



Headstrong, bold, affectionate



Strong-willed, feisty, energetic



Active, bold, playful



POLL!!!



What cat color





Herding Cats in Hard Hats: Personality Types

The Regal Leader: Confident, authoritive, and center of attention. Makes decision, expects others to follow.	The Project Owner- The decision maker. They lead and we follow.
The Curious Explorer: Investigate new places, like to climb, get into everything, and very adventurous.	Roofing and Air Barrier Trade Partners- They tie-in to every other system. Not afraid to get messy.
The Lazy Lounger: Like to relax, laid back, and not exert much energy if they don't have to.	The Glazing Trade Partner- Won't start until everything is ready. Everything has to be purrrfect. Only focus on their stuff.
The Agile Hunter: Quick, nimble, and ready to pounce. Very active and like to play.	The Building Exterior Trade Partners- They jump through hoops to get things done all over the building.
The Social Butterfly: Love attention, enjoy being around people, very vocal. Thrive on social interaction.	Mason's, Stucco/ EIFS, Metal Panel Trade Partners- They are not afraid to let you know what they are doing on the job.
The Independent Thinker: Prefer to do things on their own, not easily swayed by others, and self-reliant.	The Architect and Design Team- Hard to convince there is a different way to do things.
The Protective Guardian: Watch the project, make sure things are safe and in order, very protective.	The General Contractor and Safety Team- Pretty rigid and protective. Like to keep things in their control.
The Gentle Giant: Big, fluffy, and gentle. Very calm and affectionate.	Envelope Consultants and Quality Team- They are knowledgeable and just want to help. Puurfectionists.

Thank you!



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