Is Wood-Frame Modular the Future of Multi-Family Construction?

Building Enclosure Design for Modular Construction

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Course Description

Modular construction is touted as an opportunity to combat rising interest rates and construction prices through greater efficiency, address skilled labor shortages, and reduce jobsite waste. However, some architects and engineers are hesitant to embrace the modular approach because they don't want their designs to be compromised, and they don't think it has the flexibility or functionality to execute certain project typologies. Presented by modular design experts from the west coast, this workshop will take a close look at modular wood-frame multi-family projects in particular. First, a Seattle-based architect will examine unique design considerations, detailing and sourcing techniques, and review the advantages and challenges of the design/delivery process. A California-based building enclosure consultant will then offer insights on the building enclosure functions of heat, air, and moisture control in wood-frame buildings, and apply these concepts to the realities of modular construction. Lastly, a structural engineer will focus on unique structural design considerations and constraints associated with modular projects, including load transfer, interfacing with manufacturers, construction sequence coordination, and third-party structural inspections.

Learning Objectives

1. Highlight potential benefits associated with the use of modular construction in multi-family buildings.
2. Discuss unique design considerations for modular projects, including room layouts, spans, fire resistance, and acoustic performance.
3. Determine how building enclosure functions, including heat, air and moisture control, differ for modular vs. traditional wood-frame projects.
4. Explore the potential for the increased use of modular approaches in wood-frame construction.

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Outline

1. The Building Science of Building Enclosures
2. Degrees of Pre-fabrication
3. Benefits and Challenges of Façade Design in Modular Construction
4. Façade Design Considerations for Modular Construction
5. Rain Water Protection during Stacking of Modular Units
6. Need for Factory and Field QA / QC

The Building Science of Building Enclosures

Building Enclosures separate indoors from outdoors, by controlling (i.e., *control functions*):

- **Water penetration**
- Heat flow
- **Air flow**
- Vapor diffusion
- **Condensation**
- Light and solar radiation
- Noise, fire, and smoke

HISTORICAL CHANGES*

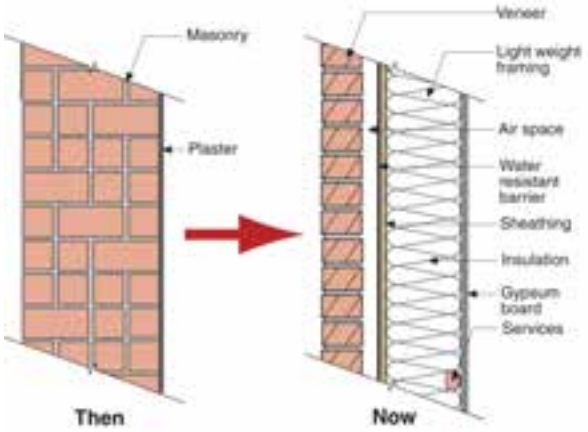
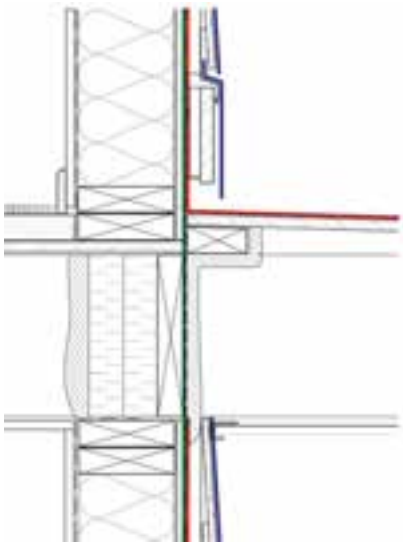


*Image from *High Performance Enclosures* by John Straube. Used with permission.

Continuity of Control Layers is Critical



Degrees of Pre-Fabricated Construction

1. Pre-Fabricated Components: Windows, HVAC equipment, etc.
2. Panelized: Wall Panels, Precast
3. Unitized: Curtain Wall, Finished precast or wall panels with windows
4. **Modular:** 6-sided boxes (Legos)

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Panelized Steel Stud Wall Frames

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Panelized Precast

Unitized Curtain Wall

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Modular Construction – 6 sided boxes

Benefits of Modular Construction

1. Lower cost (compared to field labor) and safer working conditions
2. Faster schedule (modules can be built while site is being prepared)
3. **Better quality in a controlled factory environment**
4. Reduced material waste
5. More trade availability than rural sites
6. **Reduced down-time due to weather**

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Where Does Modular Make Sense?

Modular is ideal for:

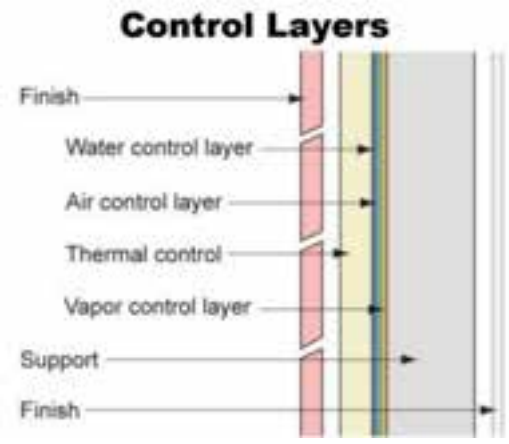
- Repetitive design
- Remote locations
- Locations where construction is disruptive

Modular may not be ideal for:

- Open floor layouts such as office spaces
- Complex floor plans

Building Enclosure Challenges of Modular Construction

1. What control layers are installed in the factory and on site?
2. How is continuity of the air/water barrier achieved between modules?
3. How to protect modules from rain before air/water barrier between units is made continuous?
4. How is detailing different from traditional construction?
5. Dimensional tolerances and on-site layout coordination
6. Structural coordination (waterproofing o/connection details)



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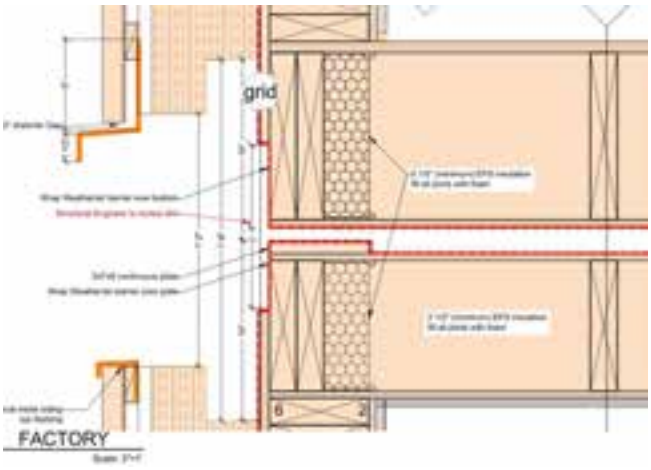
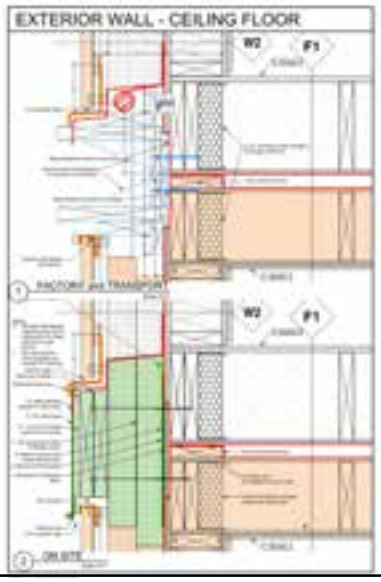
Cladding Considerations

1. Module alignment – coordinating factory and field tolerances to prevent misalignment.
2. Choosing a cladding system and attachment method that can accommodate misalignment when it happens.
3. Cladding installation in the factory or field.



What Enclosure Control Layers are Installed in Factory and On Site?

1. Air, water, thermal barrier continuity – plan for laps.
2. Expect the worse and hope for the best! At a minimum, install WRB, window/penetration flashings and a self-adhered membrane "roof" for weather protection.
3. Consider self-adhered or fluid-applied WRB to resist wind exposure.
4. Wrap all 6-sides of box for rain protection but also air barrier continuity.



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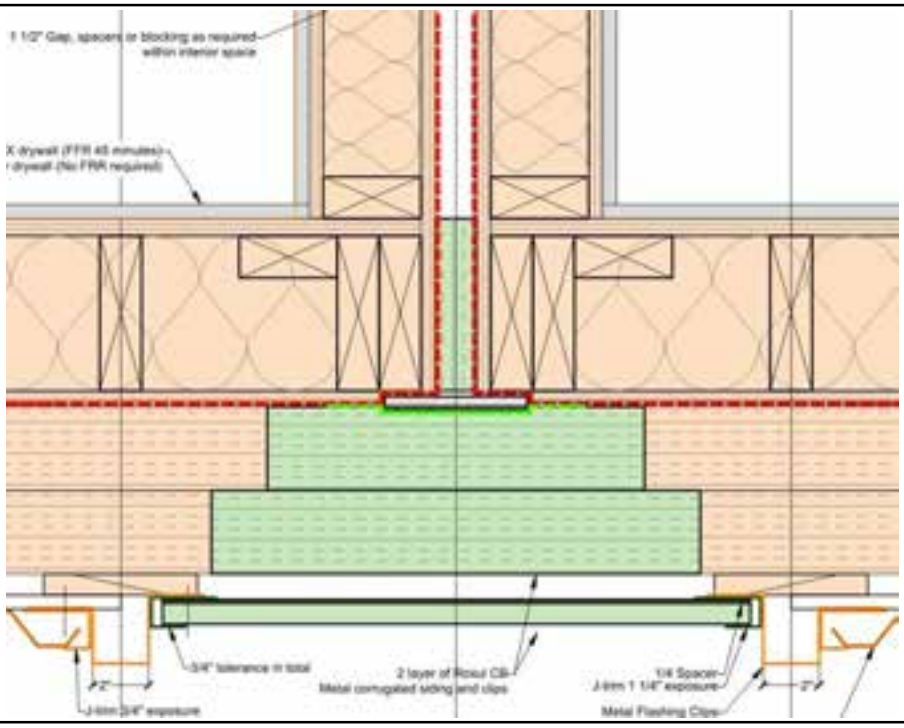
1 1/2" Gap, spacers or blocking as required within interior space
X drywall (FFR 45 minutes)
drywall (No FRR required)
3/4" tolerance in total
2 layer of Rosul CB
Metal corrugated siding and clips
1/4 Spacer
J-trim 1 1/4" exposure
2"
2"
J-trim 3/4" exposure
Metal Flashing Clips

19


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20

21

22

How to Protect Modules from Rain before Air/Water Barrier is made Continuous?

1. Protect from water intrusion within modules and between modules
2. Allow water to drain if it does get in
3. Avoid creating bathtubs at module roofs and under the modules

24

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25

How is Continuity of the Air/Water barrier Achieved between Modules?

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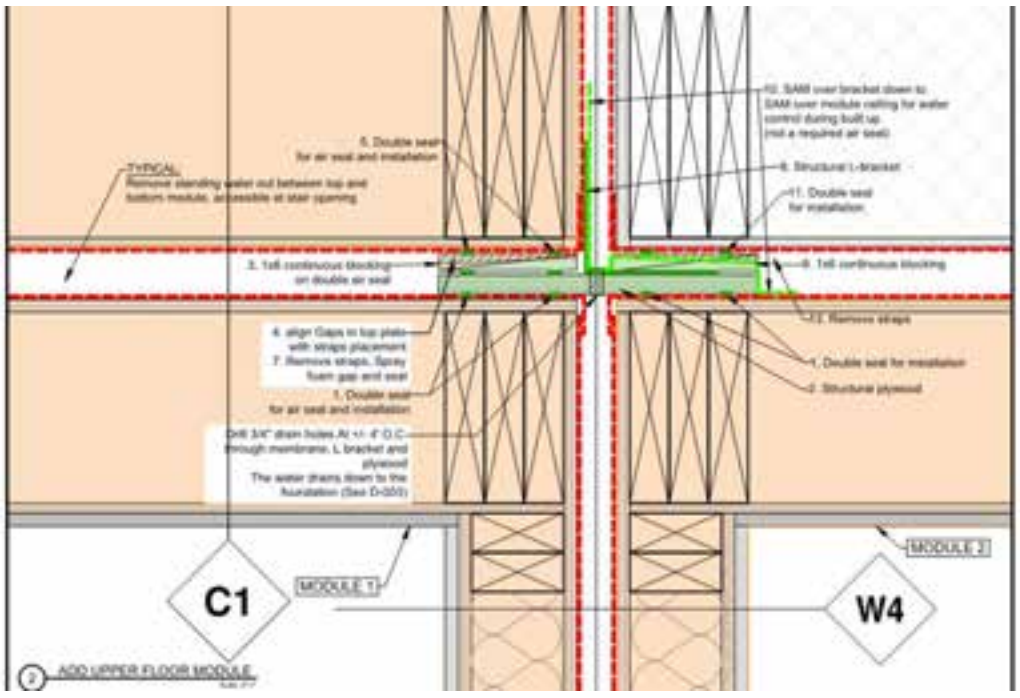
How is Continuity of the Air/Water barrier Achieved between Modules?



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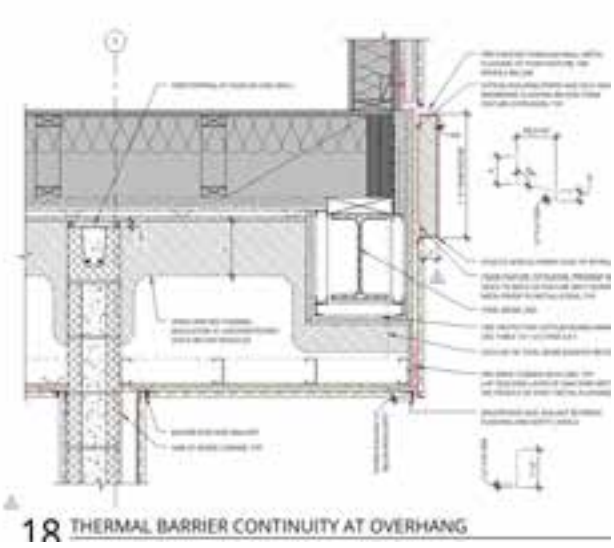
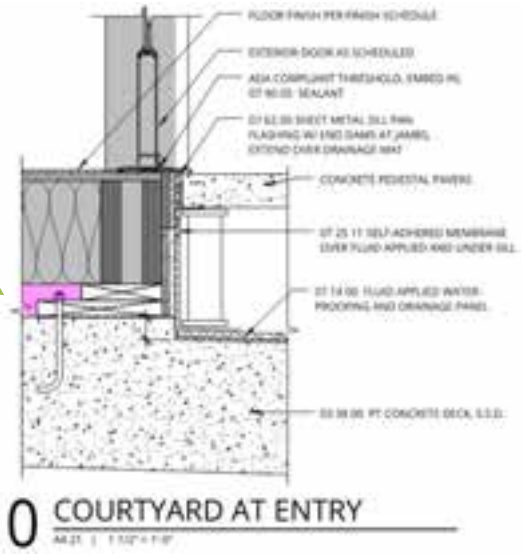
Façade Details must Accommodate Tolerances

- Modular unit set onto site-built CMU and steel structure.
- Express joint with detail that allows tolerance.



Foundation Crawl Space needs Planning

Rain Water that enters between modular units can get trapped in crawl space.



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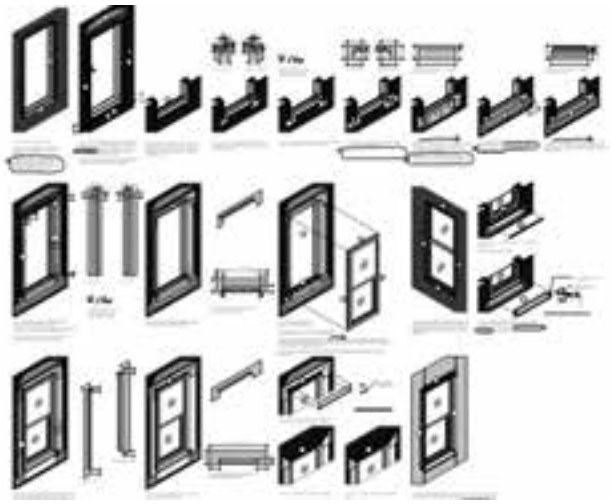
Factory QA / QC is Critical

1. Is a 15-Step Window Flashing Sequence installed in 1-hour reasonable?
2. Considered what will be installed in factory and field and allow tie-in and tails as well as temporary weatherproofing – doors, bolt-on balcony knife plates, etc.
3. Do Mock-Ups and Performance Testing in the Factory



Factory QA / QC is a Must!

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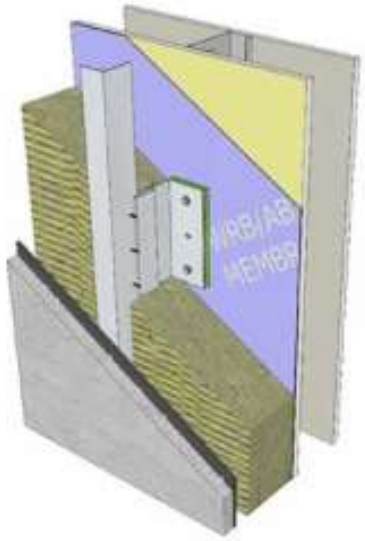
Cladding Tolerance Considerations

Choose cladding attachments that will accommodate misalignment such as furring or clip and rail system.



Cladding Tolerance Considerations

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Site Curb Coordination with Modular Tolerances

Summary of Lessons Learned

1. Consider using an integrated design process that includes builders, architects, modular manufacturer, installers, owners, and consultants early in the design process.
2. Wrap all six sides of modules with water resistive barrier (WRB) with roofing grade membrane on top of units.
3. Carefully plan how joints between units will be protected during construction. It is important to not allow water between units during construction even though units are protected. Consider what will happen to water that reaches the foundation crawl space.
4. In-factory and field review QA / QC is critical. Do mock-ups and performance testing in factory prior to full production. Field correction of factory errors is very costly.
5. Design exterior insulated rainscreen claddings for optimal ability to accommodate tolerances.

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QUESTIONS?

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37