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

Building Enclosure Design for Modular Construction

Presented by Joe Piñon, M.S., P.E. (CA)

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
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 control 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.
PART 1 – Modular Building Enclosures: What’s Different & What’s the Same?
Modular – What’s Different and What’s the Same?

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
Modular – Joints, Joints, Joints!
Modular Designs

Habitat 67, Expo 67 Montreal, Architect Moshe Safdie
Façade Pre-Fabrication Example - Unitized Curtain Wall

Pros:
* Better quality control
* Faster

Cons:
* More joints!
* not always cheaper
Unitized Curtain Wall Joints

Vertical Stack Joint

Horizontal Stack Joint
Unitized Curtain Wall Joints

Wausau Curtain Wall
Isometric Detail of 4-Way Intersection
Which is more Complicated?

versus
Building Science Control Functions

**Control Layers**

- Finish
- Water control layer
- Air control layer
- Thermal control
- Vapor control layer
- Support
- Finish

**EXTERIOR**

- Cladding
- Air space (ventilated)
- 1x1 wood strapping, screwed through insulation
- Rigid, mineral fibre insulation (thickness to meet R-value requirement)
- Vapour-permeable sheathing membrane
- Sheathing (plywood or OSB)
- 2x4 or 2x6 wood framing with batt insulation
- Polyethylene film (cold climates only)
- Gypsum board and paint

**INTERIOR**
Continuity of Control Layers is Critical
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)
PART 2 – Modular Building Enclosures: Detailing Strategies & Case Studies
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.
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 and to minimize risk of water through holes and tears.

4. Wrap all 6-sides of box for rain protection but also air barrier continuity.

What Enclosure Control Layers are Installed in Factory and On Site?
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 Roxul CB-Metal corrugated siding and clips

1/4 Spacer
- J-trim 1 1/4" exposure
- Metal Flashing Clips
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
What’s wrong with this picture?
What's wrong with this picture?
How is Continuity of the Air/Water barrier Achieved between Modules?
How is Continuity of the Air/Water barrier Achieved between Modules?
1. Double seal for installation

2. Structural plywood

3. 1x6 continuous blocking on double air seal

4. Align gaps in top plate with straps placement

5. Double seal for air seal and installation

6. Structural L-bracket

7. Remove straps, spray foam gap and seal

8. Double seal for air seal and installation

9. 1x6 continuous blocking

10. SAM over bracket down to SAM over module ceiling for water control during built up (not a required air seal)

11. Double seal for installation

12. Remove straps

Drill 3/4" drain holes at +/- 4" O.C. through membrane, L bracket and plywood

The water drains down to the foundation (See D-003)

Typical:
Remove standing water out between top and bottom module, accessible at stair opening

ADD UPPER FLOOR MODULE

MODULE 1

C1

MODULE 2

W4

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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.
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 Critical
Factory QA / QC is a Must!
Cladding Tolerance Considerations

Choose cladding attachments that will accommodate misalignment such as furring or clip and rail system.
Cladding Tolerance Considerations
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.
   * Consider moisture and relative humidity meters within interstitial spaces.

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.
This concludes The American Institute of Architects Continuing Education Systems Course

Joseph Piñon
RDH Building Science
415-713-8584
jpinon@rdh.com