WATERLOO ENGINEERING

University of Waterloo

Is prefab the future? … again?

Dr John Straube, P.Eng.

RDH Building Science

Why prefab?

→ Cheaper

→ Faster

→ Greener

→ Better Quality

→ Less time on site

→ Less weather sensitivity

Prefab

- → Media: over-hyped, solves all problems easily
  - → “Stacks like Lego”
- → Reality: can be an improvement, requires work, knowledge, experience
  - → More design upfront, more detail
- → Future: almost certainly more prefab!

- → Thanks to RDHers: Joe Pinon, Camilo Mendoza, Graham Finch, Brian Hubbs

Forms of prefab

- → Components
  - → Windows, cabinets, RTU
- → Panels (aka flat pack)
  - → Walls and floors
  - → Wide range of degrees of finish
- → Modules (aka volume)
  - → Wide range of degree of finish

Prefab cast-iron and glass kit of parts. Used 10in x 49in module, the size of the largest glass sheet available at the time

Sears Roebuck alone: 70000 homes 1908-40

BENNETT'S SMALL HOUSE CATALOG, 1920

Ray H. Bennett Lumber Co., Inc.

With 217 Illustrations

1908

BOOK OF

MODERN HOMES

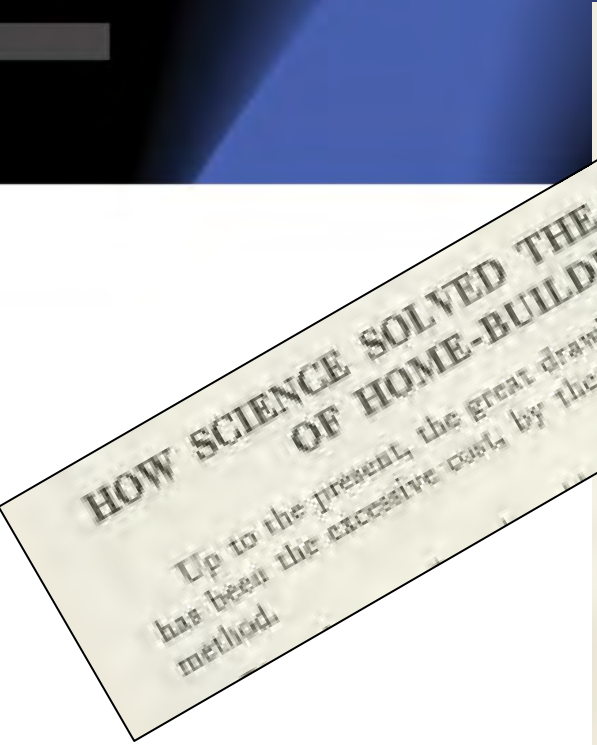
AND

BUILDING PLANS

SEARS, ROEBUCK & CO.

CHICAGO

Better-Built Ready-Cut



A Better-Built idea—routing (instead of cleating) stair-stringers for fine workmanship, and accurate fit.

HOW SCIENCE SOLVED THE HIGH COST OF HOME-BUILDING

Up to the present, the great drawback to home-building has been the excessive cost, by the individually-built-house method.

Plans by experienced architects have been costly; the cost of lumber has been high; the amount of labor necessary to cut and trim rough and finished lumber has been a serious item; there have been endless worries—delays—extra costs; plans have looked good on paper, but have not worked out well; contractors have been known to be careless about the quality of the material and of the work on the job.

What will avoid all the usual waste, delays, disappointments, and—what will cut the cost of building a home? Science says—"*simplify*"—*standardize*"—"*eliminate waste.*"

"*This is the day of brains that plans for thousands* at a time, instead of one. Why is it necessary to plan every individual home that is built? There's a wiser, more economical way. Once the plan for a house has been tried and proven true, use it many times over; let hundreds of people divide the cost—let hundreds of people reap the benefit of these plans."

"*This is the day of machinery*, the day for producing in tremendous quantities, thereby accomplishing in minutes that which would consume hours, days and weeks to achieve by usual methods. After having worked out plans to the highest point of economy, why not cut the materials by labor-saving machines *instead of the old hand method*, thereby reducing labor and waste to a minimum."

¶ ALL CHANCES FOR ERRORS AS TO QUANTITY AND QUALITY ARE ELIMINATED BY PURCHASING ALL MATERIALS AT A STATED PRICE FROM ONE COMPANY—FROM BENNETT.

SCIENCE'S ANSWER IS THE BENNETT-WAY

The best designs and plans have been produced for hundreds to share the benefits—a huge modern mill in the heart of the lumber market has been equipped with labor-and-waste-saving machinery of the latest type—and YOU, who want to build a home, reap the advantages and savings of the Bennett-Way in securing one of finer design, greater convenience, and genuine durability.

Perhaps right here, it is well to establish the difference between a Bennett Ready-Cut Home and a portable house.

The object of the portable system is to produce a building construction which may be put together to form a temporary shelter—taken apart again—moved from place to place as desired. Manufacturers of portable buildings cannot and do not represent their products to be permanent.

But Bennett Homes, Better-Built and Ready-Cut, are built for permanency. Once your Bennett Home is completed, there is absolutely no difference between it and any well constructed home, except, perhaps, that our designs are more attractive and impressive than the average homes one sees.

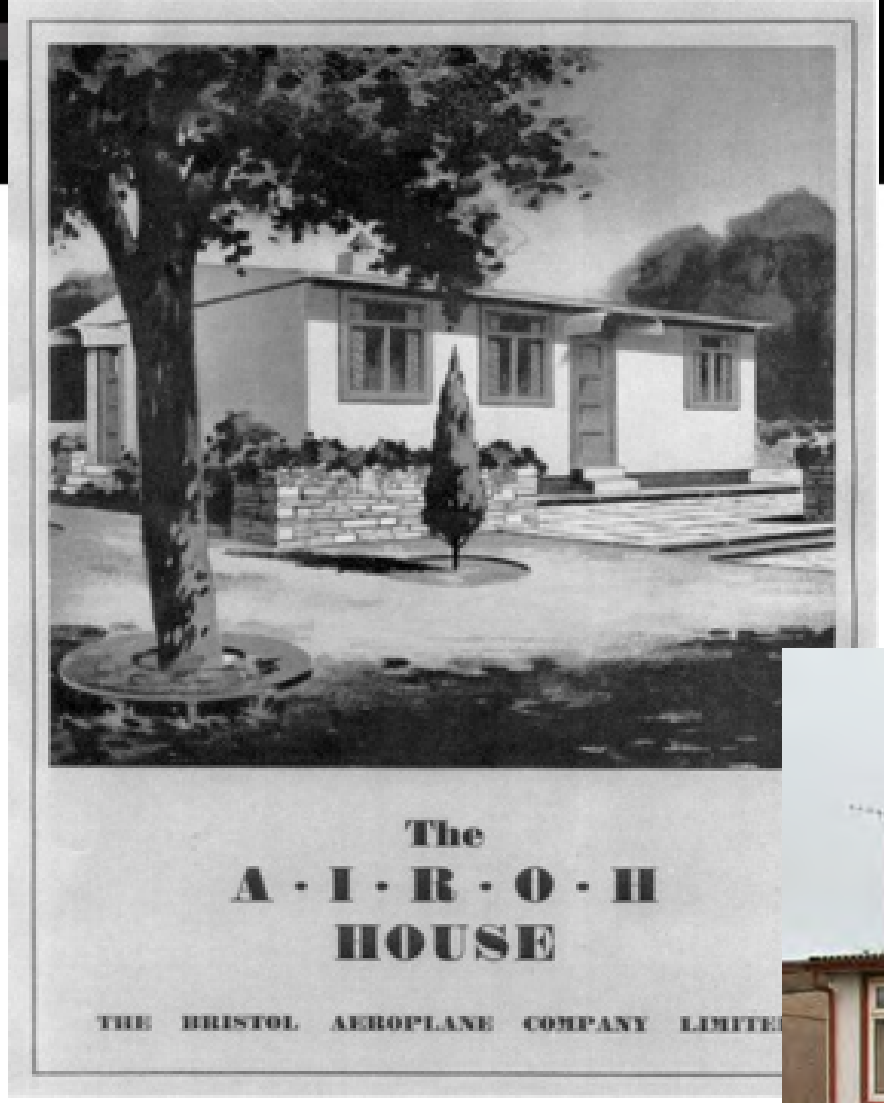
HOW RENT-MONEY COUNTS

This table shows what rent amounts to in ten and twenty years, with six per cent interest compounded annually, and gives an idea of the value of the house one can pay for by applying rent toward paying for a home.

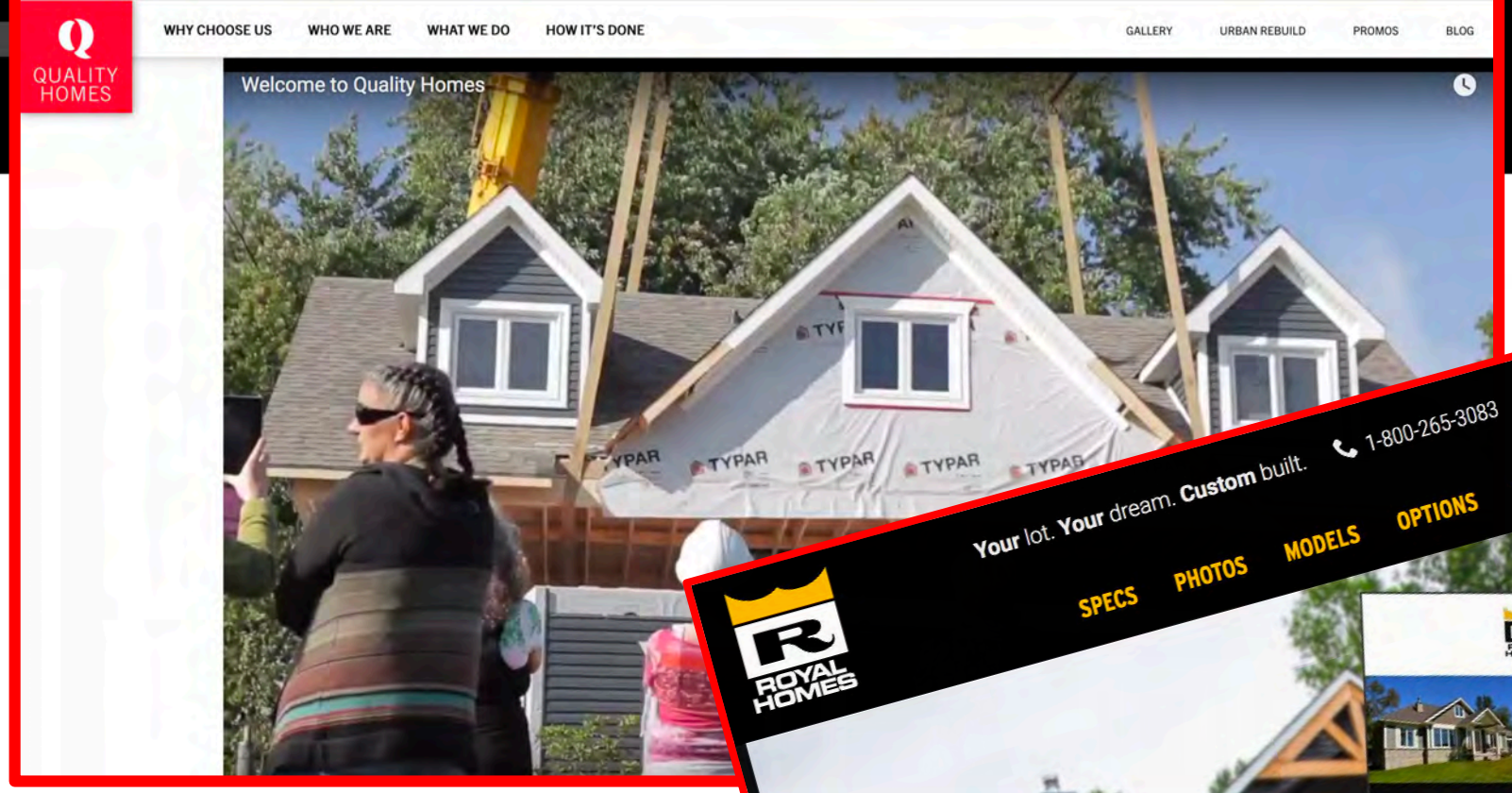
Rent per Month	In 10 Years	In 20 Years
$ 8.00	$1,265.35	$ 3,531.41
12.00	1,898.02	5,279.11
17.00	2,688.86	7,504.24
20.00	3,163.36	8,828.52
25.00	3,954.20	11,035.65
30.00	4,745.04	13,242.78
35.00	5,535.88	15,449.91
50.00	7,908.40	22,071.30

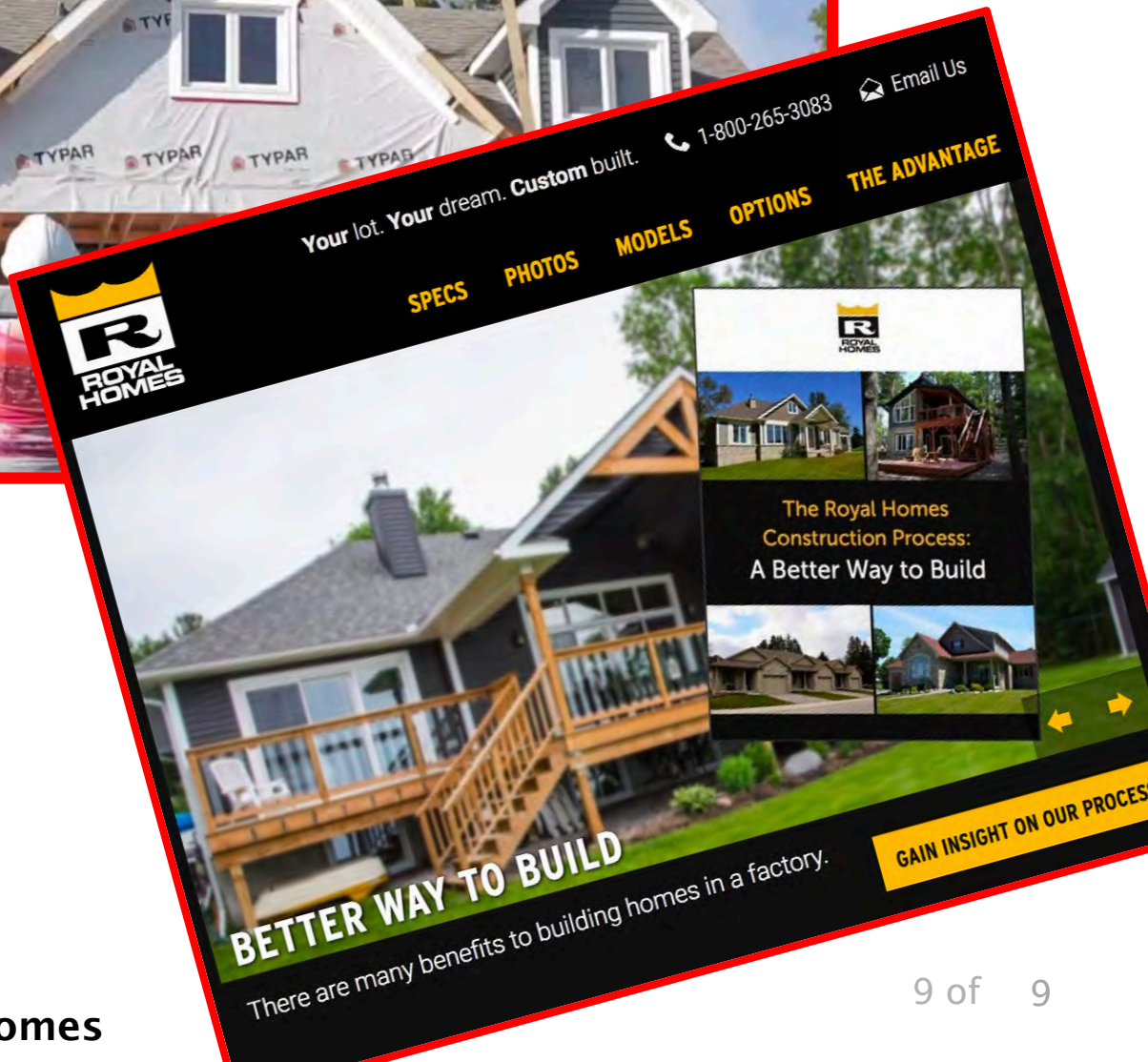
Tonawanda, heart of the Lumber Market. Great lumber-docks on one side, main trunk-line railroads on the other.

Post-War Britain



Estimated 150000 homes 1946-1960





Source: Quality Homes, Royal Homes

Habitat, Expo 67 Montreal, Moshe Safdie

Richard Rogers Partnership Architects 2008

2008 Manser Award for new housing
“mass factory-produced housing, erected in three days, incorporating top technology, top energy performance”, …
“It is radical, innovative and an outstanding step away from the traditional mud and mess of the domestic building site.”











Taylor Wimpey faces £12m repair bill for award-winning estate

Taylor Wimpey must spend millions repairing wet and dry rot at the Oxley Wood development Andrew Butterton/Alamy

Kathryn Hopkins Property Correspondent
Published at 12:01AM, April 7 2015

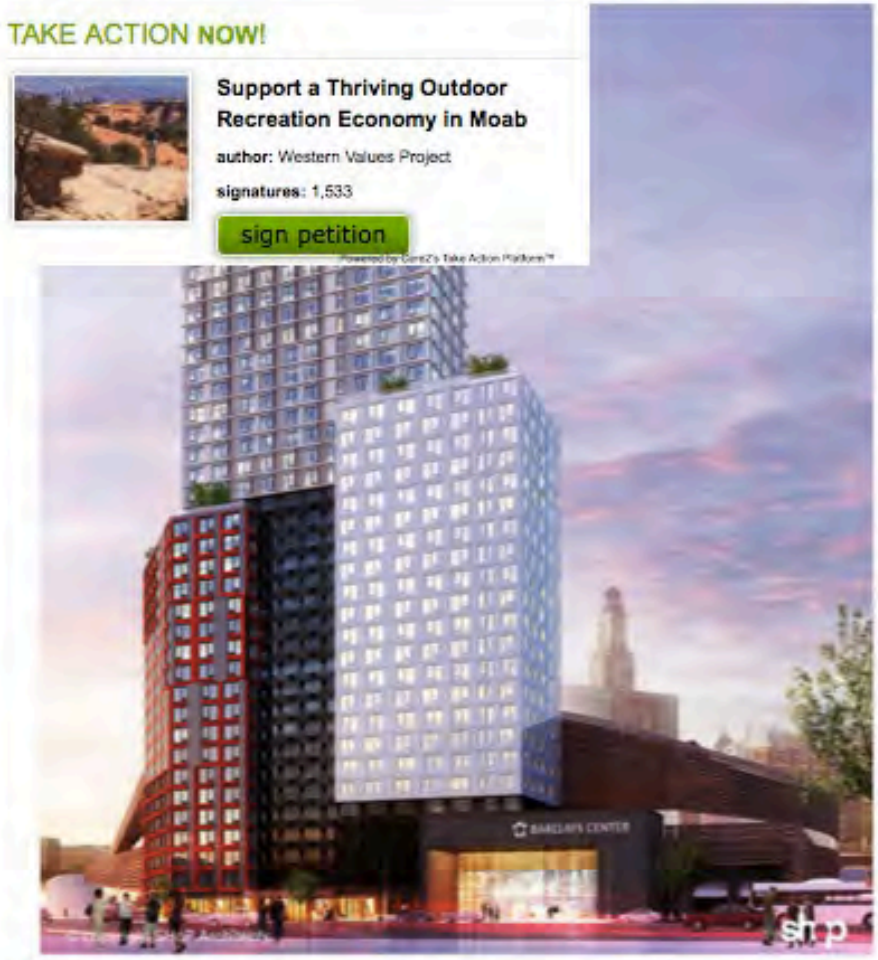
It seemed like such a good idea at the time, building an award-winning housing estat with a bargain price-tag, but eight years on Taylor Wimpey's dreams of prestige and prizes have turned into a £12 million headache.

And it all started so promisingly, too. John Prescott, then the deputy prime minister, launched a competition to produce low-cost, energy-efficient homes and the High Wycombe-based builder won. Rogers Stirk Harbour + Partners, Lord Rogers of Riverside's architectural practice, designed 122 houses for a site in Milton Keynes tha would cost £60,000 — a relatively cheap price even then — and a year later the estate

World's Largest Modular Prefabricated Tower Will Be Built at Atlantic Yards In Brooklyn and I Eat My Words

Lloyd Alter (@lloydalter)
Design / Modular Design
November 29, 2012

Share on Facebook



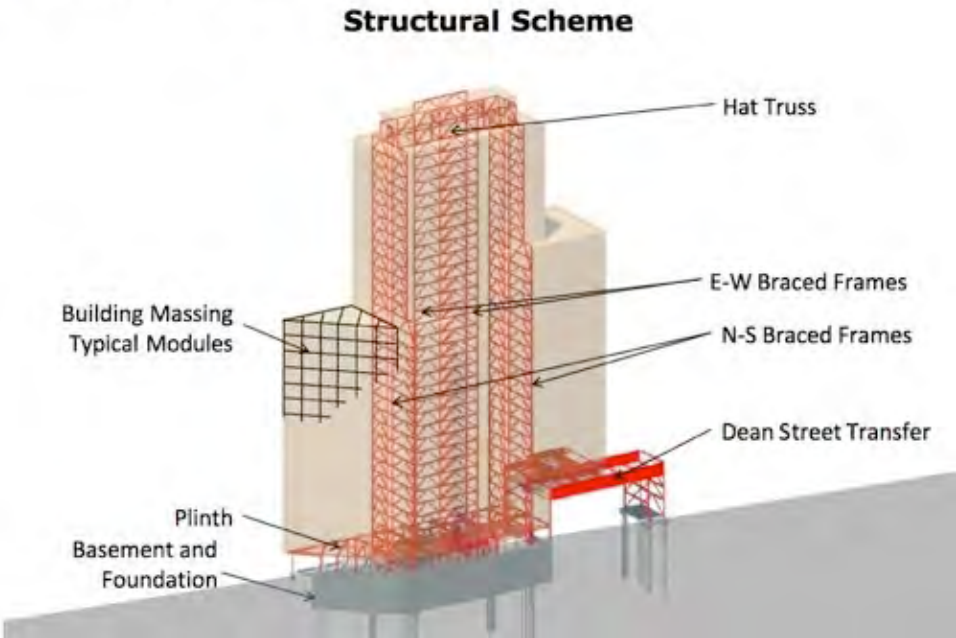
© SHoP

A year ago, when it was first announced that SHoP architects were going to be designing a prefabricated modular tower in Brooklyn at the Atlantic Yards, I said Fuggedaboutit, ain't gonna happen. There were so many things that were troubling,

SHoP Architects, Skanska Construction,
Forest City Radner

Claims abound..
"World tallest modular"
"we cracked the code"
"up to 25% cheaper" "half the time"

Building 2 Design: Engineers



Documents Reveal Woes at Pioneering Atlantic Yards Building

By **Norman Oder** | August 31, 2015

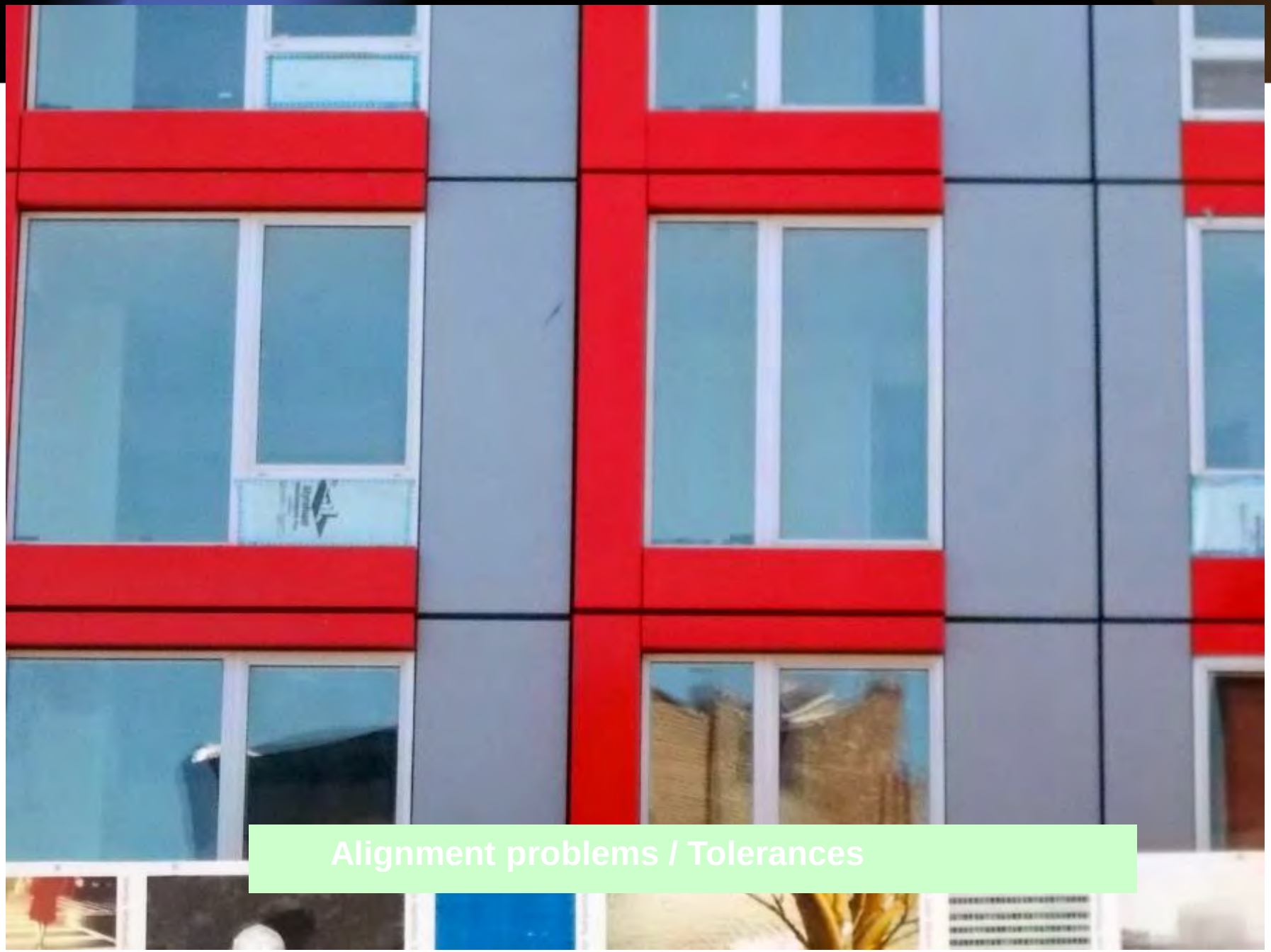
View as "Clean Read"

Norman Oder

The modular building known as B2, at 461 Dean Street, was supposed to cost less and be done much faster than a conventional high-rise. But problems in stacking the modules and keeping water out made for a slower, more expensive build-out.

The Atlantic Yards apartment tower known as B2 officially launched (http://atlanticyardsreport.blogspot.com/2012/12/the-atlantic-yards-b2-modular.html) in December 2012 with great fanfare and high hopes, and not just because of what developer Forest City Ratner

" Half of the first 39 apartments suffered significant water damage. The first four floors were largely gutted"



Alignment problems / Tolerances

Precast

→ Long history

→ Since 1930's at least as load bearing

→ Significant progress since the 1960's

→ Now reliable, known durable system

Case Study at UBC: KPMB/HCMA Architect & RDH Engineering

Staggered window wall *past slab* / precast

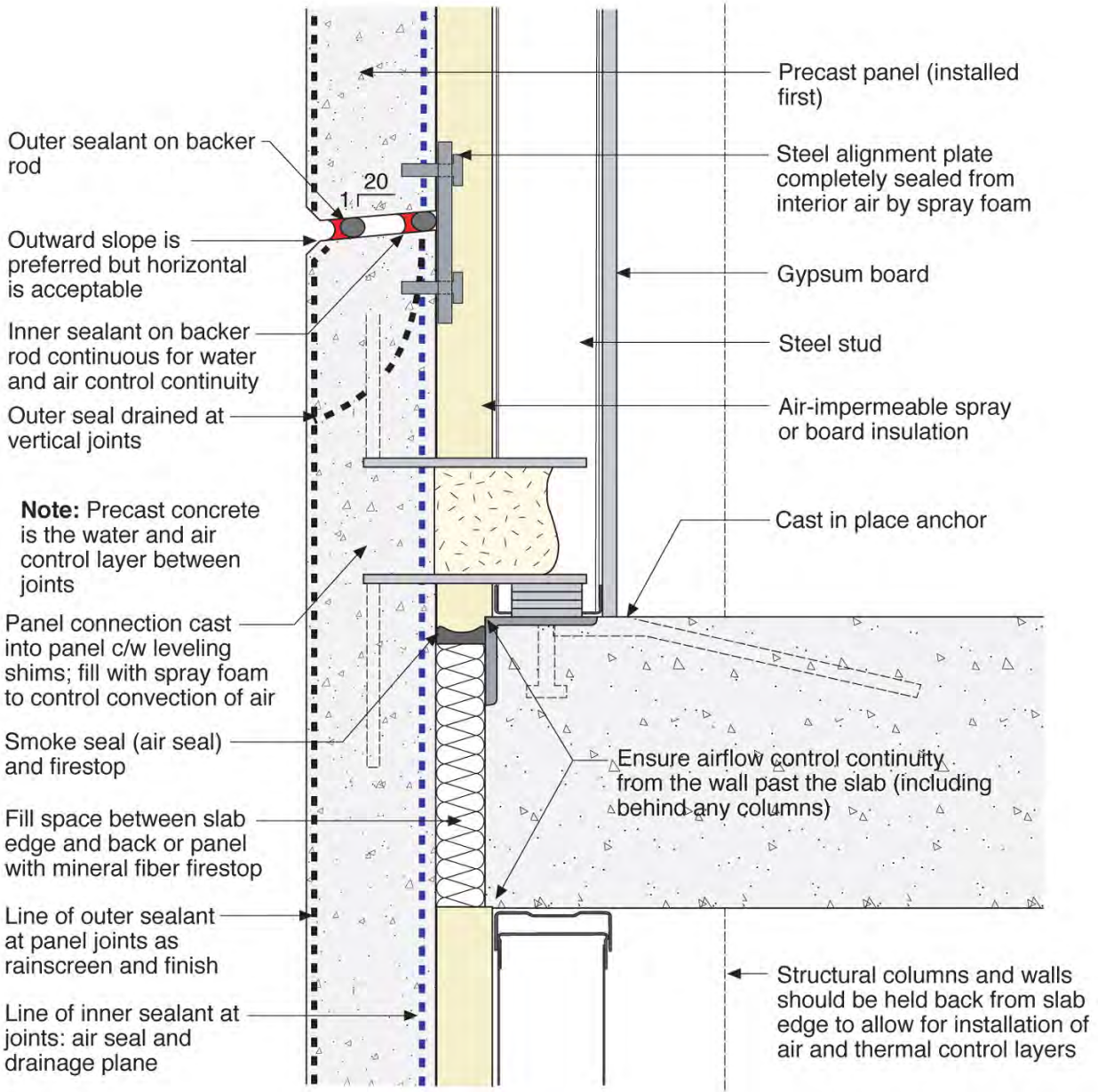
Panelized Precast w/windows installed

Adjustable connections are key

Design: ABA Architects / Melloul Blamey

Joints

- → Critical to all prefab
- → Simple, robust in precast
- → Tolerances, workmanship QC remain a focus

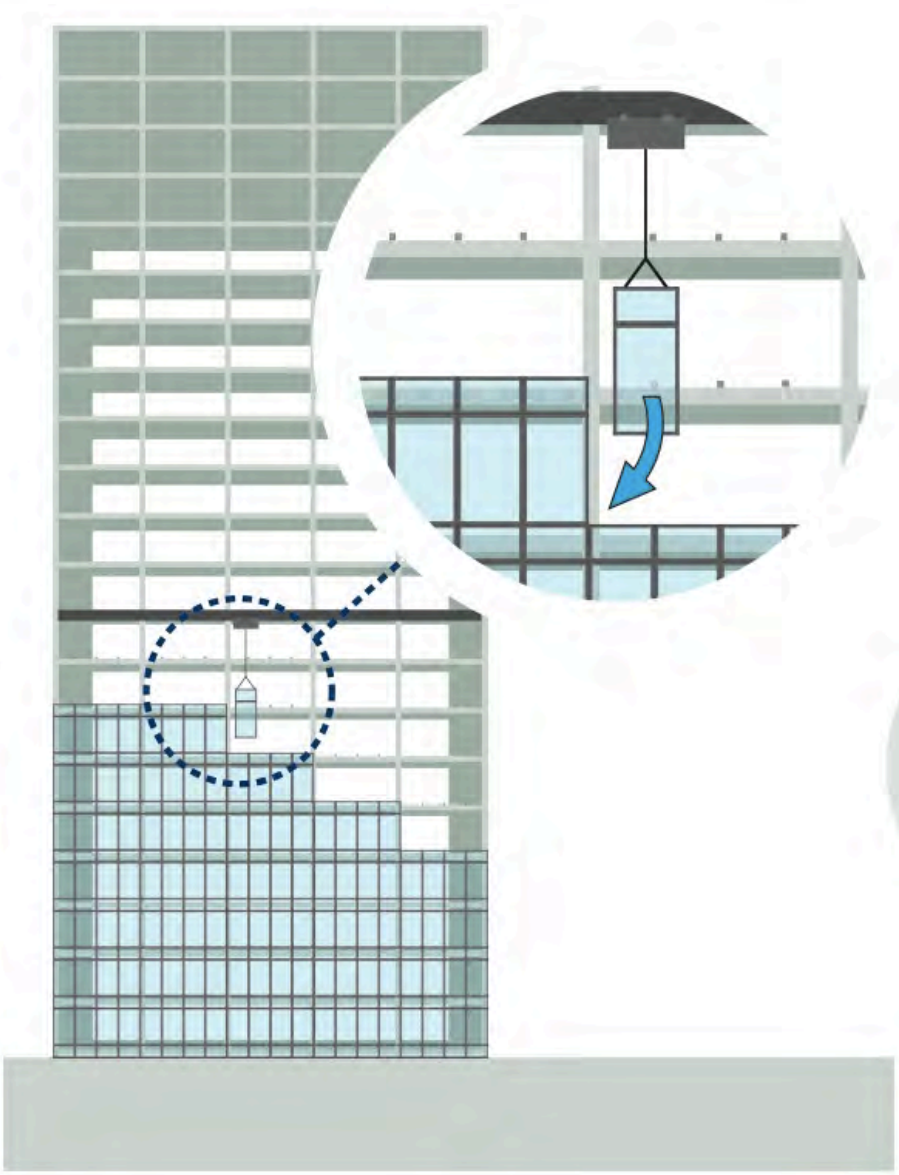


Panelized GFRC

Cross Laminated Timber

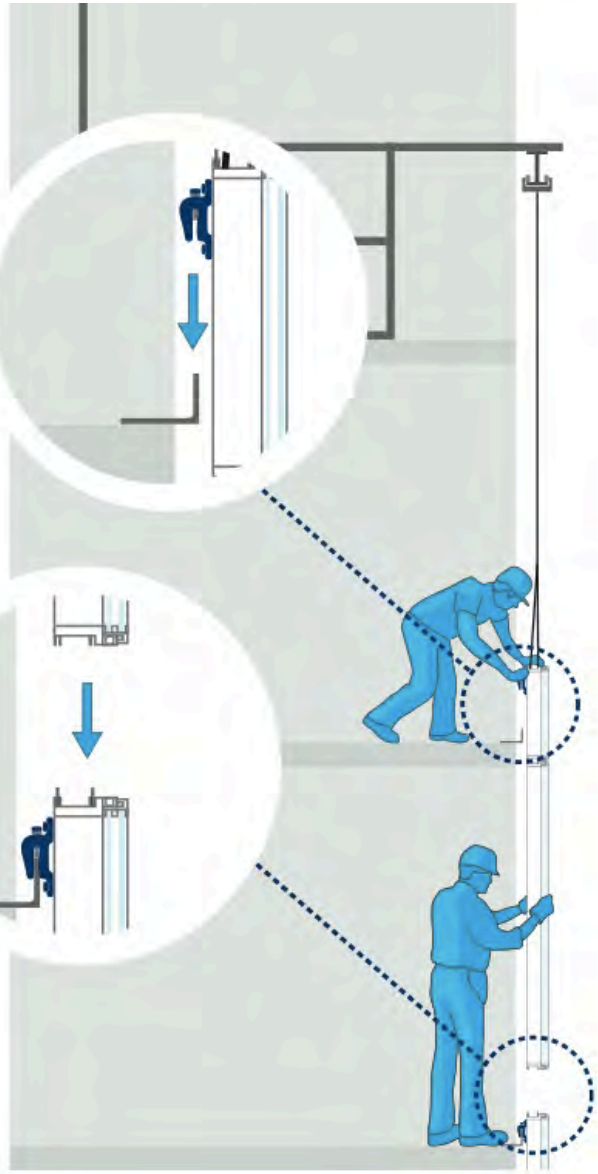
Unitized Curtain Wall

Ideal process of Curtainwall



Possible installation solution

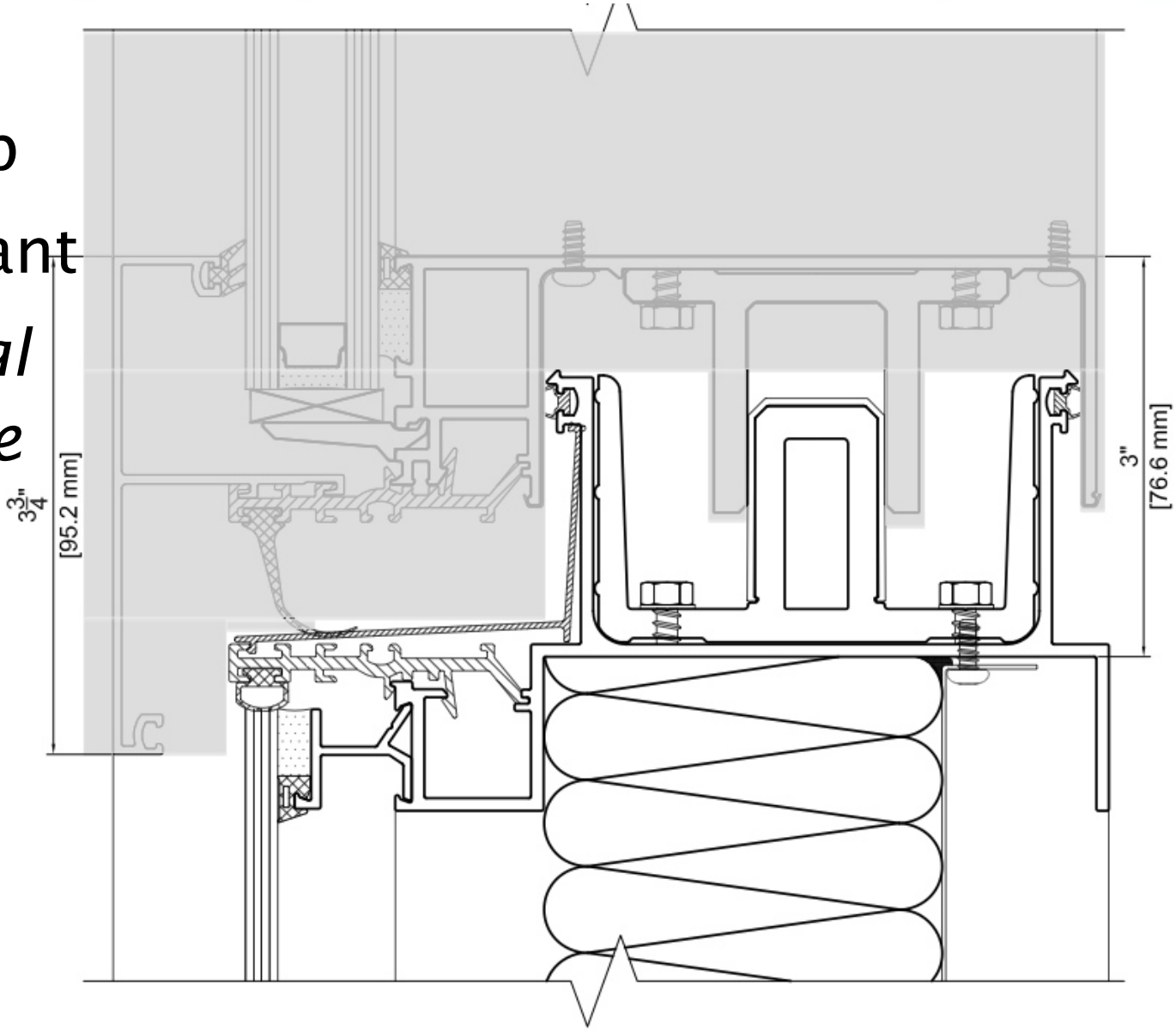
Courtesy: Raynaers



Standard element installation

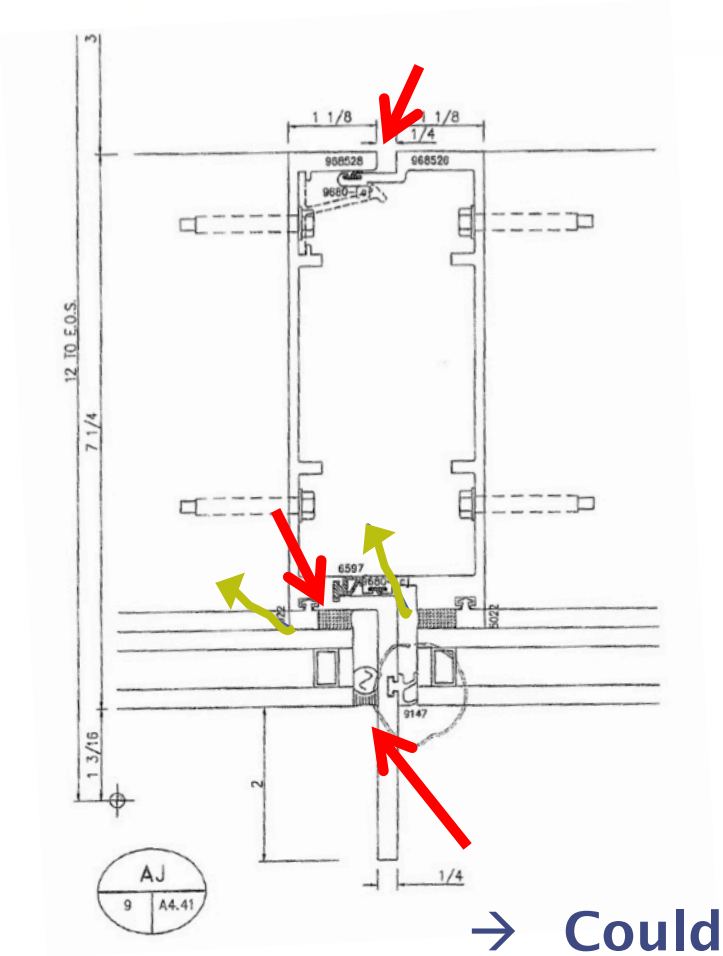
Modern Curtainwall Stack Joints

- → Easy on site
- → Complex fab
- → Lots of sealant
- → *Poor thermal performance*




This is high tech?
Lots of “pookie” for joints

Importance of Joints (Curtain Wall Example)



1/4 in. joint but 5/16 in. nozzle.
1/4 in. +1/16 in./-1/8 in. (10 ft.+ high unitized frames)

→ **Could not physically fit in the nozzle to install a reliably watertight structural seal**

→ **Units were not installed close enough together to compress stack joint gaskets.**

Panelized Steel Stud Frames

Lido Wall, Toronto

Lido Wall, Toronto


GROVE

Prefab Components

Home Metal Fabrication Gallery Blog About You Contact

Aluminum PREFABRICATED BALCONY SYSTEM

The one and only fully welded aluminum prefabricated balcony system for multi-family properties. Shipped complete.

Learn How We Help Your Role

JUST BOLT ON

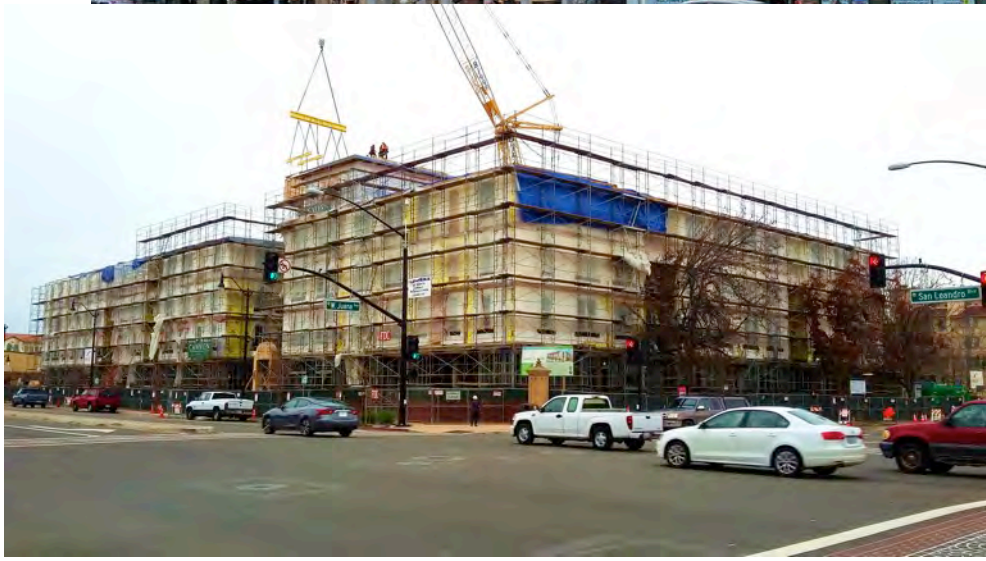
24 balconies installed in 5 hours!

Finally, a prefabricated balcony system for multi-family construction to benefit the architect, general contractor, property owner, and resident. These prefab bolt on balconies are the one and only balcony systems made out of aluminum construction, welded complete, and ready to go. Get cost value through fast install times and longevity. Architects like the

Available Joist Free!

Modular.. And when does it make sense

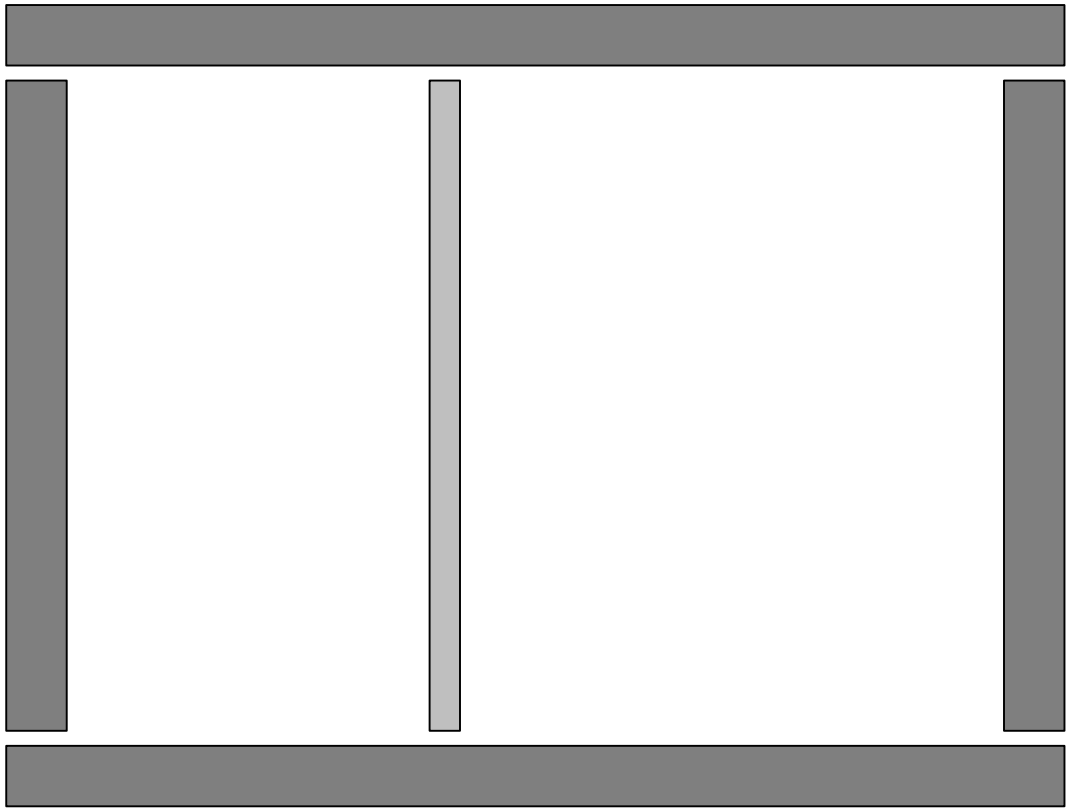
- → Modular is **ideal** for:
  - → Repetitive unit (modules)
  - → Remote locations - labour
  - → Locations where construction is disruptive – inner city
- → Modular may not be ideal for:
  - → Open floor layouts such as office spaces
  - → Complex floor plans



Panel / Site Process

→ Panels & interior *exposed to weather*

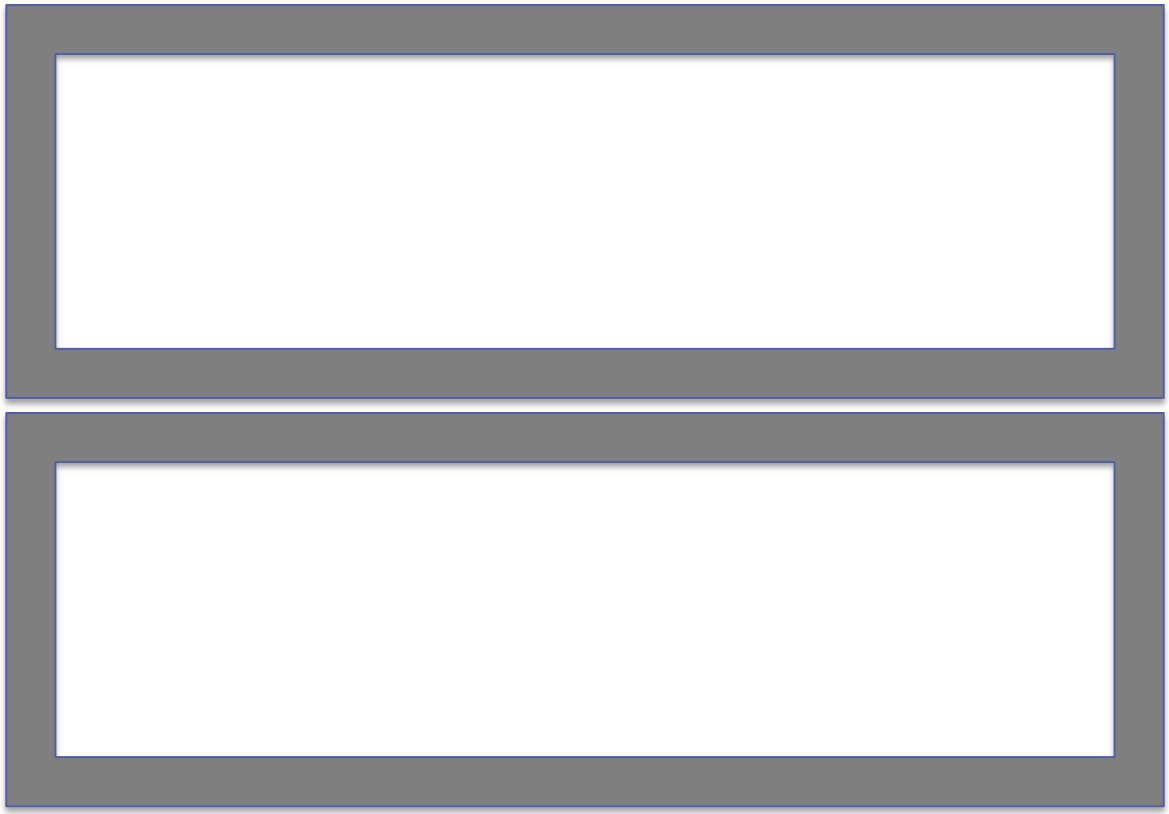
→ Limits factory work of interiors / MEP



Modular Process

→ Only exteriors exposed to weather, lots of interior work and MEP can be done

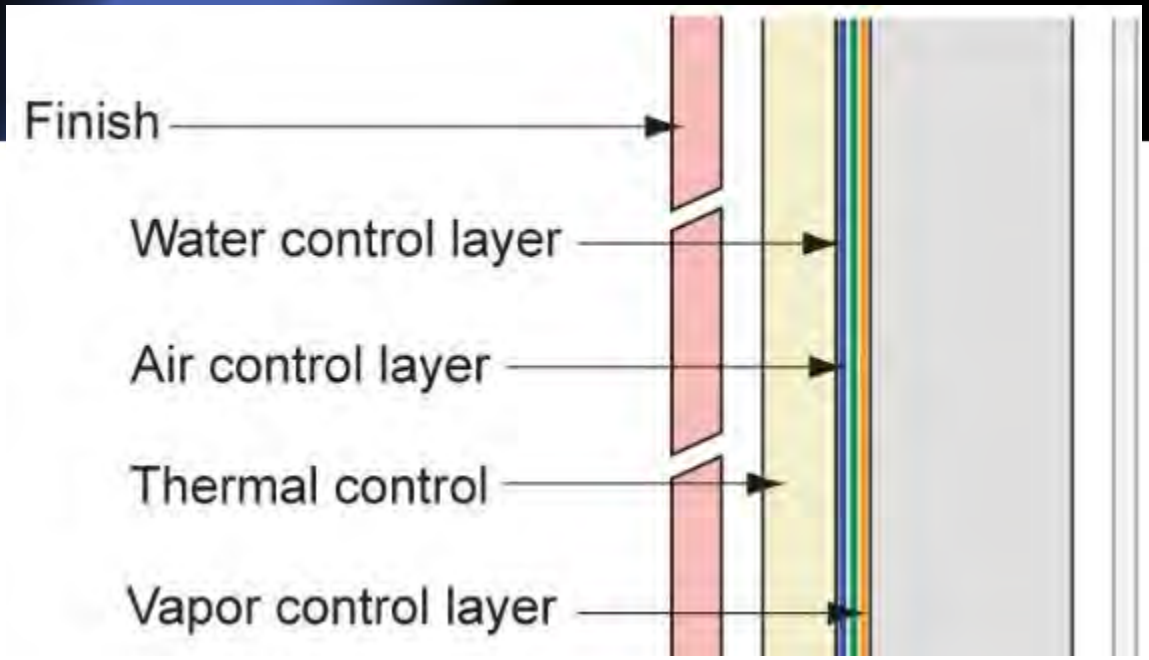
→ You are shipping air, and redundant ceiling

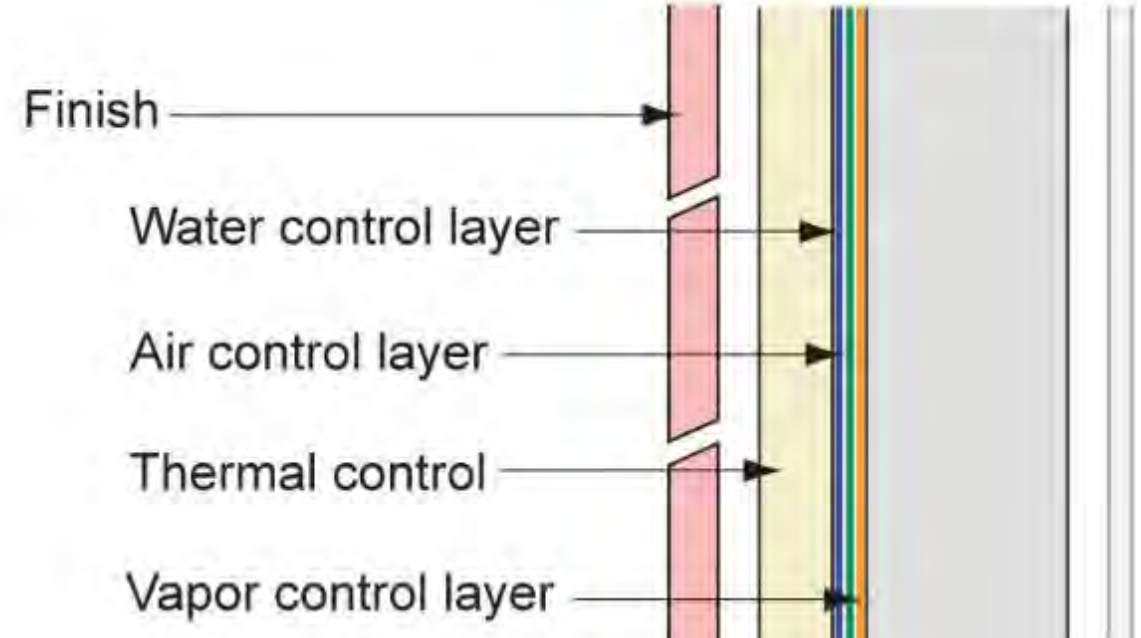


Joints

→ Key differentiator of prefab …

→ Must ensure *continuity* of structure, water, air, thermal, fire, vapor, finish etc.


Finish
Water control layer
Air control layer
Thermal control
Vapor control layer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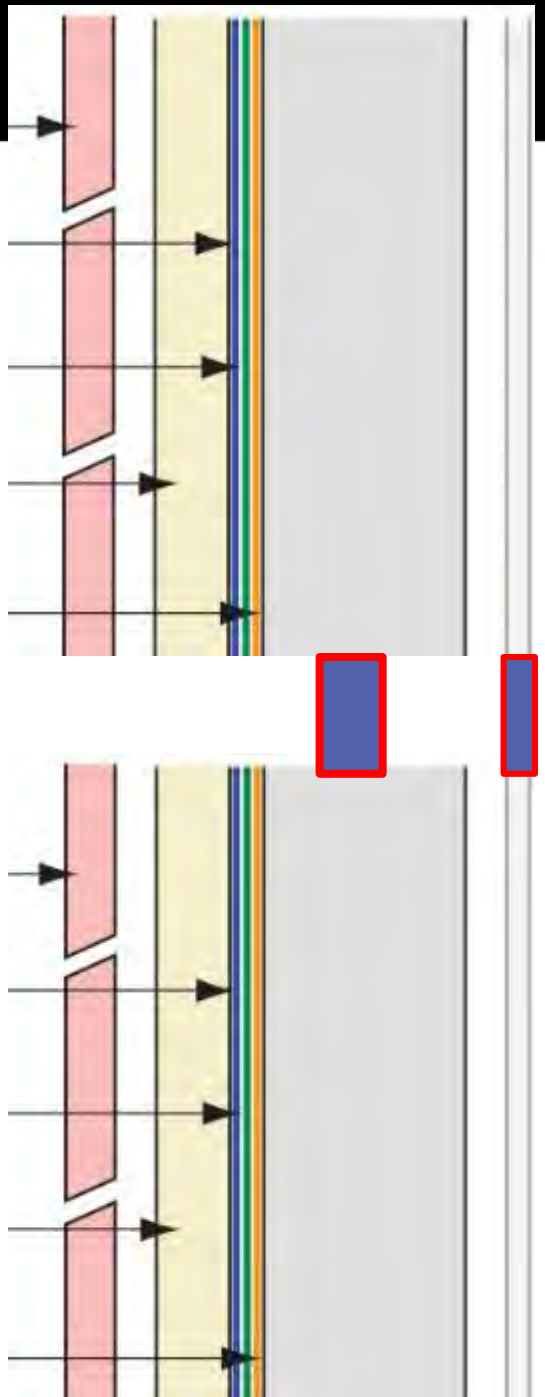
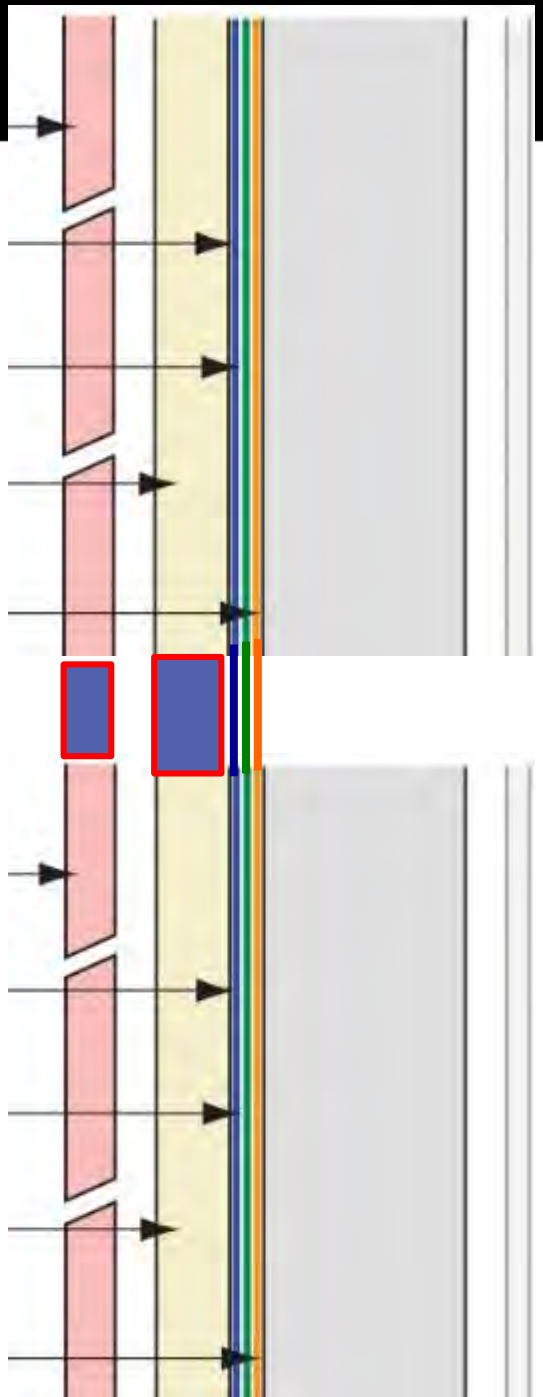


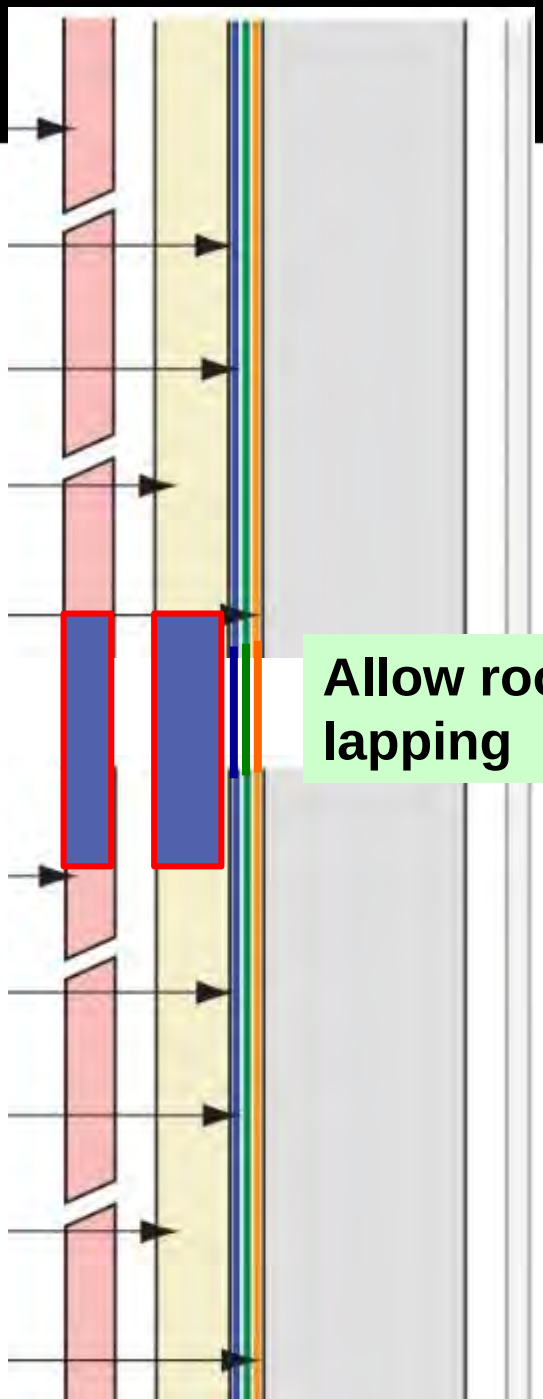
Structure
Interior Finish
Fire?

Access for lapping and fixing, minimize work on site

Exterior finish
Insulation
Air-water-vapor

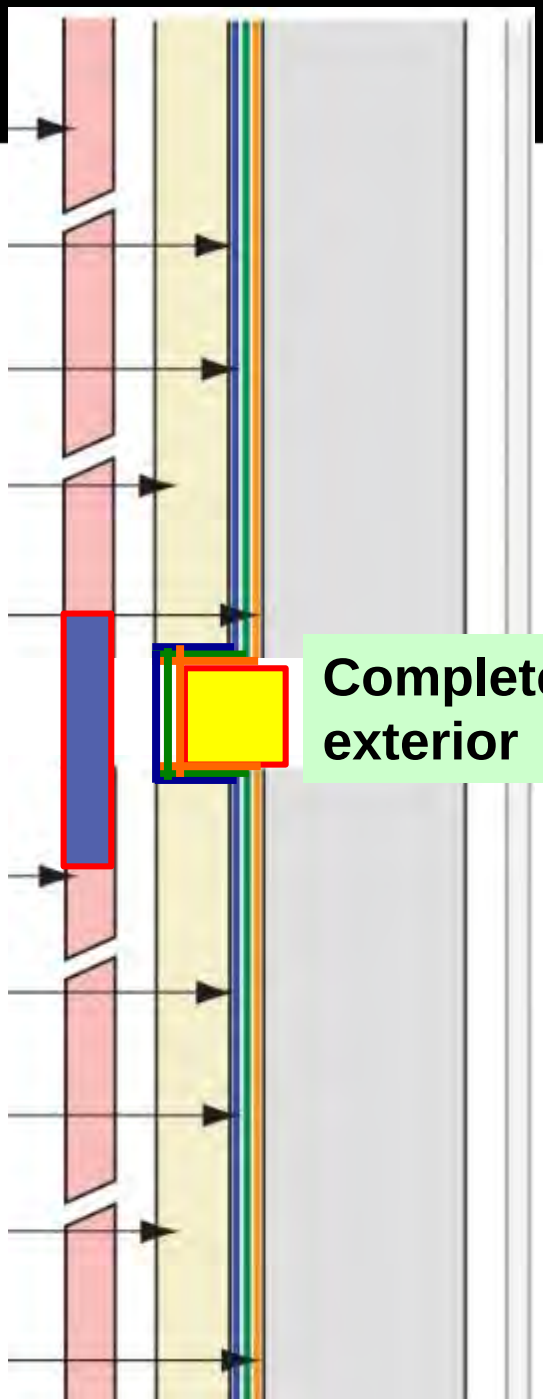


Exterior finish
Insulation
Air-water-vapor



Allow room for lapping

Account for vapor permeance, durability, thermal bridging



Complete seal near exterior