Higher Performance Buildings

ENERGY EFFICIENCY UPGRADES: DESIGN AND INSTALLATION CHALLENGES ON BUILDING ENCLOSURE REHABILITATION PROJECTS

BCBEC / EGBC

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Agenda

- → Energy Studies
  - → Post-Construction Analysis
- → Design Phase
- → Construction Phase
- → Summary and Next Steps

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Energy Studies

→ Early stage conceptual review of energy performance and upgrade opportunities

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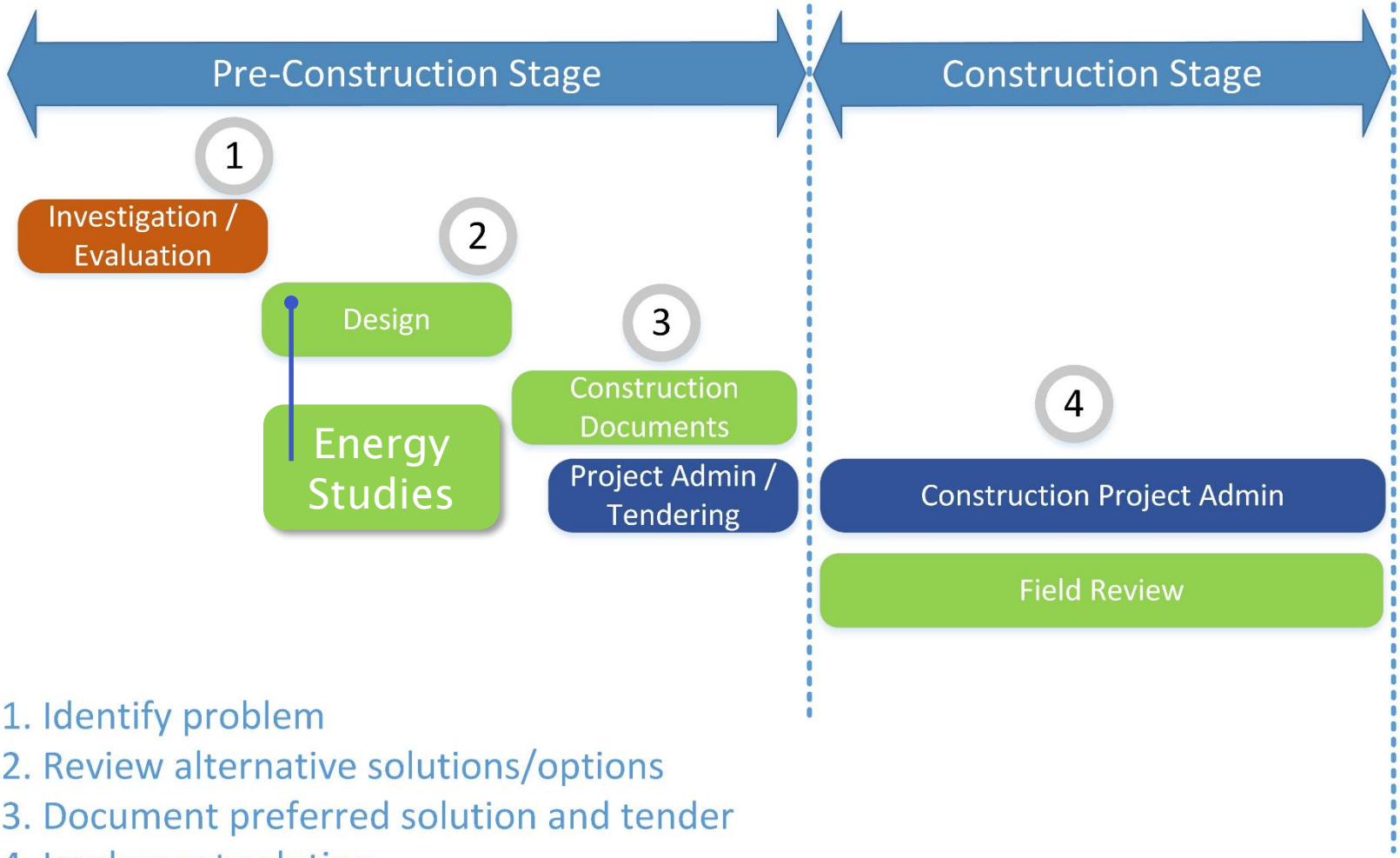
Typical Existing Building Project Phases



1. Identify problem
2. Review alternative solutions/options
3. Document preferred solution and tender
4. Implement solution
5. Optional services

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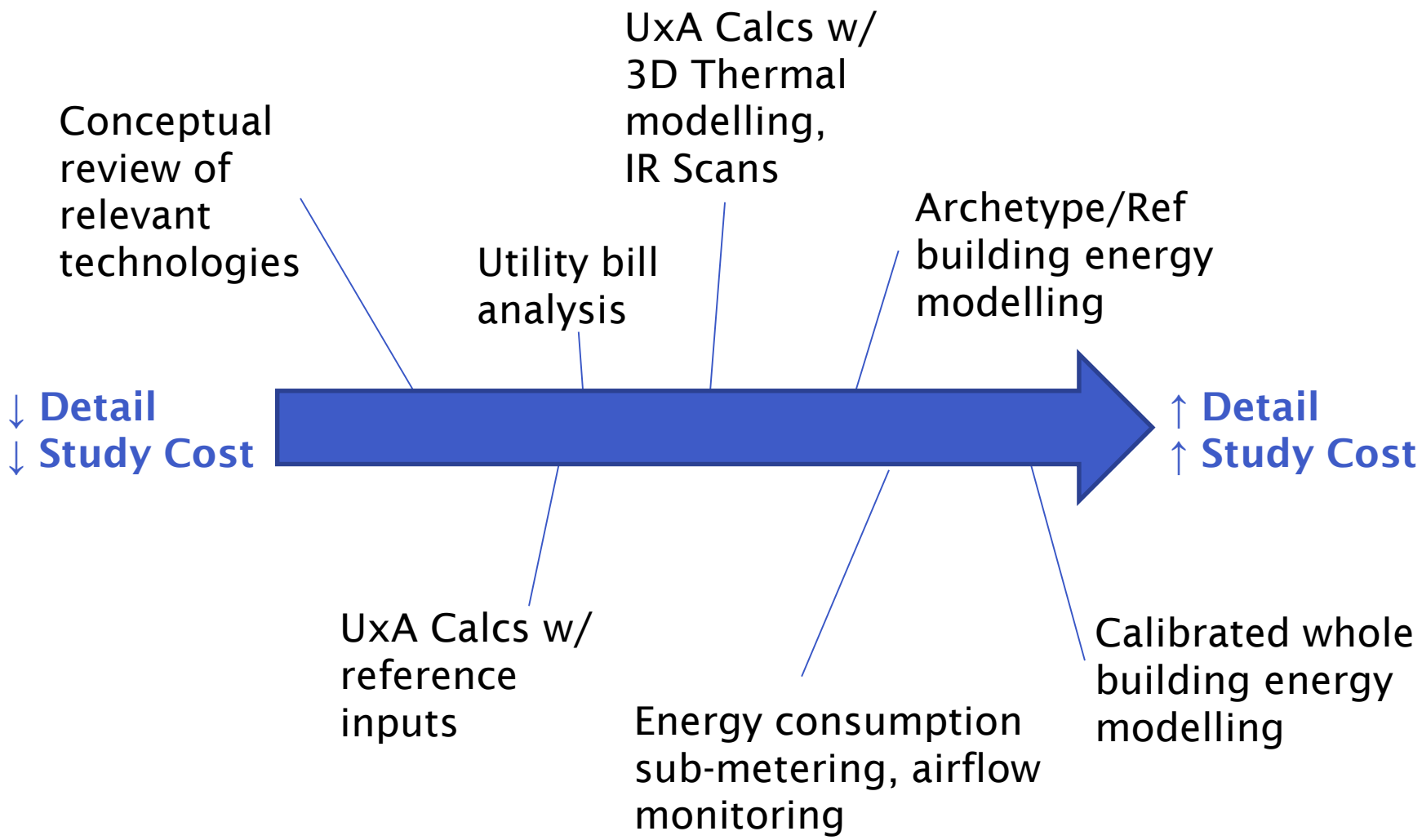
Energy Studies of Existing Buildings



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Low-Rise MURB 1 - Background

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Low-Rise MURB 1 – Deficiencies

- → Localized water ingress and high moisture content at face-sealed stucco walls
- → Systemic condensation and evidence of water ingress at windows

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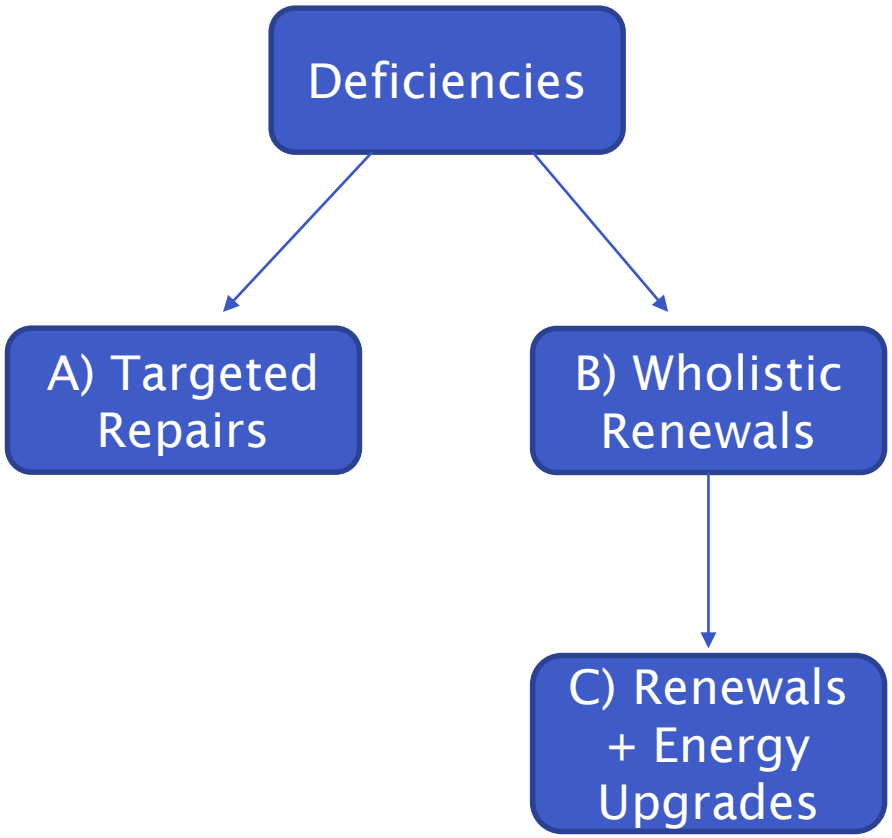
Low-Rise MURB 1 – Options




Option A: $0.8M


Option B: $1.3M


Option C: $1.4M

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Low-Rise MURB 1 – Energy Study

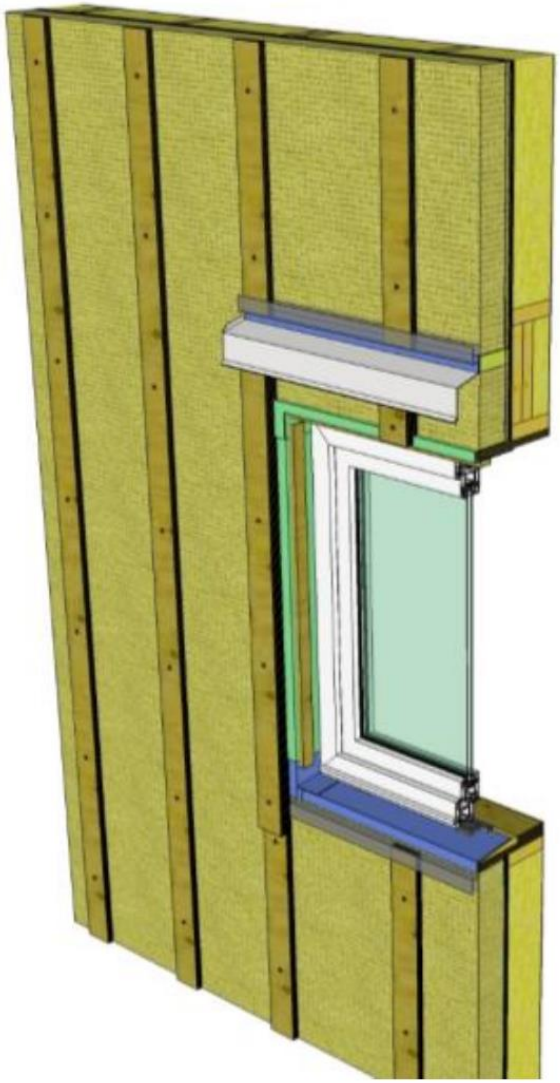
→ Improved thermal comfort

→ Minimized condensation risks

→ Reduce noise transfer

→ Opportunity to modernize building

→ Reduce energy consumption, GHGs and operational costs



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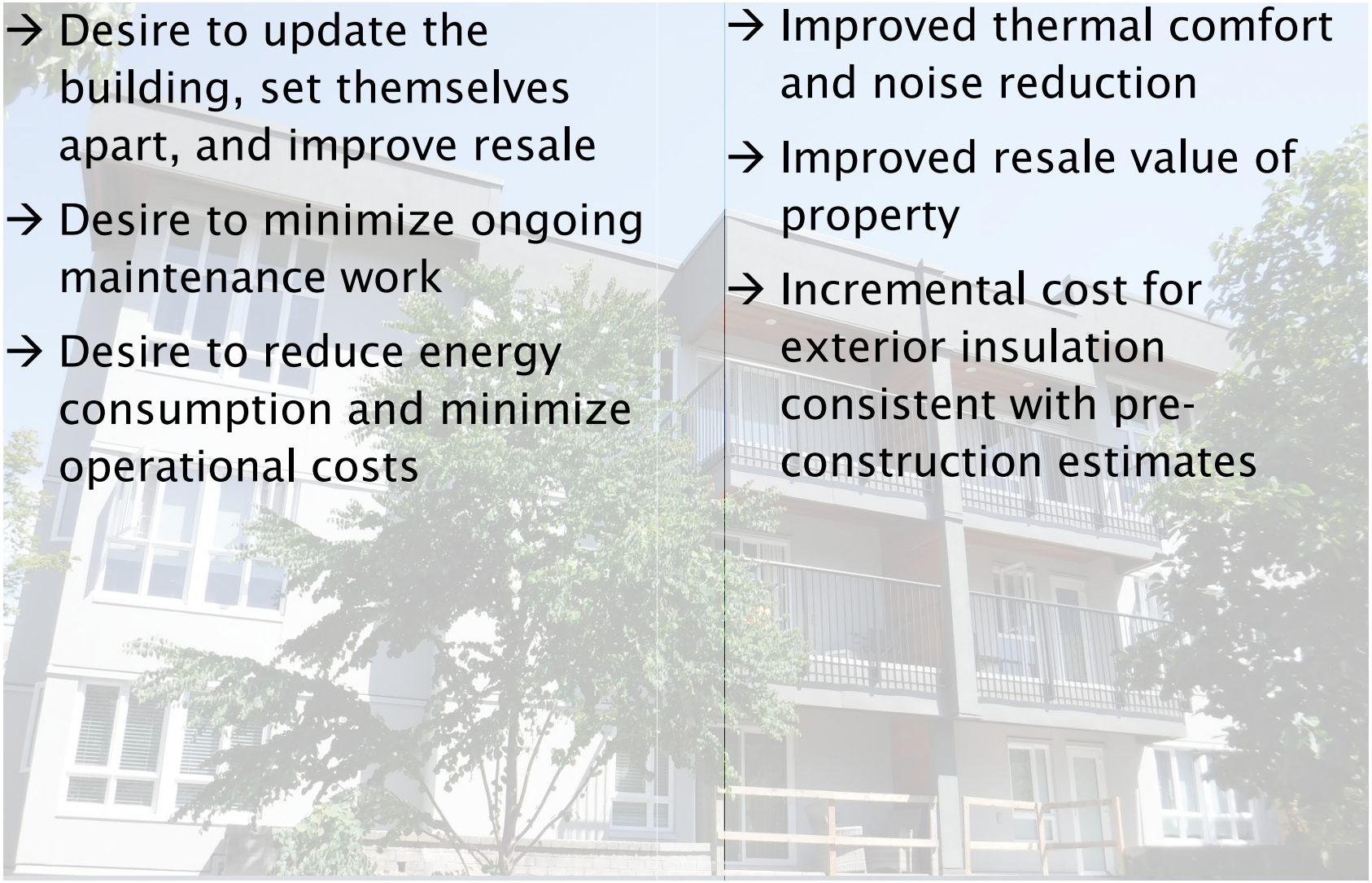
Low-Rise MURB 1 – Outcome



→ Desire to update the building, set themselves apart, and improve resale

→ Desire to minimize ongoing maintenance work

→ Desire to reduce energy consumption and minimize operational costs

→ Improved thermal comfort and noise reduction

→ Improved resale value of property

→ Incremental cost for exterior insulation consistent with pre-construction estimates

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Lord Harley - Background

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Lord Harley – Deficiencies

→ Localized water ingress and high moisture content at face-sealed stucco walls

→ Systemic condensation and evidence of water ingress at windows

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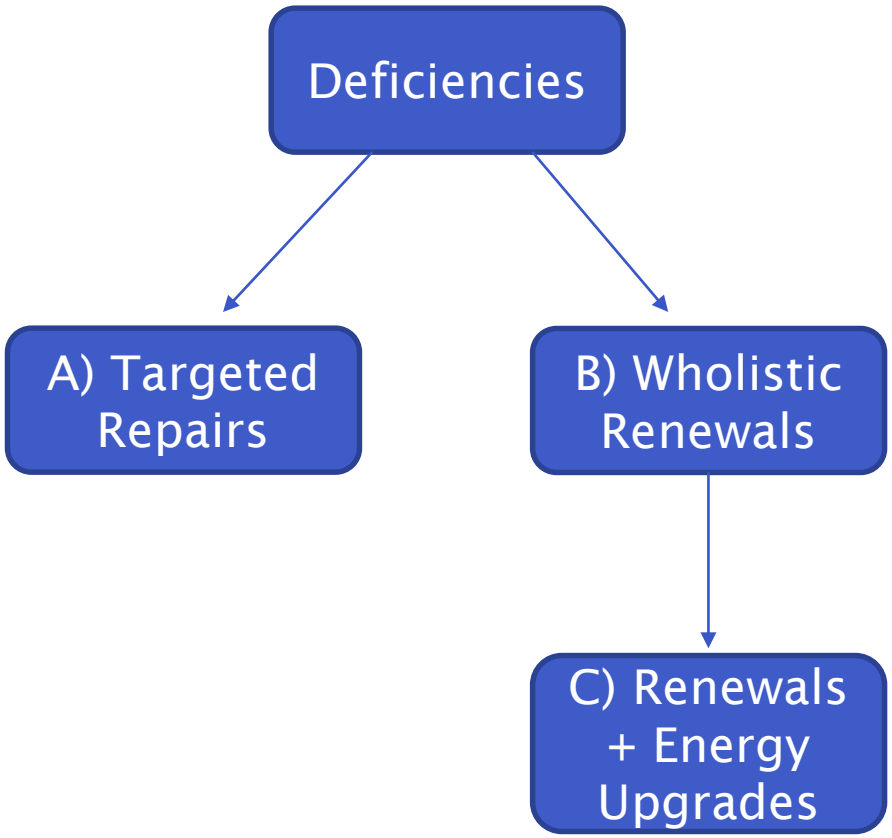
Lord Harley- Options



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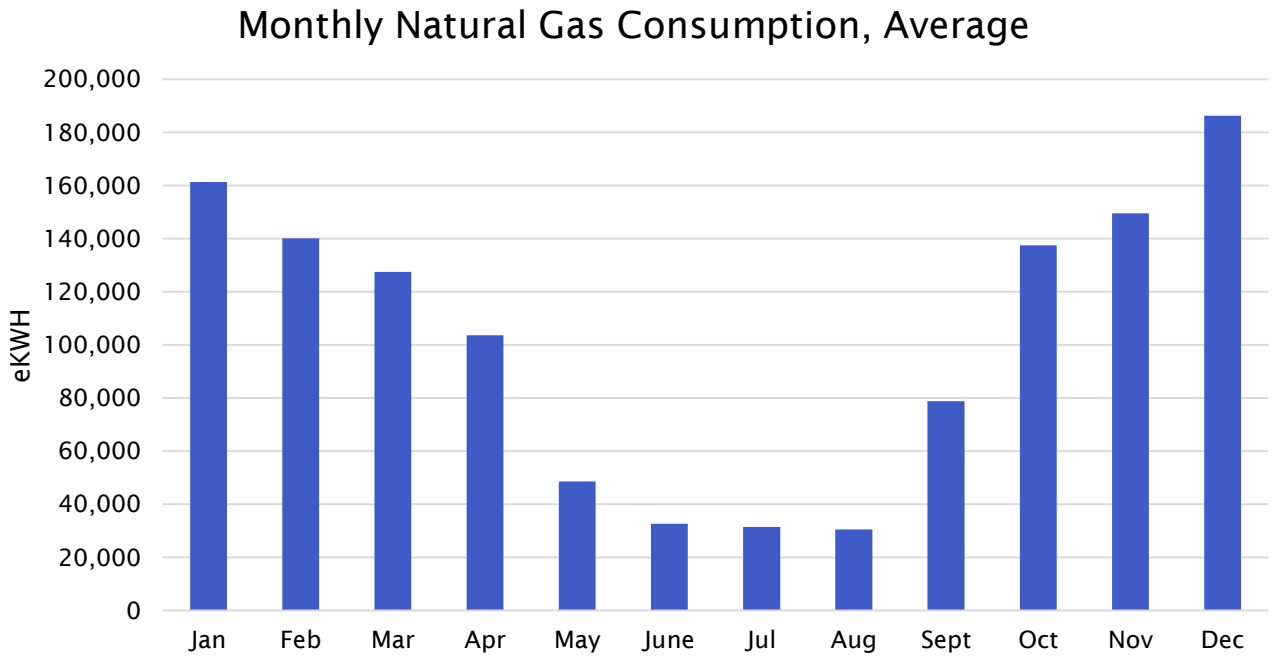
Lord Harley – Energy Study

→ Performed a high-level energy analysis on utility data and thermal models

  → Central natural gas heating

→ Determined Option 3 Natural Gas savings to be in the range of 30-50%



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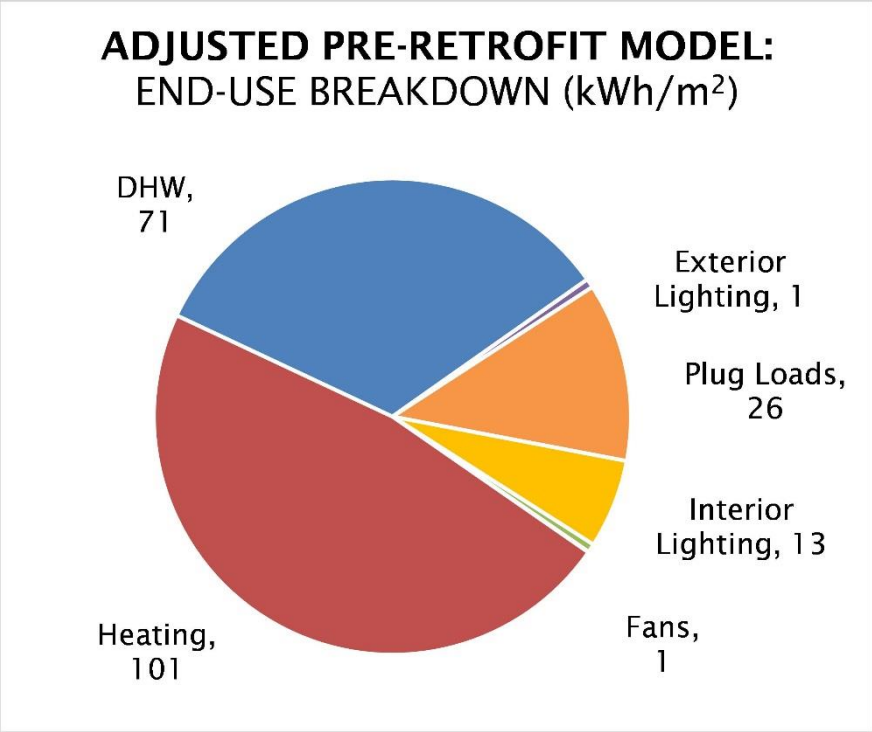
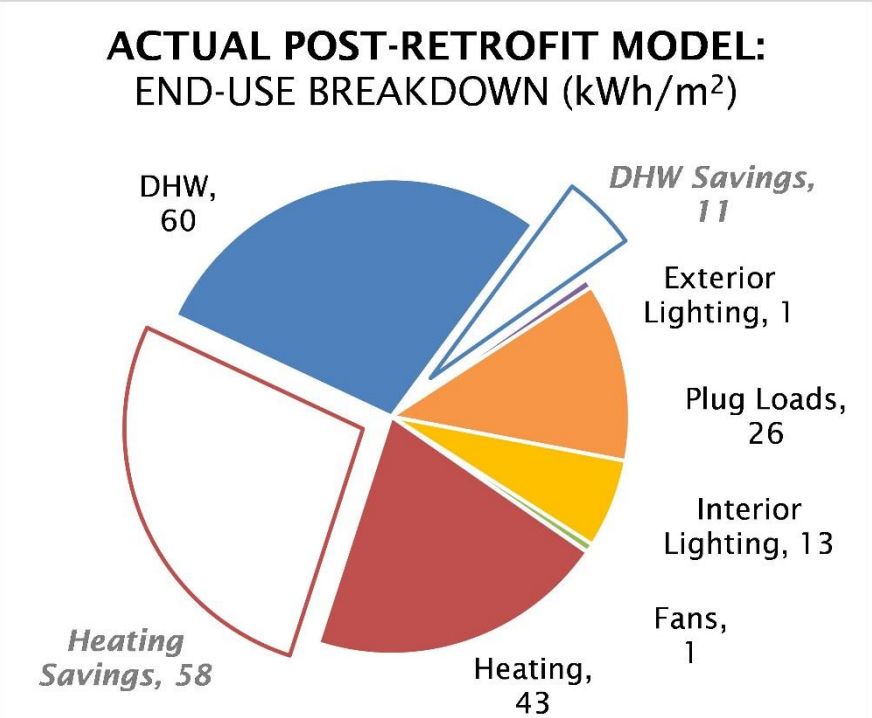
Lord Harley – Outcome

- → Individual Owner, looking to make a long-term investment
- → Desire to minimize ongoing maintenance work and operational costs
- → Desire to update aesthetic and make the rental units more attractive

Lord Harley – Post-Construction





TEUI: 213 kWh/m²/yr

TEUI: 144 kWh/m²/yr

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The Belmont - Background

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The Belmont – Deficiencies

→ Systemic condensation and evidence of water ingress at windows

→ Localized deficiencies in acrylic coating, cracks and cold joints

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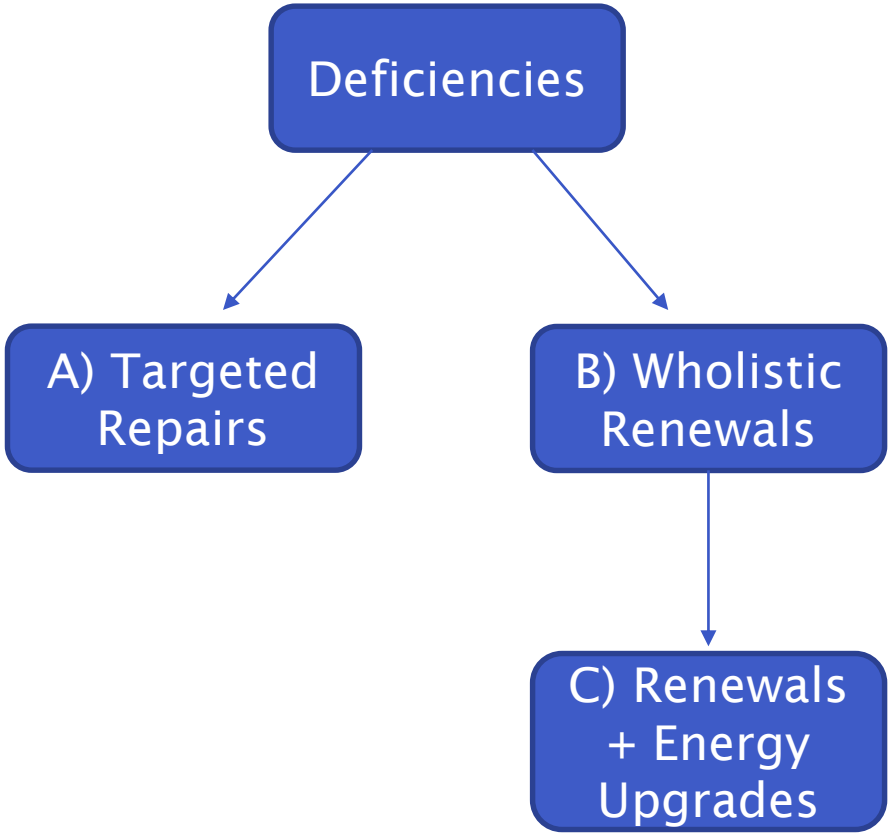
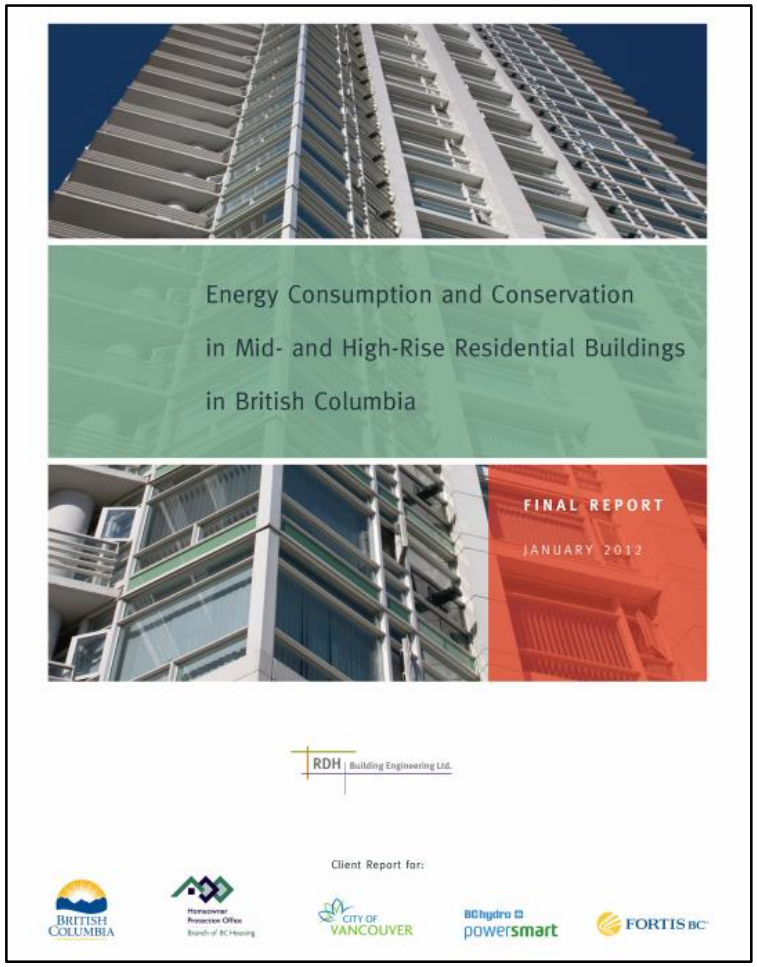
The Belmont - Options



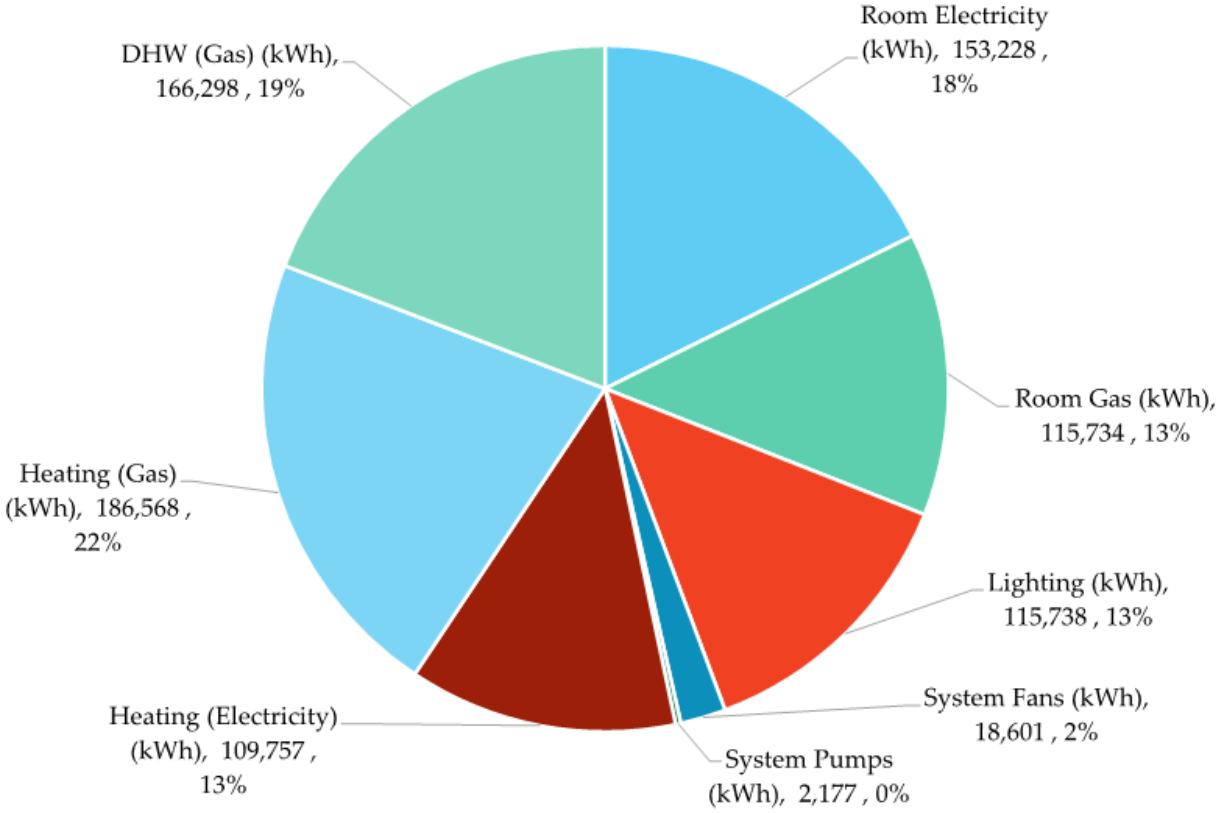


The Belmont – Energy Study

→ Performed calibrated whole building energy modelling

→ Determined Option 3 savings to be:

- → ±20% Total Annual Energy Savings
- → ±75% Suite Heating Energy (Electricity) Savings



The Belmont - Outcome

- → Desire to reduce ongoing maintenance and renewal costs
- → Desire to improve thermal comfort
- → Desire to modernize appearance
- → Desire to reduce energy consumption
- → Funding was available to help offset some of the capital costs

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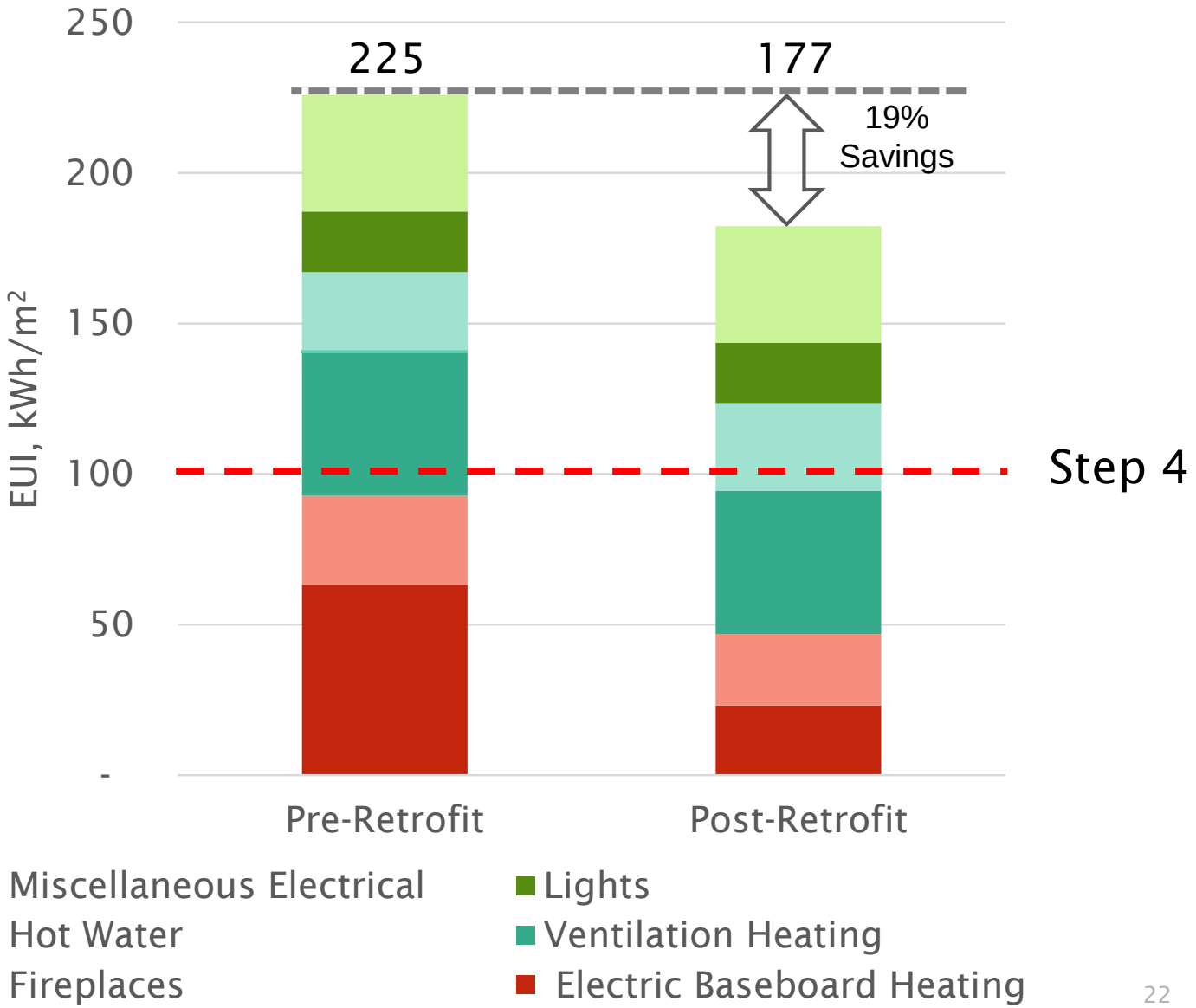
The Belmont – Post Construction



Design Phase

→ Most Common Challenges

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Design Phase

→ Of the relatively limited number of (energy upgrade) renewal and rehabilitation projects that went from Energy Studies through to construction, we noticed two most common challenges:

- → Attachment of cladding through exterior insulation to structure
- → Municipality requirement (building permit) challenges

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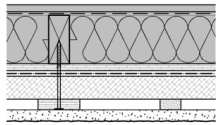
Attachment Through Exterior Insulation

→ Primary concerns:

- → Cladding doesn't fall or blow off
- → Public safety

→ Other concerns:

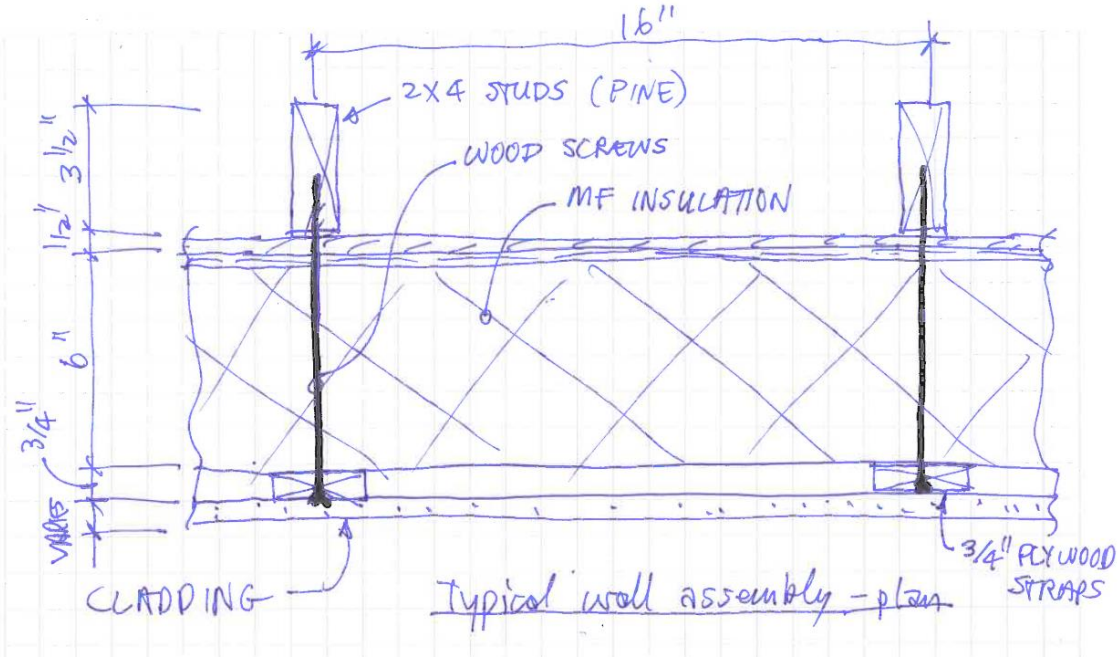
- → Longevity (cracking, buckling)
- → Aesthetics

W1	TYPICAL STUCCO CLAD EXTERIOR WALL ASSEMBLY	• EXISTING INTERIOR GYPSUM WALLBOARD • EXISTING POLY VAPOUR BARRIER • EXISTING BATT INSULATION (REPLACE DETERIORATED INSULATION AS DIRECTED BY CONSULTANT) • EXISTING 2 x 4 WOOD FRAMING (REPLACE DETERIORATED FRAMING AS DIRECTED BY CONSULTANT). PROVIDE ADDITIONAL 2 x 4 WOOD STUDS AS REQUIRED • 1/2" PLYWOOD SHEATHING • WEATHER BARRIER MEMBRANE • 2" HIGH DENSITY MINERAL FIBRE INSULATION (R-4.0 / IN.) • ¾" AIR SPACE • ¾" x 3" PLYWOOD VERTICAL STRAPPING (INSTALLED PLUMB AND SNUG TO INSULATION) @ 16" O.C. max., C/W LAG SCREWS @ 16" O.C. VERTICALLY INTO CENTRE OF EXISTING WOOD STUDS • HIGH DENSITY MINERAL FIBRE VERTICAL SUPPORT STRIPS MIDPOINT BETWEEN VERTICAL STRAPPING • ⅞" STUCCO ASSEMBLY C/W STUCCO BACKING PAPER & ACRYLIC FINISH COAT **NOTES:** 1. REMOVE EXISTING STUCCO ASSEMBLY & RELATED ACCESSORIES, EXISTING SHEATHING PAPER, AND EXISTING SHEATHING 2. *AT PREVIOUSLY REHABILITATED RAINSCREEN CAVITY WALL (AT EAST ELEVATION OF BUILDING - SITE VERIFY EXTENT):* REMOVE EXISTING RAINSCREEN CAVITY STUCCO ASSEMBLY, EXISTING VERTICAL STRAPPING AND EXISTING SHEATHING PAPER.	INTERIOR  EXTERIOR

Attachment Through Exterior Insulation

→ Early on:

- → 2011 – Partially wood-framed institutional building in Lower Mainland
- → Not much information available in the rehabilitation industry
- → Our engineers went to work



Attachment Through Exterior Insulation

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Attachment Through Exterior Insulation

- → RDH approached to conduct a study to evaluate the impact of:
  - → Different densities of insulation
  - → Very thick insulation
  - → Screw arrangements
  - → Screw head types

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Attachment Through Exterior Insulation

→ Modes of failure observed:

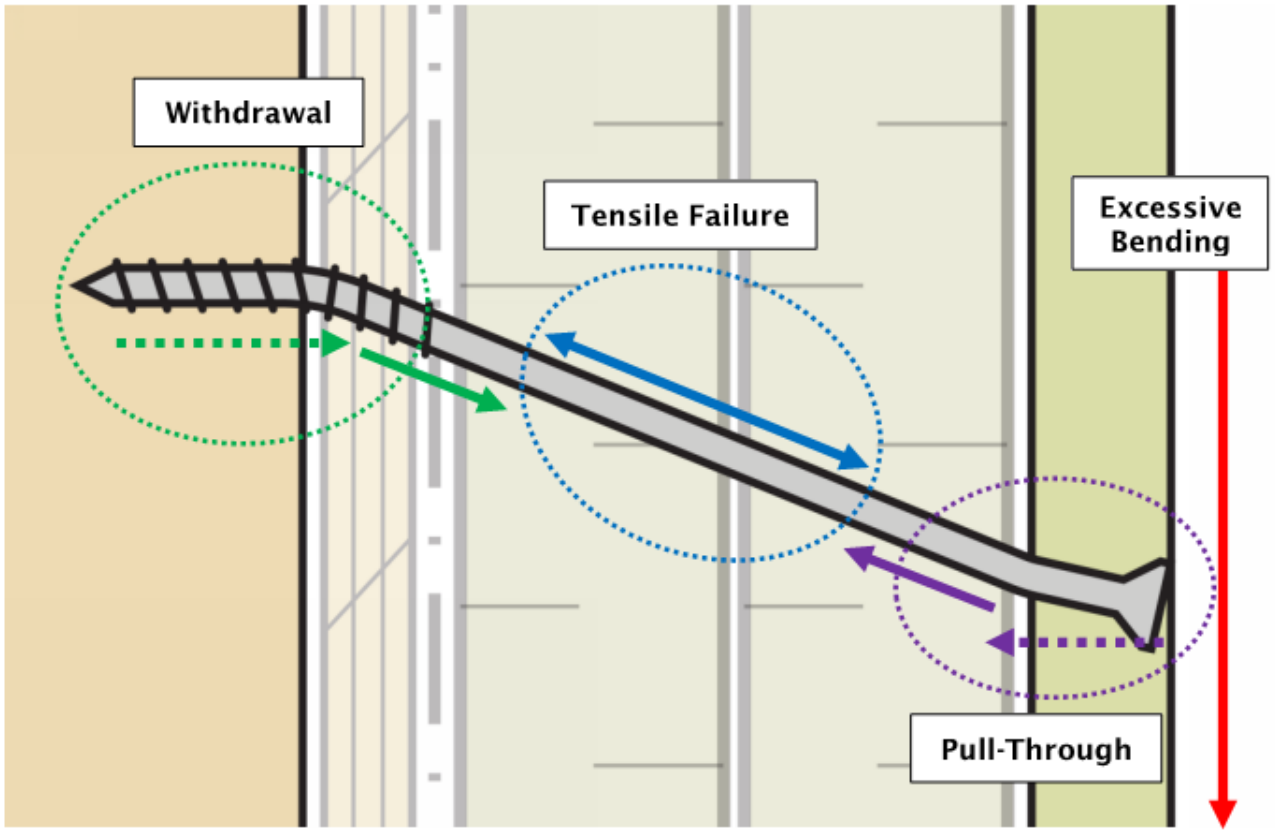
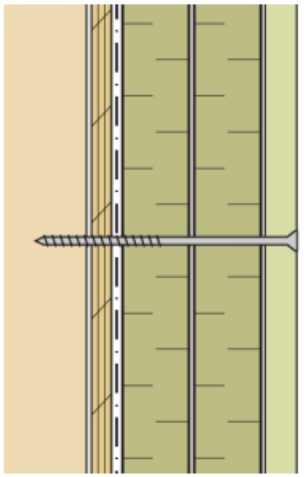


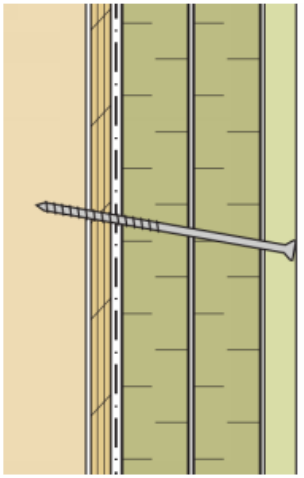
Figure 3.11 Illustration of possible mechanical failures relating to a screw securing a strapping

Attachment Through Exterior Insulation

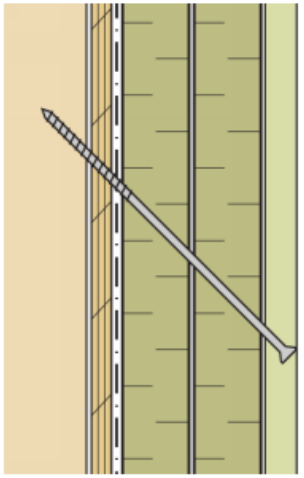
→ Screw arrangements tested:



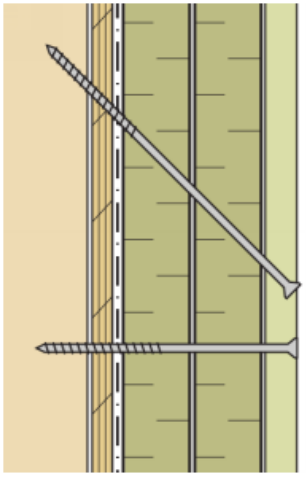
Screw at 90˚ to the strapping



Screw at 1 in 6 slope (80.5˚ to the strapping)



Screw at 45˚ to the strapping



Truss System (90˚ + 45˚)

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Attachment Through Exterior Insulation

→ Conclusions with respect to screw arrangements:

- → Angles at which screws are installed made negligible difference up to 25lbs (9.1kg)
- → When a screw is loaded beyond 45lb (20kg), there's a clear advantage to installing screws at an upward angle
- → Still need to have the assembly engineered to account for all loads and movement

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Spatial Separation – Limiting Distance

- → Municipalities are driving for all things "green", and for very good reason:
  - → Environmentally friendly practices
  - → Energy efficient buildings
  - → Passive House
  - → Example: CoV's "Greenest City Action Plan"
  - → Etc.

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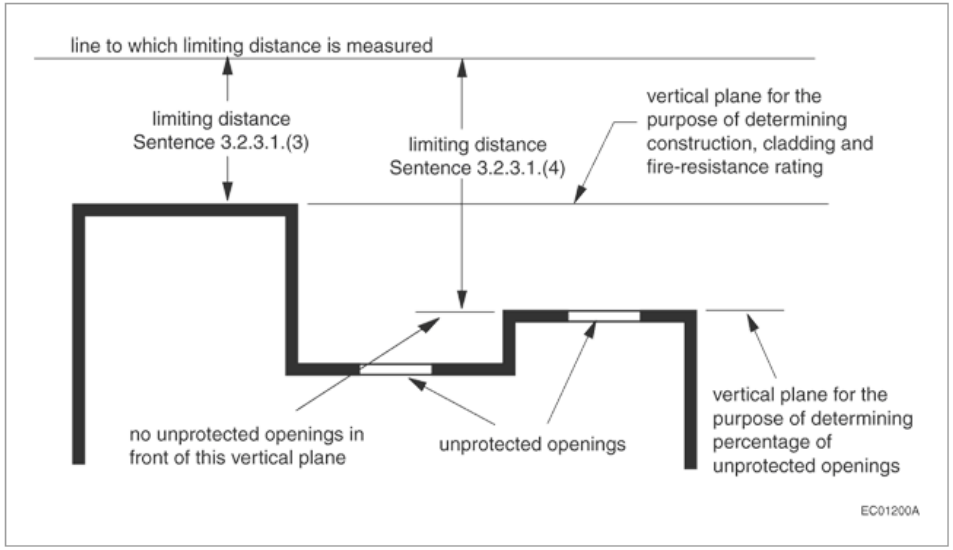
Spatial Separation – Limiting Distance

→ When applying for a building permit, the application reviewer looks at things very differently:

- → Insulation is being added to the exterior wall
- → If there is an adjacent building, the exterior wall is "moving" closer to that adjacent building
- → Provide LIMITING DISTANCE CALCULATIONS

Spatial Separation – Limiting Distance

- → Issue: ratio between unprotected opening (window) relative to exterior wall area, given the Limiting Distance
- → Limiting Distance:
  - → The distance from an exposing building face to a property line, the centre line of a street, lane or public thoroughfare, or to an imaginary line between 2 buildings or fire compartments on the same property, measured at right angles to the exposing building face



Spatial Separation – Limiting Distance

→ A report (including all calcs), declaring the increase in exterior wall thickness (due to insulation installation) does/does not encroach into the limiting distance allowable

→ If the ratios between UPO's and exterior walls don't fit within the prescribed requirements (given the distance from property lines), alternate considerations must be taken

Construction Phase

- → Implementation challenges
  - → Insulation attachment
  - → Limiting distance issues
  - → Other considerations

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Highrise MURB 2

- → Highrise + townhouse complex
  - → Constructed in 1981
- → 25 storeys, 188 suites (not sprinklered)
  - → Reinforced concrete structure
  - → Cast-in-place concrete
  - → Precast concrete panels
  - → Early window wall type of glazing assemblies

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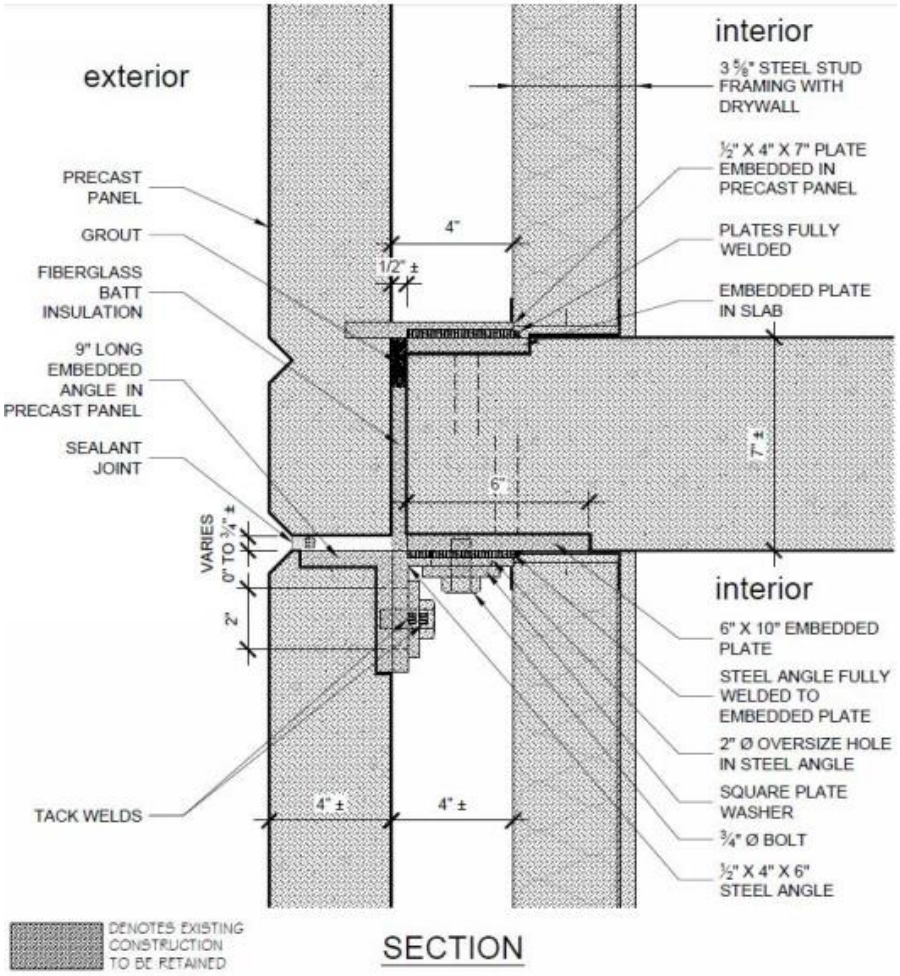
Highrise MURB 2

→ Pre-cast concrete panels:

- → Connected to structure with four steel brackets – each bracket welded to steel plates embedded into structure
- → Not protected with a coating or other finishes
- → Hairline cracks and failed sealant = water ingress



Highrise MURB 2

→ Water ingress resulted in:

- → Corrosion of brackets
- → Spalling of concrete

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Highrise MURB

→ Solution was to overclad the pre-cast concrete panel walls with an exterior insulated finish system (EIFS)

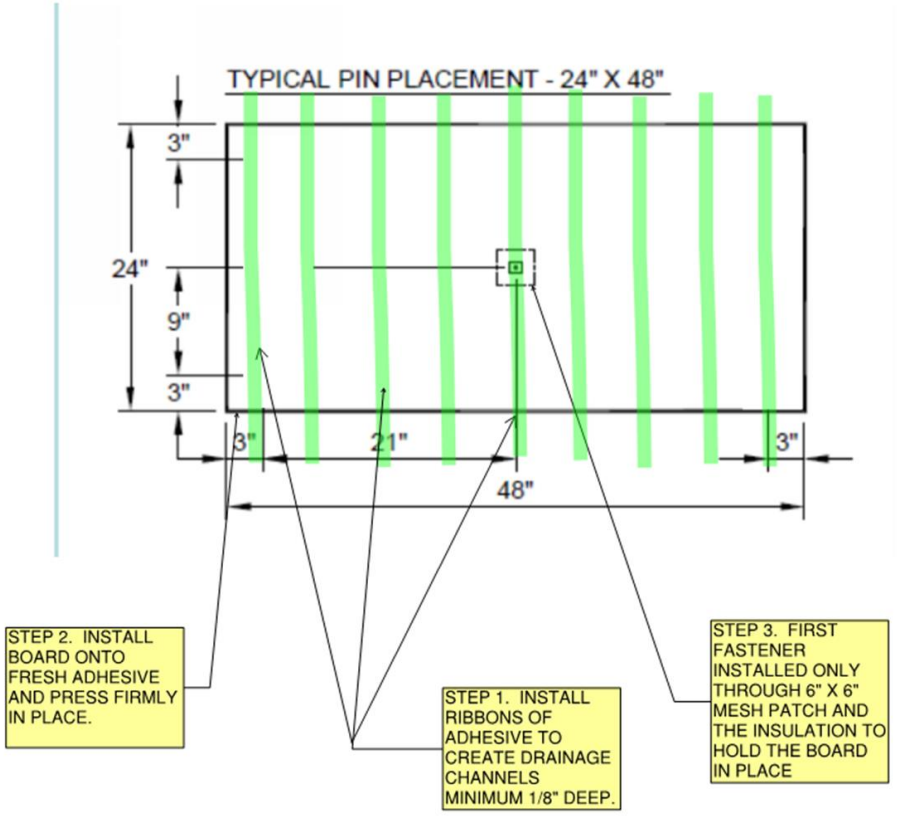
  → Due to the building being unsprinklered, mineral fibre insulation must be installed

→ Effective R-Value was to increase from R4 to R18

→ Great, so how do we attach mineral fibre insulation to pre-cast concrete?

Highrise MURB 2

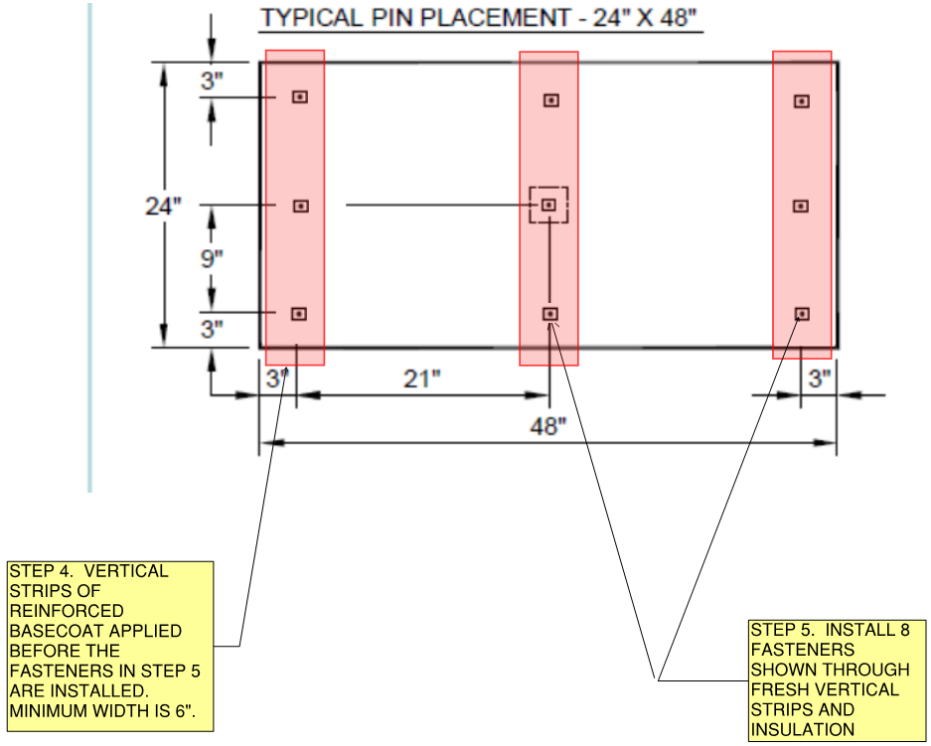
- → After several cycles of testing and revisiting the drawing board, the following 3-stage, 6-step process was derived:
- → Stage 1 – Set Adhesive
  - → Step 1: Install ribbons of adhesive to create drainage channels
  - → Step 2: Install board onto fresh adhesive and press firmly in place
  - → Step 3: First fastener installed through 6”x6” mesh patch and the insulation to hold the board in place



Highrise MURB 2

→ Stage 2 – Place Pins

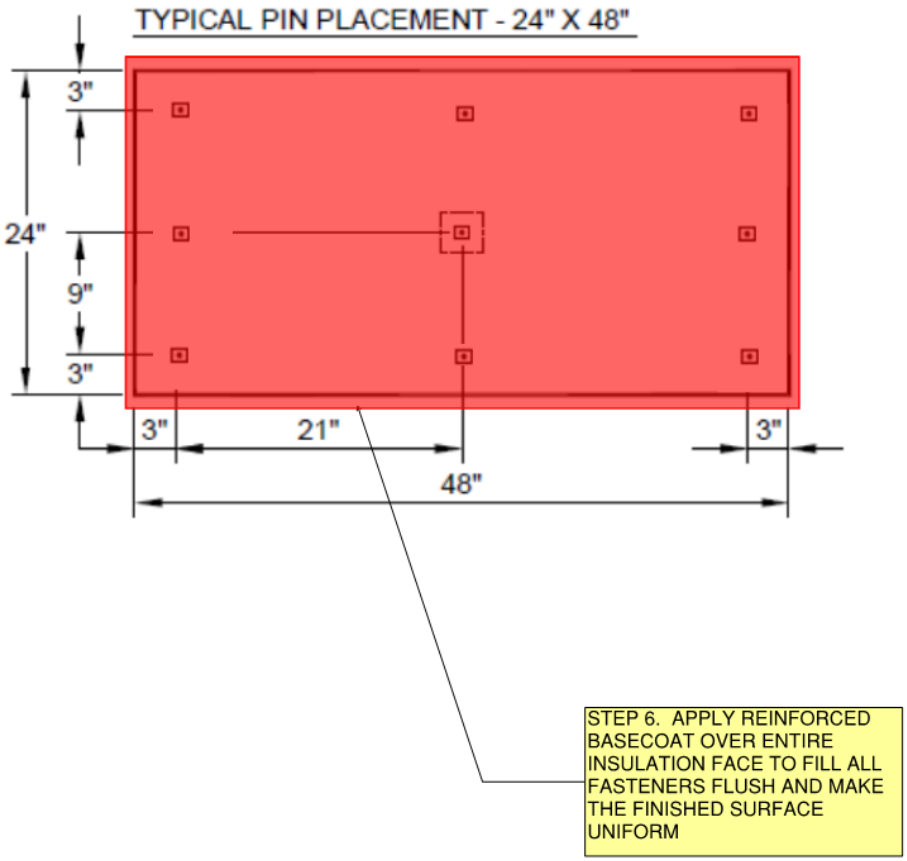
- → Step 4: Install vertical strips of reinforced basecoat applied before the fasteners in Step 5 are installed. Minimum width is 6”.
- → Step 5: Install 8 fasteners shown through fresh vertical strips and insulation



Highrise MURB 2

→ Stage 3 – Install EIFS Lamina

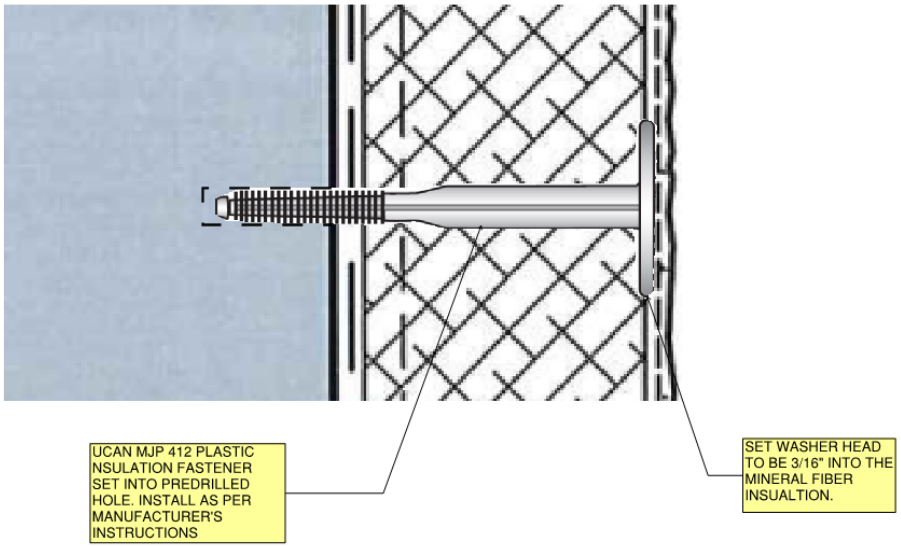
→ Step 6: Install reinforced basecoat over entire insulation face to fill all fasteners flush and make the finished surface uniform



Highrise MURB 2

→ Fastener system that satisfied the needs of this project:

→ Plastic insulation fasteners set into predrilled holes



TYPICAL INSULATION FASTENERS

Highrise MURB 2

→ Pull testing confirmed designed system provided sufficient pull-out resistance

→ Thicker-than-typical EIFS lamina provided durability to absorb subtle movements of the mineral fibre insulation boards

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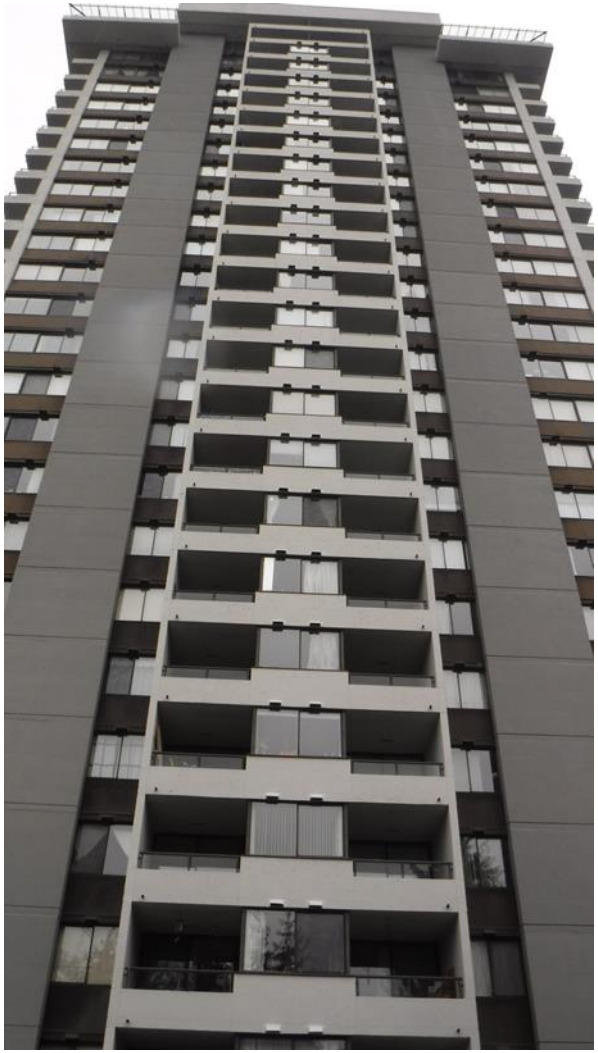
Highrise MURB 2



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Low-Rise MURB 1

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Low-Rise MURB 1

→ Owners wanted 2” of exterior insulation

→ Applied for building permit

→ Municipality came back with a list of deficiencies, including a *request for limiting distance calculations*

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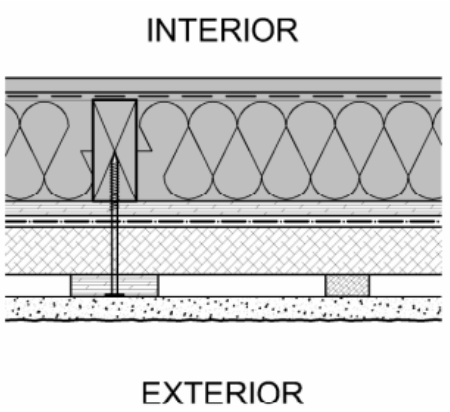

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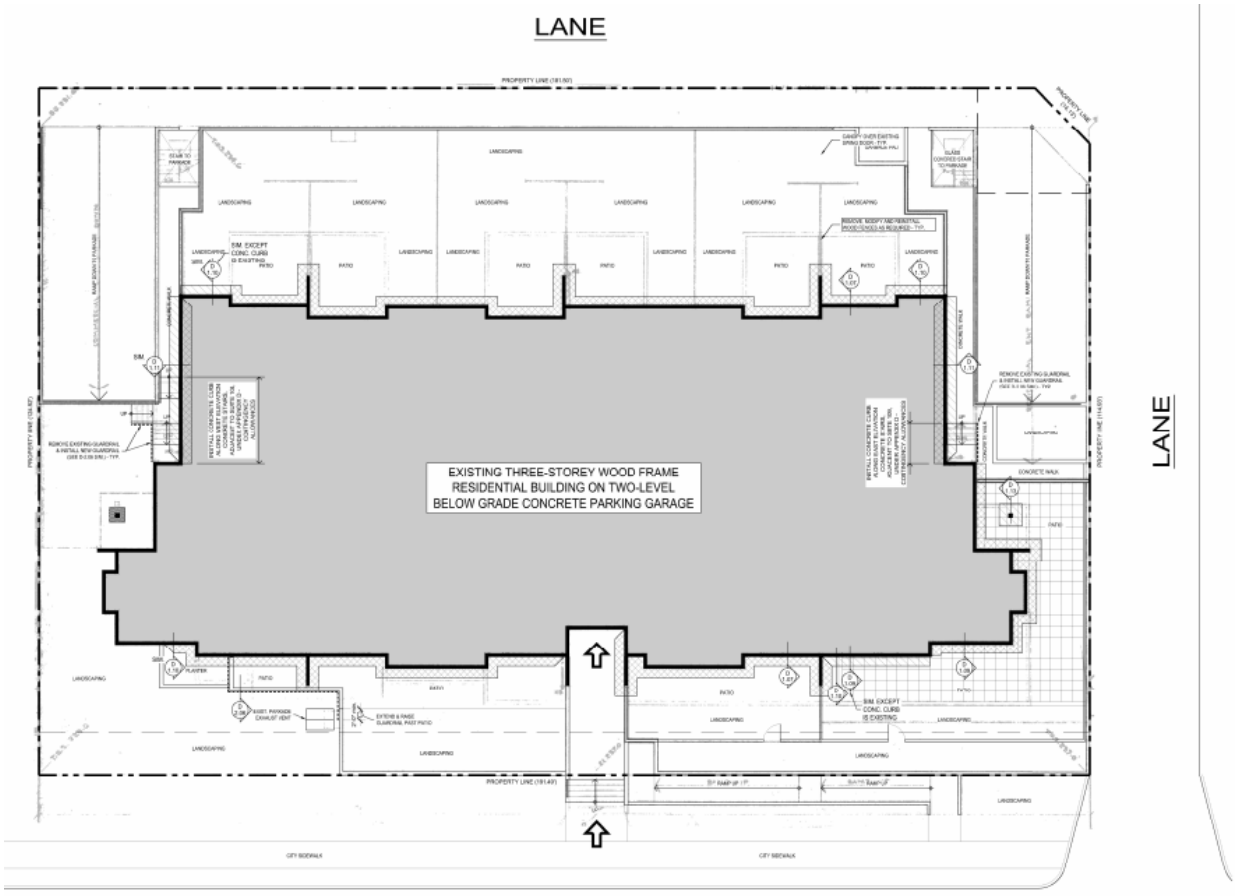
Low-Rise MURB 1

→ South elevation is bound by city side street, the east and north elevations were bound by lanes

→ West elevation is relatively close to the west property line



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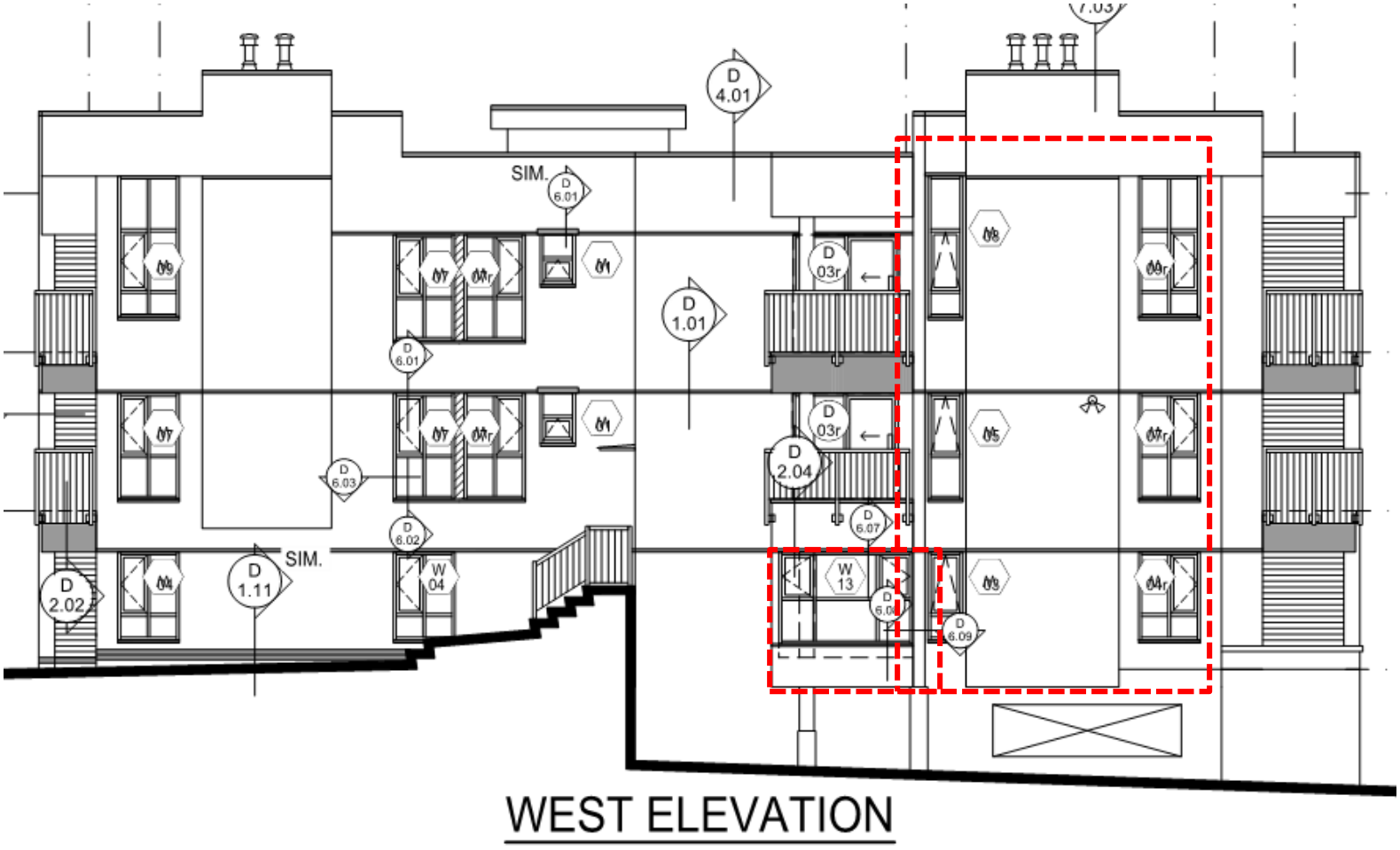
Low-Rise MURB 1



WEST ELEVATION

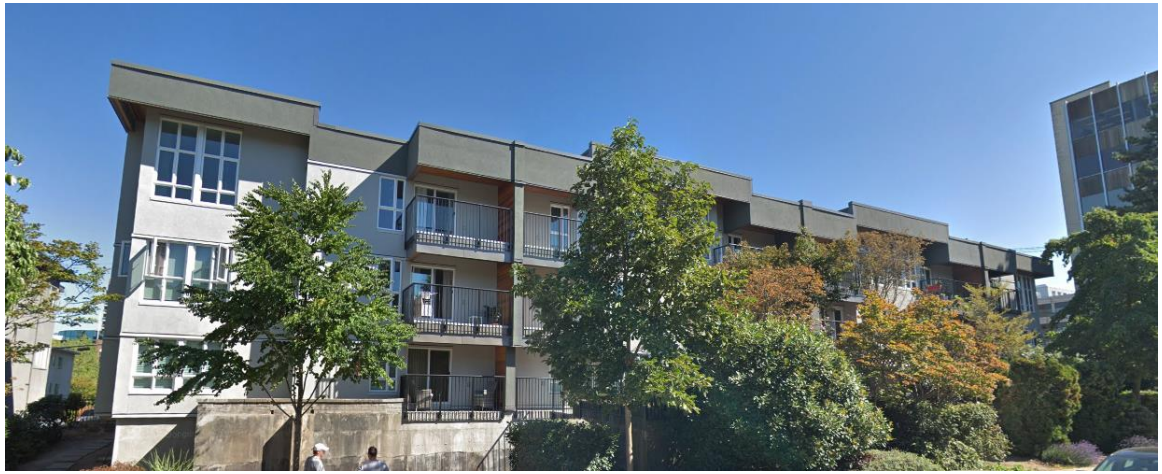
Low-Rise MURB 1

→ Limiting distance calculations were made, and a 12-page report, including all calculations shown, was produced

→ Despite the 2” increase of wall thickness, the limiting distance was not encroached upon and the overall ratio between unprotected openings and exterior wall area was within code-allowed limits

Low-Rise MURB 1

Low-Rise MURB 1



Low-Rise MURB 3

→ Four storeys, 7 suites

→ Non-combustible construction

→ Circa 1983 construction

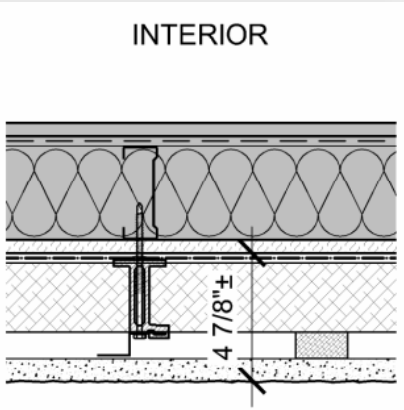
→ Full building enclosure rehabilitation

Low-Rise MURB 3

→ Owners wanted 3” of exterior insulation

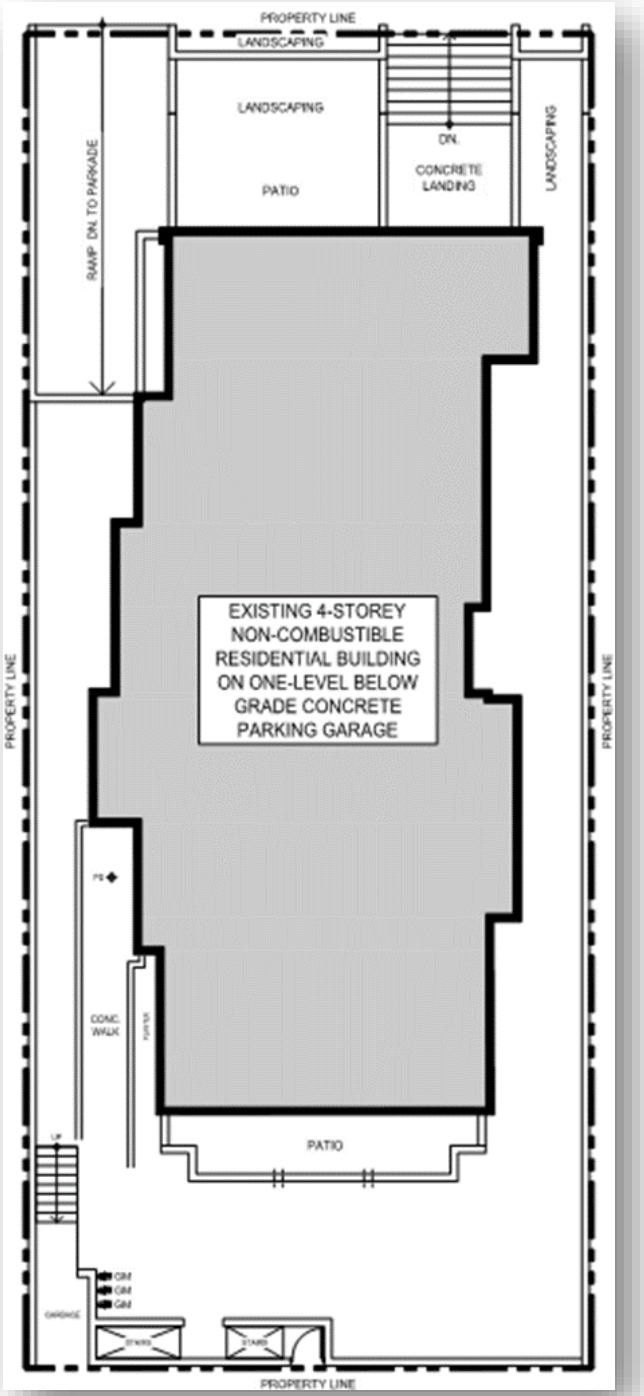
→ Applied for building permit

→ Municipality came back with a list of deficiencies, including a *request for limiting distance calculations*

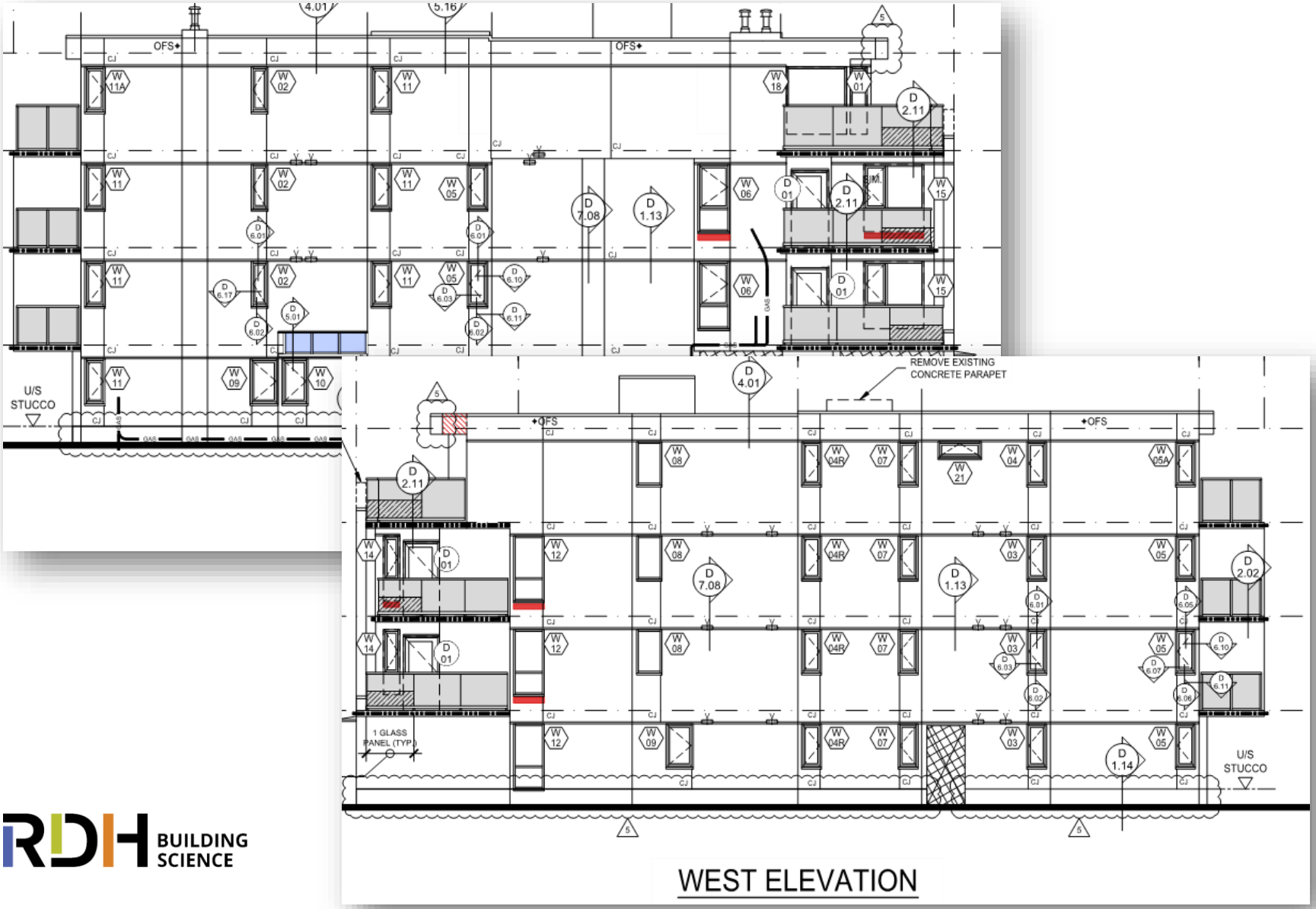
W1	TYPICAL EXTERIOR STUCCO CLAD WALL ASSEMBLY ON STEEL STUD FRAMING	• EXISTING INTERIOR GYPSUM WALLBOARD • EXISTING POLY VAPOUR BARRIER EXISTING 3 5/8" 20 GA. STEEL STUD FRAMING @ 16" O.C. C/W 25 GA. TRACKS - FIELD VERIFY (REPAIR / REPLACE DAMAGED MEMBERS AS DIRECTED BY CONSULTANT) • EXISTING BATT INSULATION (REPLACE DETERIORATED INSULATION AS DIRECTED BY CONSULTANT) • 1/2" EXTERIOR GYPSUM SHEATHING • SHEATHING MEMBRANE • 3" FIBERGLASS SPACERS (SECURED TO STUDS @ 16" O.C. MAX. HORIZONTALLY) C/W 1" OFFSET VERTICAL GALVANIZED METAL Z-GIRTS • 3" MINERAL FIBRE INSULATION FIT SNUG BETWEEN SPACERS • 1" AIR SPACE • 1" x 2" HIGH DENSITY MINERAL FIBRE VERTICAL SUPPORT SPACERS AT MIDPOINT BETWEEN VERTICAL Z-GIRTS • 7/8"± STUCCO ASSEMBLY C/W STUCCO BACKING PAPER AND ACRYLIC FINISH COAT **NOTES:** 1. REMOVE EXISTING STUCCO CLADDING & RELATED ACCESSORIES 2. REMOVE EXISTING SHEATHING PAPER 3. REMOVE EXISTING EXTERIOR SHEATHING	

Low-Rise MURB 3

→ East and west elevations are close to the property lines



Low-Rise MURB 3



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Low-Rise MURB 3

→ Limiting distance calculations were made, and a 31-page report, including all calculations shown, was produced

→ Due to the increase in wall thickness, the ratio between unprotected openings and exterior wall area at the east elevation was too high under the prescriptive allowances of the code tables

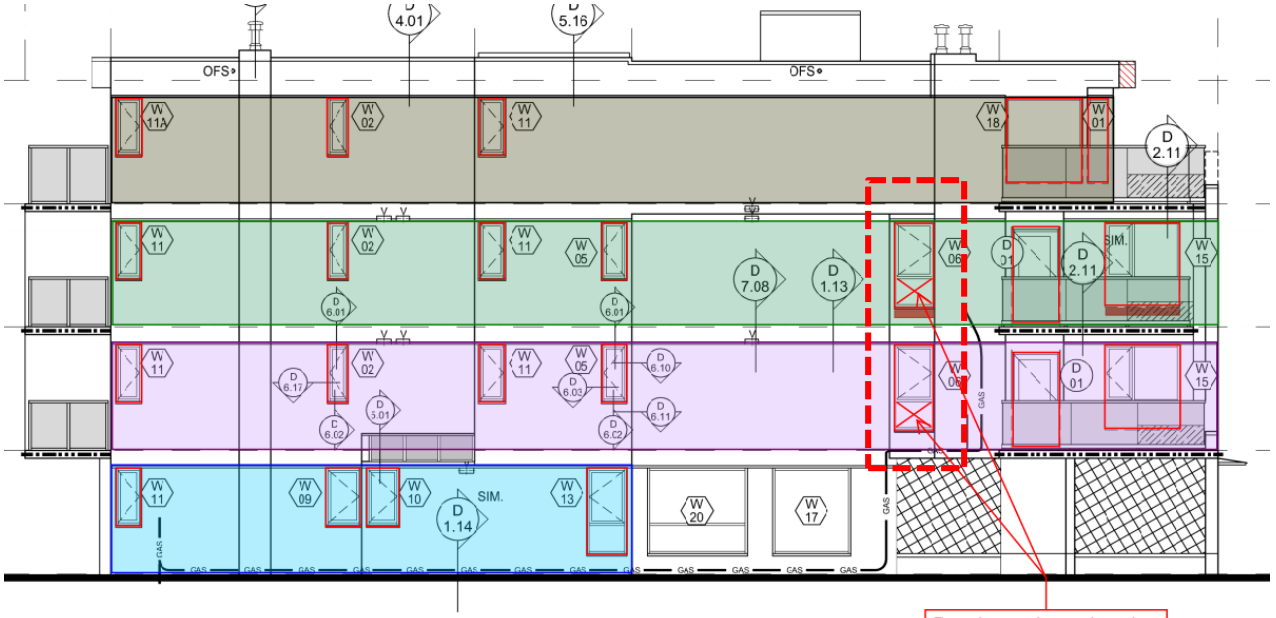
Low-Rise MURB 3

→ There were two options:

- → Reduce the overall insulation thickness
- → Reduce the overall area of unprotected openings

→ The chosen solution was to:

- → Reduce the overall area of unprotected openings.



EAST ELEVATION

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Other Considerations

Summary and Next Steps

→ Key takeaways from our project experience, and changes needed to facilitate more projects moving forward

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Summary and Next Steps

→ Energy studies indicate that measures for increasing energy efficiency works

→ Incentives more accessible for individual suite Owners to increase the energy efficiency of their existing buildings

- → Government grants
- → Rebate programs
- → Etc.

Summary and Next Steps

- → Attachment of cladding to structure through exterior insulation needs to be designed by a qualified engineer
  - → If the designer is considering “standard” cladding types, perpendicular installation of fasteners is sufficient
  - → For heavier and more robust cladding options, fasteners installed at an upward angle should be considered
- → Allow for providing limiting distance calculations as part of the building permit application process
- → Relaxations for proving limiting distance compliance
  - → Limiting distance calculations not needed for exterior insulation thicknesses up to 3” and non-combustible materials
  - → Limiting distance calculations not needed if rough opening sizes are not being increase or moved
  - → Both?

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Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT

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