FUNDAMENTALS OF SEALANT PERFORMANCE

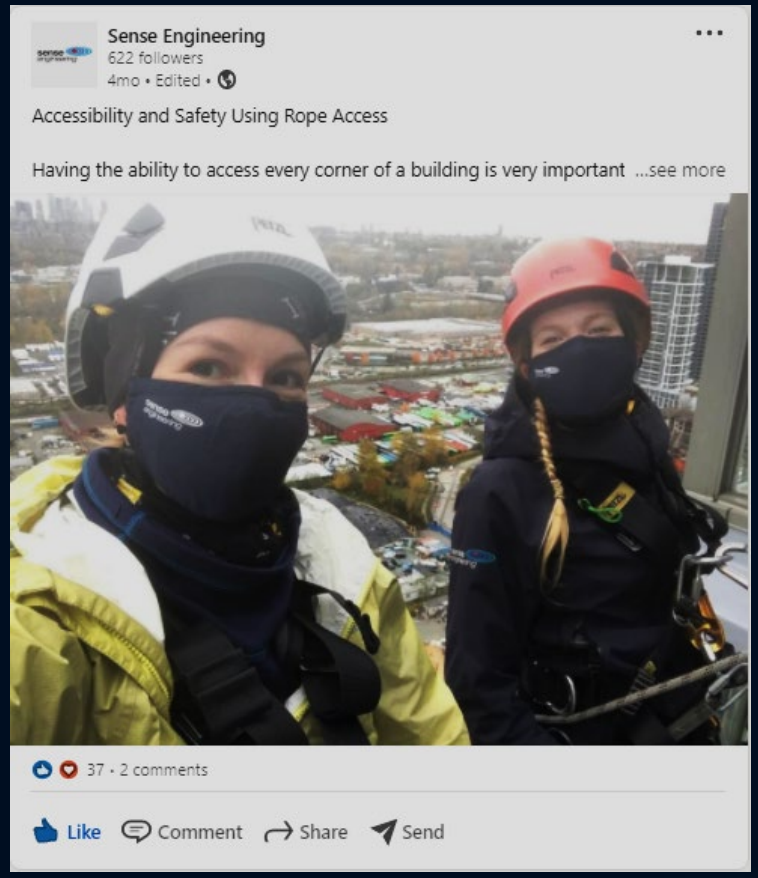
...for an Expert Crowd...

sense engineering

ENGINEERING THAT MAKES SENSE.

Agenda

- Overview of standards & performance criteria
- Sealant bond & function
- Service life considerations
- Determining renewal options
- What else?



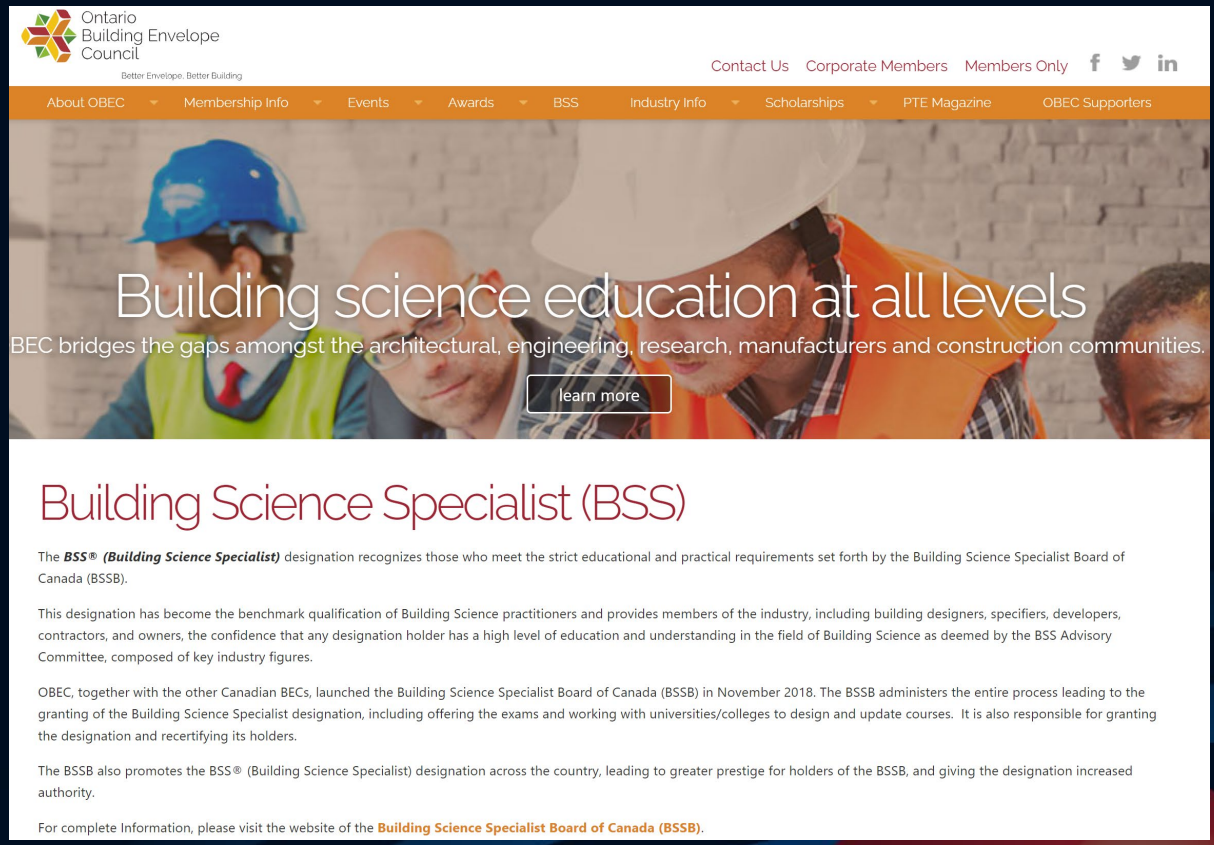
WAY BACK WHEN…

BUILDING ENVELOPE MATERIALS: SEALANTS

Kevin Day

Halsall
ENGINEERS · CONSULTANTS

UNIVERSITY OF TORONTO
SCHOOL OF CONTINUING STUDIES



WAY BACK WHEN...

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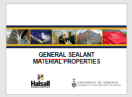

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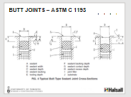

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Terminology

- Poll: Sealant vs. Caulking
- By definition:
  - Sealant moves and has “elasticity”
  - Caulking:
    - *As a noun:* it doesn’t really move, it’s a gap filler
    - *As a verb:* is the act of “applying” sealant
- Question: would you rename SWA as the **Caulking** and Waterproofing Association of Canada?

Terminology

- **Expansion Joints**
  - Extend through the building assembly, e.g., building expansion or masonry control joints
  - Expected to have significant movement
  - Example, movement expected to be ≥10% joint width
- **Termination Joints**
  - Seal between building envelope elements, e.g., window perimeters
  - Not expected to have significant movement
  - Example, movement expected to be <10% joint width

Types of Sealant

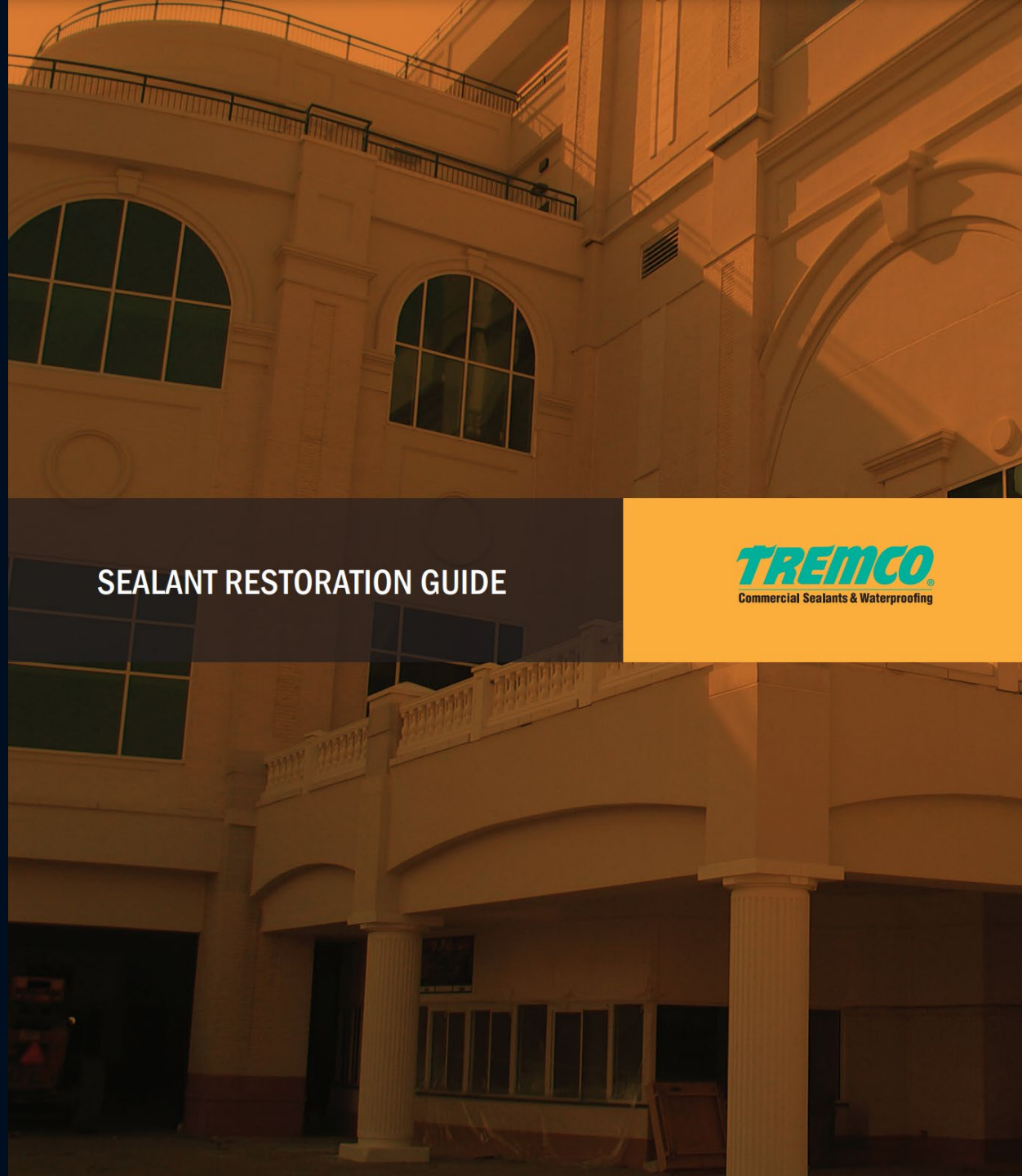
- Most commonly used **exterior** sealants:
  - Polyurethane (preceded by polysulfide)
  - Silicone
  - Acrylic
  - Hybrids, e.g., silyl terminated polyether
  - Foam gaskets e.g.,used with silicone
- Most commonly used **concealed** sealants:
  - Butyl
  - Polymer modified bitumen
  - Spray-applied foam
  - Crack injection

Resources

- Standards - order here
  - ASTM – ASTM International
  - CGSB – Canadian General Standards Board
  - ULC – Underwriters Laboratories Canada
- Industry Guides
  - AAMA – American Architectural Manufacturers Association
  - CPCI – Canadian Precast Concrete Institute
  - SWAO – Sealant & Waterproofing Association (Ontario)
  - SWRI – Sealant & Waterproofing Restoration Institute

Resources

- ASTM Standards
- ULC Standards (for SPF)
- Tremco's Sealant Restoration Guide



Performance & Service Life

EXPECTATIONS:

- Stick long enough
- Flexible long enough
- Resist water, UV, pollutants
- “Easy” repair methods
- Barrier seals or rainscreen

APPLICATION

- Priming & surface prep
- Application conditions
- Tool for bonding
- Joint proportions, width/depth
- Best before dates

The name is Bond, Sealant Bond…

ASTM C1736 [Withdrawn] Standard Practice for Non-Destructive Evaluation of Adhesion of Installed Weatherproofing Sealant Joints

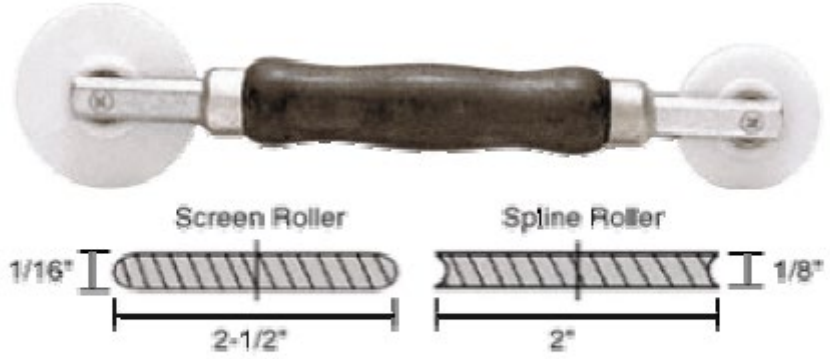


Figure 2 – Depiction of a non-pressure controlled roller device

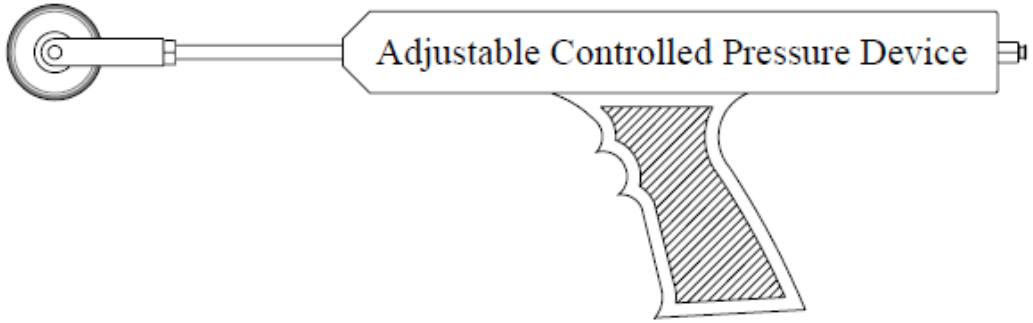
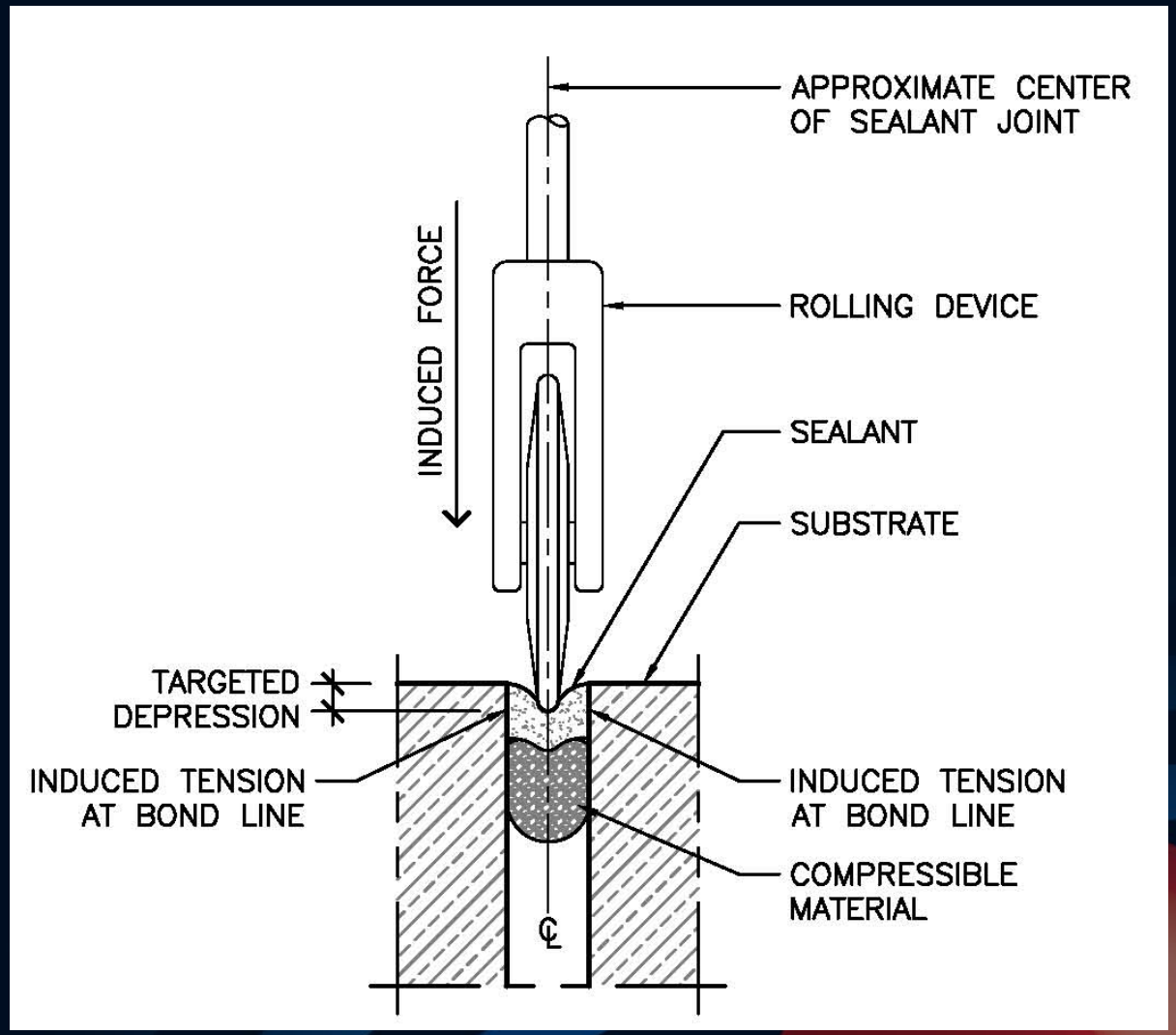
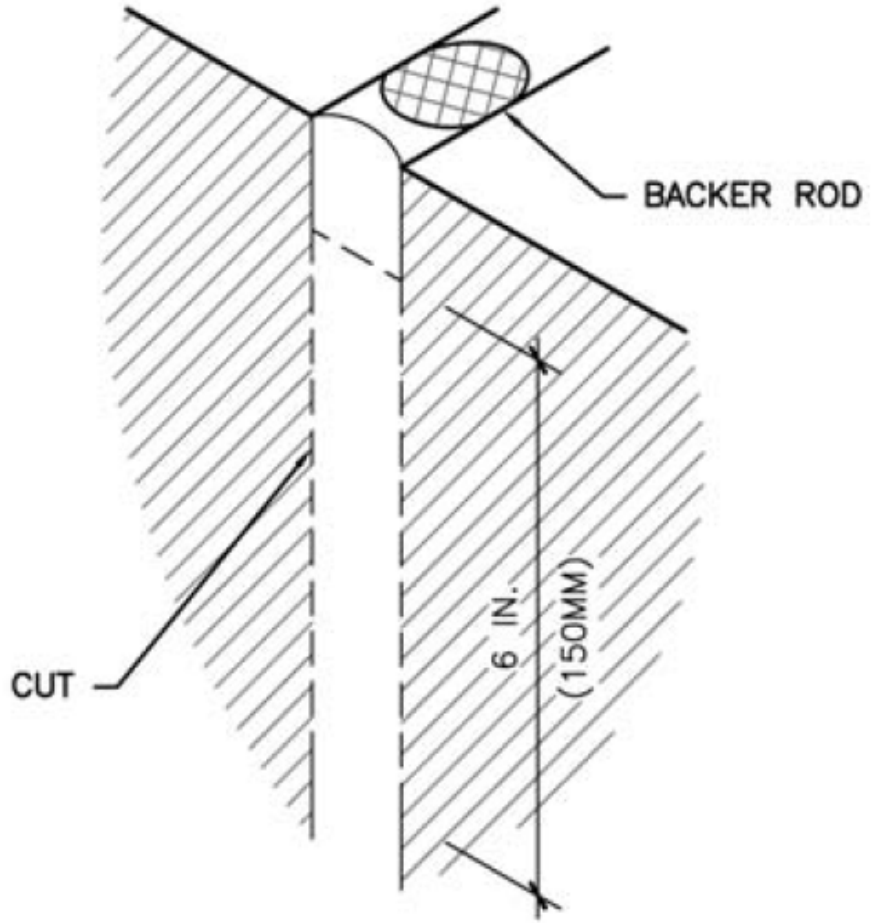


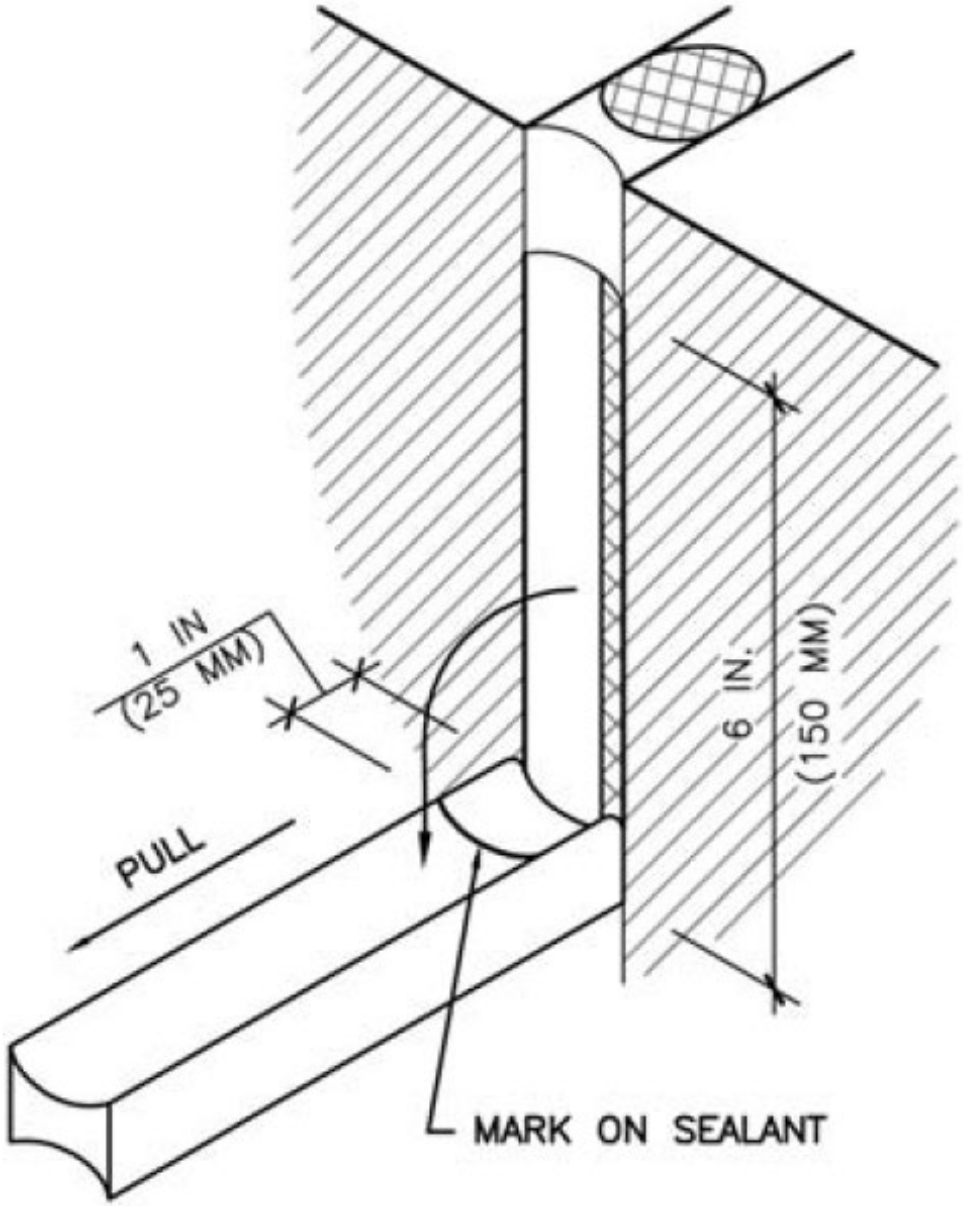
Figure 3 – Adjustable Controlled Calibrated Weatherseal Testing Device



ASTM C 1521



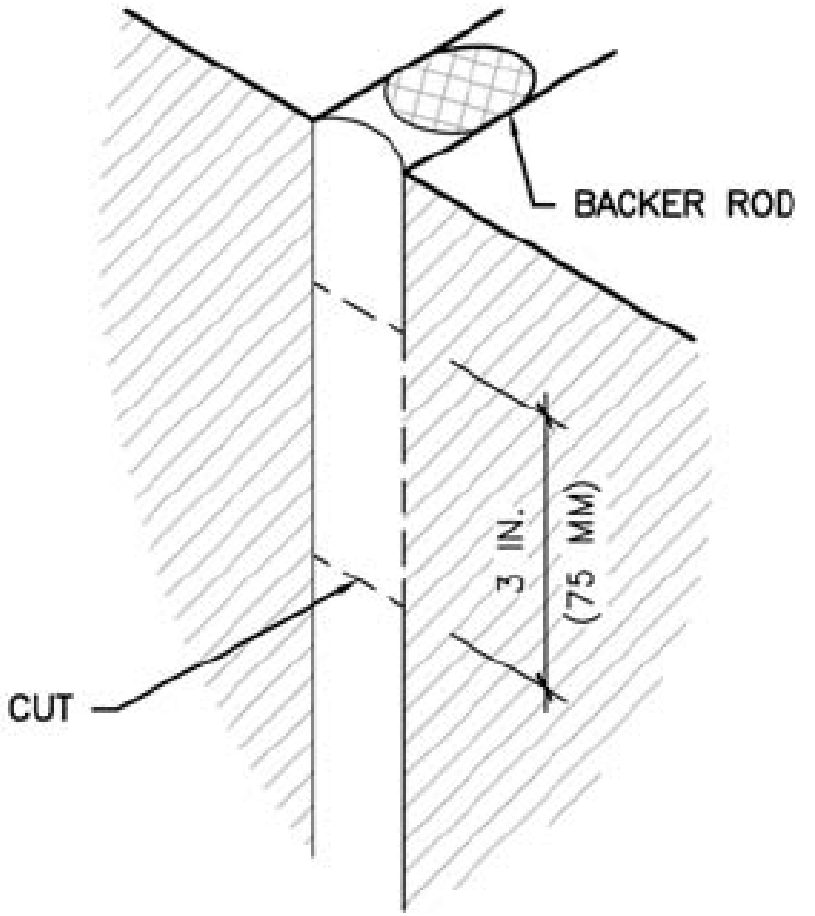
6 IN. (150 MM) CUT THROUGH SEALANT AT BOND LINE OF BOTH SUBSTRATES AND ACROSS ONE END TO CREATE TAIL



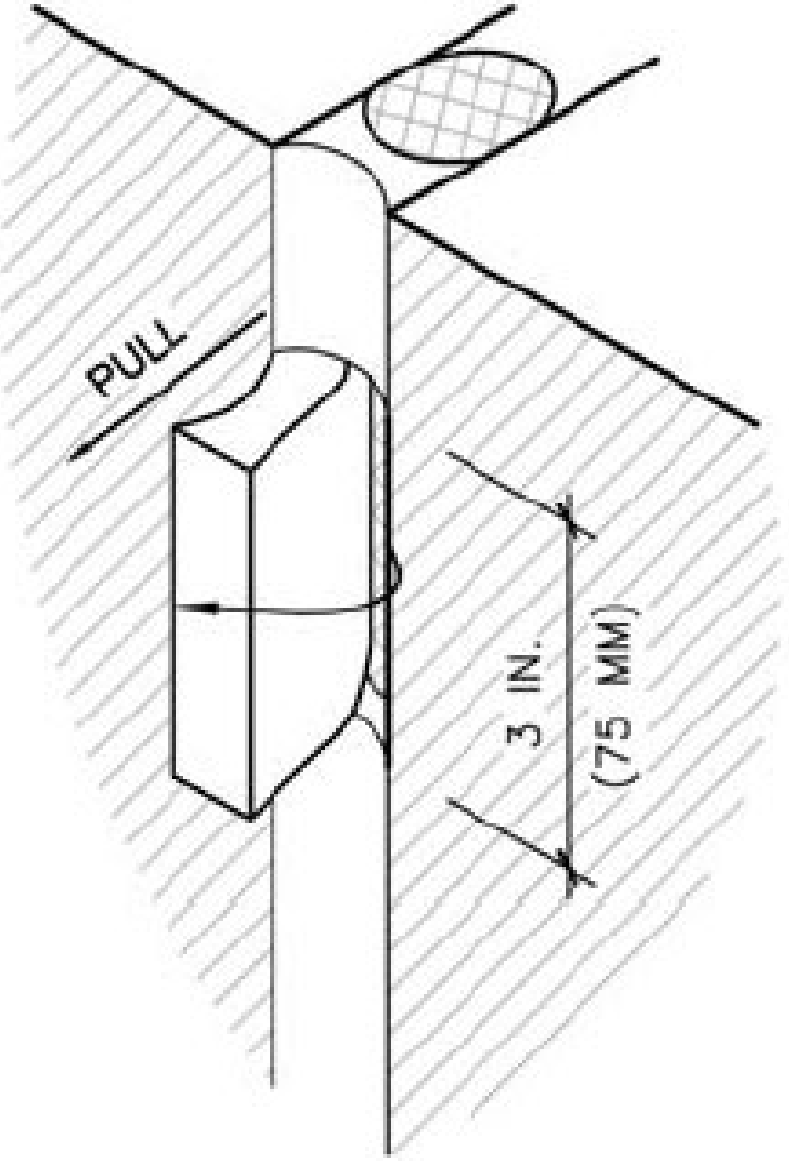
MARK CUT PORTION OF SEALANT 1 IN. (25 MM) FROM ADHESIVE BOND. PULL TAIL.

FIG. 2 Tail Procedure

ASTM C 1521



CUT THROUGH SEALANT 3 IN. (75 MM) ALONG BORDER OF ONE SUBSTRATE. CUT ACROSS SEALANT BEAD ON BOTH ENDS OF THE 3 IN. (75 MM) CUT.



PULL FLAP.

FIG. 3 Flap Procedure

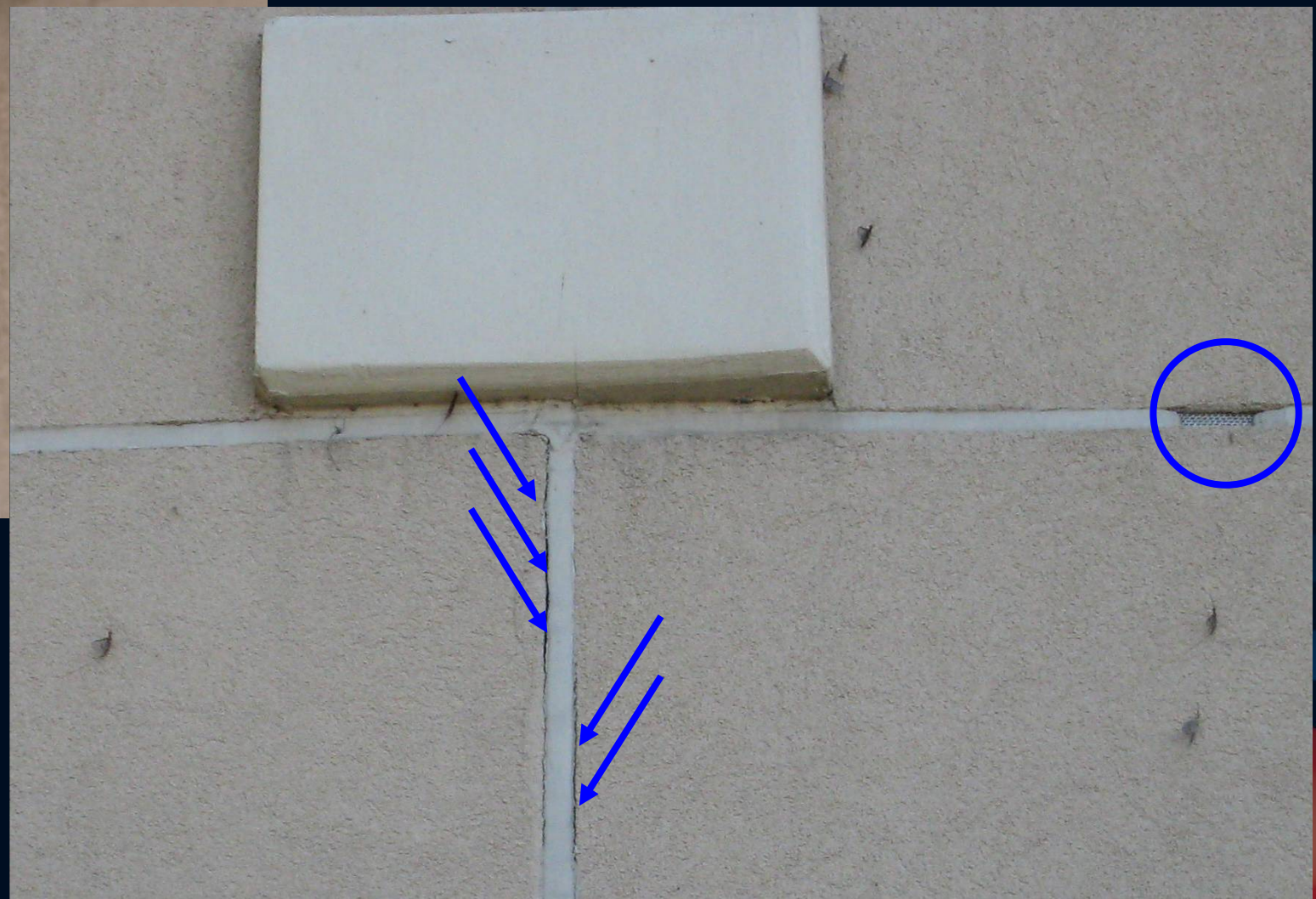
Too Prime, or Not To Prime?

That is the question…

Painting Sealants

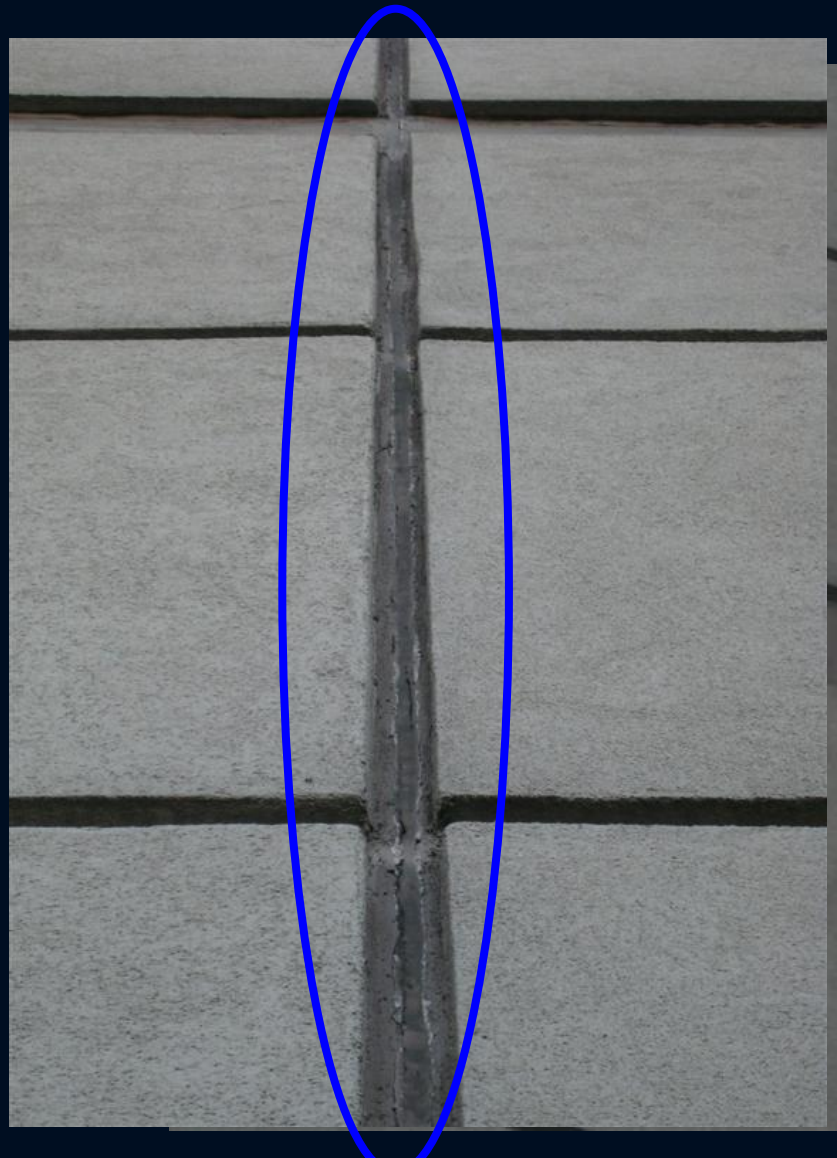
Blisters

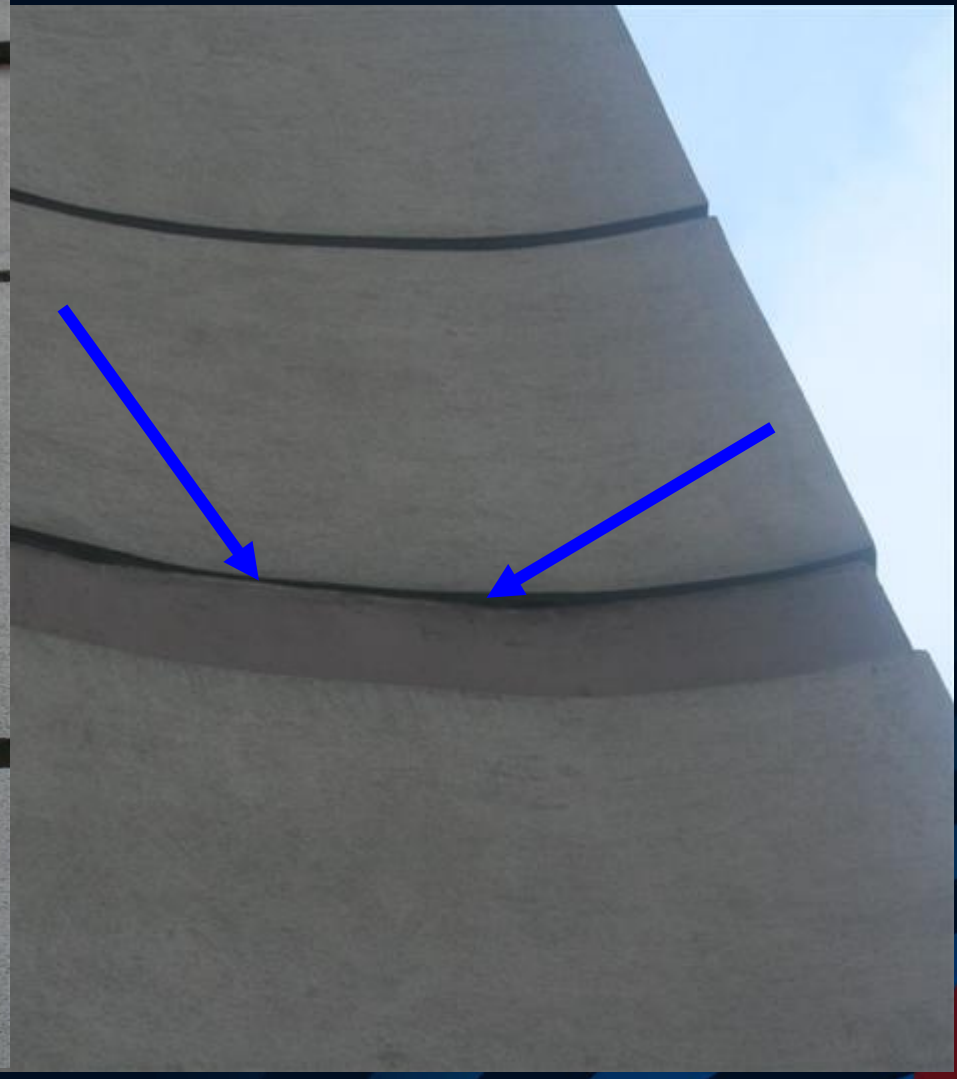
Sealant Too Thin



Know whether or not your wall is a rainscreen – if not, sealants aren't *as* critical

Looking for Trouble





Joint Design

$$J_{WIDTH} = |J_T| + |J_M| + |J_C| + |J_\delta|$$

- $J_{thermal} = (100/S_m) \cdot (C_t) \cdot (\Delta T) \cdot (L)$
  - S_m = Sealant Movement Capability
  - C_t = Coeff. Linear Thermal Expansion
  - ΔT = Range of Temperature Difference
  - L = Nominal Panel Length
- $J_{moisture\ movement} = (C_m/100) \cdot (L)$
  - C_m = Moisture Absorption Coefficient
- J_c = minimum construction tolerances
- J_δ = minimum joint width required for deflection, frame shrinkage, creep

Key

Key

Ref: M. Lacasse NRC – Interfaces, Detailing for Durability

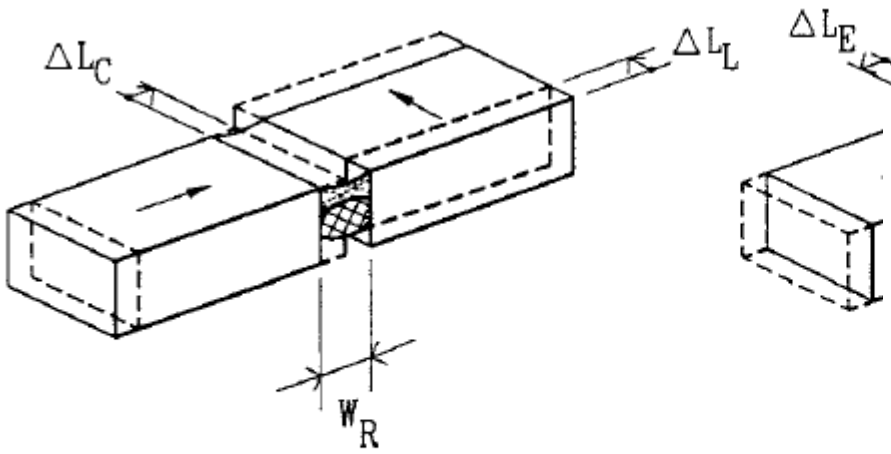
ASTM C 1472

Want to do the calculations?

- *Thermal movement*
- *Thermal (environmental induced) movement*
- *Moisture induced growth*
- *Live load deflection*
- *Dead load deflection*
- *Wind load movement*
- *Seismic load movement*
- *Movement during sealant curing*
- *Elastic frame shortening*
- *Creep*
- *Shrinkage*
- *Construction Tolerances*

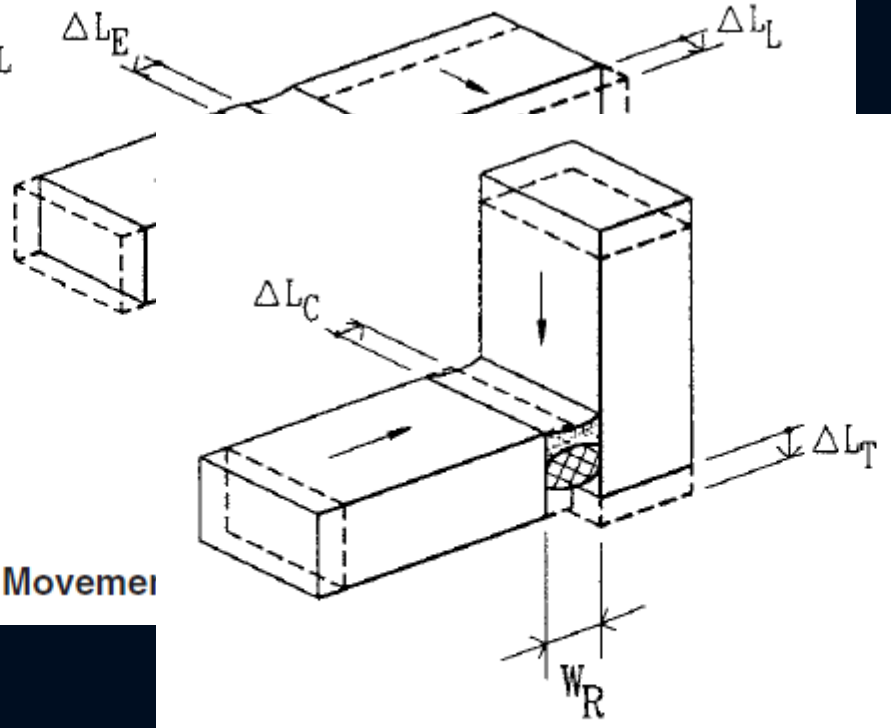
JOINT MOVEMENT – ASTM C 1472

How many dimensions, 1, 2 or 3?

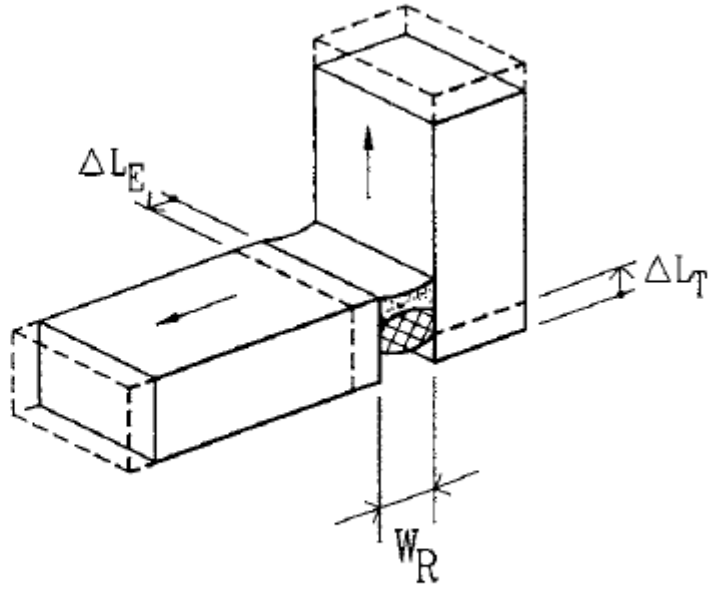


A. COMPRESSION WITH EXTENSION

FIG. 4 Extension and Compression Movemer



A. COMPRESSION WITH EXTENSION



B. EXTENSION MOVEMENTS

FIG. 3 Extension and Compression Movement with Transverse Extension

ASTM C 1472

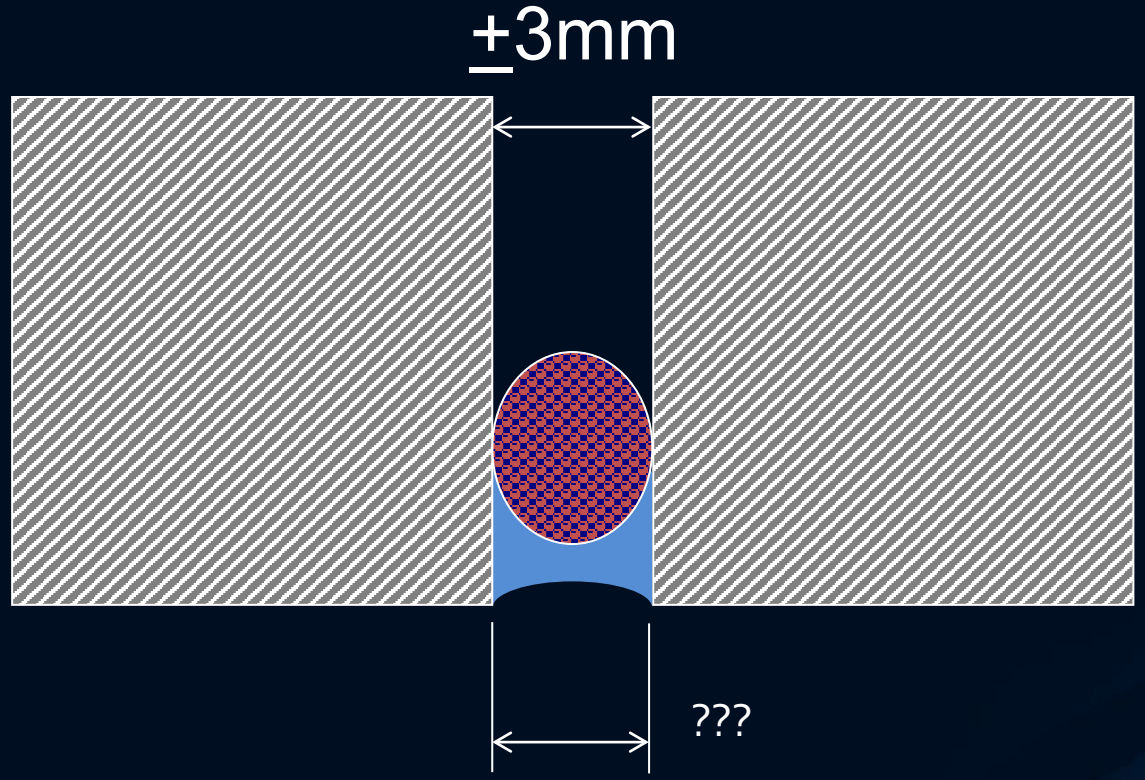
Want to do the calculations?

- 23.5755 mm ± 6 mm...
- What do you think the normal construction tolerance of concrete structural framing would be?

$$W_R = \frac{-[2(6.2484)] - \sqrt{[2(6.2484)]^2 - 4[(0.25)^2 - 2(0.25)][-((6.2484)^2 + (3.5230)^2)]}}{2[(0.25)^2 - 2(0.25)]} = 23.5755\ mm$$

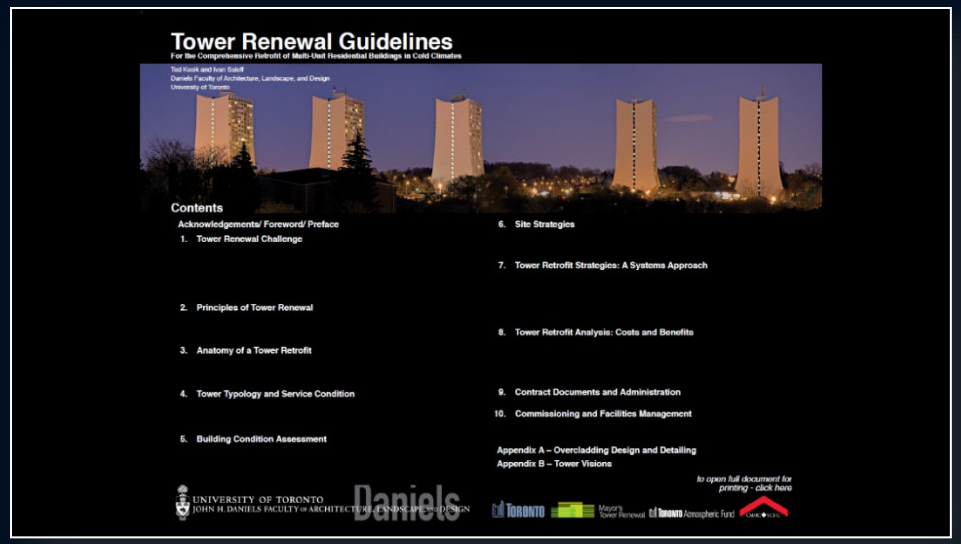
OR… Rule of Thumb?

- Size the joint 2 to 3 times the expected range of movement
- For EIFS, size the joint 4 times the range of movement



Tower Renewal

- Comprehensive guide on how to retrofit multi-unit residential buildings – adding/replacing:
  - Insulation – enclosing the structure and mitigating thermal bridging
  - Windows and doors
  - Air tightness and thermal comfort
  - Reduce passive heating/cooling loads
  - Mechanical systems/ventilation



Tower Renewal Guidelines
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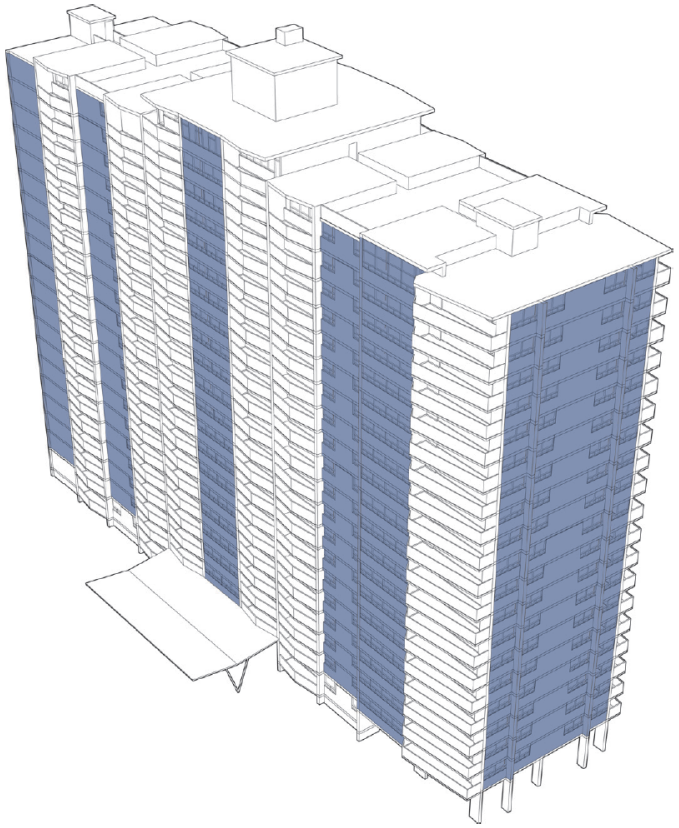
(Kesik & Saleff)

EIFS Wall Overcladding and Replacement Windows

This section of details and sequence assemblies depicts the design of external insulation and finish systems (EIFS) overcladding and window replacements for plane wall elements without balconies or projections. The shaded areas on the archetype tower building represent typical locations for these types of overcladding and window replacements.



A comprehensive discussion of EIFS technology is beyond the scope of this document, and it is assumed most design professionals are familiar with EIFS for new building applications. In the case of tower retrofits, it is important to ensure that the existing substrate is sound, and that if found to be otherwise, appropriate repairs must be carried out prior to the commencement of retrofit work. In Canada, the EIFS Council of Canada has recently launched the EIFS Quality Assurance Program to ensure the highest quality of materials, design, workmanship and inspection of EIFS projects. This is a voluntary program and there a number of critical requirements under the program that should be observed for all EIFS overcladding projects. The details and assembly sequences that follow conform to EIFS industry best practices, but these are not comprehensive. Building envelope designers and cladding engineers are ultimately responsible for the proper design and specification of overcladding systems, and it sound practice to work collaboratively with EIFS suppliers and contractors to develop appropriate and effective solutions.

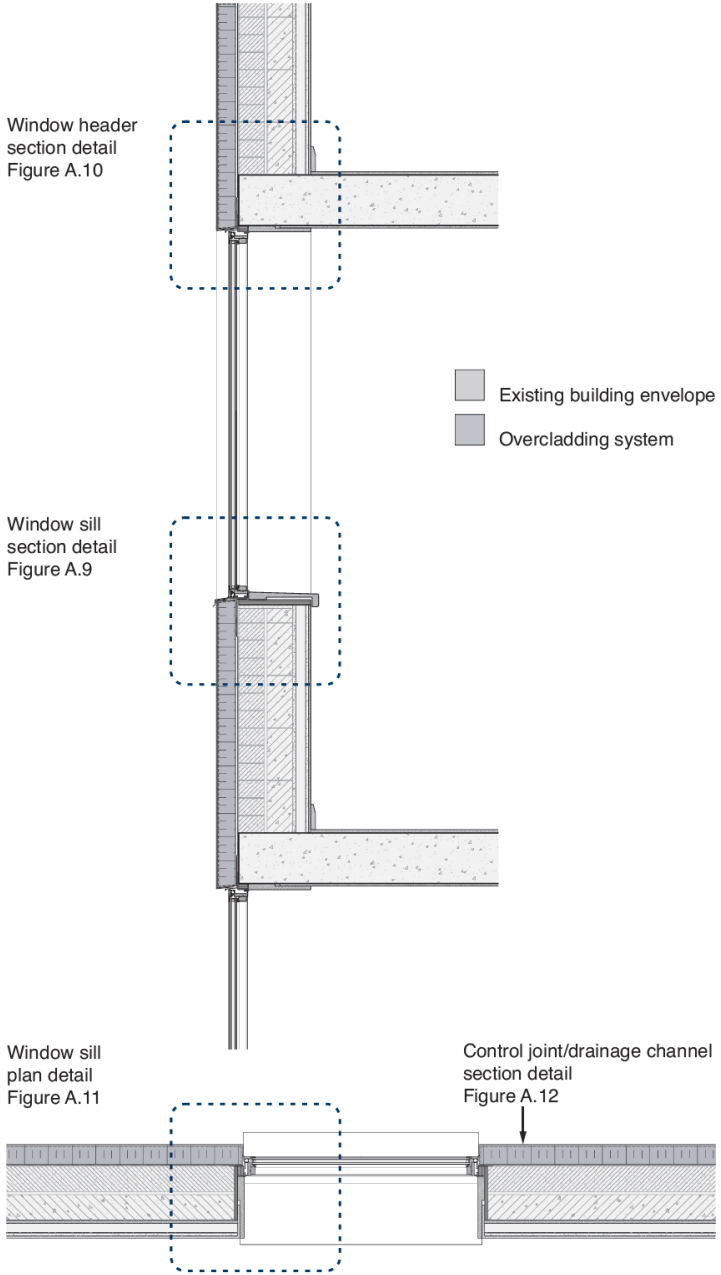
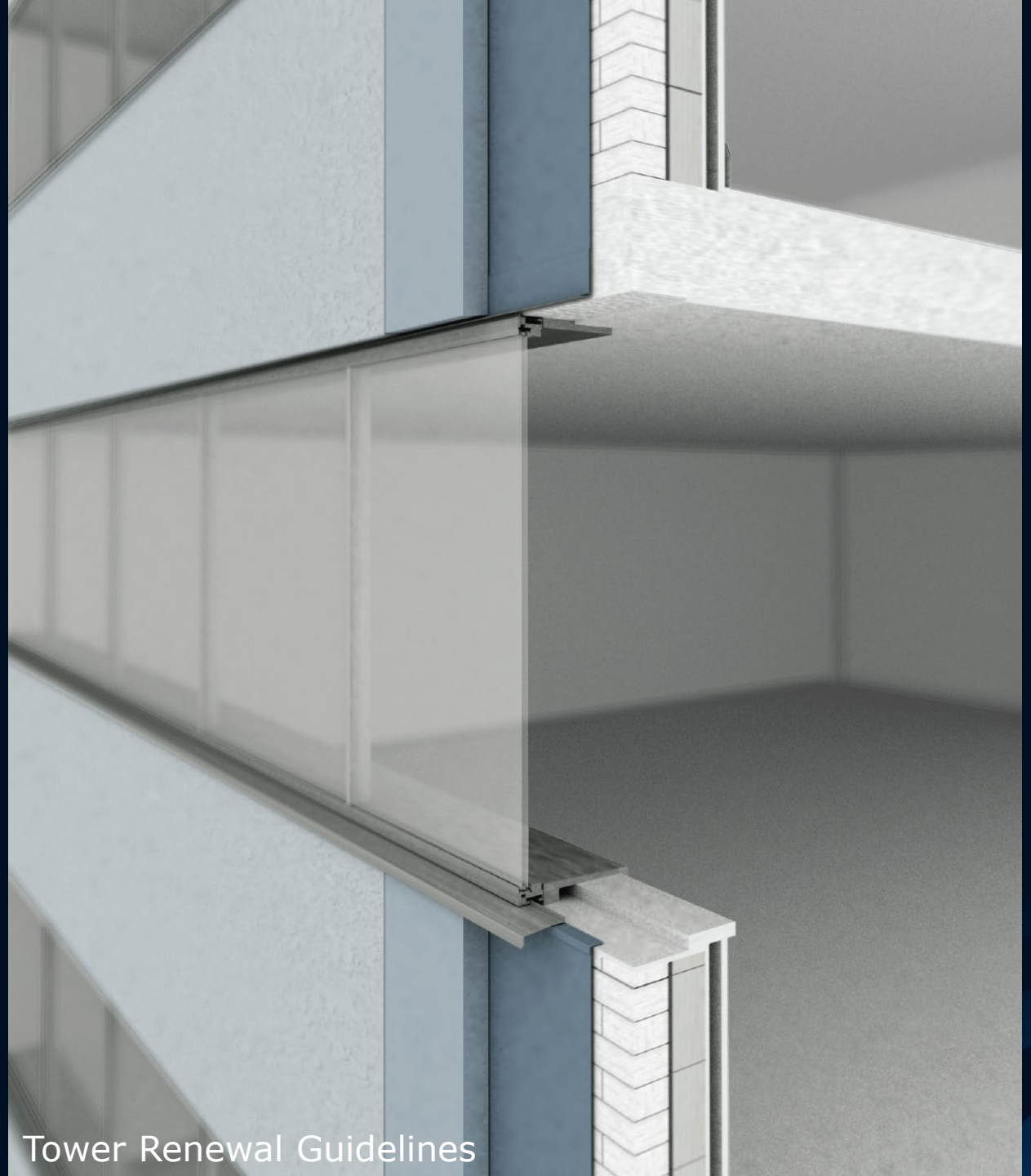


Figure A.8. Section and plan views of a typical wall and window assembly with corresponding detail drawings denoted.

EIFS Overcladding

- One of the most cost-effective exterior insulation strategies
- Add up ~R30
- Adapts well with window replacement

Tower Renewal Guidelines



EIFS Overcladding

- One of the most cost-effective exterior insulation strategies
- Add up ~R30
- Adapts well with window replacement

Tower Renewal Guidelines


1050

CMHC Case Study

- Overcladding masonry with EIFS in 1997
- Inner wall temp always ***higher*** than dew point – no condensation
- Temp of brick was stagnant with +20°C temp gradient
- Full insulation value achieved even though EIFS was detailed as rainscreen cladding
- Positive vapour drive

RESEARCH HIGHLIGHT

Technical Series 01-104

Monitoring the Performance of an EIFS Retrofit on a 15-Storey Apartment Building

INTRODUCTION

In March 1995, a 15-storey, 112-unit cooperative housing complex in Toronto, Ontario commissioned an extensive rehabilitation plan to address issues of air and water leakage and general deterioration. Among its many recommendations for the renewal of the building, the rehabilitation plan included the replacement of the existing windows and doors and installation of an exterior insulation finish system. The objectives of the wall retrofit included bringing the building into compliance with Ministry of Housing requirements, improving the durability and appearance of the wall systems, reducing air and water leakage and realizing energy cost savings.

The successful bid for the exterior cladding retrofit was an Exterior Insulation Finish System (EIFS) manufactured by Dryvit Systems Canada Inc., specifically their "Infinity MD" system which includes a means of draining moisture from within the applied EIFS overcladding. While not promoted as a pressure-equalized rainscreen system, venting of the vertical drainage channels cut into the interior face of the insulation panels was expected to provide some localized pressure equalization of the EIFS system. As moisture draining or rainscreen EIFS systems were a relatively new concept at the time this work was undertaken (1997), this rehabilitation project provided an excellent research opportunity; Canada Mortgage and Housing Corporation initiated a project to evaluate the retrofitted walls. The research project had the following objectives:

- document the development of a building envelope retrofit strategy for a high-rise apartment building;
- monitor, assess and document the performance of a high-rise apartment building envelope retrofit with respect to heat, air and moisture control;
- assess the degree to which the monitoring protocol can be implemented as part of regular operation and maintenance activities for new and existing buildings; and
- assess the potential for the development of a commercially viable, building envelope performance monitoring protocol.

RESEARCH PROGRAM

The existing exterior walls of the building were solid masonry infill within the reinforced concrete structural frame. The assembly consisted of clay brick with a raked face; filled 25 mm collar joint; concrete block backup; 25 mm thick expanded polystyrene foam insulation and an adhered, approximately 12 mm thick, plaster finish on the inside.

The new EIFS over-cladding system consists of an acrylic stucco lamina (base coat, reinforcing mesh and finish coat) installed over 75 mm expanded polystyrene insulation. As a fully adhered system, the insulation is applied directly to the brick masonry (substrate) using a two-coat trowel-applied proprietary Dryvit material; the first coat prepares the surface while the second coat adheres the insulation to the prepared surface. The coating is intended to operate as the air barrier and drainage plane and may also function as the vapour barrier. The lamina and insulation act as the first line of defense against precipitation. The second line of defense is the flashed drainage plane located at the substrate. Vertical channels located in the interior face of the insulation are intended to drain rainwater that penetrates to the coating (see Figure 1). The channels are flashed to the exterior every five stories and also laterally within the cavity above window heads. Intersections of the trowelled-on air barrier and other elements are sealed with self-adhering, rubber-modified bitumen sheet membrane, tape and/or sealant. Further, spray urethane foam is installed between the window frame and the rough opening.

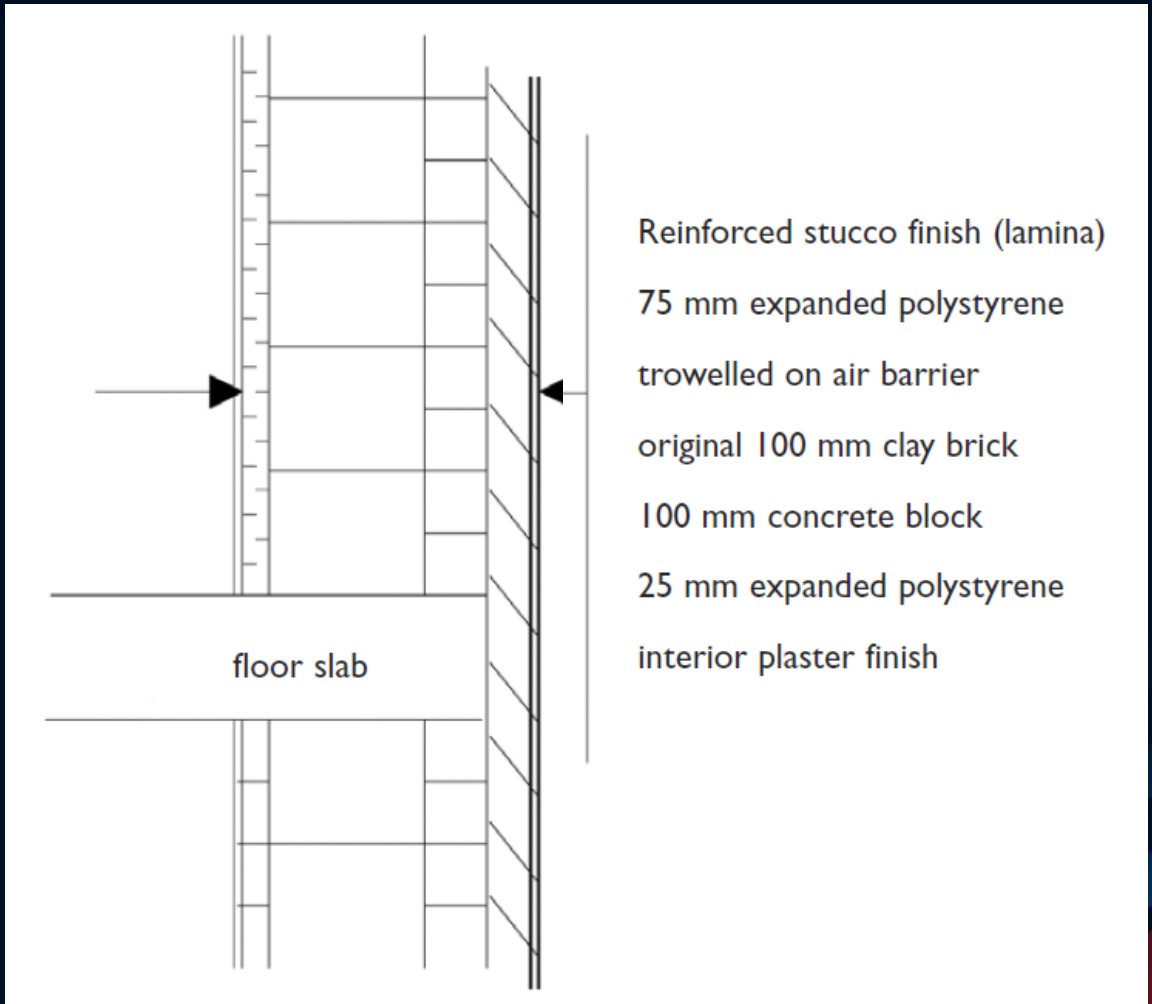
Two data acquisition systems were installed for the full monitoring period (from the fall of 1997—the time of the retrofit—to early 1999). One was installed at the 12th floor and the other at the second floor, both with west exposures; the building has a fairly open exposure on the west side. A third data acquisition system was moved over the course of the research project between three other monitoring stations: the 12th floor east exposure, 12th floor north exposure, and 2nd floor east exposure. Each monitoring station consisted of up to

Canada

CMHC SCHL
HOME TO CANADIANS

CMHC Case Study

- Pressure across the lamina ±20Pa (nominal)
- During gusts, lamina bears ~50% of the wind pressure
- Stops rain, insulates walls, & improves aesthetics



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