# Affordable Multifamily Mid-rise Housing & Deep Energy Retrofits

## Lessons from the Castle Square project

Building Science Corporation

Building America U.S. Department of Energy

U.S. Department of Energy | Energy Efficiency & Renewable Energy

# Deep Energy Retrofit Workshop

Welcome!

# Workshop Presenters

Peter Baker, P.Eng. – Building Science Corporation

Ken Neuhauser, M.Arch – Building Science Corporation

# Workshop Participants

## Who are you?

- Housing advocacy, community development
- Builders, contractors
- Energy efficiency organizations
- Homeowners interested in DER
- Students, Researchers

- Other

# Workshop Outline

Discussion of DER in context of multifamily mid-rise affordable housing drawing lessons from the Castle Square project

Sequence:

- Define DER
- Introduce the Castle Square project
- Suggest a framework for evaluating DER
- Ideal and the Real – enclosure (wall, windows), ventilation and compartmenting

# What is Deep Energy Retrofit?

- Existing buildings brought to advanced energy performance
  - At least 50% savings
  - Focus on the building – physical asset
  - Comprehensive High Performance
  - Energy
  - Indoor air quality
  - Durability
  - Comfort
  - Aesthetics
  - Amenity

# Key Concept of Deep Energy Retrofit

- Leapfrog current building practice
  - Position for another 50-100 years of service

  Important implications for:
  - Durability
  - Energy use

# Key Concept of Deep Energy Retrofit

- Any significant reworking of an assembly/ system essentially inoculates that assembly/system from further improvement for the services life
  - Consider service life of measures
  - Will components of an assembly provide appropriate performance for the full service life

# Things you should know about DER

- 50% total energy reduction is a really BIG deal!

➢ Especially if we still want to live in these houses

  - Coffee pots, toasters, microwaves, TV's, computers, refrigerators, dishwashers, clothes washers, dryers, freezers, lighting…

# Why Deep Energy Retrofit?

## DER is an opportunity to address:

- Comfort problems
- Persistent moisture problems (e.g. wet basement, leaky roof)
- Leaky walls or windows
- Making an attic and/or basement a truly useable space
- Stuffy air
- Siding you're tired of painting
- Tired aesthetics

# DER Evaluation Approach

- Understand the goals and objectives
- Evaluate and understand constraints of the project
  - Physical
  - Coordination
  - Codes
  - Budget and Financing
  - Insurance…

# Project Introduction – Castle Square

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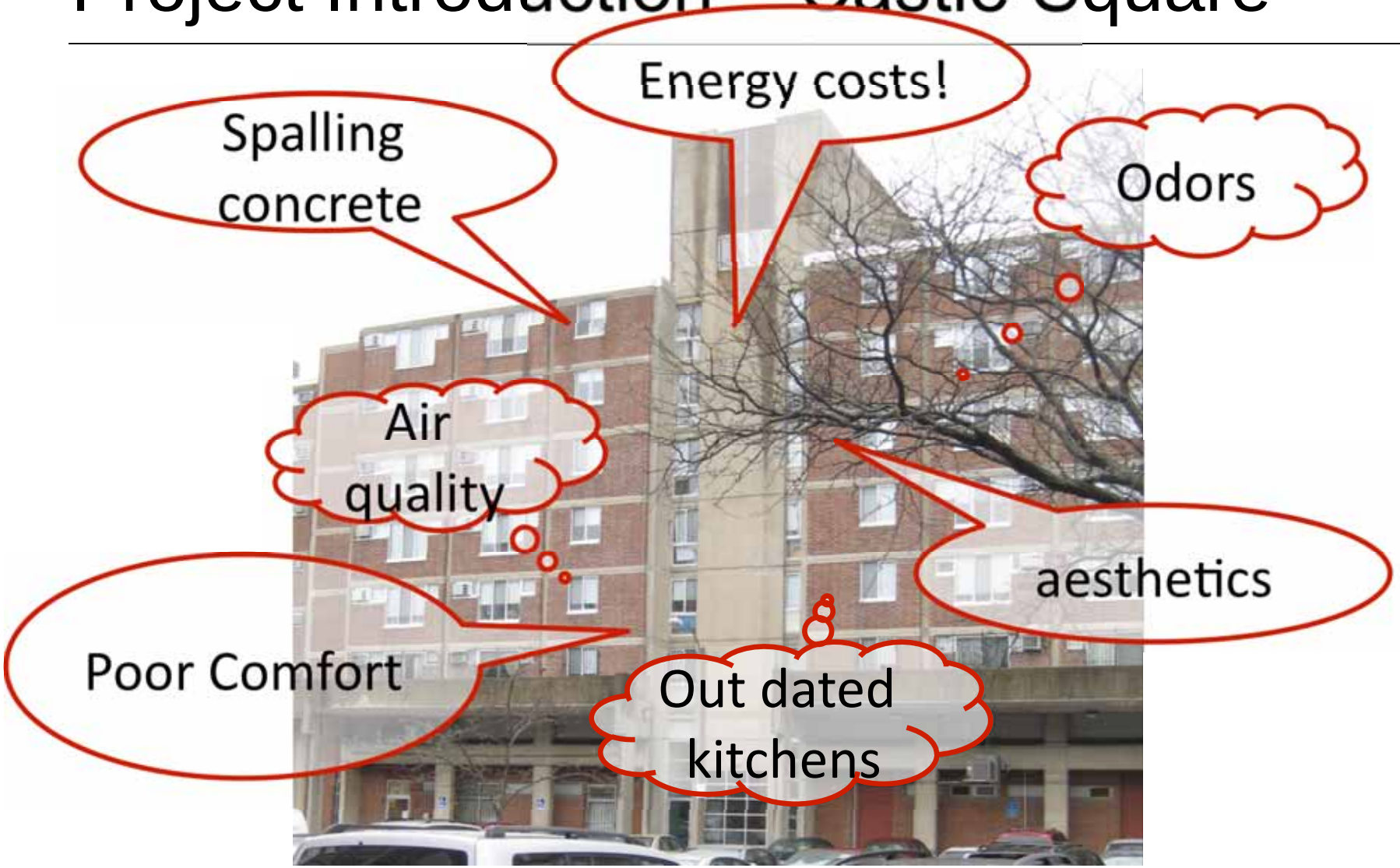


# Castle Square DER

## Project Overview:

- Occupied rehabilitation
- 1960's era, brick and concrete public housing structure
- Majority owned by residents association

# Castle Square DER

## Project Objective:

- Leverage tax incentive financing, grants, incentives, technical support, etc. to include Deep Energy Retrofit in rehabilitation scope
- Rehabilitation of otherwise limited scope

# Castle Square DER

## Project Overview:

- Owner: Castle Square Tenants Organization, Winn Development
- Location: Boston, MA
- Buildings: 4 Buildings, 7 stories (6 Residential over Ground Floor Commercial)
- Units: 192 Units, 48 Units/Building, 600-900 sq. ft./Unit

# Castle Square DER

## Project Overview:

- Ambitious performance goals, demonstration project
- Estimated Heating and Water Heating Energy Savings: 60%
- Combined Gas & Elec. Savings: 53%
- Construction Start: October, 2010
- Construction Schedule: 18 Months

# Circumstances of the Project

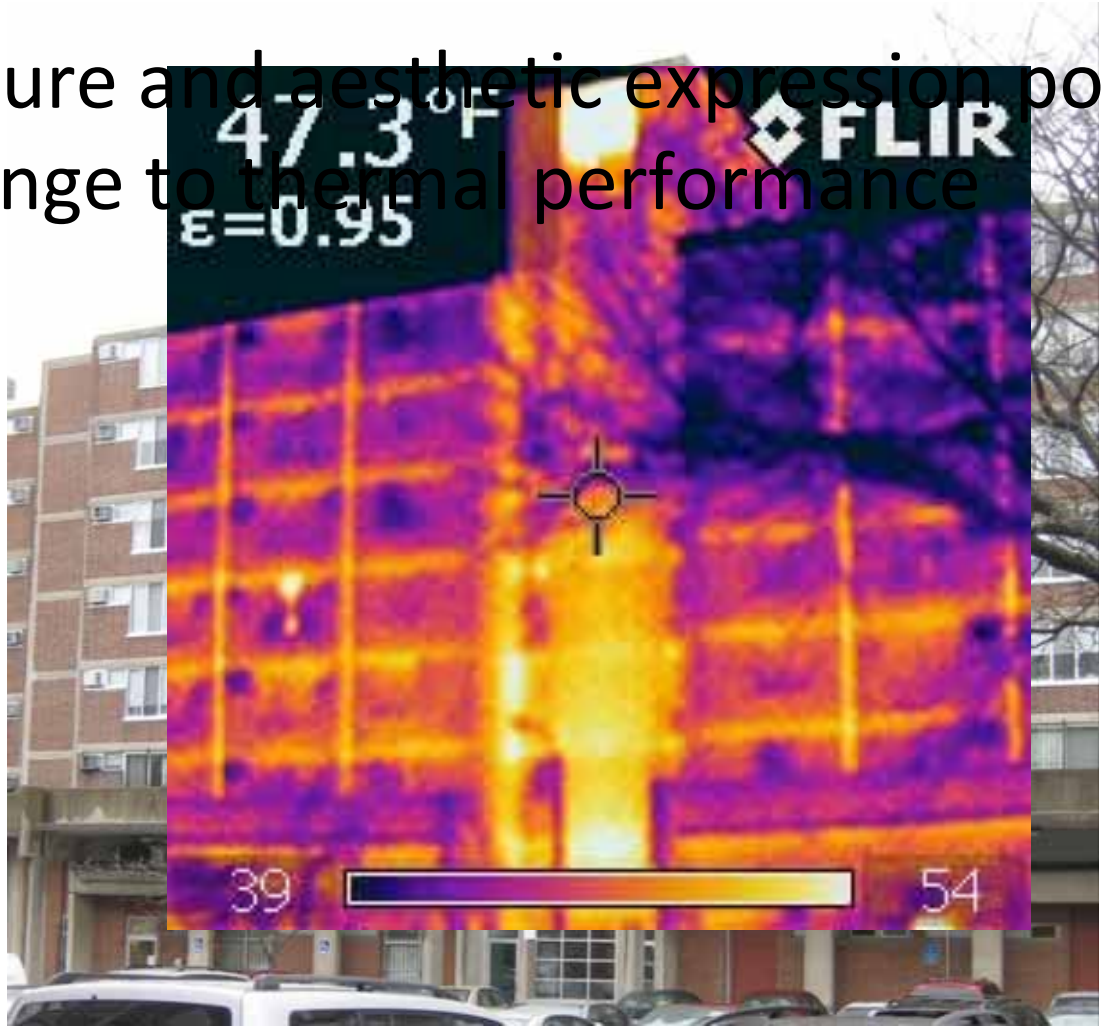
- 51% Tenant Owned
  - CSTO in charge
  - Interests of tenant group protected
  - Driving factors for the "energy" measures: Comfort, IEQ concerns
    - Exterior wall insulation and window replacement
    - Ventilation effectiveness
    - compartmenting

# Circumstances of the Project

- Originally built as subsidized housing
  - Small, compact apartments
  - Economy of layout
  - Structure affords no opportunity to run services in interstitial spaces,
  - Structure and aesthetic expression poses challenge to thermal performance

# Circumstances of the Project

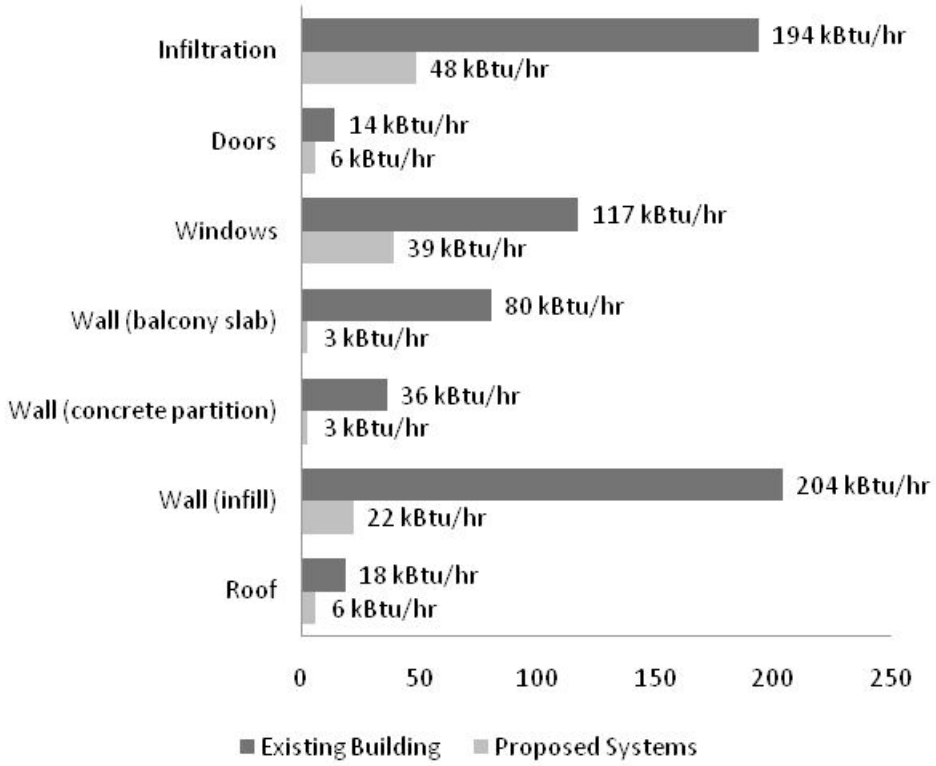
- Structure and aesthetic expression poses challenge to thermal performance



# Circumstances of the Project

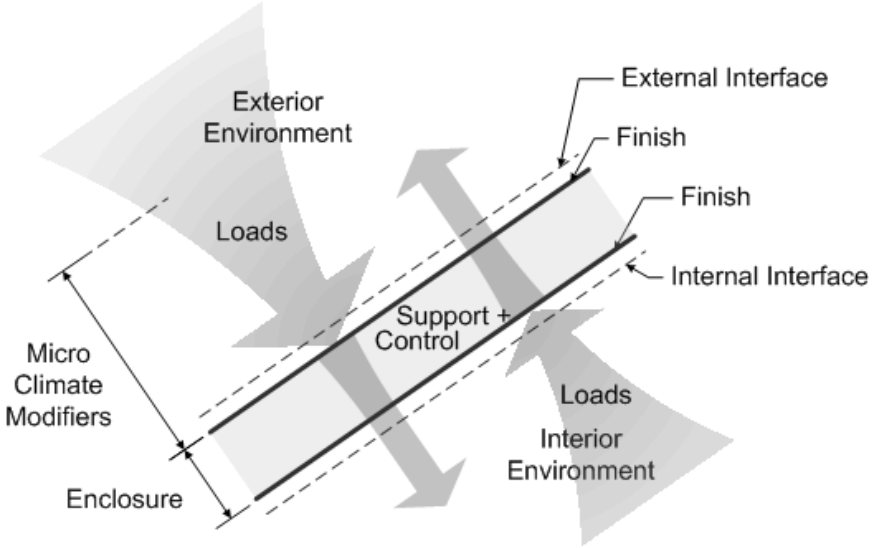
- 100% occupied renovation (!)
  - Severe constraints on scope within apartments
    - Completed over 1-2 days
    - Tenants return to functioning kitchen first day
    - Belongings in bedrooms, living room not moved

# Building Energy



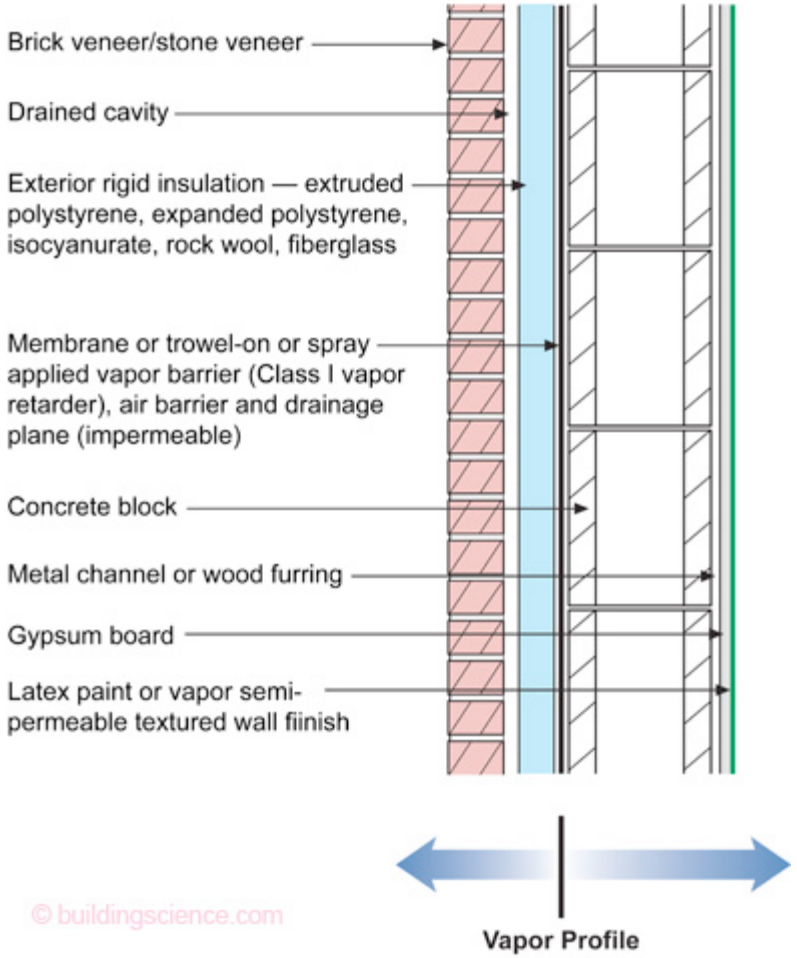
# Building Enclosure

- Environmental Separators
  - Separate interior environment from exterior environment
  - Separate two different interior environments

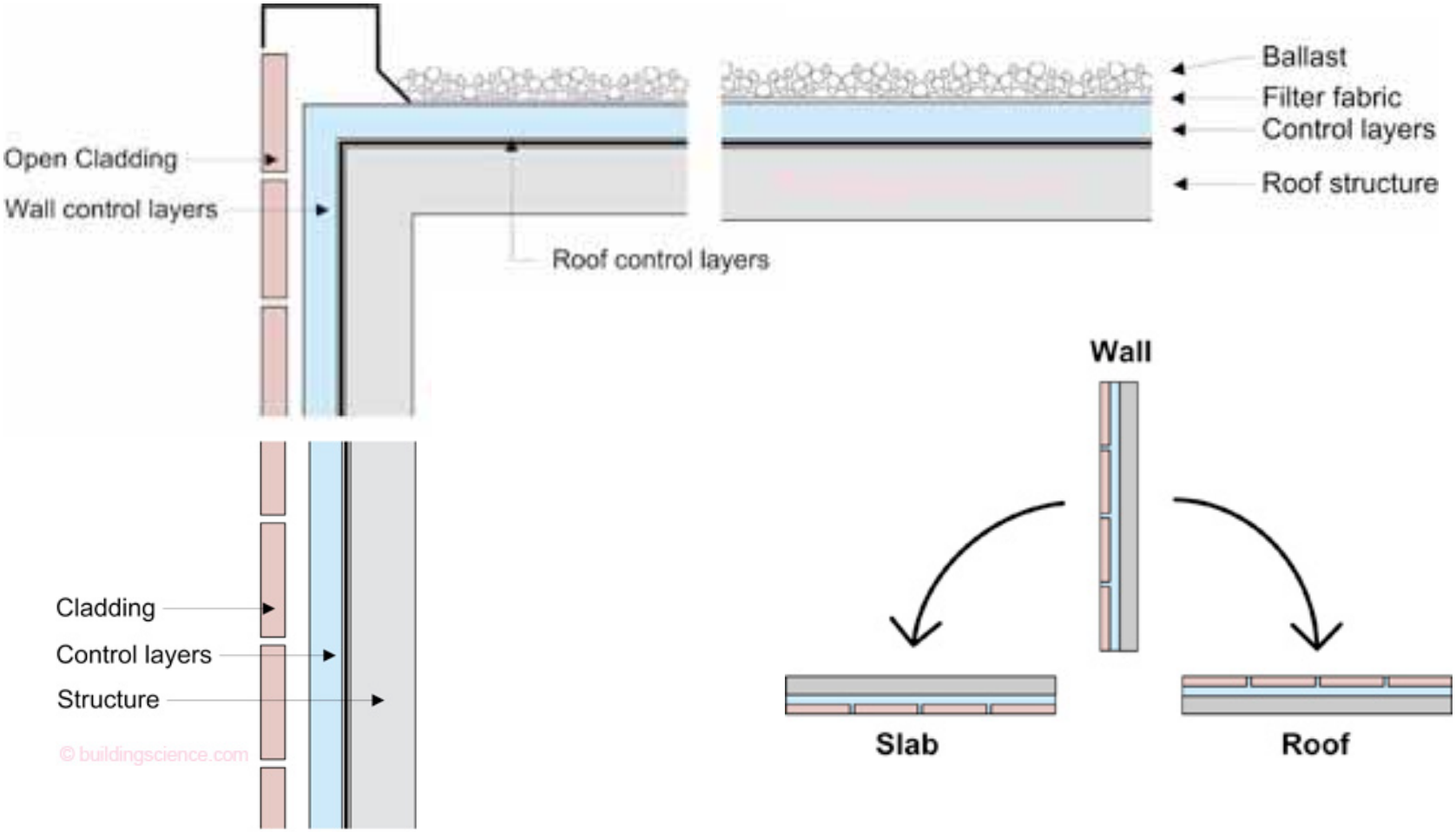


# Building Enclosure

- "The Perfect Wall"
  - Structure
  - Control Layers
    - Thermal
    - Air
    - Vapor
  - Cladding

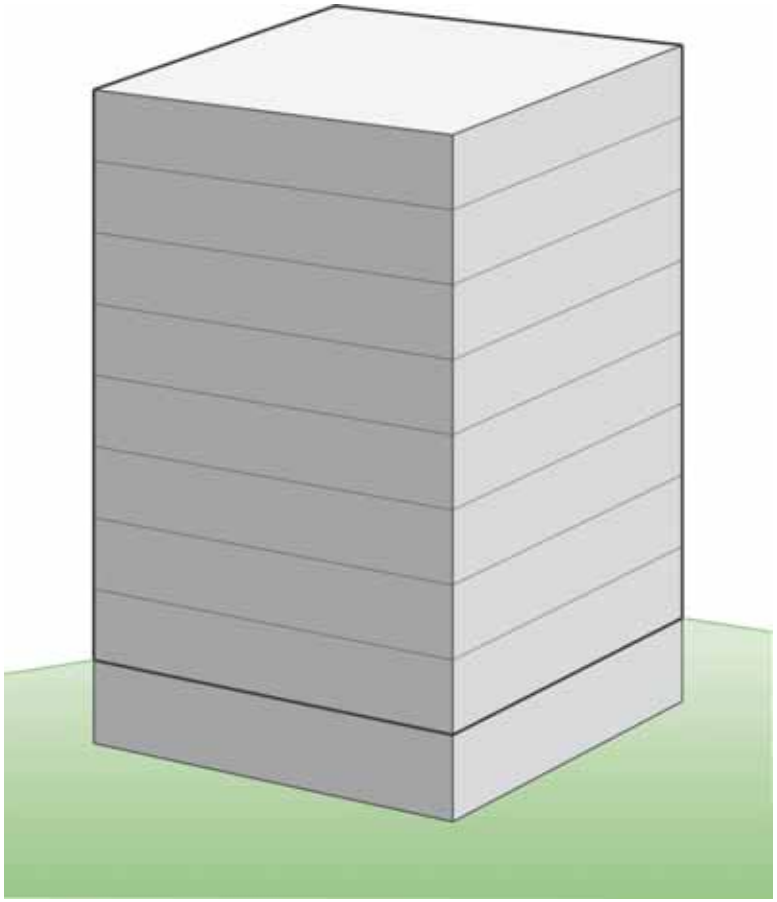


# Building Enclosure



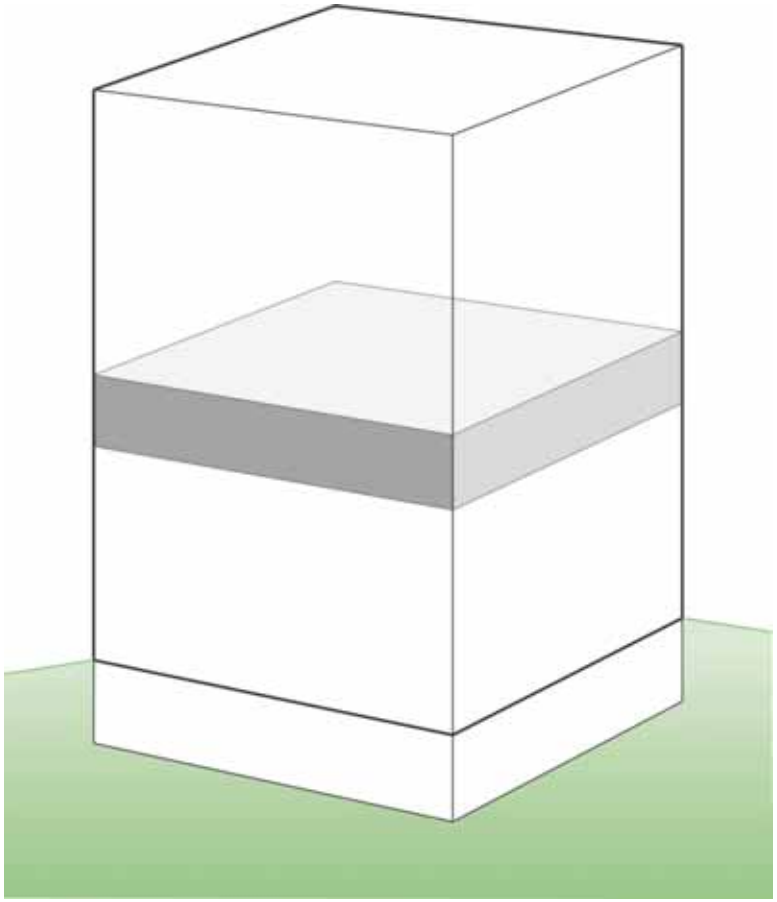
# Building Enclosure

- The building enclosure separates the interior environment from the exterior



# Building Enclosure

- Within the building, interior separations are also important and can affect the performance of the exterior building enclosure
- Separation at each floor level can reduce infiltration due to stack effect



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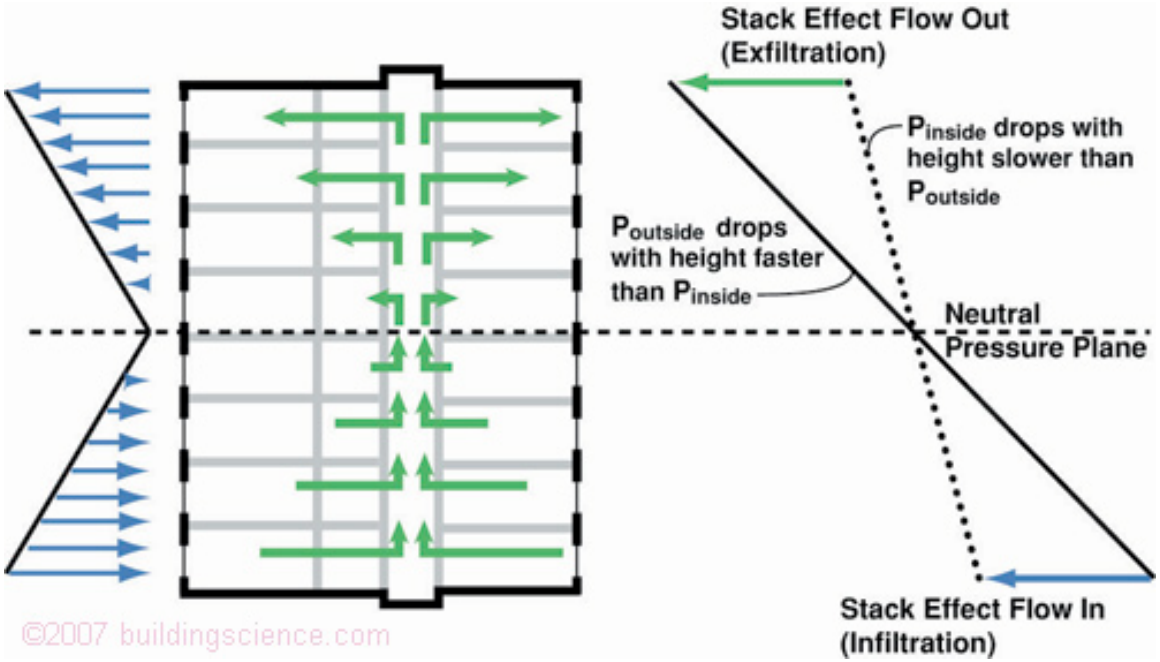


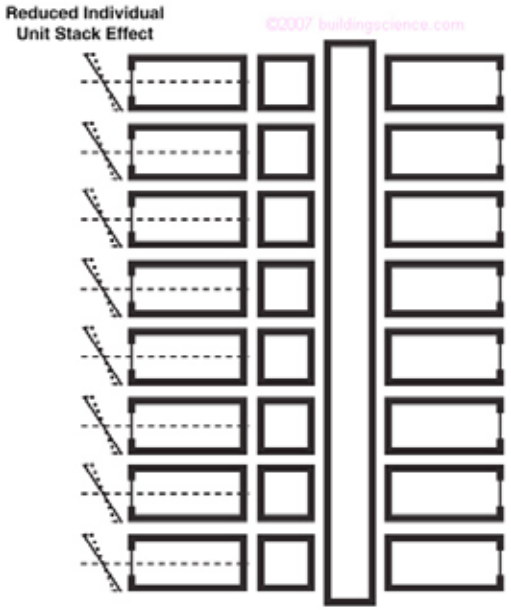

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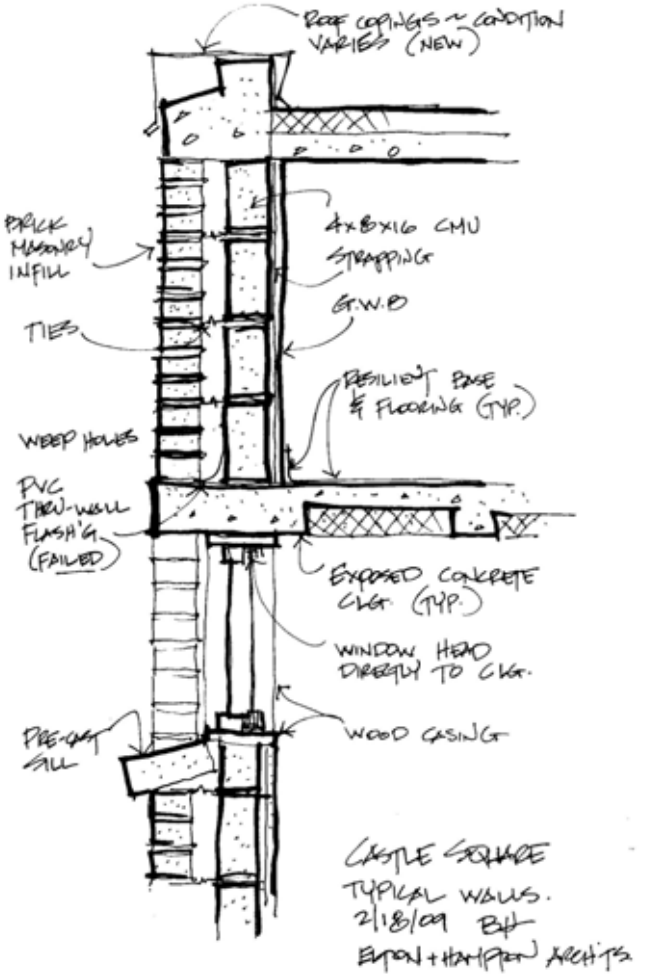



*Image courtesy of Elton + Hampton Architects*

# Building Enclosure

- Context
  - Building are un-insulated
  - Significant air leakage comfort complaints (papers blowing off of desks)
  - Exterior rain infiltration issues

# Building Enclosure

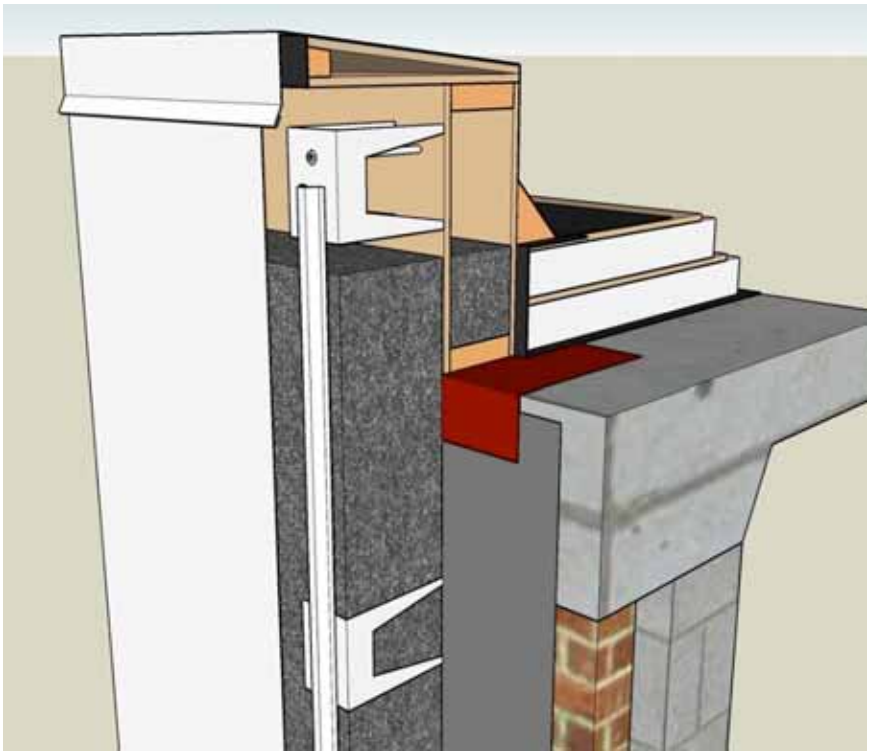
- Challenges:
  - Occupied Retrofit
  - Significant Thermal Bridging of Concrete Structure
  - Existing Building Construction Tolerances

# Building Enclosure

- Options pursued:
  - Exterior air barrier, insulation and cladding
  - Exterior insulation and finish system (EIFS)
  - Insulated metal panels (IMP)

# Building Enclosure

- Exterior air barrier, insulation, and cladding



# Building Enclosure

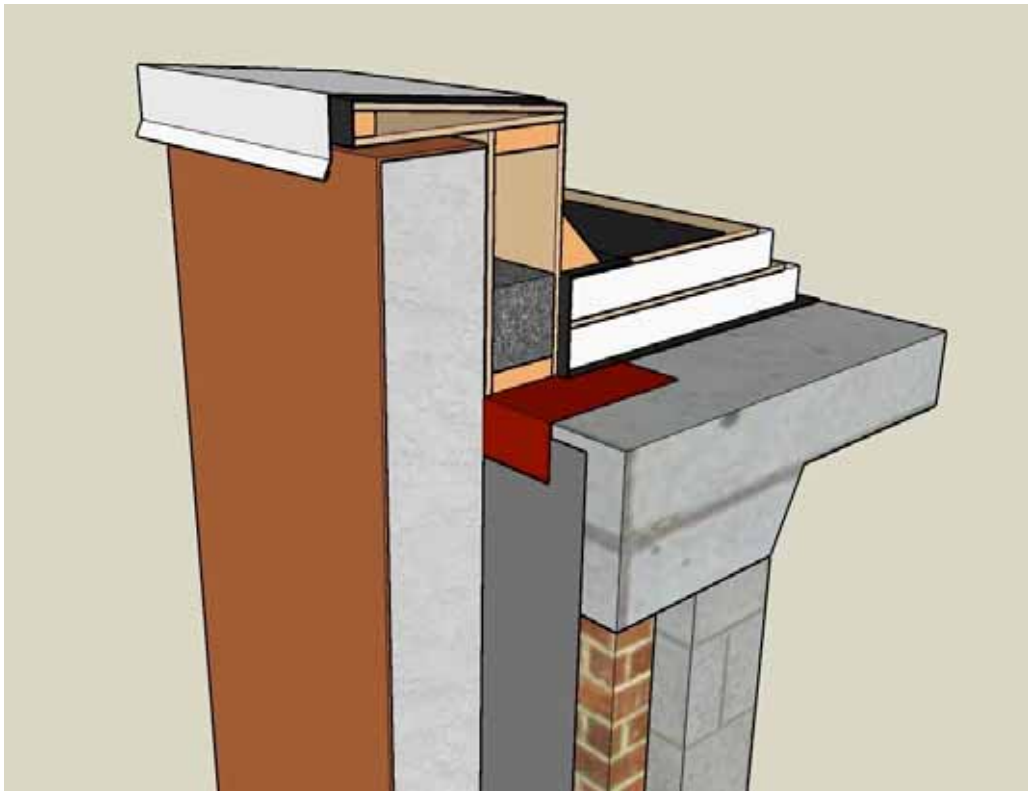
- Exterior air barrier, insulation, and cladding:
  - Large range of options
    - Insulation types
    - Air barrier materials
    - Cladding options

# Building Enclosure

- Exterior air barrier, insulation, and cladding:
  - Fire concerns
    - Lack of UL rated assemblies
  - Insulation thickness needed to achieve desired R-Value could be significant

# Building Enclosure

- Exterior insulation and finish system (EIFS)



# Building Enclosure

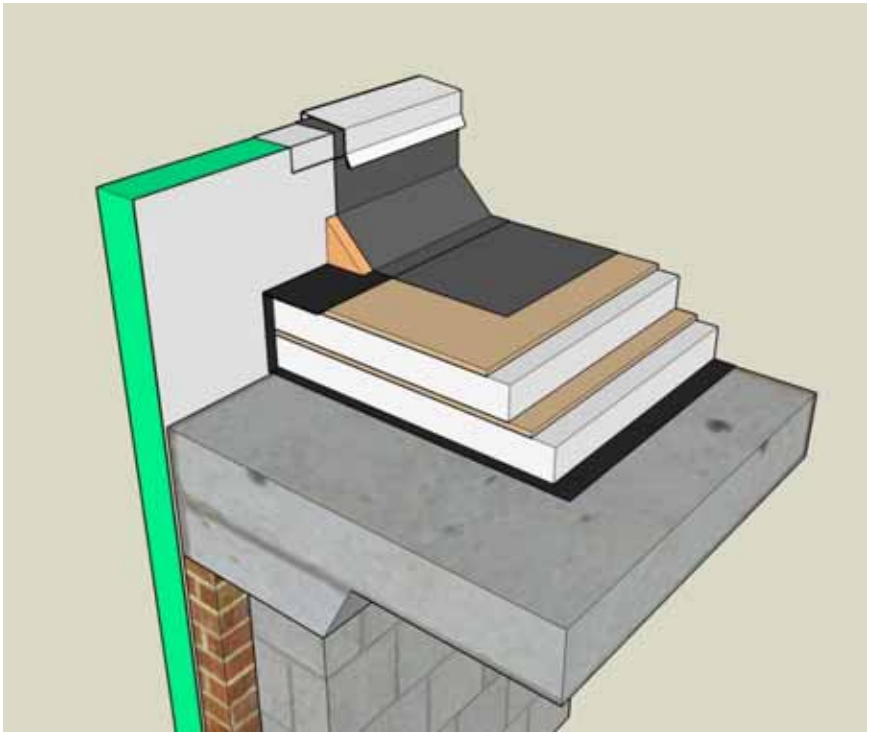
- Exterior insulation and finish system (EIFS)
  - Lower cost option
  - No need for design of cladding attachment system

# Building Enclosure

- Exterior insulation and finish system (EIFS)
  - Thick layers of insulation needed to achieve design goals
  - Insurance concerns (Fire, water, durability)

# Building Enclosure

- Insulated metal panels (IMP)



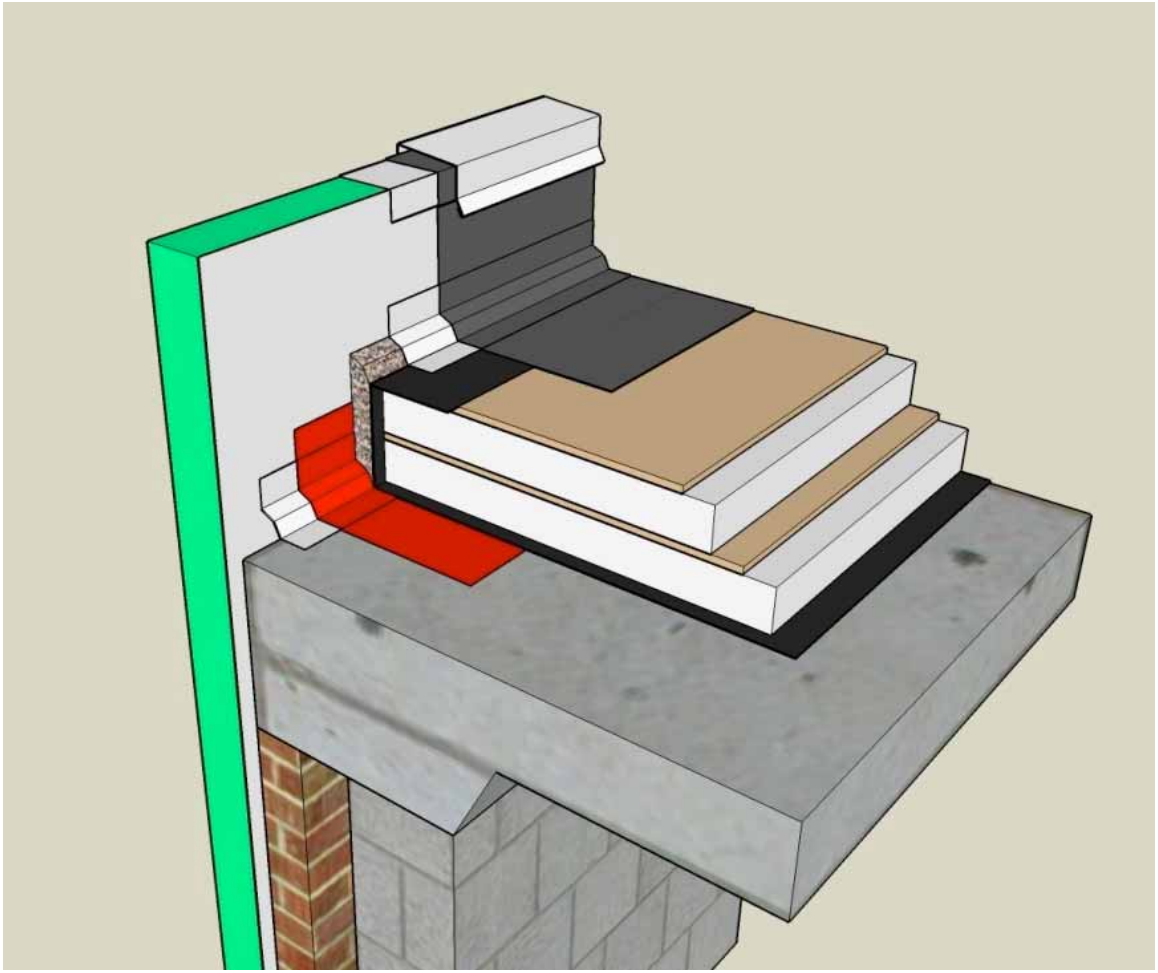
# Building Enclosure

- Insulated metal panels (IMP)
  - High R-Value – thinner overall thickness
  - Fire rated
  - Durable

# Building Enclosure

- Insulated metal panels (IMP)
  - Attachment due to building variances
    - Use panels as the complete enclosure? (air barrier, insulation, water management)
    - Use the panels as an insulated cladding with another air barrier and water management layer behind?

# Building Enclosure



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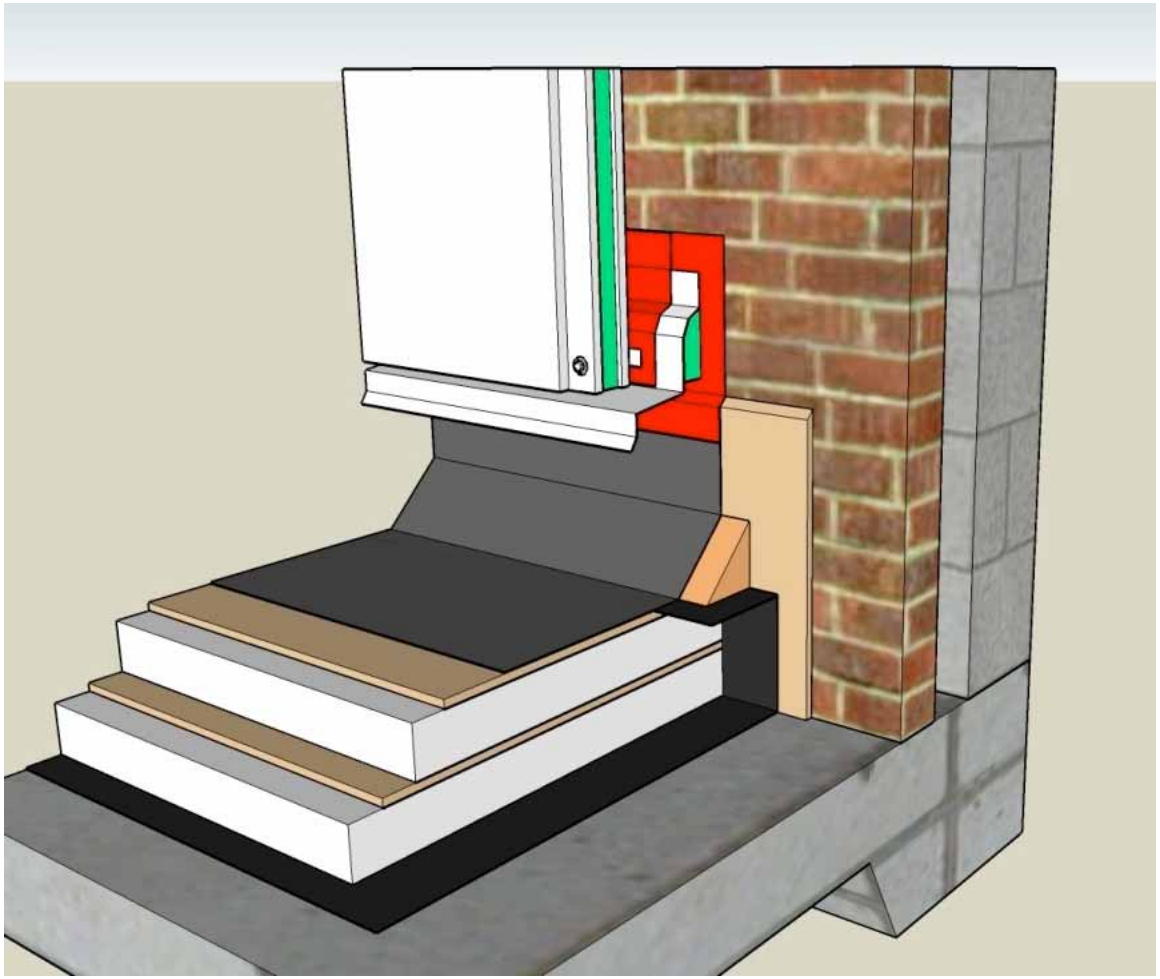

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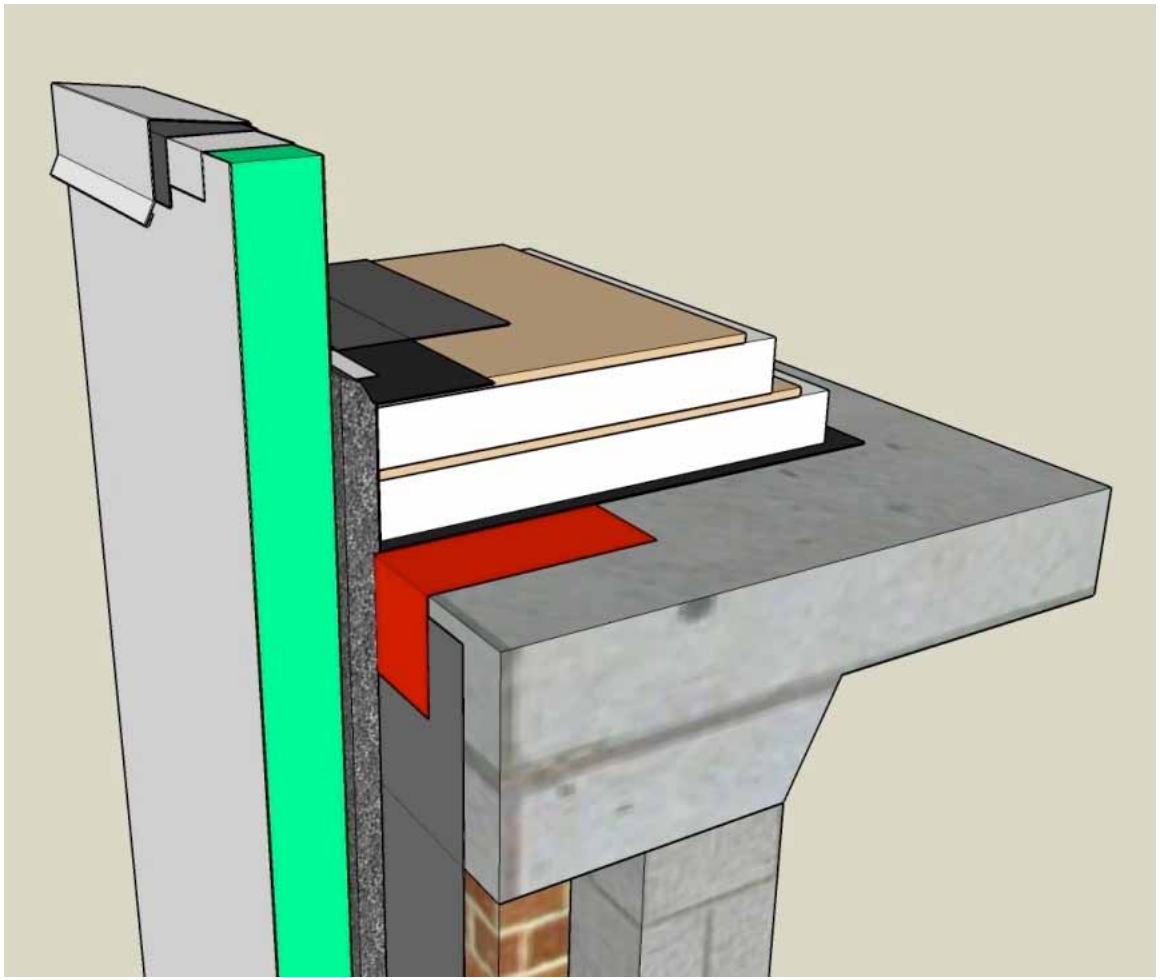

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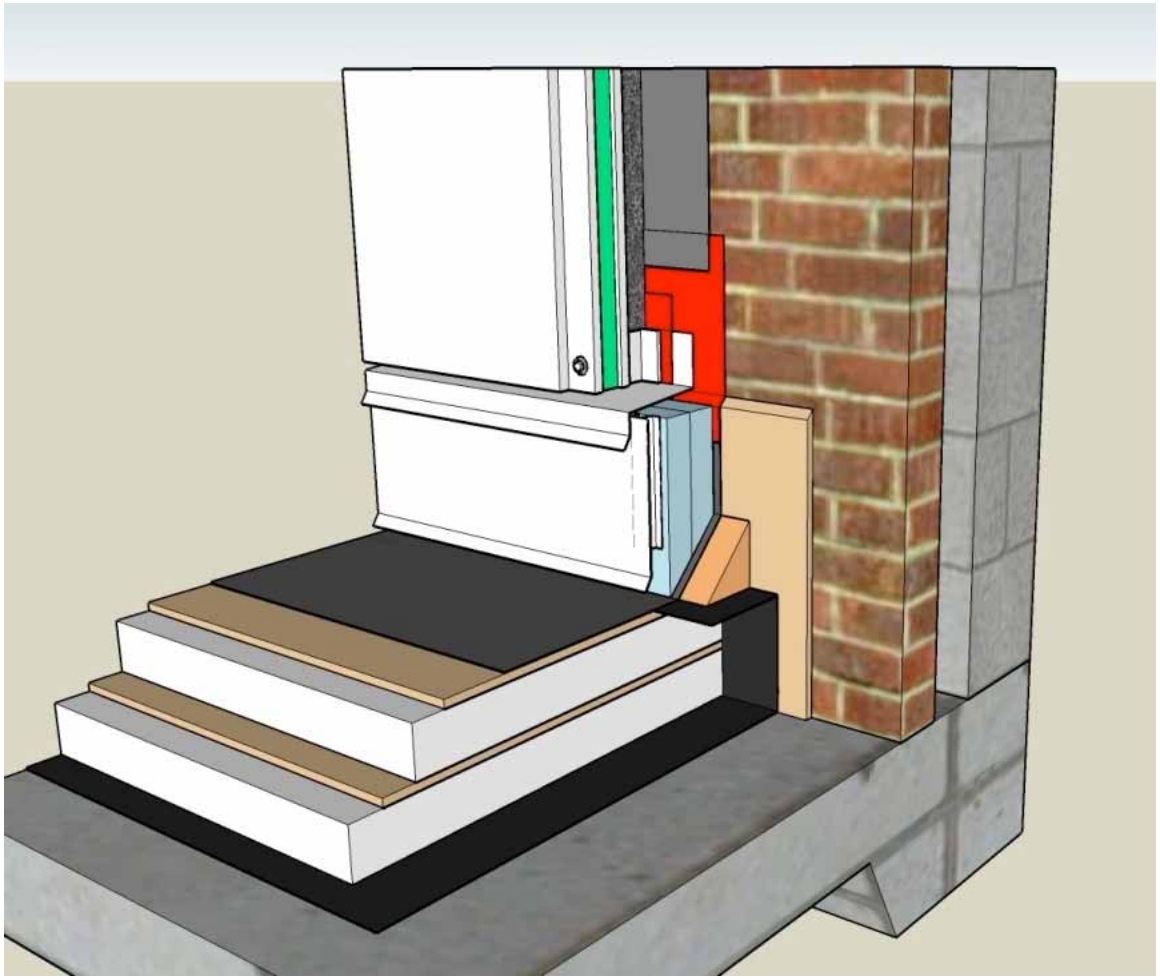
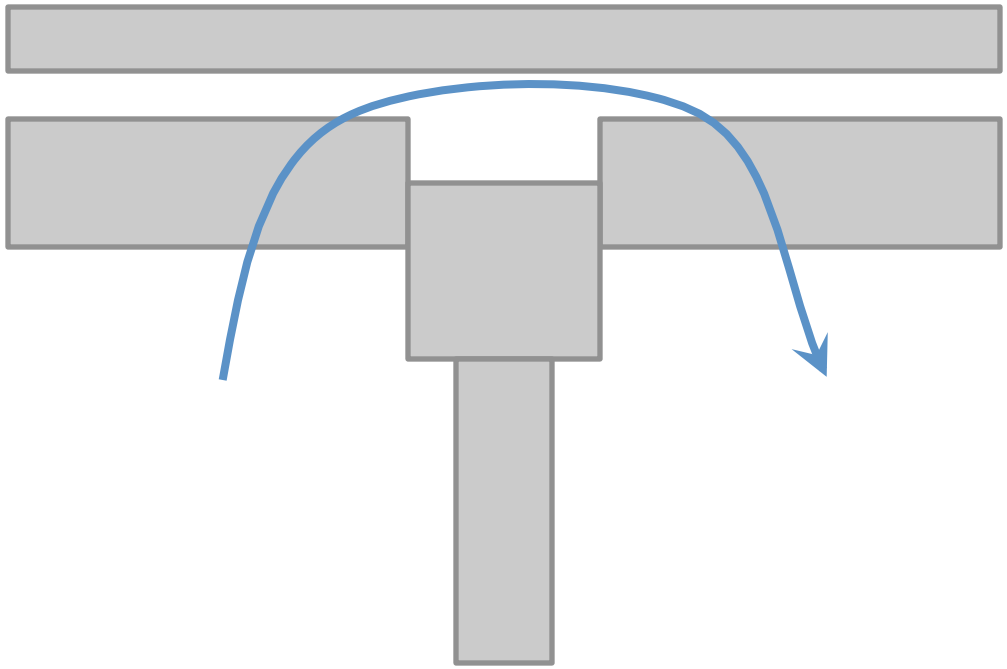


# Building Enclosure

- Insulated metal panels (IMP)
  - Compartmentalization of the living units

# Building Enclosure



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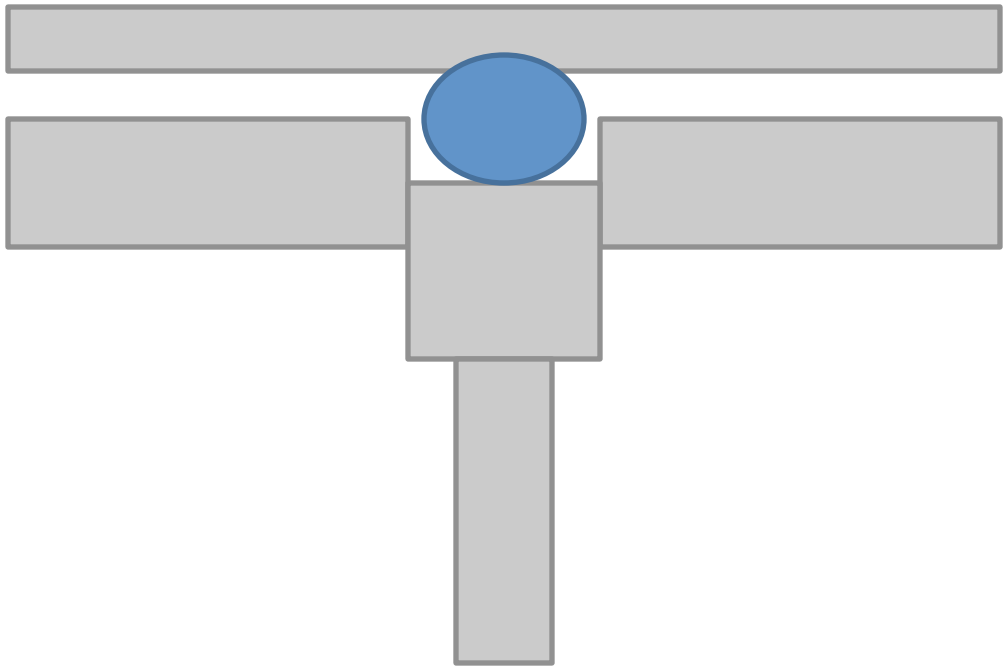

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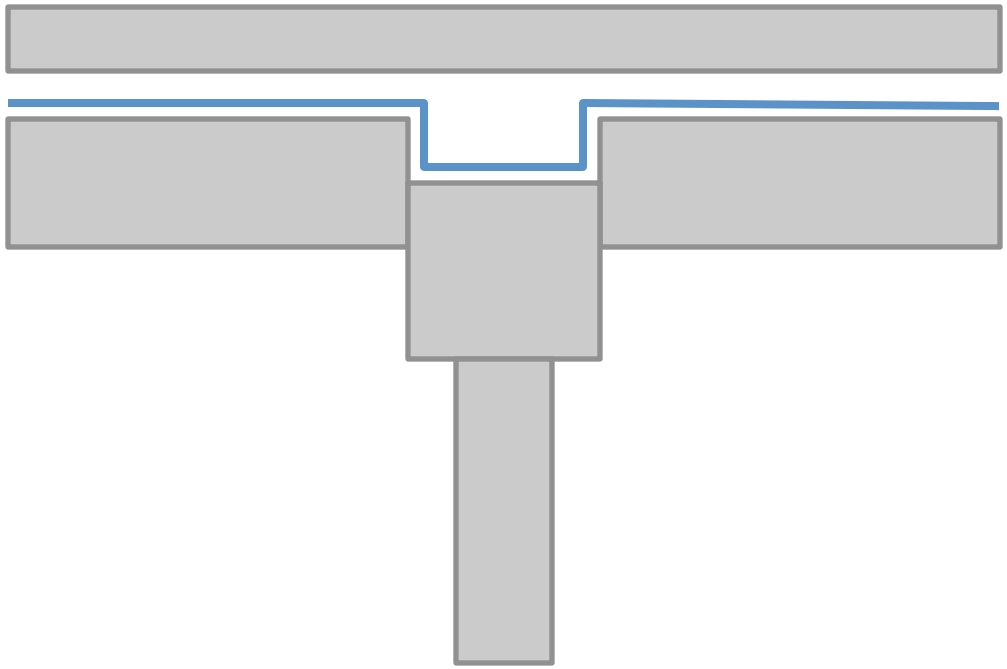
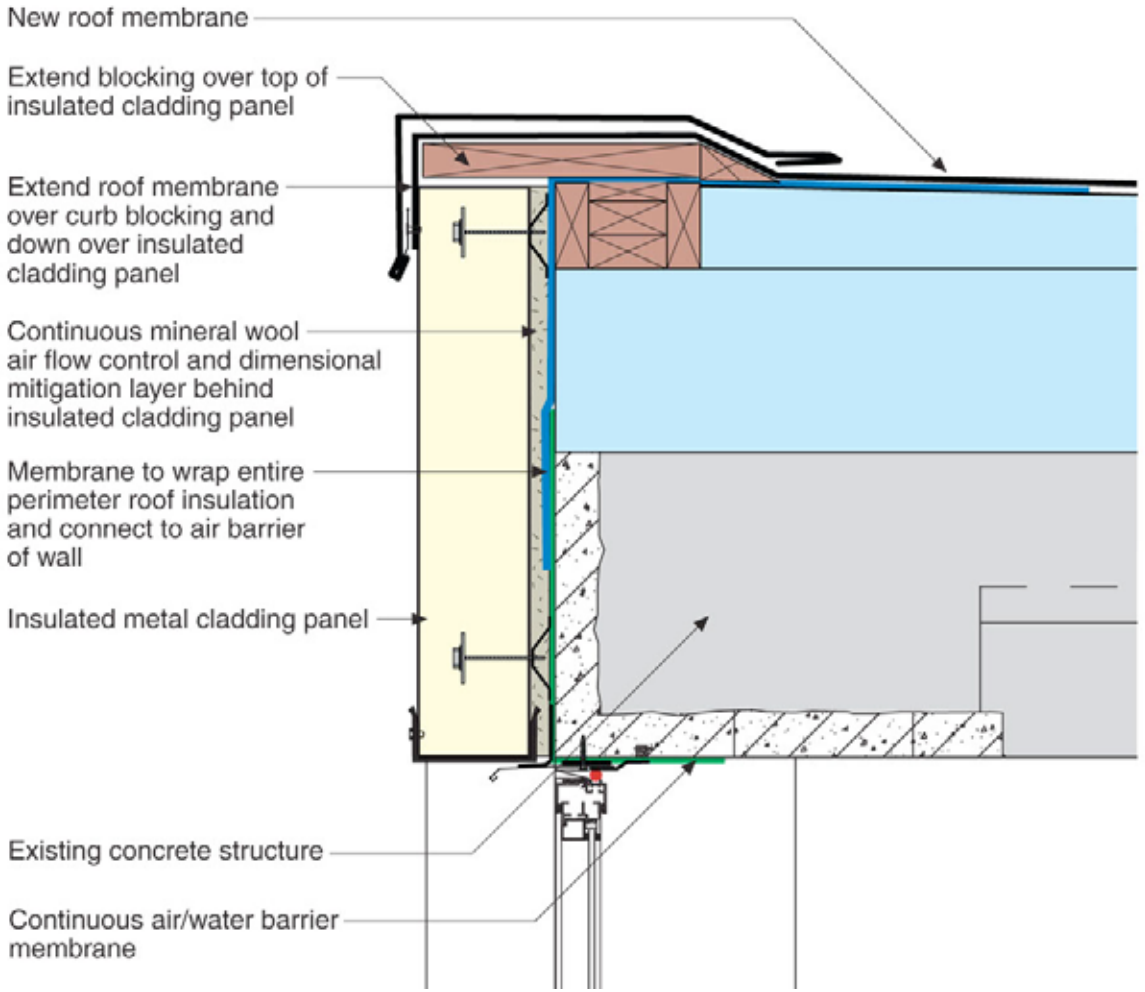


# Building Enclosure

- Insulated metal panels (IMP)
  - Integration of windows and other enclosure elements made at the air barrier/water resistive barrier location

# Building Enclosure



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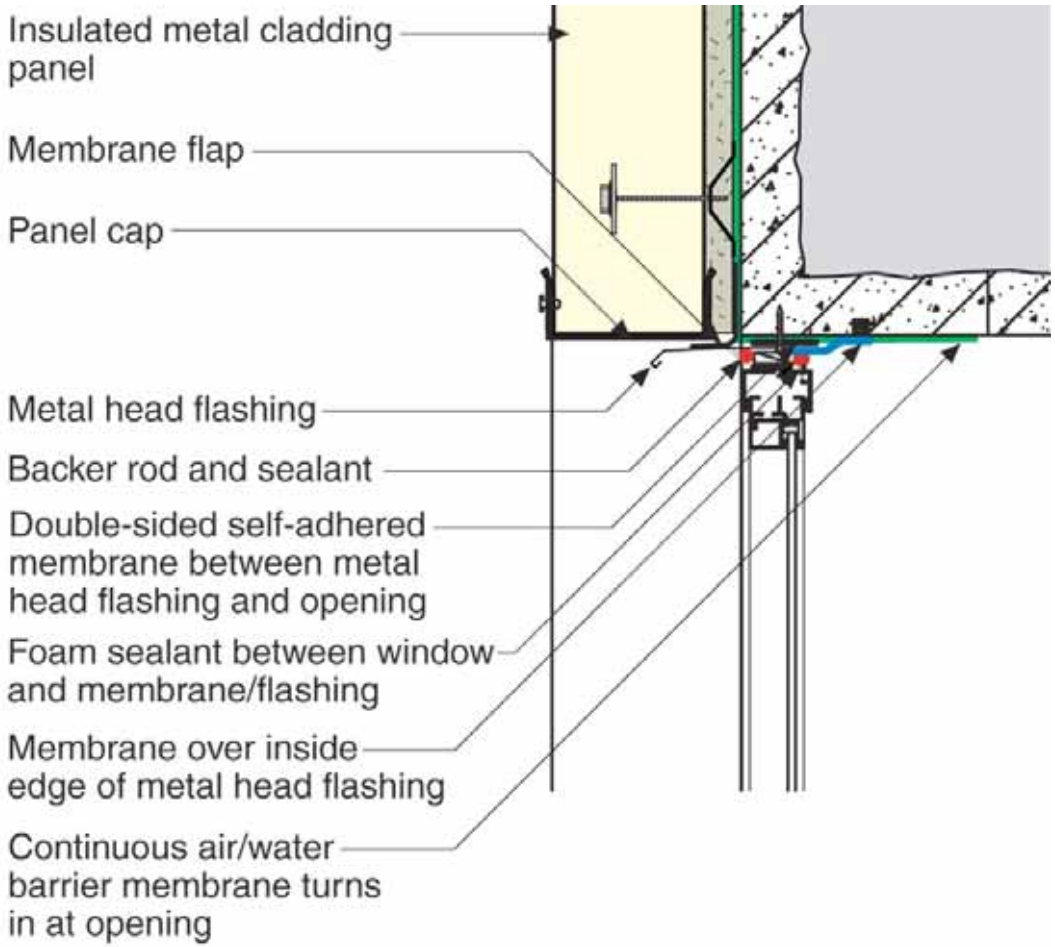

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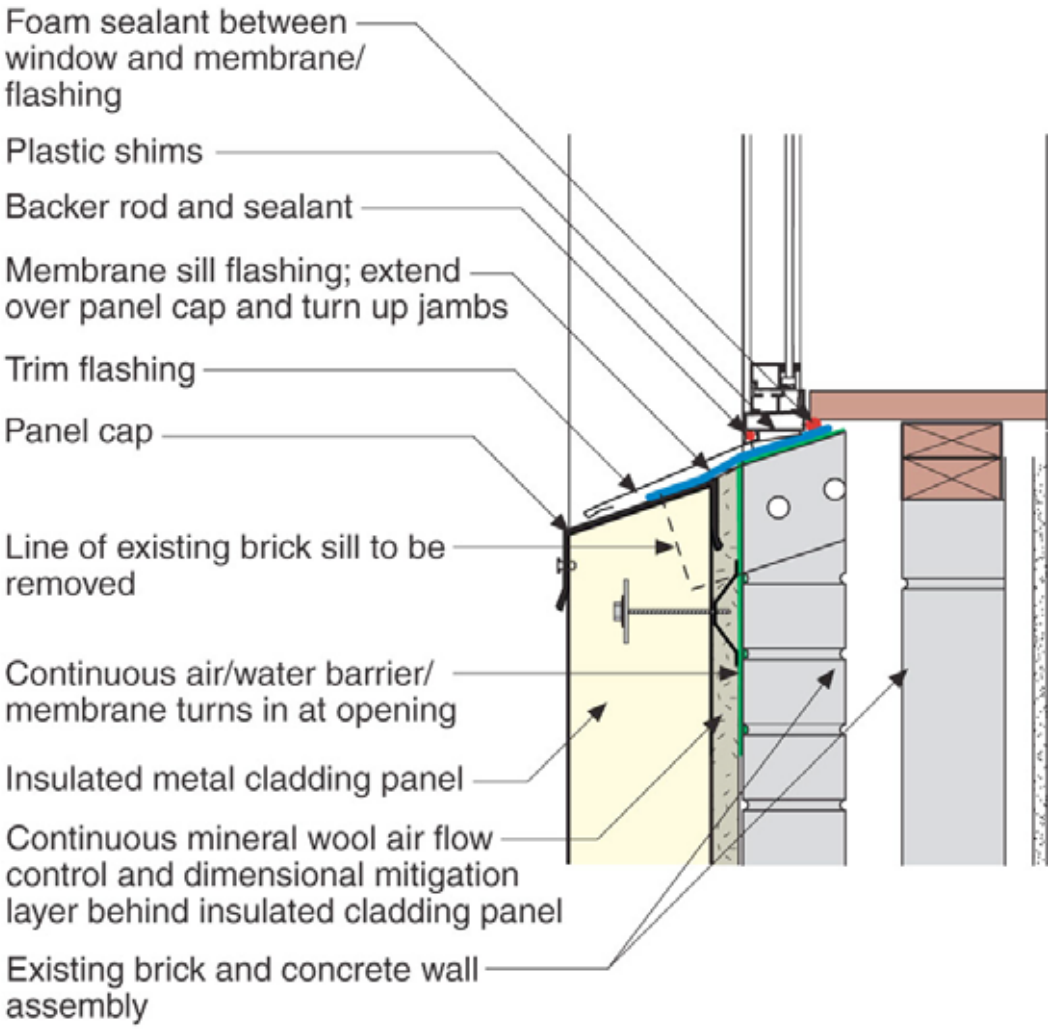

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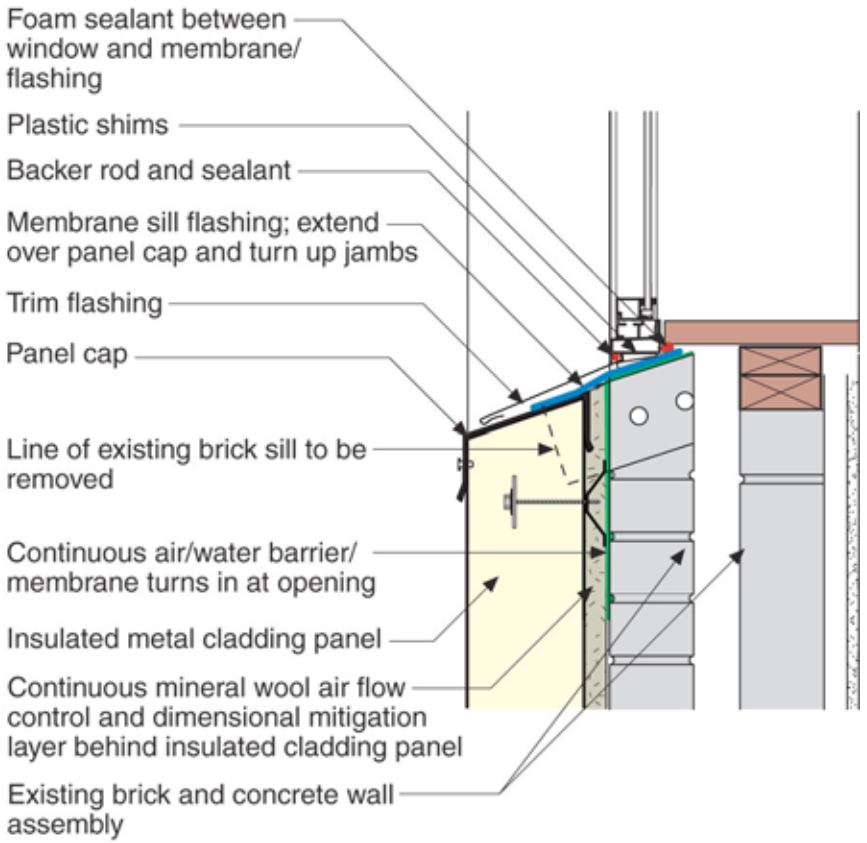
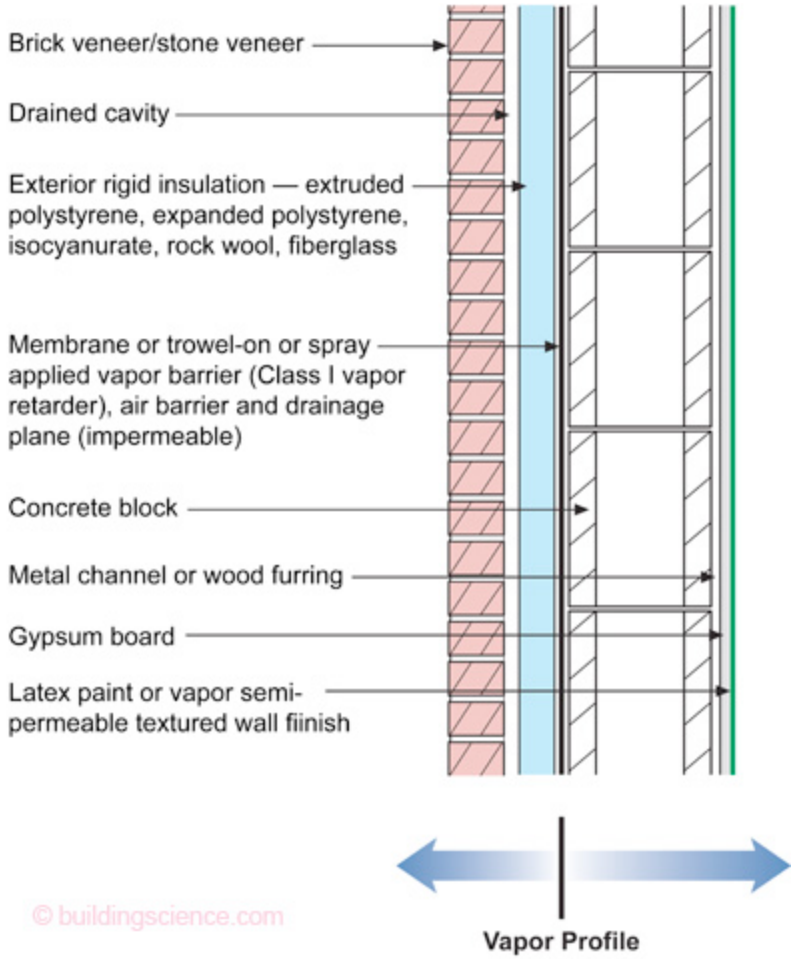



Designed wall

The “perfect wall”

# Building Enclosure

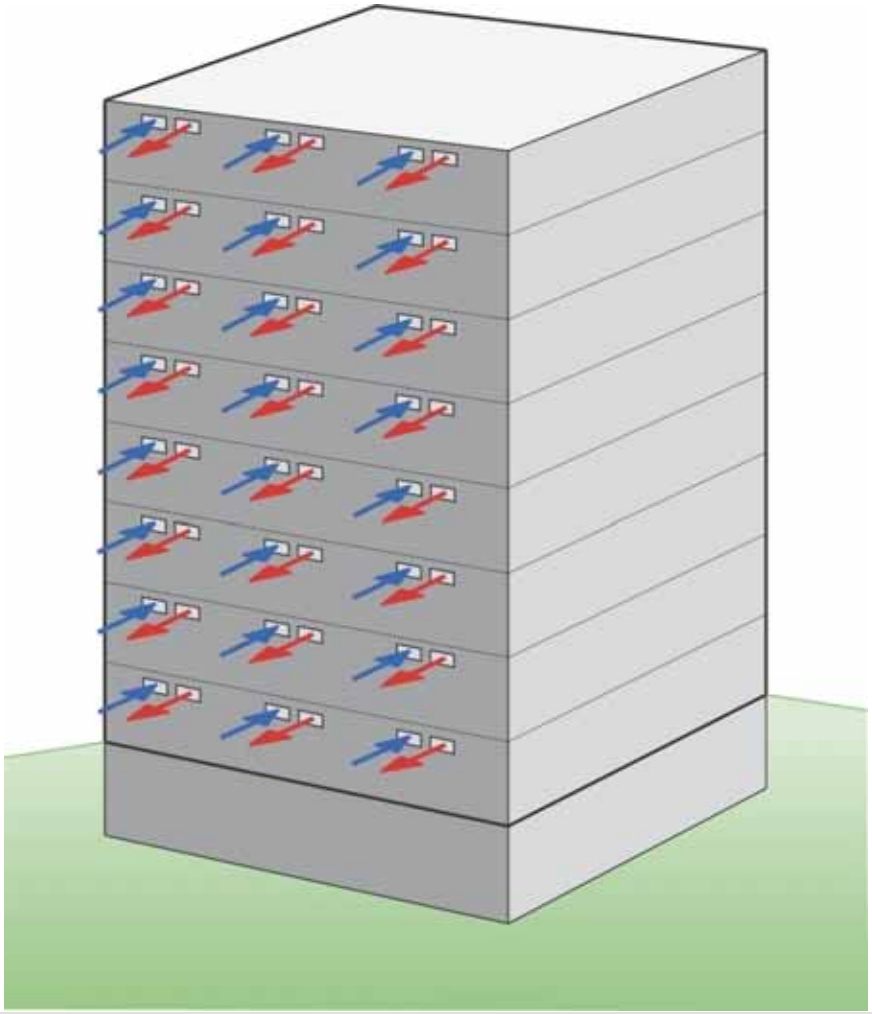
# Ventilation

"…some conditioning will be needed even for a super-insulated cube occupied by a dead hermit."

- Professor John Straube, Ph.D., P.Eng.

BSI-022: The Perfect HVAC

# Ventilation



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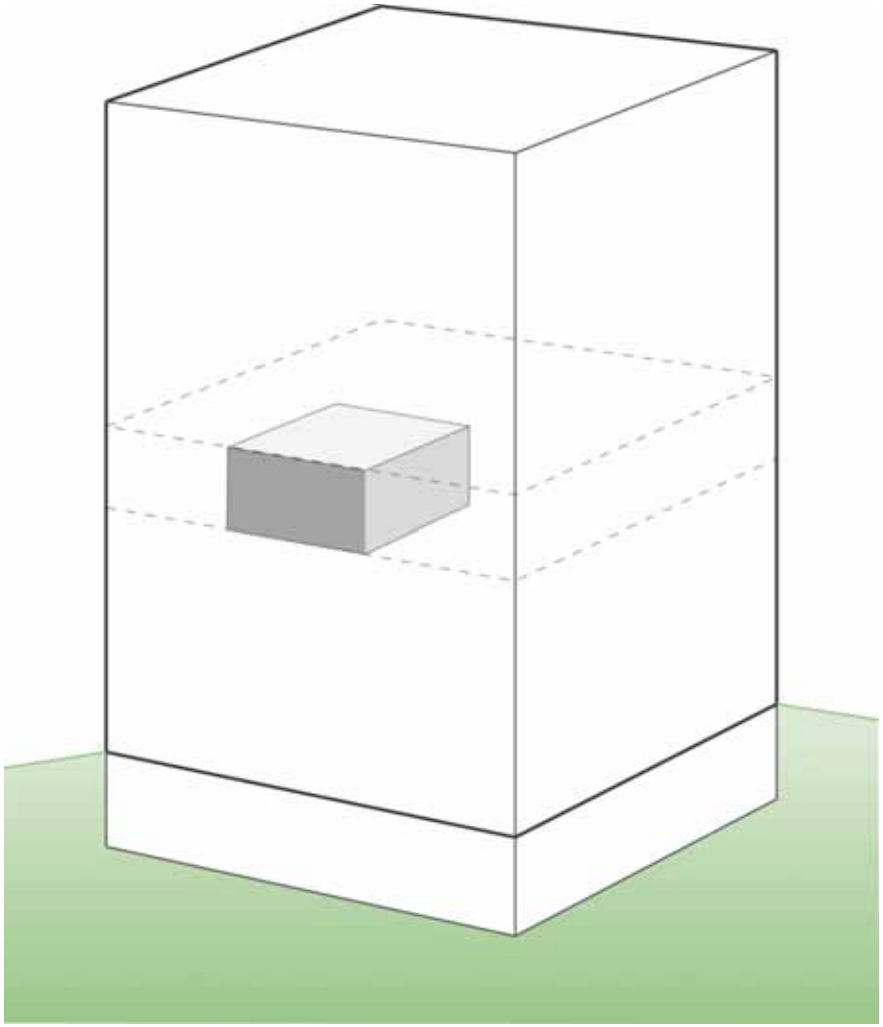

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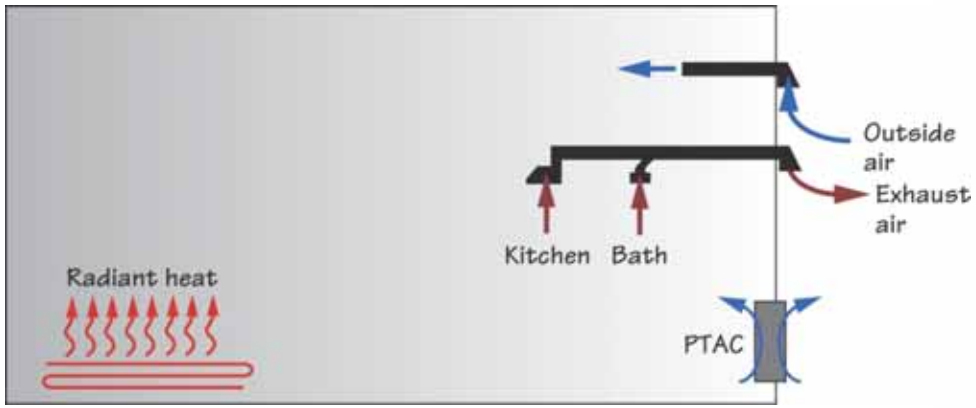
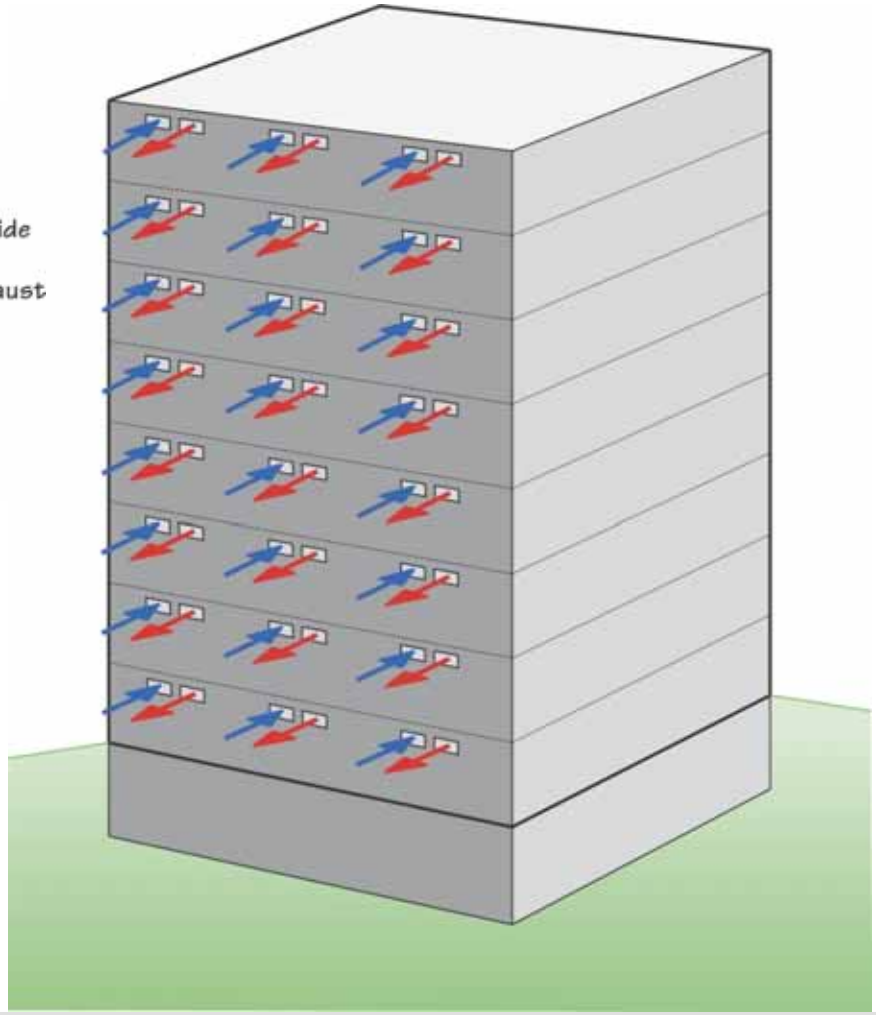


# Ventilation

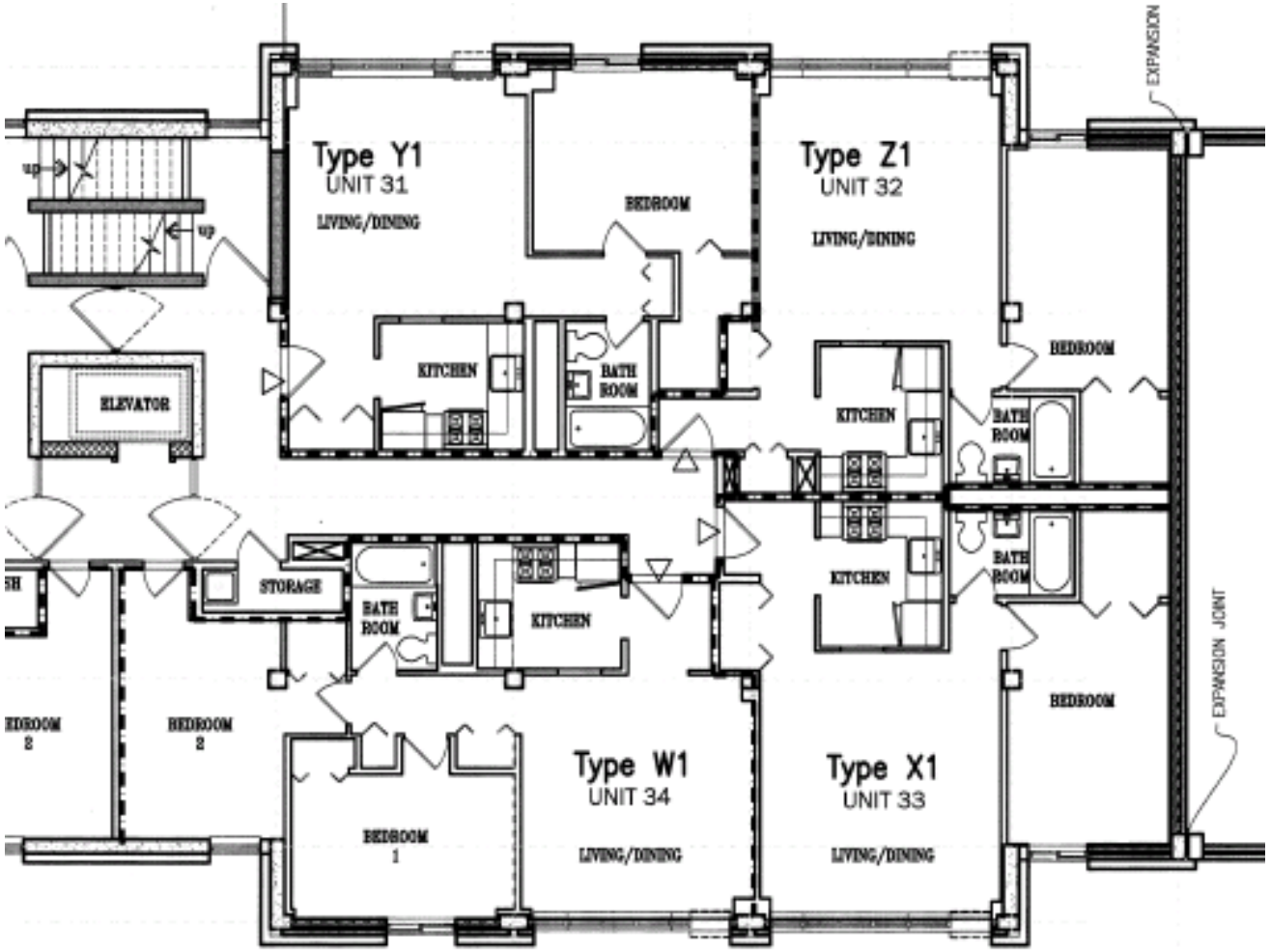
Context:

- Odor complaints a major motivation for residents
- Exhaust ventilation a part of existing infrastructure
- Project aspiring to LEED-NC recognition (ventilation distribution requirements)

# Ventilation

## Challenges:

# Ventilation



# Ventilation

## Options investigated:

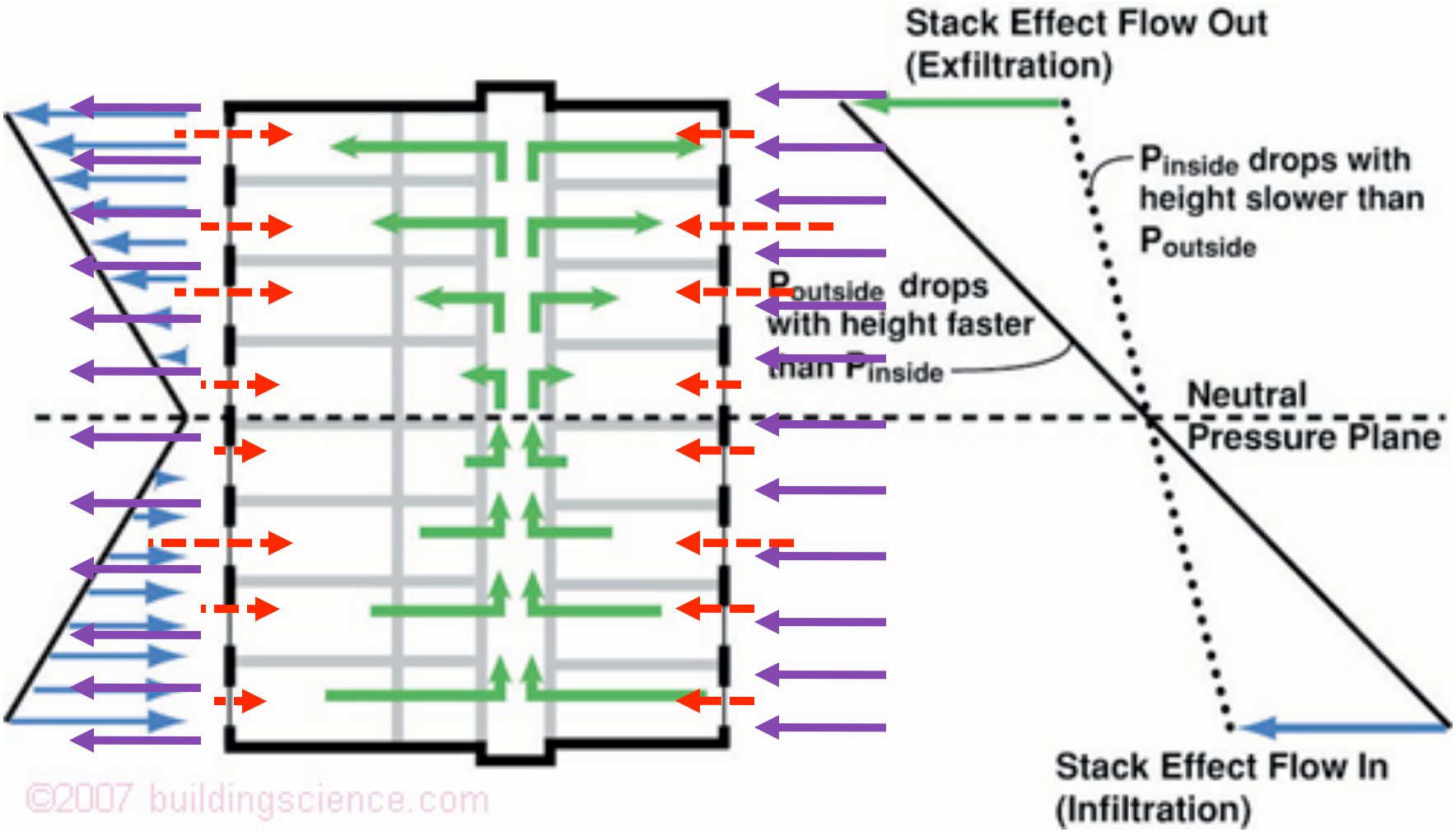
- HRV per apartment
  - Ceiling too low for dropped soffit in circulation
  - Asbestos made penetration of partitions impractical
- Central supply and Hx
  - Would need to refit or reconfigure riser
  - Distribution within apartment

# Ventilation

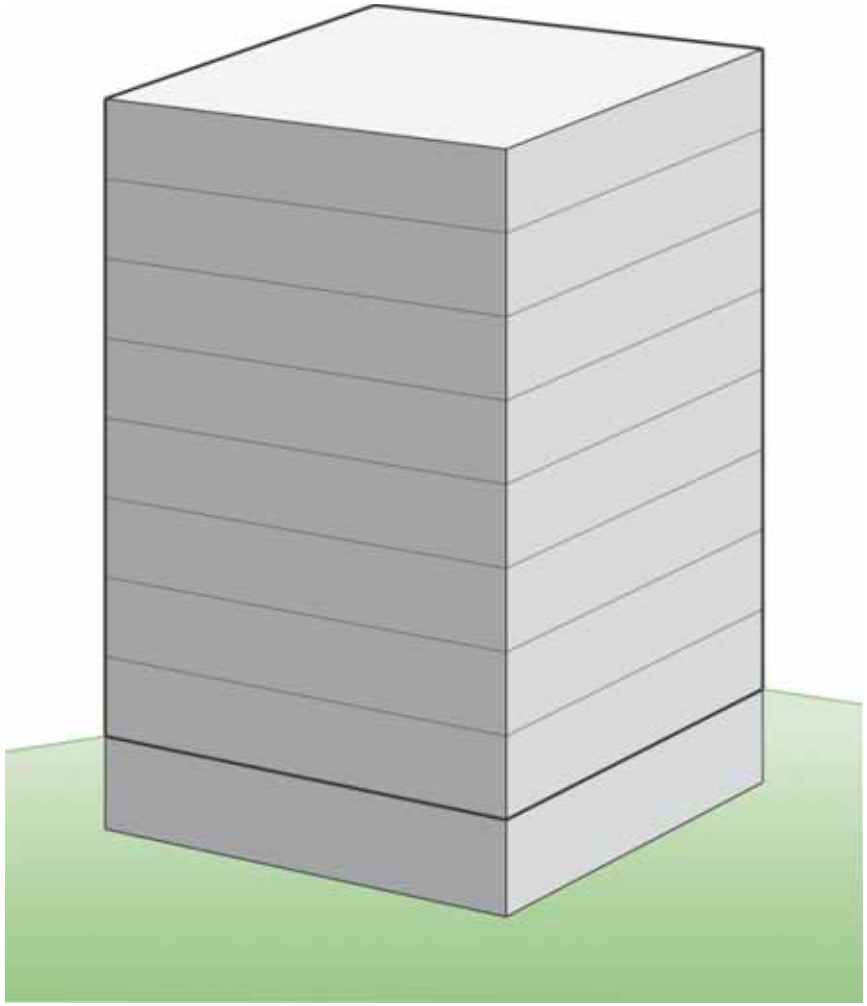
Adopted approach:

- Use existing ventilation shafts, exhaust
  - Controlled rate at unit – CAR
  - Seal exhaust riser from roof
  - Heat recovery?
  - Supply?

# Ventilation



# Compartmenting



# Compartmenting

Context:

- Odor complaints a major motivation for residents
- Project aspiring to LEED-NC recognition (apartment air tightness requirement)

# Compartmenting

## Challenges:

- Occupied renovation severely limits opportunities
  - 2 days total, New kitchen operational in 1 day
  - Residents back each evening
  - Belongings not moved from living and bedrooms
- Interstitial interconnected
  - Openings into shafts
  - Hollow walls

# Compartmenting

How to identify effective and important measures?

- Have a look at building

  (may have to get destructive)

  - Understand/confirm construction
  - Assess significance
  - Devise approaches
  - Test implementation of measures.

# Compartmenting

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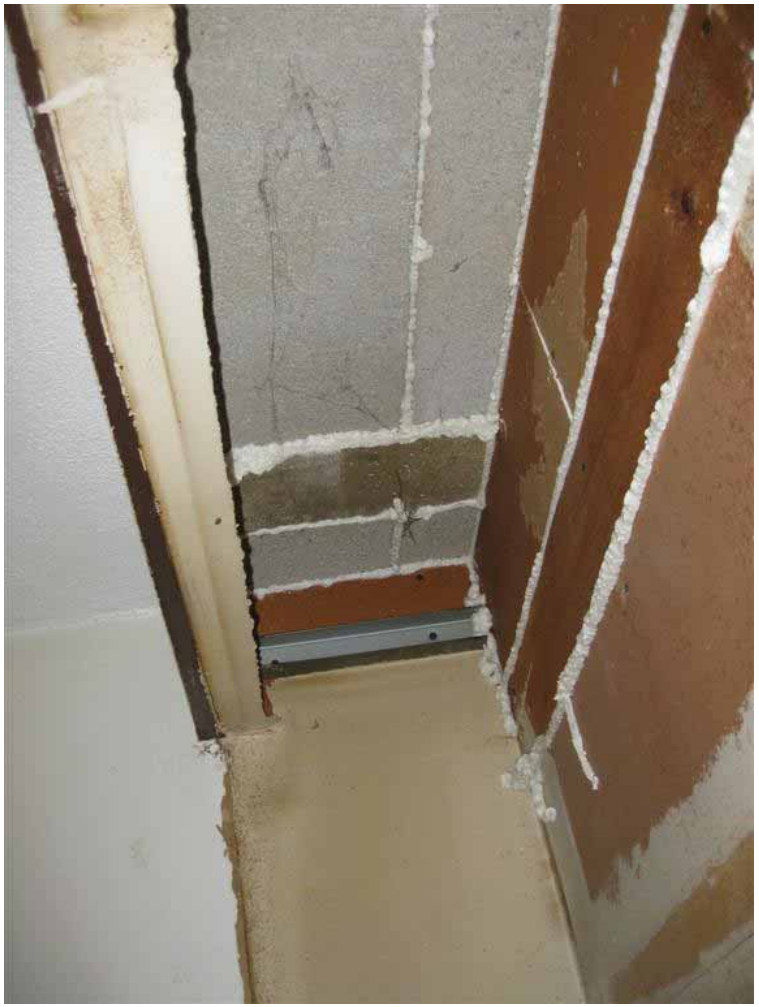

# Compartmenting

# Compartmenting

Making it stick:

- Construction M&V
  - Performance target
  - guide contractor through first few
    - make sure measures are understood,
    - uncover implementation issues,
    - evaluate target
  - spot check (sample) to performance target

# Compartmenting

## Making it stick: Performance specification

CASTLE SQUARE APARTMENTS
BOSTON, MA

May 24, 2010
SPECIFICATIONS

SECTION 01575

AIR TIGHTNESS AND TESTING REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Perform renovations of apartments, corridors, trash closets, elevator vestibules, and other rooms to achieve continuous enclosure air barriers that limit air leakage into (or out of) the space and verify air leakage control through testing. Assemblies modified or added as part of the renovation scope must be made to be air-, smoke-, and gas-tight. Apartments must achieve specific air leakage targets as indicated in this section.

The Owner's testing agency will be made available to provide technical assistance and testing for the first (6) garden apartments and the first (6) midrise apartments. Thereafter the Owner's testing agency will verify attainment of the air leakage target by sampling approximately 10% of

# Thanks for your attention!

# **Questions?**