BUILDINGENERGY BOSTON

Historic Buildings and Climate Change Mitigation: Case Study of a Low-Carbon Renovation

Heather Clark (Biome Studio)
Andy Poshadel (Petersen Engineering)
Jacob Racusin (New Frameworks)
Kohta Ueno (Building Science Corporation)

Curated by Lauren Baumann (New Ecology)

1

Kohta Ueno

Historic Buildings & Climate Change Mitigation – A Case Study of a Low Carbon Renovation

Building Enclosure Retrofit Design

May 7, 2021

bsc Building Science Corporation

BUILDINGENERGY BOSTON
WEDNESDAY–FRIDAY, MAY 5–7, 2021 • WWW.NESEA.ORG/BE21
BuildingEnergy Boston is a Conference of the Northeast Sustainable Energy Association (NESEA)

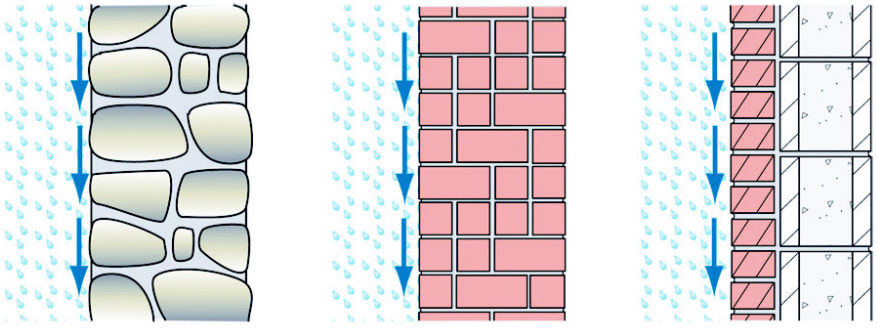
2

Masonry Wall Insulation Background

3

Mass Walls (Rain Control)

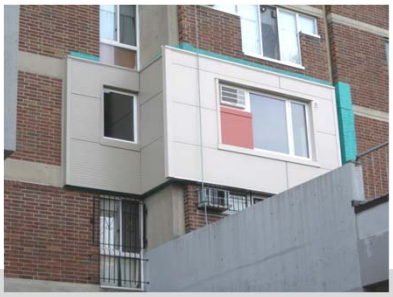
- Moisture is absorbed/safely stored during rain
- Moisture re-evaporates/dries while warmer
- No “drainage plane”



4

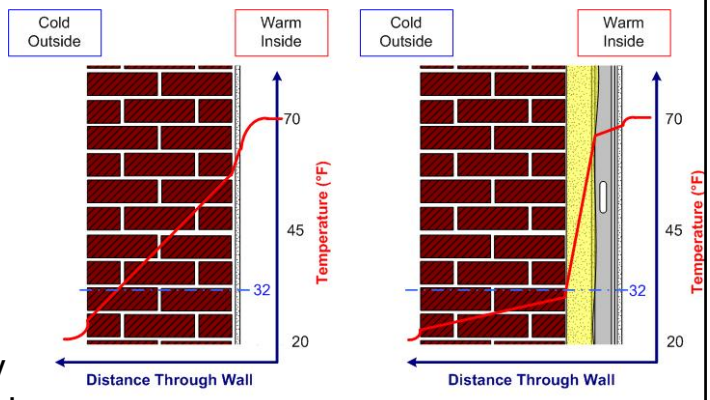
Inside or Outside Insulation?

- Insulating on exterior always preferable (masonry durability, condensation risks)
- Interior insulation → historic preservation reasons
- Interior → potential durability risks



Cold Climate Risks

- Freeze-thaw (colder + reduced drying)
- Air leakage condensation on interior face of masonry
- Rot / corrosion of embedded elements
- Covering interior → less early warning of damage problems in the wall



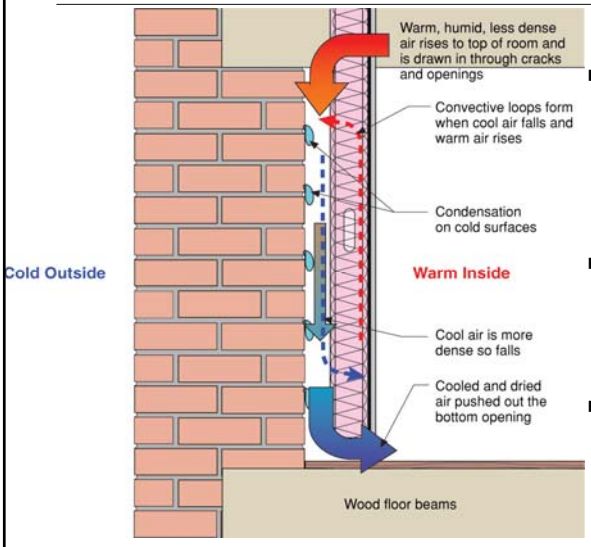
Cold Climate Risks: Freeze-Thaw

- Below & above freezing cycling (actually ~23 F)
- Soaking wet brick
- Surface “flaking off”

- Brick more/less resistant to freeze-thaw
- S_{crit} or critical degree of saturation measurement

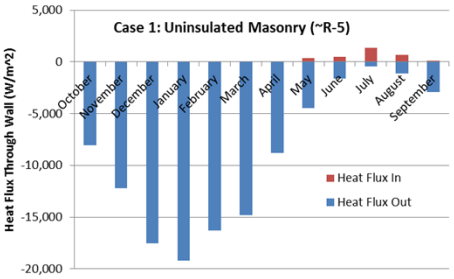


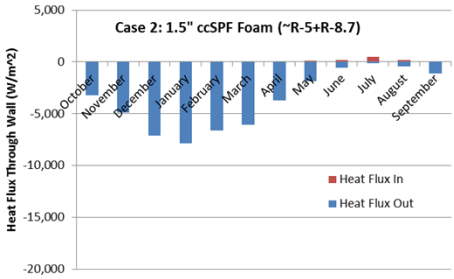

Cold Climate Risks: Condensation

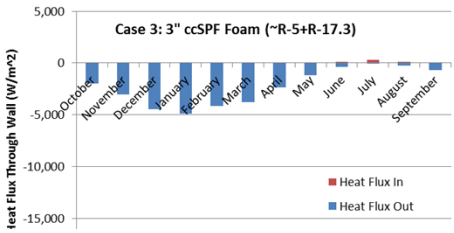


- Requires perfect workmanship at air barrier—around penetrations, etc.
- Made worse by air gap behind insulation
- **NOT RECOMMENDED**


Do We Need to Insulate Mass Walls?







Climate: Burlington, VT

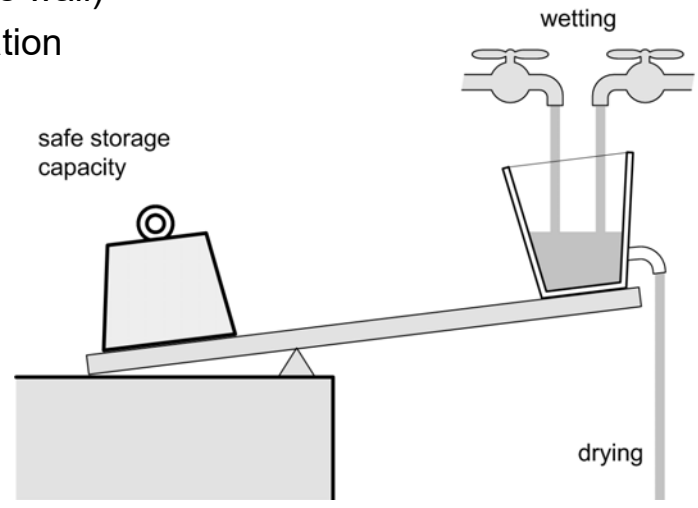
Case 2 (add 1.5” ccSPF, R-8.7) ≈ 60% reduction in heat flow through walls vs. uninsulated case

Case 3 (add 3” ccSPF, R-17.3) ≈ 75% reduction in heat flow through walls vs. uninsulated case

Mass vs. no mass → Adds ~R-1

The Moisture Balance

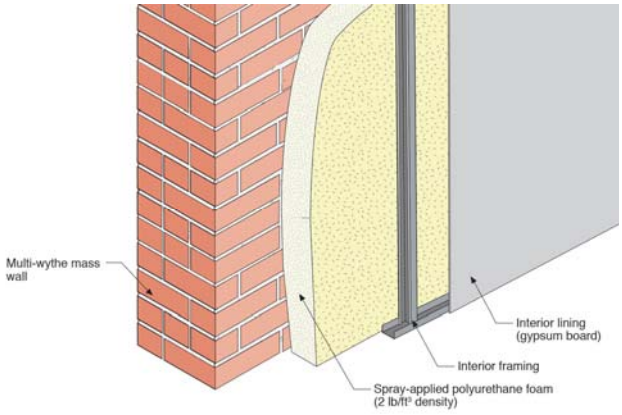
- Large storage capacity (mass wall)
- Drying decreases with insulation
  - Less heat flow in winter
  - Inhibited inward drying?
- Reduce/control wetting to compensate



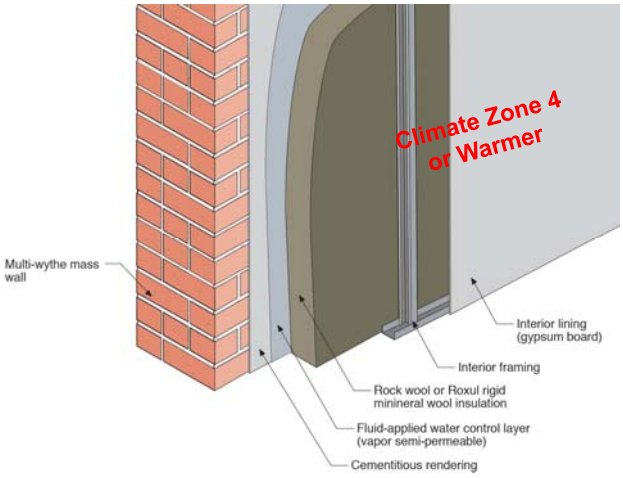
Masonry Wall Retrofit Insulation Assemblies

Masonry Interior Insulation Retrofit Assemblies

Closed-cell spray foam

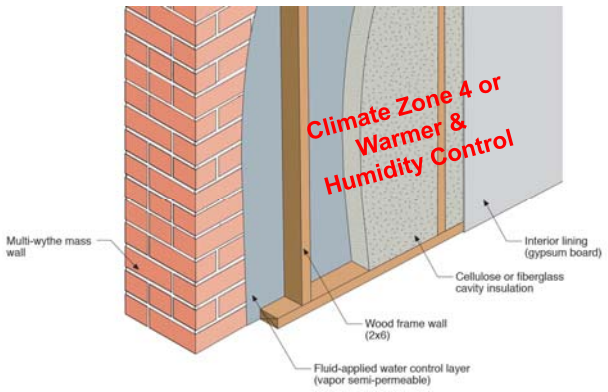


Semi-rigid mineral fiber board

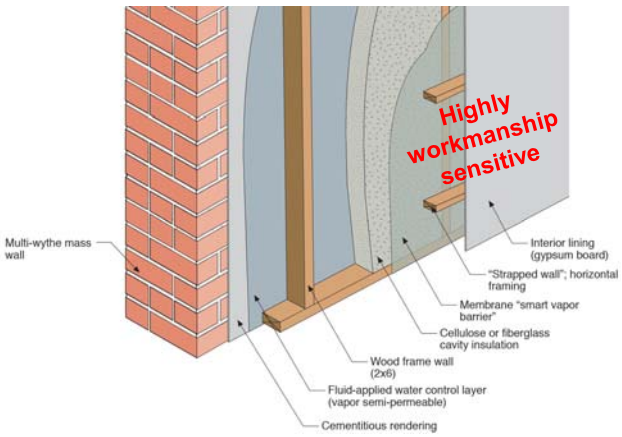


Masonry Interior Insulation Retrofit Assemblies

Cellulose/Batt & GWB

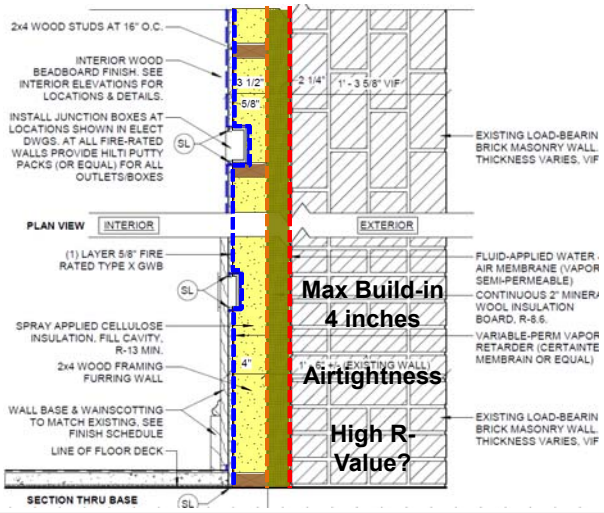


Cellulose/Batt, Smart VR, Service Cavity

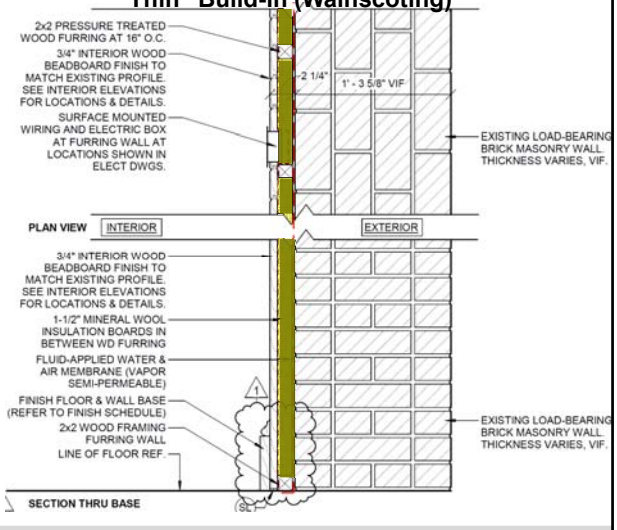


Moran Square Retrofit Assemblies

Typical Retrofit Assembly



"Thin" Build-in (Wainscoting)



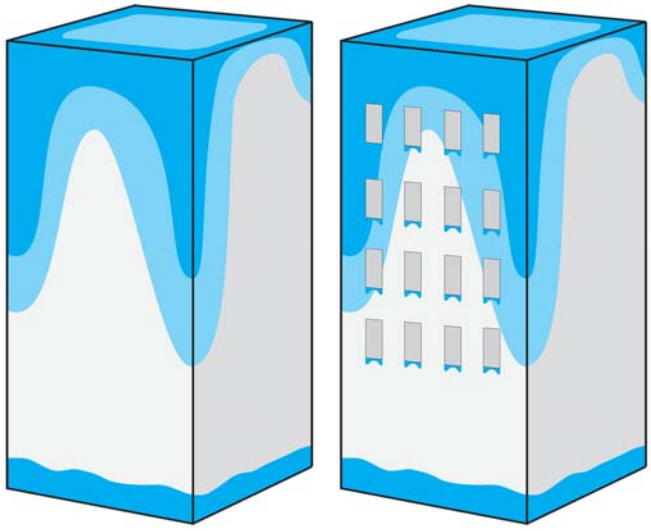
Tricky Enclosure Items

15

Wetting Patterns: What Does the Building Tell Us?

- Where to look at the building (damage, moisture)
- "Where the building touches the ground and the sky"
- And add windows

- Parapets—cold & wet
- Unheated conditions

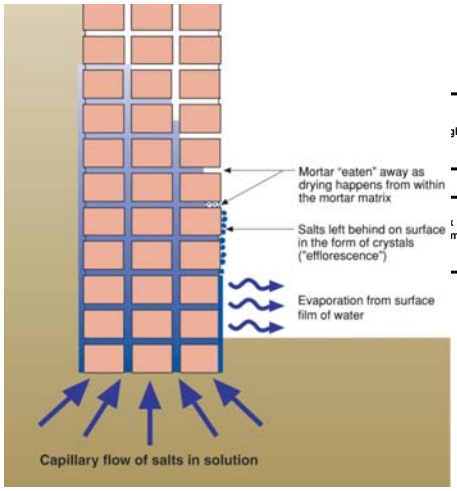


16

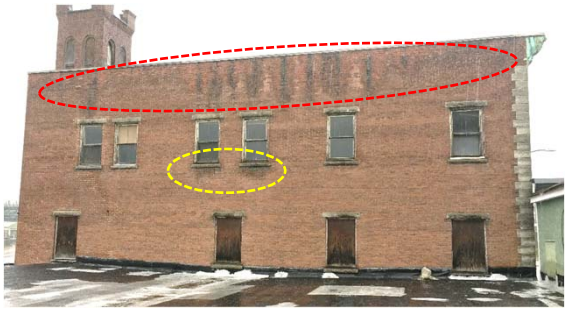
Wetting Patterns: Grade Contact Conditions

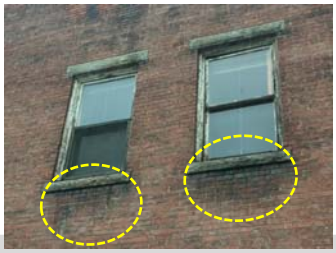
Firehouse

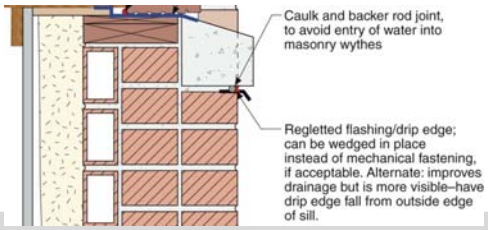
Syndicate



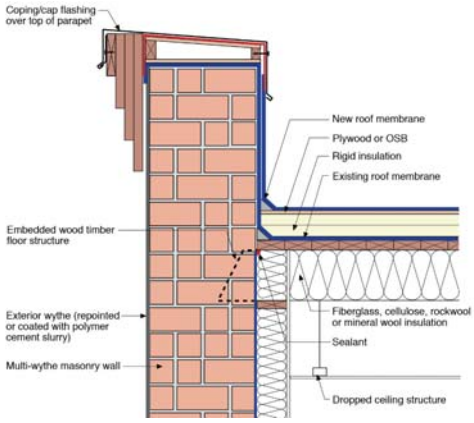
Wetting Patterns: Windows



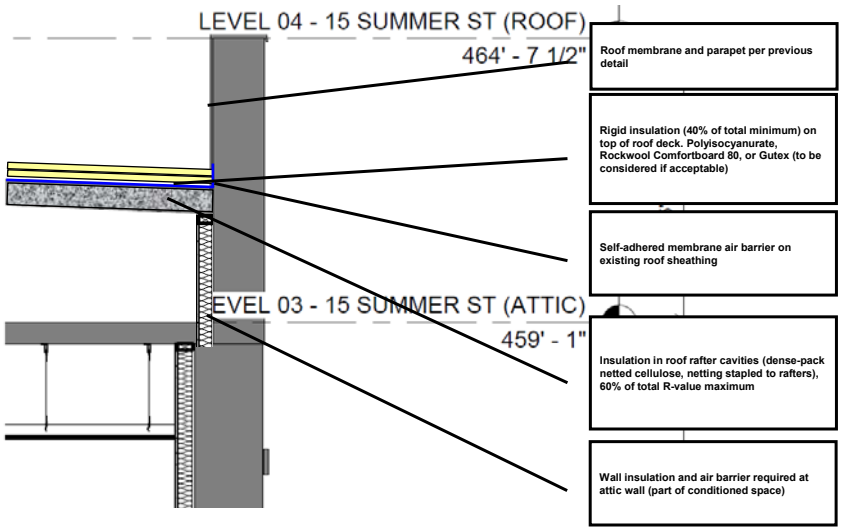




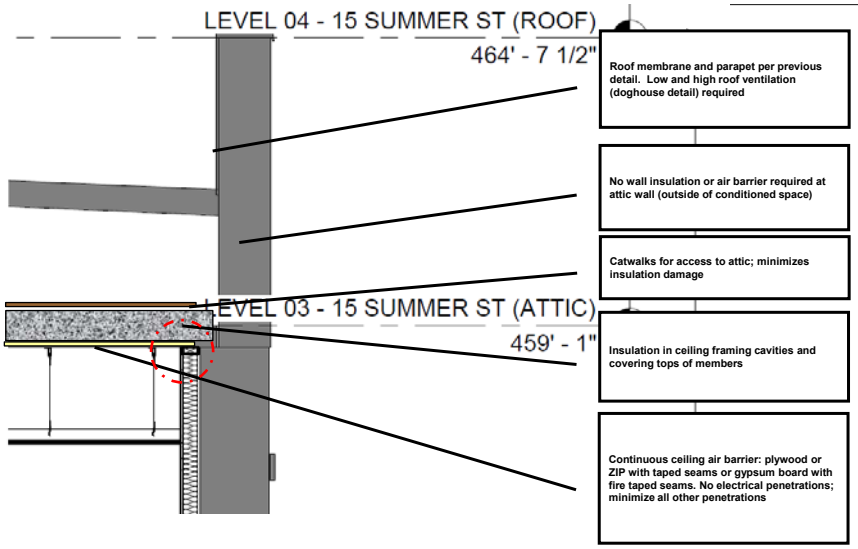
Wetting Patterns: Roof Copings



Roof/Attic: Unvented?

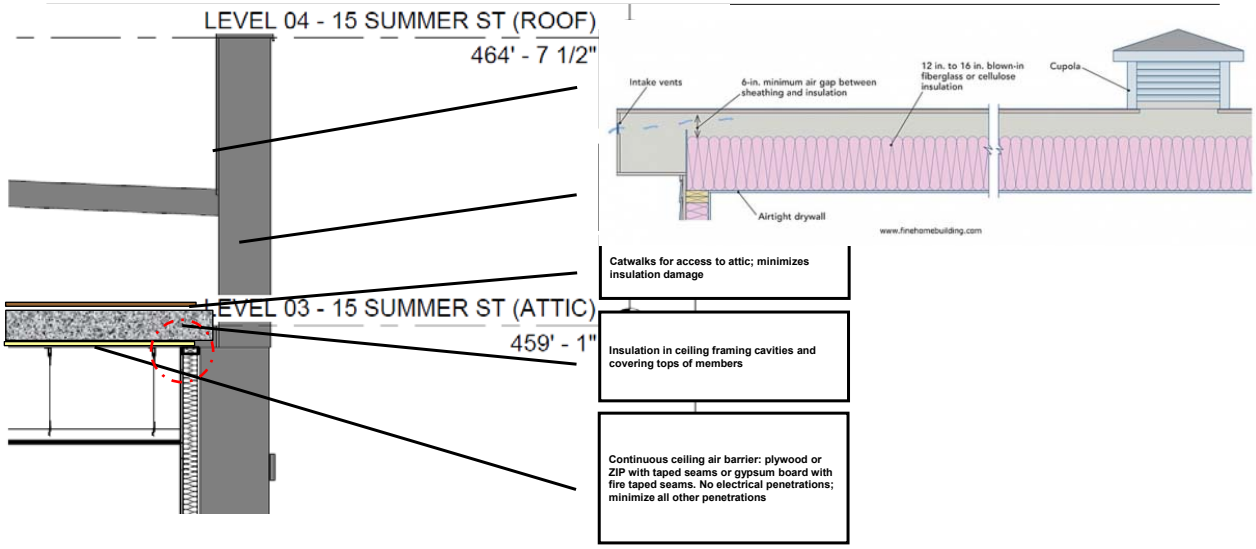


Roof/Attic: Vented?



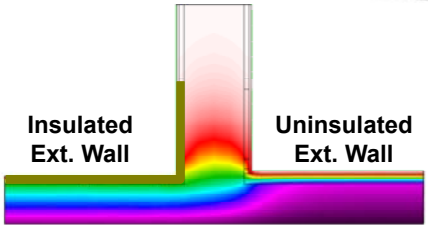
21

Roof/Attic: Vented?

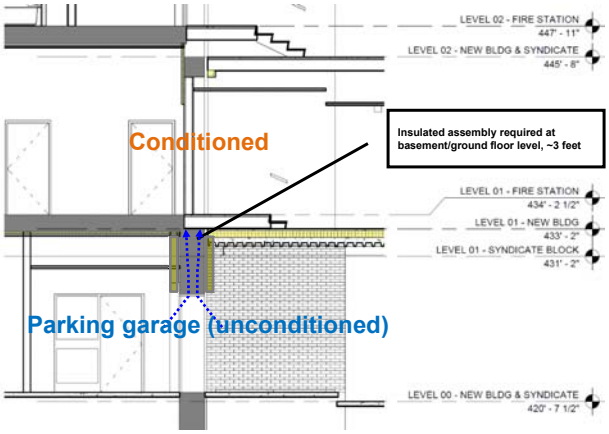


22

Masonry Thermal Bridges

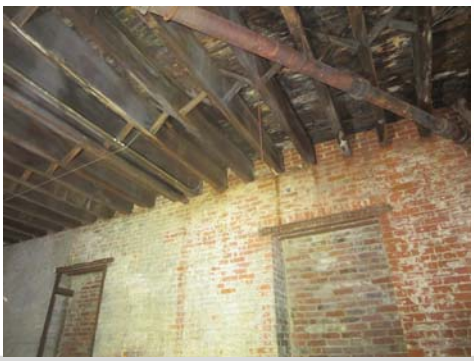


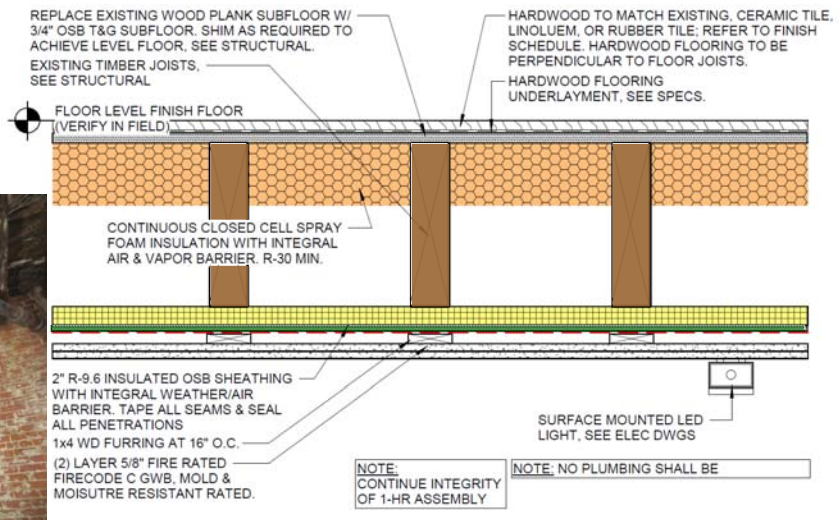
Add tee wall "wrap" for flanking loss



Floor-Ceiling Over Unconditioned @ Existing Building

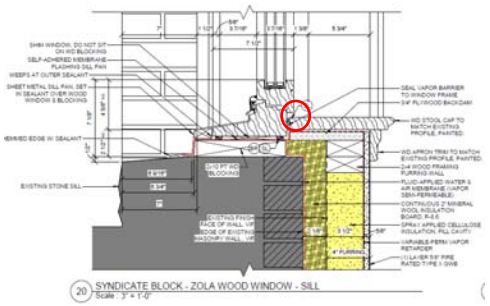
- Air barrier, insulation, 2-hour fire rating
- Taped ZIP-R as air barrier layer

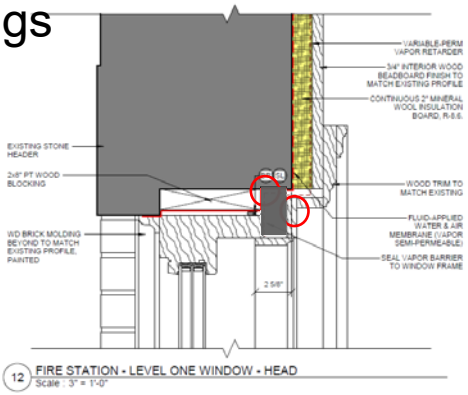




Thermal Bridges at Window Openings

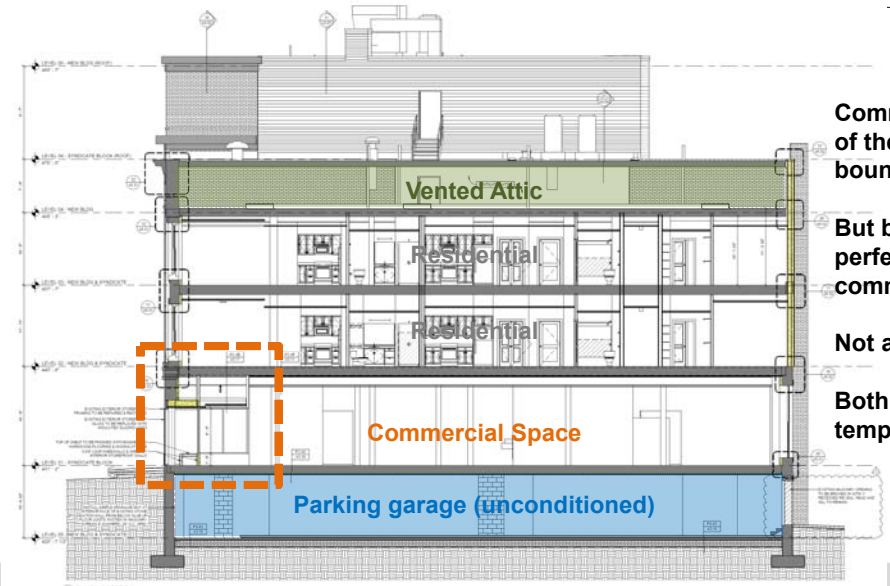
- PHIUS feedback
- Opaque frame and trim limited by historic
- Some are fixable
- Some have limited solutions





25

Retrofit Building Section (Syndicate)



Commercial space is outside of the Passive House boundary

But blower door test requires perfect air seal between commercial & residential

Not allowing guarded test

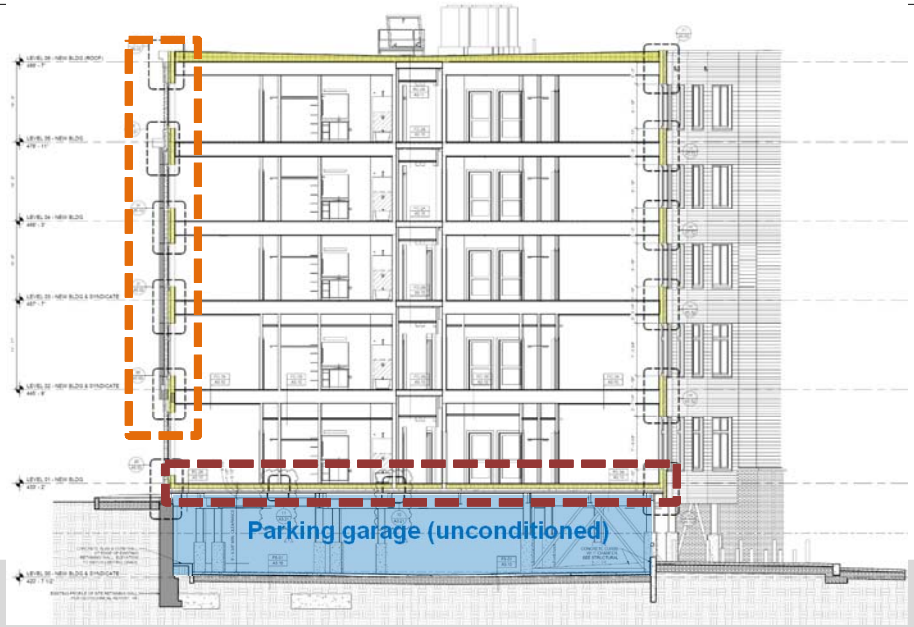
Both spaces operate at room temperature

26

New Construction Enclosure Assemblies

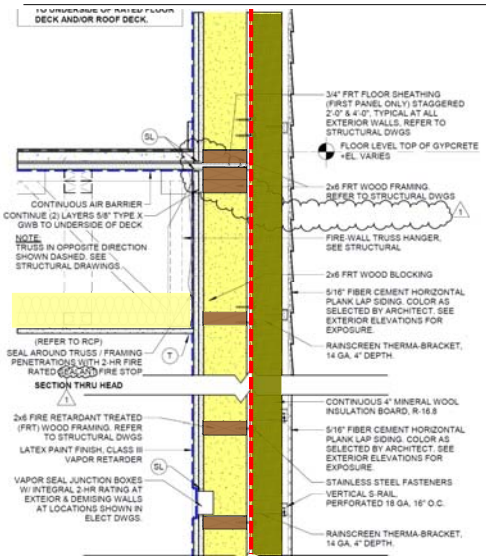
27

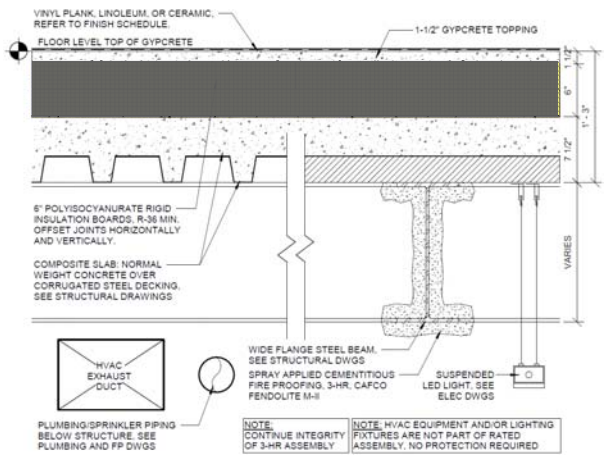
New Construction Building Section



28

Wall and Floor-over-Garage Assemblies





Questions?

Kohta Ueno
kohta (at sign) buildingscience dot com

This presentation will be available at http://buildingscience.com/past-events

Document Resources

- Building Science Digest 114: Interior Insulation Retrofits of Load-Bearing Masonry Walls In Cold Climates
  http://www.buildingscience.com/documents/digests/bsd-114-interior-insulation-retrofits-of-load-bearing-masonry-walls-in-cold-climates
- Building Science Insight 047: Thick as a Brick
  http://www.buildingscience.com/documents/insights/bsi-047-thick-as-brick/
- Building Science Insight 080: Tailor Made
  http://buildingscience.com/documents/insights/bsi080-tailor-made
- Building Science Insight 095: How Buildings Age
  http://buildingscience.com/documents/building-science-insights/bsi-095-how-buildings-age
- Building Science Insight 105: Avoiding Mass Failures
  https://www.buildingscience.com/documents/building-science-insights/bsi-105-avoiding-mass-failures
- Building America Report 1105: Internal Insulation of Masonry Walls: Final Measure Guideline
  http://www.buildingscience.com/documents/reports/rr-1105-internal-insulation-masonry-walls-final-measure-guideline/
- Building America Report 1307: Interior Insulation of Mass Masonry Walls: Joist Monitoring, Material Test Optimization, Salt Effects
  https://buildingscience.com/documents/bareports/ba-1307-interior-insulation-mass-masonry-walls/view
- Building America Report 1508: Analysis of Joist Masonry Moisture Content Monitoring
  https://buildingscience.com/documents/building-america-reports/ba-1508-analysis-joist-masonry-moisture-content-monitoring
- Green Building Advisor: Insulation Retrofits on Old Masonry Buildings: Building Science Podcast
  http://www.greenbuildingadvisor.com/blogs/dept/building-science/insulation-retrofits-old-masonry-buildings-building-science-podcast