

Kohta Ueno
Internal Insulation of Masonry Walls
 EEBA 2012




Building America Innovations



This research is paving the way for key innovations:

- Building science solutions for interior insulation of masonry walls
- Best insulation solutions (w/o moisture problems)
- Exterior water control detailing required for durability
- Building site assessment guidelines
- Assessment tools for freeze-thaw durability

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BSC Website Builder Resources

- RR-1105: Internal Insulation of Masonry Walls: Final Measure Guideline
 - Large report with building physics background, assessment techniques, recommended retrofit details, code ramifications
 - Includes field checklist for practitioner (looking for problematic details)
- BSD-114: Interior Insulation Retrofits of Load-Bearing Masonry Walls In Cold Climates
 - Overview of interior insulation of masonry
- BSI-047: Thick as a Brick
 - Overview of freeze-thaw testing of brick samples
- RR-1013: Assessing the Freeze-Thaw Resistance of Clay Brick
 - Scientific paper on freeze-thaw brick testing
- Green Building Advisor: Insulation Retrofits on Old Masonry Buildings: Building Science Podcast
 - Interview with Joe Lstiburek on insulating masonry buildings
- Link to DOE resources: www.buildingamerica.gov

Background

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Load Bearing Masonry

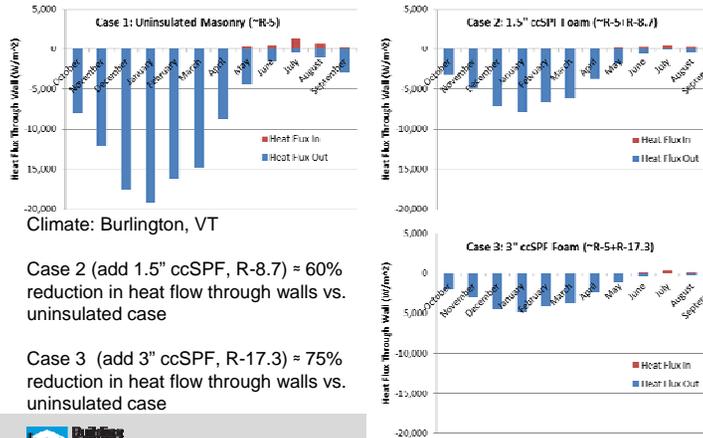
Strong
Beautiful, historic
Flexible/adaptable
Existing



Can we improve the energy performance of existing masonry walls without compromising durability?

Do We Need to Insulate Mass Walls?

Climate: Burlington, VT



Case 1: Uninsulated Masonry (~R-5)

Case 2: 1.5" ccSPF foam (~R-5+R-8.7)

Case 3: 3" ccSPF foam (~R-5+R-17.3)

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

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Overview: Inside or Outside Insulation?

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



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Durability Concerns

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Mass Masonry Walls

- Most water shed/deflected by exterior details
- Absorb water during rainfall, redistributes through wall, dries during non-rainy periods

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The Moisture Balance

- Large storage capacity (mass wall)
- Drying decreases with insulation
- Design should reduce/control wetting to compensate

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Cold Climate Risks

- Freeze-thaw (reduced drying)
- Air leakage condensation on interior face of masonry
- Rot / corrosion of embedded elements

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Embedded Wood Member Risks

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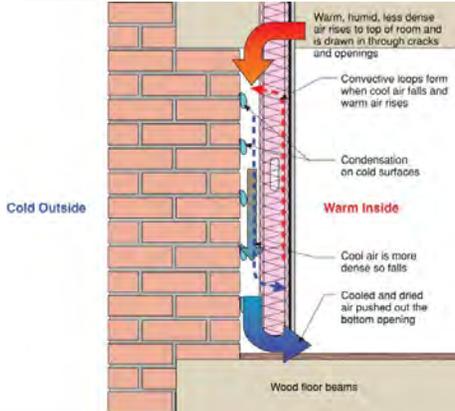
Retrofit Assemblies



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13

Cold Climate Risks: Condensation



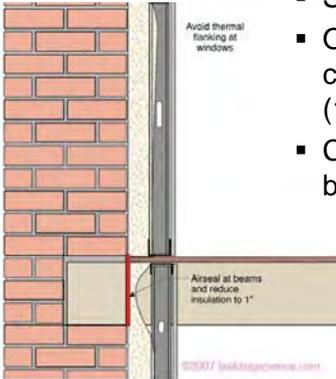
- Requires perfect workmanship at air barrier—around penetrations, etc.
- Made worse by air gap behind insulation
- **NOT RECOMMENDED**



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14

Recommended Approaches

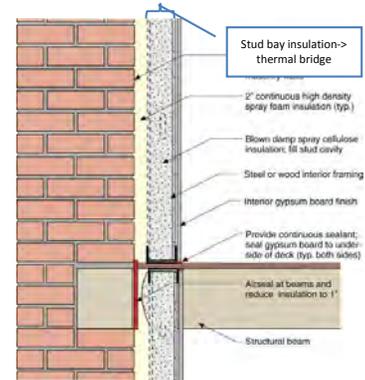


- Spray foam against masonry
- Open cell (0.5 PCF)? Closed cell (2.0 PCF)? Intermediate (1.0 PCF)?
- Condensation risks within beam pocket: air seal




15

Hybrid Wall Insulation Assembly






16

Hybrid Wall Insulation Assembly

Remove all loose and peeling paint on existing masonry walls

Tie back stud to masonry as necessary with non-rotatable clips

2" continuous high density spray foam insulation (typ.)

Blown damp spray cellulose insulation, leave steel stud space clear

Narrow section steel framing, no insulation

Interior gypsum board finish

Provide continuous sealant: seal gypsum board to underside of deck (typ. both sides)

Assess if beams and reduce insulation to 1"

Structural beam

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Water Control Details

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18

Water Concentrations

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Windows (Water Concentration)

Sealant (air barrier)

Sill pan flashing; note backdam to prevent inward water movement, overlaps and drains onto surface of sill; pan flashing should extend min. 4" up jamb vertically

Caulk and backer rod joint, to avoid entry of water into masonry wythes

Regletted flashing/drip edge; can be wedged in place instead of mechanical fastening, if acceptable. Alternative: improve drainage but is more visible—have drip edge fall from outside edge of sill

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Windows (Potential Rain Entry Point)

Liquid-applied window flashings may be a faster option (multiple manufacturers).

Roof-Wall Interface Details

Parapets

- Coping sloped inward
- Membrane wraps up and over parapet
- Drip edge projects 1-1/2"

Downspouts & Scuppers

- Can be tremendous water concentrations from low-slope roofs
- Avoid entirely with detail draining to interior?

Energy-Related Details



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25

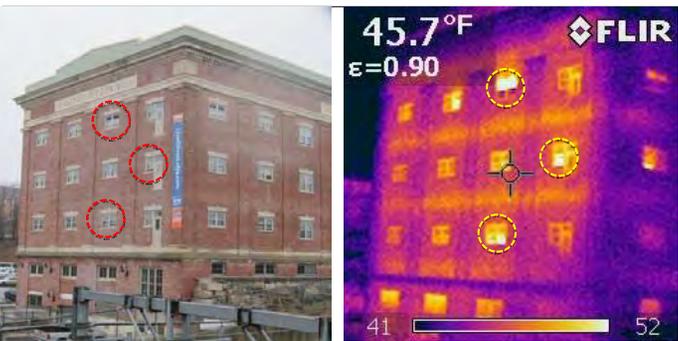
Thermal Bridging at Slab Floors



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26

Thermal Bridging at Slab Floors



45.7°F
ε=0.90

41 52

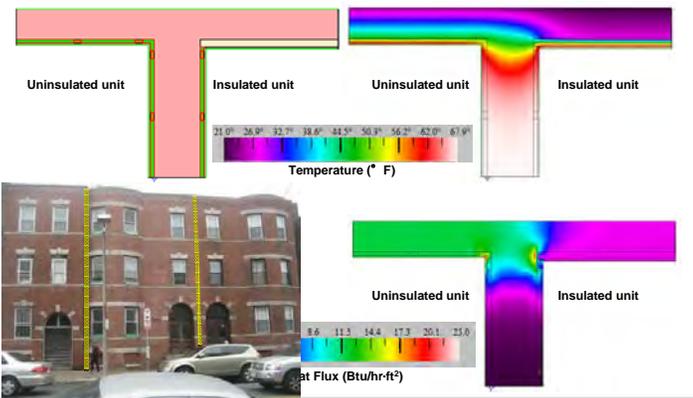
R-20 for 10 foot wall
R-3 for 1 foot floor slab
R-13 overall R value



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27

Masonry Tee Walls (THERM Runs)

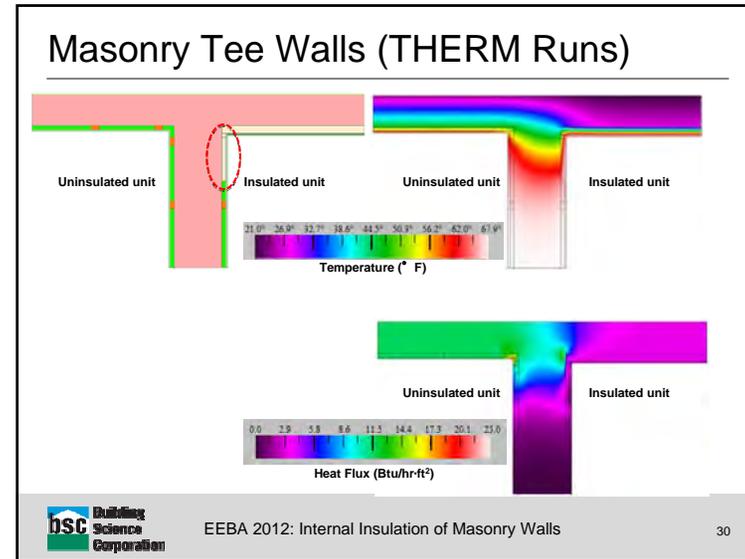
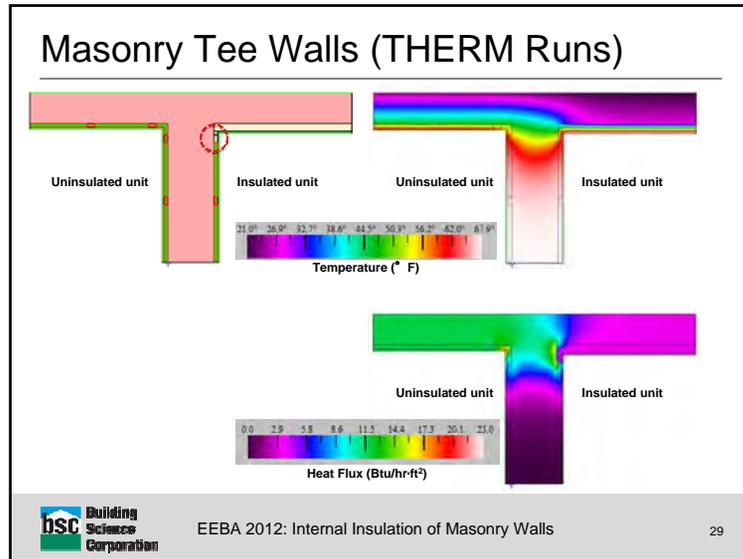


Temperature (° F)

Heat Flux (Btu/hr-ft²)

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28



Tapered Window Openings

Minimum ~R-5 for thermal comfort (radiant surface temperatures)

Leverage spray foam for air barrier continuity to window opening

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Air Barrier Issues

Can't rely on masonry alone to be an air barrier

13" brick wall, 100 sf = 3.1 sq. in. leakage EqLA

Same with 3 coat plaster = 0.054 sq. in. EqLA

Source: CBD-23. Air Leakage in Buildings

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Assessing Masonry Buildings



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33

Recommended Assessment Steps

Before insulation retrofit (in order of importance):

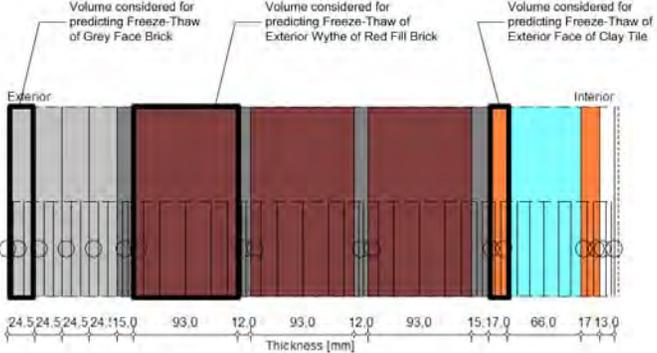
1. Site Visit Assessment
2. Simple Tests & Modeling
3. Detailed Tests & Modeling



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34

Hygrothermal Simulations



Thickness [mm]

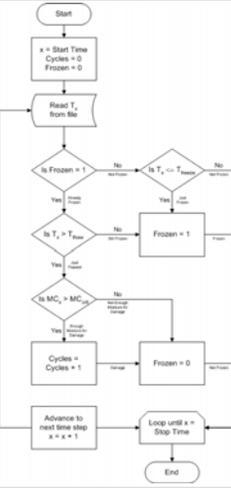
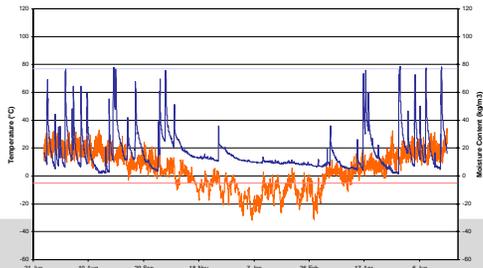


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35

Assessment

- Freeze Thaw Event
 - Brick must have higher moisture than Critical Degree of Saturation
 - Brick must freeze/thaw (<23 F and >32 F)


36

Recommended Assessment Steps

Before insulation retrofit (in order of importance):

1. Site Visit Assessment
2. Simple Tests & Modeling
3. Detailed Tests & Modeling
4. Site Load Assessment
5. Prototype Monitoring
6. Maintenance and Repair



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37

Conclusions

- To achieve high performance with masonry buildings, insulation is required
- If you cannot address water leakage/deposition issues, you should not insulate
- Must assess as-built condition on site
- Future work
 - Continued research on freeze-thaw mechanics
 - Monitoring of insulated buildings
 - Compile database of insulated buildings
 - Water repellents (silanes and siloxanes)
 - Embedded wood member durability risks



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38

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40

Questions?

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RR-1105: Internal Insulation of Masonry Walls: Final Measure Guideline
<http://www.buildingscience.com/documents/reports/rr-1105-internal-insulation-masonry-walls-final-measure-guideline/>



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41