



National Institute of Building Sciences Provider #G168

BEST4 Conference
Nibsbest4 • April 13-15, 2015

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

Participants will :



1. Understand some of the risks to embedded wood members in masonry walls (insulated or not).
2. Learn about the effect of orientation and backup wall type on embedded joist end conditions.
3. Learn about seasonal effects on embedded joist end conditions.
4. Learn about retrofit measures to ameliorate risks to embedded joist ends.



Kohta Ueno

Field Monitoring of Embedded Wood Members in Insulated Masonry Walls in a Cold Climate

BEST Conference Building Enclosure Science & Technology
April 15, 2015

Building Enclosure Science & Technology

Background

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Embedded Wood Members

- After interior insulation, wall and joist end will be colder
- Less energy flow, higher RHs, wetter conditions
- Wood can mold/rot
- How big is the risk?

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2005 Monitoring Research (Canada)

- In SK, joists stayed dry (10-15% MC)
- In ON, sometimes up to 20% MC
 - Capillarity from foundation?
 - Rainwater absorption through face of masonry?

Figure 1

Figure 2

BES

Literature Review (Con't)

- Scheffler (2009)
 - DELPHIN 2D hygrothermal simulations, steady state
 - Interior-sourced air and vapor flow risks
 - Transient simulations; beam end MCs increase w. insul.
 - Historic & modern methods to address beam end MCs
- Morelli (2010)
 - Gap in insulation above and below beam area (12" above and below → 30" left exposed)
 - 60% heat flow reduction from full insulation
 - 45% reduction with "gapped" insulation
 - "Gapped" insulation has less wetting than full insulation
 - Huge effect of rainfall deposition rates

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Monitoring Project

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Embedded Joist Monitoring

- HfH Lawrence renovation
 - c. 1906 & 1930
- Ongoing interior retrofit
- Joist moisture content:
 - 3 measurements/joist
 - 10 joists
- Variables
 - Orientation/exposure
 - Wall type
 - Insulated/non-insulated
 - Air sealed



BEST4

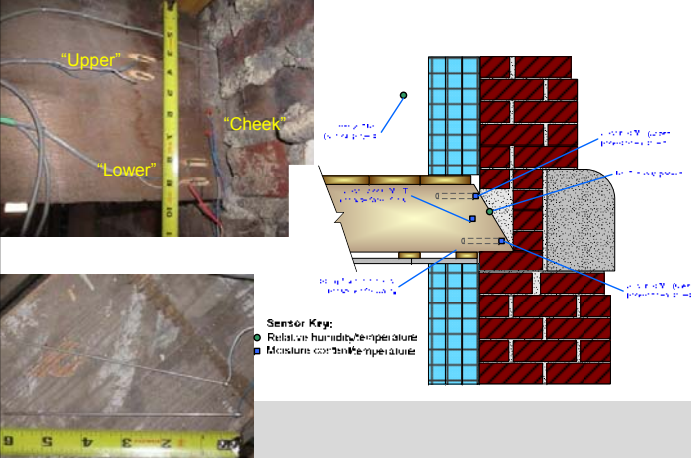
Interior Insulation Details



- 3x 2" (6" total) layers extruded polystyrene, adhered to masonry walls
- Joist pockets insulated with XPS blocks, air sealed with spray foam kits

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Joist Monitoring Package



Sensor Keys:

- Relative humidity/temperature
- Moisture content/temperature

Joist Monitoring Locations (Basement)



● Temperature/relative humidity
 ■ Monitored Joist End
 ■ Denotes 2 adjacent joists (not upper/lower) ■ 2 adjacent joist MCs
 West closer to roof-wall runoff

Insulation Option Comparison (North)

- Same orientation, 3 different insulation techniques
- Fiberglass = insulated but no air leakage control

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Joist Monitoring Locations (First)

- Temperature/relative humidity
- Monitored Joist End
- Denotes 2 adjacent joists (not upper/lower)

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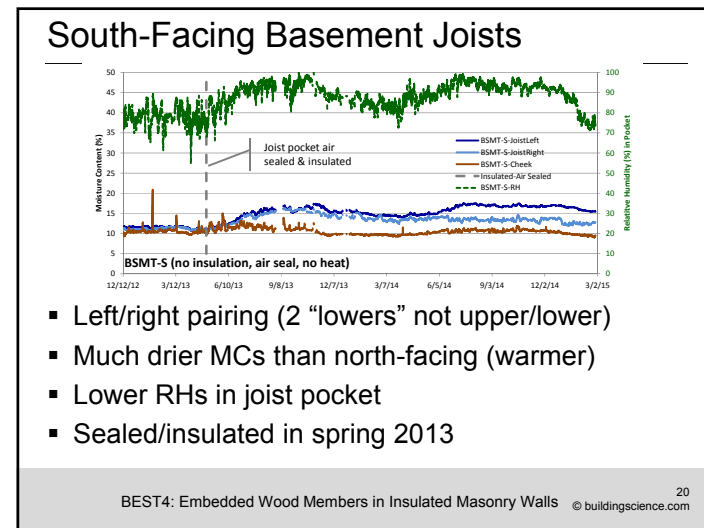
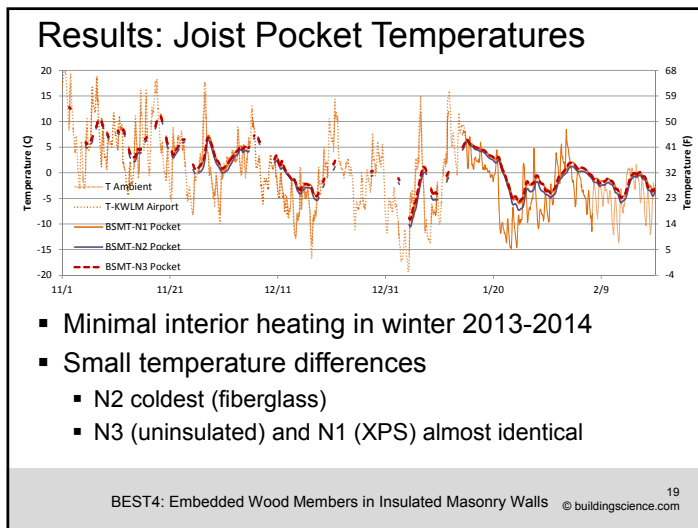
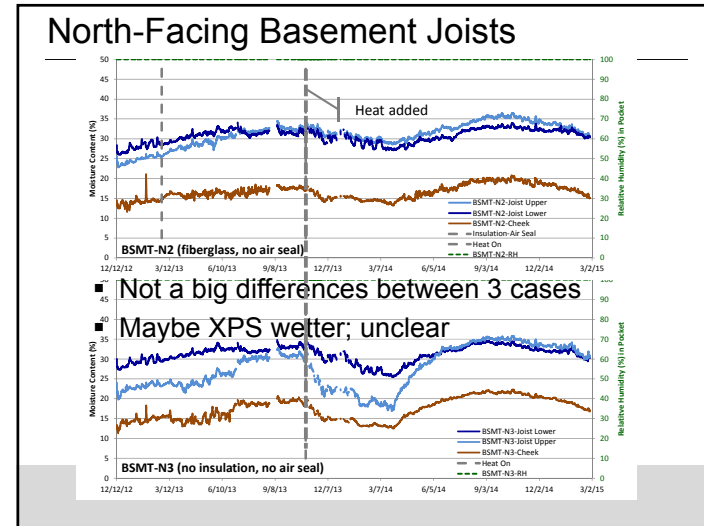
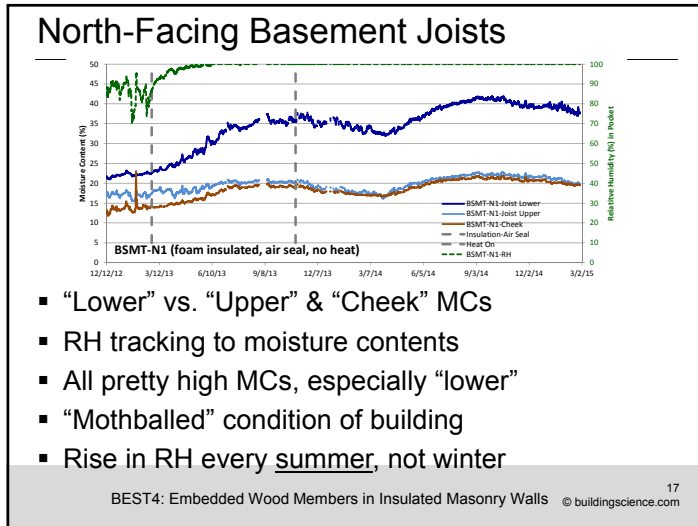
Monitoring Results

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Exterior/Interior Boundary Conditions

- Some parts heated ("Hallway"), others unheated ("Logger") → construction heating during winters
- Not very representative; still under construction
- Interior dewpoints ~identical to exterior dewpoints
- Some joists still uninsulated/unsealed

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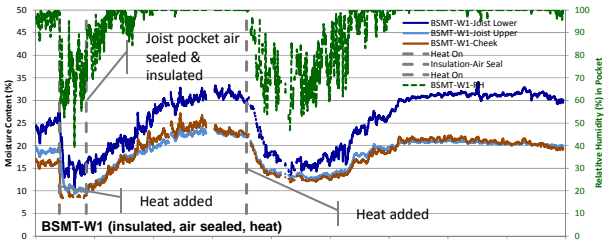
First Floor Joists



- All semi-/unheated, uninsulated, unsealed
- All in hollow clay tile/brick walls
- FIRST-N: 20-30% MCs, 100% RH pocket
- FIRST-E: 9-15% MCs 50-95% RH pocket (seasonal?)
- FIRST-S: 9-12% MCs—very safe
- Huge effect of orientation/exposure
- Basement East vs. First East

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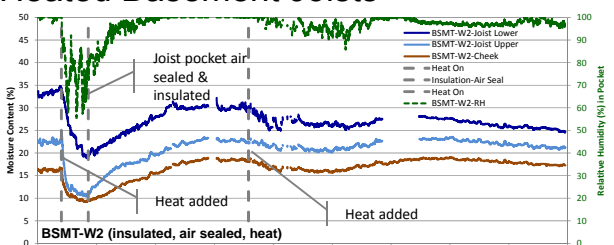
Heated Basement Joists



- Adding heat drops MCs/RH
- Even with insulation (and air sealing)
- Highest MCs/RHs in summer—inward T gradient? Seasonal rainfall?

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Heated Basement Joists



- W2 similar responses as W1
- BSMT W1 vs. W2—wetter by gutter?
- No noticeable difference

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Monitoring Conclusions

- All high MCs—20% recommended. But do they operate this way already?
- Mothballed conditions—started at high MCs?
- Higher MCs/RHs in summer—inward drive?
- “Normal” in-service response not clear yet
- Orientation very large effect
 - South-facing joists in the safe range
 - North-facing joists among the wettest
- Continued monitoring (mid-2015 construction completion target, 10 units)

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Beam “Stub” Measurements

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In-Situ Beam Moisture Contents

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In-Situ Beam Moisture Contents

Inboard Face Outboard Face

- Southeast corner (facing back of building)

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In-Situ Beam Moisture Contents

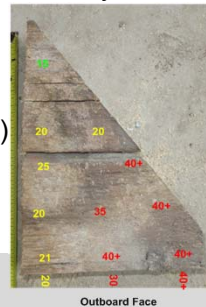
Outboard Face Inboard Face

- Southwest corner (facing front of building)

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In-Situ Beam MC Conclusions

- Beams not insulated or air sealed, bldg. unheated
- Orientation has a huge effect—sunny or shaded sides (plus driving rain, possibly)
- Joist Hi vs. Joist Lo—monitoring accurately capturing spatial difference
- Portion buried most deeply in masonry wall wettest
- “Dangerously” high MCs (35-40%) at bottom of SE joist—but not punky!
- Moldy and smelly, though...



Conclusions & Takeaways

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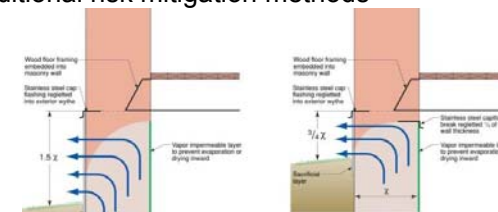
Takeaway: Models vs. Reality

- Modeling—many inputs and variables, not obvious answers:
 - Wood properties
 - Masonry properties
 - Imperfections in masonry
 - Geometry of beam pocket
- Many factors “right direction,” but absolute #s?
 - Measured MCs >>> than modeled
- Could spend a lot of time trying to tune a model... but in the end, is it a useful predictive tool?

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Takeaway: Joist Recommendations

- **Keep bulk water (rainwater) away from joist ends**
 - Pointing, reglets, sheltering details
- Keep capillary water away (see BSI-011 “Small Sacrifices”)—near grade conditions, reglet?
- Additional risk mitigation methods



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Additional Risk Mitigation Methods

Steel angle support




Interior bearing wall

Borate rod protection

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Questions?

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