U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Technology Solutions for Existing Homes

Building America Case Study

Retrofit Measures for Embedded Wood Members in Insulated Mass Masonry Walls

Lawrence, Massachusetts

PROJECT INFORMATION

Project Name: The Bixby Building (100 Parker Street)

Location: Lawrence, MA

Partners:

Merrimack Valley Habitat for Humanity, *merrimackvalleyhabitat.org*

Building Science Corporation, *buildingscience.com*

Building Component: Building envelope (masonry wall insulation)

Application: Retrofit, single- and multifamily

Years Tested: 2012–2015 (ongoing)

Applicable Climate Zones: Zones 4–6

FIELD RESEARCH SUMMARY

MC and relative humidity were monitored at joist ends in historic mass brick masonry walls retrofitted with interior insulation in a cold climate (Zone 5A); data were collected from 2012–2015. Eleven joist ends were monitored in all four orientations. Interior conditions were intermittent wintertime construction heating; the insulation retrofit was completed gradually during monitoring.

Building America U.S. Department of Energy

There are many existing buildings with load-bearing mass masonry walls and whose energy performance could be improved with insulation retrofits. However, adding insulation to the interior side of walls of such masonry buildings in cold (and particularly cold and wet) climates may cause performance and durability problems. Some concerns, which include condensation within the insulation assembly and freeze-thaw issues, have known solutions. But wood members embedded in the masonry structure will be colder (and potentially wetter) after an interior insulation retrofit; the potential impact is not well understood.

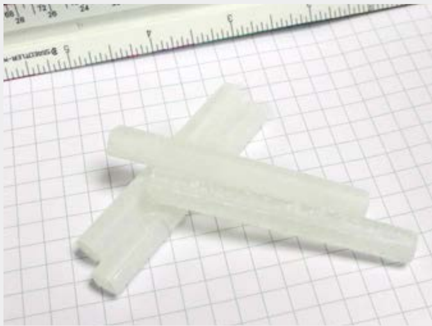
The U.S. Department of Energy's Building America research team Building Science Corporation has been studying the problem. The team has been monitoring a historic brick building in Lawrence, Massachusetts (zone 5A), which is being renovated into 10 condominium units (see sidebar). Results from the ongoing field monitoring of embedded wood joist ends indicate that many joist ends remain at high MCs. This is especially true at north- and east-facing orientations, which in some cases experience constant 100% RH conditions. These high moisture levels are not conducive to wood durability; typical guidance is that MC less than 20% is in the safe range, and that MC greater than 28% activates decay fungi.

However, this building was unheated for 2 years before monitoring; it is likely that measurements recorded wet "mothballed" conditions. More importantly, no damage was seen at the joist ends during instrumentation installation or removal of a high-MC joist "stub." This suggests that dense old-growth lumber might be able to survive these MC levels without damage. Wintertime heating dried the joist ends, which will provide lower MCs in service.

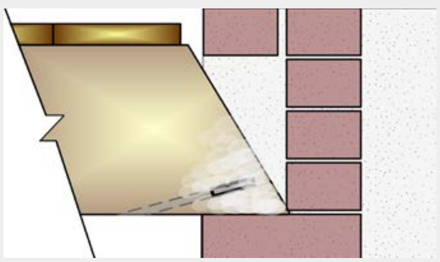
Given the uncertainty pointed out by research, definitive guidance on the vulnerability of embedded wood members (i.e., a go/no-go retrofit decision) is difficult to formulate. Surveys of joists in retrofitted buildings (in research literature) indicate that cracks in the brick façade could cause problems, but crack-free façades had acceptable performance. Proximity to grade (or worse, location below grade) increases the risks to embedded joist ends because of splashback and capillary water rise from the foundation. These conditions can be addressed with various protection methods. One option is to protect the joist ends with a solid preservative (see sidebar).

BORATE PRESERVATIVE

Joist ends can be protected from insect infestation and decay by using borate salts. They are commercially available as solid rods, which can be inserted into drilled holes in the embedded wood members.



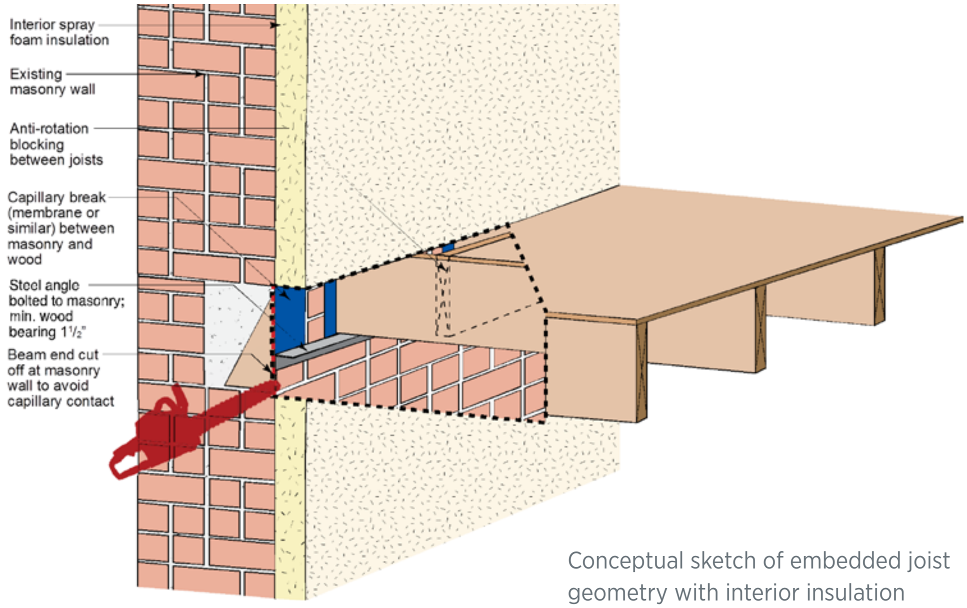
When the joist ends are wetted, the borates will migrate to the areas of the highest MC, thus providing protection. When the wood is dry, diffusion will stop, but protection will remain in place. When MC rises again, the rods will resume diffusion.



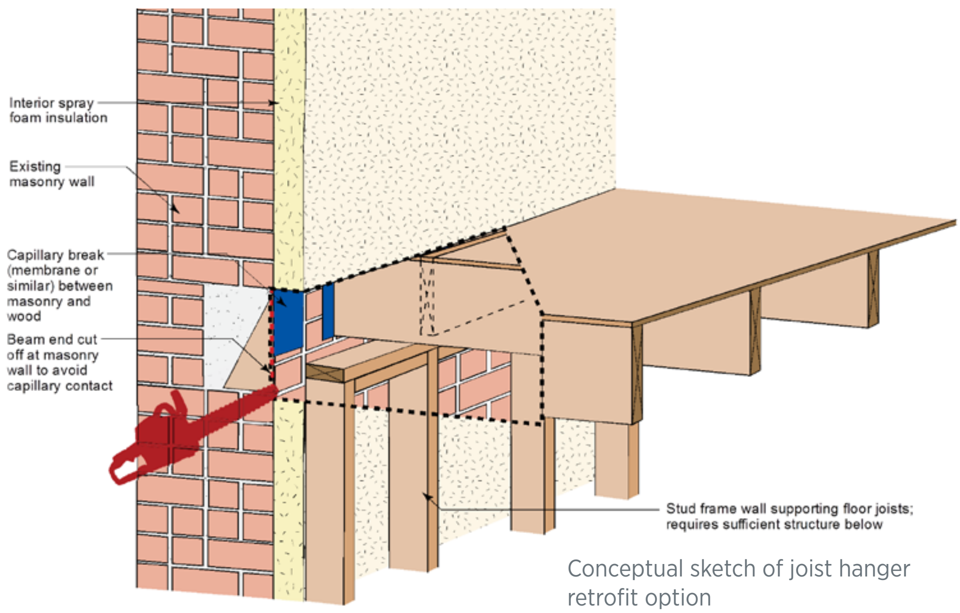
If the joist end is extensively wetted (e.g., bulk rain leakage), the borate will be consumed over time. It is possible to replace the borate rods during the service life of the building, but this seems unlikely to occur in practice due to the intrusiveness of this retrofit in service.

For more information see the *Analysis of Joist Masonry Moisture Content Monitoring* at *buildingamerica.gov*.

Image credit: All images were created by the BSC team.



Conceptual sketch of embedded joist geometry with interior insulation



Conceptual sketch of joist hanger retrofit option

Retrofit Options

In high-risk situations, which include cases with significant water damage or decay to the beam ends or when a very conservative approach is warranted, the embedded wood member condition can be eliminated entirely. The most conservative approach is to cut off the embedded "tail" of the joist (eliminating capillary wicking) after safely supporting the floor structure from another point. Support options include joist hangers attached to the masonry (top figure), a continuous angle iron attached to the masonry, and a bearing wall below the joists (bottom figure). Building codes require that joist ends have a minimum of 1-½ in.-bearing on wood or metal supports. In addition, if joist hangers are not used, lateral restraint (full-depth solid anti-rotation blocking) is required.

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