Re-Assessment of Insulated Solid Masonry Residential Buildings

INTRODUCTION

Older, solid masonry (brick or stone) buildings, particularly former commercial and industrial buildings located in urban cores, can represent attractive redevelopment opportunities as residential buildings. However, masonry buildings were typically built with little or no insulation, and this is disadvantageous from the perspective of thermal comfort and energy efficiency. While insulating the interior of solid masonry walls can address these problems while preserving heritage character, there have been concerns that this can put them at greater risk of damage from moisture and freeze-thaw cycles. As a result, insulation upgrades to older masonry buildings being converted to residential purposes may be avoided or kept to a minimum, with consequences on comfort conditions and energy efficiency.

While designers and developers have been understandably cautious about the addition of insulation to the interior of the exterior walls of solid masonry buildings, there are examples where this has been done that offer a learning opportunity. Better yet, some solid masonry buildings that have interior insulation have been previously inspected and assessed, and this represents an opportunity to revisit them to determine whether or not they are continuing to perform.

PROJECT OVERVIEW

In this project, Canada Mortgage and Housing Corporation commissioned a review of the in-service performance of solid masonry buildings retrofitted with interior insulation. The assessments were based on interviews with the owners/managers, interior reviews of the exterior walls and visual inspections of the facades from the outside. Two sets of buildings were part of this study; both sets were built between 1861 and 1946 and retrofitted prior to (or during) 2003. The first set of buildings was assessed twice, first in 2003[1] and then in 2015. The two assessments were compared to analyze the impact of added insulation on the masonry wall conditions over time. The second set was assessed only once in 2015, although some observations from before the 2000s were documented.

KEY FINDINGS

The case studies included a variety of masonry buildings made with solid red clay brick, limestone, and structural wood and steel elements. The exterior walls were insulated from inside with polyurethane foam and, in one case, with batt insulation. The interior assessment, where done, indicated that the walls were generally in good condition, with, in certain cases, some deficiencies around windows and in staircases. The results of the exterior assessment varied from overall very good to acceptable facade conditions, with one exception where the facade condition was poor.

In the cases with overall very good facade conditions, some degradation was still observed, such as the presence of efflorescence, cracks in mortar joints, and cracked stones. These deficiencies could be attributed to the design decisions made during the retrofit, for example, placement of downspouts and exhaust ducts, deficiencies in the waterproofing membrane, and size of mortar joints.

The cases of overall good facade conditions had similar deficiencies as well as open joints and spalled stone and brick. Most of these signs of deterioration could be related to age and lack of maintenance.

The cases of overall acceptable conditions had all of the above-mentioned signs of deterioration, in addition to vertical and diagonal cracks, mould, unsupported masonry, cracked and broken window sills, and corrosion of the structural steel components. Some of the signs of deterioration were observed before the retrofit; however, in some cases, degradation had increased in size and frequency since the previous assessment.

The case study that showed poor performance could be the result of an uncontrolled interior environment (for example, humidity), poor quality brick or deficient water management by the exterior wall components and would thus require further investigation to determine the causes of deterioration.

[1] Except in one case, where the observations were documented in 1998.

Fast Facts

Mortar and masonry are resilient to temperatures below freezing; however, vapour diffusion and moisture condensation and accumulation within the pores of the masonry and mortar joints as a result of freeze-thaw cycles could undermine the durability of the masonry walls.

Other risk factors are water absorptivity of the bricks, structure and size of the pores, water management capabilities of the facades, magnitude and direction of the differential air pressure regimes of the building, and indoor conditions of the building.

The risks related to increasing moisture accumulation within the wall when adding insulation can be minimized by:

- limiting water intrusion into the wall assembly;
- maintaining low indoor relative humidity;
- minimizing penetration of indoor humidity into the wall assembly;
- having a continuous air barrier system throughout the building envelope; and
- maintaining a relatively neutral air pressure across the building envelope.

The results of the reassessments of the buildings suggested that:

- interior insulation retrofits do not appear to have accelerated the deterioration or compromised the durability of the masonry buildings;
- given regular monitoring and appropriate maintenance and repair, insulated masonry buildings can continue performing reasonably well in the years ahead; and
- the performance of the exterior masonry walls insulated from inside depends on the quality of the retrofit process rather than the type of insulation; however, sprayed foam insulation is often chosen, which could be associated with its ability to fill the voids between the insulation and the masonry wall.

IMPLICATIONS FOR THE HOUSING INDUSTRY

The results of this study tend to suggest that the addition of interior insulation to solid masonry walls will not necessarily result in moisture accumulation within wall assemblies and consequent deterioration caused by damage from moisture and freeze-thaw cycles. They help build the case that older solid masonry buildings can be converted to residential buildings that offer comfortable indoor environments and affordable energy costs while preserving the heritage character of the buildings. However, the observations also indicate the importance of proper detailing, control of indoor and outdoor moisture sources, and ongoing maintenance. So while the results help allay one of the challenges associated with the conversion of older buildings to residential use, rigorous design, regular monitoring and assessment, and appropriate maintenance and repair are imperative for the longer-term performance of the retrofitted masonry buildings.

FURTHER READING

Full report – *Reassessment of the Exterior Facades of Interior Insulated Solid Masonry Residential Buildings* (https://eppdscrmssa01.blob.core.windows.net/cmhcprodcontainer/sf/project/archive/research_3/retrofitting_solid_masonry.pdf)

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