Evaluation of Residential Masonry Buildings

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ABSTRACT
This presentation examines some of the issues of water intrusion in masonry residential buildings. Included are single and double wythe walls with brick, split block and stone veneers as well as wooden frame buildings with masonry veneers. The presentation will cover a variety of problems that are occurring in the Chicago area with new construction as well as the association problems of mold and wood rot to structural members.

INTRODUCTION
Recently, in the Chicagoland area, there have been an increasing number of home and condominium owner complaints about water intrusion in masonry buildings. These problems are seen in new construction and in older buildings. Home inspectors are, more and more, expanding their services to homeowners to diagnose and provide solutions to water intrusion problems. Thermal imaging is a very helpful tool in this work, providing an easily understandable media to the homeowner and contractors.

INSPECTION TOOLS AND METHODS
Our company utilizes a FLIR SD thermal camera in all our inspections. Additional equipment includes a deep probing and pin type moisture meter, MAT tubes, a small propane torch and a boroscope. All signs of increased moisture are verified with the moisture meter. MAT (Masonry Absorption Test) tubes are utilized to provide a quantitative measure of the masonry and mortar. When allowed, a boroscope can be used to see inside the inter-wall space of double wythe and masonry veneer walls.

CONTRIBUTING FACTORS AND SPECIAL CONDITIONS
It should be noted that the last two winters (2006-2007 and 2007-2008) were relatively warm and wet, by usual Chicago area standard. Normally, Chicagoland winters (between Dec 1st and Feb 28th) average 26 F with very low relative humidity; these two winters averaged 34 F with relative humidity averaging 53. There were also many days of rain. Masonry buildings do most of their drying during the winter, when heat loss craws moisture outward and the dry air aids evaporation. Because of these two warm, wet winters, masonry buildings did not have the proper drying period. This can best be seen by the great increase of efflorescence seen after this last winter (Picture 1). Buildings constructed more recently display more pronounced efflorescence, and the pattern of the efflorescence is more distinctive (Picture 2).

Picture 1. Five year old building, Chicago

Picture 2. Two year old building, western suburbs

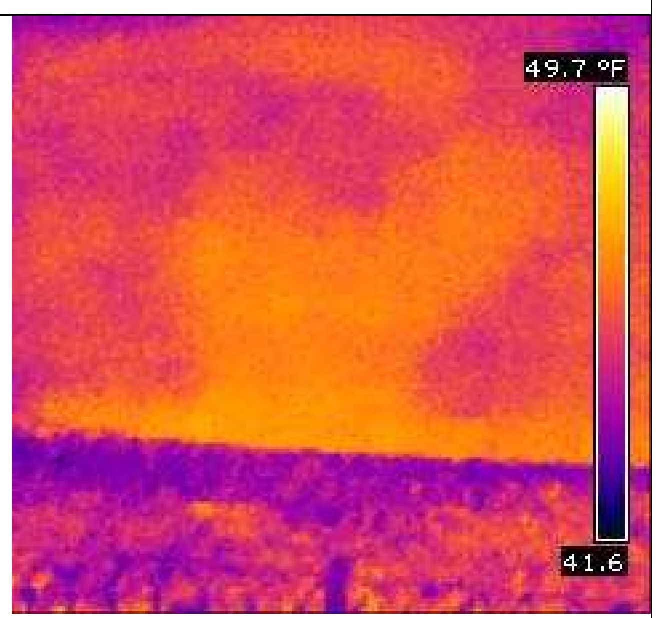
MOISTURE MOVEMENT IN MASONRY

Water in masonry can move in any direction. It can flow downward, drawn by gravity. It can flow upwards, by capillary action wicking. It can move laterally because of different moisture gradients (from wetter to dryer). It also moves according to heat gradients, from cooler to warmer. This can be easily seen, using thermal imaging, in most masonry buildings, if proper imaging rules are followed. We can see water in a brick wall draining downwards from damaged coping tiles and radiating outwards as it descends (Picture 3, 4). Also note the efflorescence patterns, which commonly indicate the front edge of the intrusion, even as the moisture dries. Likewise, water can wick up a masonry wall (Picture 5, 6). Again, please note how the efflorescence pattern correlates with the areas of increased moisture and the evident surface damage. It is always necessary to verify moisture content with deep probing moisture meter and / or MATS testing.

Picture 3. Older brick building, digital

Picture 4. Older brick building, thermal

Picture 5. Wicking water efflorescence

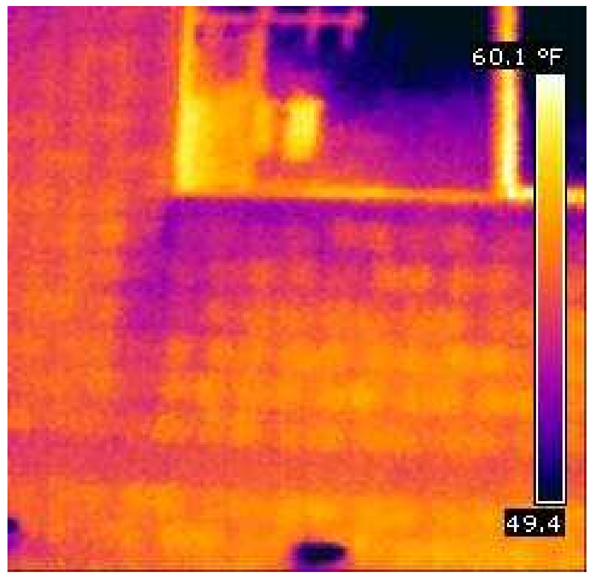


Picture 6. Wicking water, thermal

SINGLE WYTHE MASONRY WALLS

Single wythe masonry walls are not a good construction choice for the Chicago area. Because of the area's unique micro-climate, with hot, humid summers, mild and humid spring and fall and, usually, cold and dry winters, the usual standard construction details for moisture management do not apply. With a single wythe wall masonry wall, the usual 8" CMU blocks will quickly wick moisture into the building, even with sealing of the exterior. This can best be seen in the recent building boom in our area, where new builders want to speed-up the construction time at the same time as reducing material costs. The use of standard CMU and split faced block has lead to a flood of buildings reporting significant moisture intrusion. The flashing detail of single wythe walls is also not properly done. Parapet wall copings and stone window sills are readily penetrated with moisture entering the wall from above (Pictures 7, 8).

Picture 7. One year old SFH, single wythe CMU



Picture 8. Water intrusion through stone sill

DOUBLE WYTHE MASONRY WALLS

Double, and even triple wythe masonry walls are the traditional method of construction in our area. The intra-wall air spaces prevent water from completely penetrating the walls and allow the exterior wythe to serves as a barrier against driving rain. Absorbed moisture will condense in the air gap space and move downwards to be drained through weep holes, or, in newer buildings, through weep wicks. Older masonry construction also used clay coping tiles on the parapet walls, with vent spaces at their edges, which allowed intra-wall moisture to evaporate while the newer method of stone coping does not. Many times, there is no flashing under these stone copings, which allows rain water to percolate, directly, into the wall spaces. The increase of foreign masons, who are not familiar with the local climate conditions, has also contributed to the problem. These masons were not taught to scrape off mortar that extrudes into the intra-wall space (Picture 9). The resulting mortar accumulation in the air gap space provides a perfect bridge that allows moisture to enter the inner wythe. Repair or modification of older, "Chicago Common Brick" walls also causes problems. Newer bricks are much more absorptive and using them, in conjunction with the older common brick (Picture 10), provides an easy entry for moisture. Different types of mortar can also causes problems. Older, softer, common brick was used with lime putty mortars, which have a greater ability to "self heal" cracks and is less water absorbent. The currently used Type N mortar, commonly used for veneer and parapet wall work, uses Portland cement as the binding agent, but is more absorbent. Using N type mortar to repair or modify older brick creates a mismatch of materials and often leads to water infiltration through the mortar joints.

Picture 9. Mortar bridging the intra-wall gap

Picture 10. Window and door opening size changes

BRICK VENEER WALLS

Wooden framed brick veneer walls also suffer from masonry construction problems. The usual problem is improper flashing. The building should have properly installed house wrap, properly taped, flashed or detailed around window (Picture 11, 12) and door openings. In addition to the house wrap, there should be additional flashing membrane above all windows and doors. This flashing should be installed over the lintels and be equipped with end dams. Lack of care during construction often leaves these flashings damaged (Picture 13). All too often, the masonry / lintel space, even when equipped with weep wicks, is grouted or caulked. Sealing of this masonry / lintel space does not allow for proper drainage of flashing moisture. Even if the required end dams are installed, if the lintel spaces are sealed, water will over run them and cause increased moisture to enter around window and door frames (Picture 14).

Picture 11. Improper flashing above window

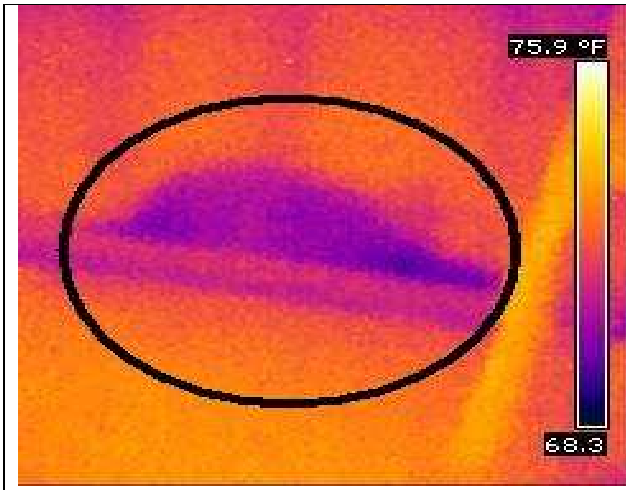
Picture 12. Proper window taping detail

	
Picture 13. Deterioration of flashing	Picture 14. Water draining over end dams

VAPOR AND MOISTURE BARRIERS

Current construction details for masonry structure buildings in the Chicago area calls for 2" furring strips, foil backed insulation and a plastic vapor barrier before the drywall is installed. To cut costs, some Architects (and almost all builders, changing the plans) use split 2 x 4 instead of actual 2 x 2 furring strips. They insulate with un-faced fiberglass and still install the plastic behind the drywall. This leads to excessive moisture, which wicks through the masonry (Picture 115), to accumulate in the fiberglass insulation (Picture 16, 17) and, eventually, leads to mold formation Picture 18).

	
Picture 15. Water intrusion through masonry	Picture 16. Exterior wall



Picture 17. Exterior wall

Picture 18. Moisture accumulation in wall

SUMMARY

Evaluation of residential masonry buildings requires a through knowledge of many different systems and disciplines. Thermal imaging can be an important tool in this evaluation, if properly used and done in conjunction with other tools and with a good understanding of all the details of the different construction methods and details, as well as with knowledge of thermodynamics, chemistry, hydrodynamics and building science.

REFERENCES

Technical Notes 8A Revised, “Standard Specifications for Portland Cement-Lime Mortar For Brick Masonry”, Brick Institute of America , Sept. 1988.

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American National Standards Institute, ASTM C 206 Standard Specification for Finishing Hydrated Lime

American National Standards Institute, ASTM C 1489 Standard Specification for Lime Putty for Structural Purposes

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ABOUT THE AUTHOR

William Decker is an Illinois Licensed Home Inspector, a Certified Master Inspector and is a former Licensed Medical Thermographer. He obtained a B.S. in Physics from DePaul University in 1976 and also has over 25 years of experience in construction, restoration and inspection of older Chicago area buildings.