Building Moisture – Causes and Cures

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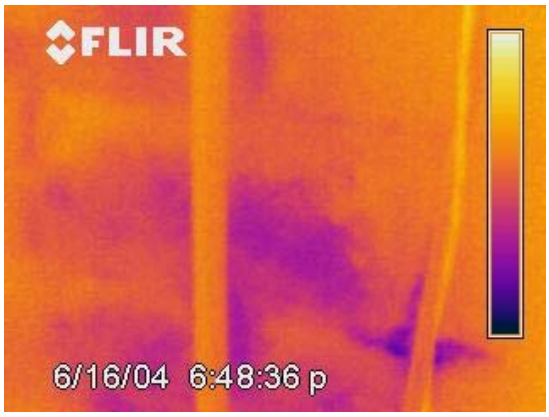
Consumers spend considerable amounts of money in search of dryer, more comfortable homes, and rightfully so. Building moisture ranks near the top of the list of most common problems discovered during inspections. Having personally inspected close to 5000 homes I can say without doubt that basement and crawlspace moisture are responsible for more real estate deals falling apart than any other defect in a building. I think it is safe to also say that building moisture, including basement and crawlspace moisture is often misdiagnosed. If your home has a suspected or obvious moisture problem the first item on your agenda should be having the home evaluated by a forensic building inspector. A forensic inspector will have the knowledge and equipment to properly diagnose your problems and create cost effective repair strategies.

It should be understood that each and every building is different when it comes to what causes moisture problems and how to control those problems. An improper diagnosis of a moisture problem could cost thousands of dollars in repair costs without properly addressing the cause. In many cases, the moisture continues to damage the home or building by concealing the symptoms of the problem without correcting the problem. It is important to understand before we continue, that the most expensive solution does not always mean the best solution. The same is true of the least expensive solution. What is the best solution? The right solution! In determining the right solution the professional that is diagnosing the problem should be equipped to properly diagnose the causes of the problem. Let's look at some of the conditions which are misunderstood by many home inspectors, government building inspectors, remedial contractors and others involved in diagnosing and repairing moisture problems.



The image on the left was taken using infrared thermography during a recent assessment of a basement water problem. The home had already been inspected by a private company that diagnosed extensive basement moisture and recommended excavation, waterproofing and new drain tiles at a cost of approximately $14,000. Needless to say, this frightened home buyer walked away from the deal. The homeowner contacted Closer Look Inspections to re-evaluate the problem and make repair recommendations.

The home was visually evaluated and we found that the home was well maintained including having clean and operational gutters and downspouts and a properly sloped grade directing water away from the building. During subsequent investigation we determined that soils in the area consist of well drained 2000 IRC Class I type soils which are considered to have good drainage characteristics[1]. (See table R405.1 below)

Investigation and infrared thermography pinpointed the problem to the sump pump discharge line. The line was broken below grade and was pumping water onto the foundation wall (the line is indicated by lighter color in image, the darker color indicates colder temperatures/moisture).

[1] **2000 International Residential Code**, table R 405.1, International Code Council (ICC)

TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS[a]	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION[b]
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines.	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines.	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines.	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines.	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures.	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures.	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures.	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture.	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays.	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity.	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils.	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.

b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

The cost of repairing the broken discharge line from the sump pump was of course much less than excavating the entire foundation. This shows just one instance of misdiagnosis of a construction problem and the potential cost of such a diagnosis.

Moisture is buildings is a complicated issue and to properly diagnose and correct building moisture problems the person assessing them should have a thorough knowledge of how and why moisture problems occur in buildings and how different buildings may be affected differently. Take two similarly constructed building in same area, one constructed using steel frame and gypsum sheathing and the other with masonry. The inspector that assesses moisture in these two buildings should understand that moisture problems may be more visually noticeable in the steel frame home, although the real moisture leakage problem is in the masonry home. Why? The "hygric buffer" capacity or ability of the material to store water may be up to 100 times greater in the masonry home[2]. Studies have shown that for an average 2000 ft^2 the hygric buffer capacity for a steel frame home with gypsum sheathing is approximately 5 gallons. On the other hand, for a solid masonry wall, the hygric buffer capacity is 500 gallons. A 100x increase! Therefore, the inspector should have some understanding of hygric buffer capacities and the materials used to construct the building under evaluation.

What this means to the inspector is that if the exterior walls are constructed of steel with gypsum sheathing a small leak could be a significant problem, while a similar leak in a wood frame or masonry wall may not be a problem at all. Consider that gypsum can store approximately 1% moisture by weight before fungal amplification begins, while wood framing can be as high as 16%. This means that a small leak could be a big problem in the steel framed home and go unnoticed in the wood frame home.

[2] **Moisture Control For Buildings**, *Joseph Lstiburek, Ph.D., ASHRAE 2002, February 2002 ASHRAE Journal*

The ability of wood and masonry to hold more moisture before fungal amplification begins also means that there is a longer drying (dwell) time available to walls constructed of these materials.

Another important consideration is the construction methods and materials used to construct the building. Remember, homes today are constructed much differently than in the past. Today, higher levels on thermal insulation, solid sheathing as opposed to spaced sheathing boards, building wrap, siding, vinyl wallpapers, etc. have all made homes more energy efficient and beautiful, but have also slowed the drying (dwell) times for these buildings. This makes it much easier for trapped water and small leaks to accumulate and turn into big problems.

The photo on the left shows an extreme case of moisture buildup due to poor construction methods. The photo was taken in a small crawlspace under an addition on a home. The builder installed no vapor barrier on the soil and installed the vapor barrier improperly exposing the floor framing to extensive moisture. The conditions present on this particular project also led to extensive fungal contamination and rotting of wood framing members.

The thing that must be understood by companies that inspect buildings for a living is that there is not a canned definition for moisture in a building. The building as a whole must be diagnosed including building pressures, building materials and methods, soils in the area, HVAC components, lot drainage, etc. before an accurate diagnosis can be made. In some cases, this can be accomplished using non-destructive methods, in other cases it can not.

In new construction, many homes start out with problems due to oversights during the construction phase. Materials are often stored unprotected outdoors, exposed to the elements. This is also true of the partially completed building. Building materials previously installed and those stored on-site are left exposed to the elements. The building is then completed, walls enclosed, etc. before allowing for proper drying of saturated building materials. The result is new homes with musty odors, mold, etc. Builders could take precautions to keep materials dry for a few extra dollars, but until they are asked to do so, they probably will not. It is our opinion that moisture detection equipment should be used to assure proper moisture content of wall framing materials before enclosing wall with gypsum. This method should be used to assure that excessively wet materials are not being installed during the construction phase. This is one area where Closer Look Inspections has put infrared thermography to work. The thermal anomalies created by temperature differentials can help in identifying potential trouble spots before walls are enclosed, etc. We have used thermography successfully to verify the successfulness of drying procedures after flooding, to spot hidden leaks and to track existing, hard to pinpoint leaks. The money saved by using state of art equipment and understanding the problems involved saves thousands of dollars in damage, insurance claims and litigation costs.

In understanding moisture in buildings, it is also important to understand some of the not so obvious factors involved with moisture. Vapor pressures, the need for and function of vapor barriers, ventilation, condensation, humidification, infiltration/exfiltration, hygric buffer capacity. By understanding how moisture moves in and through buildings we can better control moisture and properly direct it as needed. Home and building owner insurance claims and litigation involving moisture, mold and material damage could be greatly reduced if those involved in constructing, inspecting and maintaining buildings better understood the factors involved in moisture movement in and through building envelopes. Many of the problems could be avoided by altering the ways in which we build and maintain our buildings.

About the Author: *Alfred L. Tibbs Jr., CIAQT, CIAQM is the president of Closer Look Inspections in Cleveland, OH. C.L.I. is a forensic building inspection firm that specializes in building moisture problems, indoor air quality, asbestos evaluation and infrared thermography in building assessment. C.L.I. has performed close to 5000 building and environmental assessments.*