

Solar Driven Moisture in Brick Veneer

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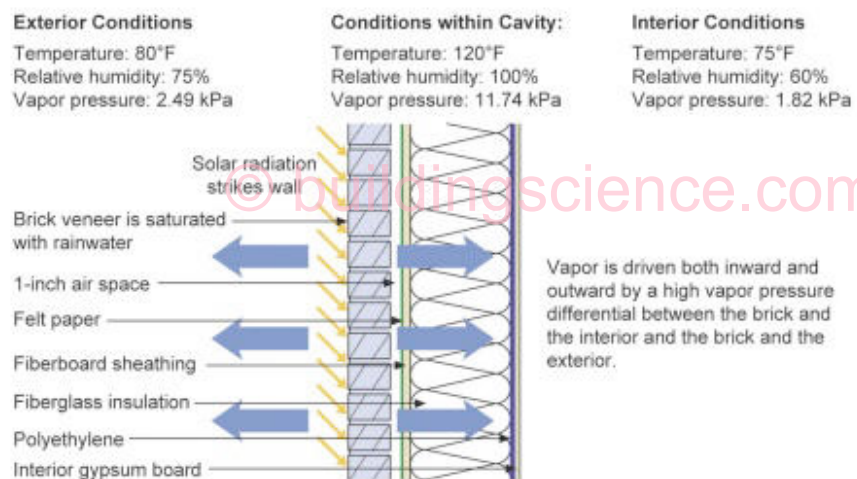
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Abstract:

Brick is a reservoir cladding, meaning that it absorbs and stores water (rain) when it becomes wet. In some homes, with brick veneer cladding systems, mold contamination has occurred within exterior wall cavities. In some homes, wood decay at bottom plates has also occurred.

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- Do not install a vapor barrier on the inside of an air conditioned assembly. Vinyl wall coverings, foil-backed batt cavity insulation and polyethylene vapor barriers should be avoided.
- Vapor permeable exterior sheathings, housewraps or building papers should not be used with absorptive claddings such as brick veneers unless a ventilated cavity is provided in conjunction with high inward drying potentials (i.e. no polyethylene vapor barriers).
- Failure will occur when brick is installed over a frame wall constructed with felt paper, fiberboard sheathing and a polyethylene vapor barrier. Kraft-faced fiberglass batts should be used in place of unfaced batts and a polyethylene vapor barrier. OSB, plywood or foam sheathing should be used in place of the fiberboard sheathing.
- Similar problems occur with stucco.

What is the nature of the problem?

In some homes located in cold and mixed climates, with brick veneer cladding systems, mold contamination has occurred within exterior wall cavities. In some homes, decay at bottom plates has also occurred.

Why has this problem occurred?

Mold and wood decay require moisture. So in the simplest sense this is a moisture problem. Sufficient moisture has accumulated within the exterior wall cavities of some homes to lead to mold growth and wood decay. The source for the moisture is rain.

Rainwater is absorbed into the brick veneer after a rainstorm. Water vapor is then transported from the rain-wetted brick veneer through the exterior

sheathing into the exterior wall cavities by a process called vapor diffusion. This water vapor condenses on the cavity side of the interior polyethylene vapor barrier. When sufficient moisture condenses on the surface of the polyethylene vapor barrier, it runs down the surface of the polyethylene under the action of gravity where it accumulates on the bottom plate of the wall. If sufficient water accumulates at the bottom plate, mold growth will occur ultimately followed by wood decay.

Why does this problem occur with brick and not with vinyl siding?

The key difference between brick and vinyl is that brick is a moisture reservoir and vinyl is not. Brick absorbs rainwater and holds it within its internal pore structure. Vinyl siding is not porous and does not absorb rainwater. When a moisture reservoir is located on the exterior of a wall assembly it can act as a source of water that can migrate by a process called vapor diffusion. Water vapor will move by vapor diffusion from a high concentration of water vapor to a lower concentration of water vapor. It will also move from a warm surface to a cold surface.

When brick gets wet after a rainstorm and then is warmed by the sun, the water vapor within the brick is at a higher concentration than its surroundings. The water vapor within the brick is also at a warmer temperature than its surroundings. Some of the moisture will move out of the brick into the outside air because the outside air is colder than the brick and because the outside moisture concentration (absolute humidity) is lower than the moisture concentration in the brick. Unfortunately, some of the moisture in the brick will move out of the backside of the brick into the exterior wall cavity through the exterior sheathing. This happens because the brick is also warmer than the wall cavity and because the moisture concentration in the brick is higher than the moisture concentration within the wall cavity.

Think of a brick veneer wall as moisture "capacitor" that is "charged" with moisture during a rainstorm that subsequently "discharges" in the direction of a temperature gradient and concentration gradient. Moisture flow by vapor diffusion occurs from warm to cold and from more to less. When the wall cavity is colder than the brick, and drier than the brick, water vapor will migrate into the cavity by the process of vapor diffusion. This condition only happens during the summer after a rainstorm.

If a reservoir is not present, this mechanism does not occur. Vinyl is not a moisture reservoir; therefore this moisture transport mechanism cannot occur with vinyl siding. If the brick wall never gets wet, this mechanism cannot occur. If the interior wall is never colder than the brick, this mechanism cannot occur. Of course, brick walls will get wet and during the summer, when the interior is air conditioned, the interior wall will be colder than the brick.

So air conditioning makes the problem worse?

Yes. The colder the interior of the house in the summertime, the more moisture is drawn inwards out of the brick veneer into the wall cavity. Recall that moisture flow by vapor diffusion is from warm to cold. Air conditioning cools the interior of the exterior walls relative to the exterior brick veneer. The lower the thermostat setting, the more moisture is drawing

inwards by vapor diffusion.

It is not practical to control this problem by eliminating air conditioning or by requiring thermostats to be set high. The comfort of occupants should not be compromised by this mold and decay problem. We point this out to explain why not all houses are affected in the same way. No two houses have the same interior-to-exterior temperature differences.

It is also interesting to note that the bottoms of walls are typically affected not the tops of walls. This is for several reasons, one of which is that walls are always colder at the bottom rather than the top. The other reasons are due to gravity. Condensed water runs downward under the action of gravity, so that the bottom of a wall will always be wetter than the top of a wall. And, the exterior brick walls are wetter at the bottom than the top since rainwater runs downward within the brick veneer due to gravity as well. Since the brick wall is wetter at the bottom than the top, the available water reservoir is greater at the bottom than the top. As a result the vapor diffusion gradient inward is greater at the bottom of the brick veneer wall than the top.

Brick walls are common, why has the problem occurred now?

Water vapor by the transport mechanism of vapor diffusion has always been driven out of a brick veneer under the action of the sun. However, in the past not much of this inward-driven moisture actually made it into the wall cavity and the moisture that did manage to get into the wall cavity also got out.

Two important changes recently occurred in typical construction practice without our understanding their significance. The first was the trend towards installing interior polyethylene sheet vapor barriers. The second was the trend towards more vapor permeable exterior sheathings and housewraps.

Interior polyethylene vapor barriers prevent wall assemblies from being able to dry towards the interior during the summer months. And the trend towards more vapor permeable sheathings makes it easier for water vapor to enter walls from the exterior.

These two changes began to occur during the 1990's. Prior to these two changes, when moisture was driven inwards out of a brick veneer into an exterior wall cavity, the moisture was not trapped within the cavity by an interior vapor barrier. The moisture that got into the wall cavity was able to also get out of the wall cavity through the interior surface finish. The kraft facing on fiberglass cavity insulation that was typical at the time was not a vapor barrier -- it was a vapor retarder -- so that the flow of water vapor was not stopped.

Polyethylene vapor barriers were introduced to reduce the wetting of exterior wall cavities from interior sources of moisture during the winter months. This they did extremely well and were embraced by building codes and builders almost everywhere. Unfortunately the reduction in drying to the interior caused by these vapor barriers has only recently begun to be understood.

The second change was also significant. Fiberboard sheathings, building

papers and housewraps were manufactured to be more vapor permeable. The reason for this change was to allow wall cavities to more easily dry towards the outside. Unfortunately, the same material properties that allow these materials and wall cavities to dry to the outside also make them prone to wetting from the outside.

It is significant to note that the mold and decay problems only occur where a permeable exterior sheathing called fiberboard has been installed. The problems do not occur where a foam sheathing, plywood or OSB has been installed. The reason for this is that the foam sheathing, plywood and OSB are less permeable than the fiberboard and therefore does not allow as much inward migration of water vapor diffusion from the brick veneer moisture reservoir.

Why are not all houses affected?

No two houses experience the same interior to exterior temperature differences; no two houses have the same rain exposure; no two houses have the same solar exposure; no two brick walls absorb rainwater the same way; and no two brick walls dry inwards or outwards the same way

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