XPERA GROUP

Understanding the Impact of Vapor Drive

Vapor driven condensation in the built environment can be catastrophic

By Thor Kamban Biberman

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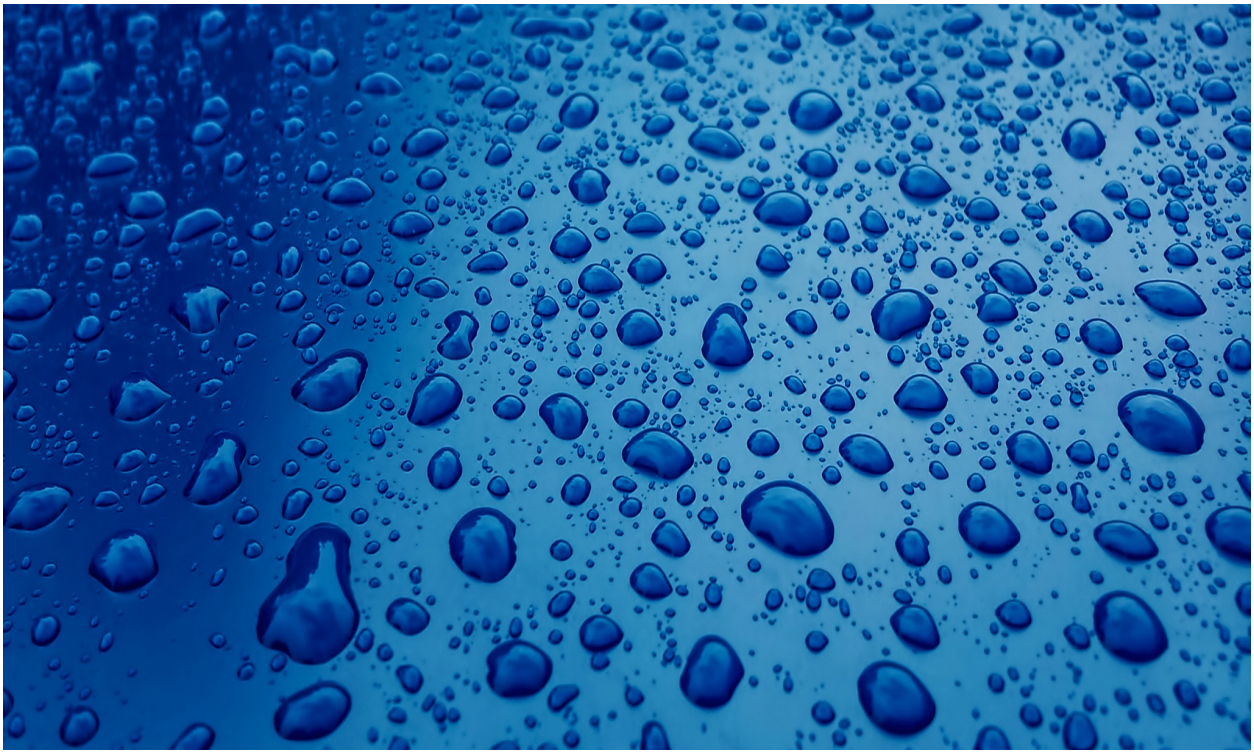
Vapor drive can be devastating, and its cause may not be readily apparent.

As explained by Michael Burgess, Xpera Group principal mechanical engineer, the very thing, such a sheet of plastic, or construction paper intended to guard against moisture, could be creating it instead.

Vapor drive has afflicted all types of properties from office buildings to residential structures.

"The problem you encounter is that people look at the physical side of this (ie. looking for external cracks) and not at the physics," Burgess said adding that air pressure and exterior and internal temperature make all the difference.



Condensation on a smooth surface, courtesy Brett Jordan

In hot and humid climates the vapor drive generally goes from the exterior to the interior. It generally travels from the interior to the exterior in colder climes. While the vapor drive tends to be more in balance in moderate climates such as in Southern California, problems can happen here as well.

"This can happen anywhere ... It can happen in a desert," Burgess said noting that condensation won't occur if the external and internal temperatures are the same.

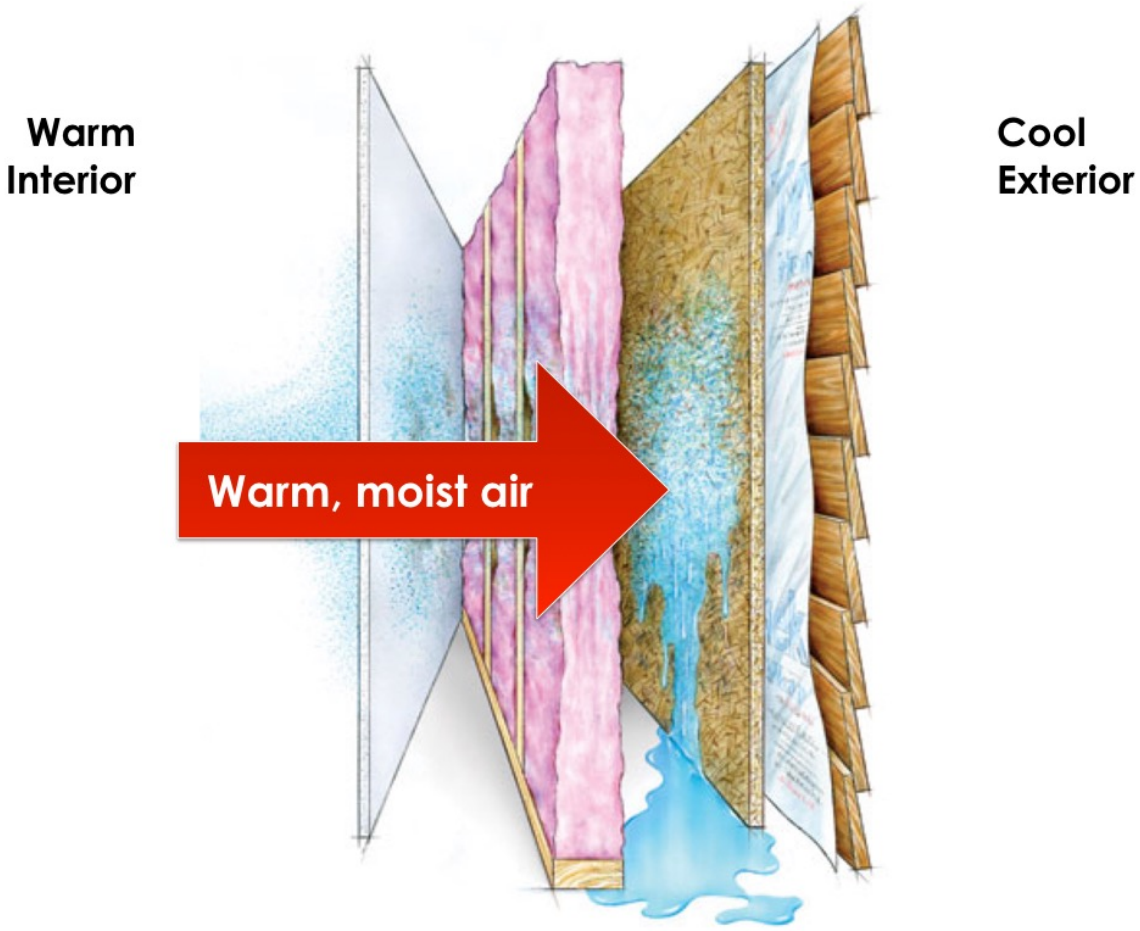


Illustration showing the flow of moist air from the warm interior towards the cool exterior, condensing on the surface of the vapor retarder, courtesy Fine Homebuilding Magazine

Not A New Problem

The problem is not new. In fact Burgess said cases have been documented at least since 1951. Burgess recalled dealing with the issue about a decade ago when a wood-framed roof supporting structure known as a subpurlin came crashing through the ceiling of a 70,000-square-foot building at the Allstate Insurance headquarters in Brea, narrowly missing an employee.

Upon the initial inspection, there was no evidence that water had come from the outside. Yet moisture had saturated a sufficiently large portion of the ceiling, the subpurlin could no longer be supported.

Damaged Caused by Moisture Entrapment, courtesy Infrogmation of New Orleans

The problem at the Allstate building resulted from the structures within the roof were heated by the sun by day, cooled by night, and barriers such as the Kraft (construction) paper and other insulation were permeable and had gaps. Once the dew point was reached, the air pressure and volume were such that the resulting moisture was forced between the roof and the ceiling surrounding the structures with water causing the failure.

"Condensation can be driven right through a building," Burgess said.

The Repair Process

"The repair was to take out the Kraft paper, dry everything up, and go in with fiberglass batt insulation," Burgess continued "You need to fill the entire cavity with insulation so there isn't any air. You need to have what's called a 'vapor retarder.'"

A vapor retarder can be made of a variety of materials such as pre-cut fiberglass, plastic or a foil sheet – anything to fill the gaps.

6 mil Polyethylene plastic sheet as vapor barrier, courtesy Wikimedia user P199

Fiberglass batt insulation, courtesy CSIRO

"Vapor drive will be stopped by an impermeable layer," Burgess said.

Burgess, who estimated that he has handled about six other such cases from Southern to Northern California since the Brea incident, has seen other cases where the Kraft paper simply didn't do the job for which it was intended.

In the case of a multifamily project in an inland portion of California northeast of San Francisco that is still being resolved, Burgess noted that 14 layers of Kraft paper weren't enough to keep the walls dry and the interior nails from rusting severely.

Burgess said he has also gone into numerous home improvement stores for example, looked up at the high ceilings and seen the tell-tale signs of where this same Kraft paper facilitated vapor drive in the buildings.

"You can see the signs of moisture," Burgess said.

A Ticking Timebomb?

"Millions of square feet of Kraft paper insulation are in danger of failure," Burgess continued adding that these types of insulation are like ticking time bombs.

Zaring Homes demolition process, courtesy Green Building Advisor

The issue isn't unique to California. As noted in a July 2010 article that appeared in Green Building Advisor, a new home development in Cincinnati had so many vapor drive problems that were not only devastating to the project, but were so pervasive, they helped push Zaring Homes into bankruptcy by the early 2000s.

In the Zaring case, the builders failed to consider the impact of heating and cooling, and the air space behind the brick veneer, resulting in extensive mold and rot.

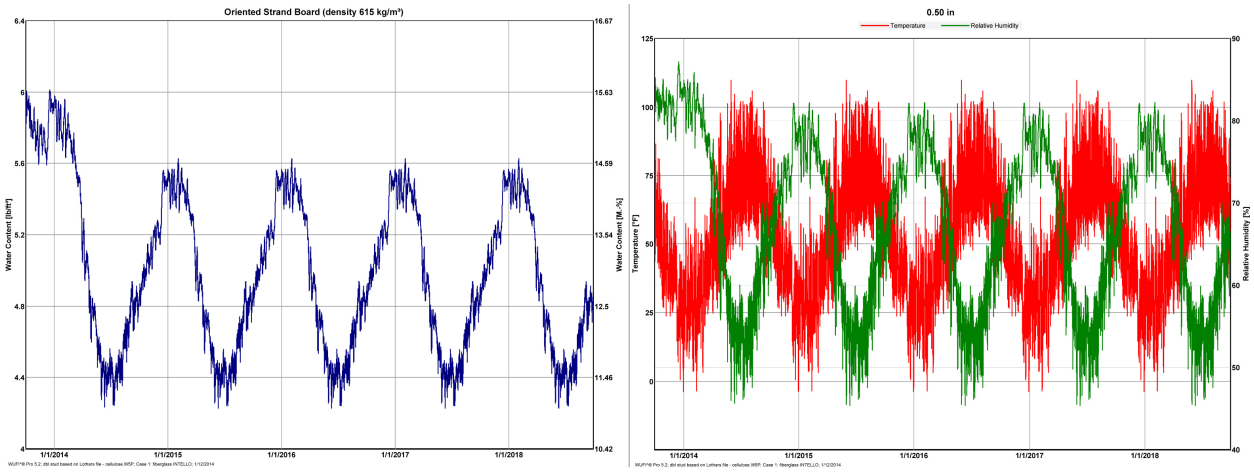
In the end, the veneer, sheathing, insulation and drywall had to be demolished and replaced. In this case, the Celotex fiberboard apparently acted as a perfect permeable membrane. The condensation occurred after the sun had shined on the brick veneer.

In addition, while interior polyethylene vapor barriers were conceived in the 1990s as the ultimate protection against moisture, some builders had failed to realize that these structures would be cooled by air conditioning. When combined with the sun's heat, it formed a perfect atmosphere for condensation that dripped down the walls.

The water doesn't only cause rust and weaken structures. The mold that results is often damaging to health and can render some buildings entirely uninhabitable, as heavy rains have done in other instances.

Through these and other experiences, Burgess has long been accustomed to making the calculations that not only help him arrive at a solution, but prevent the vapor drive problem from happening in the first place.

Along with calculating the physics problems the traditional way, a software program pioneered in large part by a joint venture of the Fraunhofer Institute for Building Physics and the Oak Ridge National Laboratory, has arrived at a 21st century solution.



Sample WUFI output, courtesy 475

The Wärme Und Feuchte Instationär (heat and moisture transiency) software known as WUFI has been designed to predict the vapor drive problem long before the first stick comes out of the ground. It has also proven to be a useful tool in coming up with vapor drive remedies in already constructed developments.

Although there is no single solution to the vapor drive problem, Burgess said there are ways to have workable insulation, air conditioning and all the comforts of home without creating the conditions for condensation that would ruin your day.

About Michael T. Burgess, P.E., CPMP, LEED-AP

Michael Burgess is a licensed professional mechanical engineer in five states and is experienced in construction management, building commissioning, forensic engineering, and design. This qualifies and enables him to view projects from both the construction industry's perspective, as well as the technical and theoretical positions. From Michael's unique vantage point as engineer and construction project management experience, he has taken special note over the last twenty-six years of how projects run into trouble; why complex projects tend to become difficult for everyone involved and how to solve the problems effectively.

About Xpera Group

Xpera Group is California's most comprehensive team of construction experts and real estate advisors. Founded in 2009 by president Ted Bumgardner, the firm has grown through a series of mergers and acquisitions and was recently named by Zweig Group as one of the top 100 fastest growing firms in the architecture, engineering and construction consulting industry. Together with affiliate company Xpera CM, Xpera Group's team of experts provide a diverse range of construction forensics, risk management, owner representation and development services. Visit **xperagroup.com** to learn more.