



Analyzing the Effects of Moisture on the Strength of Rigid Cover Boards

Understanding moisture intrusion for better roof assembly design

A high-performance rigid cover board that meets the industry's tough new Three-Part Specification for moisture performance is a key component of a proper roofing assembly.



DensDeck[®]
Prime Roof Board
with **EONIC**[™]
TECHNOLOGY



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Abstract

In a recent survey, roofing contractors ranked moisture second only to punctures in events that negatively impact the lifespan of a commercial roof. Roofing contractors also named moisture as a roof’s most frequent destructive event, estimating that nearly half of all assemblies sustain moisture-related damage within the first ten years.¹

The component that plays the most vital role in mitigating the risk of moisture damage in a commercial roofing assembly is the cover board. From forming a rigid substrate beneath the membrane to help it absorb impact from both natural and man-made forces, to protecting the layers of insulation and reducing the risk of damage from fire, industry professionals nationwide now consider a high-performance cover board an essential component of a properly designed roofing assembly. But if cover boards absorb moisture, their strength is often compromised, weakening their ability to protect the other assembly components and compromising the integrity of the entire assembly. Since the reality is that roofs get wet, it’s important to specify a rigid cover board that is designed to perform when moisture exposure occurs.

1. Research conducted by Ducker Worldwide, Troy, Michigan, Roofing Consultants’ Survey October 2016.

An Overview of Moisture Intrusion

Ensuring the life of a commercial roof begins with an effective strategy against moisture intrusion. When moisture accumulates, it can break down water-soluble adhesives, delaminate roofing materials and corrode metal components, collectively shortening the lifespan of the entire roofing assembly. In fact, according to Patrick Downey, FRCI, RRC, CCCA, President and CEO of Merik Building Construction Consultants Inc., “Moisture is one of the principle factors that causes a roof to reach the end of its service life and require either extensive repairs or replacement.”

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— Patrick Downey, Merik Building Construction Consultants, Inc.

When it comes to mitigating the risk of moisture damage, one roofing assembly component deserves particular attention – the cover board. Rigid cover boards form a solid substrate for the roofing membrane to help it absorb impact from forces such as hail, foot traffic and equipment movement, helping to make the membrane less susceptible to punctures. They also help roofing assemblies resist the forces of wind uplift, protect the layers of insulation beneath them, and mitigate the risk of damage from fire. For these reasons, industry professionals around the country now consider a high-performance cover board a mandatory element of a proper roofing assembly. Unfortunately, cover boards are often omitted as a cost-saving measure during design and

construction – a move that building owners tend to regret later when the roof lacks durability and ends up requiring expensive repairs as it ages.

“We see cover boards as a significant way of increasing the overall quality of a roof assembly and helping to prolong its service life,” Downey explains. “Cover boards provide more resistance to damage from weather-related issues such as hail storms, as well as foot traffic and the installation and maintenance of equipment such as HVAC systems.”

However, if moisture makes its way beneath the roofing membrane and into the cover board, it can have a negative effect on the entire roofing assembly. When a cover board gets wet, either as a result of leaks caused by punctures or vapor drive, it loses both compressive and flexural strength, weakening its ability to protect the membrane from punctures and resist the forces of wind uplift. It also increases the potential for mold and mildew growth, which can have a negative impact on the health of the building and its occupants. And if the building is in a climate that experiences freezing temperatures, freeze/thaw cycles can occur that can cause roofing materials to break down. If the moisture makes its way into the layers of insulation beneath the cover board, its R-value can become compromised, leading to a loss of thermal resistance.



Unfortunately, the reality is that many roofs get wet. And, when exposed to water, cover boards may absorb moisture, resulting in a loss of strength to varying degrees. Consequently, when specifying a cover board, it's important to choose one that offers an enhanced level of performance. According to Downey, this is especially important for owners who are interested in preserving the longevity of their building.



"I think the two keys for an owner that would make a cover board attractive as a component of the roof assembly is to have a condition inside the building where you have low tolerance to leakage," he explains. "So, in other words, equipment, materials, function – something inside the building that requires

or benefits from a higher quality roof assembly because they just can't tolerate roof leaks." Buildings that house a data center, a retail store or a hotel can have their business severely compromised by moisture damage, not only during an event but lingering long after as well, Downey added, "The other situation is one in which the owner is planning to occupy the building for a long period of time and wants to minimize long-term costs. That type of owner, I think, is very receptive to the higher install costs because they get more benefit from the operating cost."

Vapor Drive Can Cause Serious Moisture-Related Damage

"Compared to roof leaks, which are more obvious and identifiable, vapor drive is a silent killer in the roof assembly," says Mikael Kuronen, Georgia-Pacific Gypsum's Director of Product Management, DensDeck®.

Vapor drive occurs when there is a significant temperature discrepancy between the inside and outside of a building. The laws of physics dictate that moisture flows in specific ways

to find equilibrium. It migrates from warm areas to cooler ones, from areas of high density to areas of low density, and from areas of high pressure to low pressure. As a result, frigid temperatures outside buildings located in cold-weather regions create vapor drives that can cause accumulated warmth and humidity from inside to move up into the roofing assembly. Once there – depending on whether or not there is a vapor retarder and the correct R-value and number of layers of insulation are included in the assembly – it can condense into liquid water and cause damage. Conversely, if the building is located in a hot, humid climate, the moisture outside the building will attempt to make its way inside, where it can condense on cold surfaces inside the building.

Jim Carlson, Technical Director and Principal Consultant at Building Envelope Technology & Research, is definite about the concern for mitigating the risk of vapor drive-caused condensation and resultant moisture damage when designing and constructing all roofing assemblies.

"We want to think about vapor drive and make sure we design the roof in a way that makes guarding and protecting the system from long-term moisture accumulation a top priority," Carlson emphasizes. "That means taking serious consideration of the climate where the building is located. In many cases, we believe it's necessary to include a robust membrane vapor retarder as part of the roof assembly. If it's in a climate where we don't see a need for a vapor retarder, then it's even more important that the cover board be durable and resistant to moisture."

While a cover board can't manage vapor drive, it's important to choose one that is resistant to surface water on both sides so it can protect itself from the effects of moisture once it condenses into liquid water.

"If the cover board isn't resistant to surface moisture, and you have a roof membrane

that's supposed to be fully adhered to the board, many times the thorough adhesion we strive for won't happen," Carlson explains. "Instead, you can have little voids where the cover board may begin to break down. If the cover board doesn't maintain its integrity, then it can't be a good substrate to hold the roof on the building during high-wind events."

"Cool Roofs" and Tightly Sealed Envelopes Can Create Moisture-Management Challenges

The advent of "cool roofs" designed to help cut down on energy costs have made the value of high-performance cover boards with industry-leading moisture resistance greater than ever before – especially in northern climates where they can contribute to vapor drive. In these cases, cover boards with enhanced moisture resistance can add a considerable amount of value to the roofing assembly.

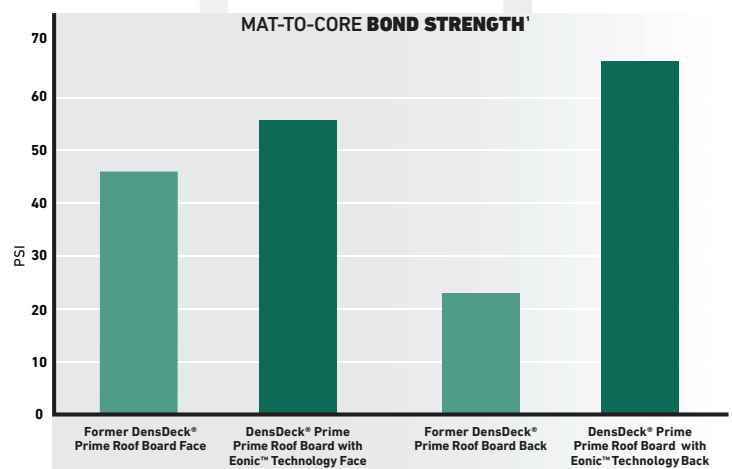
"It's the idea that over the course of summer to winter, there's some moisture that gets built up in the roof assembly," Downey says. "If it gets on the underside of a cool roof, you'll have a higher level of condensation than you would on the underside of a black roof. The ability of a cover board to be more moisture resistant under a cool roof in a northern climate might be a really big issue."

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In northern climates, temperatures outside a building are much colder and dryer than inside the building where the air is warmer and carries more moisture. As this warm, moist air rises, it converts to vapor and can

enter the roof assembly as it seeks to reach the cold dryness of the outside. When that vapor reaches the roof membrane, if the membrane is cooler than the warm, moist air, condensation will occur. As the roof warms in the daylight hours, that condensation vaporizes again and is drawn back into the building. As this happens over the months, reversing in the warmer months of the year, vapor to condensation to vapor repeatedly, the moisture resistance of the cover board is critical.



1. Comparison based on independent testing conducted by PRI Construction Materials Technologies in October 2017. 1/2" boards tested in accordance to ASTM C209.

Vapor drive through building walls is another important consideration when designing a roofing assembly built to last. This is particularly important in light of the move toward tighter building envelopes with restricted airflow designed to improve energy efficiency. In theory, the tighter the building envelope, the less impact vapor drive should have. But without proper airflow control through the walls and into the roofing assembly, warmer air can easily move inside and outside, carrying moisture with it. That air movement through the walls, which occurs when they lack an effective air barrier, can move more moisture into the roofing assembly. This can lead to the creation of vapor drive through temperature change, which can result in more thorough diffusion than bulk air movement. Tighter building envelopes also make it harder for moisture to escape if it does manage to find its way in, making the cover board's moisture resistance

and ability to dry out as quickly as possible after exposure even more important.

Punctures Lead to Leaks

In addition to vapor drive, cover boards can be exposed to moisture through punctures or other localized failures in roofing membranes and roof-and-wall junctures. Punctures can result from both environmental and man-made causes. Storms can bring hail and windblown objects that can pierce the roofing membrane. And 68 percent of commercial roofs store HVAC and other mechanical equipment that requires routine maintenance.² The resulting foot traffic puts stress on the membrane and makes it prone to perforations.

When a puncture exists and a storm occurs, the moisture is drawn into the roofing assembly, which eventually encounters the cover board. If the cover board loses its integrity from repeated condensation over time, it's going to degrade, impacting its compressive strength.

"If we've got mechanical contractors maintaining big HVAC equipment – replacing filters and changing motors – the cover board is going to be able to withstand the abuse if it is robust and moisture resistant," Carlson says.

Enhanced Moisture Resistance Helps Preserve Flexural Strength

So what criteria should be taken into consideration when choosing a high-performance cover board that will do the best job of protecting the roofing assembly against the dangers of moisture intrusion? It should provide an enhanced level of moisture resistance and dry as quickly as possible when moisture does manage to make its way into the board's core through surface water absorption.

Surface water absorption occurs when water penetrates the coated glass mat and is absorbed by the core. A cover board that strongly resists surface water absorption will help prevent moisture from finding its way into other roofing assembly components.

Moisture absorption can also have an effect on a cover board's flexural strength – the ability of a material to tolerate bending loads and a key indicator of a cover board's ability to withstand wind uplift pressure. The degree by which it will weaken after exposure is dependent on the board itself. The cellulose fiber contained in the core of gypsum fiber boards is essentially the same material found in paper towels – which are designed to absorb moisture. As a result, when these boards are exposed to moisture, they can lose a significant amount of strength. When it comes to coated glass-mat gypsum cover boards, their moisture resistance – and the effect moisture has on each board's strength – varies greatly from brand to brand. And while HD ISO boards absorb less water and therefore lose less strength after exposure to moisture, unfortunately, they have little strength to begin with.



² Source: Advance Design Rooftop HVAC Unit EIE 2012 Commercial Buildings Energy Consumption Survey



The Three-Part Specification Is the New Standard for Moisture Performance

To address the industry's demand for a higher moisture-resistance standard to mitigate the risks associated with the strength roof boards lose when wet, a new Three-Part Specification for moisture

performance was created, which includes meeting 5 percent maximum total water absorption and 1-gram surface water absorption on both sides.

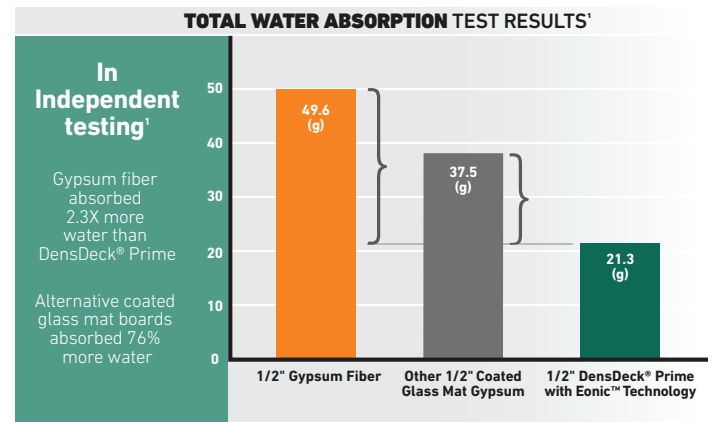
"The roofing industry continues to evolve, and manufacturing specifications have been slow to keep up," says Kuronen. "Moisture resistance technology is improving, directly impacting high-performance specifications. Continuing to rely on outdated requirements is a disservice to the building owners who depend on industry professionals' skills and expertise. The Three-Part Specification is the new standard for defining high-performance roof boards."

The new benchmark includes specifications for coated, fiberglass-mat gypsum roof boards with moisture resistance for application directly under roof membrane systems. Applicable ASTM and UL standard test methods are referenced. It aligns the definition of high-performance roof boards with current moisture technology advancements to create a new performance expectation.

"If you want a roof assembly built with high-performance roof boards," Kuronen notes, "the Three-Part Specification should become your go-to reference."

DensDeck® Prime Roof Board with EONIC™ Technology is designed to provide enhanced

protection against surface water absorption. This proprietary advancement has improved DensDeck Prime's total water absorption performance, which helps it resist bulk water while retaining the same level of vapor permeability as always. In turn, this allows DensDeck Prime Roof Board to retain more of its initial strength after moisture exposure. In fact, in independent testing of multiple roof boards by one of the most respected envelope consulting firms in North America, Trinity | ERD, the flexural strength of DensDeck Prime tested stronger after the industry-standard two-hour water absorption test than all other boards before their exposure to moisture.³ It's the only cover board currently on the market that meets the new Three-Part Specification.⁴ As a result, more and more designers seeking the highest-performing cover board are choosing DensDeck Prime Roof Board with EONIC Technology.



1. Independent third party testing conducted by PRI Construction Materials Technologies concluding in October 2017. Test conducted in accordance to ASTM C473 to meet ASTM C1177.

"We specify a lot of DensDeck Prime Roof Board both as a thermal barrier board on top of wood and steel decks, and also as a cover board," Carlson says. "We've got thousands and thousands – if not millions – of squares out there on schools and other public facilities, as well as commercial buildings. Where there's not just one layer of DensDeck Prime Roof Board, there's two layers – one on top of the deck and one on top of the rigid roof installation. In my personal opinion,

3. Independent, third-party testing of 1/2" boards conducted by Trinity ERD in Columbia, South Carolina in October 2016 and December 2017. Testing conducted in accordance to ASTM C473 to meet ASTM C1177.

4. Based on published manufacturing specifications as of Dec. 1, 2017.



DensDeck® Prime is probably the most versatile gypsum-based thermal barrier and cover board that I am currently aware of on the U.S. roofing market today.”

Downey commented, “When we specify GP products, we generally require DensDeck Prime Roof Board.” With respect to EONIC™ Technology, Downey added, “To me, the new technology is a great continuation of the increased quality that Georgia-Pacific has built into their products.”

Most roofing assemblies will be exposed to moisture at some point during their service lives. Whether as thermal barriers or as rigid form substrates, designers specify roof boards as part of their commercial roof assemblies to meet certain strength-related design intentions. Since a board’s ability to deliver on its promises of resistance and strength can be compromised by moisture, the design community should consider how well it performs after moisture exposure when specifying a high-performance roof board as part of a commercial roofing assembly.

Summary

Cover boards are an essential component of a properly designed roofing assembly. When roofs get wet – and the vast majority do – cover boards can be exposed to moisture as vapor, condensation, and as water from membrane punctures. If water manages to make its way into the cover board’s core, either through surface water absorption or channeling, moisture can intrude into other roofing components, compromising the assembly’s structural integrity. It can also weaken the cover board’s flexural strength, lessening its ability to withstand the pressure of wind uplift. DensDeck Prime Roof Board with EONIC™ Technology is designed to provide an enhanced level of protection against both surface water absorption and channeling. It’s the only roof board currently on the market that meets the industry’s tough new Three-Part Specification for moisture performance, making it the right choice for consultants looking to design the highest level of protection into their roofing assemblies. Since few elements are as damaging as moisture, every effort should be taken to avoid exposing DensDeck Prime Roof Board to moisture before, during and after installation.