



Structural Concrete Decks, Vapor Retarders, and Moisture

– Rethinking What We Know

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INTRODUCTION AND CURRENT PRACTICES

Ever since we have been installing roofing systems on structural concrete decks, roofing professionals have known that an important factor in how well an installation will perform over time depends on the concrete deck being a suitable substrate for the roofing system. Generally, we use terms such as “clean,” “smooth,” “even,” and “dry” to describe a concrete deck that is suitable for receiving a new roofing system. When a concrete deck cannot meet these descriptors, then we must address the shortcoming(s) in an effort to ensure that the installed roofing system will perform.

Consider a generic installation that is membrane-agnostic—a roofing system installed with the insulation adhered to a cast-in-place structural concrete deck (as opposed to a lightweight insulating concrete fill) with an adhered membrane over the insulation. Many would agree that this is a common installation over this type of roof deck and the need for “clean, smooth, even, and dry” is easily understood, given that the

attachment of the roofing system is dependent (among other things) on the adhesion of the insulation to the concrete deck, whether adhered with hot asphalt, low-rise foam, or other adhesives. If the surface is not clean, then the attachment could very well be interfered with and substandard; if the surface is not smooth and even, a board insulation will probably have less surface area attachment; and if the deck is not dry, moisture may well interfere with proper adhesion of the insulation.

There have been changes in the materials and methods used in the construction of structural concrete decks over the past 30 years. For clarity, *Table 1* is provided to differentiate between the different densities of cast-in-place concrete, including lightweight insulating concrete. As change has occurred, our industry has reacted when issues became known. Two significant changes to note are the use of lightweight aggregate in structural concrete and the use of non-removable forms. Forty years ago, it was not common to think of structural concrete that consisted of a proper pour over

removable forms as a potential source for a significant amount of water that roofing system designers needed to understand and account for in their designs. However, the use of lightweight aggregate that can hold more initial water than traditional “hard rock” aggregate, combined with the use of metal forms that are left in place, has resulted in a significant likelihood of having to deal with what should be considered a “wet deck.” And recent work¹ indicates that even normal-weight structural concrete poured over non-removable forms retains a significant amount of water within the concrete.

Our industry has addressed both of these changes in materials and methods in joint bulletins and technical advisories,² which generally caution about the potential for moisture and the deleterious effects of trapped moisture. *Table 2* is a summary of some of those concerns.

In addition to the referenced advisories, many manufacturers have also issued their own technical bulletins that reiterate the concerns and have provided a means to caution building owners and designers about the potential for long-term performance issues. Over the past 15–20 years, there have been numerous articles about what the concerns are and how one might mitigate those concerns.³

Generally, mitigation includes recommendations such as “Roofing shall not commence until the deck is dry”; or, in the event of moisture within the deck, “It is the designer’s responsibility to select the deck and determine its suitability for use.” Even

Deck Type	Density of the Concrete
Normal-weight structural concrete	150 lb/ft ³
Lightweight structural concrete	85 – 120 lb/ft ³
Lightweight insulating concrete	20 – 40 lb/ft ³

Table 1

when we are offering recommendations as a manufacturer, a roofing contractor, or a roof consultant, we often rely upon what has worked in other roof system configurations, such as installing a vapor retarder to the deck if its surface is dry or ensuring that a vapor retarder with a permeability of “X” is installed.

Certainly, these are good recommendations. The difficulty comes with the “recommendation behind the recommendation.” Much like the well-understood “question behind the question,” the recommendation behind the recommendation is where our industry should perhaps be focusing attention and providing solutions.

AN EVOLVING CONCERN

As noted, there have been many discussions, articles, advisories, and presentations about the potential for a concrete deck to retain moisture, particularly when installed over a non-venting substrate. Retained moisture then is something that needs to be addressed to ensure the installed roofing system will perform, and a commonly used solution is to restrain moisture movement from the deck into the roofing system through the use of a vapor retarder. Obviously, there have been other solutions proposed, such as using admixtures in the concrete to lock in the water, or adding rooftop vents to remove the water;

Problems and Issues With Structural Concrete That Retains Moisture
<ul style="list-style-type: none"> • Determining when a deck is ready for roofing • Measuring concrete moisture content • Loss of adhesion • Blistering • Insulation facer delamination • Loss of R-value • Microbial growth potential • Water-based adhesive curing and re-wetting • Corrosion of roof fasteners and other ferrous-containing roof components

Table 2

however, these solutions have been met with skepticism, given the “cost of failure” should they not perform as intended.

The concept of the cost of failure is critical to understanding the potential magnitude of this issue. For some roofing problems or design conundrums, the cost of failure can be relatively low (e.g., deciding to use a tapered insulation with a TPO recover system or deciding to forgo the tapered insulation when the existing structure does not have extensive ponding. While the better selection to eliminate ponding water may very well be to use tapered insulation, given that thermoplastic membranes generally perform in areas that pond water, the decision to forgo tapered insulation does not

necessarily mean the entire roof won’t perform). However, if a concrete deck does not dry or retains moisture and the “solution” to address this condition does not work, the cost of failure is generally high.

What, then, is changing? Simply put, we suggest the standard of care may not be enough, and we should remove our biases that have been born based on what has worked in the past. Consider the following questions:

1. How well will a vapor retarder adhere to a concrete deck that contains a significant amount of water?
2. Does cyclical vapor drive/pressure portend a potential attachment problem?

Option	Vapor Retarder/ Roofing System Construction	Critical Considerations
<p>A</p>	<ul style="list-style-type: none"> • Mechanically fastened venting base sheet, attached using pre-drilled stainless-steel fasteners • Over this base sheet, install an adhered vapor retarder (e.g., heat-welded SBS membrane or a two-ply, hot-mopped vapor retarder) • Insulation and roofing membrane adhered over the vapor retarder 	<ul style="list-style-type: none"> • The long-term durability of the fasteners into a wet deck • The maximum uplift resistance of the roofing system is limited by the use of a base sheet

Table 3 – (Continued on page 28.) Vapor retarder/roofing system constructions and critical considerations.

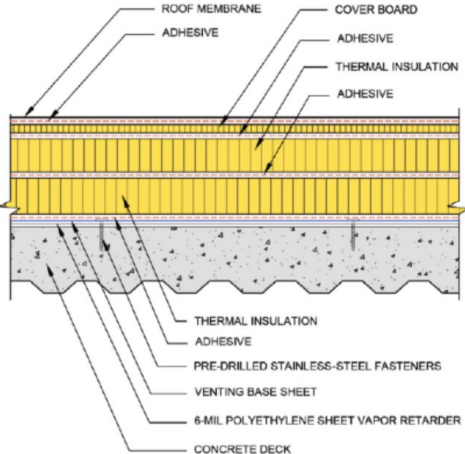
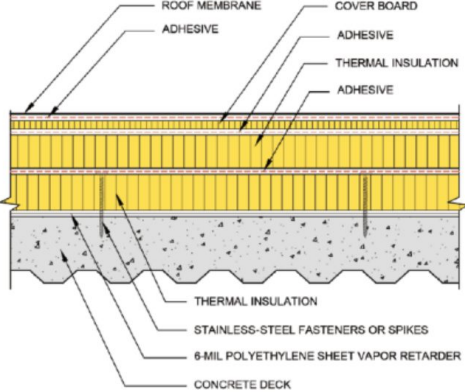
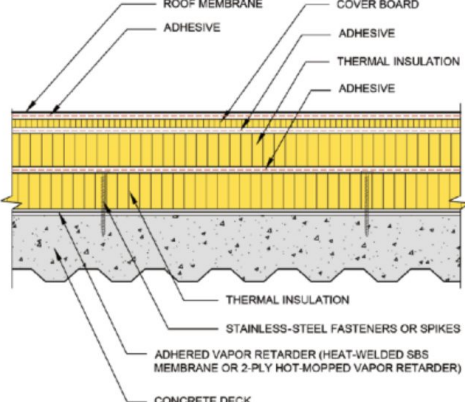
Option	Vapor Retarder/ Roofing System Construction	Critical Considerations
<p style="text-align: center;">B</p>  <p>Labels in diagram B: ROOF MEMBRANE ADHESIVE COVER BOARD ADHESIVE THERMAL INSULATION ADHESIVE THERMAL INSULATION ADHESIVE PRE-DRILLED STAINLESS-STEEL FASTENERS VENTING BASE SHEET 6-MIL POLYETHYLENE SHEET VAPOR RETARDER CONCRETE DECK</p>	<ul style="list-style-type: none"> • 6-mil polyethylene sheet vapor retarder • Mechanically fastened venting base sheet, attached using pre-drilled stainless-steel fasteners • Insulation and roofing membrane adhered over the base sheet 	<ul style="list-style-type: none"> • The long-term durability of the fasteners into a wet deck • The maximum uplift resistance of the roofing system is limited by the use of a base sheet. • This configuration results in approximately one fastener through the vapor retarder every square foot
<p style="text-align: center;">C</p>  <p>Labels in diagram C: ROOF MEMBRANE ADHESIVE COVER BOARD ADHESIVE THERMAL INSULATION ADHESIVE THERMAL INSULATION ADHESIVE STAINLESS-STEEL FASTENERS OR SPIKES 6-MIL POLYETHYLENE SHEET VAPOR RETARDER CONCRETE DECK</p>	<ul style="list-style-type: none"> • 6-mil polyethylene sheet vapor retarder • Insulation attached through the vapor retarder into the concrete deck using stainless steel fasteners or spikes • Over the first layer of insulation, adhere additional insulation (if/as required), and then the roofing membrane 	<ul style="list-style-type: none"> • The long-term durability of the fasteners into a wet deck • The uplift resistance of the roofing system is dependent on the attachment of the first layer of insulation • The attachment of the insulation is through the vapor retarder
<p style="text-align: center;">D</p>  <p>Labels in diagram D: ROOF MEMBRANE ADHESIVE COVER BOARD ADHESIVE THERMAL INSULATION ADHESIVE THERMAL INSULATION ADHESIVE STAINLESS-STEEL FASTENERS OR SPIKES ADHERED VAPOR RETARDER (HEAT-WELDED SBS MEMBRANE OR 2-PLY HOT-MOPPED VAPOR RETARDER) CONCRETE DECK</p>	<ul style="list-style-type: none"> • Adhered vapor retarder (e.g., heat-welded SBS membrane or a two-ply hot-mopped vapor retarder) • Insulation attached through the vapor retarder into the concrete deck using stainless-steel fasteners or spikes • Over the first layer of insulation, adhere additional insulation (if/as required), and then the roofing membrane 	<ul style="list-style-type: none"> • The long-term durability of the fasteners into a wet deck • This configuration adds attachment confidence for the roofing system while fastening through the vapor retarder

Table 3 – (Continued from page 27.) Vapor retarder/roofing system constructions and critical considerations.

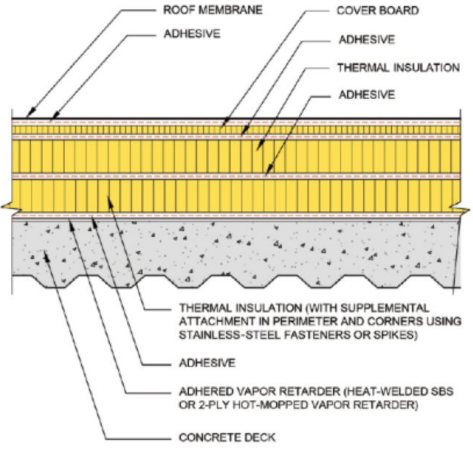
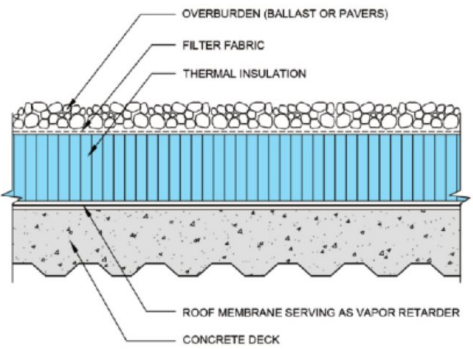
Option	Vapor Retarder/ Roofing System Construction	Critical Considerations
<p style="text-align: center;">E</p>  <p>Labels in diagram E: ROOF MEMBRANE ADHESIVE COVER BOARD ADHESIVE THERMAL INSULATION ADHESIVE THERMAL INSULATION (WITH SUPPLEMENTAL ATTACHMENT IN PERIMETER AND CORNERS USING STAINLESS-STEEL FASTENERS OR SPIKES) ADHESIVE ADHERED VAPOR RETARDER (HEAT-WELDED SBS OR 2-PLY HOT-MOPPED VAPOR RETARDER) CONCRETE DECK</p>	<ul style="list-style-type: none"> • Adhered vapor retarder (e.g., heat-welded SBS membrane or a two-ply hot-mopped vapor retarder) • Supplemental attachment through the vapor retarder in the perimeters and corners using stainless-steel fasteners or spikes • Insulation and roofing membrane adhered over the vapor retarder 	<ul style="list-style-type: none"> • The long-term durability of the fasteners into a wet deck • This configuration adds attachment confidence for the roofing system while fastening through the vapor retarder in a limited area
<p style="text-align: center;">F</p>  <p>Labels in diagram F: OVERBURDEN (BALLAST OR PAVERS) FILTER FABRIC THERMAL INSULATION ROOF MEMBRANE SERVING AS VAPOR RETARDER CONCRETE DECK</p>	<ul style="list-style-type: none"> • Use of a protected roof membrane assembly 	<ul style="list-style-type: none"> • Attachment is provided/supplemented by the overburden. • With the membrane at the deck level, it serves as the vapor retarder

Table 3 – (Continued from page 28.) Vapor retarder/roofing system constructions and critical considerations.

3. What is the long-term viability of fasteners into a concrete deck that contains much moisture? Will the fasteners prematurely corrode due to the wet environment?
4. How do you install a vapor retarder that will perform if you have questions you can't answer about its attachment to the deck?
5. Regarding self-adhering vapor retarders, what test method is indicative of performance when installed over a deck that contains a significant amount of moisture?
6. What has historically made the "best vapor retarder?"

RETHINKING VAPOR RETARDERS

Our roofing industry does have signif-

icant experience that can be drawn upon to arrive at solutions that not only address the need for a vapor retarder, but it should help the roofing system perform when there are other factors to consider or where the answers to all of the questions may not be known. Prior to doing this, we must take into account that not only is the vapor retarder restricting the movement of moisture into the roofing system, in the case of a system (insulation included) that is adhered to the vapor retarder, but it is also critical to the attachment of the roofing system. Conversely, where attachment is "through" the vapor retarder, questions arise about how much moisture is going to be restricted when you fasten through the component that depends on low permeability for its performance. Perhaps this may be less of a


concern where the vapor drive is less, such as Atlanta as opposed to Minneapolis.

There are several options available that may be acceptable and meet the needs for a roofing system. For clarity, Table 3 identifies these options, in no particular order.

DISCUSSION

Considering the questions raised about the performance of vapor retarders installed over a concrete deck that contains an unacceptable amount of moisture, it is prudent for roofing professionals to take care in their decisions. Each of these options has its own limitations that must be considered and weighed against the specific project requirements. In addition, the above list is not exhaustive; for example, the use of a lightweight insulating concrete fill may be a

solution that provides a substrate which is more amenable to mechanical attachment.

When taken into consideration with the cost of failure, we suggest that professionals utilize industry practices that are beyond the recommendations generally offered and take into account an environment that may not be conducive to a more traditionally installed vapor retarder on a concrete deck. Until further understanding and knowledge are developed through research and in-situ experience, roofing system designers should consider their responsibility for the building enclosure's performance and incorporate the potential for moisture into their designs when specifying a roofing system installed over a concrete deck—particularly when said concrete is installed over a non-venting substrate. 

FOOTNOTES

1. Mark S. Graham. "Moisture in Concrete Roof Decks." *Professional Roofing*. September 2017.
2. SPRI Industry Information Bulletin No. 2-13, "Moisture Concerns in Roofing Systems Applied Over

Lightweight Structural Concrete Roof Decks." August 2013.

3. Colin Murphy, RRC, F-IIBEC. "Wet Concrete Decks: Problems and Practical Solutions." *Interface*. August 2006; Joe Schwetz. "Risks

of Roofing Over Concrete Decks." *Interface*. July 2014; Gregory R. Doelp, PE and Philip S. Moser, PE, LEED AP. "Reducing the Risks of Moisture Problems From Concrete Roof Decks." *Interface*. April 2014.



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Blast From IIBEC's Past: 1989

Paula Baker, shown here with then President James Magowan in 1989, was IIBEC's first full-time paid employee, hired as an administrative assistant and convention coordinator in November of 1988 and named executive manager in September 1990. She resigned in 1993 when John Newark was named as executive manager.



Region I held a meeting in Newark, NJ, in November 1989 that drew 61 attendees (pictured) at a time when membership of the entire organization was approaching 400. Bob Martin was director of that region. Most membership was then concentrated in the East, in what were then Regions I and II (Joe Hale was director of the latter). What were then Regions VI and VII, covering the upper Midwest and Northwestern states, along with the Canadian provinces, had fewer than 20 members between them that year. Bill Early was director of Region III; Roy Frady, Region IV; Wells Jackson, Region V; Sam Huff, Region VI; and Harold Crooks, Region VII.



The forerunner of today's Document Competition (originally known as the RCI Specification Competition), was announced in the fall 1989 issue of *Interface* (then an eight-page quarterly newsletter). The committee was under the chairmanship of Bill Early.

Anticipating the important place that waterproofing would take in the association's mission, the Waterproofing Committee was described that year by then President George Kanz as "one of the most active committees" in the institute.