Risks of Roofing Over Concrete Decks

By Joe Schwetz

Over the years, the construction industry has been aware of moisture issues from freshly placed concrete, as well as the ability of concrete to absorb and hold great amounts of water. Over time, this water may migrate into the roof system, saturating the insulation and cover boards, causing adhered systems to become disbonded, or increasing the risk of corrosion to metal components. Many articles have been written discussing the issues of moisture and concrete. These articles identify some of the reasons and issues related to the moisture in concrete, and why problems appear to be more prevalent than in the past, such as eliminating vapor retarders (especially ones that are adhered to the concrete deck) and the practice of keeping concrete forms in place, which are typically sheet-metal form decks.

The most common ways excess water in concrete is generated include:

- Mixing and pouring new concrete decks/slabs
- Interior finish work, including:
  - — Water-based construction materials, such as paint, plaster, and drywall application
  - — Heating the interior with propane or oil burners
- Concrete decks exposed to standing water from various sources, such as:
  - — Exposure to long-term leakage into existing roofs
  - — Rain or snow
  - — Other sources

CONCRETE AND WATER

Concrete is a combination of cement, aggregate (fine and coarse), and water, typically proportioned about 10-15% cement, 60-75% aggregate, and 15-20% water. Studies have shown that from the original mix, there will be from 0.9 to 2.6 quarts (0.85 to 2.5 l) of excess water per square foot of concrete surface present in a one-month-old, 6-in.-thick concrete roof deck. This does not include possible water from rain, snow, or a curing process. This excess water may migrate into a roof system that is applied after the concrete has cured to sufficient strength to support construction traffic, which generally has been accepted as 28 days for normal-weight structural concrete. In reality, the time to cure will vary, possibly as short as 7 to 14 days, depending on the required design function of the concrete and the mix design. With this large amount of free water available, it must be noted that cure time (generically 28± days) does not mean the concrete is dry. "Cured" simply means it has reached adequate structural strength. Depending on the concrete mix or formula, it may take up to three months under ideal drying conditions and significantly longer without ideal drying conditions for a normal-weight structural concrete deck to dry sufficiently to allow for a finish product such as flooring or a roofing system to be installed.

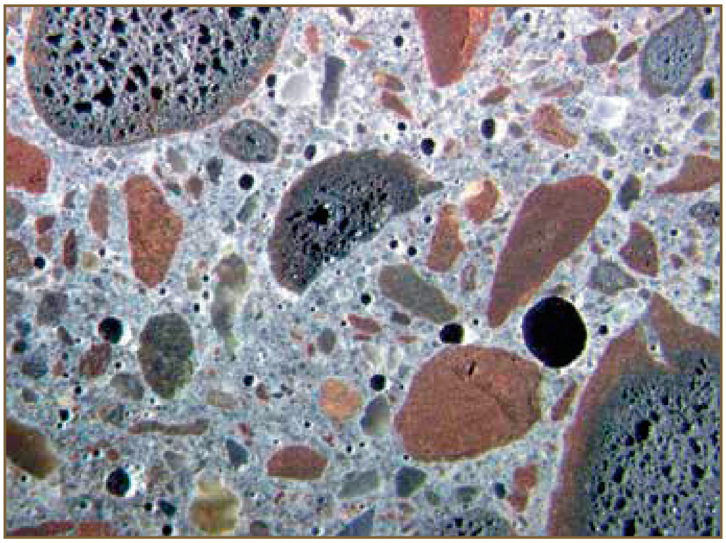

Photo 1 – Micrograph of lightweight concrete with expanded shale aggregate (compliments of SGH).

In addition to normal-weight structural concrete (NWSC), there is more lightweight structural concrete (LWSC) being specified and installed. The differences between the two structural concretes are the "in-place density" and the type of aggregate used. LWSC has a density between 90 and 115 lb./ft.^{3} (1440 to 1840 Kg/m^3), and NWSC has a density range of 140 to 150 lb./ft.^{3} (2240 to 2400 Kg/m^3). NWSC aggregate is typically a combination of fine and coarse aggregate, including sand, natural gravel, and crushed stone. The industry is starting to see more recycled aggregates, such as construction demolition and waste, as a partial replacement for natural aggregates.

The LWSC can achieve the low "in-place" densities by using a lightweight porous aggregate containing air voids. The most common aggregates used in LWSC are expanded shale slate, slag, or clay. The materials are processed at very high temperature (2000°F) in a rotary kiln. These aggregates have a textured surface, a network of internal pores, and absorb relatively large amounts of water (*Photo 1*).

The lightweight aggregate must be saturated before mixing, or it will pull water from the mix, which will make it too stiff to place. This process increases the water-to-cement ratio, causing issues with the final concrete product. To put it into perspective, the LWSC aggregate can absorb 5 to 25% of its mass with water. The Portland Cement Association (PCA) *Engineering Bulletin 119* states the dry down time for LWSC is many months more than NWSC. To achieve a 75% relative humidity for NWSC, it will take approximately three months. To achieve the same 75% relative humidity for LWSC, it will take twice as long—almost six months, according to testing noted in the PCA bulletin. The test was conducted with an 8-in. (20-cm) slab that had both its top and bottom sides exposed to air to dry. Consider that if a roof membrane is installed over the top surface, and the bottom surface is a steel form deck (as is very common), the ability of the concrete to dry will be severely affected. In reality, the ideal laboratory conditions for drying the LWSC will never be achieved during six months of field conditions.

Factors that are driving the increased use of LWSC include lower overall building costs, as well as environmental and sustainability claims. LWSC is typically more expensive than the NWSC when looked at on a unit-cost basis. The overall cost saving achieved by using LWSC, however, is due to a number of factors, but, most importantly, that the lower density reduces the dead loads.

As an example, comparing a 145-pcf concrete slab to a 115-pcf one, the reduction in density provides a weight savings of approximately 20% in the concrete. Thinner slabs of LWSC can achieve the same fire ratings as NWSC. The dead-load reductions allow reduction of the structural framing.

Concrete with lightweight aggregate is being touted as a sustainable alternative to NWSC due to savings on materials. With lower dead loads, there is a reduction in the concrete thickness, which helps reduce the reinforcement and concrete for the foundations. It will also reduce the structural members such as columns, beams, and girders. Transportation costs are less, as lighter weight and less mass are shipped.

CONSTRUCTION-GENERATED MOISTURE

Various construction activities, such as newly poured concrete floor slabs and water-based construction materials (including paint, plaster, and drywall application, among others) generate and contribute to the accumulation of moisture within an enclosed building space. Additional moisture is generated when propane- or oil-burning heaters are used to condition the interior of the building. This heating of the interior may help to dry the new construction materials or allow for interior finish work to be done.

To put this moisture accumulation into perspective, a 4-in.- (10-cm-) thick concrete floor slab generates approximately 1 ton of water for every 1,000 sq. ft. of finished concrete. For every gallon of oil burned, 1 gallon of water is produced; and a 200-lb. tank of propane produces 30 gallons of water. All of this moisture produced and trapped in an enclosed space affects the roofing system. Should these conditions exist, the project designer and/or the construction manager/general contractor must take steps to properly vent the moisture out of the enclosed space to prevent it from migrating into the roof assembly. A well-designed air barrier system that is sealed at all penetrations and perimeters can minimize moisture-laden air from leaking into the roof system.

WATER ABSORBED INTO CONCRETE

Water sitting on a deck—as precipitation on new decks or through long-term leakage into existing systems being reroofed—will typically be absorbed into the concrete. The top surface may appear dry, giving a false sense that a roof system can be installed. After the installation of the roof membrane, the moisture within the concrete will migrate into the roof system. The rate of the water migration will depend on the local climate and the conditions (temperature) within the building. The migration of the water out of the concrete will be greater than the moisture vapor passing through the roof membrane. The moisture condenses when it reaches the cold membrane surface. The accumulation of water within the assembly may affect moisture-sensitive products such as adhesives, paper-faced insulation boards, gypsum, perlite, and fiberboards.

VENTED DECKS

The Steel Deck Institute (SDI) issued a position statement in November of 2008 commenting on the use of vented composite steel floor deck forms to quicken the drying time of a poured concrete slab. The document notes that vented steel decks have traditionally been used to allow for the excess mix water to drain when an LWIC deck was poured. The paper states that the LWIC should not be confused with LWSC.

The SDI cautions designers about the use of vented decks for drying out concrete as noted:

> While some deck manufacturers have the ability to provide slots in the composite deck to assist in venting, it should be noted that the current research and testing on composite steel floor deck does not extend to vented products. While it is known that the inclusion of slots has little effect on the strength of the steel deck, the effect on draining mix water through the bottom of the deck on the properties of the cured concrete and the bond to the concrete is unknown. Specifiers should proceed with caution when requiring slots in this application.
>
> The steel deck acts as a vapor barrier, preventing diffusion of water vapor out from the bottom of the slab. Some publications (Joseph W. Lstiburek, "Concrete Floor Problems," *ASHRAE Journal*, Jan. 2008; and "Sealing Vapor Barrier Penetrations," *Concrete Construction Magazine*, July 2005) note that the amount of diffusion is directly proportional to the open area in the vapor barrier (Fick's

> Law). For example, providing a hypothetical 1.5% open area will increase the diffusion of water vapor by 1.5%, an inconsequential amount.

The document states when pouring concrete floors on steel decking, the specifiers should consider the conditions to be the same as pouring concrete on grade with a vapor barrier, for drying purposes. Designers should be concerned about this statement, as the permeability of steel is substantially less than a poly vapor barrier. The SDI suggests others means for controlling the water content, thus improving drying time, such as minimizing the water content, using water reducers, controlling drying temperatures and relative humidity, and providing protection from external moisture sources. In reality, the finish contractor—be it for flooring or roofing—has very little control through any means in reducing the excess moisture.

DETERMINING MOISTURE CONTENT

A main issue our industry has regarding water and moisture in concrete is that there is not a good, practical, consistent, and viable test to determine the moisture content of a concrete roof deck. We must also be aware that when measuring the relative humidity in a concrete slab, there is currently no reasonable method of associating measured relative humidity levels to the actual moisture content.

The plastic film test (ASTM D4263, *Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method*) is no longer considered a good, valid test, especially with LWSC. The National Roofing Contractors Association (NRCA) issued an Industry Issue Update titled *Moisture in Lightweight Structural Concrete Roof Decks* stating this method is unreliable. The NRCA notes the difficulty in achieving an airtight seal between the film and the concrete deck. It also states that if the temperatures on both the top and the bottom of the concrete slab are not nearly identical, the pressure difference can result in a false "dry" result. This is also true for the calcium chloride test (ASTM F1869). Independent testing has shown these test methods often give misleading results.

The flooring industry, which also has concerns with moisture in concrete, uses a moisture probe test (ASTM F2170, *Standard Test Method for Determining Humidity in Concrete Floor Slab Using In-Situ Probes*) to determine if the moisture in the concrete slab has reached a level at which the flooring material can be adhered. This test uses probes that are set into cores at different depths of the concrete slab and sealed for 72 hours. This test works relatively well for flooring due to the more consistent indoor temperatures and humidity. For concrete slabs that are exposed to the weather, such as roof decks, the temperature and humidity will vary, which will affect the readings from the probes. The conditioning section for ASTM F2170 states:

> 9.1 Concrete floor slabs shall be at service temperature, and the occupied air space above the floor slab shall be at service temperature and service relative humidity for at least 48 hours before making relative humidity measurements in the concrete slab.

Based on the conditioning statement, this test is not viable for concrete slabs exposed to the weather.

Furthermore, even if the amount of moisture could be measured easily and accurately in-situ, the industry has not determined or defined what the acceptable moisture content in concrete decks is for the installation of a roofing system.

CASE STUDY 1

This new construction project in the Northeast U.S. involved approximately 450 squares, with three floors of newly poured, 6-in.-thick concrete deck. Slope was built into the deck with the ridgeline running south to north in the middle of the field and drains set along the east and west walls. The walls were tilt-up concrete panels with the tops of the walls approximately 4.5 ft. above the deck elevation, and overflow scuppers cut into the panels by each drain. The roof system consists of:

- An adhered thermoplastic PVC single-ply roof membrane
- Primed glass-faced gypsum board, 0.5 in. thick
- Two layers (1.5- and 2.0-in.) glass-faced isocyanurate insulation
- Self-adhered vapor barrier and primer
- Poured concrete deck into a non-venting metal pan
- Low-rise urethane foam adhesive adhering all layers of board as well as to the adhered vapor barrier

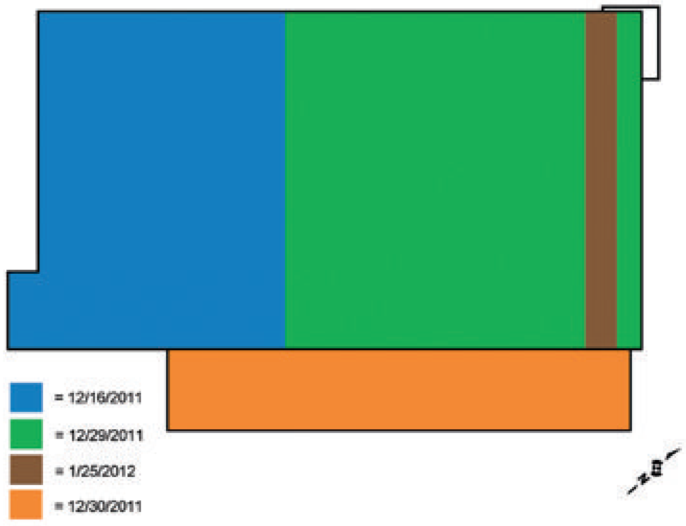

Figure 1 – Dates for the new concrete roof deck pours for Case Study 1.

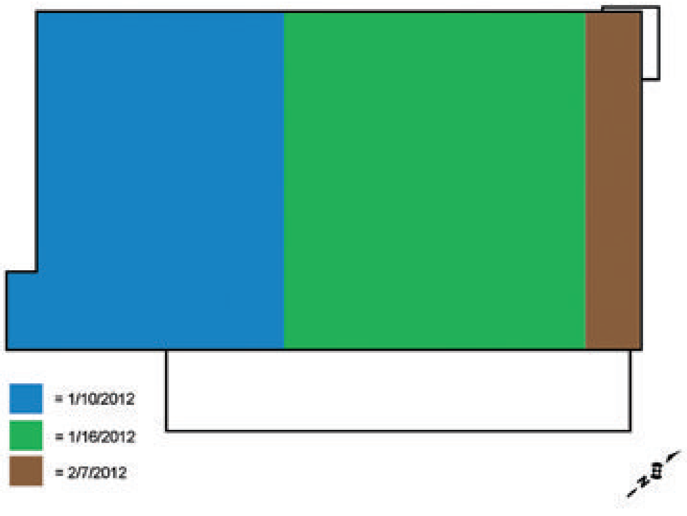

Figure 2 – Dates for the installation of the self-adhered vapor barrier, Case Study 1.

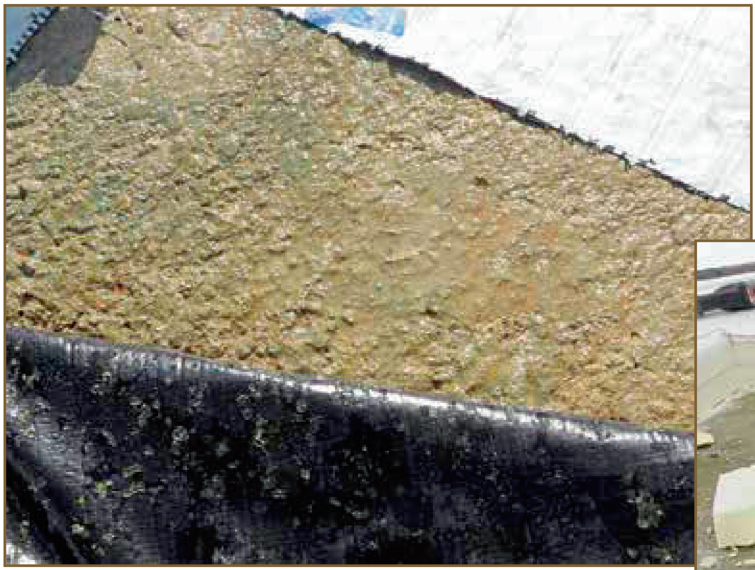

Photo 2 – Moisture between the concrete and self-adhered vapor barrier.

Photo 3 – Removal of adhered vapor barrier from primed concrete deck.

The roof deck was poured in four sections on December 16, 29, and 30, 2011; and January 25, 2012 (*Figure 1*).

The air temperature on the days of the pours ranged from 3° to 33°F. With interior finish work already in progress, the general contractor (GC) pushed the roofing contractor to dry-in the building as quickly as possible. The vapor barrier was installed over three days (January 10 and 16, and February 7, 2012), when the temperature ranged between 7° and 43°F (within the acceptable temperature installation range for the vapor barrier). (See *Figure 2*.) The roofing project reports state that the concrete was visibly dry and the GC, roofing contractor, and FM Global representative witnessed and accepted the adhesion testing of the vapor barrier to the concrete deck. According to the project records, on the south section of the roof, the initial concrete pour was exposed for 25 days, and the north sections were open for 12 to 18 days.

On January 25, the roofing contractor began installing the roof system along the ridgeline, filling in the middle area of the roof and leaving approximately 20 ft. along the perimeter open.

On February 15, blisters were seen under the adhered vapor barrier. Test cuts showed moisture and standing water on the deck (*Photos 2, 3, 4,* and *5*). An additional 12 test cuts were done on February 23, with nine test cuts showing moisture and standing water between the vapor barrier and the concrete deck (*Figure 3*). At this point, the project was shut down, and accusations and blame for the presence of the water started, followed by claims that the products and/or the workmanship were at fault.

The GC refused to share the construction documents, specifically for the concrete floor and roof deck applications. He did state that the concrete was a "normal-weight structural concrete."

The self-adhered vapor barrier sheeting was removed from the entire 20-ft.-wide perimeter on February 23. The exposed deck was left to surface-dry (*Photo 6*). On March 5, pull testing was done on new self-adhered vapor barrier to the primed deck. The first test failed within the urethane adhesive foam due to inadequate cure time. The other five assemblies all showed very good pulls, with the readings between 645 and 1,185 pound force—well above the calculated design uplift load of 28 psf for the wind uplift pressure. During this site visit, the GC did acknowledge that the interior of the building was heated to a constant 70° to 75°F temperature to allow the intumescent paint to dry.

It was subsequently determined that high moisture content in the concrete roof deck and the initial cold temperatures inside and out caused a slow cure and slower drying of the concrete. When the GC heated the interior of the structure to 70° to 75°F while the outside temperatures were averaging in the mid-20°F range, a strong moisture drive up into the roofing vapor barrier had been created. The moisture drive was so great that the diffused water that accumulated on the deck lifted the barrier sheet off of the concrete. Typically, the adhesion of the vapor barrier to concrete is well above 500 psf, indicating the moisture drive was substantial.

Concern was expressed for the water still in the concrete deck and how it might affect the roof system or appear as leaks in the building. Due to the lack of test methods, we do not know if the remaining water is great enough to potentially affect the roof system. The probability of the water in the concrete entering the building is minimal, as the steel form will prevent downward drying, and any vents or small holes will typically plug and stop water from draining from the concrete.

The roof system was completed as specified with the inclusion of sealing all of the through-deck penetrations, as well as along the walls. Two mechanically fastened batten bars, at 4 and 8 ft. from the perimeter, were installed with a cover strip welded over the top. The roofing contractor has monitored this project for the past two years, reporting no issues.

This case study is a classic example of an expedited construction schedule with pressure to dry-in the building so the interior work could be done during the coldest months of the year. While it was never determined what type of structural concrete was poured for the roof deck, the fact that it was poured over a steel pan, with outside

Photo 5 – Primer coming off the concrete deck.

Photo 4 – Moisture on the deck; minimal primer.

temperatures predominately below freezing, caused the drying time to be considerably slower. Pressure to dry-in the building by installing the adhered vapor barrier shortly after the pours, due to construction schedules, sealed the excess moisture in the concrete. To compound the issue, the interior of the building was heated to very high temperatures, which created an even greater vapor drive than what would normally be seen. Once all the factors were brought together, it was obvious that the schedule for the building had not been realistic; more time should have been scheduled to allow the concrete to dry.

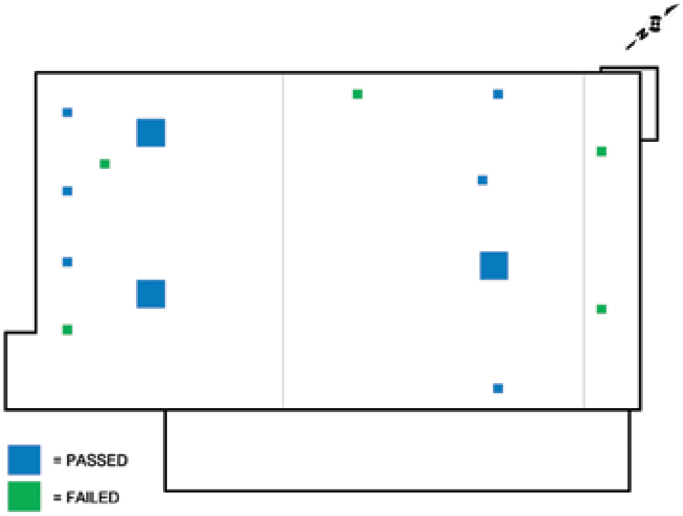

Figure 3 – Field-testing of the self-adhered vapor barrier, Case Study 1.

Photo 6 – Roofing removed from the perimeter.

Sample Number	Nuclear Gauge Reading	Moisture Weight	Lab Moisture Content	Field Observation
1	8	0.44	2.2%	All components dry
2	12	0.69	4.6%	Bottom layers of insulation damp
3	16	9.78	56.8%	Bottom layers of insulation wet

Table 1

CASE STUDY 2

Located in the Mid-Atlantic region, this office building was built in 2007/08 and is approximately 150 ft. high with a roof area of approximately 340 squares. The walls are precast concrete with formed window openings. The roof deck is a poured-in-place 8-in.-thick structural concrete deck. It is flat, with no slope to drains. There are four drains equally spaced along the two lengths of the roof. The parapets vary in height from almost flush to the roof level to approximately 4 ft. high. There are two penthouses and mechanical equipment in the center of the roof surrounded by an EIFS windscreen. The roof system consists of:

- An adhered thermoplastic (PVC) single-ply membrane
- Four-inch base layer with tapered polyisocyanurate insulation
- Concrete deck
- Low-rise urethane foam adhering the layers of insulation to each other as well as to the deck

The roof installation was uneventful up until 95-98% of completion. On a Friday afternoon in early summer, a decision was made to test the water-cooling system for the building, which had valves on the roof. It was also thought this would offer a good opportunity to conduct a flood test on the roofing system. Unfortunately, the flashings were not 100% complete, the drains had not been sealed and clamped, and the roofing contractor was not informed of the flood test. When work resumed Monday morning, it was discovered there had been numerous leaks into the interior.

The construction team brought in a consultant to determine the extent of the water intrusion into the roof system. The consultant scanned the roof using nuclear radioisotopic thermalization, based on 10-ft. grids. Readings were recorded and the data studied for where to extract the samples, based on low, intermediate, and high readings. The samples were identified, removed, bagged, and brought to a lab for evaluation for water content. See *Table 1*.

It was determined that approximately 75% of the roof was dry, 15% damp, and 10% wet. This survey noted the water infiltration occurred at the drains and where the flashing details along the penthouse were not completed. Concern was noted that while the majority of the roof appeared to be dry, over time, the trapped water would vaporize on hot days and migrate through the system. The vapor could then condense on cooler nights and during colder temperatures, reverting back to a liquid.

The construction team identified areas of the roof to be replaced (approximately one-third of the total area), which was done during the late summer and early fall of 2008 (*Figure 4*). It appears that most of the areas identified as wet/damp from the nuclear scan were replaced (heavy black lines on Roof Plan 4). Project records indicate not all of the identified damp/wet areas were replaced, primarily at the west end of the building. At the completion of the rework, 11 test cuts were done by a third party to determine the condition of the roof assembly; the cuts are designated by the orange dots on Roof Plan 5. Based

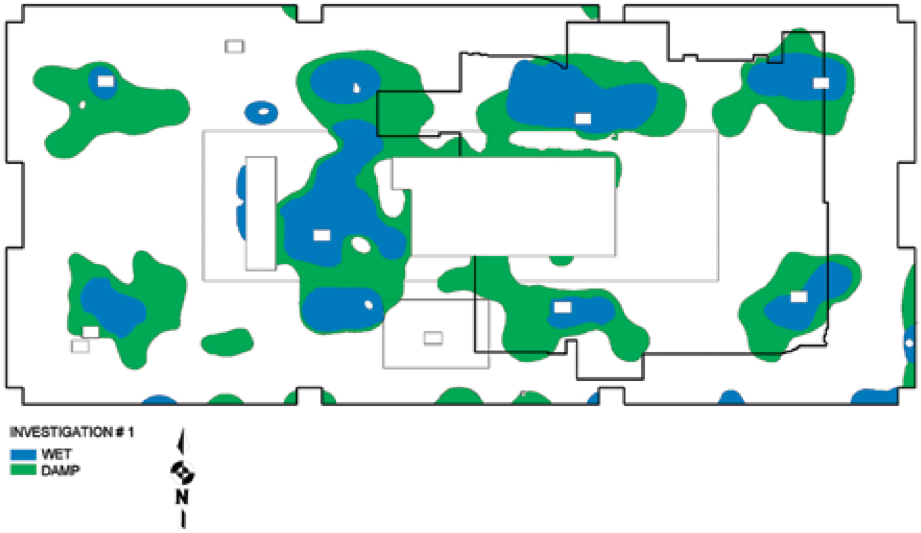

Figure 4 – Initial area of moisture in the roof system and replacement (Case Study 2).

Figure 5 – Test cuts indicating all areas of the roof to appear to be dry (Case Study 2).

	2008 Investigation	2012 Investigation	
Sample	Nuclear scan (dry/damp/wet)	Moisture (yes/no)	Unadhered membrane (yes/no)
1	Wet	No	Yes
2	Dry	Yes	No
3	Damp	Yes	Yes
4	Dry	Yes	Yes
5	Dry	No	Yes
6	Wet	Yes	No
7	Wet	Yes	No
8	Wet	No	No
9	Wet	Yes	No
10	Wet	No	No

Table 2

on the report, all test cuts indicated the roof system layers and concrete deck to be dry, including the west end of the building where there was no product replacement (*Figure 5*).

The building owner noticed a few leaks in late 2011, and upon investigating the roof, noticed the membrane billowing and insulation displaced at the west end. The owner contacted a contractor who repaired the leaks, repositioned the insulation, and added paver ballast to hold the system in place.

Upon notification of the roof issues, the roof system supplier arranged for an investigation with a roof consulting firm that had not been involved with the project. After review of the previous reports, which included the "water test," the nuclear moisture scan, and the test cuts, the roof system supplier and consultant identified where test cuts would be taken.

Ten cuts were performed with the locations determined by the 2008 nuclear scan where the original results would be compared to the present day. Sample 1 from the 2012 investigation, which showed dry conditions, matched the test cut from 2008; however, Sample 3 from the 2012 investigation showed wet conditions, whereas the 2008 test cut had been dry. These cuts were taken from the west end of the building, where the system had become unadhered. The findings show that the moisture conditions had changed for 50% of the test cuts. See *Table 2*.

The area where the roof system was replaced with new insulation and membrane had three areas that showed wet (*Figure 6*).

Excess water/moisture caused the issues with this roof installation and performance. A major contributor to the problems was the water from the flood test. The ponding water from the flood test that entered conditions (Samples 6, 7, and 9). The roof system was thoroughly checked to see if there were any breaches or possible entry points for the water, and none was found the roof system was able to move between the roofing components and along the concrete deck, aided by hydrostatic pressure (*Photos 7, 8, 9,* and *10*). After the water test, the water in the system has to travel around the insulation boards as well as the ribbons of urethane adhesive. The adhesive ribbons that were on the concrete deck most likely trapped some of the water in the U-shaped application pattern. The records indicate there were areas where the insulation was not removed and replaced for up to three months. It is also unknown if all of the wet or damp insulation was replaced. Comparing the nuclear scan results with the 2012 test cuts that were taken in the designated replacement zone (Samples 6, 7, and 9), these test cuts should have been dry. An unanswered question: Is the original insulation still in place (which can explain the results), or was it replaced and moisture migrated toward these areas? With the wet insulation and water in contact with the concrete deck for up to three months, a portion of this excess water soaked into the concrete deck. In addition, with the wet components and water on the deck, this slowed down and probably stopped the natural drying and removal of the excess water in the concrete deck. During the replacement phase, the concrete deck most likely was exposed for, at best, a few hours—not enough time to allow for any drying of the concrete.

Case Study 2 highlights the potential consequences of allowing water to remain within a roof system installed over a concrete deck. The long time between the flood test and removal and replacement of wet components allowed the water to move through the system, as well as be absorbed into the concrete. While this case study may be severe, we can learn from this event not only that there is an issue with excess concrete mix water, but also that a concrete deck exposed to the elements will

Figure 6 – Field evaluation with test cuts indicating the movement of the moisture within the system at Case Study 2.

Photo 7 – Moisture underneath the bottom layer of iso.

Photo 8 – Moisture on concrete deck.

Photo 9 – Moisture between the layers of boards.

Photo 10 – Moisture between the layers of iso.

absorb some of the water and, if not properly addressed, will affect the roof system at some point and most likely well after the "wetting" event occurred.

CONCLUSION

Moisture and concrete decks will continue to be an issue for the roofing industry, with accelerated construction schedules, the increased frequency of adhering insulation directly to concrete decks in ribbons of adhesive, leaving the metal pan/forms in place, etc. In some sense, we may see more issues, as there are perceived energy savings when the LWSC is used.

As noted above, there is currently no acceptable test method to determine the moisture content or relative humidity of a concrete deck that is exposed to the weather. Greg Doelp and Stephen Condren, engineers at Simpson Gumpertz & Heger who have documented the issues and resulting roofing-related problems with moisture entrapped in concrete roof decks, noted:

> While it might be helpful to have a field test method that could quickly and accurately measure the moisture content in a concrete roof deck, such a test method will only confirm that concrete roof decks contain too much water. Drying of wet concrete roof decks is a long-term process. Roofing systems installed over concrete decks need to be designed to accommodate the moisture within the roof decks. This usually involves inclusion of a vapor retarder within the system.

The 28-day "cure" time commonly referenced with structural concrete is the period for developing the design compressive strength of the concrete and has no correlation with the moisture content or concrete "drying." Concrete develops strength by curing that is a chemical process, not through the loss of water by drying. The cure time should never be used as a basis for when a roof system may be installed.

The Portland Cement Association has done research that shows it takes up to three months to reach a 75% relative humidity level with NWSC, and twice as long with LWSC. The test was done in a laboratory setting, with constant temperature and humidity levels, all sides of the concrete exposed, and without any additional moisture (the latter often occurs in the field). Factor in that more roof decks are being poured onto a steel pan, and the inward drying for all practical purposes is eliminated, even if vented steel decks are used, as the SDI states in its position paper.

The NRCA is seeing an increase in the number of claims associated with moisture in concrete and the use of LWSC. The solutions for repairing damaged assemblies will be expensive, regardless of whether one or all parties of the project participate.

Designers of projects that include concrete decks—either new pours or existing slabs—should strongly consider including in their roofing specifications an adequate, bonded vapor barrier on the top side of the deck to prevent any water that may be retained in the concrete from migrating into the roofing system and condensing over time. Consideration should also be given to minimize the use of organic materials and/or moisture-sensitive products within roofing systems.

Although surface dryness can generally easily be determined, the remaining free moisture that is within the concrete slab cannot readily be assessed. Until such time as a viable moisture test method is found, the decision of when a concrete deck may be roofed should include the project designer, the general contractor, the concrete contractor, and their suppliers, as they will have more knowledge of the concrete mix and moisture release rates. The designer and GC should also have the best knowledge of the potential water/moisture migration and potential vapor pressures, based on the concrete specifications and the project environment, including the building microclimate, such as heated interior, additional high-moisture interior components, and other factors that may affect the moisture drive out of the concrete. This design and management group should communicate with the roofing specifier and roofing contractor when they can safely proceed with the installation of the roof assembly.

EDITOR'S NOTE: RCI is currently developing a technical advisory on LWSC construction. When it is completed, it will be posted to the RCI website.

ACKNOWLEDGEMENTS

Micrograph (Photo 1) of lightweight concrete with expanded aggregate, from "Is Lightweight Concrete All Wet?" in *Structure*, a joint publication of NCSEA, CASE, and SEI, published 1/2013; by David Martin, Alec Zimmer, Michael Bolduc, and Emily Hopps

"Venting of Composite Steel Floor Deck," the Steel Deck Institute position paper, November 2008

William Wolf, "Designing with Lightweight Concrete," *Structure*, April 2008

Mark Graham, "Moisture in Lightweight Structural Concrete Roof Decks," NRCA Industry Issue Update

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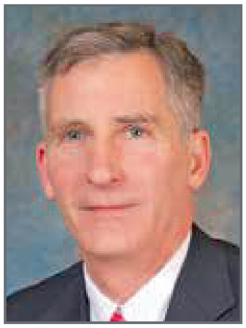
Comments from Stephen Phillips, legal counsel for the NRCA



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