Better understanding of adhesion

Recent research shows vapor retarder adhesion to new concrete roof decks varies

by Mark S. Graham

In "An evolution of knowledge," February 2022 issue, I discussed NRCA's research examining roofing-related problems with moisture in concrete roof decks. One area where NRCA considered additional research to be necessary was addressing the adequacy of vapor retarder adhesion to newly placed concrete roof decks.

NRCA has since undertaken this research, which provides designers with some guidance for proper vapor retarder selection.

Adhesion research

NRCA contracted with SRI Consultants Inc., Waunakee, Wis., to oversee test specimen preparation and conduct vapor retarder adhesion testing.

Ten 6-inch-thick concrete roof deck specimen sets were poured using normal-weight structural concrete. The top surfaces of the concrete specimens were float-finished.

After 28 days of curing at standard laboratory conditions, a two-ply built-up membrane was applied to two of the concrete roof deck specimens and four different manufacturers' self-adhering vapor retarder products were applied to the remaining concrete roof deck specimens in two specimens sets. For each of the self-adhering vapor retarder types, the manufacturer's recommended primer was used, and installations

were done in accordance with manufacturers' installation instructions by an experienced roofing contractor.

One set of each of the concrete roof deck and vapor retarder specimens were conditioned at standard laboratory conditions for 60 days. For the remaining concrete deck and vapor retarder sets, insulated enclosures were constructed on the bottoms of the specimens and heat was applied, resulting in a 30-degree Fahrenheit temperature differential across the bottom to the top of the specimens. This temperature differential created a net vapor pressure drive from the bottoms to the tops of the specimens. This same net vapor pressure assessment concept also was used in NRCA's earlier research.

After 60 days of conditioning, the vapor retarder specimens were cut to size, a load frame was applied and a calibrated pull tester was used to test the adhesion of the vapor retarders to the concrete roof deck specimens. Five specimens of each vapor retarder type and condition were tested. The average of the five specimens' results are shown in the figure.

The testing shows adhesion of vapor retarders to concrete decks varies widely. For four of the five vapor retarders, the results of the temperature differential-conditioned samples were lower than the laboratory-conditioned samples. For sample manufacturer 3-SA membrane, the temperature differential-conditioned test specimens tested higher than the specimens that had been laboratory-conditioned.

I consider the two-ply built-up roof membrane samples to be somewhat baseline control samples. Historically, the U.S. roofing industry has successfully used two-ply BUR membranes as adhered vapor retarders over concrete roof decks. In the laboratory-conditioned testing, the two-ply BUR membrane sample exhibited greater adhesion than the self-adhering vapor retarder samples. Only sample manufacturer 3-SA membrane exhibited greater adhesion than the two-ply BUR membrane samples after temperature differential conditioning.

It should be noted all samples exhibited adhesion well in excess of what is necessary to achieve Class 90 (FM 1-90) uplift.

Sample	Tested pull resistance		Difference	
	60-day laboratory conditioning (average)	60-day laboratory conditioning with temperature diffference (average)	Differential	Percent differential
Two-ply built-up membrane	1,421 psf	833 psf	-588 psf	-41%
Manufacturer 1-SA membrane	768 psf	645 psf	-123 psf	-16%
Manufacturer 2-SA membrane	331 psf	318 psf	-13 psf	-4%
Manufacturer 3-SA membrane	1,139 psf	1,311 psf	+172 psf	+15%
Manufacturer 4-SA membrane	1,415 psf	707 psf	-708 psf	-50%

Results of pull resistance testing after 60 days of laboratory conditioning and 60 days of conditioning with a temperature differential

Recommendations

Because adhesion of vapor retarders to concrete decks varies, designers should specify vapor retarders after considering vapor retarder adhesion at the time of application and while in service.

Also, manufacturers should incorporate some form of vapor drive conditioning assessment in their product developments and assessments and make that information available to specifiers. The vapor drive conditioning used in this testing is one possible assessment method.

NRCA continues to recommend roof system designers use caution when specifying the installation of membrane roof systems over newly poured normal-weight and lightweight structural concrete roof decks. When adequate dryness of concrete roof decks cannot be reasonably ensured, NRCA recommends a well-adhered, low-perm-rated vapor retarder be specified for installation directly over the concrete roof deck. Then, an adhered or loosely laid ballasted roof system can be specified over the vapor retarder, preferably installed the same day or within several days of vapor retarder installation.

Roof system types that involve mechanical fasteners that would penetrate the vapor retarder should be avoided to ensure vapor retarder performance. The purpose of the vapor retarder is to isolate a concrete deck's free water within the concrete and minimize the potential for moisture vapor transport into the roof system.

NRCA also maintains its long-standing recommendation that the use of curing and finishing compounds be avoided when placing and finishing structural concrete roof decks as these compounds are known to retard moisture release and can affect adhesion of roofing materials.

In addition, NRCA suggests roof system designers minimize the use of materials and products with organic content over concrete roof decks to decrease the potential for microbial growth in the event moisture from a concrete roof deck infiltrates the roof system. Examples of roofing products with organic content include fiberglass-reinforced, cellulosic mat-faced polyisocyanurate; perlite board; and wood fiberboard. Coated, fiberglass mat-faced polyisocyanurate insulation is preferred over fiberglass-reinforced, cellulosic mat-faced polyisocyanurate in concrete roof deck applications.

For reroofing situations over existing concrete roof decks where there is evidence of concrete deck-related moisture problems, NRCA suggests roof system designs similar to those recommended for newly placed concrete roof decks.

Additional information about moisture migration in roof assemblies is provided in the Condensation and Air Leakage Control section of The NRCA Roofing Manual: Architectural Metal Flashing and Condensation and Air Leakage Control. Additional information about concrete roof decks and vapor retarders is provided in Chapter 2—Roof Decks and Chapter 3—Air and Vapor Retarders, respectively, of The NRCA Roofing Manual: Membrane Roof Systems.

NRCA members can download both manuals free from shop.nrca.net. Hard copies also are available to purchase.

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New U.S. solar installations decreased in 2022

In December 2022, the Solar Energy Industries Association and research firm Wood Mackenzie, Edinburgh, U.K., forecasted new U.S. solar installations were on track to fall by 23% to 18.6 gigawatts by the end of 2022, according to reuters.com. Solar panel imports have stalled because of a ban on goods from China's Xinjiang region because of forced labor concerns.

The news comes as solar companies look to take advantage of subsidies in the Inflation Reduction Act, a new law that encourages clean energy technologies to address climate change.

The report predicted utility-scale project installations would contract by 40% in 2022 compared with 2021 to 10.3 GW. Big projects for utilities and other large customers make up the largest portion of the U.S. solar market. Commercial and community installations also were expected to decline, but the residential market was expected to increase 37%.

The report also forecasts supply issues are expected to last until the second half of 2023 and delay the effects of the Inflation Reduction Act.

The report predicts the market will return to growth in 2023, with average annual increases of 21% between 2023 and 2027.

ERA recommends revised approach to mitigate urban heat island effect

Based on the findings of two recent studies, the EPDM Roofing Association recommends federal, state and local governments as well as regulatory bodies pause the development and implementation of reflective roofing and "cool" roofing mandates. The studies attempted to measure the efficacy of reflective or cool roofing as a mitigation strategy against the urban heat island effect. The findings revealed complex and inconsistent temperature assessment protocols are being used in virtually all urban heat island effect evaluations, making comparisons of efficacy problematic.

For the initial study, ERA contracted with ICF, a Reston, Va.-based independent consulting firm with experience in climate change and building science. ICF analyzed existing data and previous studies about the urban heat island effect with specific focus on the measurable effects of the roof albedo of low-slope roofing. ICF's analysis of temperature data for cities with cool roof mandates found no discernible correlation between the imposition of cool roof mandates and a reduction in the urban heat island effect.

To further inform the findings of the initial study, ERA commissioned a companion literature review, working with the Department of Construction Science and Management at Clemson University, Clemson, S.C.

According to Clemson University researchers, the literature review exposed the reasons there is no clear answer about the relationship of the urban heat island effect and energy efficiency. First, the results of these studies varied because the effect of cool roofs is influenced by a range of factors such as roof type, climate and location. The studies also varied data capture and analysis, reliance on simulation-based studies and minimal data capture duration. Other factors potentially influencing varying outcomes included consideration of a "heat penalty" during the winter season and the interaction of different building heights. Additionally, there was no consistent comparison of the effect of urban tree canopy, roofs, hardscape, asphalt surfaces and insulation thickness.

According to Dhaval Gajjar, Ph.D., assistant professor and undergraduate program director at Clemson University and a primary researcher on the project: "In many instances, more recent studies based their conclusions and recommendations on widely distributed prior studies, which now must be considered dated or incomplete information given more updated research."

To read overviews of the two ERA research studies, go to professionalroofing.net.

"Both of the ERA studies exposed inconsistencies in measuring the impact of reflective roofing on the severity of the urban heat island effect, as well as on the amount of energy being used," says Jason Wilen, forensic architect at Klein & Hoffman, Chicago, and technical consultant with ERA. "Our focus, as we consider policies that are designed to lead us to a future where the urban heat island effect can be managed and even diminished, must be based on science, not supposition."