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BY TOM HUTCHINSON, AIA, FRCI, RRC

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CHALLENGING WHAT'S COOL

IS THE EXPONENTIAL GROWTH OF COOL ROOFING AN IMPENDING CATASTROPHE?

Playing on the recent election, "Joe the Architect" actually believes that specifying a cool-roof membrane allows him to perform an environmental good. Nothing could be further from the truth. The lemminglike nature of the design community and, more importantly, code bodies that have bought into this hypothesis is alarming. Cool roofing and its single-component mentality are resulting in roof-system failures across the country and impending litigation.

Following are several concerns that result from single-roof-system-component endorsement by the Washington, D.C.-based U.S. Environmental Protection Agency; Washington-based U.S. Green Building Council's LEED program; and Berkeley, Calif.-based Lawrence Berkeley National Laboratory. One may ask, "What does the EPA, USGBC or LBNL know about roof-system performance?" In truth, they may not know as much about the topic as we'd like to think.

CONDENSATION

Many building owners, design professionals, roof-membrane manufacturers, general contractors and roofing contractors have experienced moisture-saturated roof substrates and, in many cases, ice below the membrane as a result of recent cold winters in the Midwest (see photos 1 and 2).

Cool-roofing membranes with single-layer insulation, mechanically fastened to metal roof decks on conditioned buildings will result in an energy loss of up to 15 percent through the insulation joints and mechanical fasteners.

(1) Condensation below mechanically fastened cool-roof membranes in regions with cool nights is resulting in saturated insulation facers below the membrane. The results include mold growth, interior leaking and loss of wind-uplift performance caused by roof-deck corrosion. (2) Condensation below cool-roof membranes not only is saturating the insulation but resulting in ice build-up in the lap seams. (3) Moisture is dripping out of the errant screw hole. Repetitive wetting will result in roof-deck corrosion and, when located at screw fasteners, loss of wind-uplift resistance.

Single-layer-insulation applications allow the movement of moisture-laden air through the insulation joints to the underside of the membrane. In cold-temperature regions, this results in condensation. Although condensation can form on the underside of any loose-laid or mechanically fastened single-ply membrane, white membranes tend to accelerate and accentuate the accumulation of moisture because of the membrane's cooler temperatures, which may never be much higher than ambient temperature for the entire winter.

This condensation is not just minor moisture accumulating in the roof system; it can be enough to result in ice formation on the underside of the membrane, saturate insulation facers below the membrane and drip into the interior. Ice accumulation in the laps of up to 1/2-inch (13-mm) thick has been observed. Make no mistake, the membrane is watertight and performing well, but the system is failing. This moisture is the first step in the manifestation of mold on the facer, deterioration of the metal roof deck around the screw fasteners with resultant loss of wind-uplift protection, wet spots on the floor, increased potential for the slippage of individuals and/or sliding of equipment, and damaged product. Cooler surface temperatures also are resulting in the growth of mold on the rooftop, which incidentally is where air intakes often are located.

Not only are these concerns real in any building in regions that have cold temperatures, the correction is very costly. Many of the buildings affected by condensation are big-box types, totaling hundreds of thousands of square feet. Replacing the roof with a more effective roof system often will cost three to four times the original roof installation cost.

EXPANDING THE DEFINITION OF COOL

A roof system featuring concrete pavers and ballast in Chicago now is accepted by Chicago Code as a cool-roof system.

Oak Ridge, Tenn.-based Oak Ridge National Laboratory and the Waltham, Mass.-based Single Ply Roofing Industry recently issued a report that concludes after three years of testing that concrete pavers and ballast coverage of 17 pounds per square foot (83 kg/m^2) or greater provide benefits greater than actual cool-roofing membranes. The shade from the ballast also protects the membrane. Based on this report, the Sacramento-based California Energy Commission; Atlanta-based American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.; and city of Chicago have realized the benefits of ballast, giving designers another cool-roof-system option from which to choose. To learn more about ballasted roof systems as a cool-roofing option, read "Evaluating the Energy Performance of Ballasted Roof Systems" on SPRI's Web site, www.spri.net, or "cool roofing" in *eco-structure*'s June 2008 issue, page 40.

REFLECTIVITY ... GOOD OR BAD

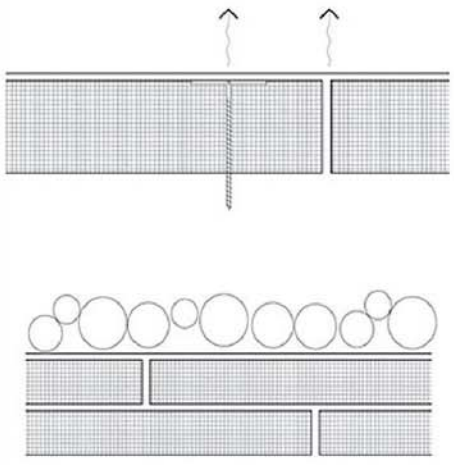
Design professionals never stop to ask "To where are we reflecting the sun's rays?" The answer often is destructive. Reflectivity off cool-roofing membranes has been found to affect adjacent masonry walls and parapets, low-density expanded polystyrene in EIFS-covered walls and sealant joints.

Masonry expands under heat. Highly concentrated solar rays reflected onto adjacent masonry walls result in masonry heated beyond what can be expected in design and undertaken by construction tolerances. The result is masonry walls that expand so much the control joints are squeezed shut and mortar debonds, resulting in moisture intrusion that brings about more deterioration. This is particularly acute on parapet walls that typically have less reinforcement than structural masonry walls. It is not unusual to see coping stones pop off the parapet because of expansion. Masonry control joints also degrade under the concentrated UV radiation, which allows for moisture intrusion and subsequent deterioration.

Reflection also affects other cladding materials, such as EIFS. EIFS systems have been known to absorb so much heat that certain insulations behind the cementitious coat, such as low-density expanded polystyrene, reportedly are melting away.

Colin Murphy, RRC, FRCI, reported in a white paper for the Raleigh, N.C.-based Roof Consultants Institute Foundation's Cool Roofing Symposium that reflection off cool roofs has affected neighboring buildings and those buildings' tenants. It also is a concern that when a lower roof features a cool-roof membrane, the resultant reflectivity passing through adjacent windows requires building owners to install blinds and, in extreme cases, new window glass. Rooftop equipment also is becoming super heated, access panels are buckling and, in at least one instance, sheared-off screws caused by sheet-metal expansion have been observed.

A little-known concern that will become more apparent as time passes is the degradation of cool-roof membranes at points where tall parapet base flashings are reflecting downward, concentrating the reflected solar rays to a point on the membrane and resulting in the premature heat aging of the membrane. This concept is similar to starting fires with a magnifying glass. Unfortunately, it is not something those outside the roofing industry would think to consider.



Single-layer mechanically fastened roof systems are up to 15 percent less energy efficient than double layer systems with offset joints.

BUILDING DESIGNERS, CODE BODIES AND ROOFING-DESIGN PROFESSIONALS SHOULD BE CONTINUALLY EDUCATING THEMSELVES ABOUT THE CAUSES, EFFECTS AND CONSEQUENCES OF THEIR ACTIONS.

(4) Reflected UV rays caused excessive expansion of this concrete masonry unit, which led to debonding of the coping from the bed mortar joint and debonding of coping head joints. Moisture intrusion is the result. Note the efflorescence. (5) Reflection from the cool-roof membrane field sheet onto adjacent masonry parapet walls is resulting in excessive expansion and debonding of the mortar joints. (6) The sealant in this control joint has deteriorated after less than two years of service as a result of heat aging brought on by the reflected UV rays from the cool roof below.

The concerns within this article have been observed on low-slope cool-roof-membrane systems. The author is not aware at this time of similar concerns related to cool metal roof systems.

THE FUTURE

The future always holds promise for some and concern for others. Building designers, code bodies and roofing-design professionals should be continually educating themselves about the causes, effects and consequences of their actions. What does the future hold for the cool-roofing movement? Consider the following:

1. Like all new and improving concepts, the cool-roofing-membrane sector of the industry will be hard hit by litigation related to condensation, building-components deterioration, energy loss, performance below what was promised, and interior and exterior injury cases caused by slippage.

So who is at fault? The complexity of accountability can be illustrated by considering ice below the membrane. The first action will be taken by the roofing contractor and most likely will be a quick, low-cost fix that will not work. Upon investigation, it will be discovered that one layer of insulation was designed into the system. Now the architect is the culprit. The architect will say the specification indicates to install the insulation in full accordance with the manufacturer's recommendations. For example, there are joints between the insulation greater than 1/4 inch (6 mm) that were to be filled. The roofing contractor will say he installed the roof insulation with all joints tightly butted together; however, per the ASTM standard quoted in the insulation product data, there is an allowable physical-dimensional change. Therefore, the manufacturer is at fault. The insulation manufacturer will say this information was noted in the product data, and it was the architect's responsibility to read the material and design a roof system that wouldn't condensate. The architect then can say EPA's Energy Star program, LBNL and others declared cool roofing was a good thing. One can quickly see how defining who is at fault will be decided in a courtroom.

2. Life-cycle assessment will push requirements for long-term performance to the forefront, requiring cool-roof-membrane manufacturers to reevaluate their allowed designs.

3. Implementation of solar appurtenances will increase and concerns with the heat generated by them on cool membranes will become an issue.

4. Education of those affecting the roofing industry will be undertaken by associations or a conglomerate of associations, such as the Rosemont, Ill.-based National Roofing Contractors Association; Waltham, Mass.-based Single Ply Roofing Industry; Raleigh, N.C.-based RCI Inc.; and Bethesda, Md.-based EPDM Roofing Association.

5. Standards organizations and municipalities will begin to realize the effects of their actions and will look to those knowledgeable about roof systems to help them evaluate potential code revisions.

6. Energy savings will be realized as one of the most important aspects of a roof, and greater thermal-insulation-value recommendations for roofs in all climate zones will occur.

The promise of performance is a Russian roulette predication. My advice is to never predict performance or anticipated energy savings. Instead, it is imperative that everyone in the design and construction industry realize the benefits of designing quality roof systems regardless of the type of roof cover and move away from suggesting a single-component solution.

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