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Feature

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EPDM Roof Considerations for Northern Climates

By Ronald L. Goodman

With any important decision in life, it is necessary to understand the trade-offs associated with the choices made. The same is true when selecting a roofing assembly.

A common theme is sustainability and the use of 'green' building methods and materials—however, trouble can arise when materials are selected and purchased solely because of perceived energy or environmental benefits.

A building's geography, use, and contents must be taken into consideration when specifying a roofing assembly. Simply put, there is no roofing system that delivers the same level of performance and energy savings in every situation and location.

Ethylene propylene diene monomer (EPDM) roofing systems are often a suitable fit for Canadian projects. Introduced to the commercial roofing market more than 50 years ago, the synthetic rubber material is widely used in low-slope roofs for both new construction and re-roofing applications. Available in both black and white, this membrane is sold in various widths and thicknesses. Reinforced EPDM has a reinforcing scrim

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between two plies of EPDM membrane, while non-reinforced products do not contain this component.

There are numerous ways to install an EPDM membrane roof, the most common of which are:

- fully adhering the membrane to the substrate with bonding adhesive;
- mechanically attaching the membrane to the substrate using fasteners; and
- ballasted applications in which the membrane is not adhered or attached to the substrate, but is held in place using pavers or stone ballast.

EPDM offers a wide range of benefits, including weatherability, hail resistance, reduced condensation potential, energy efficiency, environmental impact, and safety.

Weatherability

Xenon-arc testing is the industry standard for comparing how long a particular roofing material will resist cracking or crazing from ultraviolet (UV) exposure. Comparative ASTM weathering test data on various 1.5-mm (60-mil) membranes clearly indicates non-reinforced black EPDM can survive the most severe exposures to UV, going well beyond the industry's minimum standard.[1] The amount of energy to which membranes were exposed without exhibiting cracks was:

- non-reinforced black EPDM: 41,580 kJ/m²;
- reinforced EPDM: 35,320 kJ/m²;
- white non-reinforced EPDM: 25,200 kJ/m²;
- thermoplastic polyolefin (TPO): 20,160 kJ/m²; and
- polyvinyl chloride (PVC): 12,600 kJ/m².

It is also important to understand the amount of weathering material is not the same on all 1.5-mm single-ply membranes. Most white thermoplastic membranes are internally reinforced, and the thickness over the reinforcing scrim typically ranges from 0.5 to 0.6 mm (20 to 25 mils). EPDM membranes used in ballasted and adhered systems do not need an internal reinforcing scrim; as a result, a full 1.5 mm of weathering membrane works to prevent leaks.

Once the scrim is exposed on a reinforced membrane, it is difficult to make small repairs, whereas the non-reinforced EPDM remains repairable well beyond its estimated service life. Recent testing of a 30-year-old EPDM membrane showed it maintained—or in some cases, increased—physical properties like tensile and tear strength.[1]

Hail resistance

The frequency and severity of hail storms in Canada have been increasing in recent years.[2] In August 2012, Calgary was hit with a rash of massive storms that dropped hail the size of quarters and golf balls. The damage from these storms was so extensive the dollar values of the insurance claims accounted for approximately half of all claims across the country for the entire year. And these storms paled in comparison to the one that hit the same region in 2010.

With North America's severe weather patterns seemingly shifting, an EPDM roofing system can be a suitable choice in a wide variety of geographic areas because of its durability and puncture resistance. Most asphalt-based products and white plastic-based membranes become more brittle with age, and therefore more susceptible to damage from hail impact. The same is not true of EPDM. A 2009 report by roof consultants Jim Koontz and Tom Hutchinson states:

> The results of this research clearly indicate that non-reinforced EPDM… offers a high degree of hail resistance…field and heat aged EPDM membrane… retains the bulk of its impact resistance as it ages.[3]

Another veteran of hail research in the roofing industry, Ric Vitiello of Benchmark Services, has documented his findings in a 15-page report prepared for the EPDM Roofing Association (ERA) in 2007.[4] He commented, "Based on field and test data, it is clear EPDM outperforms other roof systems," adding, "EPDM systems are much more hail-resistant, even without special treatment."

Ballasted EPDM roofs perform especially well in hail storms, as the ballast material atop the membrane serves to break the ice balls on impact. Since the components of a ballasted system are weighted down and held in place using river-washed stones or pavers, they offer additional hail-resistance because the ballast material protects the membrane underneath.

In an independent study conducted by Jim D. Koontz & Associates, new, heat-aged and field-aged EPDM samples were subjected to severe impact by hailstones ranging from 38 to 76 mm (1.5 to 3 in.) in diameter.[5] Regardless of aging, nearly 95 per cent of the EPDM samples passed ASTM standards for hail resistance. The results were overwhelmingly positive, showing the material's usefulness in hail-prone areas or for rooftops that experience excessive traffic.

Reflection and condensation

In warmer climates, where the majority of a facility's energy consumption is due to air-conditioning, reflective 'cool' roofs can cut energy costs, decrease consumption of natural resources, and lower strain on the power grid. For the United States, cool roofs are actually mandated in American Society

Figure 1

	COOLING SAVINGS FROM WHITE	HEATING PENALTY FROM WHITE	NET PENALTY WITH WHITE
Seattle	$154	$1035	$881
Billings	$232	$1103	$871
Minneapolis	$204	$930	$726
Detroit	$313	$1027	$714
Buffalo	$352	$855	$503
Burlington	$280	$1707	$1427

*using R-25, 2322-m^2 (25,000-sf) office building with mid-efficiency gas heat and electric cooling

Examples of heating 'pealties' in Northern U.S. cities.

Dark-coloured roofs can reduce the likelihood of condensation-related issues, particularly in cold-climate regions.

of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) Zones 1, 2, and 3 because of the energy savings they can provide. However, there can be negative consequences to installing a reflective roof in a colder climate.

Reflective roofs are cool in the summer and become much colder during the winter. As a result, these membranes fall below the dewpoint, and remain below, for much longer periods than darker-coloured membranes. This can lead to problems with condensation, particularly in facilities with high relative humidity (RH). Dark-coloured roofs can reduce the likelihood of condensation-related issues, particularly in cold-climate regions.

Condensation in roofing slowly erodes the components in a silent fashion, eventually leading to premature failure. In a comprehensive study, "Condensation Risk of Mechanically Fastened Roof Systems in Cold Climates," conducted by Manfred Kehrer from the U.S. Oak Ridge National Laboratory (ORNL) and Simon Pallin of the University of Sweden, it was noted, "a cool roof will accumulate approximately twice as much moisture below the surface membrane as a black surface."[6]

The Canadian requirement to install an air barrier reduces the potential for condensation-related problems; however, if the air barrier is compromised during the life of the roofing system (by adding curbs or pipe vents, or through expansion and contraction forces that cause the air seals to be compromised), the likelihood of condensation problems significantly increases. When condensation forms, the building owners, architects, and/or design professionals are usually liable for condensation-related damages.

Safety issues

In commercial buildings, it is not uncommon for HVAC equipment to be located on the rooftop. Therefore, maintenance workers must visit the roof to service the equipment in all types of weather conditions. Frost, dew, and ice are more prone to form on white membranes and are difficult to see, creating potential for slip-and-fall hazards.

White membranes can be slippery when wet, which can be especially daunting on sloped roofs without a parapet wall. Black membranes, once exposed to the sun, begin melting snow and ice and help a roof surface dry off faster, making it safer for maintenance personnel. White roofs are also more prone to snow and ice accumulation. On sloped roofs, this can create 'avalanche' slides that can crash down on lower roofs, landscaping, and anything else located close to the building. In the case of a 20,067-m^2 (216,000-sf) warehouse in St. Louis, Mo., snow and ice pack movement was enough to dislodge gas lines running across a white roof.

Energy efficiency and environmental impact

Before selecting a roofing product based on expected energy savings, specifiers can explore the expected calculated results that can be found on the U.S. Department of Energy's (DOE's) Roof Savings Calculator.[7] While the Roof Savings Calculator does not contain data for Canadian cities, running the calculations for northern U.S. cities like Seattle, Wash., Billings, Mont., Minneapolis, Minn., Detroit, Mich., Buffalo, N.Y., and Burlington, Vt., shows a white roof colour will cost the building owner a significant amount of money due to the heating penalty (or negative effect on energy costs) associated with white roofs (Figure 1).

One of the primary design concerns among Canadian architects is how to keep buildings warm and comfortable during long, cold winters. A cool roof, by definition, makes this task more difficult.

Another theory states using white roofs will reduce the temperature of cities and, in turn, lower global warming. While white roofs are typically cooler to the touch than black roofs, they merely redirect the sun's energy. As the laws of thermodynamics dictate, the energy does not simply disappear. A recent study by Mark Z. Jacobson and John E. Ten Hoeve from Stanford University's Department of Civil & Environmental

Available in both black and white, ethylene propylene diene monomer (EPDM) assemblies offer a wide range of benefits, including weatherability, hail resistance, energy efficiency, and low environmental impact.

This warehouse in St. Louis, Mo., had significant snow and ice pack movement, dislodging gas lines running across a white roof.

Engineering discusses this phenomenon. It finds the net effect of white roofs may be raising global temperatures.[8]

The 2011 study, titled "Effects of Urban Surfaces and White Roofs on Global and Regional Climate" is much more comprehensive than earlier research, taking advantage of the latest advances in atmospheric computer modelling. Jacobson and Ten Hoeve's research indicated white 'cool' roofs may actually increase, rather than decrease, the earth's temperature.

White roof membranes possess high reflectivity, which causes sunlight and heat to be reflected upward into the atmosphere. There, the heat mixes with black and brown soot particles, which are thought to contribute to global warming. Additionally, the heating burden on buildings with white roofs in northern climates, like those found in Canada, leads to increased heating costs and energy consumption. As more natural resources are used for energy production, more carbon dioxide (CO_2) is emitted into the atmosphere. Reflecting sunlight and heat back into the atmosphere and increasing CO_2 emissions are not helping address global warming.

Conclusion

Of course, there are facilities that must be kept cold, like ice hockey rinks and freezer facilities, where a cool roof could make sense even in a cold climate. However, with a firm grasp of the trade-offs in weatherability, safety, condensation risk, energy efficiency, and environmental impacts, it would appear darker-coloured roofing assemblies would be a more suitable choice for northern climates.

Notes

[1] For more info, visit www.epdmroofs.org/attachments/2010_epdmaproventperformerepdm.pdf and www.epdmroofs.org/epdm-todays-choice/long-term-performance.

[2] Visit ec.gc.ca/meteo-weather/default.asp?lang=En&n=7E041C81-1.

[3] For more, visit www.rci-online.org/interface/2009CTS-Proceedings-koontz-hutchinson.pdf. Hutchinson has also written for *Construction Canada* about stone wool insulation and roofing. The article, "High Fibre Diet," appeared in the March 2011 issue. Visit www.constructioncanada.net and select "Archives."

[4] Visit www.epdmroofs.org/attachments/2007_04_comparativeperformanceofepdmrubberroofingmembraneasprotection-with%20editorial%20notes%20added%20in%20text.pdf.

[5] Visit www.rci-online.org/interface/2009CTS-Proceedings-koontz-hutchinson.pdf.

[6] Visit www.rci-online.org/interface/2013-CTS-kehrer-pallin.pdf.

[7] Visit web.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm.

[8] Visit www.stanford.edu/group/efmh/jacobson/Articles/Others/HeatIsland+WhiteRfs0911.pdf.

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