Sustainability of EPDM

HIGHLIGHTED BY LIFE-CYCLE ASSESSMENT

New LCA study shows EPDM offers outstanding performance in reducing environmental impact.

A new Life-Cycle Assessment, or LCA, of the long-term environmental impact of EPDM shows that it performs significantly better than comparable roof assemblies. Equally as important, the study—based on the most up-to-date data supplied by industry and public sources—reports that the environmental impact of EPDM is lower than previously thought. LCA is an analysis of the environmental aspects and potential impacts associated with a product, process, or service. It is also a criteria that is growing in importance and for assessment of environmental impact.

The study was conducted on behalf of the EPDM Roofing Association (ERA) by the GreenTeam, Inc., a strategic environmental consulting firm based in Tulsa, Okla., that specializes in building industry issues. The LCA included all inputs associated with the manufacture and installation of various roofing systems, including EPDM, TPO, PVC and SBS modified bitumen. (The sidebar on page 13 shows all the roofing systems assessed in the GreenTeam LCA study.)

Upon completion of the study, the GreenTeam data was submitted to the Athena Institute for adoption into its EcoCalculator, the industry standard for life-cycle analysis data pertaining to construction materials. Specifically, a July 2010 life-cycle assessment of roofing assem-

FIGURE 1. ROLE OF SERVICE LIFE

Membrane		System	Global Warming (Kg. CO^2)	Min. Service Life to Achieve Equivalency[1]
EPDM	60 Mil Black	Ballasted	28.3	**19 Years**
	60 Mil Black	Adhered	29.6	**19.8 Years**
	60 Mil Black	Mech. Att.	28.7	**19.2 Years**
	60 Mil White	Adhered	22.4	**15 Years**
TPO	60 Mil White	Adhered	30.0	**20.7 Years**
	60 Mil White	Mech. Att.	29.8	**20 Years**
PVC	60 Mil White	Adhered	73.1	**49 Years**
	60 Mil White	Mech. Att.	67.8	**45.4 Years**
SBS	140 Mil	Adhered	81.8	**54.8 Years**

[1]Using a comparative service life of 15 years for the lowest GWP system (fully adhered white EPDM)

blies using the Athena EcoCalculator with revised EPDM data generated by the GreenTeam shows that EPDM roofing has a lower environmental impact than PVC, TPO and asphalt based roof systems. For a typical low-slope roof over R-20 insulation and a steel deck, the EcoCalculator found that EPDM offers the lowest Global Warming Potential (GWP):

- **EPDM:** 6.93 kg CO^2 / sq. ft.
- **PVC:** 11.31 kg CO^2 / sq. ft.
- **Modified Bitumen:** 11.80 kg CO^2 / sq. ft.
- **BUR:** 20.74 kg CO^2 / sq. ft.

At only 6.93 kg CO^2 per square foot, EPDM's GWP is nearly half the nearest material. The easy-to-use EcoCalculator is available for free download at the Athena website (http://www.athenasmi.org). The calculator is available in a number of versions based on local climate conditions. The data above was generated using ASHRAE Zone 3, which would include Atlanta, Ga.

WHY IS LCA IMPORTANT?

As a forward-thinking organization that stresses environmental stewardship, ERA is keenly aware that LCA is likely to become an increasingly significant factor within the building industry in the future. The study conducted by the GreenTeam is evidence of this awareness.

At the same time, significant progress has been made to establish the specific criteria for an unbiased playing field to create effective LCA studies.

In regard to LCA and LEED, the U.S. Green Building Council has established Pilot Credit 1 Life Cycle Assessment (LCA) of Building Assemblies and Materials. The credit specifically calls for the use of the Athena Impact Estimator and EcoCalculator in order to calculate the number of LEED points than can be awarded based on a material's life-cycle impact.

As a pilot credit, its use is not mandatory, however many designers are looking into the process because the work involved is relatively simple. Most experts anticipate the pilot credit to be adopted into the next version of LEED. More information about this credit is available at http://www.leeduser.com/credit/Pilot-Credits/PC1#bev-tab

Currently, the International Green Construction Code (IgCC) encourages, but does not require, life-cycle assessment. The code offers an elective credit that may be adopted as either a mandatory requirement or as part of a menu of optional requirements by a local code body.

Moreover, the growing emphasis on environmentally responsible building practices; more sophisticated criteria for financing of construction projects; and, increasing governmental regulation within public construction is also making LCA requirements more likely in the future.

ENSURING ACCURACY OF LCA STUDIES

Because the LCA process involves a final step of interpreting the results, it is often employed as a comparative method to make decisions among alternatives. However, this is particularly challenging in the arena of low-slope roofing systems, which feature widely varying chemical components, installation methods and expected service lives.

In the most recent LCA study conducted by the GreenTeam, all outputs and impacts were calculated using SimaPro LCA software. Impacts were summarized using the categories and unit measures of the U.S. EPA TRACI Model. All materials studied were assumed to provide equal service lives, so the basic impacts were unadjusted for service life, and all impacts were calculated based on one square meter (M^2) of installed membrane.

Energy-related categories such as global warming appear to offer the greatest relevance. GWP as measured by kilograms of CO^2-equivalents varied from a low of 22.4 kg per square foot (fully adhered white non-reinforced EPDM) to a high of 81.8 kg per square foot (140-mil smooth surface SBS).

The relevance of the global warming category is further supported by the degree of differences exhibited by the membranes studied. As an example, the global warming potential of a white PVC or smooth surface SBS membrane is more than twice that of a black EPDM or white TPO roofing membrane for all system types studied.

ROLE OF INSTALLATION

One of the most interesting findings in the study is the minimal role played by attachment method in determining overall environmental impact. As an example, the various attachment methods studied (ballasted, fully adhered, mechanically attached) appear to affect overall GWP by less than 4 percent for EPDM and TPO and less than 7 percent for PVC. This lack of demonstrable difference suggests that the selection of the most suitable application method should be based on other factors such as potential longevity, ease of repair, etc.

For the TPO and PVC membranes, membrane color appears to play little or no role as a differentiating factor. As an example, the GWP for a fully adhered gray 60-mil TPO membrane (30.5 kg/ft^2) is essentially identical to the GWP for a similar white 60-mil TPO membrane (30.9 kg/ft^2). For EPDM membranes, however, the difference between white and black is more pronounced, with a fully adhered white 60-mil EPDM membrane exhibiting the lowest GWP of the study (22.4 kg/ft^2) as compared to a similar black 60-mil EPDM membrane (29.6 kg/ft^2).

THE ROLE OF SERVICE LIFE

At the conclusion of the study, the GreenTeam identified the number of years each roof system would have to perform in order to negate their GWP created during their manufacture and installation. This service life equivalency was calculated using a service life of 15 years for the system with the lowest GWP — fully adhered white EPDM — as a benchmark to compare all other systems. It was found that all four EPDM systems in the study exhibited the lowest ser-

vice life equivalencies among all tested systems, which means an EPDM system requires less service time to become carbon neutral than its counterparts. Combine the low equivalency ratings with a service life that can often exceed thirty years, and it's easy to see how EPDM can be considered one of the most sustainable and environmentally friendly roof systems available. Figure 1 (see Role of Service Life, page 11) illustrates this comparison among widely used low-slope roofing systems.

The LCA conducted by the GreenTeam was based on a cradle-to-building approach. As a consequence, no impacts were identified or measured for activities that occur during the service life of the roofing system (routine maintenance and periodic repair or renovation) or at the end of service life (removal, disposal and possible recycling).

Although many of the activities not addressed by this study such as routine maintenance and periodic renovation generate relatively small environmental impacts, their value in extending service life may be much more important than their incremental impact contribution.

For a roof system designer, the opportunity to reduce overall environmental impact by extending useful service life implies that material or design features supporting this opportunity should receive considerable attention. Such features may include the ability to accurately predict maintenance and repair requirements, relative ease of repair, and the ability to remove and replace selected roof system components.

ROOFING SYSTEMS ASSESSED BY GREENTEAM STUDY

The LCA included the following low-slope roofing membranes, thicknesses and application methods:

Membrane Types:

- Non-reinforced EPDM (black & white*)
- Reinforced EPDM (black)
- Reinforced TPO (gray & white**)
- Reinforced PVC (gray & white**)
- SBS modified bitumen (smooth surface)

*white top layer over black bottom layer
**white top layer over gray bottom layer

Membrane Thicknesses:

- 45 mil (Non-reinforced EPDM, black only)
- 60 mil (Non-reinforced and Reinforced EPDM, Reinforced TPO and PVC)
- 72 mil (Reinforced TPO)
- 80 mil (Reinforced TPO and PVC)
- 90 mil (Non-reinforced EPDM, black only)
- 140 mil (SBS modified bitumen)

Application Methods:

- Loosely laid and ballasted (EPDM, TPO, PVC)
- Fully adhered (Non-reinforced and reinforced EPDM, reinforced TPO and PVC, SBS modified bitumen)
- Mechanically attached (Reinforced EPDM, TPO and PVC)

In addition to the above membranes and application methods, the following ancillary materials necessary for system installation were also evaluated:

- Metal fasteners and plates (For insulation attachment and membrane securement as required for fully adhered and mechanically attached applications)
- Membrane bonding adhesive (for fully adhered applications)
- Ballast stone (for ballasted applications)

All LCAs were conducted on a "cradle-to-gate" (or cradle-to-building) basis, including all necessary inputs to complete the installation of the roofing membrane. Additional studies will be necessary to extend this research to include in-service and end-of-life impacts.

Input Sources. Sources of input used by the GreenTeam included:

- Previous LCA studies of low-slope roofing systems (Franklin Associates, 2001; Morrison Hershfield Ltd., 2001)
- EPDM membrane composition (TRC Environmental Corporation, 1995)
- EPDM Roofing Association (ERA) supplied information
- EPA AP-42 emission factors
- Existing LCI Databases (US LCI, Ecoinvent / SimaPro, Athena Institute)

LCI data for TPO, PVC and SBS modified bitumen was derived primarily from the Athena Institute and was based on the Franklin Associates and Morrison Hershfield LCA studies.

LCI data for EPDM was derived from Rubber Manufacturers Association (RMA) compounding and manufacturing data provided by TRC Environmental, supplemented by EPA AP-42 and existing LCI database information.

LCI data for metal fasteners and ballast stone were derived from existing LCI database information. LCI data for bonding adhesive was derived from generic adhesive formulation information provided by ERA.

For more information, visit epdmroofs.org.

TAKING THE NEXT STEP

As mentioned above, the LCA data in the GreenTeam study was conducted using a cradle-to-building approach. For this reason, additional studies will be necessary to extend this research to include in-service and end-of-life impacts.

It is also important to reiterate that after an internal review, Athena accepted and incorporated current data from ERA and updated its LCI database. Similar steps will now take place with the U.S. LCI database for use with the BEES tool developed by the National Institute of Science and Technology, as well as other LCA tools.

In the interim, it would be prudent for building design professionals using the Athena EcoCalculator to be aware of the significantly reduced EPDM impact data demonstrated by this study.