EPDM: A PROVEN PERFORMER

Long-term weathering study shows 30-year roofs continue to perform well.

A brand-new study of roof systems conducted on behalf of the EPDM Roofing Association (ERA) provides tangible proof of the long-term performance capability of EPDM roof systems. The study concluded that all of the systems examined were still performing as intended after 28 to 32 years of in-field service. The study shows that all of the aged EPDM roof samples taken have physical characteristic properties above or just below the ASTM minimum properties required of newly manufactured 45-mil EPDM membrane.

The testing performed in ERA's latest study examined five critical performance characteristics of the EPDM membrane. The roofs were inspected first-hand to give researchers a good sense of their condition in the field. Then, samples were sent to Momentum Technologies, a testing facility for the roofing industry in Uniontown, Ohio, where the following tests were performed:

- Elongation (%)
- Tensile (psi)
- Thickness XD (Cross Direction) (in)
- Thickness MD (Machine Direction) (in)
- Factory Seam Strength (psi)

The test results of these advanced-aged EPDM membranes confirm the facts generated from earlier studies—EPDM withstands the effects of various climates extremely well.

Not only can properly designed, installed and maintained EPDM membranes successfully withstand extreme weather cycles, the testing also indicates that these roofs and other EPDM systems can approach or exceed 40 years of service life.

"The first field studies of EPDM were done in the late 1980s, and we are finding a pattern," says Thomas W. Hutchinson, AIA, FRCI, RRC and principal, Hutchinson Design Group, Ltd., Barrington, Ill. "The pattern is that these roofs can really last a long time. By using today's advanced design techniques and proper roof maintenance, property owners should actually get more than 30 years out of an EPDM roof."

To help prove that theory, the samples from the latest study are being heat-aged and tested at prorated "life spans" of 40, 50 and 60 years. Updates from this study will be posted on www.epdmroofs.org.

The continued analysis of these roof systems by ERA will help develop a study that will provide details on the design and management processes that would enable such a long service life. It is believed that the information in the study

FIGURE 1. ELONGATION TEST RESULTS

Sample #	Roof Type/Location	Sample Age (yrs.)	ASTM Standard	Manufacturer Minimum	Test Results
1	**Ballasted 45 mil EPDM** N. Michigan University • Jacobetti Ctr. 1401 Presque Isle Ave. Marquette, MI 49855	32	D4637	New 350% Aged 200%	252.71%
2	**Ballasted 45 mil EPDM** N. Michigan University • Jamerich Bldg. 1401 Presque Isle Ave. Marquette, MI 49855	29	D4637	New 350% Aged 200%	494.07%
3	**Ballasted 45 mil EPDM** North Asheboro Middle School 1861 North Asheboro School Rd. Asheboro, NC 27203	28	D4637	New 350% Aged 200%	339.23%
4	**Ballasted 45 mil EPDM** 5296 County Road P West West Bend, WI 53095	29	D4637	New 350% Aged 200%	287.05%
5	**Fully Adhered 45 mil EPDM** Barrington C.C.S.D. 220 310 James Street, Barrington, IL 60010	29	D4637	New 350% Aged 200%	165.51%

will have great relevance to achieving long-term service for a number of roof systems, by encouraging thoroughly planned assessments and interventions via roof inspection and maintenance.

"Based on the data we've seen, we can predict that a 90-mil EPDM membrane that is not physically abused has the potential to last for an extended period of time," says Hutchinson. "We are talking far beyond the building owner's expected service life. It is reasonable to expect greater than 50 years from a 90-mil membrane"

FIGURE 2. TENSILE STRENGTH TEST RESULTS

Sample #	Roof Type/Location	Sample Age (yrs.)	ASTM Standard	Manufacturer Minimum	Test Results (psi)
1	**Ballasted 45 mil EPDM** N. Michigan University • Jacobetti Ctr. Marquette, MI	32	D4637	1305.00	1888.7
2	**Ballasted 45 mil EPDM** N. Michigan University • Jamerich Bldg. Marquette, MI	29	D4637	1305.00	1836.5
3	**Ballasted 45 mil EPDM** Asheboro, NC	28	D4637	1305.00	1828.8
4	**Ballasted 45 mil EPDM** West Bend, WI	29	D4637	1305.00	2200.9
5	**Fully Adhered 45 mil EPDM** Barrington, IL	29	D4637	1305.00	1519.0

The 29-year-old EPDM roof protecting the Jamerich Building at Northern Michigan University in Marquette, Mich., is still performing well.

THE STUDY IN DETAIL

The goals of ERA's long-term service life study were to:

- Verify the long-term performance characteristics of EPDM membrane
- Validate empirical sustainability experiences
- Create a foundation for specifier-to-owner discussions in regard to long-term service life.

To conduct the study, samples from five roof systems, installed between 28 and 32 years ago, were collected for analysis. They were:

1) A ballasted, 45-mil EPDM roof membrane (sample age: 32 years); Northern Michigan University; Jacobetti Center; Marquette, Mich.

2) A ballasted 45-mil EPDM (sample age: 29 years); Northern Michigan University; Jamerich Building; Marquette, Mich.

3) A ballasted 45-mil EPDM (sample age: 28 years); North Asheboro Middle School; Asheboro, N.C.

4) A ballasted 45-mil EPDM (sample age: 29 years); warehouse facility; West Bend, Wisc.

5) A fully adhered 45-mil EPDM (sample age: 29 years); Barrington Combined Community School District 220 Headquarters; Barrington, Ill.

Momentum Technologies conducted the factory seam strength tests using the ASTM Standard D816 - *Standard Test Methods for Rubber Cements*. The other four tests were conducted, using the ASTM Standard D4637 - *Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane*. In addition, manufacturer minimum physical properties for new EPDM were applied to the results.

Those results showed that all of the samples had physical characteristic properties above or just below the minimum physical characteristics of a newly manufactured 45-mil EPDM membrane.

For example, regarding elongation test results (Figure 1), four of the five roof samples exceeded the minimum characteristics for aged EPDM, and one exceeded the minimum for new EPDM.

For Tensile Strength (Figure 2), all five samples exceeded the minimum standard for newly manufactured membranes. For thickness XD (cross direction) (Figure 3), three samples exceeded the manufacturer minimum, while the other two missed by one one-thousandth of an inch. For thickness MD (machine direction), three achieved or exceeded the minimum, while one missed by one one-thousandth of an inch and another by four one-thousandths of an inch. For factory seam strength (Figure 4), it was only possible to test two of the samples, and both easily surpassed manufacturers' minimums.

ADDITIONAL OBSERVATIONS

ERA representatives are quick to point out that while a qualified roof inspector can make some judgments about the performance of a roof membrane in situ, the group's most current study "takes the process five steps further" by analyzing several different aspects of membrane performance.

One thing readers need to be keenly aware of is the state of EPDM technology at the time that these roofs were installed.

"The 45-mil EPDM roofs we examined are about as cost-effective as you can make them in terms of manufacture and design," says Hutchinson. "In addition, the proven installation methods we use today were still in their infancy when these roofs were installed.

"From this study, as well as our previous experiences in places like Saudi Arabia, we have found that ballasted or 'protected' EPDM membranes will exhibit even better weathering performance than exposed roof membranes."

FIGURE 3. THICKNESS TEST RESULTS

Sample #	Roof Type/Location	Sample Age (yrs.)	ASTM Standard	Manufacturer Minimum (in)	XD Test Results (in)	MD Test Results (in)
1	**Ballasted 45 mil EPDM** N. Michigan University • Jacobetti Ctr. Marquette, MI	32	D4637	0.0405	0.0390	0.0360
2	**Ballasted 45 mil EPDM** N. Michigan University • Jamerich Bldg. Marquette, MI	29	D4637	0.0405	0.0430	0.0390
3	**Ballasted 45 mil EPDM** Asheboro, NC	28	D4637	0.0405	0.0400	0.0400
4	**Ballasted 45 mil EPDM** West Bend, WI	29	D4637	0.0405	0.0390	0.0450
5	**Fully Adhered 45 mil EPDM** Barrington, IL	29	D4637	0.0405	0.0530	0.0530

FIGURE 4. FACTORY SEAM STRENGTH TEST RESULTS

Sample #	Roof Type/Location	Sample Age (yrs.)	ASTM Standard	Manufacturer Minimum (psi)	Test Results (psi)
1	**Ballasted 45 mil EPDM** N. Michigan University • Jacobetti Ctr. Marquette, MI	32	D816	N/A	N/A
2	**Ballasted 45 mil EPDM** N. Michigan University • Jamerich Bldg. Marquette, MI	29	D816	N/A	N/A
3	**Ballasted 45 mil EPDM** Asheboro, NC	28	D816	N/A	N/A
4	**Ballasted 45 mil EPDM** West Bend, WI	29	D816	± 100	677.40
5	**Fully Adhered 45 mil EPDM** Barrington, IL	29	D816	± 100	734.30

A HISTORY OF PERFORMANCE

It should come as no surprise that a well-designed and installed EPDM roof can attain a service life of 30 years or more.

In fact, EPDM roofing systems have been "under the microscope" of researchers for almost two decades. One of the industry's first key studies was presented in 1991 at the *Third International Symposium on Roofing Technology.* This kind of detailed scrutiny is without precedent in the single-ply roofing industry, and all of it has shed a positive light on the long-term weathering performance of EPDM membranes.

In the 1991 study, 45 membrane samples were cut from roofs in 13 states. The eight- to 10-year-old 45-mil EPDM membranes were tested for tensile strength, elongation, tear resistance, hardness, brittleness temperature, glass transition temperature and appearance.

The physical properties of the samples taken from the roofs showed a general *increase* in tensile strength and tear resistance. The brittleness temperature of these early membranes actually improved upon roof exposure.[1]

"All membranes except the 17-year-old sample were still in their early years of service life," says Brian Gish, co-author of the study. "The 17-year-old membrane had approached middle age in terms of performance, although its tensile strength was still quite high."

In 2003, EPDM roof membranes were again the focus of rigorous testing. ERA conducted a study to update the findings of Gish and Kathleen Lusardi, selecting 33 membranes—aged between 16 and 26 years—from in-service roofs in nine states. The samples included 10 ballasted and 23 fully adhered and mechanically fastened EPDM roofs.

The tensile strength, ultimate elongation, and tear resistance of the ballasted membranes remained relatively unchanged after 23 years of service life.[2] "There was no significant, observable deterioration of EPDM's physical properties," wrote researcher Tim Trial, Ph.D.

While the same general trend was observed in exposed membranes in terms of tensile strengths and tear resistance values, a decrease in the ultimate elongation was observed due to UV exposure. But overall, the study "confirms the excellent field-aging performance of EPDM," Trial reported.

WARRANTY RECORDS AS A MEASURE OF SERVICE LIFE

Prior to Dr. Tim Trial's study, James Hoff, DBA, evaluated the performance of aged EPDM membranes through an examination of manufacturer warranty records.[3] At that time, the repair costs of the first five years of service life for EPDM membranes declined by 84.6 percent. The study was updated in 2003 to include the repair costs over the first 10 years of service life (i.e., 1982 to 1993), demonstrating a repair cost drop of 60 percent between 1987 and 1993, and an astounding 93 percent decrease over the course of the study. Hoff, who is currently research director for the Center for Environmental Innovation in Roofing and president of TEGNOS Research Inc., Carmel, Ind., attributed the decline in warranty repair costs to advances in several important EPDM detailing technologies.

Today, Hutchinson continues to see "a huge preponderance of EPDM roofs in the Midwest that are doing well."

"All of the roofs we investigated were leak-free," reports Hutchinson. "The elongation of these roofs has decreased a bit, as expected, but they are still above the minimum requirements for a new EPDM roof today."

References: 1. Gish, B.D. and K.P. Lusardi, Proceedings of the 3rd International Symposium on Roofing Technology *(1991), p. 159-166.; 2. Trial, T.R. Robinson and B. Gish,* Proceedings of the RCI 19th International Conference *(2004); 3. Hoff, J.L.,* RCI Interface *(Sept. 2003).*