

# COMPARATIVE PERFORMANCE OF EPDM RUBBER ROOFING MEMBRANE AS PROTECTION AGAINST HAIL DAMAGE

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## **Introduction**

Among the most serious and challenging threats to the performance of any roofing system is hail damage. Failure of a roof membrane due to hailfall can result in flooding and damage to inventory and equipment. Protecting against hail damage is one of the ultimate tests of any roofing system.

This white paper will review the hail protection performance of several roofing systems, especially an EPDM (Ethylene Propylene Diene Terpolymer) roofing membrane. With more than 40 years of success as a roof system of choice for low slope applications, EPDM is the leading roofing choice of architects, roof consultants and contractors for both new construction and replacement roofing projects, with more than 20 billion square feet of EPDM roof installed on more than 500,000 warranted roofs.

The information in this paper is based on personal research and site studies I have conducted since 1989 while serving as a roof consultant to insurance companies, individuals and corporations. With more than 25 years of experience in the roofing industry, I am a Professional Member of the Roof Consultants Institute (RCI) and a Member and Trained Hail and Wind Damage Investigator of the Roofing Industry Committee on Weather Issues (RICOWI).

## **Hail Damage a Growing Concern**

The “hail belt” area of the United States, the region most susceptible to hailstorms, appears to be getting larger, according to research from the National Oceanic and Atmospheric Administration’s (NOAA) National Severe Storms Laboratory. Areas of the country that were not particularly vulnerable to hailstorms now seem to be receiving hail fall and areas that regularly received hailstorms are seeing more storms with larger hail. The map in figure 1 below shows sections of the Midwest and the East that are particularly prone to receiving hailfall greater than  $\frac{3}{4}$  inch in diameter. This is the size that is generally considered the minimum threshold for property damage.

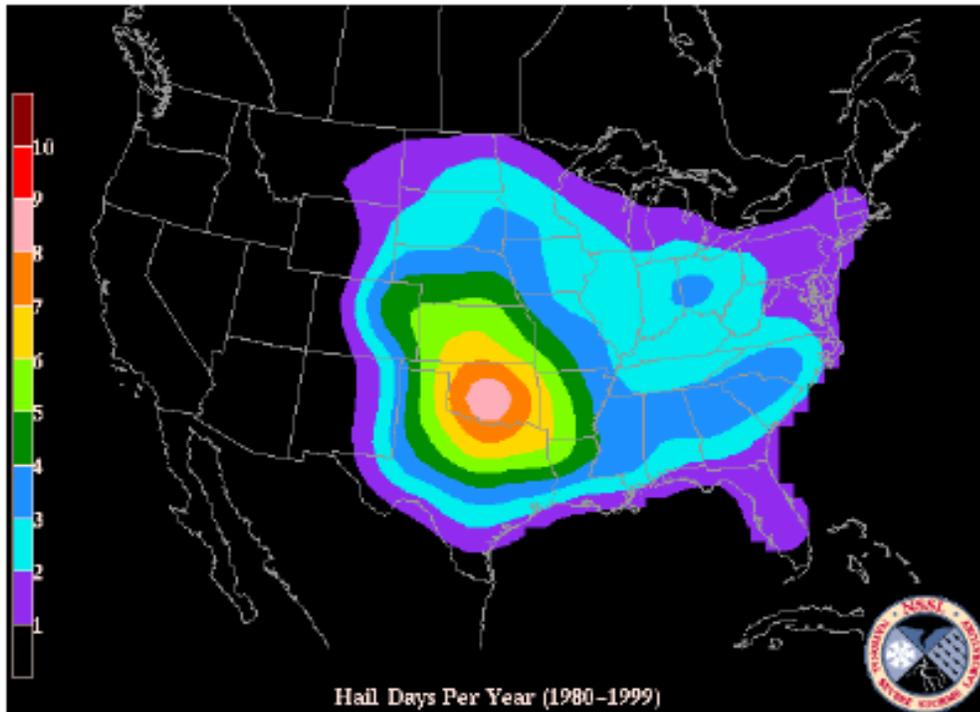


Figure 1. Average number of days per year where hail greater than or equal to 0.75" in diameter may occur within 25 miles of any point in the United States base upon NWS reports for the years 1980 to 1999 (source: DOC/NOAA/National Severe Storms Laboratory).

## Review of Roofing Systems' Hail Protection Performance

In recent years, the range of options for roofing systems has grown dramatically. Using information, both anecdotal and objective, gained during numerous site studies, we will review the performance of several of these systems in regards to protection against hail damage. While it is clear these materials perform in a more than acceptable fashion in most circumstances, they struggle to maintain their protective qualities when facing significant hailfall.

### BUILT-UP ROOF

The beginnings of built-up roofing technology go back as far as ancient Egypt with the use of pitch as a waterproofing agent. The great improvement came with the addition of interleaved felt plies to provide tensile strength to hold the system together. The bitumen used in modern systems may be coal tar pitch or asphalt but both are considered to be built-up roofs. Gravel surfaced built-up roofs are somewhat less likely to be hail damaged than smooth surfaced built-up roofs because the gravel disperses the impact energy but when damage does occur it can be more difficult to pinpoint.

Smooth surfaced or gravel, the result is the same. The asphalt or pitch is displaced or cracked at the surface and the fiberglass felt may be fractured allowing water infiltration and the beginnings of premature deterioration. Water infiltration into the insulation may spread and what begins as a small puncture may become a large repair. Multiple hail blemishes may require tear-off and re-roof as the only practical remedy. The photo in figure 2 below shows a hail impact fracture on a smooth surfaced asphalt built up roof.



**Figure 2 - Built -up roof damaged by 1 1/2" hail**

### SPRAYED POLYURETHANE FOAM

SPUF (Sprayed Polyurethane Foam) roofs are popular in some areas where hailstorms are becoming more frequent. Although the foam is closed cell and may not leak immediately after damage by hail, the required repairs to this type of roof can be very costly and the fractures can be particularly difficult to find on some of the newer granule surfaced systems. Hail damage on these roofs can be repaired unless the number of hail fractures is very large which then may require tear-off and re-roof or at least scarifying of the surface and re-coating. The photo in figure 3 reveals a fracture of the SPUF coating caused by hail impact approximately 1 1/2 inch in diameter.



**Figure 3 - Hail Damaged granule surfaced SPUF Roof**

## MODIFIED BITUMEN

Modified bitumen roof systems have been popular in this country for more than 30 years. They were originally invented in Europe and provide good service when applied correctly in the appropriate situation. Modified Bitumen is composed of asphalt that has had modifiers processed with it to give it plastic or rubber-like properties. The two most common modifiers are APP (Atactic Polypropylene) and SBS (Styrene Butadiene Styrene). Both types of modified bitumen are provided in rolls approximately three feet wide. The membrane is rolled out and seamed together with heat or cold adhesive. The system is usually made up of two or more plies similar to a built-up roof.

Modified bitumen systems are typically more hail resistant than smooth surface built up roofs but other factors come into play. The APP membrane is modified with a plastic and so is less flexible than rubber. This makes it somewhat vulnerable to fracture by hail. The SBS membrane is modified with a type of rubber that is vulnerable to ultraviolet degradation which the sun will deteriorate in short order.

Because of this, the membrane is protected by a granule surface. This granule surfacing may be displaced by hail impact and even though the membrane is not fractured, it would require replacement due to the granule displacement. Both APP and SBS membrane systems can be damaged by hail impact since they are still asphaltic products. The photos in figures 4 and 5 show an unsupported area on a smooth surfaced APP membrane and an SBS granule surfaced membrane. Both were damaged by approximately 1 ½ inch diameter hail.



**Figure 4 - APP Modified Bitumen Punctured By Hail**



**Figure 5 - SBS Modified Bitumen Roof Granule Displacement Caused By Hail**

### PVC SINGLE-PLY

PVC (Polyvinyl Chloride) single-ply roofing membrane has become a popular choice in the last 25 years. Each manufacturer of PVC membrane has its own slightly different recipe for its PVC product. There are differences in the added ingredients used in various PVC membranes, particularly the plasticizers. Since PVC in its natural state is rigid, the process of making it into a flexible single-ply roof membrane requires the addition of plasticizer chemicals. Some manufacturers use liquid and others use solid plasticizers.

The type of plasticizer used can make a great difference in whether the membrane becomes brittle as it ages and then more vulnerable to hail damage. PVC membrane is typically reinforced with a polyester fabric but some of the older types were not. The following photos in figures 6 and 7 show PVC roofs that have been impacted by  $\frac{3}{4}$  inch to  $1\frac{1}{2}$  inch hail. The first is reinforced and the second is not. The circular fractures eventually transfer through the membrane and develop into leaks.

The last two photos in this series are figures 8 and 9. They show a PVC roof approximately three years after a hailstorm. Repeated repairs were done with various types of surface caulking until the owner finally realized that it would not be possible to seal all of the hail fractures that continued to open up and leak.



**Figure 6 - Reinforced PVC Membrane Hail Fractured**



**Figure 7 - Non-Reinforced PVC Membrane Damaged By Small Hail**



**Figure 8 - Hail Damaged Reinforced PVC Membrane, Temporary Caulk Repairs**



**Figure 9 – Hail Damaged PVC Membrane With Thousands Of Temporary Caulk Repairs**

### **EPDM Roofing Performance in Hail Protection**

EPDM roof membrane provides benefits similar to some other popular membranes like low installation cost, low life cycle, maintenance and repair costs, quick installation and it can even be coated with white acrylic coating to improve its energy efficiency.\* In addition to all of the typical benefits of a high quality roof membrane, EPDM can be installed in such a way to allow for a 30 year warranty against hail damage. The photos below in figures 10 and 11 show EPDM roofs that have been impacted by hail as large as 2½ inches in diameter with no resulting membrane damage, and therefore no leaks.

\*Coating dark colored EPDM with white acrylic coating is a means to reduce air conditioning costs primarily in warm southern climates. Dark colored EPDM helps save heating costs in northern climates.



Figure 10 - EPDM Membrane Impacted by 2 1/2" Hail, No Membrane Damage



Figure 11 - EPDM Fully Adhered To Fiberboard Insulation, No Membrane Damage

## **Adaptability of EPDM roofing systems**

EPDM roof systems can be installed in any of three basic methods. The least expensive is to simply lay the membrane loose over the insulation substrate and cover it with rock ballast to prevent blow-off. The second method is by mechanically attaching the membrane at intervals on the roof and covering the attachment fasteners with EPDM cover-strip material or overlapping seams. The third method is to fully adhere the membrane to the substrate material.

The membrane can also be coated with a white acrylic coating to reflect sunlight and reduce heat gain below the roof.\*The variety of installation options increases the attractiveness of an EPDM roof system for virtually any building.

## **Proven performance**

Since its development more than 40 years ago, EPDM has continued to evolve with changes and improvements along the way. Modern seaming methods as well as accessories details, and flashing materials have helped to make this system the most popular roof membrane used today in the United States.

The membrane is available in 45, 60 and 90-mil thickness. The 90-mil membrane offers higher resistance against damage from hail or other punctures.

Ice balls have been used to simulate hail impact on roof system test decks. Figure 12 shows ultimate failure of the thinner 45-mil membrane only when impacted by a 3” diameter ice ball at 133.2 feet per second, more than 90 miles an hour.

\*Coating dark colored EPDM with white acrylic coating is a means to reduce air conditioning costs primarily in warm southern climates. Dark colored EPDM helps save heating costs in northern climates.

## Simulated Hail Testing September 9, 2005 JDK #60-22-3

### Test Deck #4 - 45 mil Unreinforced EPDM, 2.7" Polyisocyanurate Insulation

<i>Hail Ball, dia.</i>	<i>Impact, ID</i>	<i>Hail Ball Weight, g</i>	<i>Velocity, fps</i>	<i>Impact Energy, lbs*ft</i>	<i>Temp., °F</i>	<i>Pass/Fail</i>
2.75	1	156.2	128.9	88.80	41.6	Pass
2.75	2	156.1	129.8	90.01	39.5	Pass
2.75	3	156.0	129.1	89.03	38.9	Pass
2.75	4	155.9	128.0	87.50	40.7	Pass
2.75	5	156.6	127.7	87.44	38.8	Pass
3.00	1	213.1	133.6	130.21	41.5	Pass
3.00	2	215.3	132.7	129.82	39.1	Pass
3.00	3	217.7	133.2	132.31	39.9	Fail
3.00	4	216.5	133.2	131.41	40.5	Fail
3.00	5	218.2	133.2	132.62	40.0	Fail

Figure 12 – Test data for hail impact on 45-mil thickness membrane.  
Courtesy, Jim D. Koontz & Associates

### 30 year protection against hail damage

Forecasts from NOAA indicate we are entering a cycle, likely to last several years, with more frequent incidents of severe weather. This will increase the importance of effectively protecting buildings and the contents within them from the effects of a catastrophic roof failure. EPDM roof systems provide long-term protection that can extend 30 years or more into the future.

A variety of warranty terms are available for your selection, including 30-year coverage against some levels of hail damage, incidental puncture and wind damage up to 100 miles an hour. This coverage for EPDM systems is significant because most manufacturers of other roof systems do not provide warranty coverage for hail of any size.

Different companies have their own warranty programs. Please contact EPDM membrane manufacturers to learn more about warranty specifics for EPDM membrane products.

### Summary

Based on field and test data, it is clear that EPDM roof membranes outperform other roof systems in terms of hail protection. In tests including simulation of hail up to three

inches of diameter, EPDM roofing membranes did not suffer membrane damage and avoided leaking problems endemic to other roofing surfaces in similar circumstances.

As added incentives to potential buyers, EPDM roofing manufacturers and suppliers offer their product in a variety of thicknesses and with three installation options. These cost-effective considerations, combined with extensive warranty coverage as insurance of performance, make EPDM roofing the leading choice, especially when determining roofing options in areas of the country with significant hailfall.

### **Implementation**

Visit the EPDM Roofing Association [www.epdmroofs.org](http://www.epdmroofs.org) Web site for more information about the EPDM roof systems and how they can benefit you.

#### **EPDM Roofing Membrane Manufacturers:**

Carlisle-Syntec [www.carlisle-syntec.com](http://www.carlisle-syntec.com)

Firestone Building Products Company [www.firestonebpco.com](http://www.firestonebpco.com)

### **About the author**

Ric Vitiello is President of Benchmark Services Inc., a forensic roof consulting company based in Louisville, Ky., that specializes exclusively in roof failure analysis.

His professional credentials include:

- More than 25 years of experience in the roofing industry.
- Professional Member of the Roof Consultants Institute (RCI).
- Member and Trained Hail and Wind Damage Investigator with the Roofing Industry Committee on Weather Issues (RICOWI).
- Past President and Co-Founder of the Greater Louisville Roofing Contractors Association now merged with the Kentucky Roofing Contractors Association (KRCA).
- Served 12 years as a Board Member of the Louisville Better Business Bureau.
- Certified Arbitrator for the National Panel of Consumer Arbitrators.