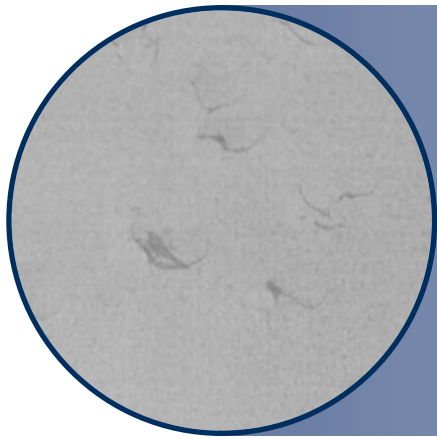


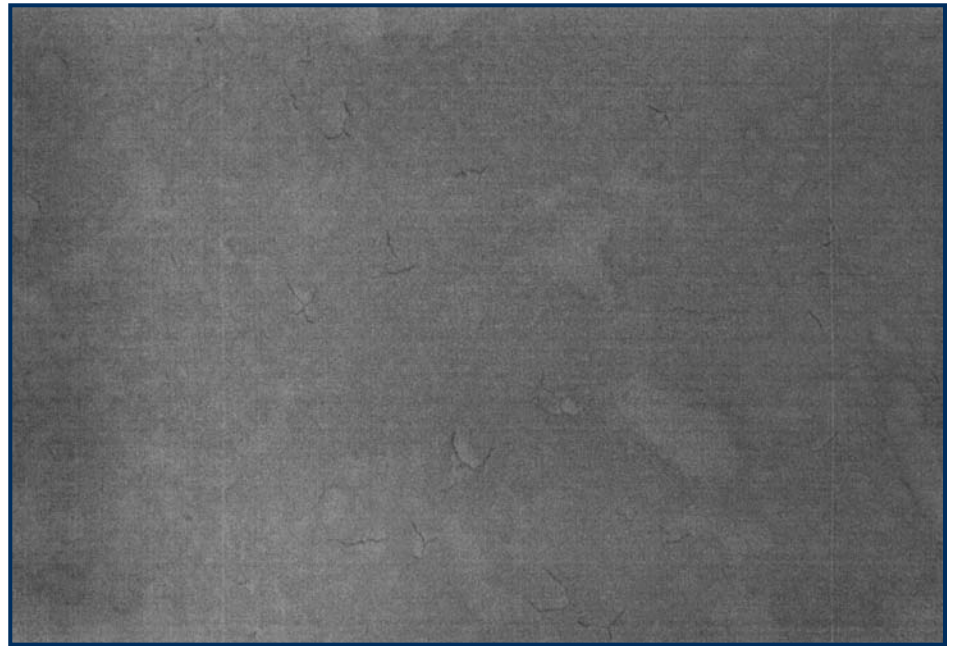


INSPECTION, EVALUATION, AND REPAIR OF SPF ROOFING SYSTEMS AFTER A WINDSTORM OR HAIL EVENT

BY MASON KNOWLES AND DON BEST

ABSTRACT:

SPF roofing systems have exceptional sustainability characteristics. They save energy, are resistant to high winds, protect the substrate against damage from hail and wind-driven missiles, and are renewable. However, when a SPF roof sustains damage from wind-driven missiles or hail, how does one determine what procedures are required to maintain the roof's long-term performance? Under which conditions can the roof be renewed? When must it be scarified, recoated, or torn off? This presentation will discuss the type of damage likely to occur during windstorms and hail events, the effect on the SPF roofing system's performance, and common sense guidelines for inspecting, evaluating, and recommending repairs. It will be presented at a technical session at RCI's Annual Convention in Reno, NV on March 25, 2000.



Note the light hail damage requiring recoating.

DAMAGE

Coating Abrasion

This condition occurs when hurricane-force winds blow sand at a velocity sufficient to erode the protective coating over the SPF. Coating-abraded SPF roofs are repaired by recoating the affected areas. (Note: If UV degradation has occurred, the affected areas must be scarified and refoamed before new coating is applied.)

Missile Damage

During high wind events, a variety of materials can potentially impact a roof and produce damage. Missile damage refers to cuts, gouges, dents, and abrasion to coating and SPF caused by flying items such as tree branches, signs, parts of other buildings (shingles, metal panels, flashing, doors, windows, etc.), and many other non-secured items hitting the roof during a windstorm. The authors have even seen a sailboat end up on a roof. The damage may be isolated to small areas of the roof or cover

large areas. Substrate damage and structural damage may or may not occur.

The type of repairs required will depend upon the size and severity of the damage. Repair small cuts (less than 3" in the SPF diameter) by caulking the holes after the damaged SPF is removed. Repair larger damaged areas by removing damaged SPF and applying new SPF and coating to the void.

Hail

Damage most likely to occur to SPF roofing systems during hail event consists of cracks, punctures, and dents to the surface of the roof. Both the protective covering/coating and the SPF can be damaged. When hail strikes a SPF roof, cracks shaped like crow's feet or semicircles may appear on the coating surface.

The diameter of the cracks can be used to determine the hail stone size. The SPF, depending on the size, weight and shape of the hail, may be dented as well. The depression typically ranges from 1/8" to 3/4" in depth. Hail damage can be isolated to small areas or cover the whole roof. Determining short-term and long-term repairs to hail damage depends on identifying the severity

INSPECTION PROCEDURES

Visual Inspection

- Look for blisters or delaminated areas.
- Check the condition of the roofing system at all flashing and termination points.
- Look for splits or cracks in the SPF.
- Look for damage from impact.
- Check for pinholes in the SPF or coating.
- Check for exposed SPF and areas of eroded coating.
- Check for areas of ponded water.
- Check for obvious substrate or structural damage.

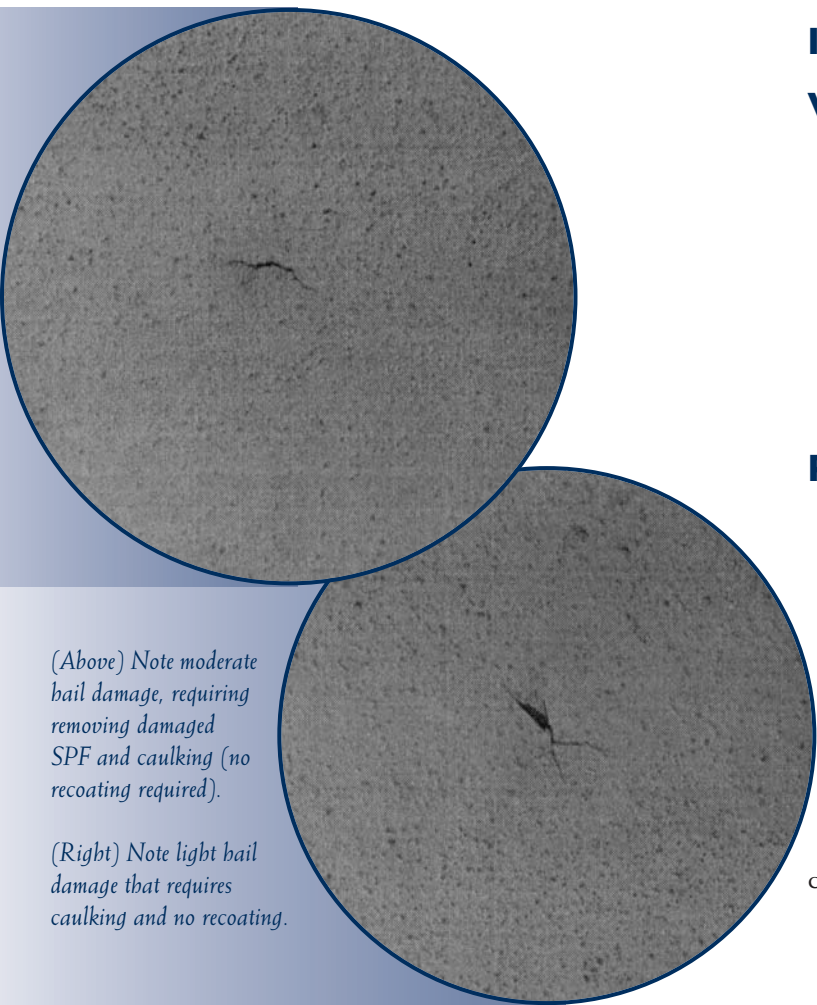
Physical Inspection

- Perform a non-destructive moisture survey. Follow up suspected moisture-laden areas with a moisture probe or core samples.
- Probe to determine SPF thickness.
- Take slit samples of the existing coating (at least 1 per 2500 square feet).
- Take SPF samples (at least 1 per 10,000 square feet).
- Take random slit samples of damaged areas.

Analyze Inspection

Core and slit samples should be examined for the following characteristics:

- UV degradation.
- Presence of moisture saturation.
- Adhesion of SPF to substrate.
- Adhesion of base coat to SPF.
- Adhesion of top coat to base coats.
- Type and condition of protective coating.
- Thickness of protective coating.
- Condition of SPF.
- Depth of damaged SPF.



(Above) Note moderate hail damage, requiring removing damaged SPF and caulking (no recoating required).

(Right) Note light hail damage that requires caulking and no recoating.

of the damage. It is important to note both the size and quantity of hail dents and cracks. For example, fifteen 3" diameter hail dents on a 1000 sq. ft. roof may be less problematic than hundreds of 3/4" diameter hail dents.

Sometimes, mechanical damage is not discovered for months or even years after the damage occurs. In these circumstances, repair procedures differ, depending on the extent of UV degradation of exposed foam and moisture absorption of the roof. A thorough inspection of the roofing system as described in SPFD Technical Guideline AY122 can help determine the extent of this damage. Any UV-degraded or moisture-laden SPF in the cuts, cracks/dents should be removed and caulked. If the cuts, cracks/dents are too numerous to remove and caulk, the affected areas should be scarified, refoamed and coated.



The skylight has been damaged by hail, but the SPF roof exhibits no visible signs of damage.

Indicate on a roof sketch the following:

- Location of core and slit sample.
- Type and location of coating deficiencies.
- SPF or coating blisters.
- Mechanical damage.
- Poor drainage.
- Repairs required for foamstops, parapet walls, gutters, flashing, scuppers, edge terminations, expansion joints, and other perimeter items.
- Repairs required to soil and vent pipes, drains, roof hatches, equipment curbs or supports, guy wires, hot stacks, skylights, mechanical units, walkways, sleeper, pitch-pans, and other penetrations.
- Water-saturated underlying roofs, insulation, or SPF.
- Sub-roof damage or deterioration.
- Areas of special consideration.

After information from the roof inspection is obtained, repair recommendations can be developed specific to the damage sustained. As discussed earlier, repairs will vary, depending on the severity and the frequency of the damage.

The accompanying chart can help classify the mechanical damage to help provide repair recommendations.

This photo depicts moderate to severe hail damage that would most likely require scarifying the surface, refoaming, and coating.



Other factors to consider:

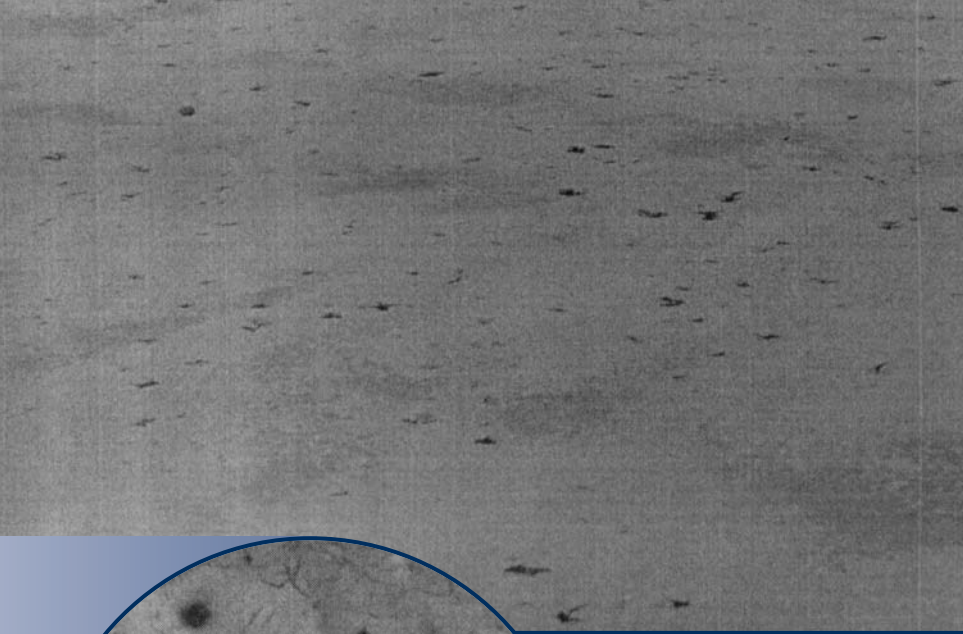
CLIMATE

Hot, Arid Climates

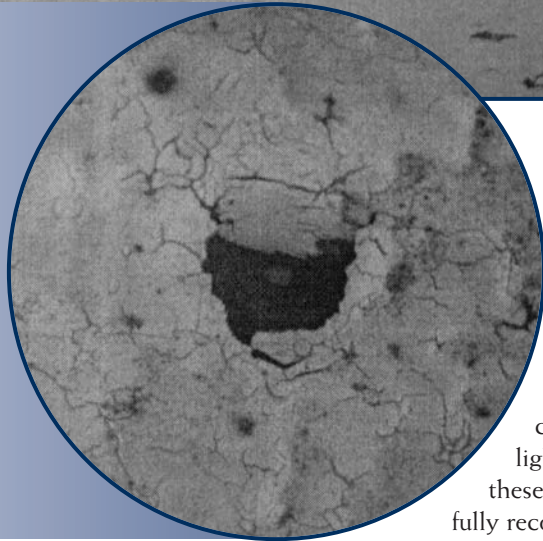
Climates such as Phoenix or Las Vegas are very forgiving in regards to light to moderate hail damage. Cracks in the coating can allow UV degradation over time. This degradation may take months to occur. However, this degradation typically does not affect the roof's water-resistant characteristics given the low humidity and exceptional drying characteristics of the climate. The main concern of light to moderate hail damage in this climate is to maintain the coating's capacity for recoat/renewal. Eventually, UV degradation of the SPF under the coating will

Type of Damage	Size & Severity	Quantity	Recommended Repair
Light	1/2" or less. Less than 1/8" deep	1. Less than ? cracks, cuts, and/or dents per square. 2. More than ? cracks, cuts, or dents per square	1. Coat and/or caulk dent, cuts and cracks. Recoat is optional, based on remaining service life of coating. 2. Recoat as required to fill in cracks.
Light to Moderate	1/2" - 3/4" diameter. Less than 1/4" deep.	Less than ? cracks/dents per sq. ft.	Coat/caulk cracks. Recoat as required to seal cracks. Some caulking may be required to seal deeper cracks.
Moderate to Severe	3/4" to 1-1/2" 1/4" to 1/2" deep.	1. Less than ? cracks/dents per square. 2. More than ? cracks/dents per square.	1. Remove damaged SPF; caulk holes and recoat as required. 2. Scarf 1/2" of roof surface; refoam and coat.
Severe	1-1/2" or larger. 1/2" or deeper.	1. Less than ? cracks/dents per square. 2. More than ? cracks/dents per square.	1. Remove damaged SPF; caulk holes; recoat as required. 2. Scarf 3/4" of roof surface; refoam and coat.

Table 1



Left: Severe hail damage requiring scarifying of the surface, refoaming, and recoating is pictured.



Inset: This photo shows a severe hail dent over brittle coating. Note the many cracks formed by small hail impact. These cracks have been created by the brittleness of the coating. If not for the cracks, the damaged foam could have been removed from the hail hole, and caulked. Because of the numerous cracks, this roof must be scarified, refoamed, and recoated. (Most likely this coating is very old; most coatings will tend to become brittle with age.)

affect the adhesion of the coating to the foam. It is recommended that the damaged areas be removed and caulked or refoamed. It should be noted there are cases of roofs with light hail damage in these areas being successfully recoated years after hail damage without any specific hail damage repairs occurring. Still, it is prudent to make hail damage repairs as soon as practically possible.

Hot, Humid Climates

Climates such as South Texas and Florida have more complex factors affecting hail-damaged SPF roofs. High temperatures

tend to quickly dry out the moisture that has seeped into the cracks and crushed foam cells very quickly. On the other hand, the high humidity creates a higher potential for SPF saturation, particularly during cooler times of the year. Lower perm-rated coatings/coverings also increase the potential for moisture saturation of the hail-damaged roofs because they do not allow drying to occur as efficiently as higher perm-rated products. As in the hot arid climates, UV degradation that can affect coating adhesion typically occurs within a few months.

Cool Climate

In cooler temperatures, the greater concern of hail-damaged roofs is moisture invasion into the SPF. There may be long periods when drying conditions do not occur. In many areas, snow may stay on the roof for extended periods, increasing the possibility of moisture saturation. It is important to repair crushed foam and coating cracks as soon as possible to prevent moisture saturation of the damaged areas. ■

ABOUT THE AUTHORS



MASON KNOWLES

Mason Knowles is the Technical Director of the Spray Polyurethane Foam Alliance (SPFA). He is the staff representative for SPFA's Building Envelope Committee, Technical Committee, and Industry Promotion Committee. Knowles' industry assignments include review of government, regulatory and building code issues, and SPFD newsletter articles on new technology related to the SPF industry. He is a member of ASTM and chairman of D08.06 Subcommittee on Spray Polyurethane Foam Roofing Systems. Knowles has been in the spray polyurethane foam industry for 30 years as a trade association executive, contractor, national technical representative, foam system house general manager, and spray foam equipment sales manager. He has an

extensive background in SPF roofing, cold storage, industrial, commercial, and residential insulation applications and has written or co-authored over 30 technical papers on SPF.



DON BEST

Don Best is the President of Best Roofing Systems, Inc. He is on the permanent faculty of RIEI, a member of the Spray Polyurethane Foam Alliance, a member of RICOWI, and has taught fluid applied roofing throughout the U.S. Best has a Roofing Technologist certificate from RIEI and is a professional member of RCI, serving on its Education Committee. He is currently the chairman for ASTM D08-0604, Task Group on Moisture Cured Urethane Coatings over SPF Roofing Systems.