An Update on Hail and Wind Considerations

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Background:

It should come as no surprise to you that SPF is durable and reliable. The recent report by the National Roofing Foundation conducted by Rene Dupuis' took an independent look, surveying 140 SPF roofs from new up to 27 years in service, including a variety of buildings in varying climates. Coatings included acrylic, silicone and urethane, as well as gravel-foam.

Mechanical Damage:

The survey found that "one unique aspect of SPF roofs ...is that they are not in immediate danger of leaking, provided the penetration does not extend all the way through the foam".(*2)

When discussing hail damage, this is very important to keep in mind. There seems to be a mindset among some roofing contractors, as well as buiiding owners and designers, that foam roofs are not suitable for hail regions at all. With all the negative publicity that surrounded the Superdome, it never leaked, despite a delay of several years in doing repairs. And the bullet holes that were discovered had done remarkably little damage.--and after all was said and done, another foam roof was applied and is performing well.

The NRF report confirmed that where roofs had experienced hail damage, the damage was localized to the upper surface of the foam and most roofs were repaired rather than replaced.

Resources on Hail:

Over the years there have been many excellent publications on hail. One of the most user friendly was by Bill Cullen.(*3)

He provided Weather Bureau maps which reflected the average number of days per year that various localities experience hail, with the hail belt ranging from the Rocky Mountains to the Appaiachians. He also cited probabilities as to the likely sizes of hail that might be experienced:

Hail Days	1"	2"	3"
2	4%	2%	1%
4	4%	3%	1%
6	6%	3%	<1%

Types of Hail Damage:

SPF roofs are not the only roofs that suffer hail damage. Cullen tabulated the type of damage for nine roof membrane tyges, including asphalt shingles; prepared roofing; bituminous BUR; Single-ply membranes; wood shingles; inorganic tiles, slates, etc.; metal; Modified Bitumen and SPF.

All could expect indentation, and all but SPF would have substrate related problems.

Hail Testing:

There are a number of hail (impact) tests available, and unfortunately there has been little correlation between them. Missiles of ice, metal and plastic have been used, with impact energies varying from 1 to 65 joules (1 to 46 ft-lbs). Cullen tabulated the terminal velocity and diameter in terms of Kinetic Energy of falling hailstones:

Dia. (mm/in.)	Terminal Velocity (m/s)	KE L (n?m)
25 (1")	22	1
31 (1-1/4")	25	6
38 (1-1/2")	28	11
44 (1-3/4")	30	19
50 (2")	33	30
56 (2-1/4")	36	72
69 (2-3/4")	38	110
75 (3")	40	163

(remember that old formula some high school teacher tried to pound into our heads?)

KE = 1/2?m?V2

or the energy increases as the square of the velocity (times the mass).

An important paper by Swiss scientist Peter Flueler' correlated hail energy to observed damage to roofing and Exterior Siding (EIFS) systems. He recommended a Classification System based on actual observation as well as laboratory testing:

Class	Category	Energy	Material
1	low	0.5 J	Window
2	normal	1.6	Tiles
3	elevated	5.6	Single Ply
4	high	12	Thin elelments

5	highest	17.3	Special

Because so many different impact tests are used in oi~r industry, the summary provided by Bill Cullen is especially useful:

Standard	Energy
ASTM D-3746	30.0
FM Class 1-SH	19.0
FM Class 1-MH	10.8
UL 1	4.6
UL 2	9.8
UL 3	18.3
UL 4	31.2

Variables that affect impact resistance include the surfacing, thickness of coating or membrane, compressive strength of substrate, thickness of membrane over scrim (if applicable), and change in properties with age.

Comparative Data Between Test Methods

One of the greatest problems with hail/impact testing is lack of agreement as to what is the best test method. Producers of relatively rigid materials such as tile and slate know that rigid (steel) impact devices give low values, which is due to lack of "give" between tile and sphere. They have a strong bias towards ice spheres as being more representative of the real world. Others, including ASTM, Factory Mutual, Underwriters Laboratories value the ease of using steel impacters.

An ASTM Joint Committee comprising members of C15,D08 and E06 initiated by Justin Henshell(*5), Chairman of D.08.20 and co-chaired by George A. Smith of FM Research Corporation (FMRC) has been gathering impact data on various roofing systems using the methods described in FM 4470, UL 2218, ASTM D 5420 (Gardner Impact), ASTM D 3746 (Steel Missile), D3746@ 0?C, and Ice Sphere missiles.

Mr. Smith has requested specimens of various roofing systems for round-robin testing. Data from seven cooperating laboratories has thus far been received. BUR specimens were constructed at FM labs and distributed to the participants. Data has thus far been received on 3-ply organic felt BUR, Asphalt Shingles, Slates and one variety of paver.

This would be a golden opportunity for the SPF industry to prepare specimens using varied compressive strengths of foam core, various mil thickness and various types of coatings, to compare not only SPF products with one another but with competitive roof systems as well.

Why Bother?

The Insurance industry is becoming much more aggressive when it come to reducing hail loss claims. The State of Texas has initiated a program which requires insurers to reduce premiums for home owners who use impact resistant roofing. The current program uses the UL 2218 rating, but individual insurers are going even further. They are studying loss history on various materials including those that are cosmetic in nature (i.e. dents to metal roofing which meet the U.L. failure criteria) but still results in claims.

Insurers in many states have notified homeowners that materials such as wood shakes will be pro-rated at time of loss, based upon loss analysis.

How does the Foam Industry benefit?

Because SPF continues to protect the interior of the building from water damage, foam roofing has an excellent story to tell. Participating in the current ASTM round-robin would provide data on what energy levels foam can meet, in a head-to-head comparison with competitive materials. Not only that, but data on various combinations of mil thickness, compressive strength and coating type would furnish performance data that could be applied to various hail regions based upon probability of occurrence.

State Farm reported(*6) that when the Texas regulation was released, only seven residential manufacturers offered a total of eleven products which met UL 2218 certification, with four meeting level 4 (31J), two meeting level 3, four meeting level 2, and one meeting level l(lowest level). State Farm has tested about 100 different materials inhouse, and found that less than half emerged without damage at the minimum test level. Factory Mutual7 recommends that SH systems be used in any region that experiences an average of 3 or more hail storms per year.

Timing

Because the insurance industry is just in the beginning stages of the "premium reductions" program, SPFA's participation in the ASTM round-robin would be very beneficial. The hail task force meets during ASTM Winter and Summer meetings, with the next one scheduled June 20, 2000 in Toronto. The Insurance Institute for Property Loss Reductione has offered to work with manufacturers in publicizing products that meet the new hail criteria.

Wind and Hurricane Considerations

SPF has an excellent story to tell when it comes to extreme wind resistance.

Surveys conducted after several recent hurricanes revealed that SPF performed far better than many competitive products. Again, the ability to keep the building dry even though the foam might have been pierced by flying missiles played an important part of this outstanding performance.

Since SPF is frequently used as a re-cover roof system, the integrity of the old roof and deck is important, as is edge attachment of that existing system. Field tests can be conducted following FM Data Sheet 1-52, or the old BUR system can be resecured as follows (*7):

For 1-60:
Roof field-1 fastener per 5ft?
Perimeter-1 per 3 ft?
Corner-i per 2 ft?

For 1-75 or 1-90:
Field-1 per 4 ft?
Perimeter-1 per 2 ft?
Corner-i per 2 ft?

Perimeter Metal

Existing roof systems may utilize gravel stop details in which the underlying wood nailer is deficient, or the metal itself is inadequately attached. FM data sheet 1-49 may be very useful in determining how to reanchor the old nailers and metal, prior to applications of a SPF recover.

Wind Ratings-How Much is Enough?

You may have noticed advertisements which indicated some roofing products have met a FM rating of 1-990. No, that's not a typo. Is there someplace in the U.S. that we're not aware of that generates 990 psf uplift forces?

Perhaps we need to understand that FM has decided to report the measured level of uplift resistance just prior to failure of a test specimen. In the old days, a category of performance was listed, and the pressure apparatus FM used was limited to about 90 psf. So, how do you test for 990? --Not with a pressure test at all. Instead, roof specimens were fully adhered directly to a concrete substrate. Since there are 1 44 sq. inches to a square foot, a 990 translates to about 6.8 psi. The test conducted is a perpendicular pull test, which will depend upon the laminarstrength of insulation, if used, or the failure of the adhesive (cohesive or adhesive) or in the case of the reported specimen, the fleece to the EPDM. Just think what SPF would have, when directly bonded to a concrete substrate! Anyone for 1-2000?

In the real world, substrate failure is certainly more likely than foam failure. But it would make an interesting ad for the millennium--2000 for 2000!

Wind Data

The basic resource of the building industry for building loads is ASCE-7(*9). This document is updated every few years, with the most recent revision in 1998. A useful update to the 1998 revision can be found in the December 1999 issue of Professional Roofing Magazine.(*10)

Both the ASCE and Factory Mutual methods for caiculating wind loads begin with the use of a wind map to pick a design wind speed. Unfortunately, ASCE now uses a different map than FM, and starting with the wrong map will guarantee an error in your calcuiations.

Both the FM and ASCE methods then note the height of the building, surrounding terrain, etc., and develop a basic uplift load. Both divide the roof into corners, perimeters and the main body of the roof, and use

multipliers (pressure coefficients) to reflect the greater uplift in the corners and perimeters.

Wind Ratings

As mentioned previously, FM generally uses a pressure table as described in FM 4470 to evaluate wind resistance. Ratings have historically ranged from 60 psf (1-60) to over 210 psf(l-210). FM provides a table in Loss Prevention Data Sheet 1 -28 which incorporates the parameters of wind speed, terrain, and height, providing a basic uplift pressure in psf. A multiplier of 2.0 is applied to all tables, so if the table indicated a particular roof would experience an uplift of 45 psf, then a 1-90 rating would be needed for the field of the roof.

Underwriters Laboratories Wind Uplift

UL also has a credible uplift apparatus. It applies both negative pressure (suction) above the roof specimen, as well as compressed air below the roof deck. The tests are much more elaborate than FM's, and more expensive to conduct as well.

The membrane roofing industry has to a great extent stayed with the FM uplift apparatus, while the structural standing seam metal roofing industry has found the UL test more useful. Part of this is that many SSR Systems use purlin spacing of 5 ft, which works nicely in the UL 10' by 10' apparatus.

UL lists their ratings in their U~ Roofing Materials and Systems Directory, as Class 30, 60 or 90. There is little correlation between an FM and UL Rating. Building Codes generally rely on the ASCE method of calculating loads, but accommodate both FM and UL listings.

To Sum Up:

SPF systems have a good track record for protecting buildings against both hail and wind load. More data on comparative hail resistance is needed by the insurance industry, as they try to adjust their premiums to their actual loss experience.

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