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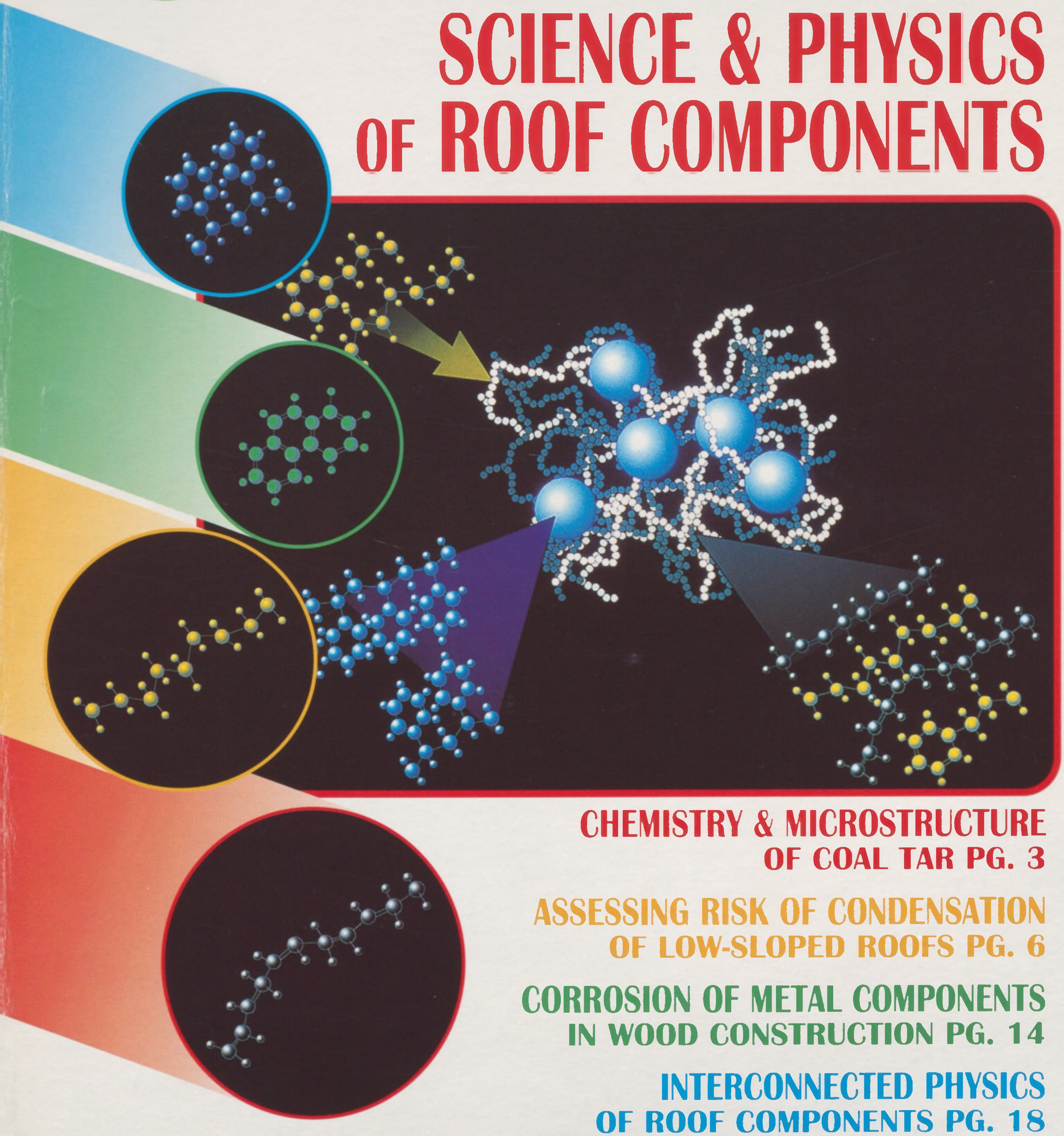
SCIENCE & PHYSICS OF ROOF COMPONENTS



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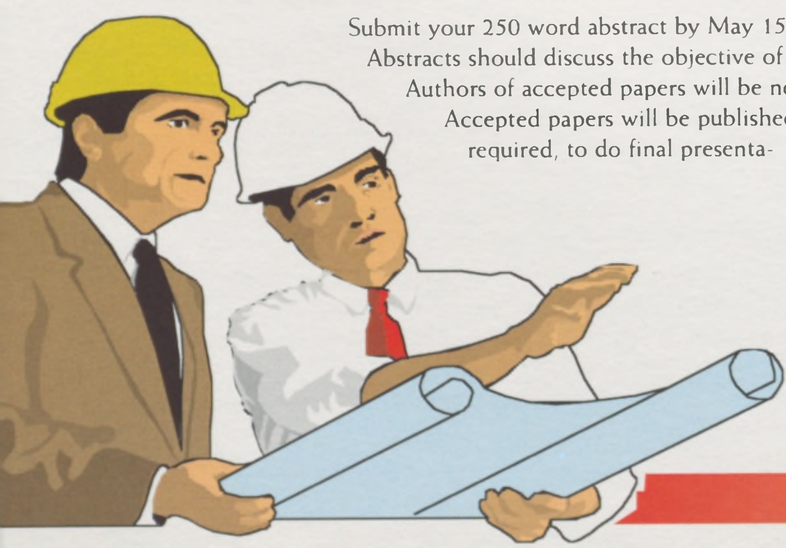

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On the Cover: Polymers and bitumens are the building blocks of polymer-modified roofing materials. Shown are the molecular structures of the polymer compounds commonly used to modify asphalt.

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President's Message

Strengthening Relationships and Working Together

This is my first attempt at writing the "President's Message." I hope it gets easier and better by this time a year from now when I will have written my last monthly message. In reading Mike Blanchette's last President's Message, I noted he admitted he was driven to stop smoking. On that basis, I consider his presidential tour not only good for RCI but good for him. I must say, however, being Irish, I don't want to think what I may be driven to stop doing.

James P. Sheahan, RRC

In February I attended the National Roofing Contractors Association (NRCA) convention in Phoenix. There I ran into numerous RCI members, not only those industry members who were displaying, but professional members too. Unarguably, the NRCA convention is a major industry event, and seeing our members participating was rewarding. RCI displayed at the show and had good traffic and interest. More importantly, there were six other professional organizations displaying at the show also. I think it is a good sign that industry groups are starting to come together to relate to one another. A goal of mine is to establish lasting liaisons with five or six industry groups this coming year. This is to put our members and RCI in the forefront of cooperating with other industry groups to collectively complete projects that none of us could do well alone.

Another major goal is to make use of our committee structure to initiate, implement, and most importantly, complete projects our membership needs and wants. Obviously, this can only be done with participation by RCI members. It takes more than a handful of RCI members on the board and the Executive Committee (E.C.) to make things happen. That board will be concentrating more on what should be done. It is the active participation of members in committees that will get the work done. Yes, this is an invitation to get involved. You will feel good about accomplishing worthwhile projects, meeting some great people and having some fun along the way.

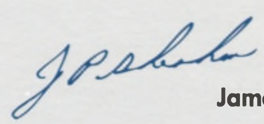
I have participated in board activity for three years and have witnessed a lot of board members with loads of enthusiasm struggle to get projects started and completed. I have also witnessed a previously understaffed headquarters taking on more than they could handle and becoming very discouraged because it couldn't be handled properly.

Today, we have nearly a full complement of staff members who are much better qualified to perform at the professional level. Getting professional input from the membership in committee activity can carry the load that once was carried by the board members and staff alone.

With a strong, well-defined, well-manned committee structure, we will have the team to invest (committee), perform (staff), and lead (board) so RCI can be a proud provider of useful products to the industry.

My final—and possibly my most important goal—is to finish what we start. What we undertake, we should do in an efficient, timely, and cost-efficient manner, and what we do should be good for the membership and the industry.

A year can seem to be a long time or a short time. I think my year as president will seem to have been very short a year from now. I don't intend to change our course but to steady it. I want us to experience real progress with projects like our education program, which happens to be the primary mission of RCI. I'll be looking forward to writing my last message to report how well all of us did.



James P. Sheahan, RRC
President

Chemistry and Microstructure of Polymer-Modified Coal Tar

By Steve Ratcliff and Frank O. Moore Jr.

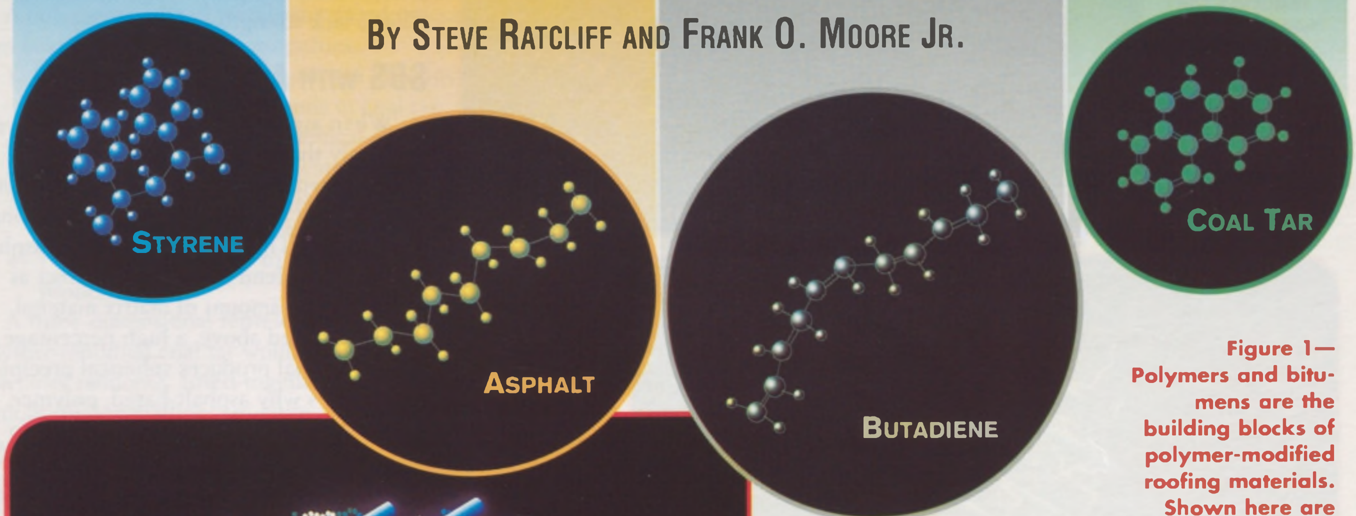


Figure 1—Polymers and bitumens are the building blocks of polymer-modified roofing materials. Shown here are the molecular structure of styrene and butadiene, which are the polymer compounds commonly used to modify asphalt.

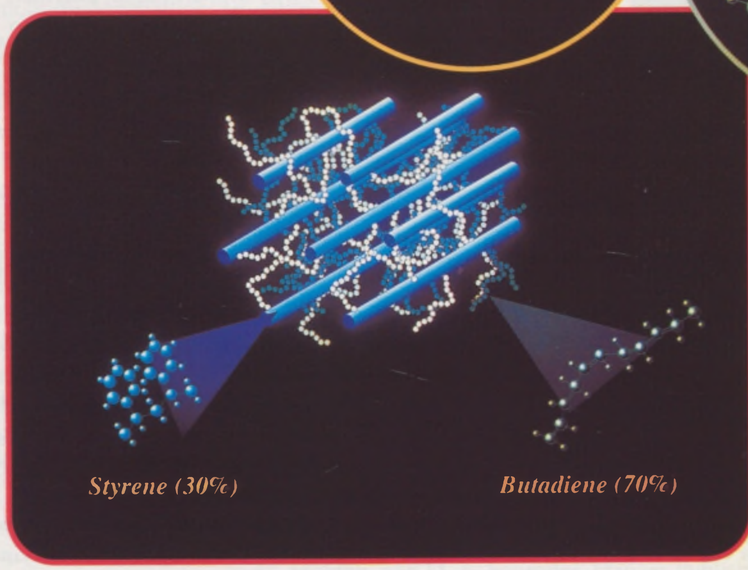


Figure 2—Artist's conception of the microstructure of SBS with no asphalt present. When the concentration of butadiene is much more than that of styrene, the styrene precipitates in a matrix of butadiene. The styrene forms spheres at low concentrations but forms cylinders as the concentration of styrene increases. If the concentration of styrene were much higher than the concentration of butadiene, then precipitates of butadiene would form in a styrene matrix.

Polymer modification is fascinating because it fundamentally alters material properties. Now, especially, this technology is of interest to the roofing community because there is a new polymer-enhanced bituminous roofing material available. Although research continues, there is enough now known to relate the chemistry and microstructure to the macroscopic properties.

Roof life cycles relate to chemistry. Unfortunately, nothing lasts forever, and even a perfectly installed roof will eventually deteriorate, due to the breakdown of its chemical components at the molecular level. The best that a roof owner can do is forestall these processes by choosing a roofing material with chemical attributes that contribute to a long-lasting, functioning membrane.

This paper presents simple models of the chemical components. Technical terms are avoided to stress the differences between the major classes of polymer-modified bitumens. In this simplified explanation, only four chemical components are mentioned, including two polymers and two bitumens (see *Figure 1*.) Using these building blocks, a graphical representation of polymer modified bitumens is presented. An attempt is made to relate the practical properties of the materials to the underlying chemistry and microstructure. First, the microstructure of polymer blends in the absence of any bitumen is described.

Polymer Components

The first two components can be called polymer A and polymer B. These building blocks can be part of the same molecular chain, with one of the polymers making up the ends. For example, in polymer-mod-

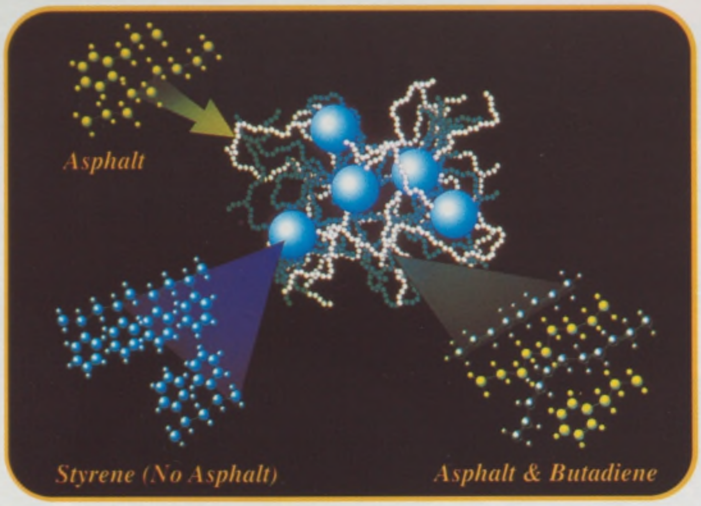


Figure 3—Asphalt won't dissolve in styrene. Absorption of asphalt by the butadiene matrix has the same effect as reducing the relative concentration of styrene. Thus, the styrene precipitates revert to a spherical shape.

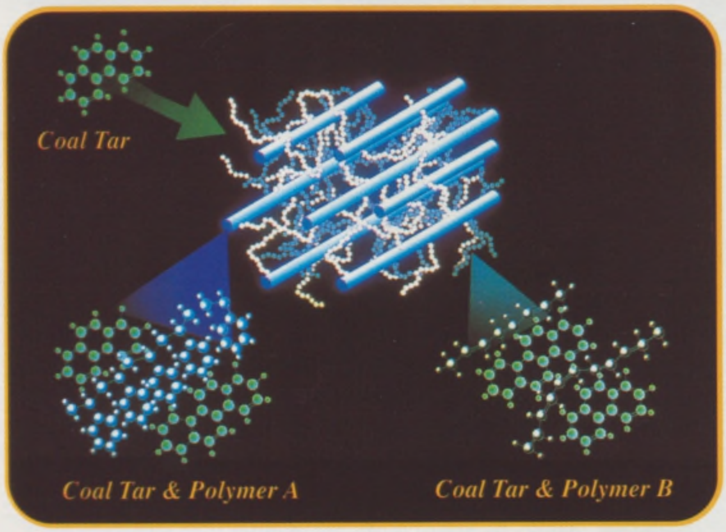


Figure 4—Coal tar is absorbed well by polymer A and B. Thus, the cylindrical microstructure of the polymer blend is retained. Also, the bitumen in this case becomes equally distributed throughout the material.

ified asphalt, the polymers typically are styrene and butadiene, and the copolymer is called styrene-butadiene-styrene (SBS), indicating that the styrene makes up the ends of the polymer chain. This structure has important consequences, imparting elastomeric properties to the blend. Chewing gum is unvulcanized styrene-butadiene rubber, while tires are made from a vulcanized styrene-butadiene rubber.

Depending on the relative proportions of the two polymers, one becomes the matrix, and the other becomes the precipitate. For example, in an SBS blend with a high concentration of butadiene, styrene precipitates in a matrix of butadiene (see *Figure 2*). The shape of the precipitate depends on the amount of precipitated material compared to the amount of matrix material. In pure SBS, spherical precipitates form at low concentrations of styrene, and cylindrical precipitates form as the concentration of styrene increases.[1]

The cylindrical microstructure can be seen in tiny samples examined under a transmission electron microscope. Slices through the cylinders appear as a hexagonal array of ellipses with similar orientation, revealing a microstructure of parallel cylinders.

The key to the elastomeric properties of SBS is that one polymer chain can terminate in different precipitates. Thus, the styrene precipitates pin the ends of long butadiene polymer chains, which can be curled up in the butadiene matrix. When the material is stretched, the chains straighten out, allowing the material to accommodate large strains; but the material returns to its original shape when the stress is removed.

This microstructure imparts strength and flexibility, which are desirable attributes in a roofing material. Bitumens such as coal tar pitch and asphalt provide waterproofing but (alone) lack strength and flexibility.

SBS with Asphalt

When asphalt is blended with SBS, typically only the butadiene matrix becomes engorged with asphalt. Styrene is an aromatic compound and does not associate strongly with asphalt. Thus, the absorption of asphalt into the SBS blend has the same effect as increasing the amount of matrix material.

As discussed above, a high percentage of matrix material produces spherical precipitates. That's why asphalt-based, polymer-modified bituminous materials are said to have a spheroidal morphology. When SBS is added to asphalt, the shape of its precipitates remains spherical because the styrene absorbs very little, if any, of the asphalt.

Figure 3 illustrates how the asphalt is absorbed by butadiene but not by styrene. Although this microstructure can work as a roofing material, it is interesting to see what happens in the case of coal tar pitch.

Polymer-Modified Coal Tar Pitch

The breakthrough of the 1990s is the discovery that coal tar can be modified with polymers in a manner similar to asphalt. Polymer-modified asphalt has been used since the 1950s and is well established as a useful material for roofing systems. Polymer-modified coal tar can be understood using similar models. To avoid confusion, the polymers are designated as Polymer A and Polymer B.

An important difference is that coal tar is made up of aromatic organic compounds that mix well with other aromatic compounds. Using a proprietary technology, coal tar blends equally well with both polymers. Thus, both polymers benefit from the water-resistance and chemical resistance of the coal tar pitch. (see *Figure 4*.)

Furthermore, because both polymers become engorged with coal tar pitch, the relative proportion of the matrix material and the precipitate material is unchanged from the pure polymer blend. Thus, polymer-modified coal tar materials have the same cylindrical microstructure as the pure polymer blend (compare *Figures 2* and *4*.) That's what is referred to as the cylindrical morphology of polymer-modified coal tar. The cylindrical morphology can be verified under a transmission electron microscope.

Based on such macroscopic properties as cold-flex temperature and elongation, the cylindrical morphology appears to offer significant advantages over the spherical morphology. The extremely low cold-flex properties and stability of the compound may be due to the uniform distribution of coal tar through both polymer phases and the consistent particle size distribution. Because there is not a distinct boundary between the predominantly coal tar matrix and the predominately coal tar precipitates, the polymer-modified membrane behaves like a homogenous material. Internal boundaries can be the source of cracking and chemical deterioration, but in this material, the coal tar is present everywhere.

A polymer-modified membrane based on coal tar "inherits" from coal tar the following properties:

1) Resistance to attack by heat and photons because of the strong carbon-carbon bonds in coal tar.
2) Relative "immunity" to chemical attacks because the coal tar neutralizes reactive chemicals.
3) The chemical reactions that do occur yield by-products that are insoluble in water.
4) There is no tendency to crystallize or change physical properties.

A three-dimensional representation of the microstructure of polymer-modified coal tar would show knobby-shaped, aromatic molecules randomly fitted together in a tight, moisture-resistant, random (noncrystalline) structure, loosely interlaced with polymer chains. The long polymer chains are like a net that gives shape on the macroscopic scale. Yet the structure still is amorphous on the molecular scale, which is analogous to the contents of the net.

Other advantageous properties are present on the microscopic scale in the polymer-modified coal tar membranes. The polymers become engorged with aromatic coal tar molecules, which physically and chemically shield the polymers from the "forces of nature," including sunlight, oxygen, and water. Meanwhile, the polymers give the coal tar strength and flexibility. Normally, coal tar pitch becomes brittle at freezing temperatures, but when interlaced with polymer A and polymer B, its flexibility is extraordinary. The cylindrical microstructure of polymer-modified coal tar results in a low temperature flexibility lower than -55°C.

Science and Technology

The new materials are radically different from any other modified bitumen. They are as different from polymer-modified asphalt as coal tar pitch is different from asphalt. The aromatic compounds in coal tar are inherently more stable than the aliphatic compounds in asphalt. The carbon-to-carbon bonds are stronger for aromatics compared to the carbon-to-carbon bonds present in roofing asphalt.

When the polymers soak up many times their weight in coal tar pitch, they endow coal tar pitch with integrity, shape, and strength. This combination of strength, chemical stability, flexibility, and polymer structure is not found in any other bituminous roofing material.

Polymer modification of asphalt and coal tar membranes is now carried out in a manufacturing facility under controlled conditions. The resulting materials represent the fastest-growing segment of the roofing market.

Comparisons of bitumen-polymer blends suggest that the coal tar blends are unique. The graphic renditions presented here highlight the uniqueness of coal tar with polymer modification.

To summarize, blends of asphalt and polymers have a spheroidal microstructure in which asphalt is absorbed in the matrix and not in precipitates. The asphalt must be characterized to obtain a compatible blend; if the asphalt constituents are not balanced properly, then the resultant material will have properties that are unstable during weathering. In contrast, blends of coal tar with the polymers have a cylindrical microstructure where coal tar is absorbed by the matrix and precipitates. This structure results in a low temperature flexibility of - 55°C or lower.

Previously, modified bitumen membranes based on asphalt were the only choice available. Now coal tar polymer-modified bitumen membranes are also commercially available in a roll form—with low temperature flexibility, good weathering characteristics, excellent stability, and multiple application methods.

1. G. Holden and N. R. Legge, *Thermoplastic Elastomers Based on Polystyrene-Polybutadiene Block Copolymers, in Thermalplastic Elastomers—A Comprehensive Review*, ed. N. R. Legge, G. Holden, and H. E. Schroder, Hanzer Publishers, New York, 1987, pp. 50-61.

ABOUT THE AUTHORS

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Steve Ratcliff

Frank O. Moore Jr.

Assessing RISK of CONDENSATION in Low-sloped Roofs Based on Basic Scientific and Probabilistic Principles

By Hitesh Doshi

Moisture and Roofing

Roofing performance is dictated to a large extent by how well it can prevent water leakage. Water can affect the performance of a roofing system in different ways. Visible water leakage through the roof into the interior is the most noticeable form of a dysfunctional roofing system. However, even when water does not show up as a leak, moisture that enters the roofing system and damages components will be considered a failure of the roof to function adequately.

The need for vapor barriers or retarders, (whatever the nomenclature, this author prefers the term "barrier"), and that of air barriers, is widely discussed. Confusion between air barriers and vapor barriers abounds. Debate about their function and need rages on, and dichotomies exist amongst design methods promulgated by various professionals (see *Figure 1*). Unfortunately, the roofs are in no position to understand these human vacillations and continue to either have no problems or big problems, depending on who you wish to believe.

So what is the down-to-earth roof consultant to do about making tough decision such as:

- Is a vapor retarder needed or not?
- Is an air barrier needed or not?
- If they are needed, where should they be located?
- Is venting effective?

No matter what the answers, there probably is some justification for each. But ultimately you, as a consultant, are responsible for your decision. Minimizing the risk in your decision requires an understanding and assessment of the risks before making decisions. Fortunately, the science related to the movement of moisture can help in qualitatively assessing the risks involved. This article provides the scientific basis that, used in its simple form, can provide the decision maker with reasonable assessment of risks involved.

Moisture from water leakage

It helps to distinguish between the sources of moisture entering the roof. Water leakage—so often characterized by waste baskets deployed for water collection and brown-stained ceilings—is what frequently causes the owners to summon consultants. Roofing systems in their primary form are designed to prevent water from such exterior sources as rain or melting snow/ice from entering into the roofing system. The major forces moving the exterior water to the interior are gravity and capillarity. The mechanisms and paths of water entry may vary, but the forces stay the same. This article assumes that the consultant is well versed in making sure that the forces of gravity and capillarity do not make the better of his or her design. A functionally waterproof roof is assumed.

Airborne moisture

Moisture that accumulates in the roofing system as a result of condensation is the issue at hand. Think of this type of moisture as a trail left by warm air which found the roofing components too cold for its comfort. For effective design, it is necessary to understand: Where did the warm air come from? And how did it get into the roofing system? Unlike water from the exterior, airborne moisture travels along with the air. Wherever the air goes, the moisture goes with it. The forces that drive the movement of airborne moisture result from the difference in air pressure and/or the difference in vapor pressure.

Measures to address airborne moisture

There are various measures in dealing with airborne moisture that enters and condenses into the roofing system. The most common measures are the following:

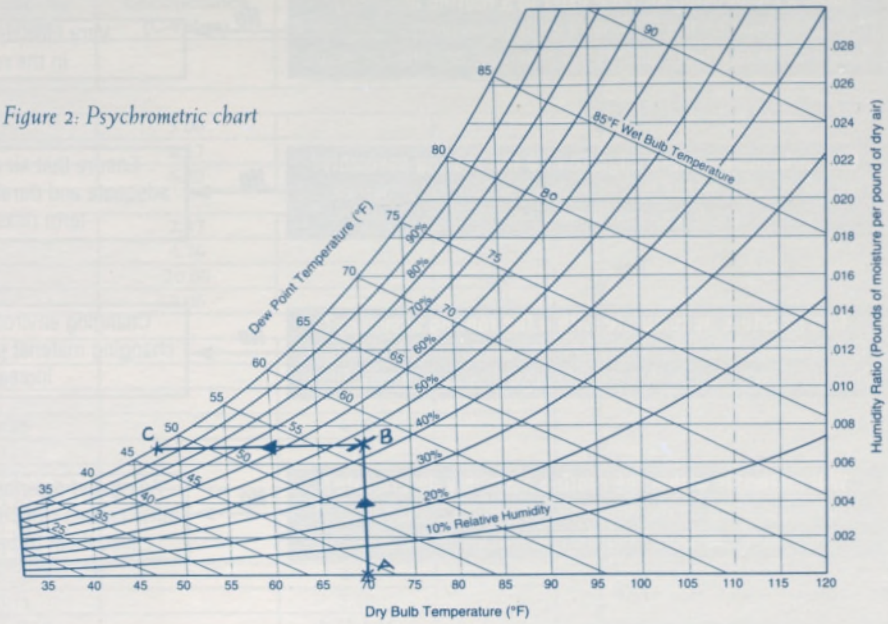
Project Location	January Temperature	Maximum Permissible Indoor Relative Humidity Before a Vapor Retarder is Required		
		NRCA Guideline	CRREL Guideline	
			Ti = 68°F	Ti = 75°F
Miami, FL	47°F	100%	80%	64%
Atlanta, GA	22°F	45%	60%	48%
St. Louis, MO	6°F	45%	50%	40%
Chicago, IL	-4°F	45%	40%	32%

Figure 1: Different Methods Lead to Different Requirements for Vapor Barrier—NRCA and CRREL Guideline.

- Provision of an air barrier
- Provision of a vapor barrier
- Provision of materials that are unaffected by expected condensation
- Provision of venting within the roofing assembly
- Control of the interior environment

The level of effectiveness of each of these measures is at the heart of the debate among various roofing professionals. Understanding and using basic scientific principles as shown in this article can help assess the risks associated with condensation and thereby aid in selecting the most appropriate moisture control measures.

Figure 2: Psychrometric chart



Science of Moisture Movement and Accumulation

The science that deals with moisture in air and its relationship to the air temperature is know as psychrometry. Most of us are familiar with the concept of relative humidity, which is one of the properties that defines the condition of air. A psychrometric chart (*Figure* 2) shows the relationship between the relative humidity of air, the temperature of air, and the corresponding moisture content of air. The moisture content is expressed as a humidity ratio in pounds of moisture per pound of dry air. The humidity ratio gives a measure of the vapor pressure. Generally, the higher the humidity ratio, the higher the vapor pressure. It can be seen from *Figure* 2 and *Figure* 3, that air at different temperatures but with the same relative humidity has different humidity ratios (and therefore different vapor pressures). Warmer air has a higher humidity ratio than colder air at the same relative humidity. And remember, vapor moves from high moisture content (vapor pressure) to low moisture content (vapor pressure).

In order to assess what measures, if any, are required to deal with airborne moisture, the following questions need to be answered:

- Does a condensing surface exist in a roofing assembly?
- Can airborne moisture migrate into the roofing assembly?
- Can moisture accumulate within the roofing assembly?
- Will materials within the roofing assembly deteriorate from accumulated moisture?

The degree to which answers to the above questions are affirmative provides the degree of the risk of condensation. *Figure* 4 shows a flow chart of the above questions. In the rest of the article, we will see how fundamental scientific principles can be used to answer the above questions.

Does a condensing surface exist in a roofing assembly?

Moisture will condense when the surface temperature at any point in the roofing assembly is below the dew point of the moisture-laden air (interior for heated buildings in cold climate). Dew point of air at a given temperature and relative humidity can be found from the Psychrometric Chart (see *Figure* 2). Locate the temperature of air on the horizontal axis—Point A (dry bulb temperature) and draw a vertical line until it meets with the curve of relative humidity—Point B. This point is called the" state point" of air with a given temperature and relative humidity. Draw a horizontal line from the state point to meet the line of 100% relative humidity—Point C. The temperature that can be read along the 100% relative humidity curve gives the dew point temperature. If the surface temperature at any point in the roof assembly is below the dew point of the air, then condensation will take place.

The temperature at any interface "x" in a roofing assembly can be calculated using the following formula:

Relative Humidity %	Temperature (°F)	Humidity Ratio lbs/lbs of dry air	Dew Point of Air (°F)
25	60	.003	<30
	70	004	34
	80	.005	43
50	60	.005	44
	70	008	51
	80	.011	59
75	60	.008	52
	70	.011	62
	80	017	72

Figure 3: Relationship of Humidity Ratio Temperature and Relative Humidity.

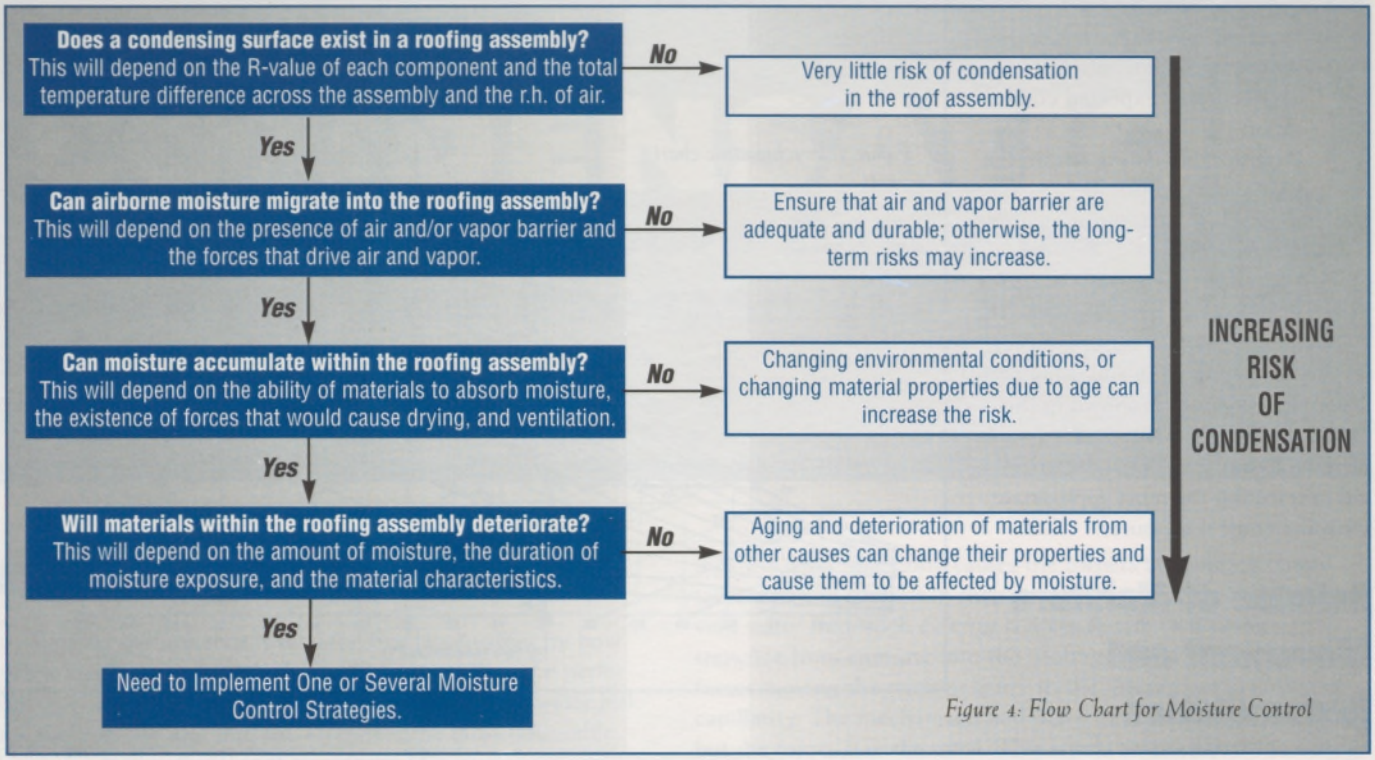


Figure 4: Flow Chart for Moisture Control

$$\frac{\Delta T_x}{R_x} = \frac{(T_i - T_o)}{R_T}$$

or

$$\Delta T_x = \frac{R_x (T_i - T_o)}{R_T}$$

where:

- R_x is the thermal resistance of all components from the inside to the surface x
- ΔT_x is the temperature difference between the inside and temperature at surface x that is $\Delta T_x = T_i - T_x$
- R_T is the total thermal resistance of the whole assembly, and
- T_i and T_o are the inside and outside temperatures respectively.

The thermal resistance can be calculated from values of thermal conductivity and thermal conductance or procured from the manufacturers. Thermal resistance is calculated as 1/C or as thickness/k. *Figure 5* provides the values of k and C for various common roofing components. Further details can be found in Reference 1.

Example: Determining surface temperature within a roofing assembly

The following example illustrates the calculation of surface temperature at a point within the roofing assembly. Consider the following assembly as shown below:

- Steel roof deck
- Expanded Polystyrene Insulation—two layers, 2″ thick each, having a density of 1.25 lb./ft.^{3}
- Single ply membrane.

It is required to calculate the temperature at the interface of the two layers of insulation. We will assume that the steel roof deck and single ply membrane have a high conductance and therefore negligible thermal resistance, and they will be ignored in this example.

From *Figure 5*, the conductance C of inside and outside air film are taken for winter conditions

$C_i = 1.63$

$C_o = 6.00$

From *Figure 5*, the conductivity k of insulation is

0.25 Btu/^oF x ft^2 x h x in

Thickness of insulation is t = 4″

$$R_T = \frac{1}{1.63} + \frac{4}{0.15} + \frac{1}{6.0} = 0.61 + 16 + 0.17 = 16.78$$

$$R_{\text{interface of two layers of insulation}} = \frac{1}{1.63} + \frac{2}{0.25} = 0.61 + 8 = 8.61$$

$T_i = 70^oF$, $T_o = 0^oF$,

$$\Delta T_{\text{interface of two layers of insulation}} = \frac{8.61\,(70-0)}{16.78} = 35.91\ ^oF$$

Therefore the temperature at interface of two layers of insulation is equal to (70 - 35.91) = 34.1^{o}F. If the interior humidity was 45% at 70^{o}F, then the dew point from the Psychrometric chart would be approximately 48^{o}F. Since the surface temperature is lower than the dew point, there is a potential for moisture to condense if it comes in contact with the surface.

In summary:

- Condensation will occur at a surface when its temperature is below dew point of air.
- Dew point depends on relative humidity and temperature

Material	Conductivity (k-value)	Conductance (C-value)	Resistance (R-value)	
			Per Inch thickness	Listed thickness
Roof Membranes				
Built-up membrane (aggregate surfacing)		3.00		0.33
Built-up membrane (smooth surfaced)		4.17		0.24
Roll roofing		6.50		0.15
Steep Slope Roofing				
Asphalt shingles		2.27		0.44
Fiber-cement shingles		4.76		0.21
Slate		20.00		0.05
Wood shingles/shakes		1.06		0.94
Roof Insulation Boards				
Mineral Fiber (basalt top faced)	0.24		4.20	
Cellular glass (faced)	0.33		3.03	
Expanded Polystyrene (EPS)				
1.25 lb/ft^3	0.25		4.00	
1.5 lb/ft^3	0.24		4.17	
2.0 lb/ft^3	0.23		4.35	
Extruded polystyrene	0.20		5.00	
Glass Fiber	0.26		3.82	
Gypsum Faced	0.89		1.12	
Perlite	0.36		2.78	
Polyisocyanurate faced	0.18		5.60	
Polyurethane	0.16-0.18		6.25-5.56	
Wood fiberboard	0.36		2.78	
Fill type roof insulation products				
Asphaltic/perlite insulating fill 22 lb/ft^3	0.40		2.50	
Foam Concrete				
120 lb/ft^3	5.4		0.19	
100 lb/ft^3	4.1		0.24	
70 lb/ft^3	2.5		0.40	
Cellular Concrete				
60 lb/ft^3	2.1		0.48	
20 lb/ft^3	0.8		1.25	
Vapor Retarder Materials				
Permeable felt		16.70		0.06
2-ply felt and asphalt membrane		8.35		0.12
Structural Deck Materials				
Cement-wood fiber panels	0.57		1.75	
Concrete normal weight (150 lb/ft^3)	20.0		0.05	
Concrete Lightweight (120 lb/ft^3)	9.1		0.11	
Precast Panels	12.5		0.08	
Gypsum 2" poured +1/2" board		0.61		1.65
2" precast panel		1.41		0.71
Wood plank softwood	1.12		0.89	
Wood plank hardwood	1.25		0.80	
Plywood	0.80		1.25	
Ceiling Insulation and Finish Material				
Glass fiber batt	0.32		3.17	
Loose Fill Cellulose	0.32		3.13	
Gypsum Board	1.11		0.90	
Mineral Fiber board	0.35		2.86	
Air Film				
Exterior in winter		6.00		
Exterior in summer		4.00		
Interior heat flow up		1.63		
Interior heat flow down		1.08		

Figure 5: Thermal Properties of Common Roofing Materials

of air in question.

- Surface temperature depends on inside air temperature, outside temperature, and the ratio of the R-value to the condensation surface compared to the total R-value of the assembly.

Since the exterior and interior conditions vary, it is helpful to do the above for ranges of different temperature and relative humidity conditions. This will provide a better assessment of the risks.

Can airborne moisture migrate into the roofing assembly?

As explained earlier, there are two mechanisms that can move the airborne moisture to the condensation plane: air pressure difference and vapor pressure difference.

Air pressure difference

There are two factors to consider regarding the impact of air pressure difference to move the air to the plane of condensation:

- Magnitude of difference
- Resistance to air flow

Some form of air pressure difference always exists across roof assemblies. Air pressure differences used for wind load calculations should give a reasonable idea of the air pressure difference existing across the roofing system. More important, though, is to understand the nature of resistance offered by the various components in the roofing assemblies. In general, the more air-tight the assembly, the more resistance to air flow will be offered. By its very nature, the waterproofing component of the roofing assembly can provide resistance to air flow. However, flexible systems such as single-ply membranes that are mechanically attached can billow and cause enough suction to draw air into the roofing system. In such systems, the air tightness of the other parts of the roofing system can play an important role to reduce air leakage.

Also note that if holes exist on the high and low pressure sides of the roof, then air can flow through the roofing system. Such a situation can exist, for example, when there is a hole in the deck and there is a hole at a junction in the roof at the top of the flashing. This can cause air to travel between the two holes. If it meets a surface below its dew point during its travel, then there will be a potential to condense. The longer the path for air to travel, the more chances for it to condense.

In summary:

- The greater the chance of air to flow into the roofing system due to air pressure differences, the greater is the likelihood of condensation.
- The more openings around the roof on the high and low pressure sides, the more widely distributed and problematic the condensation.

Note that air resistance may also be required from the point of view of adequacy of roofing system attachment. This is not discussed in this article.

Difference in moisture content or vapor pressure

There are two factors to consider in understanding the impact of vapor pressure difference in moving the air to the plane of condensation:

- Magnitude of difference between the humidity ratio on two sides of the roofing assembly
- Resistance to vapor pressure (typically given as the inverse of vapor permeability)

The magnitude of the moisture content for any given temperature and humidity conditions can be found by reading across on to the y axis of the psychrometric chart. The greater the difference, the greater is the propensity of vapor to flow into the roofing system and therefore to condense.

Resistance to vapor flow is offered by materials in the roofing assembly. A breathable or vapor permeable material provides less resistance than a non-breathable or vapor-impermeable material. Typically, the most resistance should be located on the side that is warmer than the dew point of the air. Otherwise, the vapor can reach the surface and condense before it even meets with resistance. Any vapor-resistive material that can allow air to move around it, (such as a steel deck), cannot be expected to provide vapor resistance, since the air will bypass the vapor barrier. There are some in the industry that feel that the vapor barrier need not be continuous. This should be carefully considered, especially in the following situations:

- Where the vapor barrier is part of an air barrier system that needs to be continuous.
- When holes or discontinuities in the vapor barrier allow convective air flows to develop (such as the case with steel deck)

It is possible to carry out detailed calculations to determine vapor flow. The details can be found in Reference 1.

In summary:

- The higher the vapor pressure difference, the higher the propensity for moisture to migrate
- The lower the resistance, the more propensity for moisture to migrate.

Can moisture accumulate within the roofing assembly?

The factors that will cause the moisture to accumulate are as follows:

Absorption by materials

Once moisture condenses, it goes from a vapor phase to a liquid phase (water) and maybe even a solid phase (ice). In a liquid phase, unlike the vapor phase, the water can be absorbed by materials. The absorption capacity of the materials is dictated by its porosity, density, and cell structure. Typically closed-cell products (even though of low density) will not absorb water unless the cell structure is damaged. Fibrous products, on the other hand, will absorb water. Organic facers on insulations are likely to absorb more water than inorganic facers. Higher porosity, lower density, and more open cells all make the materials more prone to water absorption. Even in situations where roofing materials may not absorb moisture—large gaps between insulation boards, for example—a condition may be created for water to accumulate at joints in the frozen state. This can be particularly detrimental to certain types of membranes, particularly BURs with organic felts.

Drying

The vapor pressure drive and the air pressure drive can change directions. This may permit some drying. One way to determine the impact of drying is by conducting the vapor pressure analysis for the whole year as shown in *Figure 6* (see also Reference 2). A plot is made of the vapor pressure of interior air and the vapor pressure in the roof assembly at the condensation plane. During the summer months, the roofing system will have a tendency to gain solar radiation and, therefore, have a poten-

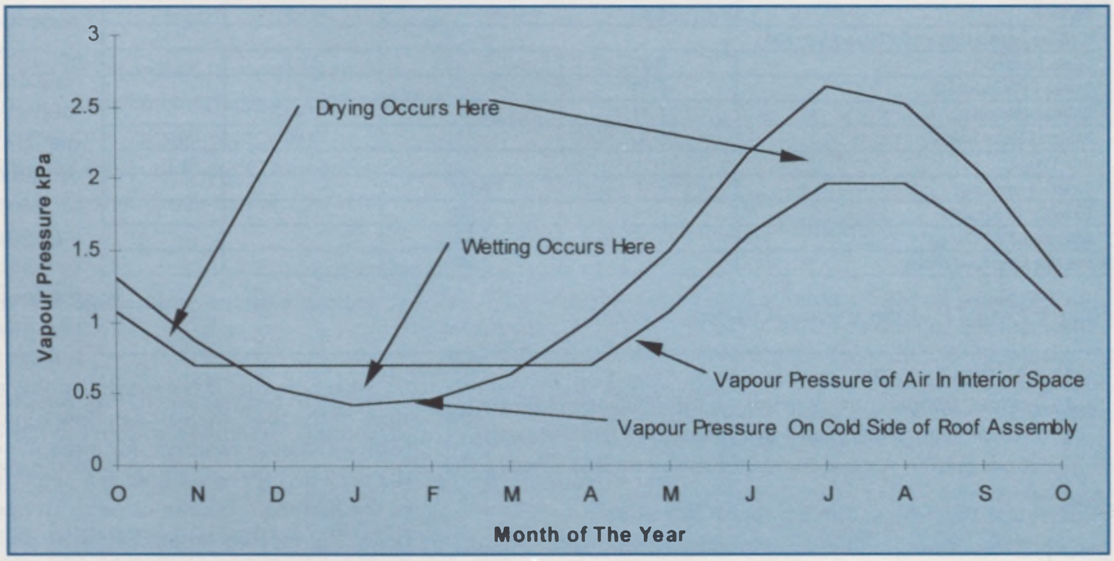


Figure 6 - Wetting and drying potential

tial for higher vapor pressure within the assembly. Area under the curve represents the wetting potential and drying potential. If wetting potential over the annual cycle is small compared to the drying potential, then some drying can be expected. A similar approach using the dew-point is provided in Reference 3.

Drying will be reduced due to the change of phase of vapor to water. This should be taken into account when assessing the risk. In areas with prolonged winter, the drying potential shown by the above method may not truly reflect the drying ability.

Venting

Venting can be effective in preventing moisture accumulation. Venting essentially occurs when there is an air pressure difference between the plane of condensation and the space to which the roof assembly is vented (typically the exterior). For venting to be effective, there has to be an air pressure difference and an unimpeded path for air to move between the spaces that are vented. The air pressure difference can be provided by mechanical means or can occur due to stack effect. Pressures due to stack effect in a low-sloped roofing system are very small. This, combined with the high resistance to air flow offered by a compact assembly, makes venting difficult. Compact roof assemblies can benefit by providing an air cavity such as is done in a roofing assembly of a cathedral ceiling.

After substantial moisture accumulation has occurred, venting in compact, low-sloped roofing systems is unlikely to be effective. Change of phase from vapor to liquid or solid makes it difficult for venting to be effective. For venting to be effective in drying the moisture, a change of phase from liquid to vapor (evaporation) is required which can be difficult in a low-sloped compact roofing system.

In summary:

- Accumulation of moisture will occur if the moisture condenses and is absorbed by the materials.
- Vapor pressure reversals and air pressure reversals can induce drying. Over an annual cycle, the reversals may cause a net drying.
- Venting is difficult to achieve in a low-sloped roofing system where there is no air space in the system.

Will materials within the roofing assembly deteriorate from moisture?

The impact of moisture prompting materials to deteriorate or become dysfunctional varies. Typically, organic materials are more prone to deterioration then inorganic materials. The length of exposure to moisture and the extent of moisture in the roofing system will determine the amount of deterioration. The following are possible:

- Loss of R-value of insulation
- Rotting of organic materials
- Dimensional changes in materials causing stresses
- Loss of strength of roofing components
- Loss of strength of structural deck
- Freeze/thaw damage

Each of the materials in the roofing assembly should be assessed in terms of its properties to resist the above deterioration. An assembly such as a loose-laid rubber system with a closed cell type insulation is less likely to have an impact from moisture accumulation than a BUR with an organic felt and using glass fiber insulation with an organic facer.

Potential for damage from moisture accumulation should be assessed assuming both long-term sustained moisture accumulation (very little drying) and short-term but heavy moisture accumulation (high amount of moisture which can eventually dry out).

Summary

Impact of moisture condensation within a roofing assembly requires an understanding of the underlying physical principles. Appropriate moisture control measures can be selected by dealing with the following four issues:

- Existence of condensing surface within a roofing assembly.
- Potential of moisture to move toward the condensing surface, either by vapor diffusion or by air leakage.
- Amount and duration of accumulation which will be affected by absorptance of materials, drying potential created by environmental conditions, and venting of the roof assembly.
- Potential for deterioration and damage to materials from moisture accumulation.

Based on the above, one may decide to handle the risks of condensation by addressing one or all of the above issues as seen in *Figure 4*. As can be seen in the figure, moisture control may be achieved with a high level of certainty simply by completely addressing just one of the above issues. Dealing with several of the issues allows the user to handle uncertainties and allows redundancies to be built into the moisture control design of roofing assemblies.

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About the Author

Hitesh Doshi

Hitesh Doshi *is a Building Science Educator, Researcher and Practicing Professional Engineer. He teaches building performance, including building economics, in the Department of Architectural Science and Landscape Architecture at the Ryerson Polytechnic University in Toronto, Ontario, Canada. Prior to joining Ryerson, Doshi was with Trow Consulting Engineers Limited, a large, multi-disciplined engineering firm. He has written several articles, including a series of ten roof columns for Plant Engineering and Maintenance Magazine, where he was the contributing editor and continues to write for peer reviewed as well as trade publications. Doshi serves on the Education Services and Code Committees of RCI.*

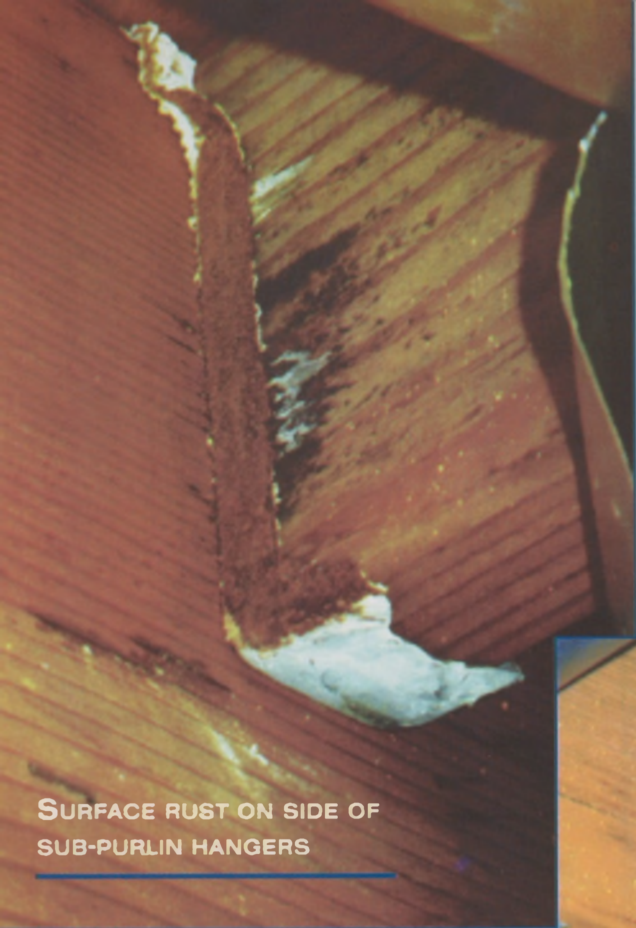
Roof Consultants Institute
Continuing Education Reading Test (CERT)

Interface Journal, the technical publication of the Roof Consultants Institute, offers this opportunity for its members to earn Continuing Educational Units (CEUs) toward registration or renewal of Registered Roof Observer and Registered Roof Consultant certification.

After reading the article, "Assessing Risk of Condensation in Low-sloped Roofs Based on Basic Scientific and Probabilistic Principles," by Hitesh Doshi, beginning on page 6, you may answer the questions below. Please send responses to the author C/O Editor of *Interface*, Roof Consultants Institute, 7424 Chapel Hill Road, Raleigh, NC 27607. Your responses will be graded and returned to you. Successful completion of this test is worth 0.1 CEU units.

QUESTIONS

1. Name two ways in which airborne moisture can enter into the roofing system.
2. List three forces that cause the water to move into the roofing system?
3. Use the Psychrometric Chart to determine the dew point of air that is at 72°F and 35% relative humidity.
4. In question 3, does the dew point increase or decrease if the relative humidity is increased to 50% at the same temperature?
5. In question 4, will the potential for condensation be higher or lower compared to that in question 3?
6. Assume that there is a roof as follows: steel deck, no vapor retarder, 1-inch wood fiberboard insulation, and 4-ply BUR membrane with organic felts. The design indoor temperature is 70°F and 30% relative humidity in winter and exterior winter design temperature is 25°F. Assess the risk related to moisture condensation within the roofing assembly, using the criteria provided in the article. Assume that in summertime the temperature at the roof membrane surface is 110°F. Assess the drying potential.
7. The roof in question 6 is proposed to be recovered with 0.5" of fiberboard insulation and a 4-ply BUR membrane with glass felts. Assess the risk related to moisture condensation using the criteria provided in the article.
8. List measures to prevent air-borne moisture from condensing within a compact roofing assembly. Identify the parameters that each measure controls.



SURFACE RUST ON SIDE OF SUB-PURLIN HANGERS

CORROSION OF METAL COMPONENTS in Wood Construction—

BY STEVEN A. MANDZIK, RRC, CDT

CLEAN SUB-PURLIN HANGER WITH WHITE POWDER BEGINNING TO FORM

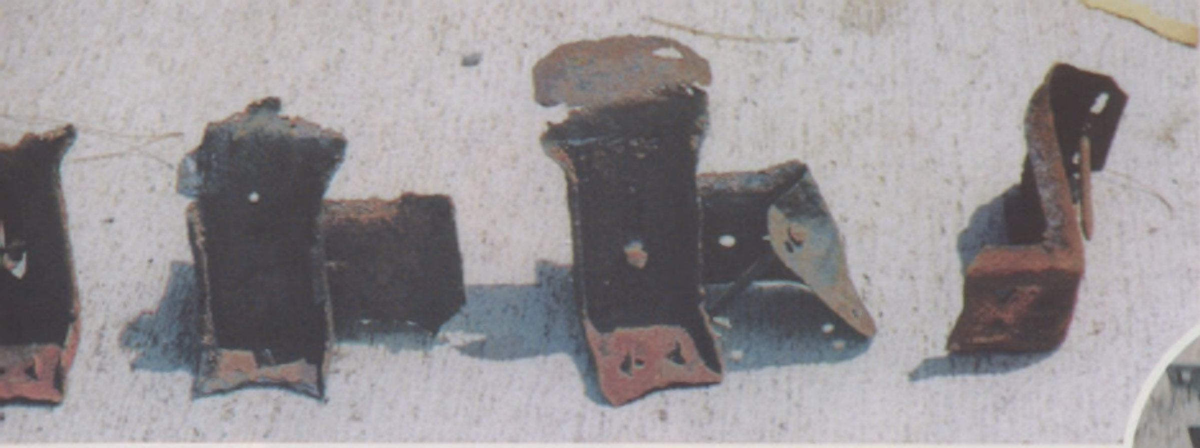
WHITE POWDER COVERING ENTIRE SUB-PURLIN HANGER

SURFACE RUST ON SIDE OF SUB-PURLIN HANGERS.

Ceiling foil has been widely used in California commercial buildings. All owners, managers, roofers, maintenance persons, and consultants should be aware of problems resulting from its use. It is a paper product faced on both sides with foil and stapled under each sub purlin, creating a 2′x8′x3-1/2″ cavity between the plywood decking and the foil. Reasons for its use vary from being a radiant barrier (reflecting heat away from the building) to being used for light reflectivity (reflecting light into the building) so that the building has a much brighter appearance when showing it to prospective buyers. Ceiling foil should not be confused with batt insulation, also faced on one or both sides with foil.

Over the past several years, there has been an increasing occurrence relating to the rusting of sub purlin hanger supports within the ceilings of buildings, in part caused by the use of this foil. It is a problem that is likely occurring in numerous buildings, yet goes undetected until re-roofing or roof repairs begin.

This rusting has occurred in Southern California commercial buildings consisting of plywood decking with wood sub-purlin, purlin, and Glulam



TYPICAL RUSTING OF SUB-PURLIN HANGERS

NEW (FACE-NAILED) SUB-PURLIN HANGER

supports joined with metal hangers. The plywood decking and the structural wood were not a fire-resistant/pressure-treated type. The existing roof systems have been a base sheet (mechanically-fastened), one ply of felt, and a mineral surfaced cap sheet installed in hot asphalt with no roof insulation used.

It first came to our attention in 1993 during a re-roofing operation when the old roof was being removed. During the tear-off process, several 2"x4"x8' sub-purlins fell, only to be supported by the acoustical ceiling below. No new roofing had yet been installed, and no plywood decking had been removed to cause the problem. Upon inspection of the plywood deck, we found that the plywood decking nail heads were completely rusted off and their shanks greatly reduced in diameter. The plywood decking was then removed for a close inspection under the deck. We found that the top lip of the sub-purlins hangers—the portion that rests on top of the purlins—was completely missing. The remaining sides and bottoms of the hangers were in an advanced state of rusting. This rusting occurred in numerous areas throughout the entire plywood decking area in varying degrees of rust. The re-roofing work was immediately stopped, and a structural engineer was employed to review the situation.

Due to the severe rusting, it was determined that the sub-purlin hangers no longer had the ability to carry a vertical load. The structural engineer provided recommendations and drawings requiring 2"x4" wood ledgers to be nailed underneath all sub-purlins. As the building was almost entirely warehouse space, the work was performed from within the building by a general contractor and averaged $0.72 per square foot above the cost of the roof. Typically, plywood decking replacement has averaged 1% during re-roofing; however, due to the structural inspections conducted from on top of the roof, approximately 15% of the plywood decking was removed and replaced. Major portions of the decking were renailed where nails were no longer present. This additional work was performed by the roofing contractor and added another $0.12 per square foot to the contract.

Since 1993, we have experienced three more sub-purlin hanger failures, all beginning with a re-roof operation and ending with similar structural remodeling as described above. The latest project (1995) had all acoustical ceilings and required 100% of the plywood decking to be removed from on top of the roof as none of the work could be done from within the building. Under each sub purlin, 2"x4" wood ledgers were installed while standing on the decking supports and adjacent plywood panels. The structural repair costs were $2.68 per square foot above the re-roof cost.

In each of the four cases noted above, we spent considerable time researching the cause of the rusting. We found tenants in each building were not conducting any high-level humidity operations. In terms of age, three of the buildings were 16 years old, while the fourth was 11 years old at the time of discovery. The 11-year-old building demonstrated the worst case of rusting. The interior humidity was recorded in this last building at floor level in two different areas and measured 28% and 44% while the exterior humidity was 44%. Although the floor level humidity did not appear extreme, there must have been a considerable amount of humidity trapped above the ceiling foil to cause the severe rusting. During the normal cycles of daily weather changes from hot to cold, the dew point was achieved in the roof cavities, and this humidity condensed on the surfaces of the metal hangers. Since there were no gaps left at the edges of the stapled foil, no venting of moisture vapor was possible.

Over the past two years, I have inspected 24 buildings on behalf of one owner who has taken a proactive approach to assessing roof conditions as they relate to the use of ceiling foil. To date we have not found the severe, flaking rust conditions on the sub-purlin hangers as experienced elsewhere. However, we have found surface rusting of the hangers in almost every building, as well as the presence of a white powder covering the sides and bottoms of the hangers. Direct evidence of moisture was found on top of the ceiling foil in at least one building.

Although severe rusting was not found, the owner has been advised that it is possible these buildings may experience sub-purlin hanger failure unless some action is taken.

The use of ceiling foil has had an effect on a portion of the 25 million square feet I help to manage. There has been a great amount of inconvenience and danger associated with the situation. Tenants have narrowly avoided being hit with falling sub-purlins. In one case, a tenant evacuated the building for fear of accidents. Roofers have almost fallen through the poorly-supported decking while making repairs or during the re-roofing process. Because of potential problems associated with its use, building costs are bound to rise with the increased chance of accidents. All buildings with this type of construction should be inspected for possible rusted hanger problems.

TYPICAL CEILING FOIL PAPER STAPLED BENEATH SUB-PURLINS

CONDENSATION STAINING ON PAPER CEILING FOIL DIRECTLY BENEATH SUB-PURLIN HANGER

It has been a very complicated procedure to inspect this condition and just as difficult to find conclusive recommendations from professionals. The ceiling foil may only be a radiant barrier and completely removing it is probably the first step in reducing or preventing the condensation. However, city building departments, fire marshals, and architects are unwilling to comment on, or put in writing, the use of the foil and if it can be taken down.

RUSTED HEAD AND SHANK OF PLYWOOD DECKING NAIL.

Energy Efficiency Standards published by the California Energy Commission containing the California Code of Regulations Title 24 indicate "aluminum foil" as a type of insulation in the form of "reflective foil." The regulation further states that "Repairs shall not increase the pre-existing energy consumption of the repaired component, system, or equipment." Consequently, tearing it down or even changing its design (cutting holes or slits in it for ventilation) appears to violate the energy regulations. I have found publications indicating that the use of ceiling foil as a radiant barrier has its advantages in reflecting heat away from the building. However, I have not found any information on the disadvantages of its use. It appears to have created a problem that could amount to very expensive structural repair costs for building owners in California, if not other states. The reluctance of licensed or registered building professionals, designers or builders—people who have recommended its use in the past—to recommend tearing it down may be based on current energy regulations and fear of retribution from building officials.

Unfortunately, it is a problem that is not going away. Considering the possible loss of life, the expense of possible structural remodeling, and the future use of ceiling foil, further research is needed. Any input from those who may have insight into this matter is appreciated.

About the Author

Steven A. Mandzik
RRC, CDT

Steve Mandzik *has 26 years in the construction industry as a roofing contractor, roof consultant, and, in the last six years, as the in-house roof consultant for Property Consulting Services, a division of Insignia Commercial Group Inc., responsible for managing more than 25 million square feet of roofing. He is a Registered Roof Consultant with RCI and a Certified Document Technologist with CSI.*

Fastener Quality Act – Again Delayed

The Fastener Quality Act (FQA), passed by Congress in 1990, was postponed for the second time in the fall of 1998. The act, which would have required fastener manufacturers to certify their manufacturing processes and to have them tested at laboratories certified by the federal government, was stalled due to doubts about perceived problems.

The National Institute of Standards & Technology (NIST), charged to develop standards on fasteners, expressed doubts about the need for such. Fastener manufacturers and exporters have lobbied to delay the FQA due to burdensome requirements, noting no fatality can be directly attributed to fastener failure. At the same time, critics of the industry claim only luck has prevented disaster to date following a flood of cheap and poorly labeled fasteners into the U.S. since the late 1980s.

Builders should be cautious in their purchasing practices, other industry leaders suggest.

RCItems

Keeping RCI Members on Top of Institute News

April 1999

James P. Sheahan Elected President of RCI

By Kris Ammerman, Executive Editor *Interface*

The voting membership of the Roof Consultants Institute elected James P. Sheahan, owner of J. P. Sheahan Associates Inc., as its President to bring the association into the 21st century. At the group's 14th Annual Convention and Trade Show in Charlotte, NC, on March 16, Immediate Past President Michael Blanchette passed the gavel to Sheahan, previously First Vice President.

Jim graduated from the University of Toledo with a B.S. in chemical engineering in 1953. The next two years were spent designing components utilizing plastic materials in aircraft for the Douglas Aircraft Co. In 1955, he joined the Navy and became a pilot—first serving on active duty, and then as a member of the Navy Reserve into the mid '60s. Jim's flying skills and love of flying have served him in both his business and private life, as he continues to pilot his own plane, usually combining business and pleasure in the same trip. (Jim survived a frightening crash landing in 1997 when his aircraft lost power above the clouds over Barrington, MA.)

From 1959-1978, Jim gained experience in many facets of the construction industry—primarily in waterproofing and insulation—through his work with Dow Chemical Company. Beginning in the Technical Service & Development Department, he eventually became involved in Research & Development. In 1962, Jim was granted the first of 15 patents (with one currently pending) on roof-related products, mostly dealing with early leak detection. By the mid 60s, Jim was put in charge of market development for the Spiral Generation building concept at Dow. In the '70s, Jim was made market manager for Dow Roofing Systems and eventually worked in warranty administration and claims management.

In 1979, with 20 years' experience in insulation and roofing products and systems, Jim formed J. P. Sheahan Associates Inc., a roofing, insulation, and marketing consulting firm. Jim deals extensively with quality control, warranty service, contracting, developing specifications, and serves as an expert witness in litigation cases.

Over the years, Sheahan has published and presented many papers and served on various panels regarding issues of insulation and roofing systems before such groups as the MRCA, NRCA, SPI, CSI, SPRI, AIA, and, of course, RCI. He had been a representative to the Cellular Plastics Division of the Society of Plastic Industries (SPI) for 15 years and is currently a member of CSI, ASTM (D-08), and BTECC.

In 1989, Jim became a member of RCI, earning his Registered Roof Consultant designation in 1990. He was elected Treasurer of the Executive Committee in 1996 and has served on various committees.

Jim and his wife Jan maintain his office in their home, which is alongside a river where Jim enjoys fishing when he has the time. They have "survived" raising six children, who have delighted their parents with eight "wonderful" grandkids for them to spoil. The couple also enjoy cross country skiing and travelling by their airplane to visit friends throughout the country and to find isolated places, such as islands in the Caribbean.

During his tenure as president, Jim hopes to expand RCI's influence in the industry at large and to strengthen ties with other associations. Jim has also proposed changing the association's official colors to green and gold and holding the 2000 convention in Dublin, but to date the rest of the board has resisted his powers of persuasion.

Inside

EXECUTIVE NOTES

Important Member Survey

Several months ago, I indicated that we would soon be sending an important survey to members. That survey is completed and is going in the mail as you read this. You should receive it very soon.

It is an extensive survey, probably more extensive than you are used to receiving from RCI, and for some of you, it will take some effort to complete. But I'd like to ask you very seriously to spend that effort for us. This survey is very important, and I'll tell you why.

Francis A. Acquaviva

You know that one of RCI's important functions is to represent the profession of roof consulting to a variety of different "publics," both inside the roofing industry and outside. In talking to a member of the industry—let's say a major manufacturer—it's important that we are able to convey to him the importance of the consultant profession. One way to do that is by indicating what proportion of a typical year's worth of roofing in the U.S. is actively specified by consultants. Is it 10%, 25%, 40% or more? You can see how important that information can be, and we can only get it if each of you tells us what your firm specifies. Further, we want your RCI membership to be valuable to you, and that will only happen if we know what you need in terms of benefits, such as publications and continuing education. So in the survey, we will ask you.

Finally, we're going to ask what your income was last year and the amount of your firm's gross billings. No way, you say! Understandable. But we need this information for reasons similar to why we need to know what you specify. At the same time, we understand clearly the sensitive nature of that information. For that reason, we are hiring an outside research firm to conduct the survey and tabulate the results. No one in this office or in the RCI volunteer sector will see the individual data. It will remain totally confidential.

There are many other questions on the survey—some specifically for individual practitioners, some for the directors of firms. Each of the questions is important to us. I learned many years ago in doing similar surveys that you should only ask survey questions for which you have a clear need for the responses. We have that need. You can trust me on that. You can also believe that we will report the data to you as soon as we are able. This survey will benefit all of us, and I look forward to your responses.

Upcoming RRO and RRC Exam Possibilities

Exam(s)	Location	Date
RRC	Oakland, CA	May 2
RRO	Las Vegas, NV	May 15
RRC/RRO	Toronto, ON	August 28
RRC	Dallas, TX	October 10
RRO	Kansas City, MO	October 16
RRC	Richmond, VA	November 7
RRO	Tampa, FL	December 11

Submit applications 90 days in advance of scheduled exam. One must have an approved application on file in order to sit for an exam.

Fees (US funds) for RRO and RRC registrations are as follows:

- RRO Application Fee—$75.00, RCI member; $125.00, non-member
- RRO Exam Fee — $50.00, RCI member; $75.00, non-member
- RRC Application/Exam Fee—$200.00, RCI member; $300.00, non-member

Please call RCI Headquarters at (919) 859-0742 for an application.

—Micki Kamszik,
Registration Director

At its January 27, 1999 Executive Committee Meeting, the RCI Board of Directors took the following actions:

CEUs

A motion was approved to offer Continuing Education Units (CEUs) to instructors of RCI educational programs. CEUs may be used to obtain or renew RRC and RRO certifications and are also accepted by other organizations, such as AIA, for continuing education requirements.

Industry Liaisoning

President Mike Blanchette reported on attending functions and discussing industry issues meetings with representatives of Factory Mutual, NRCA, SPRI, and RICOWI.

Committee Work

- Committee chairpersons are requested to send monthly reports to Bill Cypher for the board's information and for publication in *Interface*.
- Authorization has been sought by the Publications Committee to add the Legal Road Map for Consultants, published by Oasis Press, to RCI's list of available publications. The committee will also be in charge of judging for the Horowitz Award.
- The Education Committee is focusing on updating textbooks, particularly the graphics.
- The Ethics Committee is considering a regular column in *RCItems*.
- Discussion was held regarding the efficacy of forming an ad-hoc committee on RCI-Mercury and its control.

Marketing

Marketing Manager Bill Myers obtained several advertisements and submitted articles on RCI which were published in industry publications, including *Contractors Guide*, *Midwest Roofer*, *Slate Roofing Quarterly*, *Today's Facility Manager*, and *Buyer's Guide*. RCI exhibited at the Carolina Roofing and Sheet Metal Association trade show.

Membership

Membership growth was at 27 for January. Renewal letters were sent out to 350 inactive members with a good response reported.

Reno Convention Dates Set

The 2000 Convention was set for Reno, Nevada, March 24-28, 2000.

Region News

Elections were to be held in Regions III and V (see results in separate articles, pages 13 and 14). The Region VII election has been deferred for one year.

Registration

Micki Kamszik, Registration Manager, is drafting a new application for the Registered Roof Consultant, which in part reverts to an earlier version of the application.

Instructors to be Granted Continuing Education Units (CEUs)

Kami Farahmandpour

By Kris Ammerman, Executive Editor *Interface*

Kamran (Kami) Farahmandpour is a man of commitment: to his family, his work, and his association—RCI. Following his graduation from the Illinois Institute of Technology in 1984 with a bachelors degree in mechanical engineering, he joined the staff of Engineers International Inc., where he worked as a field engineer. From 1987 to 1989, he was employed by Chicago Concrete Consultants Ltd., Highland Park, IL. In 1989, Farahmandpour joined CTL as an Associate Evaluation Engineer, and has since been promoted to Principal Engineer.

While at CTL, Kami has served as a project manager on more than 100 projects involving evaluation and repair of building envelope systems and evaluation of construction materials. His building envelope expertise includes roofing and waterproofing systems and facades. Farahmandpour is a Licensed Professional Engineer, Registered Roof Consultant, Certified Construction Specifier, and Certified Construction Contract Administrator.

In addition to the traditional roofing and waterproofing projects, Kami has been involved in several unique projects, such as the design of clay tile roofing systems for geometrically complex domes, repair of underwater deep pier foundations, conceptual design of low-level radioactive containment tanks, research and development of nondestructive testing methods, and design of a test plot for long-term evaluation of concrete burial vaults. He has also investigated construction materials for expansion joints and form liners.

In 1992, Kami joined RCI. "Back then I considered myself a newcomer to the roof consulting community. Through selfless sharing of their expertise and experience, many RCI members, such as Dave Siple and Joe Hale, helped me refine my expertise. I owe most of my success as a roof consultant to RCI and the many lasting friendships I have made through the association. That is why I have committed myself to helping RCI and its members in any way that I can."

He has done so through broad involvement with the association, serving as coordinator of the Building Envelope Symposia since 1996 and helping to put together six symposia across the country since that time. Their success, Kami claims, is primarily due to involvement by other RCI volunteers who have worked very hard to make each one happen.

Kami is also a member of the RCI Education Committee, working with a team of "outstanding individuals" to revise the education program manuals.

Other industry involvements include memberships in the American Concrete Institute (ACI Committee 515—Protective Systems for Concrete and 546—Repair of Concrete), the National Roofing Contractors' Association, and the International Concrete Repair Institute.

Kami's design of a new roof for the University of Illinois at Chicago's Richard J. Daley Library received an award in RCI's 1995 Document Competition for Large Roofing Projects. In 1997 and 1998, he received Outstanding Volunteer awards for his contributions to the Institute.

In his free time, Kami enjoys spending time with his three-year-old daughter, Neli, and wife Forouz and doing woodworking projects. Kami's intimate involvement in all that he does exemplifies the approach to excellence that RCI supports and honors.

AWARDS

Written Word Wins Website aWard

The Written Word, owned by Ian Lurie, won best "general" website recently from *The Seattle Times*. The company, based in Seattle, is the designer of RCI's website, RCI-online, and also its searchable on-line roofing database, RCI-Mercury.

The Written Word's site impressed the judges with its "minimal text and jazzy design." The award was open to sites hosted anywhere in the world and was chosen among some 140 entries nominated by readers.

In an unrelated contest sponsored recently by the Puget Sound Chapter of the Society for Technical Communications, another site developed by The Written Word (elastizell.com) won an Excellence Award (2nd place) for online publications.

RCI has entered into an agreement with The Written Word to offer RCI members professional web development services. The program includes design, hosting, and training/consulting services. Any web presence developed through the program will be listed and linked from RCI's website. The Institute also offers members the use of the RCI logo on their sites for linkage purposes as long as their membership is maintained. Members interested in the program should contact RCI at (800) 828-1902 or RCI@rci-online.org, or contact The Written Word directly at (206) 938-0990 or Ian@writtenword.com.

To see Ian Lurie's winning website, visit http://www.writtenword.com.

Roof Construction Guide Wins Award

The Roof Construction Guide, published by the Roof Consultants Institute and written and designed by RCI member Colin Murphy, RRC, and colleague Ian Lurie, recently won a Merit Award from the Puget Sound Chapter of the Society for Technical Communications.

Judges of the contest, which Lurie described as "pretty stiff—usually won by organizations like Microsoft, Boeing, and Hewlett-Packard"—cited the manual's "strong writing" as its best feature.

Ian Lurie was a co-presenter at RCI's recent Charlotte convention, where he spoke on "Internet Technologies for Project Management." Colin Murphy, Director of Region VII, was a co-presenter of the "Rooftop Sampling" auxiliary seminar at the convention.

The Roof Construction Guide may be purchased from RCI for $69 by members and $99 by nonmembers by calling 1-800-828-1902.

Fricklas Receives J. A. Piper Award

Richard Fricklas, RCI honorary member, roof consultant, freelance writer, and retired technical director of the Roofing Industry Educational Institute (RIEI), received the National Roofing Contractors Association's J. A. Piper Award at is convention in Phoenix.

The award, first presented in 1948, is named for former NRCA President Joseph A. Piper, whose extraordinary efforts kept the association alive during the Great Depression. The J. A. Piper Award recognizes roofing professionals who have devoted constant, outstanding service to the association and roofing industry. Fricklas is the 52nd recipient of the award.

Ark Roofing Receives *RSI's* Certificate of Merit Award

Ark Roofing, Inc., Irving, TX, whose president, Marty Banner, is an Industry member of RCI, was recently granted the Certificate of Merit Award presented by *RSI* magazine at a reception during the NRCA convention in Phoenix.

Ark submitted illustrations of the sequential steps of various re-roofing and repair projects, a color brochure of its industry involvement, a typical proposal package, and information on the company's industry and community service. Among the latter was the Fielder Museum roof restoration project highlighted in the August 1998 issue of *Interface* journal.

Committees

RCI's EDUCATION COMMITTEE

Second in a series of RCI committee reports

Introduction

In August 1997, the RCI Board of Directors received and accepted a report from a special Board task force on the design, role, and functions of RCI committees. In accepting that report, the Board overhauled the Institute committee structure and set up a series of standing committees to take oversight responsibility for a number of the Institute's functions. In addition to having the responsibility for things like bylaw changes and nominations for Institute officers, each of the standing committees has a general responsibility to make recommendations to the Board of Directors concerning policy in their particular area. All committees are required to adhere to a set of standard operating procedures which prescribe necessary reports, meeting frequency, voting procedures, etc. Each committee also has its own mandate which describes its purpose, membership composition, current objectives, and any procedures that are specific to that committee. The mandate for the Ethics Committee, for instance, describes how the committee deals with ethical complaints; the Nominating Committee mandate would describe how officer elections are conducted.

The accompanying article from Education Committee Chair, Joe Hale, is the second of a series of articles designed to explain the specific purpose, function, and objectives of that committee. As you read these articles, keep in mind that the RCI committees, just like the staff and the Board of Directors, work for RCI members. Each committee chair would be pleased to receive comments and suggestions about the work of his or her group, or individual interest in serving on a committee at some time in the future. All RCI committee chairs can be reached by e-mail through the RCI Website (www.rci-online.org) or—if you are steadfastly resisting the computer age—you can reach any committee chair by writing to him or her at RCI Headquarters. We look forward to hearing from you.

—Francis A. Acquaviva, Executive Director

DICK HOROWITZ, 1993

DAVE SIPLE, RRC, FRCI

ROBERT PHILLIPS, 1987

The education committee is a standing committee of the Institute. From its inception, the charter members of RCI recognized the need to provide meaningful educational experiences for its members. Various programs have been presented at region meetings for many years.

The education committee became proactive in the late 1980s, led by the steering committee, which was comprised of Richard Horowitz, RRC, AIA, FRCI (now deceased), Robert Phillips, RRC, FRCI, and the author. Richard served as the chairman, and at a weekend meeting in Hagerstown, Maryland, his mind went to work at fast forward to develop an educational plan. From this plan, the Institute developed three programs: Phase I, II, and III. They are

By Joe Hale, Chairman

Joe Hale, FRCI

Basic Roof Consulting Course, January 1995, Toronto, Ontario.

now known as the Basics of Roofing, Fundamentals of Roof Consulting, and Advanced Roof Consulting courses. Two other important programs were later developed: the RoofTop Quality Assurance course (RTQA) and the Building Envelope Symposia program.

These five programs are a work in progress, developed, improved, and presented by dedicated volunteers, past and present. Through his exemplary dedication and sacrifice, one individual in particular—Dave Siple, RRC, FRCI, stands out in memory. Special thanks needs to be extended to him for his years of selfless hard work, which resulted in many hours of his own time developing chapters, lessons, plans, etc.

The education committee is currently holding teleconferences monthly in the evening on their own time. Future programs are being explored and developed, including a comprehensive home studies course. Other short courses may be developed addressing specific technical methods, materials, codes, specifications, etc.

The education committee is dedicated to continued dissemination of information for the roofing industry. With the support of the membership and the continued generosity of the volunteers and their families, the education committee and the Institute are ready to enter the next century at "fast forward," as Richard Horowitz would have had us do.

Have you noticed you can remove RCItems from your issue of Interface without damaging it?
Just pull gently and you have two stand-alone publications.

RCI + IRWC + NRCA = Phoenix

Representatives of RCI attended the conventions of the Independent Roofing and Waterproofing Consultants (IRWC) and the National Roofing Contractors Association (NRCA) in February in Phoenix. They participated in a presentation and a panel discussion and discussed issues between both groups.

IRWC Discusses Absorption Into RCI

An open discussion concerning the possible merger of the Independent Roofing and Waterproofing Consultants with RCI was held at the former's annual convention. The two groups are the only professional associations of roof consultants in North America and have co-existed for some time.

Representatives from RCI answered questions the members of IRWC had about our organization. It served as an opportunity to have an open exchange on the philosophies of both and how they might differ. Further discussions are to take place in the near future.

Mike Blanchette, James Sheahan, and Ed Betker also presented a condensed version of the "mock trial" presentation which was part of RCI's program for its annual meetings in Dallas and Charlotte.

Contractor/Consultant Panel Discussion at NRCA

RCI members Robb Smith, Mike Blanchette, and Ed Betker represented the consultant's viewpoint, and Robert Dalsin, Mike Gaulin, and Frank Lawson maintained the contractor's viewpoint in a panel discussion hosted by the NRCA. Bruce McCrory, assisted by Jack Robinson, moderated the session. Entitled "Roofing Contractor/Consultant Relations," the panels presented what they felt were the most common problems encountered when working with each other on projects. The concerns expressed by both groups, in most instances, were very similar. They focused on effective communication, competent and informed field personnel, the consequences of negative reporting or comments, the importance of clear, well-prepared specifications, contractor input at pre-bid meetings, the contractor and consultant employees who should be in attendance at preconstruction conferences, the consequences of project delays, and the financial issues related to proper and timely project completion and close-out. Additional concerns were expressed by members of the audience.

Most, if not all of the items discussed could be resolved by actions of the consultant, contractor, or both. The session was recorded, and copies of the recording can be obtained from the NRCA.

—Ed Betker

If Your Area Code Has Changed....

Broadcast faxes being sent to old numbers on our database cost RCI money and fail to get you the information you need about regional meetings, building envelope symposia, and other important news.

...Please inform RCI.

Keener Holds Roofing Seminar

Keener Consulting, Inc. conducted a Roofing Management Seminar in conjunction with Grand Valley State University in Grand Rapids, MI on February 5. In attendance were architects, property management personnel, facilities people, large commercial retailers, and school representatives. RCI was mentioned as a source for good roofing consultants.

Peter Keener, owner of Keener Consulting Inc., is a professional member of RCI and has served as an expert witness in several roof litigation cases. He has been a roof consultant since 1988 and has managed and consulted on over 150 roofing projects totaling more than $15 million.

Digital Roof Has Top Showing at NRCA Convention

Joel Hopkins, CEO, Digital Roof Corporation, reported that his company recorded the second highest number of attendees of all exhibitors at the National Roofing Contractors Association convention in Phoenix in February. You can visit Digital Roof at www.DigitalRoof.com.

Roof Reporters Launches Website

Al Maccagli, RRC, of Roof Reporters, Lake Worth, Florida, reports that folks can now visit his company's new website at www.roofreporters.com.

Late Breaking News

Name

Phone Fax E-mail Address

MY NEWS:

Send to: *RCItems*, 7424 Chapel Hill Road, Raleigh, NC 27607
Fax: 919-859-1328. Phone: 919-859-0742

new members for FEBRUARY 1999

Name	Company	Region	Category	Name	Company	Region	Category
Timothy Besbris	Nu-Tek Roof Systems	I	I	Bradley R. Jones	B. R. Jones Roofing Co.	I	I
David Bessant	Peerless Enterprises	VIII	I	Blake Joplin	Canon Consulting & Engineering	II	PA
Billy Brooks	GAF Materials	II	IA	Howard D. McCall	Mascon, Inc.	IV	I
William E. Cone	P & S Ventures	II	I	Robert Mills	Exterior Research & Design	VII	P
John Cook		III	P	Walter Mohr	Soprema Inc.	I	I
Peter Corsi	NBS Consultants	I	P	Jim Money	RMAX Inc.	IV	I
James P. Crowe	Crowe Building Products Ltd.	VIII	I	Malcolm L. Nunn, Jr.	Roof Systems of VA, Inc.	II	I
Thomas Davis	Madsen/Kneppers & Associates	VI	P	Edward F. Onori	Beardsley Design Associates	I	P
John A. Deighan	PSI	II	P	Tony Perez	A. J. P. Consulting Corp.	I	I
W. T. Doggett	Doggett Architects	II	P	Larry Peters	IMETCO	II	I
Pedro A. Estopinan	Miami-Dade County	II	QAO	Noel Prudent	Vac-It-All Services, Inc.	III	I
Michael J. Flaherty	Gale Associates Inc.	I	P	Collin G. Qualls	Seaman Corporation	I	IA
David Flickinger	NRCA	III	IA	Edward Stagg	Accuseal Roofing Ltd.	VIII	I
Richard Grobousky	AMBE Ltd.	III	P	Mark Stoll	Performance Roof Systems Inc.	IV	IA
David Roy Guthrie	Inter-Provincial Insp. (1982) Ltd.	VIII	QAO	Paul Syroka	Journeyman Professionals Inc.	I	QAO
Terry Johnson	Hydrotech Membrane Corp.	VIII	I	J. David Walden	Conestoga Roofing & Sheet Metal	VIII	I

Questions & Answers

ROOFING FELTS

I recently discovered a BUR membrane problem on an ongoing, 4-ply, 400-square reroofing project, and I am interested in finding out if anyone else has reported this problem. During application of a type VI ply felt, the material appeared to be floating (not frothing). After double-brooming, the sheet appears to lay flat, and bleed-through is observed. When the next sheet is applied (hot asphalt mopped or spread), the bottom sheet appears to re-float. The problem is very subtle and was first detected through routine sampling (the floating is visually detected, but its effect is not readily apparent). When the samples were separated, hundreds of minute air bubbles were found throughout the interply layers.

The vendor visited the site and is investigating the problem. We believed that there may have been a problem with the "run" of material, so the existing felt rolls were removed and replaced with different "run" numbers. Mock-up sampling using the new rolls, and even some of the old felts found the same problem. The delayed reaction does not appear to be due to surface moisture. Rather, it appears that moisture may be in the sand material or possibly in the fiberglass mat itself (just speculation on my part). This reaction is puzzling, and I am interested to find other sources that may have experienced similar problems.

Cris N. Bodine, RRC
Waterproofing Consulting Co, Inc.
Herndon, VA

This column will present ongoing situations which consultants experience in the course of their work. Readers are encouraged to submit both questions and answers to: "Q & A," *RCItems*, 7424 Chapel Hill Road, Raleigh, NC 27607. Fax: 919-859-1328. E-mail: Kris@rci-online.org. Make sure to label the entry as a "Q & A" for the newsletter, to supply a phone number, and, in the case of answers, to indicate to which question you are responding.

Q&A

☐ I have experienced the following situation in the course of my work. What can others tell me about similar experiences?
☐ I am answering the question posed by __________ in the __________ issue of *RCItems*.

Name ____________ Phone Number ____________ Fax Number ____________

Send to: "Q & A," *RCItems*, 7424 Chapel Hill Road, Raleigh, NC 27607. Fax: 919-859-1328.

FILL OUT THE DIRECTORY UPDATE FORM ON THE BACK OF THE WRAPPER ENCLOSING THIS PUBLICATION.

Proposed Florida Code Hits Snag; Rejects Chapter 34

By Al Maccagli, RRC

The State of Florida is developing a statewide building code to go into effect January 1, 2001. Currently, Florida municipalities can choose from the SBCCI Standard Building Code, the South Florida Building Code, or the EPCOT code. This creates massive confusion, especially when local amendments and updates are added into the mix.

In July 1996, the Governor established the Florida Building Codes Study Commission to evaluate the existing code system. The Commission found a "complex and confusing patchwork system of codes and regulations administered by more than 400 local and state jurisdictions." After 16 months, the Commission submitted a report, titled "Five Foundations for a Better Built Environment," to the Legislature, which was the basis of House Bill 4181. Through HB 4181, the Legislature directed the development of a single, statewide code.

The development of this new building code has been entrusted to the expanded Florida Board of Building Codes and Standards, now known as the Florida Building Commission. Effective February 1999, groups represented include engineers, architects, contractors, building and fire officials, persons with disabilities, building owners, the insurance industry, product manufacturers, and local and state government.

The Florida Building Code will be developed within the next 18 months, and then presented to the Legislature before its year 2000 session for review and approval. When approved, it will become the sole building code for the state of Florida in the year 2001.

I have attended a few of the Structural Technical Advisory Committee (TAC) meetings on roofing. The Committee has adopted Chapter 15 of the 1999 SBCCI Standard Building Code as the base code. In February, the committee met to discuss proposed modifications to this chapter. Nine modifications were submitted. The modifications were submitted by various groups, including the South Florida (Miami area) Roofing and Sheet Metal Contractors Association and The Broward County (Ft. Lauderdale area) Roofing Contractors.

The Miami contractors proposed "the Adoption of Chapter 34, the Roofing Chapter, of the South Florida Building Code as an appendix for coastal construction areas only for a cost-effective and public protective code will strengthen roofing requirements of the current Standard Building Code. The chapter utilizes engineering standards of ASCE 7 for expected wind loads and other national standards where appropriate; it allows for new and innovative products; provides roofing specific definitions, permitting requirements, inspection requirements, installation and materials requirements. It involves a system based approval method where the individual components are tested to a specific level of performance."

This modification was tabled pending a March 3 review of Chapter 34 by an appointed subcommittee. I was lucky enough to be chosen for this subcommittee.

Chapter 34 of the SFBC was written largely by Trinity Engineering and revised (via a lawsuit) by the Miami Contractors Association. I have worked with this code since its inception and saw it as the first code to incorporate current knowledge we have accumulated on roofing and wind. It is based on sound engineering and roofing practices. More importantly, it is the only code that makes the designer prove the roof system has been tested to meet the uplift design of a specific building before a permit can be issued. It also has provisions for moisture surveys before recovering an existing roof, fastener withdrawal testing of old decks, and performance testing of adhered tile systems. All the issues in Chapter 34 are endorsed by manufacturers as good roofing practice, but they are not enforced.

In 1993, the ASCE held a conference on hurricanes following Andrew and Iniki. The summary of the conference stated that, "Tests and test methods must be developed which will clearly demonstrate the ability of components and systems to resist high winds..." Chapter 34 accomplished this with a great deal of accuracy and thoroughness. Chapter 15 does not.

On March 3, after impassioned pleas from members of the South Florida roofing community, including the Contractors Association and Miami-Dade code compliance, the subcommittee voted against the modification by a vote of 7 to 5. The subcommittee did, however, vote to adopt certain passages from Chapter 34 that were desirable. Chapter 34 will be examined over the coming months for this purpose.

Most committee members cited the high cost of administration that the chapter would incur. One industry member quoted the cost of testing and product approval that manufacturers had to endure in Miami.

In my opinion, it is unfortunate that Chapter 34 will not be adopted, even as an appendix for high wind areas. This has the potential to set South Florida back to the same place we were in 1992. I hate to drag out such a tired old saying, but "Those who do not learn from history are destined to repeat it."

Region I Discusses Presence on EC

February 5, 1999
Boston, Mass.

On Friday, February 5, approximately 55 members of Region I met just outside of Boston, Massachusetts. This meeting opened with Region I Director, Rick Wagner, discussing Region I business, including the RCI Convention in Charlotte, North Carolina, as well as the need for more involvement by the Region I chapter in the future direction of RCI.

Roofing Databases

Following Rick Wagner was Joel Hopkins of Digital Roof Corporation, Ontario, who spoke on the advantages of utilizing a roofing database. Hopkins sent a very important message to our members by stating "most of our business relationships are with individuals at companies as opposed to being with the company itself. When that individual moves on for whatever reason, in many cases, so does your business with that company. Utilizing a database program enhances your relationship with the company. It binds your relationship through electronic partnering." Joel then ran through a step-by-step demonstration of the program. He talked about modifications that can be made to customize it and showed how flexible, adaptive, and relatively easy to use these types of programs can be, even for most computer novices.

Ethics

After a short break, Robert F. Martin of Roof Maintenance Systems in Farmingdale, New Jersey, spoke on ethics and roof consulting. Martin began his presentation by reiterating some of the items that Rick Wagner had gone over earlier with regard to the need for greater participation and representation on the Board of Directors for Region I. "We are currently the second largest and, based on recent data, the fastest growing region in RCI. However, we have no representation on the Executive Committee (EC)," Martin said.

Martin went on to review the history of RCI and the reasons for professional and industry member classifications. Although we are an organization of roofing consultants, we need input and participation from the entire industry. Cooperation and participation between roofing contractors, roofing manufacturers, and roofing consultants and the changes that have developed because of this relationship have gone a long way to reducing the number of roof failures.

Martin stated, "It seems that over the years we have lost the definition and responsibilities of our member classifications. These items were discussed during the infancy of RCI but seem to have been left in the dust." The Ethics Committee will, by the end of this year, define each membership classification and their responsibilities.

At the end of Bob's presentation, a lively discussion ensued on ethical issues, such as what is a conflict of interest, why do applicants for RRC have to show experience if they are capable of passing the test, as well as who should and should not be able to sit for the RRC exam.

Cold Storage Buildings

After lunch, participants were treated to a discussion on cold storage buildings by Wayne Tobiasson. A study of 10 roofs in the Dallas/Arlington, Texas area was performed through a cooperative research and development agreement between the Cold Region Research and Engineering Laboratory (CRREL) and Owens Corning. The buildings, for the most part, were kept at zero degrees, with one freezer kept at approximately 18 degrees. The roof decks were either concrete plank or steel deck, and all but four of the roofs examined were second roofs installed over an insulated, built-up roof.

All of the roofs were ballasted EPDM, which acted not only as a waterproofing membrane, but also as a vapor retarder. In the Dallas environment, the vapor drive on these buildings was from the outside inward all year. The roofs examined had seven different types of insulation within them. Wayne went on to state that in cold storage building, thermographs of wet areas may be shown as lighter and darker anomalies. In most cases, the lighter anomalies are wet insulation on top of the system and are bright due to the solar loading of the roof surface. The darker anomalies are normally wet at the deck and frozen so that they show up as a colder temperature. This study showed that the areas of wet insulation were apparently due to either openings in the roof or from air infiltration from the underside of the deck. In general, it was found that the two most moisture-resistant insulations utilized in this project were cellular glass and extruded polystyrene insulation boards. Cellular glass is resistant to moisture but can break down from freeze-thaw cycling.

Heating Systems to Combat Ice

The final presentation of the day was by James Buska of CRREL, who provided a very impressive presentation on electric heating systems for combatting icing problems. This presentation was an independent review of Buska's article regarding this topic appearing in the January 1999 issue of *Interface*.

The study was performed over several years and consisted of attempting several ways to reduce icing on metal standing seam roof systems. Several methods were implemented including the utilization of heating cables, both on the roof and under the roof, on top of fascia and behind fascia metal, as well as the utilization of snow guards that were adhered or attached with various different methods.

It was found that the heating systems create melt paths under the ice allowing water to flow through these channels and off the roof. It was noted that the ice that remained in place around the heater cables was found to be porous as opposed to a solid block of ice. This, again, allowed water to flow through these areas and off the roof.

All in all, it was found that the best way to reduce icing and snow loads on metal standing seam roofs is to provide proper ventilation to the underside of the deck. In essence, this keeps the underside of the roof deck at or near the temperature of the roof surface, eliminating or minimizing the icing problems to a great degree.

The next Region I meeting will be held in Philadelphia April 30. The theme will be polymers in roofing.

—William Tipton

Luther Mock New Region III Director

Luther C. Mock, RRC, was elected to a two-year term as Director of Region III, replacing outgoing director Dennis McNeil, in a three-way race in mid February. Mock is a partner and corporate secretary of Martin, Riley, Mock (MRM), Fort Wayne, IN. The firm provides professional services in architecture, roof consulting, mechanical and electrical engineering, and interior design.

With an associate of architectural engineering technology degree from ITT Technical Institute in Fort Wayne, Mock began as a senior draftsman with architectural firms before helping to found MRM in 1986. At MRM, Mock organized an auditing program to analyze roofs and developed roof management software.

Luther joined RCI in 1990 and earned his Registered Roof Consultant registration that same year. He is a member of the American Society for Testing Materials (ASTM), the Midwest Roofing Contractors Association (MRCA), the Construction Specifications Institute (CSI), an associate member of American Institute of Architects (AIA), and a member of the faculty at the Roofing Industry Educational Institute (RIEI).

Mock is an EPA-approved asbestos project designer and inspector. He is also a member of ASTM D-08 committee of "Roofing , Waterproofing and Bituminous Materials". He has been a past winner in RCI's Document Competitions and in 1995, earned a National Project Profile award from Butler Roof Systems. Luther has been a member of the RCI Nominating Committee and served on the Building Codes & Standards Committee.

The father of two enjoys playing the piano, reading, home improvement projects, and studying personal and professional development materials in his spare time.

Luther will chair the next Region III meeting in Charlotte during the convention, and in Indianapolis on April 16.

REGIONAL NEWS

Region V Elects David Davis as Director

David G. Davis was elected Director of Region V in March. A native of Philadelphia who grew up in South Bend, Indiana and graduated from Kent State in Ohio, Davis settled in Denver, Colorado in 1970 and established his professional career there. He worked on several significant architectural projects in Colorado in the 1970s and began to focus his interests on waterproofing membranes, roofing systems, and curtain walls.

In 1981, Davis, registered as an architect in Colorado, Texas, and Utah, founded Davis & Associates Architects, PC. It soon became apparent that the evaluation and maintenance of existing roofing inventories was of great value to his clients, and so, in 1986, he founded TechniScan Inc. The firm utilizes infrared scanning technologies to inventory and develop roof management systems on over 15,000,000 square feet of roofing portfolios in a tri-state area. The firm has developed roof management and asset management software utilized by its client base and has offices in Denver, Colorado Springs, Fort Collins, and Salt Lake City.

In 1993, Davis joined RCI when he recognized it as "an important forum for sharing knowledge and developing proficiency standards in our industry." As its new director, Davis hopes to take an active role in developing more activity and growth in Region V. He is also a member of AIA, NRCA, the Colorado Society of Architects, and the Denver Chapter AIA.

In his spare time, Dave enjoys the Colorado environment—including skiing, biking, soaring, and blue water sailing—with wife Jan and teen-aged son Corey.

Region II Meets in Charleston

January 21, 1999
Charleston, SC

C. Allan Kidd, RRC, EIT

Twenty-three members of RCI's Region II met in Charleston, SC on January 22. Many of the region's states were represented at this fine coastal city. The weather cooperated perfectly with temperatures on Thursday (the 15th) in the 70s and in the 60s on Friday. In conjunction with the meeting, Rick Cook of Austin • Dillon • Cook (ADC) had an oyster roast at his home on Thursday evening. A large time and much food were had by all. Our thanks go out to Rick for opening up his home to all these roofing ruffians.

The meeting began with the reading of appropriate portions of the RCI bylaws and proceeded quickly into a short business meeting. An update regarding the convention was discussed along with plans for a region meeting at the convention and a summer meeting in Raleigh.

The main topic of the day's educational sessions was steep roofing. Rick Cook delivered an informative and enlightening series of lectures on steep roofing topics including asphalt shingles, clay tile and slate. Several participants added considerable information in field experience regarding these topics. ADC also provided bound copies of the information covered by Rick for all of the participants to use as references. RCI would like to thank Rick and his staff at ADC for putting together such a quality program.

After a buffet lunch, RCI's Mercury database was discussed and demonstrated. Several members, including Dick Canon of Canon Consulting, indicated their satisfaction with the system and highly recommended it to all involved. In keeping with this business management theme, Allan Kidd of CTL Engineering presented a discussion on personalities in the workplace. This lighthearted and informative presentation covered the four basic personality types and how they interact with each other at home and in the workplace.

The next Region II meeting is tentatively scheduled for July 16 in Raleigh. At this time, the educational topics of the event have not been determined. The meeting will coincide with a visit to RCI's headquarters. If you have any suggestions regarding a topic for this meeting, please call the Region II Director, Allan Kidd, at 704-553-8285.

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WHAT THE MAN ON THE ROOF SAW.... CONTEST

Interface Journal is holding a contest for all readers of the journal.

What's the craziest thing you've seen from a roof? From a rooftop viewpoint, all kinds of things become visible. What have you seen and how did you react? Write a paragraph and tell us about it. The event must have happened personally to you. Send the details of your experience to us by **April 15, 1999** (think of is as a potential tax rebate).

Interface will publish the experiences in future issues. And we will pick our favorite. The winner will receive a **$50** credit toward RCI activities or products. You can use the credit to attend a regional meeting, register for the next Convention, purchase a publication from the RCI publications list, or even credit it toward your membership renewal fee.

My story: ______________________________

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Fax or mail to: Kris Ammerman, Executive Editor, *Interface*, RCI,
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Send by April 15, 1999

RCI CALENDAR OF EVENTS

APRIL

16 Region III Meeting
• Indianapolis, IN
19-20 RoofTech '99*
• Vancouver, BC
20 Exec. Committee Teleconference
23-25 Fundamentals of Roofing Course
• New York area
29-30 Rooftop Quality Assurance Course
• Otobicoke, ON
29-1 Advanced Roof Consulting Course
• Oakland, CA
30 Region I Meeting
• Philadelphia, PA

MAY

2 RRC Exam
• Oakland, CA
13 Region IV Meeting
• Houston, TX
14-15 Rooftop Quality Assurance Course
15 RRO Exam
• Las Vegas, NV
18 Exec. Committee Teleconference

JUNE

13-14 Nat. Assoc. of State Facility Admins.*
• Jackson Hole, WY
15 Board of Directors Teleconference
20-22 Assoc. of Physical Plant Admins.*
• Cincinnati, OH

JULY

16 Region II Meeting
• Raleigh, NC
20 Exec. Committee Teleconference

AUGUST

17 Exec. Committee Teleconference
28 RRC/RRO Exams
• Toronto, ON

SEPTEMBER

9-10 Region III Meeting
• TBA
18-20 Midyear Board Meeting
• TBA
24 Region I Meeting
• Syracuse, NY
23-25 Fundamentals of Roofing Course
• Indianapolis, IN
30 Basics of Roofing Course
• Chicago, IL

OCTOBER

3-5 Internat. Facility Mngmnt. Assoc.*
• Los Angeles, CA
7-9 Advanced Roof Consulting Course
10 RRC Exam
• Dallas, TX
15-16 Rooftop Quality Assurance Course
16 RRO Exam
• Kansas City, MO
19 Exec. Committee Teleconference
28-29 Building Envelope Symposium
• New York area
28 Region IV Meeting
• Dallas, TX
29 Region III Meeting
• Kansas City, MO

NOVEMBER

4-6 Advanced Roof Consulting Course
7 RRC Exam
• Richmond, VA
16 Exec. Committee Teleconference
18-20 Fundamentals of Roofing Course
• Phoenix, AZ

DECEMBER

2 Basics of Roofing Course
• Raleigh, NC
3 Region I Meeting
• Western PA/Ohio
10-11 Rooftop Quality Assurance Course
11 RRO Exam
• Tampa, FL
21 Board of Directors Teleconference

All events (except those with an asterisk) are presented by RCI.

ALL RCI PLANNED EVENTS ARE SUBJECT TO CHANGE OR CANCELLATION. Call RCI for current dates, locations, and fees. Telephone 1-800-828-1902 or (919) 859-0742.

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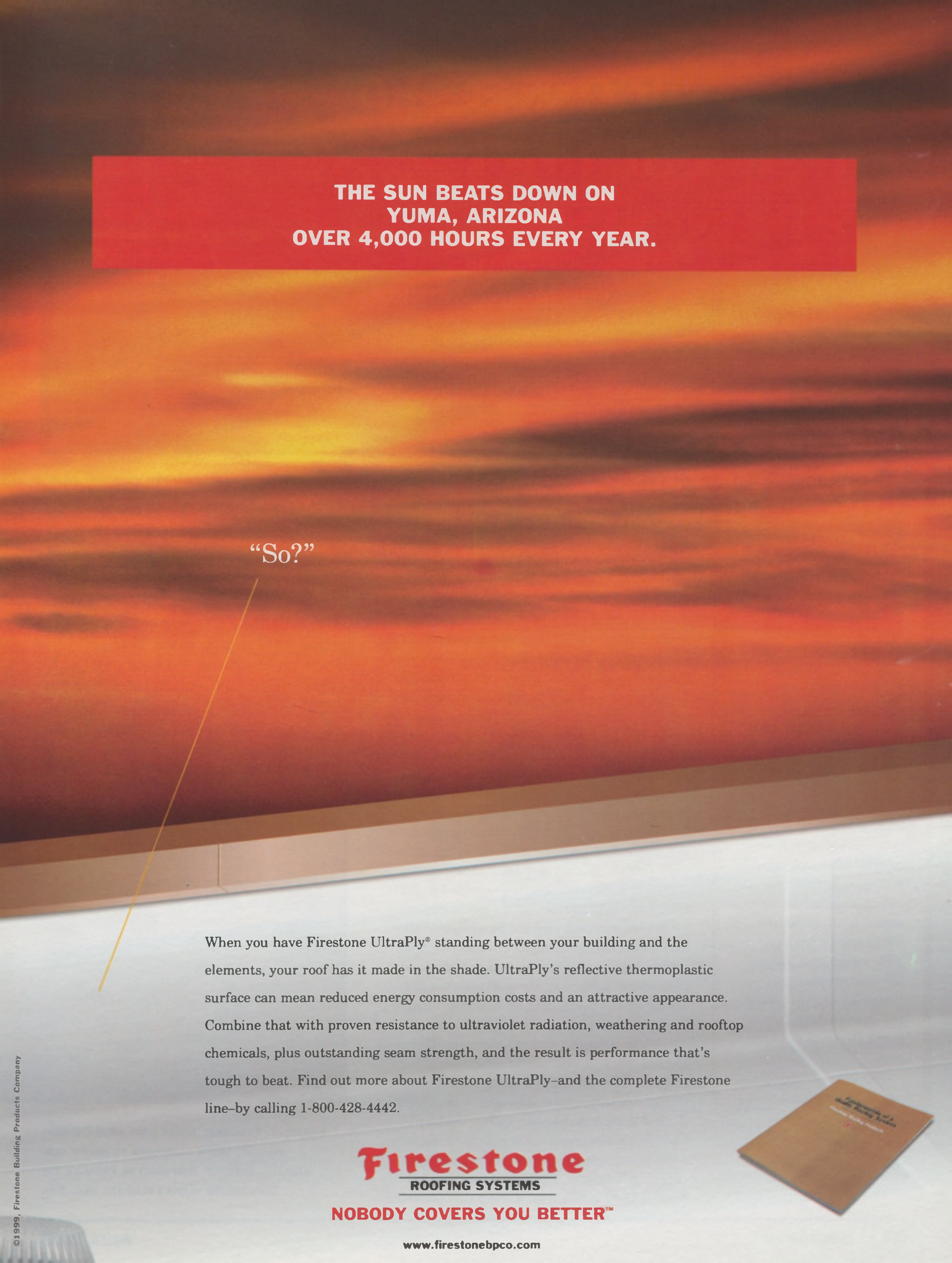
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THE INTERCONNECTED PHYSICS OF ROOF COMPONENTS

By Lyle D. Hogan, PE, FRCI, RRC

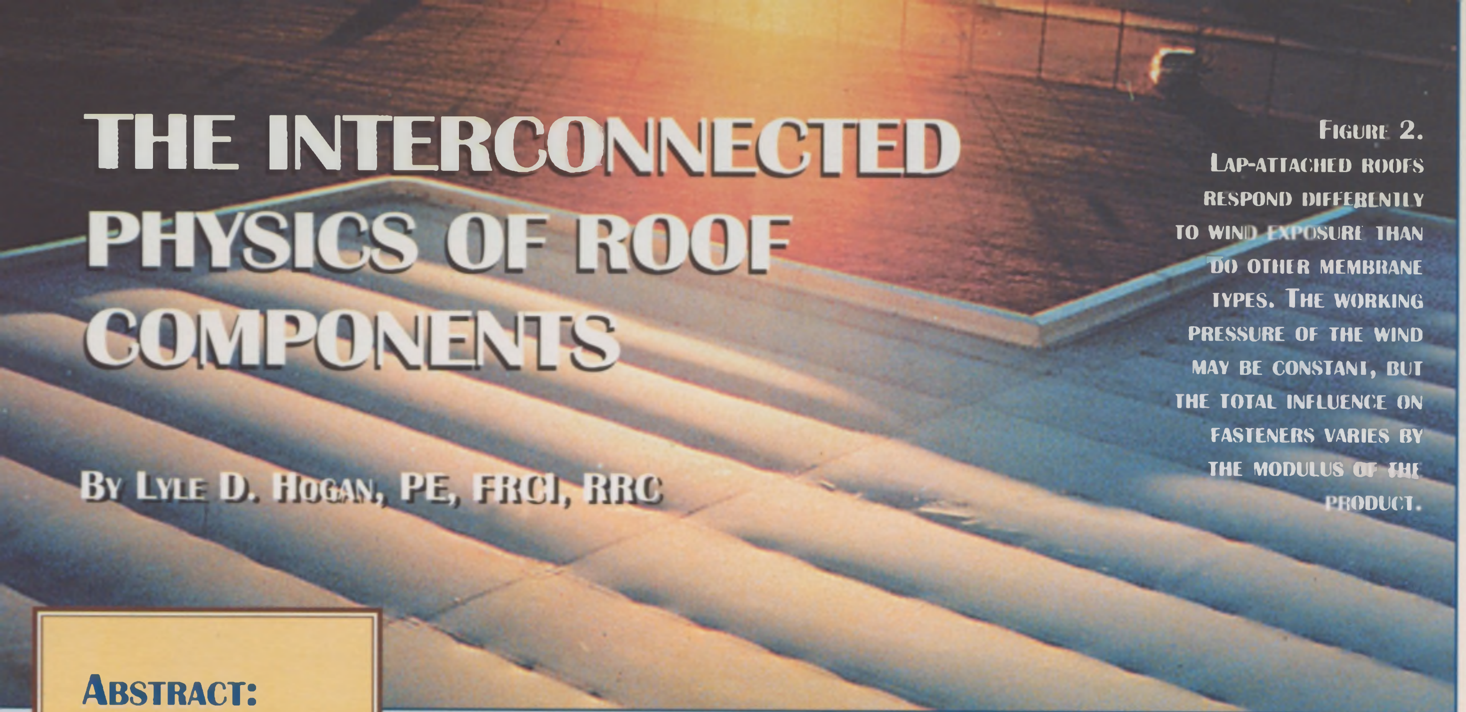

Figure 2. Lap-attached roofs respond differently to wind exposure than do other membrane types. The working pressure of the wind may be constant, but the total influence on fasteners varies by the modulus of the product.

Abstract:

Roof construction is founded in physics. As disturbing as that may be, the concept is encountered daily. Behavior of roof assemblies (including the various substrate types) is somewhat predictable when examined in the backdrop of physics.

A related notion, mechanics of solids, proceeds upon inescapable constants such as gravity and mass (at least regarding construction on this planet). This treatise is not intended as a comprehensive discussion of the physical sciences. Instead, the concepts offered are meant to illustrate the relationships between and among roof assembly components. Examples of other building construction components are used as analogies.

Inertia

The bulk or mass of roof components can be understood by inertia. Consider the difficulty in accelerating or bringing to a halt an element of a roof deck. An earthquake is a type of natural event which can induce acceleration. Plywood decks on wood structures behave radically different from a cast-in-place concrete deck during such exposure. The shock energy will be transmitted and reflected through these media at a rate governed by density of the materials used and the fixity of connections (among other variables).

Similarly, a vertical load may create identical deflections in plywood and steel decks. This would suggest that they are equally capable substrates for a given project. Yet, abrupt vertical loading may induce far different instantaneous deflection with attendant susceptibility for irreversible deformation and membrane rupture. Inertia is the phenomena responsible for this difference in behavior.

Inertia can be witnessed by analyzing the various corrugations of steel roof decks. Span tables confirm that for any gauge of deck, load capabilities differ, varying only with the fluting configuration (i.e. shape, profile, spacing, and opening).

A related aspect is thermal inertia. This is the tendency of some decks to serve as a thermal sink better than others, responding slowly to top side temperature changes. A concrete deck slightly less than five inches thick will have five times greater thermal inertia than some other lightweight substrates examined (Beech & Saunders, 1985). Separate research by Kunzel and Petersson confirmed that underside temperatures (of heavy concrete decks; see *Figure 1*) changed little with wide changes in the external environment. Roof coverings should be appropriately matched to perform in the setting of several parameters. Deck inertia is important among them.

Thermal storage capacity should be considered in surfacings as well. Gravel surfacing has the capacity to act as a thermal "flywheel." Removal of the surfacing and replacement with a mineral-surfaced cap sheet will generate a new behavior of the substrate (Duchene, 1985).

Modulus

Young's Modulus of Elasticity (E) is the slope of a graph plotting deformation against the ten-

Figure 1. Concrete decks have high thermal inertia. When compared to other substrates, rooftop temperature changes are transmitted slowly into the building.

sile load per unit area. This works well for examining solid materials; however, some roof materials do not behave as pure solids through a reasonably expected service temperature range. That is, the value for E would vary greatly with changes in temperature. A modulus of elasticity is therefore not meaningful for these materials, but a load-strain relationship nonetheless exists (albeit quite temperature sensitive). Bitumen is an example of a material having engineering properties which range according to temperature. This is the basis for studying the rheological properties of materials.

Anyone having drilled, punched, or sheared stainless steel is well aware of its hardness in comparison with other metals. For this reason, many suppose that stainless steel is stronger than the same thickness of carbon steel. Its tensile strength is well in excess of that for carbon steel (85,000 psi compared to 60,000 psi). Yet the modulus for the stainless is 28,000 ksi compared to 29,500 ksi for carbon steel (Eshbach & Souders, 1974). Carbon steel, then, has a greater slope for load-strain relationships, deforming less for a stated load. This difference can be viewed in span tables contrasting stainless with carbon steel roof deck sheets. The concept is better appreciated if the surface hardness of stainless is neglected for the moment.

One-ply membranes also behave according to modulus values. For instance, wind-induced oscillation (flutter) imparts energy to the fasteners. Other factors being constant, the higher modulus membranes transmit this energy more effectively than lower-modulus, more flexible products (i.e. EPDM). A highly-reinforced, lap-attached, sheet membrane would apply much different loads to the fastening devices during wind events than would a thick, bituminous, adhered membrane (*Figure 2*). Yet, the working pressure of the prevailing wind is the same. The varying modulus values of the two products hold part of the explanation.

Membrane modulus values also played a part of deck span tables as various products were implemented. Designers were told, for instance, to size structural elements so as to limit vertical deflections to l/180, l/240, etc. This was in an effort to avoid rupturing of a high modulus bituminous membrane (built-up roof), the hands-down system of choice for decades. This author is unaware of any current polymeric membrane product incapable of withstanding vertical deflections of the substrate well in excess of the figures above. Many such products have had performance problems, but the resilient nature (low modulus) of the coverings is largely immune to damage from deck deflection.

Moment

A force times its measured distance from some point of influence is considered the moment value acting about that point. Comparatively hard or brittle materials are well capable of transmitting moment. Further, rigid materials "attract" moment. Consider two types of pitch pocket filler surrounding an iron penetration (*Figure 3*). Movement of the iron is transmitted through the material. Rigid fillers (like cementitious grout) impart more separation stress to the sides of the pitch pocket form than more resilient polymeric products.

**Figure 3.
Rigid filler in a pitch pocket attracts and transmits moment better than a resilient product. Susceptibility for splitting and separation then becomes apparent.**

Steel deck sheets may be installed spanning across three, four, or more bar joists. That arrangement is intended to transmit moment induced (by loads in one area) across the supports into other regions. Multiple single spans may work apart at the sheet endlaps. Distribution of the moment is appealing management of an influence that might split a comparatively rigid membrane.

Shear Diaphragm

A structure having only horizontal and vertical members would be unstable, even when fastened appropriately to adjacent members. Lateral loads imparted (by wind and earthquake acceleration) induce horizontal shear in the structure. As a result, a diaphragm is needed in the horizontal plane.

In the absence of a diaphragm, horizontal shear can aggravate connections and result in twisting or torsional behavior within the structure. Resistance is provided in several locations in a structure by using a diaphragm and/or diagonal bracing (*Figure 4*). Bracing (bridging) may be found between and among wood joists and steel purlins. This, however, is to control potential rotation of the members and should not be confused with shear diaphragm elements.

**Figure 4.
A structural system having only vertical and horizontal members must be stiffened against horizontal loads. Shown here is ordinary diagonal bracing using steel sections.**

A plywood roof deck is an excellent shear diaphragm when anchored properly into framing members. This is also the reason plywood is used at corners of framed wood walls, substituting for other types of sheathing found elsewhere in the same construction (*Figure 5*).

FIGURE 5.
PLYWOOD IS USED AT CORNERS OF FRAMED WOOD WALLS, SUBSTITUTING FOR ORDINARY SHEATHING USED ELSEWHERE. THE PLYWOOD IMPARTS HORIZONTAL SHEAR RESISTANCE TO THE FRAMING.

FIGURE 6.
STRUCTURAL METAL ROOFS ARE CARRIED ON A SYSTEM OF CONCEALED CLIPS, ALLOWING LONGITUDINAL MOVEMENT OF THE PANS. BEING, THEREFORE, SEPARATED FROM THE STRUCTURE, THE ASSEMBLY IS INCAPABLE OF SERVING AS A SHEAR DIAPHRAGM.

A structural metal roof, by definition, has no deck or substrate. Modern standing seam coverings are carried on a system of concealed clips which accommodate thermal movement (*Figure 6*). This appealing divorcement of the roof covering from the framing elements, however, renders standing seam assemblies incapable of serving as a shear diaphragm. Such resistance must be gained elsewhere in that type of structure such as with the diagonal elements described above. Note that even conventional steel decks do not develop full diaphragm capability until side lap stitching screws are in place (*Figure 7*).

FLUID DYNAMICS

Those things that flow can be examined in a study of fluid dynamics. A substance does not have to be in "liquid" form to be a fluid. For roofing analysis, wind is the fluid of interest. Wind tunnels all whistle the same tune, and the influence on construction surfaces can be modeled reliably. Bernoulli's Energy Equation is the form used to express working pressure as a function of fluid velocity. Modified appropriately for the density of air, the influence is generally in the form:

$$P = 1/2\ \rho(v)^2$$

where: P = the pressure of the wind acting on the surface
ρ = the density of air
v = the wind speed

Simplified, the pressure acting on a surface varies as the square of the wind velocity. This is pivotal in understanding why roofs come off (even though most should not). Try holding your hand from the window of an automobile moving at both 40 k/hr and 80 k/hr. The velocity has doubled, but the difference in pressure experienced has increased exponentially. Such an example ratifies the velocity pressure curve, a parabolic function because the formula is a second degree equation (*Figure 8*).

Roof design for wind resistance embodies a shape factor analysis. That is, we convert the pressure acting normal to a wall surface to an influence over the top of a structure. Such converting incorporates a 50% escalation of the working pressure for design purposes (1.5 times the wall surface pressure). Other escalations and factors are applied later.

COEFFICIENTS OF THERMAL MOVEMENT

The movement of various construction materials as a function of temperature is well known. A coefficient of thermal expansion has been determined for virtually everything used in roof construction. Joining certain materials occasionally results in mismatch, particularly where long-term waterproofing is required. Sheet metal accessories integrated into membrane products is a classic case where this union is crucial.

FIGURE 7.
CONVENTIONAL STEEL DECKS DO NOT DEVELOP FULL DIAPHRAGM CAPABILITY UNTIL SIDE LAP STITCHING SCREWS ARE IN PLACE.

Consider light-gage (0.032 inch) aluminum and how it compares with bulk (0.125 inch) aluminum of the same length. Note that the coefficient of thermal expansion is unrelated to the thickness of the material (Hogan, 1993). That is, the amount of movement has nothing to do with the gage of the material. The difference in performance is the amount of shear force exerted on the fasteners used to secure the accessories.

The force acting on the fasteners (of bulk thickness metals) may be substantial, potentially shearing the attachment devices and/or elongating fastener holes. The force actually at work is identical to the force required to stretch it by the same amount (Beiser, 1991). Because of this, the thicker bulk metals are divorced from a membrane while light gage metals may be functionally restrained by frequent fastening.

Summary Remarks

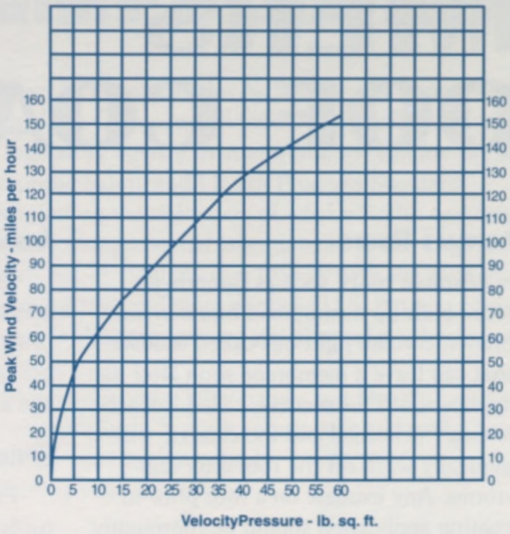

Figure 8. The velocity pressure curve is parabolic because it is the plot of a second degree equation. The pressure varies as the square of velocity.

Nonperformance of various roof types may be explained when the properties of one component are not well matched to others in the composite. The interaction of the components has been explored by several researchers. Van Wagoner (1989) has examined the membrane and insulation combination. The deck and structure have played a pivotal role in the observations of this writer. I will not attempt to improve on Griffin (1982) who postulated:

"The characteristic problems of roof system designs are a combination of incompatible materials rather than isolated failures of single components. Two or more components may satisfy their individual material requirements to perfection and yet, in combination, fail disastrously."

Successful integration of the multiple components is crucial to achieving the optimum roof service life. A better understanding of physics will lead the way to improved system performance.

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This article is reprinted from the proceedings of the Energy Efficient Building Association's (EEBA) Conference Oct. 28-31, 1998 in Washington, DC.

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Lyle Hogan *is a senior engineer with Geoscience Group, Inc., working out of the firm's Greensboro, NC office. He is a registered engineer, Registered Roof Consultant, licensed home inspector, and Fellow of the Roof Consultants Institute. His technical articles have been published in numerous technical journals and conference proceedings. He is Senior Editor of* Interface Journal.

USE OF PRIMERS PRIOR TO ROOF COATING

RCMA Tech-Note

Primers aid in the adhesion of the coating by providing a bond between the surface of a roof and the roof coating. Primers come in many different forms; the type of primer employed will be based upon the substrate, weather conditions, and the type of coating being applied. A decision to employ a primer should not be made without consulting the manufacturer's requirements for the specific coating and substrate.

A primer is never a substitute for proper roof membrane preparation. The substrate should be clean and dry prior to roof coating application. Dust, chalking film, bitumen exudate and greases or oils should be cleaned off of the roof prior to the application of coatings. For more on preparing a modified bitumen roof surface prior to coating application, consult the Roof Coating Manufacturers Association/Asphalt Roofing Manufacturers Association (RCMA/ARMA) document entitled, "Evaluation and Preparation of Modified Bitumen Roofing Systems for the Application of Surface Coatings."

Surfaces which generally require primer include: metal flashings, gravel stops, and other metal edging; concrete and masonry roof decks, masonry walls and floors, and gypsum and other porous surfaces. Asphalt primers should be used with asphalt materials only. Primers are compatible with modified bitumen products, but the manufacturer recommendations should be checked before using a primer. Primers are generally applied to clean dry surfaces; however, asphalt emulsions primers can be applied to damp (not wet) surfaces. Primer and surface coating application should occur in short order. Following are some general guidelines regarding the application of primer which are useful to consider.

Asphalt Roofs

Asphalt roofs, such as smooth-surfaced built-up or modified bitumen membranes, contain light oils called exudate that can leave a membrane soon after its application. This process, called "tobacco juicing," is normal and the exudate will generally wash off the roof after rainstorms. Any exudate on a roof prior to coating application should be thoroughly cleaned. Special primers to resist the exudate from bleeding through fresh coating may be requested for application of acrylic coatings.

Glaze-coated built-up roofing can also release exudate. In addition, the glaze coat, if not reinforced, will crack or "alligator." One way to reduce this effect on new roofs, or to cover cracks in older roofs, is to prepare the roof with a layer of fiber-reinforced asphalt emulsion coating prior to the application of reflective coating. On old, weathered asphalt roofs, many coating manufacturers recommend the use of primer after cleaning the membrane to prepare the surface for coating. When coating an existing aluminum roof with an acrylic coating, primer is usually needed. Consult the coating manufacturer for recommendations.

Metal Roofs

Primers are generally recommended before applying a surface coating to a metal roof, regardless of whether the roof is new or old. Special primers are made for both aluminum asphalt and elastomeric coating application over metal roofing. Certain primers, such as zinc-chromate-based primers, may be incompatible with some coatings. The use of primer is not a substitute for removing rust and scale on weathered metal roofing. Ask the coating manufacturer for guidance in preparing metal roofing for surface coatings.

Coal Tar Roofs

Generally speaking, coal tar roof coatings are considered self-priming and do not require primer application prior to application of coal tar coating or resaturant.

Acrylic Coated Roofs

On roofs with an existing layer of acrylic coatings, primer may be required prior to application of new coating. The use of primer is largely dictated by the age and condition of the existing coating.

Sprayed Polyurethane Foam Roofs

Existing sprayed polyurethane foam roofs may have been coated with silicone-based coatings. As adhesion of acrylic coatings is difficult over silicone, manufacturers often perform adhesion tests on a sample of the roof membrane and recommend the appropriate primer to help assure the proper attachment of the new coating. If silicone roof coatings require special coating procedures, contact the roofing manufacturer for instructions.

Single Ply Roofs

If coating is an option, the manufacturer of the roof membrane generally sells specialty primers for these membranes.

Concrete

Prior to coating a concrete surface, the concrete shall be clean and dry. Loose concrete should be removed or repaired before coating. A primer is used on concrete to seal the pores of the concrete an aid in the adhesion of the coating. The coating manufacturer should be contacted for a recommended primer. If a release agent or curing compound has been used on the concrete surface, inform the coating manufacturer, as these may inhibit the adhesion of the primer and coating.

Note: These recommendations were prepared by and have the approval of the Roof Coating Manufacturers Association for informational purposes only. They are not intended to revoke or change the requirements or specifications of the individual roofing material manufacturers or local, state, and federal building officials that have jurisdiction in your area.

SMACNA Claims OSHA Has Gone Too Far

In a recent letter to Assistant Secretary of Labor Charles N. Jeffress, the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) warned the Occupational Safety and Health Administration (OSHA) that it appears to be exceeding its statutory authority as a regulatory agency in attempting to redefine the scope and content of health and safety standards in its recently released draft "Proposed Safety and Health Program Standard."

"OSHA is, in effect, expanding and altering the definition of what a health and safety program standard is, through regulatory initiative rather than seeking the necessary Congressional amendments to the original OSHA statute," the letter says.

The Occupational Safety and Health Act of 1970 charges OSHA with the promulgation and enforcement of occupational safety and health standards to protect the working men and women of the U.S. But according to SMACNA, OSHA's 'Proposed Safety and Health Program Standard' seeks to mandate the management practices of employers' safety and health programs," thereby contradicting an employer's rights.

SMACNA recommends that OSHA revisit its own 1989 Safety and Health Guidelines and reconvene representatives of both labor and management organizations to promulgate "a more appropriate and useful proposed safety and health program guideline" in place of the recently issued and "overly-restrictive" standard.

SMACNA represents 4,500 contributing contractor firms.

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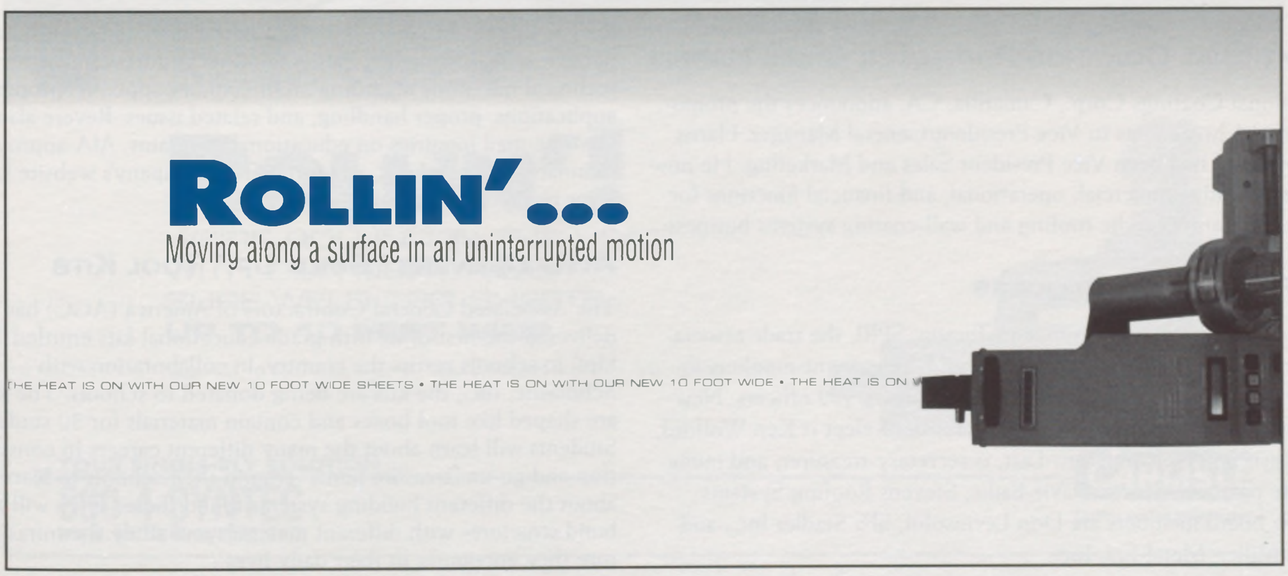


PUBLICATIONS AND PROMOTIONS

Koppers Offers Catalog

Koppers Industries Inc. is offering a new 32-page catalog on their commercial roofing systems. The new brochure provides current coal tar specification and application considerations, as well as flashing specifications and detail drawings. For information, phone 412-227-2001 and request KI-447-12/98.

NRCA Releases Materials Guides

The National Roofing Contractors Association (NRCA) has made available its 1999 editions of the Low-Slope Roofing Materials Guide and Steep-Slope Roofing Materials Guide. For further information, phone 847-299-9070, ext. 226.

PEOPLE

Integrated Roofing & Waterproofing Names Lockhart COO

Integrated Roofing & Waterproofing Inc., founded in Houston in December, has named James R. "Butch" Lockhart its Chief Operating Officer. Lockhart most recently served as vice president of GAF Materials Corp. in Wayne, NJ, and previously held vice president positions with Firestone Building Products Co., Carmel, IN. Integrated recently acquired six roofing contracting firms around the country.

National Coatings Promotes Chris Harris

National Coatings Corp., Camarilla, CA, announces the promotion of Chris Harris to Vice President/General Manager. Harris previously had been Vice President Sales and Marketing. He now oversees all commercial, operational, and financial functions for the company's acrylic roofing and wall-coating systems business.

SPRI Elects Officers

During its annual conference in Tucson, SPRI, the trade association representing sheet membrane and component suppliers to the commercial roofing industry, elected its 1999 officers. New president is Peter Davis, Sarnafil; president-elect is Ken Wolford, Siplast; Bob Nelson, Duro-Last, is secretary-treasurer; and immediate past president is Davie Bailie, Stevens Roofing Systems. New board members are Don Levinsohn, SFS Stadler Inc.; and Jim Miller, Metal-Era, Inc.

CTL Names Helm as Cincinnati Manager

CTL Engineering has appointed Charlie Helm as the Branch Manager of its Cincinnati office. CTL is a consulting engineering firm that specializes in testing, inspection, and analytical laboratory services.

PURCHASES/ PARTNERSHIPS

ESOP Purchases Major Interest in CTL

The majority interest of the 72-year-old engineering firm of CTL Engineering Inc. was purchased recently by an Employee Stock Ownership Plan. The stock was previously owned by Bjorn Kvammen, who joined the firm in 1973 as a soils engineer. CTL has 220 employees in nine offices. C. K. Satyapriya has been newly appointed as Chairman of the Board. Kvammen will remain as an advisor to the firm.

Celotex Withdraws from PIMA

Celotex Corp., Tampa, FL, has withdrawn its membership from the Polyisocyanurate Insulation Manufacturers Association (PIMA), of which it was a founding member. Celotex says the action was taken because PIMA "has become focused on commercial roof insulation, which is not consistent with our strategic business objectives."

PROGRAMS

Copper Questions Answered

Revere Copper Products Inc. has a new e-mail address: archcopper @reverecopper.com. This is the direct address to use for all technical questions regarding architectural copper, its properties, applications, proper handling, and related issues. Revere also welcomes e-mail inquiries on educational programs, AIA-approved seminars, new products, and more. The company's website is www.reverecopper.com.

AGC Delivers "Build Up!" Tool Kits

The Associated General Contractors of America (AGC) has delivered the first of its fifth grade educational kits entitled "Build Up!" to schools across the country. In collaboration with Scholastic, Inc., the kits are being donated to schools. The kits are shaped like tool boxes and contain materials for 30 students. Students will learn about the many different careers in construction and go on "treasure hunts" around their schools to learn about the different building systems found there. They will also build structures with different materials and study the infrastructure they encounter in their daily lives.

PRODUCTS

GenFlex Introduces TPO Walkway Pads

GenFlex Roofing Systems has introduced a line of TPO Heat Weldable Walkway Pads to protect roofs from heavy foot traffic. They are available in blue to differentiate the walkway from the roof and come in 5/32" (156 mils) x 30" x 60' (150 sf/roll) size. For more information, phone 800-443-4272.

New TPO Edge Sealant

GenFlex Roofing systems is now packaging its new TPO Edge Sealant in small plastic bottles for convenience and ease of handling. A 16-ounce bottle is meant to cover 115 lf. It is available in white, black, and light grey. For info, phone 800-443-4272.

PLAUDITS

MRCA is 50 Years Old

The Midwest Roofing Contractors Association (MRCA) will hold its 50th year celebration Oct. 28 and 29, 1999 at Bartle Hall in Kansas City, MO. The group serves more than 200 members.

Core cut before installing fastener.

Pre-drilling hole for fastener through core.

Standardizing Pullout Test Procedures

By Stan Choiniere & SPRI's Fasteners Subcommittee

To optimize the accuracy of pullout test procedures, a national standard has been developed, ANSI/SPRI FX-1.

Pullout tests provide valuable data—as long as they are performed in a consistent manner. But how do you make sure that happens?

Even though pullout testing was intended to solve problems, it often created confusion because of the absence of a standard procedure. When a designer was trying to select the best options for a specific project, he would often compare the results of pullout tests performed by more than one individual, so results could be misleading due to variables in both the procedure and equipment used.

It became clear that a national standard was needed to spell out, in detail, how to perform a pullout test. This project was initiated in the early 1990s by the Fasteners Subcommittee of SPRI, the association representing sheet membrane and component suppliers to the commercial roofing industry. This group evaluated the procedures of its member companies, took into account all of the data needs for fastener selection, and considered the variables that could affect test consistency.

Armed with this information, SPRI's Fasteners Subcommittee started the task of developing a standard procedure. After a great deal of tweaking and polishing, the subcommittee brought its final draft to the entire technical body of SPRI for comments and approval. Surprisingly, there were very few challenges to the document so, with some minor changes, the document was approved and made available as a "Guideline" for pullout tests. However, since SPRI is not a standards-setting body, the document was not always accepted as the valuable tool that it is.

ANSI Accreditation Of SPRI

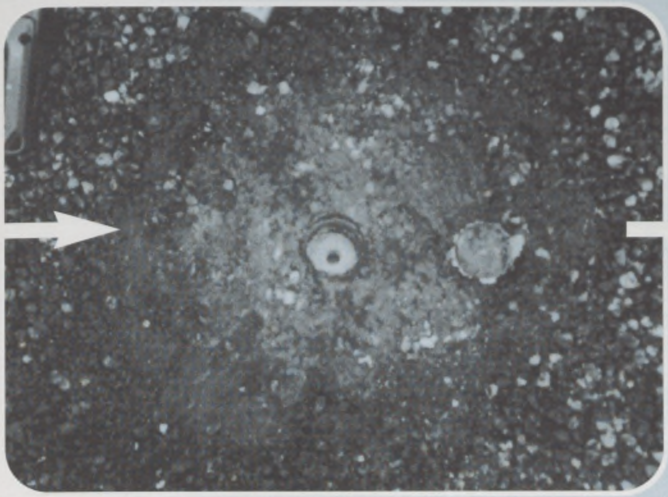
In 1994, the American National Standards Institute (ANSI) officially recognized SPRI as a canvassing organization. This opened the door for SPRI to advance the pullout test procedure to the next level and have it become an American national standard.

The Fasteners Subcommittee again refined the document, putting it into mandatory language and adding metric equivalence. It was then sent to the people on a canvass list which includes more than 30 roof designers, roofing and fastener manufacturers, code officials, and qualified industry experts.

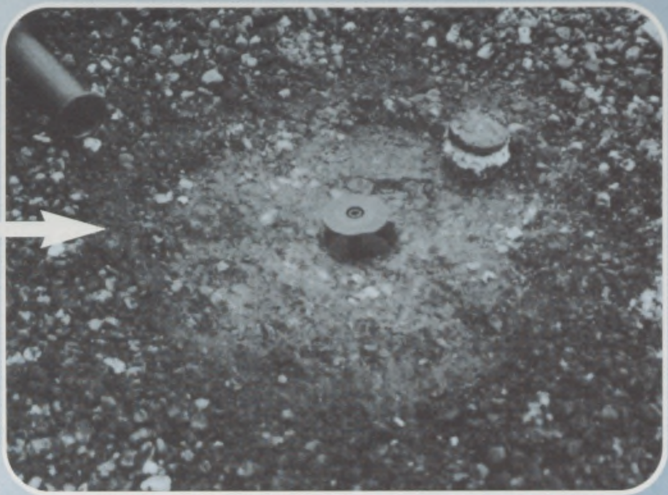
About two-thirds of the group approved the document on the first ballot. There were some that didn't fully understand the intention of the procedure—i.e., that it was a "field" test, not a lab test with controlled conditions. Some wanted more sophisticated test equipment, which was also not practical for a field test. Some wanted to eliminate limits on pullout tests in below-freezing temps (the procedure warns against testing frozen, moisture-laden decks due to false high values).

After addressing each one of these negative votes individually, all but two people returned positive votes on the second ballot. The only remaining concern was the frozen wet deck issue. With more than the required 2/3 of those voting to approve the document, ANSI adopted the procedure in 1996.

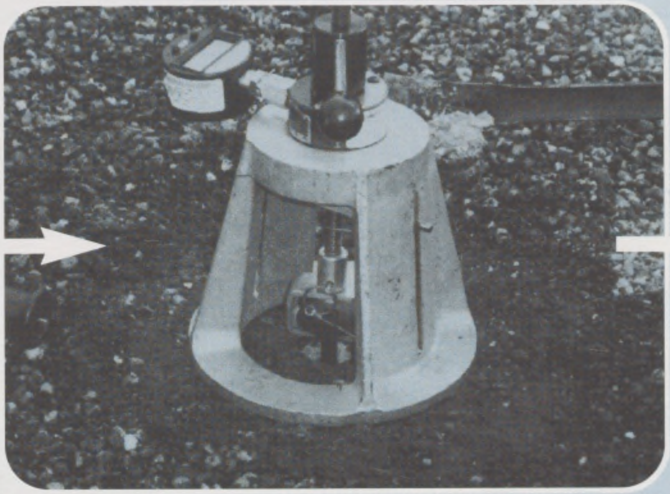
The procedure is very easy to follow and has even led some test equipment manufacturers to upgrade equipment to make it more versatile. Analog gauges and hydraulic load cells are specified to improve accuracy over spring-type scales. Analog gauges



Ready to install fastener.



Fastener in place ready for pullout.



Digital/hydraulic pullout tester in place.

Digital readout.

All photos supplied by Olympic Fasteners.

have limited accuracy in broad scales so the standard calls for a calibrated tolerance of +/- 5%, with a limit on the range of the gauge based on anticipated pullout values. New technology with digital readouts allow 0.25% accuracy, giving a broader usable range.

This standard spells out how many tests must be done on each job, by size, and where these tests should be done. Details, such as removing existing roof material that can influence test values, are also covered.

The worksheet outlines all of the pertinent data needed for fastener selection.

Using the ANSI/SPRI FX-1 procedure helps the design professional compare competitive products more accurately, assuming the procedure is followed carefully. Many sectors of the roofing community are now using this procedure and are confident in its data.

ANSI/SPRI FX-1-1996 can be ordered from SPRI for $2 per copy at (781) 444-0242, or through the RCI Mercury system.

About the Authors

Stan Choiniere

has chaired SPRI's Fasteners Subcommittee for several years. He is currently a member of that association's board of direc tors, and has previously served as its vice president. Choiniere is the Technical Director of Olympic Fasteners, Agawam, MA. He has written numerous magazine articles on a variety of roofing topics. Choiniere co-authored a technical paper for the 1997 International Roofing Symposium. He has also presented seminars on roofing fasteners and mechanically fastened roof systems.

The SPRI Fastener Subcommittee

members represent a number of representatives from the various fastener manufacturers supplying the commercial roofing industry.

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Industry Calendar

APRIL 1999

8 • NRCA Conference on Roof Problem Analysis
Newark, NJ
Info: (847) 299-9070

19-20 • ROOFTech '99 (CRCA)
Vancouver, BC
Info: (800) 461-2722

22 • NRCA Conference on Roof Problem Analysis
Seattle, WA
Info: (847) 299-9070

25-27 • Constr. Alliance National Issues Conf. (SMACNA)
Washington, DC
Info: 703-803-2990

MAY 1999

6-9 • AIA National Convention and Expo
Dallas, TX
Info: 202-626-7395

12-15 • Dach + Wand '99
(German Central Assoc. of Roofing Contractors)
Stuttgart, Germany
Info: 847-299-9070, ext. 231

JUNE 1999

13-14 • National Assoc. of State Facility Administrators
Jackson Hole, WY

20-22 • Association of Physical Plant Administrators
Cincinnati, OH

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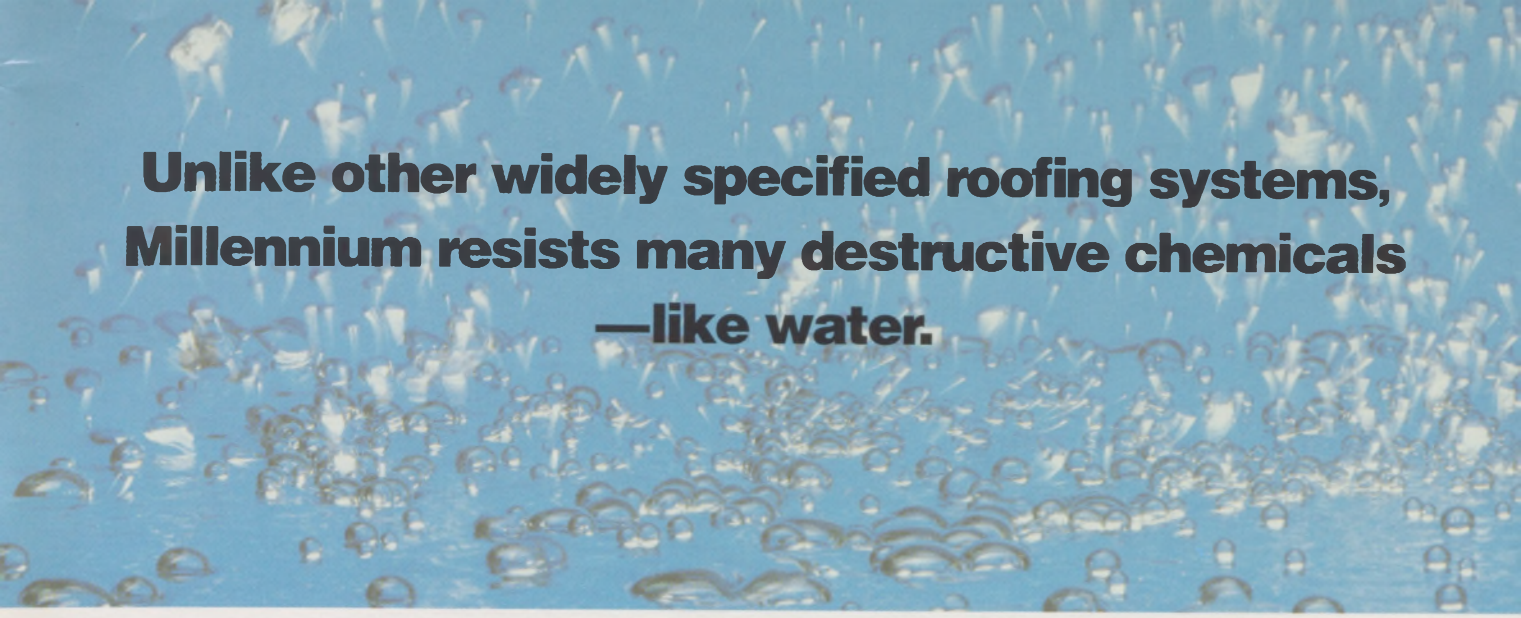

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