A Few Simple Rules

What to Do to Ensure a Built-up Roof Will Perform As Expected

By Helene Hardy Pierce, FRCI

Built-up Roofing (BUR) has been around a long, long time, and as most are aware, it has an excellent record of providing long-term performance for property owners. This long-term performance is predicated on a few simple rules that most roof consultants, specifiers, and designers know, but on occasion, may overlook. While these rules are applicable to built-up roofing, several of them apply to most low-slope systems. This article revisits these rules and why they should be heeded.

Rule #1

Use the Right Asphalt

While ASTM D312 Type III and Type IV represent approximately 95% of the hot asphalt sold for use in the roofing industry today and are acceptable for use in most geographic areas of the country, this rule must still be stated. ASTM D312 is the standard specification for asphalt used in roofing, and asphalt used in a built-up roof should meet this standard. The exception to this rule is when a modified, mopping-grade asphalt is specified and used. These newer asphalts may meet the intent of the standard but not the "letter of the law." The roof consultant or specifier should require that the published performance characteristics of modified, mopping-grade asphalts be met when ASTM D312 is not applicable.

When using D312 asphalt, the correct type must be used for both the climate and the slope of the application; asphalt is a viscoelastic material, and an asphalt that is too "soft" can cold flow on a fairly small slope on a hot summer day.

Because Type II asphalt is not readily available in most markets, and many roofing contractors use the same Type III or Type IV mopping-grade asphalt for built-up roofs as for SBS modified bitumen installations, this is a rule that is not often broken.

Figure 1. Cap sheet installed on steeper slope with the wrong type of asphalt.

Rule #2

Use the Right Amount of Asphalt

It's simple: the saying, "if a little is good, a lot must be better" does not apply to the construction of a built-up roof. In general, specifications and manufacturers' recommendations state that a built-up roof is constructed with approximately 25 lbs. of asphalt per square per ply sheet with a tolerance of +/- some amount, e.g., 15%. This quantity of asphalt equates to a cross-section about the thickness of a dime for each ply installed. Why is breaking this rule a problem? Too little asphalt, and the roof does not have enough of the component in the finished membrane that keeps water out. Too much asphalt, and the roof now has a plane where slippage of the plies and asphalt can occur; in addition, heavy interply mopping weights reduce the stabilizing properties of the ply sheets.

Figure 2. Ponding water reduces the life expectancy of a roofing system.

Getting the right amount of asphalt was made much easier with the introduction of "equiviscous temperature" (EVT) and the determination by researchers that there is an optimum viscosity for asphalt. When installed at this optimum viscosity, the resulting amount of asphalt will be approximately 25 lbs per square. EVT also takes into consideration how the asphalt is being installed (either by hand mopping or by mechanical spreader), specifying an apparent viscosity of 125 centipoise for hand mopping and 75 centipoise for mechanical spreader applications. Adhering to the EVT specific for the asphalt being installed helps ensure uniform, consistent application of the asphalt in the right amount because asphalt that is too "cold" results in heavy moppings and asphalt that is too hot causes light interply mopping weights.

Rule #3

Design for Forces That Act on the Roof

Built-up roofing systems have sufficient strength to resist normal expansion and contraction forces that are exerted on a roof; however, they typically have a low ability to accommodate excessive building or substrate movement. Rephrased, if the roof must be used to "hold the walls" together or if the use of "loose-laid insulation" has a benefit, then a traditional 3- or 4-ply built-up roofing system is not a good choice.

A built-up roof typically provides high tensile strength with low elongation. Guidelines about where expansion joints should be installed in the roofing system need to be followed and should not be ignored by the designer.

These guidelines include installing expansion joints where the deck changes direction, approximately every 200 feet (although many consider that this dimension can be expanded for membranes with high elongation properties), where there is a change in deck material, anywhere there is a structural expansion joint, etc.

In addition, insulation or decking below a built-up roof must be properly anchored. In fact, Griffin and Fricklas claim that "unanchored insulation boards is by far the most common cause of BUR membrane splitting."[1]

Rule #4

Roofs Should Not Hold Water

It seems elementary, but roofs should not pond water. Certainly there are exceptions to this, such as limiting precipitation run-off to assist antiquated stormwater systems that cannot handle water from deluging rains; but in general, ponding water should be avoided on low-slope roofing applications. A common definition of ponding is water that remains on the roof 48 hours after precipitation has ceased. This definition takes into account that there may be some small areas of standing water immediately following a rainfall, but the water should have drained or evaporated after a couple of days of drying.

Ponding water causes a myriad of problems that most property owners want to avoid: acting as a source for vegetation growth; self-perpetuating deck deflection (a small amount of water adds a concentrated load to the deck, causing deflection, which in turn increases the area ponding water,

Figure 3. Improperly stored materials should not be used in the construction of a built-up roof.

which increases the load, etc.); allowing a much larger amount of water to enter the roofing system (and, ultimately, the interior of the building in the event of a small defect in the roofing system); and accentuating and accelerating the effects of ultraviolet exposure on asphaltic-based materials.

To avoid ponding water, designers should provide a minimum of 1/4 inch per foot slope in the structure. This is often the best method for the property owner, because when slope is properly constructed into the structure, one doesn't have to worry about it in future re-roofing programs. Where the structure does not provide adequate slope, the use of tapered insulation or a tapered fill can provide slope. The installation of additional drains and the use of crickets and saddles can also either eliminate ponding water or minimize its extent.

Rule #5

Keep Materials Dry

While today's fiberglass built-up roofing felts are much more forgiving than their predecessor organic felts, all materials must be kept dry before and during installation to prevent blistering in the roof system. Proper storage is key. Do not overstock the roof. Use breathable tarps to cover material on the roof (plastic sheets used as covers can result in condensation, causing the stored materials to become wet). Store material on pallets to minimize the possibility of material sitting in water. Store rolls on end to prevent crushing, and keep materials stored on the roof neat and organized to prevent physical damage.

In addition to proper storage of materials, roofing materials should not be installed during inclement weather or when precipitation is predicted. Care should be taken to make sure the substrate is clean and dry before roofing and if the job requires roofing at night or in the early morning, make sure dew is not forming on materials or substrate as the work progresses. Each of these steps can help prevent problems with the finished roofing system.

Rule #6

Two Plus Two Does Not Equal Four

In straight mathematical terms, two plus two does equal four, but in built-up roofing, the math works this way: two plus four equals four. Many roof consultants and product manufacturers clearly state that there should be no phasing of a built-up roof. This is a clean and simple rule to understand; if the roof being constructed is a four-ply, built-up roof, then only as much insulation should be installed as can be covered the same day with all four of the plies in the built-up roofing membrane. Phased construction of a built-up roof greatly increases the potential for blistering of the membrane and does not allow for the total number of plies to be installed in a shingled fashion. Phased application contains perils, such as roofing over a very small amount of overnight precipitation or dew that, even with the best of intentions, can cause harm.

In reality, there are times when a roofing contractor may get ahead of the ply sheet installation and have installed more insulation than can be covered in the same day; or, weather may change quickly, both of which necessitate getting the building protected through the installation of two plies in hot asphalt. When this occurs, both the Asphalt Roofing Manufacturers Association (ARMA) and the National Roofing Contractors Association (NRCA)[2] agree that the continuation of the membrane on the next work day should start with making sure the roof is dry and clean, and then with the installation of the required total number of plies over this temporary roof; ergo, 2 + 4 = 4.

Rule #7

Use Modified Bitumen Flashing Materials to Strip-in Metal

This rule is controversial simply because in practice, gravel stops have been stripped-in with two plies of felt in many applications across the country for many more years than modified bitumens have been available – and they've been available for over 30 years!

The reality is that splitting of these felts at the joints in a gravel stop will probably occur because the 2-ply application cannot accommodate the movement in the edge metal and the two plies themselves have a high coefficient of expansion and contraction. Because of this, many tend to treat gravel stop strip-ins as a maintenance item, whereas this rule suggests that this maintenance can be avoided altogether or minimized by simply switching to a better alternative.

Modified bitumen membranes are compatible with built-up roofing systems and typically provide superior performance when used as a flashing material in the construction of a built-up roof. Even on gravel stops, when properly installed, modified bitumen membranes can accommodate the metal and provide a maintenance-free solution for the life of the built-up roof. In fact, modified bitumen membranes provide the basis for our final rule – Rule #8.

Figure 4. Modified bitumens perform well as metal flashing strip-in material.

Rule #8

Use Modified Bitumen Membranes as a Flashing Membrane

In general, the growth and acceptance of modified bitumen membranes has had the added benefit of creating flashing details that have been shown to provide great performance over a long period of time. These flashing details are now recognized as often providing the best performance available for the completion of a built-up roofing system. Another benefit of using modified bitumen flashing membranes is that the construction of these details is often the same or similar, whether the finished membrane is a built-up system or a modified bitumen system – so contractors don't have to worry about training their crews on another set of criteria, and confusion on how a particular detail should be flashed is minimized or eliminated.

Figure 5. Flashing details are critical to the long-term performance of any roofing system.

ROOF KNOWLEDGE ASSESSMENT

Test your knowledge of roofing with the following questions, developed by Donald E. Bush Sr., RRC, FRCI, PE, chairman of the RRC Examination Development Subcommittee.

1. **Simplified heat transfer calculations normally used for building design require knowledge of what four indexes of heat transmission?**

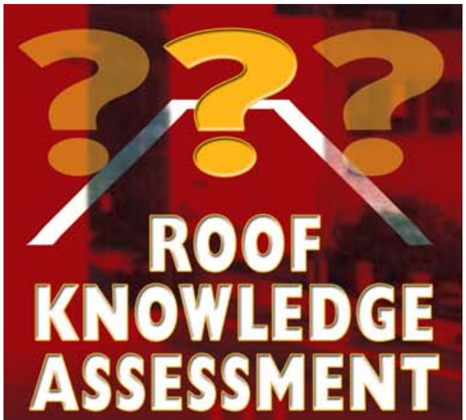
2. **To qualify as thermal insulation, what must the maximum k-value be of the material being used?**

3. **Radiation accounts for the extremes in roof-surface temperatures above and below atmospheric temperatures. How much can an insulated roof's surface temperature differ from the atmospheric temperatures during clear, sunny days and clear, cloudless nights?**

4. **Solar cooling load is dissipated via what four basic mechanisms?**

5. **To qualify as a cool roof, what are the requirements of the standard set by the Heat Island Group of the Environmental Energy Technology Division of the Lawrence Berkeley National Laboratories?**

Answers on page 28



Answers to questions on page 27:

1. a. **Thermal conductivity – k = heat (BTU) transferred per hour through a 1-inch thick, 1-foot^2 area of homogeneous material per °F temperature difference from surface to surface.**

   b. **Conductance – $C = \frac{k}{\text{thickness}}$ is the corresponding unit for a material given thickness**

   c. **Thermal resistance – R = 1/C indicates a material's resistance to conductive heat flow. The unit for R is °F • h • ft^2/BTU.**

   d. **Overall coefficient of transmission U is a unit like k and C, measured in BTU transmitted per hour (BTU/h) through 1 ft^2 of construction per °F from air on one side to air on the other, $\left(U = \frac{1}{\sum R}\right)$.**
   All component materials that make up the roof assembly, including the inside and outside air films, must be considered in the total resistance computation.

2. **k-value of 0.5 or less.**

3. a. **Clear sunny days – +75°F**

   b. **Clear cloudless nights – 10°F or more**

4. 1. **Surface reflectance**
   2. **Surface emittance**
   3. **Conductance**
   4. **Convection**

5. 1. **Minimum solar reflectance = 0.70 and minimum thermal emittance = 0.75 or**
   2. **Minimum emittance less than 0.75, minimum reflectance = 0.955 – 0.34 emittance**

Reference: ***Chapter 5* — Manual of Low Slope Roof Systems**

Final Comments About These Simple Rules

There are more options available to the roofing professional today than at any other time in history. These eight simple rules represent basic items that should not be ignored in the design and construction of a built-up roof. Certainly there are other guidelines and requirements that must be met to realize a good roofing system; in fact, for each type of roofing technology, every professional has his or her own set of rules, such as "do not install product that has an expired shelf-life." However, regardless of how complicated this industry becomes, if we remind ourselves of the simple rules that we should know and understand, then specifying, installing, and enjoying a roof that performs will be much easier.

References

1 C. W. Griffin and R. L. Fricklas, *Manual of Low-Slope Roof Systems*, 4th Edition, McGraw Hill, New York, NY 2006
2 *ARMA/NRCA BUR Quality Manual*

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Updated Version of ANSI/SPRI Fastener Standard FX-1 Now Available

An updated and revised version of the ANSI/SPRI "Standard Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners, ANSI/SPRI FX-1-2006," has been officially canvassed and reaffirmed as an official national standard in accordance with protocol established by the American National Standards Institute (ANSI).

SPRI, the association representing sheet membrane and component suppliers to the commercial roofing industry, developed this standard for measuring the pullout resistance of roofing fasteners in field conditions. It was first published in 1996, revised in 2001, and now, in accordance with ANSI requirements calling for the re-canvassing of standards every five years, FX-1 has been reviewed and re-issued in a more user-friendly version.

"While it can be used on both new and older decks," SPRI Technical Director David Roodvoets adds, "this standardized test is particularly useful in a reroofing situation." The test's significance is enhanced by the fact that its findings are accepted by all industry segments, including fastener suppliers, membrane manufacturers, and Factory Mutual Engineering and Research Corp. In cases where fastener spacing or amounts are questioned, this test method can be used to validate actual field requirements. The FX-1 Standard has become a key component in verifying the suitability of steel deck with 10-ft-wide mechanically attached systems, particularly when complying with Factory Mutual and the tensile strength of the deck is unknown.

All SPRI standards can be downloaded free of charge at the SPRI website www.spri.org.