SINGLE-PLIES FOR SMALL JOBS

Sorting through the array of single-ply roofing options

by Michael Russo

Because PVC is thermoplastic, it can be melted and fused by heat using a hand-held, hot-air welder (above) or an automatic welder (left). The seam is theoretically as strong as the membrane.

EPDM, the most common and least expensive single ply, has excellent strength, durability, and flexibility across a broad range of temperatures.

In the last 10 years, the market share of single-ply systems has increased from 3 or 4 percent to over 50 percent of the commercial roofing market. Single plies have proved they are cost-effective, high-performance alternatives to built-up roofing (BUR), and can provide similar benefits in low-slope residential applications.

One of the primary reasons for the success of these systems is that they allow the contractor to get on and off the roof quickly. Generally, application is clean and quick compared to BUR. Built-up roofing is particularly difficult to use in residential applications, especially in reroofing. In addition to the stench, spills from a kettle or a pipe leak can dump hot asphalt on a home owner's shrubs, front yard, or sidewalk. What's more, the cost of getting a crew up on a residential roof to install hot BUR can be prohibitive.

It's true that single-ply materials cost more than two plies of roll roofing and asphalt. But in jobs smaller than 1,500 square feet, material costs will make no difference. The savings are in labor. Set-up time is dead time for a roofing crew. With hot BUR, a three- or four-person crew can sit idle for two or three hours while asphalt is heating. The minimum charge for a BUR crew to set up is $600 or more. On a 300-square-foot roof, that's $2 per square foot before work even begins. By contrast, a single-ply crew can start as soon as it shows up. Hence, on small jobs most single plies will be less expensive to install than BUR, regardless of the specification used.

This is not to say that hot built-up systems do not perform well. Properly specified, some systems have lasted for more than 50 years before needing replacement. But for small-size residential and light-commercial work, labor is the critical factor.

Single Ply Considered

Single-ply manufacturers look on the residential market quite differently than the commercial market. Many companies object strongly to the use of their products on projects of less than 50 to 100 squares, which precludes most residential and light-commercial projects. This is not surprising; profits in this area are negligible, and liability is high.

With a few exceptions, material warranties are not available on products used in the residential market, although the contractor can expect the typical two-year warranty from the installer. This should not, however, dissuade the contractor from using single ply. The problems that occurred in the 1960s with some early membranes were corrected long ago.

Today it is extremely rare for a single-ply system to fail because of a membrane problem; most failures result from application mistakes. Contractors can do without a material warranty, but it's essential that they use an experienced applicator. Few builders have the experience or equipment to install the new single plies themselves.

The three types of single-ply systems used most in residential and light-commercial applications are, in declining order, modified bitumen, EPDM, and PVC. Annual sales of these membranes guarantee they are all here to stay.

Modified Bitumens

Modified bitumen is the fastest-growing single ply in commercial roofing, and the most practical choice for residential applications. These prefabricated bitumen roofing membranes are typically 120 to 170 mils thick, and are made from modified asphalt reinforced with nonwoven fiberglass, polyester, or both. This is similar to BUR membrane, but made in the factory.

The modifiers used to alter asphalt bitumens fall into two general categories: SBS (styrene butadiene styrene) and APP (atactic polypropylene). Both types of modified bitumens have performed well in the field, but they differ in these key performance areas:

Low-temperature brittleness and ductility. The SBS modifieds perform somewhat better at low temperatures than APP products. Both, however, are substantially better than conventional BUR.

Heat aging. The APP modifieds stand up better under exposure to heat and sunlight than the SBS variety. Granule or slate surfacing (usually factory applied) is needed on SBS modifieds to block ultraviolet rays. APP modifieds can stand up to direct sunlight.

Field application. Generally, both types of modified-bitumen sheets lay down well in temperatures above 40°F. Below that, the rolls must be stored in a warm place before being installed.

From the above, you might conclude that SBS, modified bitumens are the product for you if you work in a colder climate, while APP products are preferable in hot, sunny Florida. But before deciding, let's examine the application techniques for both systems.

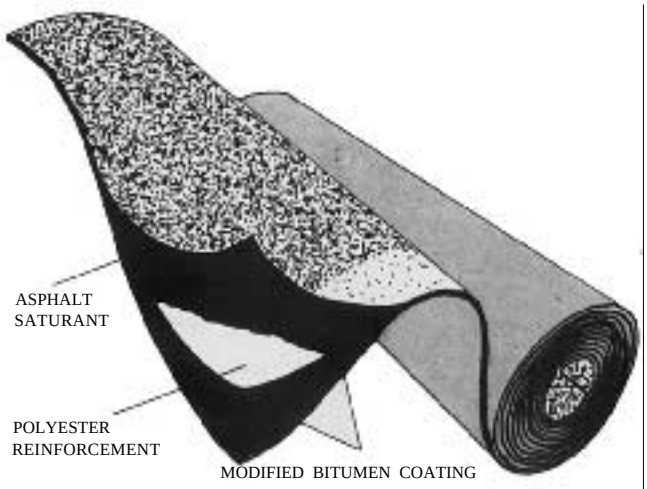
Applying Modified Bitumens

A major advantage of modified bitumens is their versatile installation. Achieving a watertight seal around every penetration and projection is difficult at best with BUR. And it's very expensive with plastomeric (PVC) or elastomeric (EPDM) systems. Each small penetration may require a pitch pocket for BUR, clad metal flashing for PVC, and preformed accessories for EPDM. Modified bitumens, however, can easily be attached with hot asphalt, or torched to the penetrations, and flashing is easier as well.

One of the major differences between APP and SBS modified bitumens is the method of application. APP systems are typically installed with a torch, which melts the modified asphalt on the surface of the membrane while it is rolled forward and the seams pressed into place. Most SBS systems, on the other hand, are mopped down with standard asphalt, which needs no open flame.

For torch-applied systems on residential wood decks, a base sheet should be mechanically fastened or mopped down before the membrane is installed. Also, if cant strips are used, make them flame-resistant. The potential fire hazard of this application has been a major issue in the commercial roofing industry. Some insurance companies have refused to carry contractors who torch-apply modified bitumens.

Using an experienced and conscientious roofing contractor should eliminate any undue fire hazard. (For more information, a standard document, *Safety in Torch-Welded Roofing*, is available from the Midwest Roofing Contractors Assn., 1000 Power & Light Bldg., Kansas City, MO 64105.) If the idea of an open flame on the roof makes you nervous, however, you can always choose a mopped-down, SBS modified bitumen.



Modified bitumen (above) is essentially built-up roofing on a roll, but is easier to seal at penetrations and flashings. One type is sealed with hot asphalt, another uses a torch (left).

These systems are fully adhered with hot asphalt, which must be brought up to the roof in a patch kettle. This is the system's primary disadvantage in residential applications. As with APP modifieds, a base sheet must be installed so hot bitumen won't seep through the joints of the plywood deck. To solve these problems, one manufacturer has reportedly introduced a cold adhesive system, which holds great appeal for small jobs.

Some thicker SBS sheets can be torch applied. However, it is often difficult for the applicator to tell when the SBS is hot enough and the applicator may burn the sheet with the torch.

Problems have also cropped up with SBS modifieds installed in temperatures at or below 40°F. The thick sheets can roll out stiff and give the finished roof a washboard appearance. APP modifieds may be even more difficult to install in cold weather. A roofer who is familiar only with the thinner, conventional BUR felts will very likely have problems applying modified bitumens in cold weather.

Both APP and SBS modified bitumens produce good lap-joint strength. Lap-joint integrity is more of a concern in EPDM systems, and will be discussed later.

Modified bitumens also have advantages in reroofing. They can easily be applied to an existing BUR roof membrane after removing the gravel. However, the substrate must be sound, well attached, and dry. A base sheet may be needed, depending on the manufacturer's specs.

Finally, installation time is fast, compared to BUR, but on larger roofs with few penetrations it may not be as fast as EPDM and PVC. This is because a 10- or 20-square roof can be covered with a single large sheet of EPDM or PVC.

A Closer Look at EPDM

Ethylene propylene diene monomer (EPDM) is the most used single ply in commercial roofing. This synthetic rubber has been used in many reroofing applications, and over a wide variety of existing BUR systems.

The primary attribute of this elastomeric sheet is its ability to elongate, remain dimensionally stable, resist ozone, and remain flexible at low temperatures. EPDM also retains its strength and durability at extreme temperatures. Roof membranes are subjected to wide temperature variations. Together with moisture and time, these three elements constitute "weathering."

Since EPDM is highly stable across temperature changes, the membrane will not pull on its flashings or attachment points as other materials do. This helps explain EPDM's high level of performance.

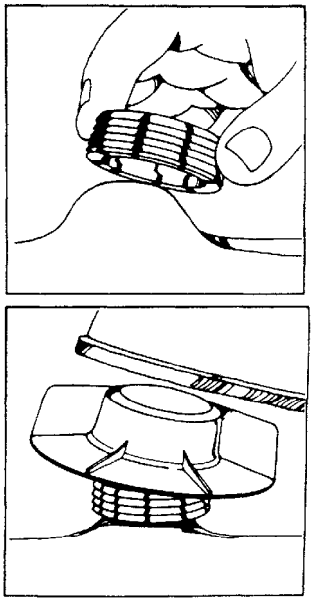
EPDM is impervious to most rooftop contaminants, except lubricant and compressor oils. Oils probably represent the worst field danger to EPDM, but shouldn't be a problem in residential applications.

In terms of material cost, EPDM is the least expensive single ply available. (A current price war between major suppliers has dropped prices even lower.) The system has been used successfully in residential applications, although many manufacturers shun this market due to liability risks. Even so, at least one major supplier (Kelly Energy Systems of Waterbury, Conn.) actively sells membrane for residential use.

EPDM Application

Most EPDM roofs on commercial buildings are ballasted (covered) with at least 10 pounds per square foot of river-bottom stone. This is cheap, but not every roof can withstand the weight, so this technique is impractical for residential and most light-commercial projects.

EPDM membranes may also be mechanically fastened to the deck in various ways. Strip or bar-type fasteners were prevalent three or four years ago, but were not entirely successful. Today, individual disks or plates that bond the membrane to the substrate are more common. In addition, a number of attachment systems have been developed that do not penetrate the membrane. Typically, fasteners are installed four feet on center across the field of the roof.



Mechanical attachment of EPDM is gaining popularity, particularly on large roofs. Several types of fasteners, such as the snap-on/screw-on clip (above), have been developed that do not penetrate the membrane.

Mechanical attachment has become increasingly popular in commercial applications because it is less expensive than fully adhering the membrane with adhesive over large roof areas. On small jobs, however, it's cost-competitive to fully adhere the membrane.

EPDM membranes can be fully adhered to wood decks with an adhesive recommended by the manufacturer. But when the plywood shrinks, gaps in the boards will create stress in the EPDM, which may lead to performance problems. The adhesive should therefore be applied one inch short of the edges of the plywood. This small area of unadhered EPDM will allow the membrane to expand over the gaps in the plywood boards.

It is also recommended that no H-clips be used to support the plywood decking at mid-span. Foot traffic on an EPDM roof can pop these clips up—and through—the membrane.

Since mechanically attached and fully adhered systems are comparable in both price and performance, the decision lies with the contractor.

Joe Bator

PVC membrane can be welded with heat or solvents. Solvent welding of seams is done with a portable machine (left) or by hand (below).

Lap Splices

In both fully adhered and mechanically attached systems, lap splices are the weak link in EPDM systems. But residential roofs with few penetrations will have few lap splices and therefore little potential for leaks. (EPDM rolls range in size from 5x50 feet to 50x200 feet.)

Most EPDM sheets have a coating of talc or mica dust, which must be thoroughly cleaned off to get a good lap splice. The most effective solvents for cleaning the lap-joint area are chlorinated hydrocarbons, such as trichloroethylene. However, white gas is normally used on the job site and works reasonably well. Workers should use clean cloths and avoid transporting more contaminants along the seam by scrubbing.

Rubber-based (neoprene/phenolic) contact adhesive in a solvent carrier is the most widely used method for splicing. It is easy to apply, has reasonable storage life, and dries fast.

On the negative side, it does not adhere well to EPDM, it contains flammable solvents, and two surfaces must be prepared simultaneously. After bringing the two prepared surfaces together, it is also difficult to reposition the sheet.

A recent chemical development that benefits workers is the "splice wash." This solution cleans the surface of talc, and helps prepare the bonding site for a better adhesive grip. The lap is first cleaned, then primed, then coated with the contact adhesive. The primer must first flash off and cure before the contact adhesive is applied. This can slow cold-weather construction (below 40°F).

Some EPDM systems use adhesive tape splices. The tapes are synthetic rubber compounds, cured or uncured, that adhere directly to the EPDM sheet. Again, you can use a primer plus the adhesive tape to make a stronger lap joint. Lap-joint construction is reportedly much quicker when a tape system is used.

PVC Membranes

Unlike EPDMs, which are cured or vulcanized, PVC (polyvinyl chloride) membranes are thermoplastic in nature. That is, they can be melted and fused by heat or solvent—theoretically forming a bond as strong as the material itself. Instead of using a contact adhesive to form lap splices, the PVC can be welded with hot air or solvent.

PVC is more expensive than EPDM, but on smaller jobs the increase in price is not as significant. Also, the "heat weldable" nature of the product is an advantage in the field.

The first-generation PVC membranes had a 10-year service life, but some failed early due to material problems. Some manufacturers dropped out, but a handful continued to improve the membranes and systems. Today we are seeing a resurgence of PVC membranes, with much improved third- and fourth-generation products.

Because dimensional stability of the roofing membrane is critical, most PVC sheets today are reinforced. Reinforced PVC is more stable but offers less elongation (generally, 20 percent elongation compared to 300 percent for a non-reinforced sheet). In most residential applications, a reinforced sheet is recommended.

The major problem with PVCs in the past was shrinkage. Plasticizers in the sheet keep the material flexible over a wide temperature range, and their loss can cause a change in mechanical properties and a hardening of the material. Some early PVCs had extensive plasticizer loss and literally "cracked up" on the roof.

But with the new, thicker membranes, these problems reportedly have been solved. According to one manufacturer, test samples of 10- and 15-year-old PVC roofs showed physical values equal to or better than minimum standards published for new materials. On the roofs where they did have failures, this company honored every warranty. On residential applications, however, they offer no warranties.

Like EPDMs, PVCs can be either fully adhered or mechanically attached. In reroofing, however, a separator sheet is needed between the asphalt and the PVC—or an aluminum-foil barrier between coal-tar pitch and PVC—to prevent plasticizer migration, which would embrittle the membrane.

In-Field Performance

To give the contractor some idea of the performance of BUR and single plies in the field, the results of a National Roofing Contractors Association (NRCA) study are cited below.

In an informal poll, large-volume roofing contractors cited lap adhesion as the number-one problem, based on the number of call-backs.

These reports came from an informal poll of 52 NRCA officers (all large-volume roofing contractors). Keep in mind that the numbers are TMX statistically valid. Unfortunately, valid field-performance data for today's roofing systems is simply not available.

The contractors were asked about the difficulties they have had with different systems, based on the number of call-backs. The contractors rated the call-backs on a scale of 1 to 10, with "1" representing no call-backs and "10" representing frequent call-backs.

Average Call-Backs (1-10)

BUR: 2.65
EPDM: 3.39
Modified bitumen: 2.98
PVC: 4.79
Other systems: 3.0

The contractors were also asked if there were any common trends in the problems. Without a doubt, the number-one problem was lap adhesion. This was mentioned eight times in association with EPDM, and five times with modified bitumen. Other problems included splits and felt separation with BUR, and shrinkage with PVC.

Although this information is based on large-scale commercial projects, the problems would also pertain to residential and light-commercial applications. Moreover, the contractors surveyed have highly experienced crews. It is reasonable to assume that their quality control is higher than that of the typical roofing contractor hired for small projects. Hence, call-back averages would probably be higher on smaller jobs.

Slope to Drain

Although the systems studied above will generally hold up fairly well with some ponding, standing water is not a good thing on any roof. On flat roofs it's good practice to provide positive drainage using a minimum 1/4-inch-per-foot slope. The real danger lies in ice damming up at the gutters. Sufficient slope should be included to keep water moving into the gutters.

Energy Efficiency

On residential roofs, insulation is typically found below the roof deck. But the contractor should be aware of the energy-saving potential of installing a rigid insulation above the deck, with any of the single-ply systems mentioned above.

Indeed, 1 1/2-inch-thick urethane foam board adds about R-10 to the roof system. If a rigid-board stock is used, it should be mechanically attached to the deck. It may be quicker and less expensive to spot mop the insulation, but industry experience has shown this is not reliable.

Also, if a ceiling isn't well insulated, the color of the membrane may come into play. Installing a black roof in such a situation could cause excessive heat buildup in summer. PVCs are typically light gray and reflect some of the heat. For high reflectivity, EPDM is available in white—at a premium over the standard black membrane. Modified bitumens can be installed with a field-applied fibrated aluminum or white coating, and some manufacturers offer factory-applied reflective surfacings as an option.

Wind and Fire Resistance

The single-ply systems mentioned above typically carry Factory Mutual's I-90 wind-uplift rating when installed over a steel deck. However, manufacturers rarely conduct wind tests over wood decks, which are the most common in residential applications. Still, the single-ply systems covered here could easily pass Underwriters' Laboratories' UL 997 wind test for roof shingles. In high winds, shingles will blow off long before the single ply is affected.

Single plies have also come a long way in terms of fire resistance, with a multitude of code-approved options, often without the ballast or coatings required with conventional BUR assem-

blies. On the other hand, the huge variety of roof systems and the complexity of fire testing can be confusing for architects and contractors alike.

Most local codes accept unrated roofings on residential structures. One exception is the Southern Building Code, which is prevalent in much of the Southeast. This requires a UL Class A or B fire-resistance rating for roofing in an ordinanced fire district, and a Class C rating in unordinanced areas.

It is up to contractors to determine the required fire-resistance rating for their projects. Only a handful of single-ply manufacturers have fire tested their systems over wood decks, and a discussion of the fire resistance of modified bitumen, EPDM, and PVC would require an article the length of this one.

Let's just say that every one of these systems can be designed to meet code approval in residential applications—and still remain reasonably competitive with BUR. ■

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