Volume 1
Spring 2026

Roofing 101:
Essential Design & Building Science Guide

The technical essentials for the building envelope—from material selection to detailing pitfalls—to help streamline your next project.

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Single-Ply Roof Membrane Types and Comparison

By: Andrea Wagner Watts

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Single-ply roof membranes are ubiquitous in the commercial roofing industry, comprising the majority of low-slope roof installations. Their popularity is driven by advantages such as ease of installation, cost-effectiveness, and durability, with some options also offering sustainability benefits.

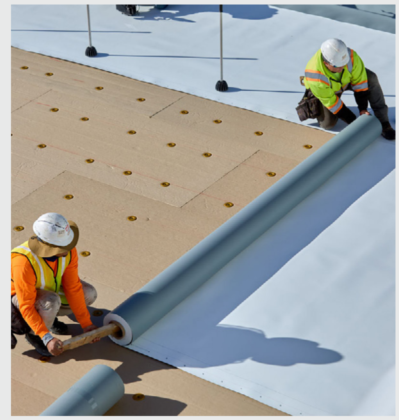
Here is a breakdown of the most common single-ply roof membrane types including a comparison of their performance, durability, and energy efficiency properties.

Single-Ply Roof Membrane Types and Attributes

The primary types of single-ply roof membranes are thermoplastic polyolefin (TPO), polyvinyl chloride (PVC)/polyvinyl chloride with ketone ethylene ester (PVC KEE), and ethylene propylene diene monomer (EPDM). TPO and PVC membranes consist of three layers:

1. A base polymer layer
2. A reinforcement made of polyester or fiberglass
3. A top cap layer that includes heat and ultraviolet (UV) stabilizers providing weather resistance

EverGuard® TPO Extreme Smooth Membranes



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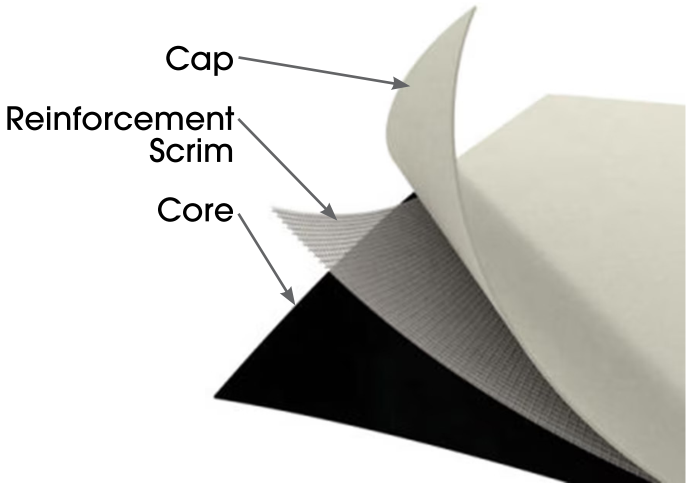
GAF EverGuard Extreme® TPO is ideal for applications (including high-heat and solar applications) where you want the very best long term performance you can get.* Our TPO membranes offer inherent flexibility, excellent heat-sealable properties, long-term heat and UV resistance, fungal resistance,** and high reflectivity (white only). The construction of our TPO membrane has remained unchanged for more than 20 years, selling more than 6 billion square feet. We operate manufacturing plants across the United States, and we offer 10- and 12-foot rolls and a variety of thicknesses.

* Per ASTM D573-13.

** Meets ASTM G21. GAF warranties and guarantees do not provide coverage against fungi or other biological growth. Refer to gaf.com for more information on warranty and guarantee coverage and restrictions.

These materials are reliant on the thickness and durability of the cap layer for their longevity and performance, so it is important to specify a membrane from a manufacturer you trust.



Membrane Cap, Scrim, and Core

EPDM membranes have a different structure, consisting of:

1. An elastomeric base layer
2. An AFR fire-retardant middle layer
3. A FRM polyester-fiber reinforced top layer

While these single-ply roof membrane types share similar structures, they differ in chemical composition, attachment methods, chemical resistance, and overall durability.

Thermoset vs. Thermoplastic

One of the most important differences among single-ply roof membrane types is whether they fall into the thermoset or thermoplastic category.

During the manufacturing process, thermoset materials undergo a chemical change that makes them permanently "set" after their initial exposure to heat. They cannot be remolded or re-formed. Thermoplastics, however, can be reheated and fused when exposed to high heat. This allows for welding of seams and detailing membranes.

These differences have implications for each type of membrane. With EPDM, which is a thermoset, the seams must be glued or taped. With TPO, PVC, and PVC KEE, which are thermoplastics, you can weld the seams and detailing membranes, making a monolithic membrane.

TPO

TPO roofing was introduced in the 1980s and standardized in 2003 with first publication of ASTM D6878. Known for its low cost and fast installation, TPO comprises more than 50% of the commercial roof market.* TPO can be attached mechanically, adhered, induction-welded, or adhered. Because it is a thermoplastic, the seams can be heat-welded, providing superior strength and longevity at the laps.

TPO membranes come in varying thicknesses including 45, 60, and 80 mil—with or without fleece backing for additional impact resistance. Most TPO roofs are white, making TPO an excellent choice for cool roof applications in areas where a high Solar Reflectivity Index (SRI) is required.

TPO also comes in many different colors, some that also have high SRI values, which can provide a designer with additional design options such as was used on the Austin Hose building in Amarillo, TX. TPO is flexible without the use of plasticizers, dimensionally stable, and resistant to fungus and many chemicals (except acids, greases, or oils). With 4–10% recycled content, depending on the specific product, GAF TPO roofing also reduces the demand for raw materials. One drawback of TPO is that it is initially less flexible than other membranes such as PVC.

Austin Hose Headquarters, Amarillo, TX. Roofing System: EverGuard® TPO 60-mil Smooth Membrane in a custom Goldenrod yellow and Slate Gray design

In addition to standard TPO, higher performance, extreme TPO membranes are available. These membranes are tested for extended heat aging per ASTM D573-13 and are ideal for high heat and solar applications. For more information on GAF EverGuard® TPO membranes and specifications here.

PVC

PVC roof membranes were first developed in Switzerland and Germany during the 1960s and made their way to the U.S. in the 1970s. As a thermoplastic, PVC offers the advantage of heat-welded seams, similar to TPO, which creates a strong, continuous membrane. They can be installed using mechanical attachment, induction welding, or with adhesive. GAF EverGuard® PVC membranes are available in 50, 60, or 80 mil thicknesses, with optional fleece backing.

PVC is known for its durability and puncture resistance along with fire resistance properties. PVC incorporates a liquid plasticizer, giving it superior flexibility—ideal for roofs with complex contours. It's also dimensionally stable and resistant to most chemicals, including oil and grease. One of the drawbacks of PVC is that it is not compatible with asphaltic materials and can be prone to organic growth under certain conditions.

Available in white and other reflective colors, PVC is another popular choice among single-ply roof membrane types for high-SRI applications. GAF PVC membranes also contain 5% recycled content, offering sustainability benefits in addition to performance.

PVC KEE

Developed in the 1980s, PVC KEE contains a solid plasticizer that enhances flexibility, long-term weatherability, and UV resistance of the membrane. The result is a high-performing, durable cool roof solution. PVC KEE membranes can be mechanically attached, induction welded or adhered. Their chemical and fire resistance is superior to other single-ply roof membrane types. Thanks to their ability to withstand jet fuel, oils, and grease, they're especially well-suited for roofs on restaurants, airports and surrounding buildings, and other facilities with high exposure to harsh contaminants. These additional benefits do come at a higher cost than other single-ply membranes.

GAF EverGuard® PVC KEE membranes are available in the same reflective colors and thicknesses as standard PVC—50, 60, or 80 mil—with or without fleece backing.

EPDM

EPDM is a synthetic rubber product that is naturally black in color. It has been used as a roofing membrane since the 1960s. Today, it accounts for approximately 15% of the commercial roofing market. EPDM ranges in thickness from 45 to 90 mil and can be mechanically attached, ballasted, or adhered. As a thermoset product, EPDM requires seams to be glued or taped rather than heat welded. Due to the inclusion of carbon black, the material has high heat and UV resistance.

A drawback of EPDM is its tendency to shrink and crack over time when exposed to prolonged high temperatures when not properly reinforced. This shrinkage can place additional stress on seams, potentially compromising adhesion. It has limited resistance to acids, grease, and animal or vegetable oils and should not come in contact with asphaltic materials.

Because of its dark color, EPDM absorbs heat, making it a less favorable choice for cool roof applications. While there is the option to laminate white titanium oxide to the top sheet, it's typically more expensive, less durable, and more challenging to seam. Still, EPDM maintains a stronghold in colder, heating dominated climates, especially in areas that do not have consistent snow.

Cost and Life Cycle Considerations

While actual costs vary based on factors like location, roof size and complexity, and membrane type/thickness, some general comparisons can be made. PVC KEE membranes tend to have the highest initial cost. Standard PVC and TPO are generally more affordable, with TPO often being the most cost-effective choice among thermoplastics. EPDM typically has the lowest installation cost, but its seams may require more ongoing maintenance and repairs, potentially increasing long-term expenses.

Warranties vary among the membrane types as well. EPDM warranties typically cover 20 years but may be longer depending on the type of installation. GAF

EverGuard® TPO roofs may qualify for warranties ranging from 25 to 35 years, depending on membrane thickness, fleece backing, and installation method and if the Extreme version is selected. GAF EverGuard PVC systems offer warranties up to 30 years, while GAF EverGuard® PVC KEE systems can be eligible for warranties of 30 to 35 years. Overall, lifespan and warranty coverage across single-ply roof membrane types are often comparable. Lifespan is more dependent on membrane thickness rather than membrane type. With an 80 mil TPO, you can get a guarantee similar to a PVC KEE — with the coverage being system-dependent. The membrane thickness and attachment method all come into play.

Membrane Selection and Water Mitigation

Since bulk water from rain and melting snow collects more quickly and drains more slowly than on roofs with a higher slope, low-slope roofs can be susceptible to ponding (standing water), which can result in premature deterioration of the roofing membrane. EPDM, while water-resistant, can degrade when water is allowed to stand for extended periods.

GAF EverGuard TPO, PVC and PVC KEE membranes are durable under ponding water conditions. Tapered polyiso insulation can help improve drainage on low-slope roofs by directing the flow of water to drains. Because of their flexibility, durability, and heat-welded seams, both TPO and PVC work well with tapered insulation. You can contact our tapered design group for more information.

Roof Retrofit Applications

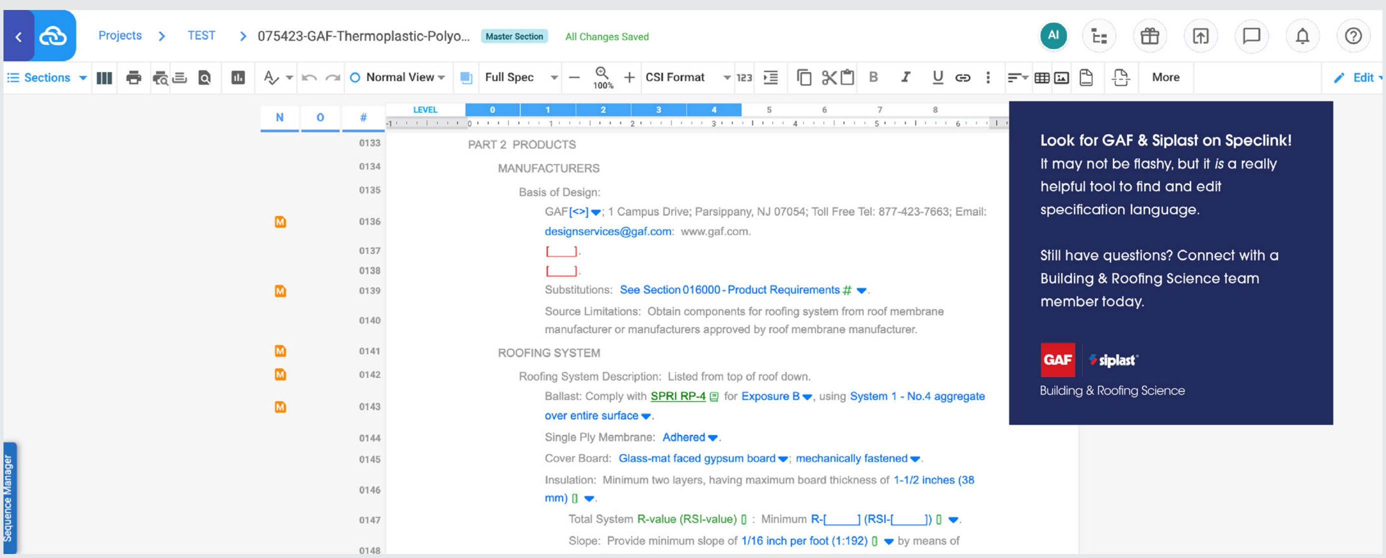
Because TPO and PVC/PVC KEE membranes can be installed more quickly and economically than some other roof systems, they are excellent choices for reroofing existing buildings. Their higher SRI also helps minimize cooling costs, thus improving buildings' energy efficiency.

If an existing built-up roof or modified bitumen roof is in relatively good condition with minimal underlying moisture, a fleece-back TPO or PVC/PVC KEE membrane can be installed as a new top layer without the expense and disruption of tearing off the entire roof. Read this blog for more information on hybrid roof assemblies or get system specific details here.

When choosing between single-ply roof membrane types, it's good to know there are options to suit a wide range of project needs. Whether you're prioritizing chemical resistance, sustainability, or durability under heavy foot traffic, ponding water, or extreme weather, there's a membrane type designed to meet your needs.

*excluding restoration, metal and LAR

Look for GAF & Siplast on Speclink



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A Practical Guide to Single-Ply Roofing Attachment Methods

By: Andrea Wagner Watts

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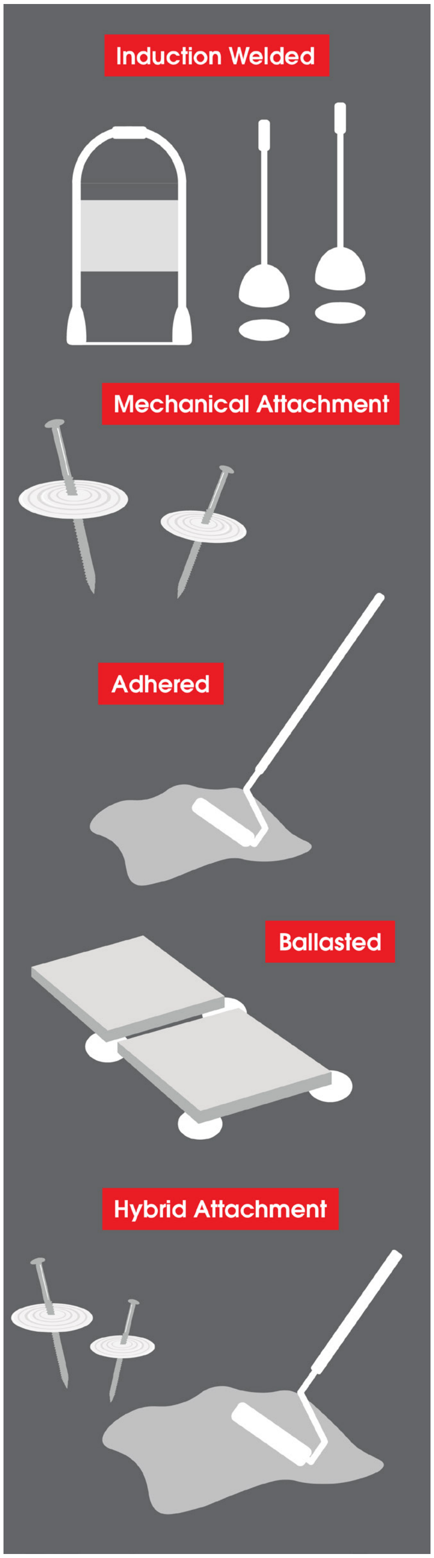
A Practical Guide to Single-Ply Roofing Attachment Methods

When designing your next low-slope roof assembly, there are a number of single-ply roofing attachment methods to consider. Whether you choose a TPO, PVC, or EPDM membrane, the attachment method you select will typically be influenced by the building type and location, the rest of the roof assembly, and the construction schedule and cost. The most common single-ply roofing attachment methods are mechanical, induction-welded, adhered, and ballasted. Depending on the unique circumstances of your project, it may also make sense to employ a hybrid approach, or a combination of methods. Let's explore the main features, as well as the pros and cons, of each.

Mechanical Attachment

In most roof assemblies, the roof membrane is the primary air Mechanical attachment is achieved using mechanical fasteners (usually screws) set through metal plates designed to help spread the force imposed on the membrane and make the attachment more secure. The type and size of fastener is determined by the roof deck material and thickness of the total roof assembly. The fastener pattern and spacing is specified by the roofing manufacturer based on lab assembly testing and is often subject to local code requirements[1].



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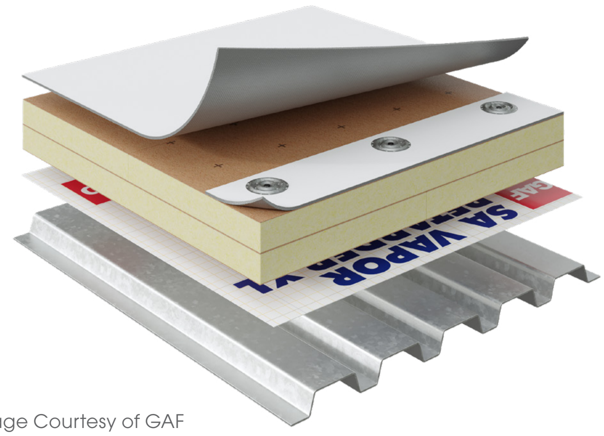

Image Courtesy of GAF

Mechanical attachment is the most common single-ply roofing attachment method since it is fast, economical, and can be installed in various temperatures. However, in conditions of high wind uplift, or where the roof deck is not airtight, membranes installed mechanically may be subject to billowing. Billowing is caused by air that is pulled into the roof assembly, often by crosswinds providing an uplift force over the roof, causing the membrane to lift and flutter. In addition, exposed fasteners could be subject to damage from hail or heavy foot traffic if those conditions are present.

Finally thermal bridging (the transfer of heat between the interior and exterior of the building) through the fasteners could also be an issue depending on exterior climate and interior building conditions. You can find more information on the impacts of thermal bridging through fasteners here.

Induction-Welded

Image Courtesy of GAF | Siplast

Induction welding is a type of mechanical attachment that uses numerous heat-welded attachment points that form strong bonds throughout the field of the roofing membrane. It uses a portable electromagnetic induction tool to weld specially coated mechanically attached plates on the surface of the insulation or coverboard to the underside of a PVC or TPO roof membrane, thus securing the membrane without the need for further penetrations.

Induction welding can be more economical than mechanical attachment because the same plates can be used to attach both the insulation and the membrane. It has the added advantages of having no exposed fasteners and strong wind uplift resistance due to more attachment points of the membrane compared to mechanically attached systems. This also reduces membrane billowing.

Adhered

Image Courtesy of GAF | Siplast

An adhered membrane is one in which a roofing adhesive is applied to the underside of the membrane, and sometimes to the insulation or coverboard directly beneath the membrane as well. Adhered membranes have no exposed fasteners and provide exceptional wind uplift resistance by evenly distributing wind pressure across the membrane. Adhesives may also be a preferred attachment method on concrete decks where mechanical attachment can be difficult. Drawbacks can include the temperature range (above 40 degrees) required for their proper application, which might impact the construction schedule in colder climates. Additionally, odors and VOCs associated with some standard adhesives may be an issue when reroofing an occupied building. Depending on the type of membrane, quick-spray or quick-lay adhesives could be an option, as well as low-rise foam, which can be applied to only one surface rather than coating both the membrane and the substrate. In addition, newer low-temperature formula adhesives can be installed at temperatures as low as 20 degrees, and low-VOC adhesives can be used in situations where odor is a concern. Self-adhered membranes, which do not require a separate adhesive application, can shorten installation time if installed by a skilled contractor.

Ballasted

A ballasted roof consists of a single-ply membrane that is loose-laid over the roof substrate and held in place by large aggregate or pavers. This method offers strong protection against weathering and damage from hail and is most commonly used with thermoset membranes like EPDM membrane, rather than thermoplastics such as TPO or PVC membranes. While it can be a fast and cost-effective single-ply attachment method, it poses challenges: leak sources can be difficult to locate, and the roof structure must be designed to support the added weight of the ballast. In regions with high winds, building codes1 may restrict ballasted roofs due to the risk of wind uplift turning ballast into dangerous projectiles.

Hybrid Attachment

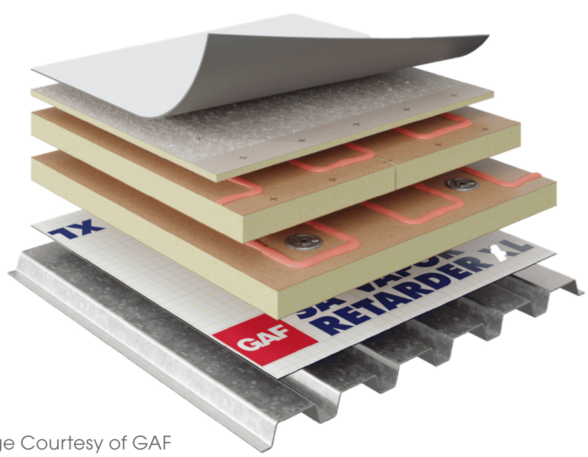

Image Courtesy of GAF

A hybrid attachment system combines the advantages of at least two single-ply roofing attachment methods, while potentially minimizing the possible disadvantages of each. One roof assembly to consider is where the insulation layers and cover board are mechanically fastened to the underlying deck. Depending on the climate zone, if the roof membrane is also mechanically attached, there could be concerns about thermal bridging or impacts from hail that could damage the fasteners. A possible solution is to adhere the single-ply roof membrane to the mechanically attached insulation or cover board below. However, with a fastener right under the membrane, it could telegraph through, creating a potential weak point at the fastener plate on a roof subjected to heavy foot traffic or rolling equipment.

In very severe hail assemblies, it is common to mechanically attach only the first layer of insulation and then adhere everything (second layer of insulation, coverboard and membrane) above it. This approach would minimize the impacts of thermal bridging while also protecting the fasteners from damage. In summary, many adhered assemblies fall into this category, as the first layer of insulation is often required to be mechanically attached for uplift resistance.

Choosing the RIght Attachment Method

When selecting a single-ply roofing attachment method, you may want to start with the climate zone and typical weather conditions at your building site. In areas prone to high winds, induction-welded or adhered membrane systems can help prevent membrane billowing. For roofs exposed to severe hail or heavy foot traffic, an adhered or hybrid system may offer better protection by burying vulnerable fasteners within the assembly. In more moderate environments, a standard mechanically attached system may be the quickest and most cost-effective choice.

When both durability and thermal performance are key priorities, a hybrid system is often recommended, as it allows fasteners to be buried, yielding excellent performance. It is important for designers to be mindful that the familiarity and experience of local roofing contractors with various attachment methods can influence both the construction timeline and overall cost. This can be an overlooked, but is an important consideration in the decision-making process.

For more information or assistance in navigating single-ply roofing attachment methods for your project, reach out to the GAF | Siplast Building & Roofing Science Team at buildingscience@gaf.com.

[1]Always consult your local code requirements when designing and installing a roofing system.

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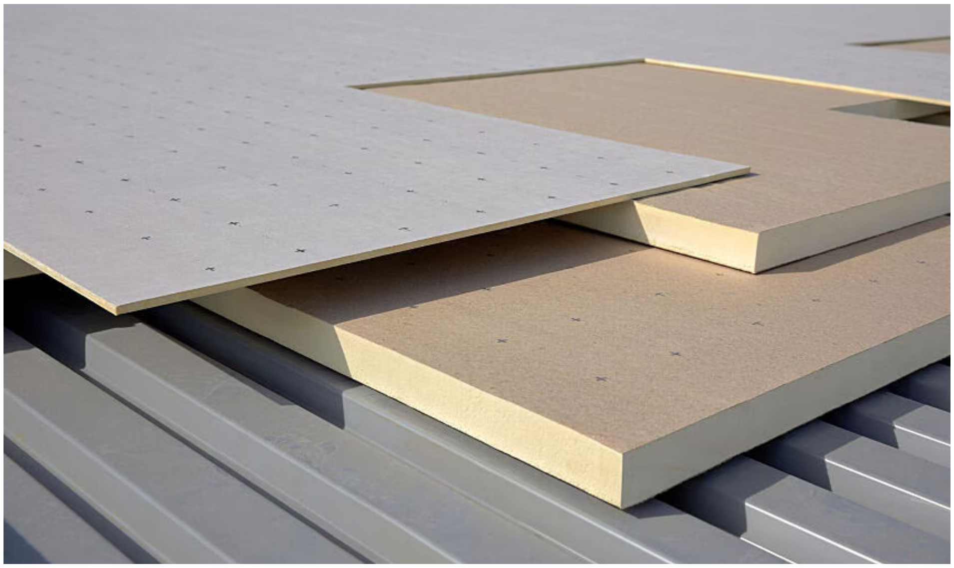
Why Do I Need A Coverboard?

By: Andrea Wagner Watts



All Images Courtesy of GAF | Siplast

Coverboards can be important components of commercial roof assemblies. They can increase the resilience and durability of the roof by helping it better withstand environmental exposure, wind uplift, and long-term wear. In certain circumstances, coverboards can be absolutely essential to the longevity of a roofing system.

So, what exactly are coverboards? And in what situations should you specify one? Let's take a closer look.

What Is a Coverboard?

A coverboard is a thin, dense substrate installed between the insulation and the top waterproofing membrane of the roof. It can help protect the roof from various types of impacts, protect the insulation from damage and, ultimately, help provide extra protection for the entire roof assembly. It can also provide a stable surface for the installation of the roof membrane and any overburden while increasing the roof's wind uplift resistance.

Top 5 Reasons to Specify a Coverboard

There are certain high-risk and high-performance scenarios in which the installation of a coverboard is imperative. They include:

1. Hail-Prone Regions

Due to the accelerating impacts of climate change, nearly two-thirds of the U.S. is now susceptible to the damaging effects of hailstorms. Factory Mutual (FM) has identified certain areas of the country by hail zone, ranging from Moderate to Severe and Very Severe. If your project is in a Very Severe Hail (VSH) region, FM requires

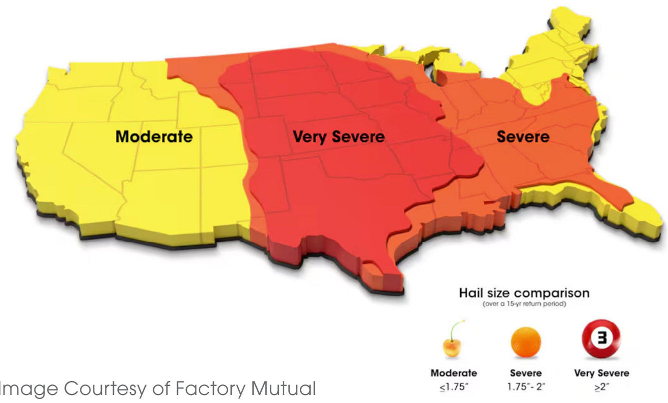


Image Courtesy of Factory Mutual

the buildings it insures to meet the requirements for a VSH assembly, which often includes a heavy-duty glass-mat gypsum coverboard, like DensDeck® StormX™ Prime.

The attachment method of the roof membrane can be equally important, since mechanical attachment can lead to membrane damage when hail strikes the membrane at fastener locations. For this reason, it is recommended that the coverboard and the roof membrane both be adhered, burying the fasteners deeper in the assembly and providing better membrane protection.

Adhering the assembly layers also has the benefit of minimizing the effects of thermal bridging, which can cause a significant drop in effective R-value. Even if your project is not in a VSH zone, it is worth considering the extra protection a gypsum coverboard can help provide if your building is subject to severe or moderate hail*. More hail system resources can be found here.

2. Rooftop Solar Installations

Photovoltaic panels mounted on a roof impose additional weight, mounting hardware concerns, and long-term maintenance requirements, all of which can make the roof membrane more vulnerable to damage. Adding an HD ISO or gypsum coverboard can provide extra protection while increasing wind uplift resistance.

An HD ISO coverboard contributes additional R-value to the roof assembly while adding negligible weight. Gypsum coverboards, although heavier than HD ISO, provide more compressive strength, which could be a factor depending on the number, type, weight and attachment method of the solar components.

Just like when designing for hail, the attachment method can also impact the long-term performance of a roof

Image Courtesy of Adobe Stock

membrane under a solar installation, as can the choice of the equipment mounts. Our photovoltaic brochure highlights how the use of a coverboard, attachment method and maintenance all work together to potentially extend the life of the roof assembly.

3. Vegetative or Ballasted Roofs

A vegetative roof, or a roof with other types of overburden, such as pavers, ballasted systems, or rooftop amenities, is subject to a unique combination of stresses. Additional weight, moisture, traffic, and other forces make the protection of the roof assembly paramount.

Designing an HD ISO or gypsum coverboard for these assemblies is best practices in these situations, as it greatly reduces the chances of membrane damage and subsequent compromise of the roof insulation.

4. High Traffic Roofs

Any roof with high-maintenance equipment and heavy foot traffic is a candidate for a coverboard. High-traffic roofs are common on schools, hospitals, data centers, and other buildings that require frequent rooftop access. Additionally, in the case of a building with a lot of rooftop mechanical equipment, there are numerous

Image Courtesy of GAF | Siplast

opportunities for membrane damage from dropped tools and wheeled carts transporting supplies for equipment repair and replacement.

In addition to coverboards, walkway pads are a good addition to further protect the membrane in high traffic areas**.

5. Lightweight Assemblies

The addition of a coverboard can enhance the overall durability and resilience of a commercial roof, especially one with an otherwise lightweight roof assembly. For example, an HD ISO coverboard can provide lightweight protection while contributing to the R-value of the assembly, thus allowing for the insulation under the coverboard to be slightly thinner and still meet R-value requirements.

A building owner committed to sustainability and long-term building resilience may also appreciate the additional advantages of this layer as part of the lightweight roof assembly: Insulation is the only building component that actually pays for itself in terms of reducing operational carbon (and, thus, the overall carbon footprint) of the building, the addition of an HD ISO coverboard can provide multiple benefits.

The Most Common Types of Coverboards

There are many different types of coverboards, manufactured for a variety of applications. The three most widely used are:

High-Density Polyiso (HD ISO)

HD ISO coverboards are lightweight, have a high R-value per inch, provide moderate compressive strength, and can be moisture and mold resistant. They offer increased thermal performance, protection from light to moderate foot traffic, and provide ease of handling and installation for installers.

GAF EnergyGuard™ HD ISO coverboards have an R-value of 2.5, which is significantly higher than their non-polyiso coverboard counterparts. They also meet the requirements of ASTM D3273 for resistance to mold growth***. Some HD ISO products may also achieve ANSI/UL 790 Class A Roofing Fire Resistance Rating over combustible decks.

Gypsum

Gypsum coverboards have the advantages of fire resistance, high compressive strength, and dimensional stability. The higher compressive strength may provide a higher degree of impact protection. They're easier to install than plywood and OSB but are heavier than HD Iso. They typically meet ASTM specifications for resistance to humidity, moisture, and mold growth.

Glass-Mat Gypsum

Glass-mat gypsum coverboards have a high-density gypsum core with fiberglass facers for enhanced compressive strength. They are fire-resistant as well as resistant to moisture and mold growth when tested to ASTM D3272*. GAF carries a variety of gypsum and gypsum-mat coverboards for any situation.

In addition to the above three, there are other types of coverboards on the market, including cementitious, perlite, wood fiber (like GAF STRUCTODECK®), and asphaltic (like GAF Sturdy-Dek®). These options are more commonly used on projects with more modest budgets or in applications that require torching or mopping applications of modified bitumen and built-up roof assemblies.

Value-Engineering Challenges

Coverboards are sometimes targeted in Value-Engineering efforts, with the claim being made that omitting them saves money and doesn't affect the warranty. However, failing to install coverboards can adversely affect the long-term performance of the roof assembly, potentially putting the owner's investment at risk.

When you calculate the costs of roof damage, repair, and replacement, as well as increased life cycle costs as a result of shorter replacement intervals, it makes sense to future-proof the roof with the added protection of a coverboard.

*GAF warranties and guarantees do not provide coverage against hail except where additional hail coverage is purchased for eligible systems. Refer to applicable warranty or guarantee for complete coverage and restrictions, available at gaf.com.

**GAF warranties and guarantees do not provide coverage against traffic except where GAF walkways are applied. Refer to GAF.com for more information on warranty and guarantee coverage and restrictions.

***GAF warranties and guarantees do not provide coverage for mold or other biological growth.

Air Barriers, Vapor Retarders, and the Roof In Between

By: Andrea Wagner Watts

All Images Courtesy of GAF | Siplast

Buildings are designed to keep the outside weather out and the inside space conditioned as the occupants desire. A building's enclosure or envelope is made up of multiple layers of materials with the goal of stopping the uncontrolled movement of water, air, heat, and moisture vapor.

On roofs, these layers must include an air barrier and sometimes a dedicated vapor retarder. When designed and installed properly, they can help building owners save energy while maintaining occupant comfort. Here are the key details to understand.

Understanding the Importance of Air Barriers

Uncontrolled air movement is a problem for two reasons: energy loss and moisture. According to BuildingGreen, uncontrolled air movement accounts for 10% to 40% of heat gain or loss in buildings. This loss means additional energy must be used to maintain a constant interior temperature. To reduce this unnecessary energy usage, the International Energy Conservation Code (IECC) now requires continuous air barriers on all six sides of a building.

Air also brings uncontrolled moisture vapor into building assemblies. One hundred times more moisture will come through one square-inch hole by way of air infiltration than will come through a 4-by-8-foot piece of gypsum by way of diffusion during the same time period. So, it's critical to ensure buildings are properly sealed for air infiltration.

When it comes to air barriers, proper installation is more critical than the material used. They should be installed as part of an air barrier assembly, not just as an added layer on the roof or exterior walls. If the air barrier on the roof isn't properly tied into the air barrier assembly on the walls, interior air could escape around the roof perimeter. This can be seen as heat loss in the yellow and white colors in an infrared photo.

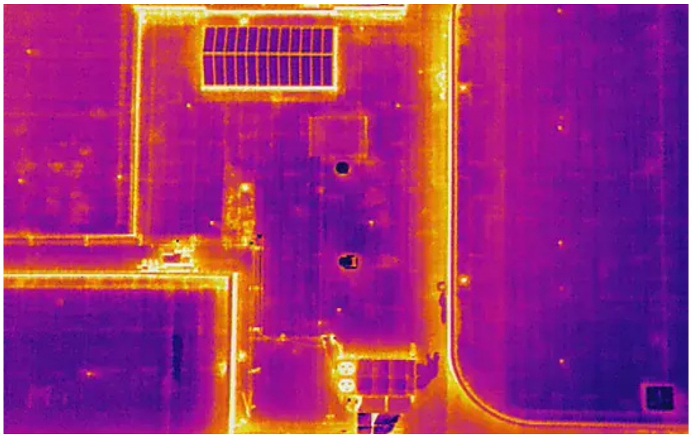


Figure 1. IR Camera image of building roof looking down, showing temperature difference at roof perimeter, indicating air loss (Image courtesy of Nexus).

Designing the Air Barrier Assembly

In most roof assemblies, the roof membrane is the primary air barrier. Its effectiveness in providing a continuous air barrier—based on how the layers of the assembly are attached and if a vapor retarder is installed—depends on the rest of the assembly.

Roof assemblies vary in how much air gets into the assembly from the interior of the building (think stack effect or hot air rising through a space). This varies based on how the layers of an assembly are attached and if a vapor retarder is installed. As the red arrows illustrate in Figure 2 below, by using an adhered membrane instead of mechanically attaching it, air can't push up through the assembly and billow the membrane. And when a dedicated air barrier is added to the roof deck, air (and heat and moisture) can't get into the roof assembly at all. Adding an air barrier also minimizes the wind uplift pressures on the roof assembly.

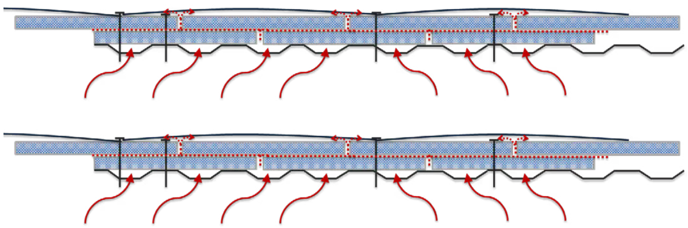


Figure 2. Three different roof assemblies allowing different amounts of air and moisture.

Determining Whether a Vapor Retarder Is Needed

If a building has a dedicated air barrier, it may or may not need a vapor retarder. Vapor retarders—which aren't always a full barrier, so "retarder" is the correct term—slow the migration of vapor through the roof assembly, lower condensation risks, and function as an air barrier, if installed as such.

The International Building Code recognizes three classes of vapor retarders, ranging from Class I at or less than 0.1 perms to Class III at less than 10 perms. Materials with a permanence greater than 10 perms are classified as permeable and aren't recognized as retarders. The problem comes when designers want to install retarders in a location and in such a way that moisture can get inadvertently trapped between two materials with low vapor permeance.

The effects of this can be seen in the image below, where the roof assembly has degraded as a result of long-term trapped moisture.

The best option is to install the vapor retarder on the warm side of the insulation and use it as an air barrier to prevent moisture from getting trapped between materials.

Using Vapor Retarders as Temporary Roofs

When Class I vapor retarders are installed on a concrete roof deck or on top of a cover board over a metal roof deck, they can function as a temporary roof during construction. This allows interior finishing to start until the trades are ready to complete the roof.

The final layers of the roof assembly can be installed when no further construction will be done on the roof. This provides a clean, aesthetically pleasing roof, as was required in the casino project pictured below.

Figure 3. Moisture trapped between two Class I vapor retarders caused degradation of the insulation and roof deck (Image courtesy of SGH).

Vapor Retarders Benefit Roof Performance

Ultimately, air barriers are a code requirement for all new roofs based on the IECC. However, vapor retarders remain optional depending on the project's needs.

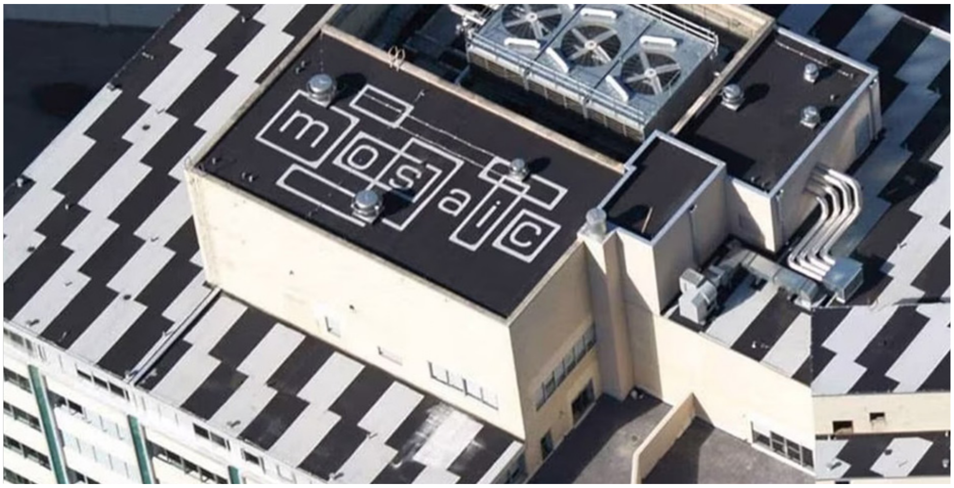
In cases where there's a concrete deck, a temporary roof is desired, or a high vapor load is on the interior of the building, vapor retarders and properly designed assemblies benefit roof performance by keeping air and vapor where they're meant to be.

Curious to learn more about the crucial role air barriers and vapor retarders play in roofing installation? Check out this vapor retarder overview video.

Durability From a Timeless Product

Exploring the Performance Benefits of Low-Slope Asphaltic and Hybrid Roof Systems

By: Andrea Wagner Watts



The completed roof renovation at Mosaic Ultra Urban Living Apartments project in Dallas, Texas. All photos courtesy GAF/Siplast.

Asphaltic-based low-slope roofing is one of the oldest low-slope roofing technologies; appropriately, it remains a leader in construction segments such as healthcare, education, hospitality, and mixed use. Asphaltic-based roof systems are durable, have a long history of proven performance, and their redundancy provides owners peace of mind. The benefits of asphaltic-based roof systems include durability and redundancy. When used in hybrid systems that combine modified plies with a single-ply cap sheet, the result is a roof system that offers the best of both technologies.

Section 1

A Short History of Low-Slope Asphaltic Roofing

All asphaltic roof systems start with the same base raw material. The terms bitumen and asphalt are often used interchangeably within the construction industry: asphalt is the most common reference in the U.S., while bitumen is the preferred term internationally. Bitumen is an immensely viscous material that, depending on its exact composition, can be a sticky, black liquid or an apparently solid mass. Bitumen can be found naturally or it can be a by-product from refining crude oil. Pitch Lake in Trinidad has the world's largest known deposit of natural bitumen, estimated to contain at least 10 million tons of material.

A Long History of People and Bitumen

The qualities of bitumen have been known and used for human construction projects since ancient times. The earliest estimated use of bitumen dates back

Natural bitumen at Pitch Lake in Trinidad

RUBEROID®Energy-Cap™ 30 Granule FR Membrane

RUBEROID® EnergyCap™ 30 Granule FR modified bitumen membrane is a fire-resistant modified bitumen membrane with bright white granule surfacing.

Lightweight - Installed roof designs weigh less than 3 pounds per square feet

Durable - RUBEROID® EnergyCap™ 30 Granule FR combines the strength of fiberglass reinforcement with the elongation characteristics of SBS-modified asphalt

Certified - RUBEROID® EnergyCap™ 30 Granule FR is backed by GAF, a company with over 130 years in the roofing business

40,000 years to the paleolithic period, where bitumen was used to adhere handles onto primitive stone tools.1 The use of natural bitumen for waterproofing, as well as an adhesive, dates at least to the fifth millennium BC, where it was used in crop storage baskets discovered in Mehrgarh, from the Indus Valley civilization.[2] By the third millennium BC, refined rock asphalt was in use throughout the region of present-day India and was used to waterproof the Great Bath in Mohenjo-daro.[3] In the ancient Near East, the Sumerians used natural bitumen deposits for mortar between bricks and stones, to adhere parts of carvings into place, and for ship caulking and waterproofing.[4]

Bitumen in Modern Times

Documentation of modern low-slope roofs using layers of bitumen and ply sheets to provide waterproofing goes back to at least the 1890s. Multi-layer asphaltic or bitumen roof systems remained the dominant roof assembly of choice until the 1970s and they have continued to endure due to their exceptional hardiness and multiple layers of protection. However, by 2022, asphaltic systems had fallen in popularity: making up about 20 percent of the commercial roofing market. Despite this decline, bitumen or asphaltic roofs are still relied upon today for projects due to their remarkable durability. The redundancy achieved by multiple layers of bitumen provides resilient protection from damage due to heavy foot traffic and during storms and wind events. Bitumen systems can be elastomeric, have built-in puncture resistance, and are compatible with a variety of substrates and conditions. Additionally, bitumen roof systems create an effective, simple, and practical water control system. If the top layer is damaged, the layers below will continue to protect the building from water intrusion.

Not only is a bitumen roof system a time-tested technology with proven performance and redundancy, but modern advances have increased installation options, surfacing variety, and detailing and repair advantages.

Section 2

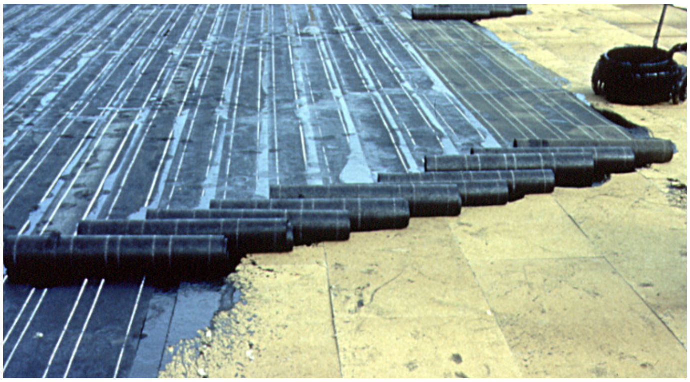
Meet the Family – Types of Low-Slope Asphaltic Roofing

BUR

The original asphaltic roof system for low-slope roofs is referred to as a built-up roof (BUR) system. BUR roof systems have been used for more than one hundred years in the U.S. BUR roof systems are made up of multiple, alternating layers of reinforcing ply sheets and asphalt, providing multiple layers of protection. BUR systems remain in use today because of the excellent protection they provide.

The core of the BUR system is assembled using a shingling system of alternating layers of plies and liquid oxidized asphalt, embedding each ply into a layer of asphalt and ensuring substantial overlap with the previous ply. Historically, rags, paper, or asbestos were used as the reinforcing plies. Thanks to technology advancements, the plies are generally asphalt-impregnated fiberglass felts, fabrics or mats. Fiberglass felt plies or glass plies contribute to the fire-resistance of the roof system.

Installers traditionally rely on hot mopping of the asphalt requiring kettles, either placed on the roof or on the ground onsite. Advances in manufacturing have created alternative options such as cold-applied adhesive solutions instead of hot mopping asphalt and kettles. Cold-applied adhesives have temperature installation limits, but they can reduce the challenge of keeping an asphalt kettle hot enough during cooler weather.



Installation of a BUR roof system.

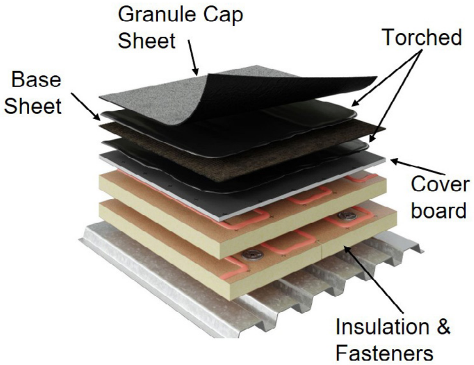


Diagram of layers in a BUR roof system.

The layering process is repeated on the roof with the application of asphalt or cold-applied adhesive, followed by the installation of additional plies until the desired number of plies is achieved. The multiple plies, when saturated in asphalt or cold-applied adhesive, create a barrier that provides additional resistance to water intrusion. The complete roof assembly typically ranges from 2 to 5 plies. This installation method can be labor intensive and requires quality workmanship to be successful. The system is then surfaced with either a mineral-surfaced cap sheet or with a flood coat of asphalt and mineral aggregate or gravel, a liquid applied coating, or, historically, slag.

Benefits of BUR

Built up roofing owes its popularity to the number of benefits it provides. It is a time-tested technology, with more than 100 years of history. These roofs provide many layers of protection, so that if the top layer becomes damaged, the additional layers below will continue to protect the building from water intrusion. BUR is, by design, redundant.

BUR system materials remain relatively inexpensive and offer excellent fire resistance. However, BUR installation is more labor intensive than other low-slope roofing choices.

Because of its proven performance and resilience, BUR systems may be eligible for guarantees or warranties exceeding 20 years, depending on the materials used and the system installed. Modern BUR manufacturers also offer reflective cap sheets or granules. These cap sheets are available to help reflect the sun's rays away from the building, which can assist in maintaining internal temperatures.

Developments in Roofing After World War II

Roofing, and the construction industry in general, experienced dramatic shifts in materials after World War II. This shift in both technology and availability changed how buildings were built. Roofs became noticeably flatter as lightweight steel construction supplanted the use of concrete and wood framing. As roofs became flatter, more equipment moved to the roof and the amount of foot traffic on the roof increased. The greater use of steel created buildings that flexed and moved more, requiring materials capable of accommodating the movement without failures. Additionally, the efforts from the war produced new types of polymers that were used in automotive and aeronautic applications that also found their way into roofing.

At the same time, the quality of BUR materials dropped dramatically. As a result, the industry developed a "new" bitumen that utilized polymers added to a bituminous base. These modified bitumen blends were used to create new membranes with the redundancy and durability of traditional BUR, but with additional properties from the rubber or plastic modifiers. The new formulas were able to accommodate the movement and have increased durability as the modified bitumen had a higher softening point and more elongation.

Creating Modified Bitumen Blends

Modified bitumen used in roof materials is produced by blending together raw bitumen, filler, and polymer which are then layered with reinforcement to create a modified bitumen roll. Not all bitumen blends are the same. The quality of the final material is highly dependent on the quality of raw materials used, the manufacturer's formulation, and the blending process. It is critical to be aware that there are different asphalt sources of varying quality and different types and quantities of polymer and fillers that can alter the final properties and durability of a material.

Bitumen forms the foundation of a good quality blend. Not all bitumen is receptive to modification and blending with the other components of the final material. Additionally, lower quality bitumen results in poor performance and premature aging of the entire product. Therefore, a manufacturer's asphalt source is extremely important.

While fillers are the lowest cost material used, they have important roles to play in the final formulation. Filler is the material that stabilizes the blend and provides the finished product with many of its engineered properties. Fillers are typically mineral-based. They are used to stabilize the formula, bolster fire resistance, and increase ultra-violet light (UV) and weathering resistance. For example, the addition of carbon and graphite can increase fire performance. Limestone and basalt can decrease the cost of the formula and aid in absorbing excess oil. Waxes and tackifying oils are added to increase self-adhesive properties of the formula. Most modified bitumen formulas contain between 25 percent and 35 percent filler. If a formulation has too much filler, more than 35 percent in filler additives, the final blend degrades.

Polymers are the most expensive element of a modified bitumen blend. There are three common polymers used to modify asphalt today: SBS (styrene butadiene styrene), APP (atactic polypropylene), and IPP (isotactic polypropylene). We're going to focus on the two most common polymer blends currently used in roofing: APP and SBS.

APP

APP is short for Atactic Polypropylene. It is a plastic-type polymer that imparts rigidity to the final material. A good APP-modified bitumen material will typically have 20-30 percent APP in the final formulation. APP modified bitumen materials have a higher softening temperature and are harder or have a higher durometer than SBS modified bitumens.

SBS

SBS, or Styrene-Butadiene-Styrene, is a rubber-type polymer that comprises roughly 10 to 13 percent of the total blend. An SBS-modified bitumen blend is a softer, more malleable final product than an APP blend. This additive allows the blended SBS to achieve greater elongation than other asphaltic systems.

Reinforcing Scrim

Reinforcing scrim acts as a carrier for the modified bitumen. The scrim is embedded within the sheet and provides dimensional stability for the roll, improves fastener retention, and increases puncture resistance. There are three primary types of reinforcing scrim: fiberglass, polyester and composite or hybrid mats.

The type of scrim or reinforcement will influence different properties of the material. Fiberglass reinforcement is more fire resistant and provides dimensional stability while polyester reinforcement is more puncture resistant and has better elongation and tear resistance.

The modified bitumen sheets can be specified based on the type of reinforcement using different ASTM specification numbers. In the case of SBS rolls, ASTM D 6163 denotes a fiberglass reinforcement, ASTM D 6164 is for polyester reinforcement and ASTM E6162 is the specification for SBS sheets with a combination or hybrid reinforcement. In addition to specifying the ASTM specification number, it is valuable to also reference the Type and Grade of the material. The Type further indicates the mass and physical properties of the sheet: Type II materials have a larger net mass, peak load, and tear strength than Type I. The Grade indicates the surfacing of the sheet, either G for granule or S for smooth.

Summary

All of the components of a modified bitumen sheet - the bitumen, filler, and polymer - come together through a blending process. Adding a polymer changes the dispersal and consistency of all the products throughout the blend, making the blending protocol incredibly important. The blending time and temperature can greatly affect the dispersal and consistency of the filler and polymer within

Case Study

Mosaic Ultra Urban Living Apartments
Dallas, Texas

The Mosaic project involved the 2007 renovation of the former Fidelity Union Bank and Insurance complex, two vacant downtown Dallas office towers. Mosaic is one of Dallas' most striking high-rise residential communities.

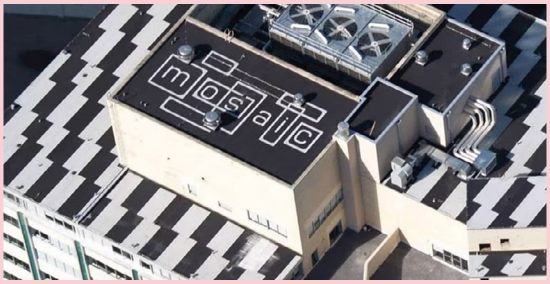
The Challenge

These former office towers required full removal of up to four layers of existing roofing and insulation from 15 different roof levels. Inadequate drainage had created severe ponding issues on all roofing levels, as well.

The Solution

Products including highly energy-efficient insulation, a strong, resilient, non-woven polyester mat coated with weather-resistant, APP polymer-modified asphalt, and selfadhered SBS helped create an updated and effective roofing system. The roofing renovation happened on time and within budget. Tapered polyiso foam insulation was used to provide high thermal efficiency and to virtually eliminate ponding water. A durable non-woven glass mat, coated with flexible, polymer-modified asphalt, was also used, which combined the strength of fiberglass reinforcement with the elongation characteristics of SBS modified asphalt.

The self-adhered modified bitumen roof systems earned praise for being clean and environmentally friendly. This project was the Winner of the ARMA Quality Asphalt Roofing Case-Study Award.



The completed roof renovation at Mosaic Ultra Urban Living Apartments project in Dallas, Texas.

the bitumen matrix, changing the properties of the final material. The modified bitumen is then extruded into rolls with the reinforcement of choice to make the final roll used on a building.

Section 3

Installation and Application Options

Commercial asphalt roofing systems are multi-ply systems consisting of two or more waterproofing layers.

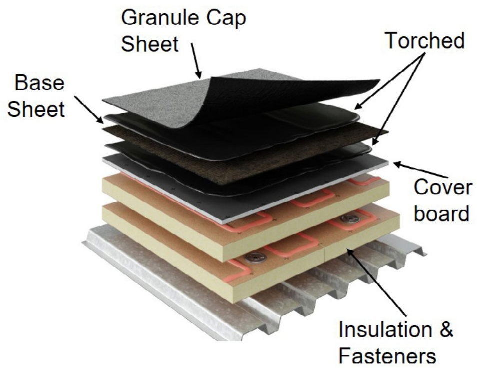


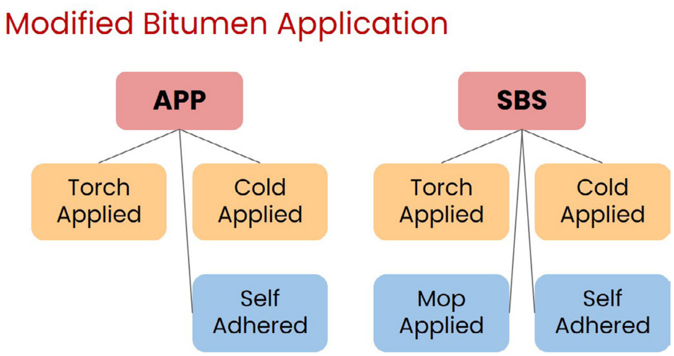
Figure 5. Installed image of a modified bitumen system

This redundancy provides building owners with durable protection for their building. Beyond the material properties, asphaltic or bitumen roof systems are adaptable and can be installed using various methods with multiple detailing options and surfacing varieties.

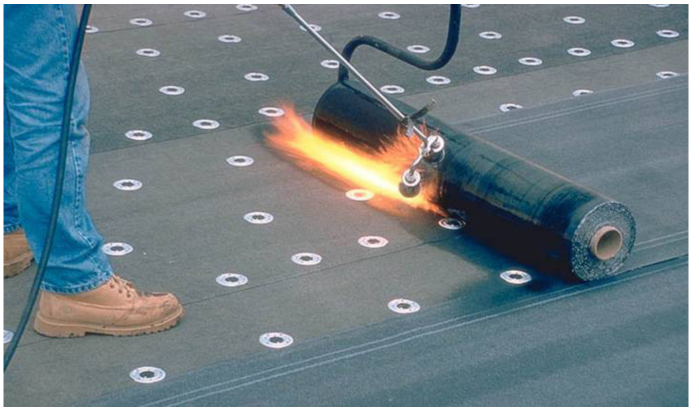
Installation Options

Modified bitumen systems consist of at least two layers: a base sheet and a cap sheet. An additional base sheet may be mechanically attached to the roof deck in cases where the application requires. Both SBS and APP sheets can be torch applied, cold applied or self-adhered. However, APP is most commonly installed by torching due to the high temperatures required to get the material to flux or melt; cold-applied and self-adhered options for APP may not be readily available. Additionally, SBS has the ability to be hot mopped. This list of installation methods may not be exhaustive of all options available on the market as the industry is always changing and new products are introduced and discontinued (see Figure 5). It is not necessary for both layers of a modified bitumen system to be installed in the same manner.

Both APP and SBS modified rolls can be installed using a torch method. Torch application uses an open-flamed torch to heat the back side of the sheet to flux, or the point of



Installation options for modified bitumen systems.



Installation of a modified bitumen roll using torch application.

Sealing the seams of an SBS membrane with a welder, similar to the method used to seal seams of a single-ply membrane.

softening the modified bitumen so that it will adhere to the substrate below as it cools. It is important to note that APP fluxes at a much higher temperature than SBS, so crews who are used to torching one style of sheet may initially struggle to torch the other style. Because of the lower temperatures at which SBS membranes soften, the seams of the membrane can be sealed using a welder similar to the method to seal seams of a single-ply membrane (Picture).

SBS modified bitumen rolls installed using a cold-applied adhesive.

The other hot method for applying asphaltic roof systems is called hot-mopping. This is the method used for BUR roofing but can be used for SBS systems as well. Hot mopping involves melting blocks of asphalt in a large kettle and spreading the melted asphalt on the roof with mops. In addition to being an adhesive, this method can provide additional redundancy to the SBS system as you have a thicker sheet that already provides waterproofing being embedded in a layer of asphalt which will act as its own waterproofing component.

SBS can also be installed using a cold-applied adhesive. For this method, a solvent-based or solvent-free liquid adhesive is applied to the roof surface or previously laid membrane and spread evenly using a tool such as a notched squeegee. The modified bitumen sheet is then rolled into the adhesive. This option is good for when asphaltic fumes, open flames, and kettles that can accompany hot-applied roofing are not permissible.

Finally, self-adhered modified bitumen membranes are available, both for SBS and a few APP systems. A self-adhered membrane is installed by removing a release film off the back of an already rolled out membrane. The membrane is then rolled to ensure it adheres to the substrate below. This method can increase the speed of installation over other traditional methods. Self-adhered membranes do not produce unpleasant odors, fumes, or heat, an important factor installing on an occupied building.

Surfacing Variety

Asphaltic assemblies need a top surface to provide protection from UV, excessive surface temperatures, to provide fire protection, and to provide puncture and roof traffic resistance. There are many options available to designers and owners depending on the desired aesthetic and roof use. These options include a flood coat of asphalt and mineral aggregate or gravel, a mineral-surfaced cap sheet, an elastomeric coating, or even a traditional fleeceback single-ply membrane.

SBS modified bitumen rolls installed using a cold-applied adhesive.

The traditional method to complete a bitumen roof such as BUR is a flood coating of asphalt with embedded gravel. The gravel layer protects from UV degradation, roof traffic, storm damage, and wind debris. For this option to be successful, the roof structure below must be designed and built to accommodate the anticipated additional weight of the gravel.

One of the most common ways to surface an asphaltic roof assembly is with a mineral surfaced or granulated cap sheet. This sheet employs a modified sheet that is thicker and has the granules already factory applied to the sheet. This cap sheet provides UV protection and surfacing to protect from traffic. Bright white granules with a high solar reflective index (SRI) for projects that need to meet specific reflectivity requirements are also available.

Some modified bitumen assemblies can also be surfaced with a coating. The coating can be a squeegee-applied glaze coat of Type 1 asphalt, an asphaltic-based clay emulsion coating or any number of elastomeric coatings such as silicone, acrylics or urethanes. The elastomeric coatings may not be as strong against debris or roof traffic, but there are multiple options with high SRI values.

Overburden

Not to be overlooked as an option for going over asphaltic roof systems is overburden. While the first job of a roof is to act as the primary defense to prevent water entering into a building, due to current market trends and legislation, this previously underutilized asset is being recognized by owners for the opportunity it can offer when considering sustainability certifications or stretch code complaince. Roofing overburden is defined as "any manner of material, equipment or installation that is situated on top of, and covering all or a portion of, a roof or waterproofing membrane assembly."5 There are many overburden options and roof assembly considerations when meeting sustainability goals. This can include vegetative roof assemblies, planters, plaza decks, and even equipment such as solar photovoltaic arrays.*

1. **Vegetative Roofs:** Vegetative roofs consist of plants that are installed in trays or assemblies that are built in-place on the roof with extensive or intensive plant configurations. Tray systems and extensive roofs are generally in depths of less than six inches and consist of shallow rooted plants, such as sedums. Intensive vegetative roof systems have deeper soil depths and can accommodate larger plant installations.

2. **Blue Roofs:** Blue roofs are systems that are designed to provide stormwater detention. Rainfall onto the roof is managed using orifices, weirs, or other outlet devices that control the discharge rate of rooftop runoff.

3. **Blue-Green Roofs:** A blue-green roof is a blue roof with a vegetative roof assembly.

4. **Purple Roofs:** A purple roof is a "sponge" roof that is designed to retain and detain rainwater. It incorporates a sponge-like layer made of hydrophilic mineral wool, a dense polyester fabric detention layer, and may or may not include an additional honeycomb layer to increase the volume of rainwater that can be managed.

5. **Rooftop Solar:** Solar PV panels come in both single sided and bifacial (double-sided) modules. Modules are traditionally supported by racking systems on the rooftop that are either mechanically attached to the roof, mechanically attached to a structural canopy that is attached to the roof, or held in place with ballast.

6. **Agrivoltaics:** The emerging practice of agrivoltaics, or agriculture combined with photovoltaics, is showing promise as a mutually beneficial symbiotic solution to not only increase the efficiency of solar panels, but also increase plant size and crop yields by shading and limiting soil evaporation.

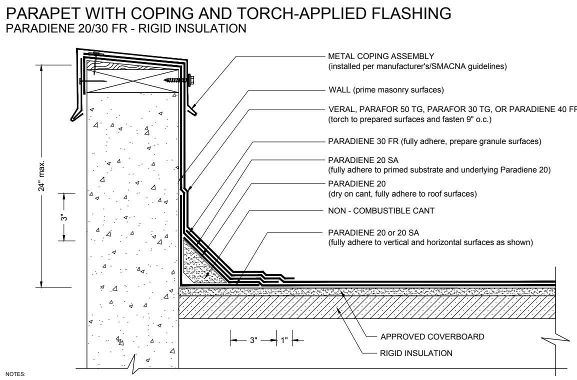
A vegetative low-slope roof.

The overburden's success depends on the roof assembly beneath. For installations such as solar or vegetative, the plants and solar array will need to be accessed for service or removed for repairs or replacement. These anticipated actions require a more robust roof assembly for the long-term durability and serviceability of the complete roof. For fully covered roofs such as vegetative roofs or plaza decks, a smooth modified sheet cap sheet may be the best option. For solar arrays, a cap sheet with a more finished appearance may be selected as it will be seen and weathered throughout the life of the project. Nevertheless, asphaltic roof systems provide the redundancy and durability required to be buried under these assemblies.

Finally, a fleece-backed thermoplastic membrane can be the surfacing or cap for a modified system. These membranes can have high SRI values, are resistant to ponding water, are easy to repair and maintain, and may offer more resistance to certain chemicals. This type of "hybrid" system provides the redundancy of a modified system with the benefits of a thermoplastic membrane.

Detailing and Repair

As with the vast majority of roof systems, transition details can be done with materials of a technology similar to the roof material itself. For example, an SBS system can be specified to use an SBS flashing sheet with a granule surfacing to match the rest of the roof or an unsurfaced flashing sheet.



A vegetative low-slope roof.

For parapets (Figure 13), transition flashing typically uses 3-4 layers at the 90-degree bend, typically uses a cant strip, and has at least 2 layers up the vertical wall. Additionally, there are asphaltic backed foil surfaced flashing options available. The foil surfaced flashing option, when used on parapets and edge details, can direct heat away from the wall edge, potentially reducing the amount of movement at the roof-to-wall interface.

There are other detailing options available for use with modified bitumen systems that provide flexibility depending on the application. Liquid applied flashings are such an option and there are multiple chemistry options on the market such as polymethyl methacrylate (PMMA), polyurethane methacrylate (PUMA), and styrene ethylbutlyene styrene (SEBS). These flashings are often applied in multiple layers and may require an embedded fabric between them. Liquid applied flashings can be used for penetrations, parapet transitions, unusual wall formations and at unique details.

Case Study

Dougherty County Jail, Georgia

The Challenge

In addition to the primary concern of completing the reroof of this facility with minimal impact to daily operations, the Dougherty County Board of Commissioners was seeking a roof system that was both economical and would help advance the County's environmental objectives.

The Solution

- Existing lightweight insulating concrete on one half of the building proved its worth as a sustainable insulation and was left in place, while a system combining the unique properties of lightweight insulating concrete and premium-expanded polystyrene foam insulation board allowed the other half of the facility to be reroofed without tear-off of the old tapered system. This saved money and reduced the roofing material waste from this reroofing project.
- In both cases, the use of combined lightweight insulating concrete and premium-expanded polystyrene foam insulation board created proper slope-to-drain and provided sufficient R-value. The material selection also allowed project completion without impacting prison operations.
- Finally, the entire facility was reroofed with a two-ply modified bitumen system. The system consists of a high tensile fiberglass scrim/fiberglass mat composite impregnated and coated with high-quality SBS-modified bitumen. The finish plies are granule-surfaced and protect the base from the elements and abuse. This combination of asphaltic roofing was selected in order to protect the building and maintain health and operational effectiveness for years to come.

To meet financial and environmental goals, a hybrid system was made for the reroof. This involved a two-ply modified bitumen system, consisting of a high tensile fiberglass scrim/fiberglass mat composite impregnated and coated with high-quality SBS-modified bitumen.

Bitumen and modified bitumen roofing systems have multiple options for recover if they do not contain any trapped moisture within the roof assembly. Avoiding a complete tear off allows for a more cost-effective way to extend the life of the existing roof. Liquid applied coatings can extend the life of a roof system. Liquid applied membranes allow for greater flexibility during installation and are especially adept in recover situations. These coatings and membranes can be made of PMMA, PUMA, acrylic, silicone among others. Liquid applied membranes allow for flexibility both on the full recoat and when recoating and resealing the transition details on the roof. Another option for recover is to apply a fleece-backed single ply membrane such as TPO, PVC or PVC-KEE over the existing roof. These membranes can be adhered to the asphalt roof system in a similar manner as an original cap sheet would be applied over the roof system.

Section 4

The Hybrid Roof Assembly

This leads to a discussion of the benefits of a hybrid roof assembly. Hybrid roof assemblies offer another way for roof assemblies to contribute to a building's energy efficiency, resiliency, and sustainability goals. Hybrid assemblies combine the benefits of modified-bitumen roof systems with those of single ply roof systems. This intentional combination of materials aims to increase the robustness of the assembly, including UV protection, resistance to ponding water, ease of repair, and resistance to certain chemicals. Hybrid roof assemblies are the latest roofing trend aimed at meeting the demands of modern roofs.

What is a Hybrid Roof Assembly?

A hybrid roof assembly is where two roofing membranes, composed of different materials and product technologies, are used in one single roof system. One type of hybrid assembly consists of a modified bitumen base layer with a cap layer of a thermoplastic single-ply membrane, such as Thermoplastic Polyolefin (TPO) or Polyvinyl Chloride (PVC) or PVC-KEE. Each component of the roof system is chosen for its strengths, and together, the system combines the best of all the technologies present. A hybrid system such as this has increased robustness, with effectively two plies or more of membrane.

The combination of an asphaltic base sheet covered by a single-ply membrane increases the overall system thickness and robustness compared to a traditional single-ply system. It provides additional redundancy and protection against punctures, which can be a concern with single-ply applications. As mentioned previously, asphaltic systems are vulnerable to UV exposure without surfacing.

They also have minimal resistance to ponding water and certain chemical contaminants; these material shortcomings can be overcome with the addition of a single-ply membrane. If this is a priority for a project, a higher SRI value can be achieved using a single-ply membrane with both high new and aged SRI values than can sometimes be found with modified bitumen cap sheets. When higher SRI value options are chosen, the single-ply membranes placed as a cap layer over bitumen systems can decrease the roof surface temperatures and potentially help reduce the heat island effect of the building. PVC and PVC-KEE (Ketone Ethylene Ester) membranes may also provide protection where exposure to chemicals is a concern, and they generally hold up well in ponding water conditions. Therefore, the combined attributes of bitumen systems and

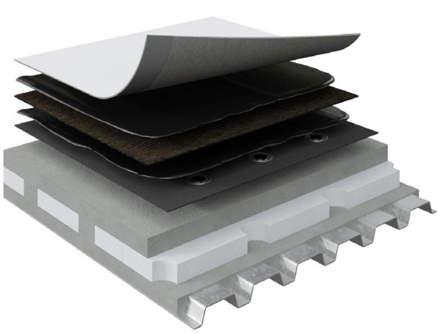


Diagram of a hybrid roof assembly combining an asphaltic base sheet covered by a single-ply membrane.

Single-ply Membranes 101

Single-ply membranes are the most popular roofing membrane today due to their ease of installation and relatively low cost. Due to the nature of a single-ply roof, it can be installed more quickly than a traditional asphaltic system using mechanical attachment, induction welding or adhesives. Membrane types differ in their chemical composition, their performance when exposed to chemicals at the roof surface, and treatment of the seams during installation, among other attributes. Since the chemical make-up of each of the membranes is different, certain membrane types are more suitable for different applications.

single-ply membranes complement each other, providing a durable, efficient, and redundant roof system.

Common Hybrid Roof Applications

Hybrid roof assemblies can be a logical choice for data centers, education facilities, and hospitals due to their strong protection against leaks and multi-ply system redundancy. The redundancy of the second layer of membrane in the form of an asphaltic base sheet provides a secondary protection against leaks if the single-ply membrane is breached.

Additionally, the reflective, UV stable single-ply membrane can provide a cap sheet that is more durable against certain environmental situations such as specific chemicals that is necessary for specific projects. The addition of a reflective membrane over a dark-colored asphaltic membrane can greatly increase the Solar Reflectance Index (SRI) of the roof surface. SRI is an indicator of the ability of a surface to reflect solar energy back into the atmosphere. In general, roof material surfaces with a higher SRI will be cooler than a surface with a lower SRI under the same solar energy exposure. A lower roof surface temperature can result in less heat being absorbed into the building interior during the summer months, thus reducing building cooling loads.

Hybrid Roof Installation Advantages and Considerations

Hybrid systems are not confined to new construction. A key benefit of a hybrid roof assembly occurs in retrofit or recover scenarios where there is an existing-modified bitumen or built-up roof (BUR) that is in overall fair condition and with minimal underlying moisture present. A single-ply membrane can be installed on top of the existing roof system without an expensive and disruptive tear-off of the existing assembly. The addition of the single-ply membrane adds reflectivity to the existing darker colored membrane and increases the service life of the roof assembly due to the additional layer of UV and weather protection. Additionally, the single-ply membrane can be installed with low VOC options that have minimum odor and noise disturbance if construction takes place while the building is occupied. This can include mechanical attachment, induction welding or adhesives.

Whether it is a new roof or a recover of an existing roof, there must be something separating the two materials. This is due to the chemical incompatibility of the single-ply membrane and the modified bitumen. In both scenarios, the easiest way to separate the materials is to use a fleece-backed membrane where the factory-applied fleece backing acts as the separator. In re-roof applications, a coverboard or polymat can be used as a separator with a smooth backed membrane. Any type of attachment method can be used provided it meets the other requirements for the project.

Demonstrable Benefits Support the Marriage of New and Old Technology

The possibility of combining the best aspects of two different roofing technologies makes a hybrid roof assembly worth the hype. Putting bitumen systems together with a single-ply membrane provides the best aspects of each for the roof. The single-ply membrane integrates a reflective surface for improved energy efficiency, and increased protection against chemical exposure and ponding water, while the asphaltic base increases overall system waterproofing redundancy, durability, and protection. The ability for this method to be used in both new construction and recover scenarios makes a multi-ply hybrid roof an assembly choice that is here to stay.

Summary

In summary, asphaltic or bitumen-based roof assemblies remain an important roofing solution. Modified bitumen systems are simple, practical, versatile, and durable. They provide multiple options for the final assembly look including granules and single-ply membranes as well as the protection required for roofs with overburden.

Modified-bitumen roofs (both APP and SBS) are tear and puncture resistant, have multiple installation options and have choices in scrim to improve specific other properties. As a comparison, built-up roof systems use relatively inexpensive materials compared to modified bitumen, but modified bitumen systems are easier to quality control in the field. All bitumen roof systems are resistant to overall damage from roof traffic, temperature shifts, and weather, and can be considered for many different types of roofing projects.

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