FLAT-ROOF INSPECTION, *with a Focus on* Modified Bitumen

John Cranor, ASHI Certified Inspector

Because of the costly damage they can cause, roof leaks surely top the list of home inspectors' liability concerns. This is especially true when inspecting flat or low-sloped roofs.

My roofing experience began more than 30 years ago; my father and grandfather were both roofing contractors, so I practically grew up installing and repairing roofs. Now, 30 years later, with thousands of roofs under my belt, the task of accurately reporting or determining the cause of a leak in a low-sloped roof can still be challenging. After being called on numerous times as a consultant in litigation between homeowners and roofing contractors or regarding home inspection complaints, I wrote this article with the hope it will help ASHI members with these challenges, thereby better serving their clients.

The types of low-slope roofing seem endless: asphalt built-up, EPDM, PVC, Modified Bitumen and TPO, to name a few. Much of the information in this article could be applied to all low-slope roofing; however, the focus is on a worthy material called Modified Bitumen (MB) and on its residential use. Please note: Specifications and details vary from manufacturer to manufacturer, as well as for specific material types and for commercial use. This article is intended as a general guide for home inspectors — not an exhaustive reference. And, additional information covering flashing and general concerns will be published next month in the March *Reporter*.

What is Modified Bitumen?

Unlike and not to be confused with asphalt roll roofing, Modified Bitumen (MB) membranes are tough and resist tearing. When correctly installed, they make a reliable roof. To the contrary, asphalt roll roofing is thinner than MB, easily torn and the application usually involves nails and roof cement. An MB membrane is reinforced with fiberglass, polyester or a combination of the two, which gives it strength; puncture resistance and overall system integrity. The asphalt (bitumen) is the waterproofing element, which has been modified (or improved) with Polymers. The membrane can be surfaced with mineral granules or metal foil in a variety of colors or left unsurfaced (smooth). MB is often referred to as rubber or a rubberized roof, but it is important for a home inspector to know it is not the same as an EPDM (rubber) roof.

A variety of Polymer blends is available. For residential use, the two most common modifiers are: Styrene-butadiene-styrene (SBS) and Atactic polypropylene (APP).

- **SBS polymer** gives the asphalt a rubber-like characteristic. Known to have good flexibility in cold temperatures, it's more sensitive to UV radiation than APP. Usually, it's applied with hot asphalt: however, it can be applied using a cold adhesive. To prevent premature deterioration from UV radiation, granules similar to those found on shingles or metal foils are used to surface this type of membrane.

- **APP polymer** is known to perform better in hot weather applications, and it is more resistant to UV radiation than SBS. It's usually applied with a torch (heat-welded); however, some manufactures have cold adhesives available. APP is usually an unsurfaced (smooth) material, but there are granular-surfaced versions available. It is generally recommended that unsurfaced membranes be painted with a reflective paint to increase its resistance to UV radiation. It is my experience that this greatly increases the life of the roof.

On homes, the membrane is usually single-ply, although multi-plies can be installed.

An inspector could make some general assumptions about the type of MB; however, I recommend simply describing it as MB. It's difficult to differentiate types once they're installed.

Several manufacturers have introduced self-adhering (peel and stick) versions of MB over the past 10 years. This article does not address this type, but it is important to know they are out there. They have the same basic installation details and defects as other types. I have seen peel-and-stick versions used to repair built-in gutters, as well as entire roofs. From experience, I believe their ability to adhere depends on the condition of the surface, including how well it was cleaned. Like tape, self-adhering MB will not stick to dirt, rust, etc.

THE INSPECTION

Where to start

The goal of a roof inspection is to identify the following:

- roofing materials,
- deficiencies,
- roof components that are not functioning properly, and
- components that are near the end of their expected service life.

All successful inspectors have their own roof inspection protocols. I recommend starting from below, as follows.

While on the ground, carefully view any perimeter edge flashing, noting any irregular appearance that deserves a closer evaluation once on the roof.

On a masonry home, note any efflorescence along the top of exterior walls, which could be related to a roof leak, or any masonry deterioration that could contribute to a roof leak.

Prior to getting on the roof, thoroughly inspect interior ceilings, walls and attics for evidence of leakage and/or damage. Signs of a leak on a ceiling don't mean the roof is leaking directly overhead. Often, flat roofs have layers such as base sheets, more than one ply, old roof, rigid insulation or metal decking. The leak may originate in one spot and zigzag down until it finds the path of least resistance before it shows up, often many feet away. On a metal deck, for example, it is possible that water entered on the front high side of the home and trailed down the metal to the rear low side before it found its way down to stain a ceiling. Experienced roofers hired to locate and repair leaks always determine the type of roof decking, asking whether the leak showed during the rain or sometime after. This information helps them find the leak.

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What about Structure?

Structural defects can affect roof performance. Often, I find residential additions with inadequate flat roofs. The once-flat roof has deflected downward several inches into the shape of a bowl, causing cracks and noticeable bowing in the interior ceiling. If it's a drop ceiling, you can see the bottom side of the structure by removing the ceiling tiles. The decking should not be rusted (if metal); even slight rust should be reported and further evaluated. Rusty roof decking can be an indication of high humidity in the building; but more often indicates faulting roofing. What appears to be surface rust on the underside of metal decking can actually be significant damage, so be careful walking on a rusty metal deck.

As we focus on MB, please be aware there are many structural issues and roof deck materials not covered in this article.

Why walk the roof?

Opinions differ on whether to walk on roofs, but I don't know how anyone can adequately inspect a flat roof without walking on it. When inspecting any roof, always err on the side of safety, always know where you are on the roof and never walk backwards. As you walk around inspecting the roof, pay close attention to how it feels underfoot. Often, rigid insulation is found with MB roofs, although it is less common on homes than in commercial buildings. It is impossible to visually detect wet insulation, and it's difficult to detect it from feel. A sunken or spongy-feeling area may indicate the insulation is wet and damaged. Sometimes, you can hear the sound of water squishing, or you may see water squirt out from the membrane when pressure is applied. Be careful not to step on blisters or anything else that could damage the roof. ▶▶▶

Inspecting Roofs: Steep vs. Low-Slope

When inspecting a low-slope roof, it's important to remember that unlike steep roofing, which relies on water shedding to keep water out, low-slope roofing must be completely waterproof. We've all seen deteriorated shingle roofs that continue to shed water because the slope and overlapped shingles keep the water moving down and off the roof. In contrast, on a low-sloped roof, the smallest hole or slightest installation error can result in significant leaking. A small hole on a steep roof might mean a ceiling stain or a few drips; a small hole on a flat roof could cause a water fall, collapsed ceilings, ruined floors, etc.

What are the components of the roof system?

Home inspectors, probably more than anyone including roofers, understand that the home is a system of components where one component can directly affect another. The roof system is no different. Roof system components include the following:

- roof covering (or membrane),
- flashings,
- penetrations,
- drainage,
- ventilation,
- insulation (on a flat roof), and
- deck (or substrate).

If one component fails, it adversely affects the entire roof system.

The waterproof system of any flat roof has three main parts:

1) the membrane (or the cap sheet),
2) the seals (or the sealants that form a waterproof joint between two waterproof materials), and
3) the flashing.

The majority of roof failures (leaks) occur at laps, flashings and seals, a small part of the total roof. So, careful attention should be given to where the membranes lap, or meet a vertical angle, such as around a skylight, plumbing vent stack, mechanical equipment curb, parapet wall, house exterior wall, or terminate at the perimeter edge or at an installed guard rail.

What are common membrane issues?

1) **Laps are critical on flat roofs** and should be examined for full and uniform adhesion. On an MB roof, you should see the following:
   - a uniform flow-out of asphalt at the laps (ideally ⅜" of asphalt flow-out at all laps, including base flashing);
   - the bottom edge overlapping the adjacent row (a minimum 3");

This new roof is an example of poor workmanship. The base wall flashing was not adhered to the roof membrane.

Another example of poor workmanship on a new roof. A poorly adhered lap was improperly patched with roof cement and the scupper was improperly installed.

This roof is no longer watertight because a lap has failed.

- End laps (or T joints) staggered so no adjacent end laps coincide (a minimum 18") and the end lap overlapping the other end by approximately 6"; and
- Laps parallel to the slope of the roof so the gravity flow of water is never running against the lap.

Examine the laps for indications of short laps, overheating, voids and/or seal deficiencies.

2) **Blisters** are commonly caused by moisture entrapment within the roof system, but may also be due to poor adhesion, air entrapment and/or vapor. Blisters should always be reported as a deficiency, but the cause and/or the decision whether it should be repaired is best left to a roofing contractor. If not moisture-related, not in a lap and not within a walking path, small blisters are probably insignificant and commonly ignored by roofing contractors.

3) **Splits** can be an indication of stress or movement within the structure, and, if so, flashing will usually have also failed. In large buildings, stress is controlled with the installation of expansion joints, which are seldom used in homes. Splits are caused by a number of reasons in addition to stress, including faulty installation.

4) **Wrinkles (or ridges)** in the membrane can be due to movement in the membrane, but also can be an installation flaw. Wrinkles usually end up splitting.

5) **Movement, slippage or migration of the membrane** is not commonly seen on homes unless the slope is steeper than normal. Usually, it's related to thermal forces, the lack of adhesion and/or the use of a membrane not rated for a steep slope. Movement of the membrane can contribute to splits, flashing failures and wrinkles.

6) **Damage.** As with any roof, MB is susceptible to damage. The causes of damage are numerous such as punctures from fallen tree limbs, foot traffic, dropped tools, sharp objects, vibrating roofing installation mechanical equipment, fasteners backing out of substrate puncturing the membrane, etc. Also, rooftop mechanical equipment such as kitchen exhaust fans can discharge cooking oils, etc., which can quickly degrade a roof membrane. Any potential discharge must be controlled to prevent roof damage.

Determining age

Determining the exact age or estimating the remaining service life of any roof is tough, and Modified Bitumen is no exception. Although the ASHI Standards and Code of Ethics requires us to report on a system that is near the end of its expected service life, it does not require providing life expectancies. Modified Bitumen manufacturers offer ▸▸▸

warranties that range from five to 20 years. In my opinion, manufacturers use long-term warranties as a marketing tool because they know most premature failures are not due to the material.

The actual service life of any roof depends on the quality of the material, environment, foot traffic and especially workmanship and maintenance. If conditions and workmanship are good and if maintained, MB might be serviceable for 12 years. In my opinion, it is risky to anticipate more or to state remaining life, never forgetting that MB failures (leaks) almost always occur at terminations, flashings or penetrations.

Like other asphalt products, MB dries out and cracks. Surface cracking (or the alligator appearance) is common and will appear on smooth-surfaced MB after a few years, especially if not coated with a UV protective coating. It is difficult to describe a worn out MB roof, but indications of advanced age include severe, deep surface cracking; extensive granule loss; and rusted flashing.

Flashing: a topic unto itself

Most leaks occur at flashing. In my opinion, detailing flashing is more craft than science, requiring careful thought, design and installation. Good flashing details must be able to move with the stresses, hold up to the forces of nature and remain watertight — a difficult task even under perfect design and conditions. As an inspector, you will come across what seems like an endless number of flashing situations and potential errors — more than I can begin to include here. Next month, I'll cover some of the basic flashing issues related to MB roofs.

What to look for at transition areas

On any roof, transition areas deserve careful inspection. These areas, where different materials come in contact with each other — often where low slopes change to steep slopes — are stress points in the roof system.

The seals, both roofing materials and/or any flashing, should be thoroughly inspected for cracking, splitting, open gaps or deterioration that could have an effect on the waterproof roof system. Installation errors are common in transition tie-in areas.

For example, there should not be metal flashing in the upward transition to a steep roof. The field membrane should be turned up a minimum of 18" on the steep slope and, at minimum, a 30" strip of base flashing should extend up and under the steep roof covering for a minimal of 24" and out over the low-sloped field membrane for 6".

Using metal flashing at upward shingle transitions is technically incorrect ▶▶▶

A deteriorated roof. The roof pictured above is patched where it leaked. It leaked because the transition between the MB roof and the shingle roof was done incorrectly. The illustration below depicts the correct way to make this type of transition.

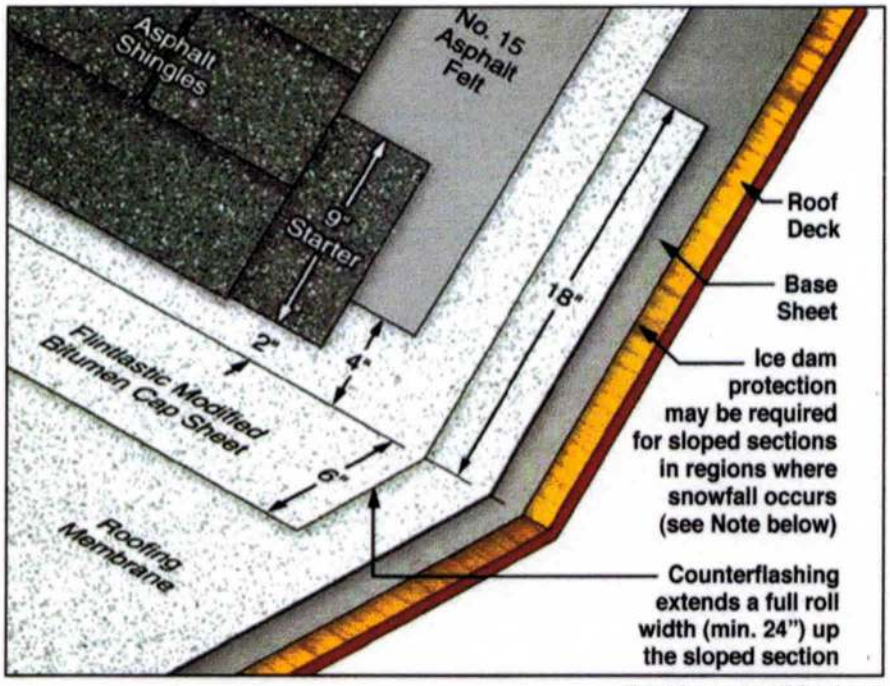

Illustration courtesy of Certainteed

Modified Bitumen membranes are especially not suited for ponding conditions.

Beyond the Scope

There are a variety of devices (outside the scope of a home inspection) that can be employed to confirm or find leaks. Moisture meters work well and are used routinely by many inspectors. Infrared photography, gaining popularity among home inspectors, can detect the signatures of wet insulation. Both devices are only as good as the trained user.

because the sheet metal will expand in temperature swings, tearing or splitting the membrane.

On the contrary, when a flat roof is at the higher elevation and the steep roof comes up to it, there must be a perimeter-edge flashing detail that extends down a minimum of 4" over the adjoining steep roofing, i.e., shingles.

However, in this case, the face of the flashing should not be nailed. The shingles should extend under the face of the flashing and any nails should be covered with the perimeter-edge flashing. As with all perimeter-edge flashing, the face should be anchored down with cleats to resist the wind forces. However, I never see that detail on homes.

Parapet walls

Technically, parapet walls are not part of the roof system; however, they can compromise its waterproofing function. They should be inspected for deteriorating or improperly installed copings (the sheet metal or terra cotta tile on top of the wall). The copings should be secure, overlapped approximately 3" and sealed watertight. Inspect exposed masonry for cracked or open mortar joints, and inspect walls covered in wood, vinyl, stucco or other materials for deterioration or anything that could allow water to penetrate them.

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Evaluate drainage, check for debris

All flat-roof inspections should include an evaluation of the drainage. In most cases, poor roof drainage is due to poor design or roof deflection. The weight of ponding water can cause damage to the structure and the roofing system. Many older commercial roofs are notorious for standing water and some old-timers argue it is a good thing because it keeps the roof cooler during the summer. In truth, the potential harm far outweighs any conceived benefit. What's more, building codes and all manufacturers of roofing require positive drainage. Modified Bitumen membranes are especially not suited for ponding conditions.

As you walk around inspecting the roof, look for signs of "ponding." If it is dry, low areas usually are filled with dirt. The dirt can have a degrading effect on the membrane. You may even find vegetation growing in dirt-filled sunken areas, with its roots growing into laps of the membrane.

Inspect the drains and/or scuppers. Drains should be clean and have a minimum 3" opening with a grate to prevent clogging. Ponding is defined as water that remains on the roof for more than 48 hours after precipitation ends. Poor drainage or severe ponding should always be reported for correction, but incidental water on a flat roof is generally considered acceptable.

Poor drainage can be corrected by adding drains in low spots, pumps or tapered insulation under the membrane. If the roof is totally enclosed by walls, pay careful attention to overflow drains. If the primary drains were to clog, there must be a way for the water to drain off and prevent overloading of the roof structure.

Note excessive debris on the roof. It can impede drainage, clog drains and/or gutters and sharp debris can puncture the roof.

The scuppers (the square or rectangular holes cut through a wall to allow water to run off) receive a lot of water flow and are another potential place to have a leak. They and any associated flashing should be carefully evaluated; even ones made of copper develop pinholes.

Checking seals

Joints between the membrane and flashing or some other waterproof material are sealed with flexible waterproof materials. Sealants also are used to cut off water along the top of base flashing or at the counter-flashing reglet. Acceptable uses of sealant include around skylight caps and plumbing collars, and on coping joints, etc. However, sealants, caulks and/or mastics are not flashing substitutes. Overuse is an indication of poor workmanship. Sealants should be carefully evaluated for drying, cracking and/or deterioration, keeping in mind failure can be difficult to detect.

No Leaks: Then what?

More often than not, an MB roof installation will have a reportable issue. Some are significant; others are debatable, especially if it has withstood the test of time without leaking. It is difficult to know where to draw the line, but hopefully, this article will help. In closing, I suggest always advising clients that flat roofing requires annual inspection and maintenance.

Watch for part two of this article in the March *Reporter*. It will focus on flashings for MB roof installations and some general issues with this type of roof. ■

All photos in this article are by John Cranor.

John Cranor owns Cranor Inspection Services located in Glen Allen, Va. He joined ASHI in 1998 and has served as chairman of the Technical Committee and the Standards Committee. Under his leadership, the Technical Committee took responsibility for developing the high-profile Virtual Home Inspection on the ASHI Web site. As a third-generation roofing contractor, his experience in roofing spans more than 30 years.

Cranor is the past-president of the Central Virgina Chapter of ASHI, and past-president of the Virginia Association of Real Estate Inspectors (VAREI). The Examination Board of Professional Home Inspectors called on his technical expertise in the development of its exam. Visit his Web site at www.house-whisperer.com.

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Part II of II

John Cranor, ASHI Certified Inspector

Although I practically grew up installing and repairing roofs, I have to admit I still find it challenging to accurately determine and report the cause of a leak in a low-slopped roof. In the February *ASHI Reporter*, I focused on Modified Bitumen (MB), which, when installed correctly, is a tough, tear-resistant roofing material for a flat roof.

In discussing what I've learned about inspecting MB membrane roofs, I covered two frequently used types of polymer blends, the components of a residential roof system, and I described some common membrane roof issues such as transition areas, laps, blisters, wrinkles, movement and damage, promising to focus on flashing and several additional issues this month.

Flashing

Most leaks occur at flashing. In my opinion, detailing flashing is more craft than science, requiring careful thought, design and installation. To function as intended, flashing details must be able to move with the stresses, hold up to the forces of nature and remain watertight — a difficult task even under perfect design and conditions.

There is an endless number of flashing situations and/or potential errors that you may come across as an inspector, more than can be covered here. In fact, I have never found a book that fully covers the subject of flashing. This article will attempt to cover only the basics or the more commonly observed issues on residential flat roofs with MB membranes.

In low-sloped roofing, flashing can be metal or membrane. There should be flashing anywhere the field of the roof membrane is interrupted or terminated. Remember, the field membrane should turn up on vertical interruptions such as walls, curbs, etc.; then have a base flashing over it. The base flashing should always be of the same type material as the field membrane.

Metal should not be part of the base flashing. Metal should be used only on flanges of roof penetrations, around the perimeter, water shedding counter flashing or sometimes to protect the roof from mechanical damage and for decorative reasons.

The base flashing should turn up on the vertical interruption a minimum of 8". Eight inches is an industry standard and conforms to most MB membrane manufacturer's specifications. Most manufacturers also have maximum heights for vertical flashing: 24" is common. The base flashing should be lapped a minimum of 3" at roll widths.

Often, you see base flashing installed in long lengths, which eliminates laps, but there is a greater risk of poor adhesion, so watch for that. Both inside and outside corners on walls should have a reinforcing ply of membrane; often, the reinforced plies in corners have unusual shapes, which are sometimes referred to as bow ties and footballs.

The top edge of the base flashing must be sealed water-tight and mechanically fastened, with the fasteners spaced a minimum of 8" apart on flashing up to 12" above roofline and 4" apart on flashing 12" up to 24" above the roofline. The base flashing and fasteners should have a counter flashing or coping that covers the top edge and fasteners. The counter flashing should extend below the fasteners and top edge of the base flashing a minimum of 4" and have a drip lip.

In some situations, the skylight or mechanical equipment itself may be used to mechanically fasten the top edge of the base flashing.

Even though frequently used to repair a roof or to add life to an aging one, roof cement and fabric is not considered an adequate substitute for base or counter flashing.

On homes, the counter flashing is often the siding or the steep roofing on an adjacent sloped roof. Base flashing membrane should never be installed directly over the steep roofing or the siding.

Most siding is water-resistant not waterproof and cannot be integrated into the roof system. Base flashing should never bridge over the corners; it should always be adhered tight to the substrate and cant strip. Bridged-over flashing is prone to damage and considered a defect.

Vertical angles

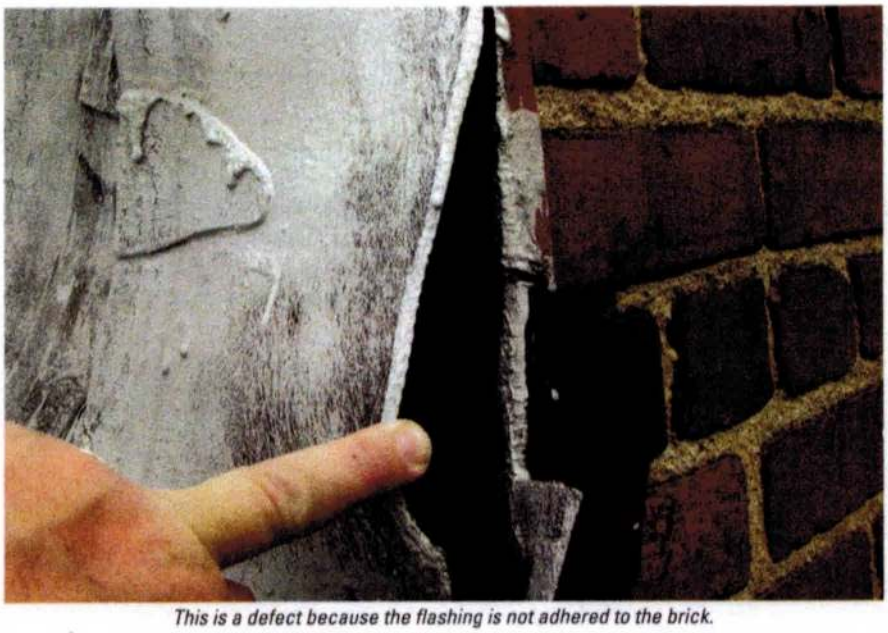
One important specification that often is not followed on an MB roof is that 90-degree vertical angles in the membrane should be avoided. Ninety-degree bends are prone to cracking and leaking. Any vertical angle more than 2" high must have a "cant strip," which is a triangular strip usually made of Perlite, fiberboard or wood. The cant strip allows the base flashing membrane to make a 45-degree instead of a sharp 90-degree turn. The lack of a cant strip or the presence of a 90-degree vertical turn on an MB roof is a reportable defect.

Metal flashings are used around the perimeter as counter flashings, as copings, etc. Perimeter-edge flashing is often referred to as gravel stop. Metal flashings should be a heavy gauge (minimum 16 oz. copper, 24-gauge galvanize or .032 aluminum). The flange on perimeter-edge flashing (gravel stop) must be a minimum of 3.5" wide. The flange on other metal penetrations, such as a plumbing collar, must be a minimum of 4" wide. All metal flashing flanges must be stripped off with membrane, and at minimum the strip should be 8" inches wide.

Failure points

In my experience, one of the most common defects and failure points on an MB roof occurs at the perimeter-edge flashing. Usually, the membrane loses its adhesion to the metal, often ▸▸▸

At only slightly more than 2" high, this base flashing was improperly installed.



This is a defect because the flashing is not adhered to the brick.

The membrane has separated from the perimeter flashing. The flashing was not primed, possibly a contributing factor to the failure.

because the metal-edge flashing was not cleaned and primed with an asphalt primer as required. All metal flashings must be secured (mechanically fastened down), cleaned and asphalt-primed so the membrane flashing will stick to it. When not primed, it holds for a while, but rarely functions long term.

In my experience, the second most common defect on MB roofs, especially on homes, is the failure to strip metal flashings. The perimeter flashing, as well as any flange on installed metal flashing, should be sandwiched between the roof field membrane and a top cap sheet or a strip of membrane (often referred to as being stripped off by roofers). Commonly, the field membrane is improperly sealed over the perimeter-edge flashing, as well as other flanges on installed metal flashings. Sometimes, if the flashing was primed, this works and sometimes not, but technically it's incorrect if not sandwiched and stripped off.

> "Always carefully check the seal at the perimeter flashing. Be careful with how much you pull up on the membrane because if it's not primed, it will easily separate from the flashing."

Always carefully check the seal at the perimeter flashing. Be careful with how much you pull up on the membrane because if it's not primed, it will separate easily from the flashing. You should be able to visually determine whether or not it's sealed. Although difficult to determine, it is important to know that the perimeter flashing must be adequately secured to resist wind forces.

From my experience, these are the basic or the more frequently observed flashing issues you'll encounter when inspecting residential flat roofs with MB membranes.

More issues

Last month, I listed laps, blisters, wrinkles, movement and damage as membrane defects to watch for when inspecting an MB roof. In addition to problems with the membrane, I've found the following to be frequently encountered issues with a residential-membrane roof:

Mechanical equipment should never sit directly on the roof membrane. The vibration of the heavy equipment slowly cuts into the membrane, leading to a leak. Although the equipment often is

found sitting on two 4"x4"s or similar material, it should sit on a flashed curb or on a steel frame with angle iron legs penetrating the roof.

Guard railing is common on homes where the flat roof also is used as a sun deck.

Leaks often occur around the guardrail posts. Rarely are posts properly flashed, and the stress applied to the railing makes the post connections prone to leaking. Sometimes the post are split, damaged and not painted, all compromising the waterproof joint. The membrane used around the base of the post often makes that prohibited 90-degree turn on MB roofing.

Recently, I inspected a newly installed MB roof that had 4"x 4" guardrail posts. There were leaks from eight of the 10 posts. Railing posts or vertical supports should be set in a metal-sleeve flashing detail with the flange stripped off. Always closely inspect guardrail posts and the ceiling below them.

Pitch pans (or pitch pockets) are metal fabricated flashing components that are used around irregularly shaped roof penetrations such as angle iron or sometimes around guard railing posts. Historically, pitch pans were filled with hot pitch or hot asphalt, creating a watertight seal. More common today, the pans are filled with pitch pan fillers (a cold formula designed for that use) or with roof cement. Carefully inspect pitch pans for cracking, separation, voids, etc. They should be sealed and should not hold water.

Penetrations such as plumbing or mechanical system vents should be at least 18" from walls, curbs, edges or other penetrations so that there is enough space for proper flashing.

Doors often open out to a flat roof on a home. The door threshold transition is an area prone to leaking. Usually, the door threshold is not wrapped as well as it could be. Often, the roofing membrane is just trimmed off around the threshold and caulked, and the caulking is not watertight. Always closely inspect doorways, as well as the ceilings below.

A General Guide

This two-part article is intended as a general guide for home inspectors. Please note: Specifications and details vary from manufacturer to manufacturer and for commercial use.

Although it is not an exhaustive reference, hopefully it will help home inspectors meet the challenge of inspecting low-slope and flat roofs, specifically those with a Modified Bitumen membrane. ■

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