INSPECTION, MAINTENANCE AND REPAIR OF BALLASTED EPDM ROOF SYSTEMS

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A ballasted EPDM single-ply roof system is extremely difficult to inspect and repair. The minimum ten pounds per square foot of ballast, plus airborne dust, debris, and residue from the ballast, create an obscuring layer over most of the roof surface. When a leak occurs in a loose laid, ballasted EPDM roof system extensive and costly damage to both the building interior and structure can result before the source of the leak is recognized and repaired. The non-adhered layers of membrane, insulation and vapor retarder (if any) that constitute a ballasted EPDM single-ply roof system, offer multiple channels for water to travel laterally before entering the building. Unless the roof membrane has factory defects or was damaged during installation, the most likely cause of any roof leaks will be abuse, design deficiencies, improperly installed flashing, deteriorated flashing or membrane seam failure.

This paper will focus on the following procedures for eliminating or dramatically reducing the cost of damage incurred due to leaks in a loose laid, ballasted EPDM roof system:

1) How to recognize and repair improperly installed or deteriorated flashings before they become the source of a leak.

2) Innovative techniques to simplify locating the source of a roof leak before extensive damage is incurred.

The aforementioned procedures are the results of studies and field tests conducted on over forty ballasted EPDM roof systems ranging in age from one to ten years. These studies have been ongoing since the date of installation for most of these roof systems.

Although this paper will focus on EPDM, it should be noted that other loose laid, ballasted single-ply membranes may share many similar characteristics and problems.

KEYWORDS

Bridging, leak, leak source, recover.

INTRODUCTION

Every roof, regardless of type, should be inspected at least once a year, and semiannually if possible. Annual roof inspections are a valuable tool for obtaining, and in some instances extending, the anticipated service life of a roof system. If done properly, a roof inspection can expose a variety of potential roof defects before they manifest themselves as destructive roof leaks. Most defects can be readily repaired at minimal expense with no damage to the roof system or building interior.

Unlike smooth surfaced roofs and even gravel surfaced built-up roofs, ballasted single-ply roof systems sometimes appear to be almost impossible to inspect. Ten pounds per square foot of river-washed stone ballast and the accompanying dirt and debris obscure the entire roof surface. Fortunately, what you can't see on a ballasted EPDM roof system is normally not a problem. This is because the entire system is loose laid and the stresses on the membrane sheet and field seams, admittedly the weak link of EPDM, is minimal. Our subjective observations indicate that, by far, most leaks in ballasted EPDM roof systems occur at the roof perimeter or at penetrations through the roof system.

Before initiating a visual roof inspection, a history of roof leaks, if any, should be obtained. The building owner, maintenance foreman or primary roofing contractor are excellent sources of information. If the roof has a history of leaks associated with failed seams or membrane defects, an extensive inspection will have to be performed. This inspection should include test cuts for membrane property and seam strength analysis, wet insulation, deteriorated deck, etc. The results of the inspection could indicate isolated seam or membrane defects or they could indicate complete roof failure. Because leaks due to seam or membrane failure are relatively infrequent in a ballasted EPDM roof system, this paper will focus on the more positive aspects of an annual roof inspection.

If the roof system does not have a history of leaks or if the roof leaks that have occurred are readily explainable, a roof inspection can be conducted quickly and effectively. Concentrating on the two major areas of concern: the perimeter of the roof system and any penetration through the roof membrane, a systematic roof inspection can uncover a variety of minor defects that can be simply repaired before becoming major problems.

INSPECTION AND MAINTENANCE

Perimeter Conditions

Metal edge flashing and fascia: Inspect all metal edge flashing and fascia for proper securement to the building perimeter. Inspect EPDM attachment to metal edges for conformity to the membrane manufacturer's recommended details. Where field seams occur at the edge of the roof, inspect for membrane separation or excessive bridging at angle changes of metal edge details.

Wall or parapet: Inspect field seams for separation or excessive bridging at horizontal to vertical angle changes. Inspect securement of all termination bar, reglet, cap flashing, etc. to the building surface. Inspect all sealants for shrinkage and watertight integrity. On masonry walls, verify that any weep

holes are not covered by the EPDM flashing material.

Tie-in to adjacent roof system: Inspect the juncture between the two roof systems for fishmouths, deteriorated materials and poor adhesion between tie-in materials. Inspect the adjacent roof for any defects or deterioration that could create leaks that would cause water to migrate under the ballasted EPDM roof system. Conduct the inspection for an approximate ten foot width along the tie-in.

Roof Penetrations

General: Examine the integrity of all penetrating elements for breaks, open joints, corrosion and other deficiencies.

Round penetrations: Inspect all round ducts, pipes and sleeves for proper, watertight flashing details. Inspect for proper installation of prefabricated flashing sleeves including clamping ring and associated sealants. Inspect material overlap on all field fabricated flashing details for bridging or loss of interface adhesion. Inspect all sealants for shrinkage and watertight integrity.

Square penetrations: Inspect all square ducts, curbs and pads for loose or bridged corners, proper adhesion of flashing material to the substrate, proper securement of all termination details and watertight condition of all required sealants.

Pourable sealer (pitch) pockets: Inspect pourable sealer pockets for proper attachment to the roofing substrate. Inspect for loose membrane to flashing material adhesion (fishmouths), and bridging or air bubbles at the corners. Pourable sealer material must be properly cured and solidly adhered to the penetrating object and sides of the pourable sealer pocket, and must be crowned to shed water away from the penetrating object.

Roof drains: Inspect roof drains for installation of water sealant between the membrane sheet and drain body. Inspect around the drain for lack of membrane to membrane adhesion and assure that the roof drain is not plugged with gravel, dirt or other debris. Check for a tight clamping ring at the drain body.

Surface Conditions

Stone, gravel or paver ballast: Assure that the ballast is intact, continuous and evenly distributed. If wind scouring has occurred, ballast should be redistributed as necessary to cover the membrane and prevent uneven loading. If wind scouring is a reoccurring problem or if the ballast is displaying excessive fragmentation, consult the membrane manufacturer for an evaluation and recommendation on how they would like the problem corrected.

Walkway and equipment pads: Assure that all walkway and equipment pads are intact and functioning as intended. Replace any deteriorated pads with units identical in type, width, length and height. Note if any traffic patterns are developing across the roof surface not protected by walkway and/or equipment pads. This is caused by workmen maintaining mechanical equipment, washing windows, etc. If such traffic patterns are noticed, consult the roofing membrane manufacturer to determine how to best protect the roof membrane.

Upon completion of the roof inspection, all defects should be noted in a report to the building owner with recommendations for repairs.

Annual or biannual roof inspections are a very effective tool to help assure a watertight condition within a building, and avoid serious problems to both the roof system and building interior associated with roof leaks.

FINDING A ROOF LEAK

It is important to verify that the leak is indeed coming from the roof and not from another source. Inevitably, any moisture that enters a building from overhead is immediately considered a roof leak by the building owner. In reality, many "roof leaks" turn out to be something entirely different; condensation from piping, poorly insulated roof decks, uninsulated equipment or leaks in overhead sprinkler and drain lines, failed window seals, etc. Uncovering a moisture source not associated with the integrity of the roof membrane or flashings can save an owner valuable time and money as well as improve the credibility of the contractor, manufacturer or consultant involved.

Once it is established that the source of the moisture is coming from a leak in the roof, an extensive analysis of the existing roof system is the next required step. To simplify locating the source of a leak on any ballasted roof system, several questions must be answered.

■ Does the roof deck slope to drain or eave?

If the roof deck has built-in slope to drain or eave, the leak source will inevitably occur on the up-slope side of the leak. If the roof deck is dead level the leak source could be in any direction from the leak. This will require a more widespread search to find the leak. Visually inspect the underside of the roof deck and framing for built-in slope to drain. Building drawings may contain this information, however building drawings are not always available, and even if they are, they should be verified. Time should also be taken to assure that the roof leak has not affected the integrity of the roof deck.

■ Is there a vapor retarder?

If there is no vapor retarder, any moisture within the roof system should not travel far before it finds its way into the building interior. Thus, the search for the leak source can be conducted relatively close to the leak itself. If there is a vapor retarder or another water barrier with continuity (such as a monolithic deck or older recovered roof), the moisture within the roof system has the capability of traveling a fair distance before finding egress to the building interior. This will greatly expand the field of search necessary to find the leak source.

■ What type of insulation?

A variety of different insulations can be used under a ballasted roof system. Knowing the type and moisture absorption rate of the insulation (eg. fiberboard absorbs moisture readily, extruded polystyrene does not) can be valuable information when trying to find the source of a leak. It is also valuable when attempting to analyze the extent of damage caused to the existing roof system because of the leak. Depending on the extent of the leak, insulations that absorb moisture readily may have to be replaced before they cause further damage to the roof system or structural deck. This is due to their tendency to retain moisture over long periods of time. Insulations that absorb and retain moisture are

more conducive to the use of nondestructive test methods for locating the extent of moisture migration within the roof system. Aside from the disadvantages, this factor can prove extremely useful in determining the leak source.

■ What are the roof membrane qualities?

After determining the general location of the leak source, knowing the membrane manufacturer's recommended flashing details, seam layout and membrane thickness could become important factors in finding the exact location of the leak source. If the membrane manufacturer's recommended flashing details were not followed, whether initially or as additional penetrations were installed, the leak source will most likely occur at these locations. If the flashing details are intact, the next logical leak source will be a failed field seam. Knowing the location of all field seams will simplify locating the problem area. The thinner the membrane material the greater the chance of a puncture in the membrane being the leak source.

■ Is there a warranty on the roof system?

If the roof system is still within the membrane manufacturer's warranty period, certain guidelines must be followed. Although most guidelines are similar, they do differ slightly from one manufacturer to another. Always refer to the applicable membrane manufacturer's specific warranty guidelines. This will assure that the building owner gets any due compensation from the membrane manufacturer, and that the owner does not inadvertently void their warranty.

■ Was the ballasted roof system installed over an existing roof system (recover)?

If there is a recover situation, it is important to know the construction of the original roof system. In the event of a roof leak the original roof system will act similar to a roof deck with a vapor retarder. If the original roof system is sloped, the leak source will be found up-slope allowing the moisture to travel an excessive distance before entering the building.

Armed with the aforementioned knowledge, most of the roof leaks on a ballasted EPDM roof system can be located with relative ease. Referencing from column lines, windows, airhandling units, vent stacks, drain locations, etc., transfer the location of the leak from within the building to the roof surface. Once on the roof, the closest penetrations, flashings or perimeter details are the prime suspects for the source of the roof leak. By inspecting details in the area of the leak, concentrating in the direction dictated by the design of the existing system (such as up-slope on a sloped roof system, circular on a dead level roof system), the source of the roof leak will be uncovered 9 out of 10 times. If the source of the roof leak is one of the 10% that occur in the field seam or in the membrane sheet, a more intensive search has to be conducted.

If the roof deck slopes or if the ballasted system was installed over an existing system with tapered insulation, the field of search is 180 degrees or less off the leak. If the substrate is dead level then the field of search is 360 degrees off the leak. Rather than randomly moving thousands of pounds of stone ballast in a haphazard attempt to locate the source, a more rational approach is preferable. This can usually be accomplished by using a nuclear moisture gage to narrow the scope of the search. In order to take a reading with the nuclear gage, approximately a two square foot area of ballast has to be cleared.

Obtain a reference base reading in an area where there is no moisture present in the roof system before initiating the search. If necessary, this can be confirmed with a test cut. For the purpose of this paper, the reference base reading will be considered a zero reading. All readings relatively higher than the base reading probably indicate the presence of moisture and will be termed a positive reading. On a ballasted EPDM roof system that has a sloped substrate, either sloped deck or existing roof with tapered insulation, the leak will normally occur near the bottom of a teardrop shaped pattern of moisture migration. The leak source will occur near the top of the teardrop pattern.

Figure 1 shows a typical pattern for a roof leak on a sloped substrate. The initial nuclear gage reading should be taken directly over the location where moisture is entering the building. The first set of readings should be taken on a line perpendicular to the slope of the roof in alternate directions from the initial reading. These readings should be taken approximately five feet apart until a zero reading occurs. The second set of readings should be taken on a line parallel to the slope of the roof, opposite every positive first set reading. These readings should also be taken at five foot intervals until a zero reading occurs. A line can now be drawn between the zero and positive readings, establishing the perimeter boundary of the roof moisture. Once the extent of the moisture migration is established, clear an approximately 100 square foot area at the apex of the affected roof area. Spread the ballast evenly around the cleared area so as not to overload the roof structure. Once cleared, inspect all exposed seams for deterioration or failure. If the seams are still intact, inspect the field sheet for cuts, deterioration, etc. If residual dirt on the membrane makes the visual inspection difficult, scrubbing the membrane with a wet rag or mop may be necessary. Mark the leak source on a building drawing for future reference.

On a ballasted EPDM roof system that has a dead level substrate, the leak will usually occur near the perimeter of a circular pattern of moisture migration. The source of the leak will be the center of the circle.

Figure 2 shows a typical pattern for a roof leak on a dead level substrate. As with the sloped substrate, the initial nuclear gage reading should be taken directly over the location where moisture is entering the building. The first set of readings should be taken in four directions off of the initial reading, radiating on lines 90 degrees from each other, and continuing at approximately five foot intervals until a zero reading occurs. Scribe a line between the zero and positive readings until a rough circle is formed. Clear a 100 square foot area in the center of the circle. Spread the ballast evenly around the cleared area so as not to overload the roof structure. Once cleared, inspect all exposed seams for deterioration or failure. If all seams are intact inspect the field sheet for cuts, deterioration, etc. If residual dirt on the membrane makes the visual inspection difficult, scrubbing the membrane with a wet rag or mop may be necessary. Mark the leak source on a building drawing for future reference.

This paper acknowledges that there are exceptions to every rule. However, adhering to these relatively simple procedures, most leaks occurring in a ballasted EPDM roof system

can be readily located and repaired before serious damage to the roof system or building interior has occurred. We also recognize that there are other nondestructive test methods available. Our expertise is limited to nuclear gage and infrared thermography. Of the two, the nuclear gage is by far the most practical for this situation.

CONCLUSIONS

Ballasted EPDM roof systems are commonly used for new construction and reroofing projects. In this paper we have attempted to allay some of the concerns surrounding the inspection, maintenance and repair of a ballasted EPDM single-ply roof system.

SUMMARY

Inspection and Maintenance

■ Unless the roof system has a history of leaks traceable to failed seams or membrane defects, focus the major thrust of the roof inspection on all areas not covered by ballast, such as perimeter details and penetrations.

■ Systematically inspect the perimeter of the roof including drip edges, walls, parapets, etc., for watertight integrity.

■ Once the perimeter is secure, inspect all penetrations through the roof membrane for conformance to specifications and watertight integrity.

■ Assure all ballast, regardless of type, is intact, continuous and evenly distributed.

■ Assure that all walkway and equipment pads are intact and functioning as intended. Add new pads where traffic patterns indicate a necessity.

■ Note all defects on a building drawing or sketch and specify repairs to be initiated as soon as weather permits. The maintenance repair specification should not void any written or implied roof warranties.

Locating A Leak

■ Check to see if the moisture is originating from a source other than a roof leak.

■ Look for the obvious. Deteriorated flashings, metal edging, pourable sealer pockets, etc.

■ Utilize a nuclear gage to systematically inspect the roof system for wet insulation and subsequently the source of the leak.

REFERENCE

NRCA/SPRI Inspection and Emergency Repair Manual for Existing Single-Ply Roofing Systems, 1990.

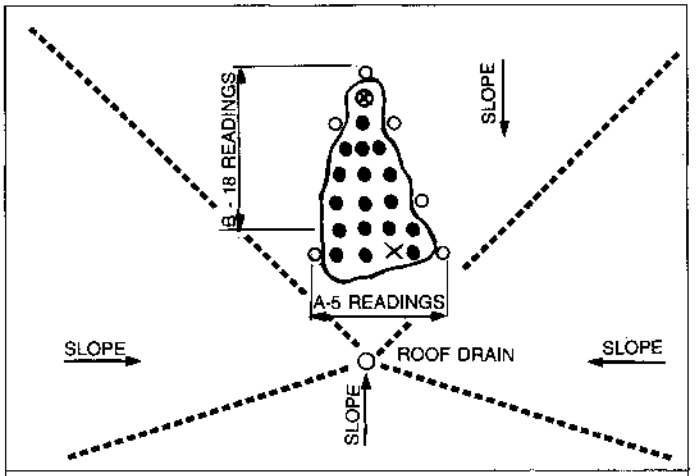
GLOSSARY OF TERMS

Leak—Location where moisture from a leak source enters a building or structure.

Leak Source—Imperfection in the roofing system that allows penetration of moisture. Depending on the building and roof construction, the leak source may occur at a substantial distance from the leak.

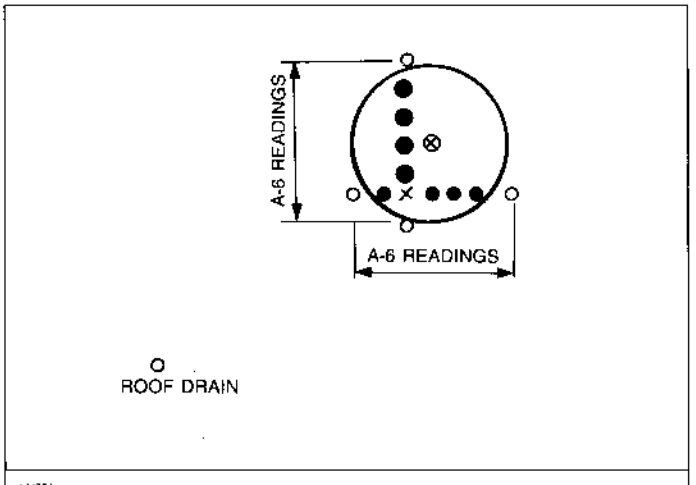
Recover—The installation of a new roof membrane (and insulation if required) over an existing roof system with no or minimal removal of the old roof.

Bridging—A loss of adhesion between the membrane sheet or flashing material and substrate created at a change in direction of the material. When bridging occurs at a field seam, a half cylindrical or half conical opening may occur between the sheets at the corner of the change in direction.



KEY:
- ● Positive nuclear gage readings.
- O Zero nuclear gage readings.
- ⊗ Source of leak.
- X Leak/initial nuclear gage reading.
- A 1st set of nuclear gage readings taken perpendicular to the roof slope at 5'0" intervals apart.
- B 2nd set of nuclear gage readings taken parallel to the roof slope, in line with the positive 1st set of nuclear gage readings, at 5'0" intervals apart.
- Irregular shape is the outline of the extent of the roof leak as defined by the positive and zero nuclear gage readings.

Figure 1 Sloped substrate.



KEY:
- ● Positive nuclear gage readings.
- O Zero nuclear gage readings.
- ⊗ Source of leak.
- X Leak/initial nuclear gage reading.
- A 1st set of nuclear gage readings taken in four directions, 90° from each other, and at 5'0" intervals apart.
- B 2nd set of nuclear gage readings taken parallel to the roof slope, in line with the positive 1st set of nuclear gage readings, at 5'0" intervals apart.
- O Large circle is the outline of the extent of the roof leak as defined by the positive and zero nuclear gage readings.

Figure 2 Dead level substrate.