PMR Systems:

THE FORGOTTEN SOLUTION

By Mike Watts, CSI, CDT

Photo 1: Twenty-plus-year-old vapor retarder examined during reroofing showing soft asphalt.

Sometimes the most logical solution is overlooked. Architects and consultants often choose what they think is the right membrane for the project rather than choosing the right roofing "system." There are basically two ways to design a low-sloped roofing membrane system: the membrane can be exposed or it can be protected. This article will examine the history and evolution of the Protected Membrane Roof, and hopefully raise some questions as to why the PMR system isn't considered more often when selecting roofing systems on new or retrofit projects.

Before roofs were insulated, the membrane was placed directly on the roof deck. The membrane was tempered from the extreme temperature cycles because of heat loss through the deck in winter. It was also cooled somewhat in the summer months because the under side of the deck would usually be much cooler than the top of the membrane. Because of rising costs of fuel, large buildings with flat roofs needed to be insulated. The only insulation materials available were products like cork and wood fiber, and these materials were adversely affected by moisture. The membrane had to be moved from the deck to the top of the insulation. This seemingly simple move greatly affected the performance of the roof membrane. It was now exposed to all of the temperature changes from winter to summer. Because of moisture vapor infiltrating from below, vapor "barriers" were installed over the decks, and other "solutions" such as coated base sheets and roof vents were used. Today, there are many insulations to choose from as well as membranes made from asphalt, rubber, plastic, and a combination of some or all of these materials. In most roofing systems used today, the membrane is placed over the insulation.

Many articles are published each year about membranes, insulation, fasteners, wind, fire, etc; however, very few are written on the protected membrane roof system. This concept of roofing was developed by The Dow Chemical Company in the 1950s, patented and first brought to the market in the late 1960s as the IRMA (Insulated Roof Membrane Assembly). The original IRMA system was comprised of three plies of organic felt mopped to the deck or substrate, followed by a glaze coat and then a flood coat of steep asphalt. Once cooled, the Styrofoam Roofmate® (extruded polystyrene) could be embedded in the flood coat of asphalt. A minimum of 10 pounds per square foot of #5 crushed stone was then applied over the Styrofoam®. The theory was sound. Protect the membrane from ultraviolet rays, thermal shock, and foot traffic, and the membrane would age more slowly, resulting in a longer life.

During the early years of the IRMA system, only asphalt, coal tar pitch, and rubberized asphalt membranes were used. These systems experienced excellent track records when com-

pared to exposed membrane systems of that era. The insulation protected the membrane from physical abuse while keeping it at a much lower temperature. The extruded polystyrene was the only insulation that could be installed over the membrane and be exposed to the elements while maintaining the original physical properties such as R-value, compressive strength, and resistance to moisture. These insulation properties were critical to the performance of the IRMA system.

As the popularity of the system increased and more of the roofs were installed, it became apparent that this roofing system had many benefits over conventional roofing systems. The IRMA system eliminated blistering by keeping the membrane cool, thus there could be no vaporization of moisture trapped between the plies of felt. Damage due to physical abuse was almost impossible. Maintenance cost was greatly reduced, and the system did not need a "vapor barrier" because the roof membrane served a dual role because of its location. Moisture vapor could not be trapped in the system. Liquid moisture was prevented from entering from the top, and vapor was not a concern from the bottom of the membrane.

This explains why the system was embraced by many manufacturing facilities worldwide. The IRMA system offered solutions to problems many owners had dealt with for years. Controlling the dew point was very critical in high humidity and high temperature manufacturing environments. The protected membrane approach solved this problem. Examining any old asphalt vapor retarder during the reroofing process could prove the theory behind the PMR system was sound. In most cases, where conventional roofing systems had failed, the vapor retarder acted as the membrane and the insulation was usually saturated with moisture. Even though the vapor retarder could have been twenty or more years old, the asphalt was usually soft and pliable because it had been protected (*Photo 1*).

Felts and asphalt have been used for years as below-grade waterproofing membranes, yet they do not blister or degrade like exposed asphalt membranes. They are protected from the harsh elements by the backfill. It has been this author's experience that moisture alone will not degrade asphalt. Sunlight (UV) and moisture must combine for degradation to occur.

Some problems did develop with the early generation systems when the extruded insulation was not adequately embedded in the flood coat of asphalt. This usually occurred when the temperature of the asphalt was either too hot or too cool and the adhesion of the foam was compromised. Combine this with

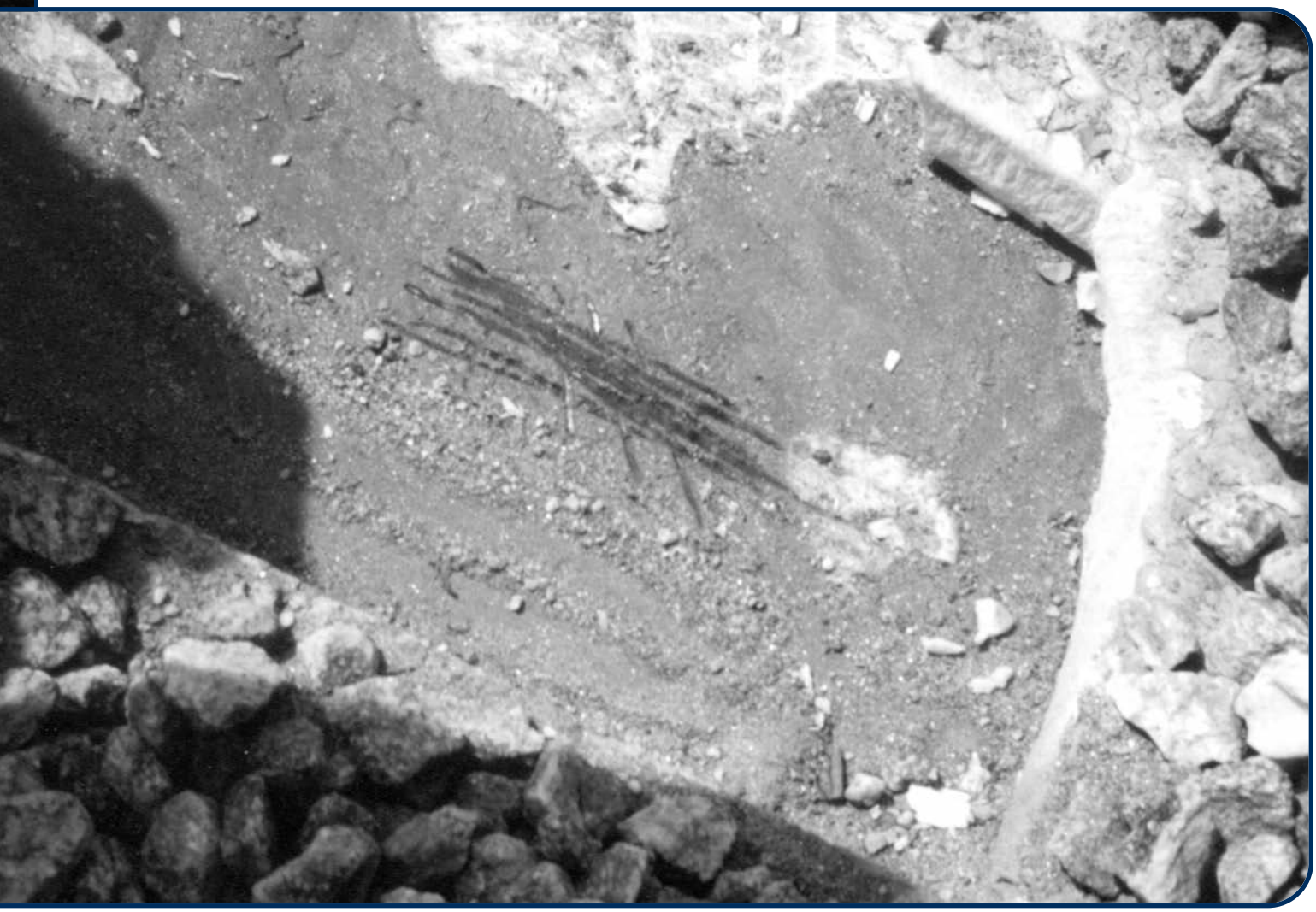

Photo 2: Twenty-plus-year-old PMR system demonstrating soft membrane.

Photo 3: New installation of unadhered foam PMR system with fabric and ballast.

ponded water or light ballast, and the insulation could become buoyant and separation from the membrane could occur. If the extruded foam separated from the asphalt flood coat, it was easily repaired, and no major damage would occur. If the separation happened to be between the flood coat of asphalt and the top layer of felt, rotting of the organic felts could occur if the floating board was not discovered in a timely manner. This sometimes required more extensive repairs. In the first generation IRMA, the installation of the foam was critical to the long-term performance of the system, especially in very low-slope or dead-level applications.

When fiberglass felts became the standard in built-up membranes, this became less of a problem because exposure of the top ply would not cause deterioration of the membrane. There were some bad installations due to workmanship and inappropriate applications that led to major problems and some failures, but all-in-all, the IRMA system preformed very well throughout the warranty period of ten years. There are many first-generation IRMA roofs still performing well after 20 to 25 years of service (*Photo 2*).

With the growing popularity of single-ply membranes, an alternate method of securing the foam had to be developed. This was accomplished by installing a geotextile fabric over the foam that would "tie" the system together and keep any individual pieces of foam from floating in the case of ponding water or light ballast. The fabric also reduced the possibility of small particles of stone from getting to the membrane. This simple change greatly improved the performance of the protected membrane system and enabled the foam to be reused if membrane replacement became necessary. This system could also be incorporated in vertical expansion where the foam would be moved to a higher roof as the building expanded, sometimes years later. Because the foam was loose, there was no stress on the membrane, and the foam continued to perform the role of insulator and protector. This became the next generation of PMR, or protected membrane roofs, known as the "unadhered system" (*Photo 3*).

When the patent expired in the mid '80s, Dow stopped offering a system warranty and relied on the membrane manufacturers to warrant the roof. Manufacturers wanted to install systems with materials they either manufactured or private labeled, so conventional roofs using exposed single-ply membranes began to gain market share. This ultimately influenced the growth of PMR applications over the next decade as the single-ply sheets were perceived as ideal for many roofing problems. These systems could be ballasted, mechanically fastened, or adhered. With time, these applications had their share of problems, and other solutions like modified bitumen and thermoplastic sheets

increased in popularity. During this time, specifiers and owners who had success with PMR systems continued installing them on their projects.

Today, PMR systems are offered by several membrane manufacturers and single-source warranties are available. PMR systems can be used with stone ballast, paver ballast, earth overlay, and extruded polystyrene laminated with latex modified concrete. This Light - guard® system can be installed with single source warranties of up to 20 years in duration and with up to 110 MPH wind velocity coverage. With this system, the specifier can select the membrane of his or her choice.

Installing the membrane on the deck is an accepted approach in plaza waterproofing. Rubberized asphalt membranes have been used successfully in this application for over 25 years with excellent results. One manufacturer offers a Garden Roof® system that was developed in Germany. More and more designers are looking for sustainable roofs and ways to utilize roofs as usable space and not just a necessary evil.

PMR systems are again growing in popularity, and architects, consultants, owners, and contractors should give these systems consideration on their projects. A roofing system that can extend the life of the membrane and reduce maintenance costs should not be overlooked. The PMR system may not be suitable for every project, but where long-term performance is a prerequisite for owner-occupied buildings, the system should be considered. One thing is for sure: membranes last longer when they are protected. ■

About the Author

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