

PMR SYSTEMS

*A Problem Solver You
May Be Overlooking*

Figure II—Royal Center Project.

If you are a consultant or roof system designer, are you playing the game with a full deck of cards? Do you truly consider all your options when designing your projects? Some designers pick their market segments carefully and build their reputations on not only that segment of the market but also a very limited systems repertoire. This article is not for those narrow scope firms—it is for those of you who design considering all available options. One of the options that you may be overlooking is PMR systems. And the inclusion of this option can make you a true hero.

Are PMRs new? Hardly. PMR is an internationally known acronym for Protected Membrane Roofing systems. You may also know them as IRMA systems (Insulated Roof Membrane Assembly) or as the Upside Down Roof. PMR systems are a rearrangement of common roofing materials in a configuration where the primary roof insulation is installed above the roof membrane rather than in its customary location, beneath the roof membrane. The insulation



Figure I—Typical PMR system being installed.

is typically loose applied and covered by a filter fabric followed by stone ballast (See Figure I). Other configurations include concrete-surfaced interlocking insulation boards, ballast pavers, and even a poured concrete top surface. These are all variations of the same theme—the insulation is installed above the membrane, protecting it from sunlight exposure, temperature extremes, and mechanical damage.

ROYAL CENTER II PROJECT



Figure III—Work on Royal Center II.

PMR systems have been sold since the late 1960s, but they are more popular in some areas than in others. A significant portion of the roofs in Canada are PMR systems because of the extreme temperature conditions. The same is true of Alaska. In the lower 48, New York and Washington, DC have been stronger areas for PMR systems, presumably because of a larger percentage of concrete decks in those areas. PMRs have also found a home in certain niche industries such as the paper mills, where high interior relative humidities favor PMR systems.

There have been some problems associated with PMR systems, especially in the earlier years. The first installations were prior to the current emphasis on energy conservation and utilized 1- or 1.5-inch thick insulation. With this thin insulation, the ballast was sufficient to overcome buoyancy. The insulation was adhered to the roof membrane with hot asphalt. As roof insulation thicknesses became greater, the ballast was insufficient to overcome buoyancy, and individual boards floated up and did not return to their original position, creating "floaters." There were also problems associated with fine stone getting between the insulation boards. With thermal cycling and a high coefficient of expansion and contraction of the insulation, board joints

would widen and the insulation would be displaced toward the roof perimeter. Because of these problems, PMRs are now installed with unadhered foam and with a geo-textile filtration fabric under stone ballast.

According to industry sources, PMR systems are in a slight growth mode in recent years, or at least holding their own. In spite of their apparent advantages, there are several reasons why these systems have not gained more popularity in the lower 48. First of all, they can be more expensive, depending on the application. Although rarely the least expensive approach, they are competitive when compared to systems incorporating a separate vapor retarder when compared to other quality systems on concrete decks. Also hindering widespread acceptance of this approach is that PMR systems utilize only one type of insulation—extruded polystyrene foam—because of water and freeze thaw requirements in PMRs. Extruded polystyrene foam is not manufactured by any of the full-system commercial roofing manufacturers.

Does that mean that the PMR system is a proprietary system because it utilizes only one type of insulation? No, because extruded polystyrene roof insulation suitable for this use is man-

ROYAL CENTER III PROJECT

Figure IV—BUR membrane on concrete deck.



ufactured by three or four U.S. manufacturers and the membrane systems available for this application are almost limitless.

Although PMR systems are not the most common form of flat roof construction, this basic construction approach is the standard design for a close cousin—the insulated plaza or terrace. In this application, it is common to waterproof the structural slab and install extruded polystyrene foam insulation with or without a drainage layer. Then a top surfacing consisting of pedestals and pavers, a monolithic wear slab, or a greenscape area is applied. These plazas or terraces are virtually the same thing as a PMR roof but with a higher compressive strength insulation and a more expensive top surface.

WHAT ARE THE IDEAL APPLICATIONS FOR PMR SYSTEMS?

First of all, recognize that they do not fit everywhere. There are limiting characteristics. PMR systems utilize loose-applied insulation, held in place by ballast. Although the roof membrane can be well attached to the structure, the wind resistance of the system is often limited by the wind stability of the surfacing ballast. As with any ballasted assembly, structural load-bearing capacity can be a limitation precluding a PMR system. However, light-weight cementitious surfaces laminated to the insulation may erase this limitation. Lastly, PMR systems can be more costly than conventional alternatives. The insulation itself is more



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ROYAL CENTER III PROJECT



Above: Figure V—Termination of PMR system on Royal Center III.

Right: Figure VI—Trades working on Royal Center III.



expensive per R value than the more widely-used polyisocyanurate insulation used in competitive conventional systems. If the deck type is such that a separate membrane underlayment board is required (such as a steel deck), the PMR system becomes non-competitive.

However, whenever roofing over a poured monolithic concrete slab, PMR systems should be considered. Concrete decks make excellent roof system substructures, but they do have disadvantages that can be eliminated with a PMR system. Monolithic poured structural decks are largely water impervious. When membranes leak over such a deck with a conventional system, large areas of roofing can become saturated before the leakage is detected. With the right type of membrane fully adhered to the deck in a PMR system, water cannot readily move laterally. This makes leak location easier and reduces damage to the roof system. Also, over these types of decks, PMR systems are most competitive with conventional systems.

Another situation which calls for consideration of PMR systems is when interior humidities are such that a vapor retarder should be considered. Vapor retarders are not included in roof systems unless needed because they create their own problems. To be effective, they need to be completely sealed at all junctures and not penetrated by multiple fasteners and other openings. The vapor retarder becomes a secondary membrane which will trap water, sometimes allowing large areas of roofing to become saturated from a minor defect while leakage goes undetected in the building. In a properly-designed PMR system, the membrane functions as both the roof membrane and the vapor retarder, eliminating the dual membrane moisture entrapment phenomena.

The two situations just mentioned are automatic consideration for PMR designs. These systems can also be used to solve a variety of problems. High traffic roof areas that don't justify a full-blown plaza approach are easily accommodated with a PMR system approach. Sometimes a specific appearance from adjacent

buildings becomes an important design consideration. PMR systems can be installed with a variety of top coverings and can be decorative. PMR systems should also be considered for extreme weather locations—either hot or cold locations. For example, Hal Aamot of the CRREL (Cold Regions Roofing Engineering Laboratory), reported considerably lower maintenance costs for PMR BUR systems in Alaska when compared to conventional construction.

CASE STUDIES

1. ROYAL CENTER II AND III, ALPHARETTA, GA

These two buildings were part of a high-end office complex in North Atlanta. Both Royal Center II and III were five stories tall with a large penthouse and equipment screen wall on the roof. The buildings were approximately 500 ft. long and 90 ft. deep. Both buildings were steel frame with precast cladding. The floor systems were poured structural concrete. However, the roof deck on Royal Center II was a steel deck (see *top figure, page 9*).

Royal Center II was the first to be constructed. The roof system on this building consisted of (from the steel deck up) gypsum board, 2-in. isoboard, 3/4-in. perlite, and a two-ply SBS modified system. Naturally, there was a push to get the roof on the building to allow completion of the interior. The penthouse and screen wall area included an EIFS wall finish and considerable mechanical work (see *Figure III*). It was a continuous struggle to keep adequate roof system protection in place. At the end of the construction period, there was plenty of finger pointing, but eventually the general contractor and a couple of subs paid for substantial roof system repairs.



Figure VII—Picture of Connector Roof on Sloppy Floyd Building.

On Royal Center III, the decision was made to change the roof deck to poured structural concrete. This opened the door to solving the worker abuse problem with a PMR system. Both ends of the building were completed with a PMR system consisting of a 4-ply glass felt BUR mopped solidly to the primed concrete deck (see Figure IV), 3 in. of loose-applied extruded polystyrene insulation, a filter fabric, and stone ballast.

The center section was left temporarily incomplete to allow trades to complete their work without damaging the roof. There were no tie-off problems because the BUR on each end was merely terminated beyond the end of the insulation. At the end of the completed section, the ballast was held back and the foam weighted down (see Figure V). It was planned that the center section would be waterproofed with a two-ply temporary roof. This temporary roof would have been worked on and then repaired and left in place at the time of roof completion. As it turned out, the outside of the center section was completed with wall flashing, kickback crickets, and a BUR membrane flashed into interior drains. The poured concrete deck provided an excellent work platform and proved to be sufficiently watertight to allow interior completion (see Figure VI). Completing the roof installation behind the other trades was an easy process.

2. SLOPPY FLOYD BUILDING, ATLANTA, GA

This large office structure, owned by the State of Georgia, consisted of two high-rise structures separated by a two-story connector (see Figure VII). The roof was almost 30 years old and due for replacement. The original connector roof consisted of a concrete deck, Foamglass roof insulation adhered to the deck with coal tar pitch, and a gravel-surfaced coal tar pitch BUR membrane. The roof drained poorly, but adjacent low windows on the high rise building precluded the use of tapered roof insulation. Additional drains would be very expensive due to interior ceiling construction. The owner liked the coal tar BUR system, but wanted a more attractive appearance.

A PMR system was ideal to accommodate the coal tar pitch left on the deck and to achieve the appearance desired. The roof system design recommended included a coal tar pitch BUR fully

SLOPPY FLOYD BUILDING PROJECT

mopped to the deck, followed by a bond breaker sheet, loose-applied insulation, and a top surface of either fabric and stone, or interlocking ballast pavers (or a combination), depending on bid results. The PMR approach allowed a fully-adhered membrane system without the difficulty of adhering insulation to a pitch-surfaced deck. This approach also allowed a clean, attractive surface.

Some design precautions should be considered. Make sure that the structure is adequate to support the ballast and roof system loading. It is important to have good drainage—a minimum of 1/4 inch per foot is recommended. It would not be logical to use a PMR system on a roof utilizing controlled flow drains. Be sure your wind uplift requirements can be met. If a lightweight, concrete-surfaced insulation board is used, detail the attachment properly to achieve desired wind resistance. Because the roof membrane is covered by the insulation and top surfacing, some specifiers borrow from waterproofing practices and require water testing of the membrane prior to completing the system. When specifying a stone-surfaced PMR system, be sure to use a filtration fabric specifically approved for PMR systems by the fabric manufacturer.

PMR systems do not fit everywhere, but under the right conditions, they definitely have their place. They can make the designer/specifier a hero and a true problem solver. ■

ABOUT THE AUTHOR

Jerry Teitsma started his roofing career with Dow Chemical after receiving an M.S. in Building Construction from Michigan State University. During his tenure with Dow, he became National Technical Manager for Roofing, taught in the University of Nebraska Construction Management Department, and conducted a one-year energy research study project at the National Bureau of Standards. More recently, he has owned a roofing products distribution and insulation tapering company; operated Roof Systems Consultants Inc., in Roswell, GA.; and currently serves as Technical Director for the Roofing Industry Educational Institute (RIEI). He is a Registered Roof Consultant with RCI and a Construction Document Technologist through CSI.



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