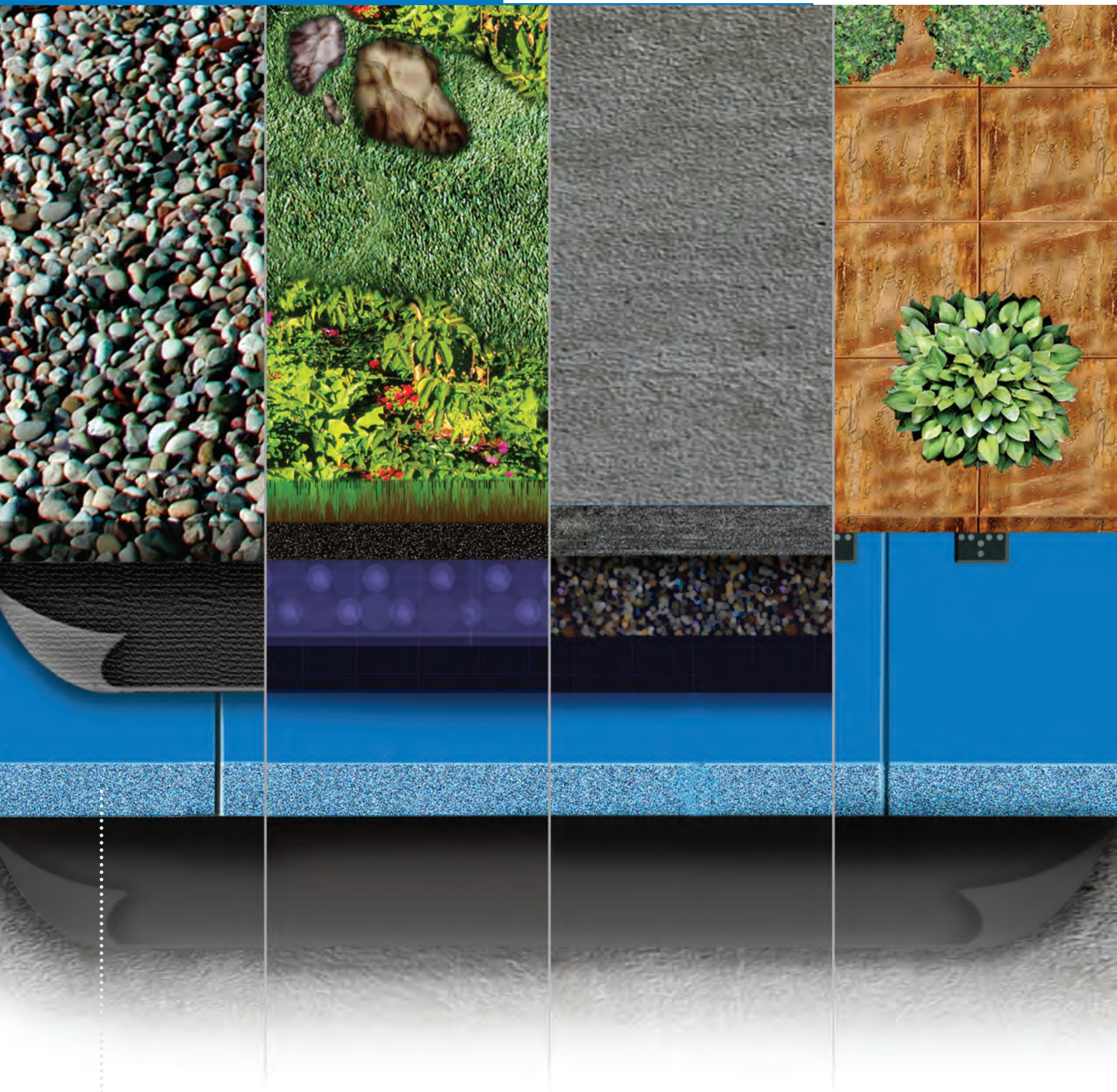
INSTALLATION INFORMATION United States COMMERCIAL



Protected Membrane Roof Installation Guidelines

PMR FIRST ... TO LAST.

Table of Contents

Overview

CHANGING THE SEQUENCE

Protected membrane roofing's breakthrough contribution to flat roof technology was the incorporation of an "upside-down" approach to insulating the roof: placing the insulation on top of the waterproof membrane to improve the membrane's effectiveness and the insulation's efficiency.

This advancement was made possible in large part by the use of STYROFOAM™ extruded polystyrene insulation, whose closed-cell, water-resistant qualities have proven to be a key component in protected membrane roof (PMR) systems.

A conventional roof places the membrane on top of the insulation, leaving the membrane vulnerable to extreme temperature changes, freeze-thaw conditions and physical abuse from heavy foot traffic (Figure 1).

The PMR system places the insulation on top of the membrane, protecting the roofing membrane from extreme temperature changes and physical abuse (Figure 2).

The main difference between PMR and conventional roofing is the sequence in which the materials are applied. The key to the PMR system is that the insulation is placed on top of the waterproofing membrane. This configuration protects the membrane, resulting in superior long-term performance and durability.

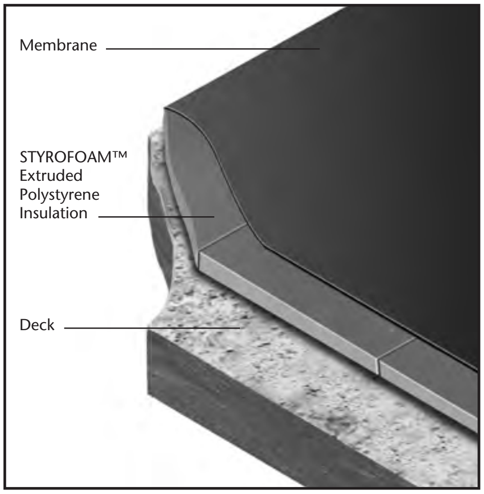


Figure 1: Conventional Roof With Membrane Above the Insulation (depending upon building and climate conditions, a vapor barrier may also be used)

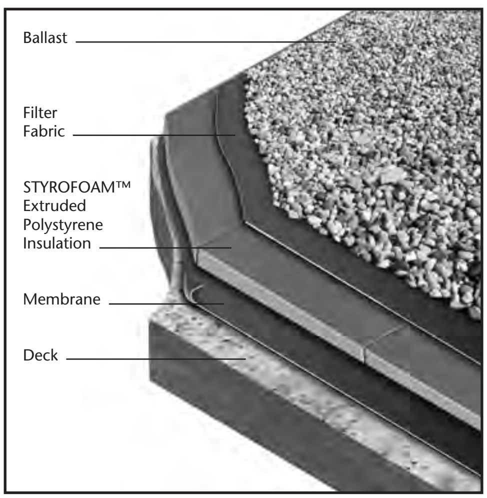


Figure 2: PMR With Membrane Below the Insulation

CHANGING THE SEQUENCE

Advantages of PMR

All flat roof assemblies consist of the same basic elements assembled in a seemingly logical order: a deck (composed of wood, metal or concrete), covered with insulation and topped with a waterproofing membrane. A protected membrane roof can employ the same elements, but the membrane is positioned *under* the insulation, offering superior long-term performance and durability.

PMR assemblies:

- Maintain the membrane at a nearly constant temperature, close to the temperature of the building's interior; this minimizes the stresses on the membrane by reducing the harmful effects of freeze-thaw cycling, thermal cycling and excessive heat
- Protect the membrane from weathering, foot traffic and other types of physical abuse – both during and after construction
- Allow year-round construction since the roof is waterproofed first, then insulated
- Permit easy removal and re-installation of the ballast and insulation for making repairs or for constructing additional stories. In addition, a protected membrane roof provides an environmentally preferred option to reuse the insulation
- Allow for a range of ballast options – stone, precast paving slabs, green roof, interlocking stone or concrete – depending on use and aesthetic considerations
- Are compatible with a range of membrane types
- Eliminate the need for a separate vapor retarder

PROVIDE DURABILITY AND PROTECTION

With the membrane positioned under the insulation, the choice of insulation becomes an important consideration. The insulation must be able to withstand wet environments (without sacrificing insulation performance) and foot traffic during and after construction, while continuing to perform over time.

Because of its durability and outstanding moisture-resistant qualities, STYROFOAM™ extruded polystyrene insulation delivers exceptional performance in roofing and plaza applications.

- Provides excellent moisture resistance and long-term R-value*
- Offers exceptional durability to extend the life of the plaza or roof
- Protects the membrane against weathering, physical abuse and damage
- Maintains the membrane at a relatively constant temperature
- Controls dew point location

*R means resistance to heat flow. The higher the R-value, the greater the insulating power.

Glossary

Absorption: the ability of a material to absorb quantities of gases or liquids, such as moisture.

Accelerated Weathering: an experimental test where a material is exposed in a controlled environment to various elements (heat, water, condensation or light) to magnify the effects of weathering. The material's physical properties are measured before and after the process to identify any detrimental effects of weathering.

Aggregate: rock, stone, crushed stone, crushed slag or water-worn gravel used for ballasting a roof system.

Aging: the effect on materials exposed to an environment for a defined time.

Alligatoring: the cracking of the exposed bitumen on a built-up roof, producing a pattern of cracks similar to an alligator's hide.

Asphalt: a dark brown or black substance left as a residue when processing crude oil or petroleum. Asphalt may be further refined to conform to various roofing grade specifications.

Asphalt Emulsion: a mixture of asphalt particles and an emulsifying agent, such as bentonite clay and water.

Ballast: an anchoring material, such as stone or precast concrete pavers, used to hold insulation and/or roof membranes in place.

Base Ply: the bottom ply of roofing in a roof membrane or roof system.

Base Sheet: an impregnated, saturated or coated felt placed as the first ply in some multi-ply built-up and modified bitumen roof membranes.

Blocking: sections of wood built into a roof assembly, usually attached above the deck and below the membrane or flashing, used to stiffen the deck around an opening, act as a stop for insulation, support a curb or to serve as a nailer for attachment of the membrane and/or flashing.

Built-up Roof (BUR) Membrane: a continuous, semi-flexible multi-ply roof membrane, made up of plies or layers of saturated felts, fabrics or mats with bitumen in between.

Cant Strip: a beveled or triangular-shaped strip of wood or other suitable material used to transition from the horizontal surface of a roof deck or rigid insulation to a vertical surface.

Caulking: sealing and making weather-tight the joints, seams or voids between adjacent units using a sealant.

Compatible Materials: two or more substances that can be mixed, blended or attached without separating, reacting or affecting the materials adversely.

Condensation: the conversion of water vapor or other gas to liquid state as the temperature drops or atmospheric pressure rises. (Also see Dew Point.)

Counterflashing: formed metal sheeting secured on or into another surface used to protect the upper edge of the membrane or underlying metal flashing and associated fasteners from exposure to the weather.

Curb: a raised roof location relatively low in height.

Dead Load: permanent non-moving load that results from the weight of a building's structural and architectural components, mechanical and electrical equipment, and the roof assembly itself.

Deck: a structural component of the roof of a building designed to safely support the design dead and live loads, including the weight of the roof systems, and the additional live loads required by the governing building codes. Decks are either non-combustible (e.g., corrugated metal, concrete or gypsum) or combustible (e.g., wood plank or plywood) and are the substrate used to apply the roofing or waterproofing system.

Design Load: load specified in building codes or standards published by federal, state, county or city agencies, or in owners' specifications to be used in the design of a building.

Dew Point: the temperature where water vapor condenses in cooling air at the existing atmospheric pressure and vapor content. Cooling at or below the dew point will cause condensation.

Dynamic Load: any load that is non-static, such as a wind load or a moving live load.

Glossary

Fabric: a woven cloth or material of organic or inorganic filaments, threads or yarns. Can be used as a reinforcement in certain membranes and flashings or used in a protected membrane roof application to reduce the ballast requirements.

Flashing: materials used to weatherproof or seal the roof system edges at perimeters, penetrations, walls, expansion joints, valleys, drains and other places where the roof covering is interrupted or terminated.

Gravel Stop: a low profile, upward-projecting metal edge flashing with a flange along the roof side, usually formed from sheet or extruded metal. Installed along the perimeter of a roof to provide a continuous finished edge for roofing material.

Humidity: the amount of moisture contained in the atmosphere. Generally expressed as percent relative humidity (% RH). It is the ratio of the amount of water vapor actually present in the air, compared to the maximum amount that the air could contain at the same temperature.

Inverted Roof Membrane Assembly (IRMA): same as protected membrane roof (PMR) assembly, where a closed-cell insulation (e.g., STYROFOAM™ insulation) and ballast are placed over the roof membrane.

Live Load: temporary load that the roof structure must be designed to support, as required by governing building codes. Can include people, installation equipment, vehicles, wind, snow, ice or rain, etc.

Loose-laid Membrane: membrane that is not attached to the substrate except at the perimeter of the roof and at penetrations. Typically, a loose-laid membrane is held in place with ballast.

Mechanically Fastened Membrane: membrane that is attached at defined intervals to the substrate, using various fasteners and/or other mechanical devices.

Membrane: a flexible or semi-flexible material that waterproofs (excludes water) a roof.

Parapet Wall: that part of a perimeter wall immediately adjacent to the roof, which extends above the roof.

PMR: protected membrane roof.

Positive Drainage: the drainage profile of a deck, considering the roof slope and loading deflections to ensure the roof deck drains within 48 hours of rainfall during ambient drying conditions.

Ridge: highest point on the roof where two roof areas intersect.

Roof Assembly: an assembly of interacting roof components (includes the roof deck, vapor retarder [if present], insulation and roof covering).

Roof Slope: the angle a roof surface makes with the horizontal. Typically expressed as a ratio of rise to run, such as 4:12, or as a percent.

Square: 100 square feet of roof area.

Substrate: the surface on which the roofing or waterproofing membrane is applied (e.g., the structural deck or insulation).

Vapor Retarder: a material that restricts the movement of water vapor.

Wind Uplift: the force caused by the deflection of wind at roof edges, roof peaks or obstructions, causing a drop in air pressure immediately above the roof surface (e.g., suction). Uplift may also occur from air movement from underneath the roof deck, causing the membrane to balloon and pull away from the deck.

Components

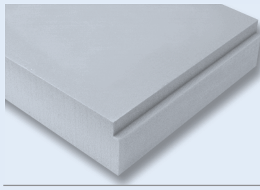
STYROFOAM™ EXTRUDED POLYSTYRENE INSULATION

Description

STYROFOAM™ extruded polystyrene insulation is a rigid, closed-cell insulation, ideally suited and designed for PMR installations. Because of the properties imparted during the extrusion process combined with the hydrophobic nature of polystyrene, STYROFOAM insulation has a high resistance to both water and water vapor, providing demonstrated long-term mechanical and thermal performance.

The boards are available in a range of thicknesses, densities, and edge and surface treatments.

STYROFOAM™ ROOFMATE™



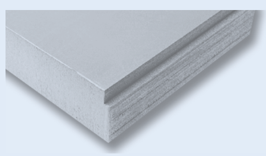
An extruded polystyrene foam insulation providing excellent moisture resistance, durability and long-term R-value. Ideal for installation above waterproofing or roofing membranes in PMR applications.

STYROFOAM™ Ribbed ROOFMATE™

An extruded polystyrene foam insulation board with 1/4" x 1/2" drainage channels on the bottom long edge of each board. The top surface of the board has ribs that form corrugations in the long dimension of the board.

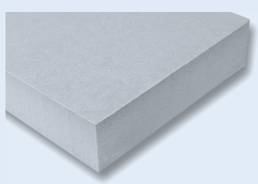
Designed for installation above waterproofing or roofing membranes in PMR applications that use pavers as ballast. Pavers can be installed directly over the ribbed foam surface without needing pedestals.

STYROFOAM™ PLAZAMATE™



A high-density extruded polystyrene foam insulation board designed to be installed above waterproofing or roofing membranes in most plaza deck applications.

STYROFOAM™ Highload 40, 60 and 100



An extruded polystyrene foam insulation board with high compressive strength developed specifically for in-ground application and freezer floors. The products are also well-suited for plaza decks and protected membrane roofs that must withstand heavy traffic.

Components

STYROFOAM™ EXTRUDED POLYSTYRENE INSULATION

Function

Provide thermal properties: STYROFOAM™ extruded polystyrene insulation has a high aged thermal resistance (R-value) when compared with competitive roof insulations.

Provide membrane protection: By installing the insulation over the membrane, the membrane is kept at a relatively constant temperature year-round and protected from weathering, mechanical damage and abuse.

Specification

The insulation shall meet ASTM C578-05 (Type V, VI or VII depending on the required properties) or CAN/ULC S701 Type 4.

Install required thickness of STYROFOAM™ extruded polystyrene insulation unbonded over the roof membrane. Install a slip or separation sheet over the membrane if the membrane is coal tar or Type 1 or 2 asphalt, or if required by the membrane manufacturer.

Butt boards tightly together with a maximum 3/8" gap between boards, staggering end joints. The recommended stagger between each board is 2'. However, in cases where boards have been cut to fit, try and maximize the stagger where possible. At a minimum, each board should have at least an 8" stagger.

When using STYROFOAM insulation with pre-cut drainage channels, ensure that the drainage channel edges are face down (i.e., on the membrane side).

Bevel edges to fit closely to cant slopes.

Fit around protrusions and obstructions with a maximum 3/4" gap to minimize heat loss.

Multi-layer foam installation:

- The bottom layer of insulation (the layer directly on the membrane) must be at least 2" thick.
- The bottom layer must be the thickest or, at minimum, equal to the top layer (e.g., 3" bottom and 3" top).
- Lay successive layers of insulation unbonded or unadhered.
- Stagger or offset all joints from those of the underlying layer.

Installation Notes

Protect insulation from physical damage.

Handle boards carefully to prevent damage during installation.

Always wear protective eyewear and gloves when handling and cutting insulation.

Always store insulation away from direct sunlight, particularly when storing for an extended time. Cover with a light-colored opaque tarp for protection from solar radiation. The surface degradation caused by ultraviolet (UV) light will have no measurable effect on the insulating value unless the deterioration is allowed to continue until actual thickness is lost.

Always check the compatibility with other products that may come in direct contact with the insulation, particularly those containing solvents. Preventive care must be taken, such as allowing the solvents to evaporate, providing a slip sheet or painting the surface of the insulation with white latex paint. Always brush off any surface dust before applying white latex paint on the insulation.

STYROFOAM™ extruded polystyrene insulation is combustible and may constitute a fire hazard if improperly used or installed. The insulation contains a flame-retardant additive to inhibit ignition from small fire sources. During shipping, storage, installation and use, this material should not be exposed to open flames or other ignition sources.

Components

FABRIC

Description

Ballast reduction fabric, commonly known as filter fabric, is used in PMR installations between the ballast and insulation. This water-permeable material must have proven long-term weather resistance, be strong enough to withstand traffic abuse and prevent displacement of the insulation under flotation conditions.

Function

- Prevent fines from penetrating between insulation boards
- Raft the insulation together to reduce ballast requirements
- Reduce mechanical damage to insulation
- Allow easy stone removal if access required to flashings, insulation and/or membrane

Specification

Apply fabric unbonded and shingle fashion over the installed insulation (Figure 3).

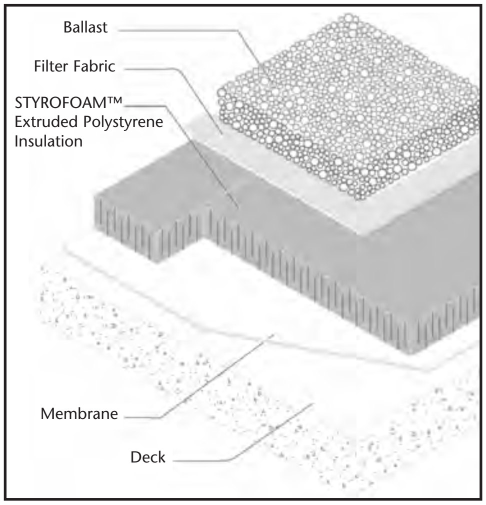


Figure 3: Fabric Placement**

Overlap all edges a minimum of 12". If a small piece has to be used, minimum size should be 8' x 8'.

Slit fabric to fit over any roof penetrations. Cut around roof drains and other openings (Figure 4).

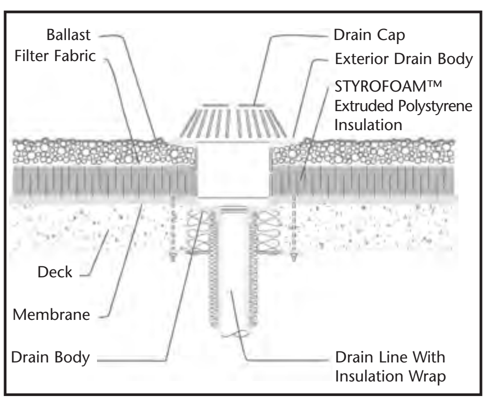


Figure 4: Drain Detail With Fabric**

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow
**This is an illustration of a typical detail. Responsibility for actual design remains that of the designer.

Components

FABRIC

Extend the fabric up the roof perimeter cants and roof protrusions by at least 3" above the top level of the ballast (typically about a 6" upturn) and place it loose under the metal counterflashings (Figure 5).

Fabrics, such as Fabrene V.I.E.,† should meet or exceed the guidelines listed in Table 1.

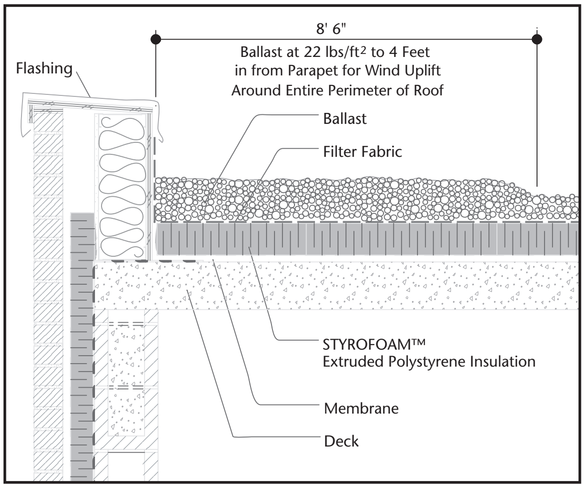


Figure 5: Parapet Detail With Fabric**

TABLE 1

Specification Guidelines

Criteria	Test Method	Units	Value
Unit Weight	ASTM D1910	oz/yd²	4.0 (max)
Notch Tear		lb	
MD	ASTM D2262		7.0 (min)
CD			7.0 (min)
Tensile Grab		lbf	
MD	ASTM D1682		70 (min)
CD			60 (min)
Elongation @ break	ASTM D1682	%	15 (min)
UV Resistance			Approved for outdoor use
Material			Woven polyolefin preferred to promote run-off

Installation Notes

Store all materials in dry, protected areas in an upright position.

Dow experience has shown that when the STYROFOAM™ extruded polystyrene insulation is exposed to both direct sunlight and an outdoor air temperature over 90°F, distortion of the foam can occur in as little as 30 minutes when a heavy, dark-colored fabric is over the insulation. To prevent this phenomenon during hot weather, temporarily place white opaque polyethylene film on the fabric until the ballast is laid.

Install the fabric unadhered directly over the foam insulation. Wetting the fabric sometimes helps secure it until the ballast can be applied.

Supporting Documentation

TechNote 501a: "Protecting STYROFOAM Brand Insulation Below Dark Roofing Membranes and Fabrics"

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

**This is an illustration of a typical detail. Responsibility for actual design remains that of the designer.

†Fabrene V.I.E. is a registered trademark of PGI - Fabrene Inc.

Components

BALLAST

Description

Crushed stone or washed, rounded riverbed rock, ASTM D448 Gradation #2, 4, 5 or 57 depending on membrane type, building height, wind zone and parapet height (Table 2).

Depending on the ballast design, the range of ballast is 10 to 15 lb/ft^2 with additional ballast around perimeters and penetrations (15 to 20 lb/ft^2). In some cases, pavers can be used. See "Pavers" on page 12 for additional details.

Function

Prevent uplift and prevent flotation: The amount and placement of ballast is based on the following considerations:

- Design wind speed – Refer to the ANSI/ASCE 7-95 wind speed map, contact the local code authority for the design wind speed for the building location or refer to TechNote 508: "Ballast Design Guide for IRMA Roofs"
- Roof height – Use the worst-case elevation (e.g., from ground level to the highest point of the roof)
- Parapet height – Measured from the top of the ballast to the top of the parapet, use the shortest parapet height in any variation
- Membrane type – Adhered, loose-laid or mechanically attached

Areas of extra ballasting: Extra ballast, required to overcome high wind loads and restrain insulation during heavy rainstorms, should be considered in the following locations:

- Perimeter edge – 8.5' wide band running along the perimeter edge of the roof insulation. As an alternate to additional ballast, 1 to 4 rows of concrete pavers may be installed along the perimeter edge (see TechNote 508).
- Penetrations through the insulation – 4' wide band around any roof penetration greater than 4' in any direction (e.g., skylights, equipment pads, etc.).
- Corners – Concrete pavers may be required with steel strapping and anchors for certain designs (see TechNote 508). See "Pavers" on page 12 for details about concrete pavers.
- Building exposure – Consider the surrounding terrain and its potential effect on the overall wind exposure (e.g., nearby woods versus shorelines).
- Membrane type – Adhered, mechanically fastened or fully ballasted. For additional details, see "All Other Components" on page 13.

Prevent wind scouring: The wind performance of stone ballasted PMRs has been excellent. Only a few isolated minor scouring problems have occurred, typically limited to small areas in a corner. In these few cases, the ballast has blown inbound by about 4' and piled up on the filter fabric, creating additional weight.

Prevent UV degradation of the insulation: Most PMR applications use a filter fabric that typically incorporates a UV stabilizer. However, if no fabric is used, the insulation must be totally covered by the ballast to prevent UV degradation. The quality of the ballast is very critical in these types of applications. Too small (fines not more than 10 percent of mix) and the stones may work into the insulation joints or be moved by the wind; too large and the ballast may not provide adequate cover to protect from UV light.

Provide a Class A fire-resistant roof cover: Class A roof covering, as defined by ULC S107, ULI 790 and ASTM E108. (See "Fire and Wind Ratings" on page 20 for additional details.) The requirements for Class A roof construction cover the performance of roof assemblies and roof covering materials when exposed to a fire originating from sources outside a building. The stone ballast or pavers provide the Class A fire rating.

TABLE 2

Standard Sizes of Coarse Aggregate (Weight % Finer Than Sieve Openings)

ASTM D448 Gradation	Nominal Size Square Openings	3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	3/16"
2	2-1/2" to 1-1/2"	100%	90-100%	35-70%	0-15%		0-5%			
4	1-1/2" to 3/4"			100%	90-100%	20-55%	0-15%		0-5%	
5	1" to 1/2"				100%	90-100%	20-55%	0-10%	0-5%	
57	1" to No. 4				100%	95-100%		25-60%		0-10%

Components

BALLAST

Design Approach

Refer to TechNote 508 for the recommended amount and placement of ballast. The ballast design depends on:

- Type of membrane (adhered, loose-laid or mechanically attached)
- Building height
- Design wind speed
- Site exposure
- Parapet height
- Gravel stop height

Specification

ASTM D448 Gradation #2, 4, 5 or 57 washed free of fines or stones.

Spread stone ballast uniformly over installed insulation to provide minimum weight or thickness.

Spread additional ballast around the roof perimeter for a width of 8.5' to increase ballast weight or thickness.

Spread additional ballast around any penetration for a width of 4' around any penetration that exceeds 4' in any direction.

Installation Notes

Make sure that proper provisions have been specified to seal off openings in the roof deck and any perimeter blocks. This will prevent air from getting below the roofing membrane and billowing it.

For PMR installations without a fabric, ensure that the ballast does not contain too many small stones (fines not more than 10 percent of mix) as they may work into the insulation joints or be moved by the wind. Conversely, too many large stones may not provide adequate cover to protect the insulation from UV light where a fabric is not used.

If ballast has been moved by wind scour, repair is simple. Just replace the insulation (if necessary), re-lay the filter fabric and replace the ballast. A small paver can be added, if required.

If a gravel stop is required, the height of the gravel stop at a building perimeter should be at least 2" from the top of the ballast.

Supporting Documentation

TechNote 508: “Ballast Design Guide for IRMA Roofs”

National Research Council of Canada report by Kind and Wardlaw. Report on PMRs using a 30' x 30' wind tunnel, with various ASTM gradation/sizes of ballast. (See reports NRC LTR-LA 269, NRC LTR-LA 234, NRC No. 15544.)

ANSI/SPRI RP-4 Wind Design Standard for Ballasted Single-Ply Roofing Systems (for mechanically attached and loose-laid PMR)

ASTM D448 Standard Classification for Sizes of Aggregate for Road and Bridge Construction

ANSI/ASCE 7 Minimum Design Loads for Buildings and Other Structures (includes Basic Wind Speed Map)

Components

PAVERS

Description

Concrete slab pavers or interlocking pavers can be used to supplement or replace conventional stone ballast requirements and create a surface for rooftop decks, walkways, terraces, gardens and similar applications.

Note: *For structural plaza deck design, such as for parking decks and other high-traffic areas, the design is the responsibility of an architect and/or structural engineer.*

Function

Note: *For additional information, see "Ballast" on page 10.*

Narrow roof walkways for access: Pavers can be placed to facilitate access to rooftop equipment.

Prevent wind scouring: In exposed areas or areas of high winds, pavers may be required. In certain conditions, the pavers should be strapped together using galvanized or stainless steel straps, mechanically fastened to each paver.

Perimeter ballast: Additional ballast is required around the building perimeter in a PMR design. Depending on the design, pavers can be installed instead of conventional stone ballast.

Plaza-deck design: For light traffic requirements, the stone ballast can be replaced with concrete pavers completely. In many cases, the pavers must be raised from the surface of the fabric and insulation. See "Installation Notes" for details.

Specification

PAVERS

Concrete pavers shall be manufactured from minimum 3,000 lb/in^2 concrete with a minimum weight of 18 lb/ft^2.

When ribbed insulation is not used and the total area to be covered by pavers is more than 10 percent and the location has more than 3,000 heating degree-days, pavers should be raised from the surface of the fabric and insulation using spacers to maintain at least a 3/16" ventilating air space ("diffusion open" design). The spacer can be:

- 1" thick insulation cut into 6" square blocks and placed under the four corners of the paver (limited to 108 lb/in^2 live loading)
- Preformed pavers with at least a 3/16" foot in each corner or ribbed undersurface
- Paver pedestal of injection molded, weathering-grade plastic, installed under each corner (e.g., PAVE-EL by Envirospec Inc., Terra-Tabs by Wausau Tile, etc.)
- Layer of pea gravel 1" (min.) free of fines

Note: *This air space is not required if the pavers are covering only a limited area (less than 10 percent of roof area), such as corners or narrow roof walkways.*

PAVER STRAPPING AND FASTENERS (IF REQUIRED):

Straps shall be of 22 gauge galvanized or stainless steel, 3" wide and 12' long.

Fasteners shall be 1/4" x 1-1/4" corrosion-resistant metal anchors, expanded in pre-drilled holes (e.g., Zamac Nailin #2814 by Powers Fasteners, Inc).

Installation Notes

When pavers cover more than 10 percent of the insulation surface and are located in climates with more than 3,000 heating degree-days, create a 3/16" space between the insulation and the underside of the pavers. In colder climates, the air space will minimize any freeze-thaw spalling on the concrete and moisture build-up in the insulation due to vapor drive from the inside.

Components

ALL OTHER COMPONENTS

Description

MEMBRANES

The membrane is the flexible or semi-flexible waterproofing layer on the roof deck. In a PMR application, the membrane is sandwiched between the roof deck and the insulation.

Membranes fall into three general categories: built-up roof (BUR), two-ply modified bitumen, single-ply (sheet) or liquid membranes.

***Note:** PMR assemblies should be installed with adhered membranes only.*

BUR membranes are semi-flexible, multi-ply roof membranes, consisting of plies or layers of saturated felts, coated felts, fabrics or mats between alternate layers of bitumen, either asphalt or coal tar based.

Modified bitumen membranes are similar to BUR membranes, but instead are manufactured in a production facility, using asphalt modified with various additives. The membrane is fully adhered and the seams overlap to provide an uninterrupted waterproof layer.

Sheet or single-ply membranes are prefabricated sheets of polymer-based material, such as thermoplastic (e.g., PVC), elastomeric (e.g., EPDM) or modified bitumen with polymer modifiers. Single-ply roofs can be:

- *Fully or partially adhered:* The membrane is fully or partially adhered to the underlying substrate with a flood coat.
- *Loose-laid:* The membrane is not attached to the substrate except at the perimeter and at penetrations. In a PMR assembly, the loose-laid membrane is held in place with full ballast. (See "Ballast" on page 10 for details.) Care must be taken to ensure that air infiltration underneath the membrane is prevented.
- *Mechanically fastened:* The membrane is attached at defined intervals to the substrate. Mechanical fastening may use various fasteners and/or other mechanical devices, such as plates or battens.
- *Self-adhering:* The membrane is adhered to a substrate and to itself at overlaps without the use of an additional adhesive. This is usually accomplished with a surface adhesive protected by a release paper or film that prevents the membrane from bonding to itself during shipping and handling.

***Note:** With some membranes, manufacturers may recommend a slip sheet (e.g., 4-mil polyethylene film) over the membrane to prevent adhesion of the foam to the membrane or plasticizer migration (e.g., chemical attack) to the STYROFOAM™ extruded polystyrene insulation. Consult the membrane manufacturer for recommendations.*

Liquid membranes are applied in-situ as a liquid that hardens or sets into a continuous, monolithic membrane over the substrate. These liquids are generally applied by spraying or with rollers and include:

- Hot-applied rubberized asphalts, a blend of asphalt, mineral fillers, elastomers, virgin or reclaimed oil. Some versions consist of two coats of rubberized asphalt with a polyester mat in between (fully reinforced or two-ply system).
- Cold-applied liquid compounds consist of emulsions and solutions of resins, elastomers (e.g., polyurethanes, silicones, acrylics, etc.) and bitumens and/or modified bitumens.

FLASHINGS

Flashings are materials used to weatherproof or seal the roof system edges at perimeters, penetrations, walls, expansion joints, valleys, drains and other places where the roof covering is interrupted or terminated. For example, membrane base flashing covers the edge of the field membrane, and cap flashings or counterflashings shield the upper edges of the base flashing.

ROOF DECK

The roof deck (including drains and gutters) is the structural component of a building's roof. The deck must be capable of safely supporting the design dead and live loads, including the weight of the roof systems and the additional live loads required by governing building codes.

Decks are either non-combustible (e.g., corrugated metal, concrete or gypsum) or combustible (e.g., wood plank or plywood), and provide the substrate to which the roofing or waterproofing system is applied.

Components

ALL OTHER COMPONENTS

Function

The **roof deck** should:

- Provide structural support to accommodate both live and dead loads without significant deflection.
- Provide dimensional stability by forming a stable substrate not affected adversely by cyclical thermal- and moisture-induced movement.
- Provide fire resistance as determined by the building type and intended use.
- Provide a substrate for the roof system.
- Accommodate building movement. Where necessary, building expansion joints and roof area dividers should be designed and installed.
- Provide for drainage (either by sloping the roof deck or using tapered insulation or both). The roof surface should be sound and should drain water freely within 48 hours following a rain. Every effort should be made to isolate and correct the causes of any standing water or ponding on the roof. CRCA and NRCA recommend a minimum slope of 1/4" per foot (2 percent). The International Building Code (IBC) also requires a slope of 1/4", except for coal tar membranes that require 1/8" slope. However, if the roof is designed to allow ponding, ensure the insulation is *not* adhered to the membrane and a filter fabric is used.
- Provide suitable roof drains and gutters. Care should be taken to prevent ballast from entering the drains and/or gutters by using perforated collars or paving stones. When concerns exist, a drainage assessment should be conducted per SMACNA guidelines.

The **membrane** should:

- Provide a continuous waterproofing barrier to protect the interior environment.
- If the membrane is tacky, use a slip or separation sheet (e.g., 4-mil polyethylene) to minimize adhesion between the membrane and insulation.
- If there are compatibility issues with the membrane, such as with certain PVC or coal tar membranes, refer to the manufacturer's or supplier's recommendations. In some cases, a slip or separation sheet (e.g., 4-mil polyethylene) may be required.

The **flashing** should:

- Provide a continuous waterproofing barrier when tied into the membrane to protect the interior environment.
- Extend well above the expected high water level (typically 8" minimum).

Specification

General: The overall system (including membrane and insulation) should be designed so that the dew point is located above the membrane. The system should be designed so that freezing will not occur at the membrane level.

Where required, an adequate thermal barrier should be provided between the insulation and the interior of the building. The thermal barrier may consist of the deck, a ceiling assembly or an underlayment board equivalent to 1/2" gypsum board.

Membrane: Refer to membrane manufacturer's literature for details. The manufacturer or supplier of the membrane shall be responsible for determining compatibility of the membrane with STYROFOAM™ extruded polystyrene insulation.

Roof deck and flashing: Refer to general roofing specification for details.

Installation Notes

See the NRCA Roofing and Waterproofing Manual – Fifth Edition. Online edition available at: http://www.nrca.net/rp/technical/manual/manual.aspx

See the CRCA Roofing Specification Manual. Details available at: http://www.roofingcanada.com/ItemsForSale.asp

Cold Rain Phenomenon

THE ISSUE

"Cold rain phenomenon" (or "cold water wash") occurs during periods of cold rain and/or melting snow or when the ambient condition is 33°F to 50°F. In these conditions, the deck temperature may be temporarily reduced. The issue is that there may be additional heat loss, and in buildings with high humidity, such as pulp and paper mills, the likelihood of condensation increases.

DISCUSSION

Increased heat loss: Heat loss studies have shown that extra heat loss in PMR systems during periods of "cold rain" is a temporary phenomenon, occurring only during the short time of cold rain in a heating season. In fact, cold rain in the cooling season creates a cooling advantage for a PMR system. Studies comparing a conventional versus PMR assembly show only a 3 percent overall heat loss disadvantage for the PMR assembly.

High temperature/high humidity buildings: According to NRCA, a building with 45 percent RH is considered high moisture occupancy. Other buildings, such as pulp and paper mills, textile mills and natatoriums, can have an even higher internal humidity. Combining high humidity with a higher than normal operating temperature results in a "high temperature/high humidity" building environment that requires special design consideration.

The severe operating conditions of high temperature/high humidity buildings are particularly problematic for conventional roof systems. The high temperatures drive the high humidity up into the roof system, resulting in severe condensation and premature deterioration of the insulation and roof deck.

A PMR system offers an inherent design solution for this moisture problem. The waterproof roof membrane is an excellent vapor retarder. With the membrane directly on the roof deck and the insulation above the membrane, the membrane effectively blocks water vapor from reaching the insulation. Also, the membrane is maintained at a temperature near that of the interior, dramatically reducing the probability of condensation on the membrane and minimizing the possibility of premature roof failure.

The "cold rain phenomenon" can change this situation. Cold rain, filtering past the insulation to the membrane, can cool the membrane and the deck below, resulting in a temporary condensation condition on the underside of the deck. For some businesses, like pulp and paper mills, this dripping condensation can create problems with the manufacturing processes and products, causing decreased productivity and increased production costs.

To solve this problem, a thin layer of insulation can be placed below the membrane. This layer keeps the roof deck warm during brief cold rain periods – maintaining the inherent advantages of a PMR system while mitigating the problem of the "cold rain phenomenon."

See TechNote 507: "STYROFOAM™ Insulation in the Optimum Design System for Pulp & Paper Mill Roofs" for additional details.

CONCLUSION

The effect of "cold rain phenomenon" is temporary and does not have a significant overall effect on the performance of a PMR assembly. Generally, thicker amounts of insulation are not required to counteract the negative effects of cold rain.

In high humidity and high temperature applications, sandwiching the membrane between two layers of insulation, coupled with a vapor retarder on the roof deck will address condensation problems in high humidity roofing systems. Remember that the thicker insulation layer should be *above* the membrane to ensure the dew point is *above* the membrane.

Conditions, Issues and Ratings

SPECIAL CONDITIONS AND ISSUES

Moisture Absorption

THE ISSUE

STYROFOAM™ extruded polystyrene insulation will absorb water and the insulation value will be reduced.

DISCUSSION

In a PMR design, it is critical that any insulation installed *above* the membrane can perform in a wet environment without any detrimental effects on its long-term performance. STYROFOAM™ extruded polystyrene insulation has a unique closed-cell structure that provides excellent moisture resistance and long-term R-value.

Nine PMR systems were monitored over a period of 22 years and the insulation properties assessed. The average moisture content of the insulation was 0.9 percent on a percent by volume basis, with a retained R-value of 96 percent.

In plaza deck designs, it is important that a drainage layer be created *above* the insulation, allowing precipitation to drain off the top surface of the insulation, creating a "diffusion open" assembly. If the insulation is sandwiched between a vapor barrier (e.g., pavers) and the roof deck, vapor cannot escape so it is driven back into the insulation. To create a "diffusion open" layer, ensure impermeable roof coverings (such as pavers) have a ventilating air space. This could be a layer of fine-free gravel or a 3/16" minimum air space. See "Pavers" on page 12 for additional details. In addition, if the wearing surface is installed in direct contact with the insulation, moisture may become trapped and freeze-thaw cycling could cause spalling on the bottom of the wearing surface.

Always ensure that the roof deck has proper drainage; if the PMR system has significant ponding (e.g., standing water), the insulation will not be "diffusion open." Follow roofing association guidelines for drainage recommendations.

CONCLUSION

STYROFOAM™ extruded polystyrene insulation offers demonstrated long-term performance in a PMR assembly.

Dimensional Stability

THE ISSUE

STYROFOAM™ extruded polystyrene insulation "shrinks" over time, leading to increased heat loss.

DISCUSSION

All building materials will experience dimensional change due to temperature fluctuations. STYROFOAM™ extruded polystyrene insulation is no different.

For example, the coefficient of expansion of STYROFOAM extruded polystyrene insulation is 3.5 x 10^{-5} in/in/°F. A 2' x 8' sheet of insulation exposed to a temperature swing of 75°F could result in a maximum change of just 1/4" in the 8' direction. Once the temperature is reduced, the insulation will return to its original cut dimension. In addition, this theoretical change does not account for the temperature profile across the insulation. For example, while one side may see a large temperature swing, the underside may see only a small change.

This relatively small gap between the boards does not significantly increase the heat loss through the board joints. In heat loss studies comparing PMR versus conventional roofs, there was no significant difference between the two systems. The findings showed that the PMR system used 3 percent more energy per year.

In addition to addressing the coefficient of expansion, another consideration is the "creep" of materials. Creep is the permanent deformation resulting from continuous, long-term dead (or non-moving) loads. Creep is generally only an issue for STYROFOAM insulation used in pavements, airport runways, parking decks, floors, etc. – installations where the insulation is used to carry a significant load for a long time. In these applications, higher compressive strength insulation may be required.

CONCLUSION

All building materials have a coefficient of expansion that results in dimensional change with temperature fluctuations. The dimensional change that occurs in STYROFOAM™ insulation in a PMR assembly does not significantly impact the system's thermal performance.

Green Roof Design

THE ISSUE

Can PMR assemblies be used for "green roof" designs?

DISCUSSION

In a "green roof" design, the ballast in a PMR assembly is essentially replaced with green material – usually soil and plantings – plus a drainage layer directly on top of the insulation (Figure 6). Replacing conventional ballast with vegetation can limit storm water runoff and, by filtering the runoff through the plants, also improve the quality of the runoff. The plantings not only ballast the insulation, they can, depending on the configuration, also add additional R-value to the roof assembly. Green roofs provide habitat for insects and other wildlife and often are considered in buildings applying for LEED†† (Leadership in Energy & Environmental Design) certification.

Many materials may be suitable as ballast, provided they are compatible with the insulation, prevent flotation, shield ultraviolet light and provide a Class A fire-resistant roof finish.

The roof structure must also be designed to accommodate the dead load from the additional weight of the plantings (including when they are fully saturated by rainfall and covered in several feet of snow), plus any live load from traffic, if applicable. It is also important to design the roof slope and drainage system to accommodate rain runoff.

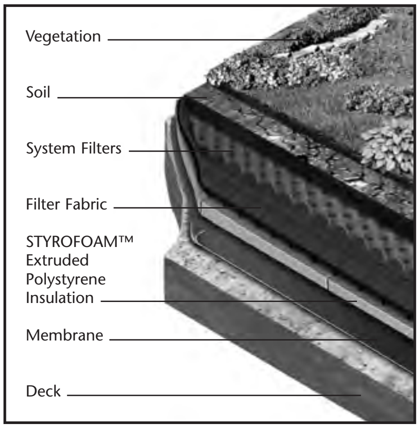


Figure 6: Green Roof Design

PMR assemblies are ideal for green roof designs:

- The membrane is protected under the insulation.
- Because STYROFOAM™ extruded polystyrene products come in a range of compressive strengths, the insulation layer can be designed to withstand the higher dead loads.
- STYROFOAM insulation is proven to outperform in a moist environment.
- STYROFOAM insulation has a high modulus of elasticity, allowing it to perform under long-term live or cycle loading. Maximum recommended dynamic (live) load is 1/10 of the rated compressive strength for 1,000,000 repetitions to address creep and fatigue guidelines.

Typically, a drainage layer is placed over the insulation to direct runoff to the drains, as well as keep the top surface of the insulation "diffusion open." (See "Moisture Absorption" on page 16 for details.) This drainage layer usually includes a fabric over the insulation to protect the joints and keep them open for drainage. Any stone used for this drainage layer must be clean and have a low percentage of fines. In some cases, a drainage mat combined with a filter fabric has also been used successfully to create the necessary air space.

For additional information on green roof design, see:

Design Guidelines for Green Roofs, by Steven Peck and Monica Kuhn, B.E.S., B. Arch., OAA, an OAA and CMHC publication, available at http://www.cmhc-schl.gc.ca

CONCLUSION

PMR assemblies are ideally suited to green roof designs.

Conditions, Issues and Ratings

SPECIAL CONDITIONS AND ISSUES

Finding Leaks in a PMR

THE ISSUE

Is it more difficult to locate a leak with a PMR or conventional roof assembly?

DISCUSSION

Building upon years of in-field experience, the majority of roof leaks in PMR systems occur at flashing as opposed to the interior field area. The field area is protected from physical abuse, UV attack and thermal cycling – all factors that are the primary causes of roof failures – by both the insulation and ballast over the membrane. However, sometimes interior field leaks do occur.

Concrete decks: For PMR installations on concrete decks, generally the membrane is fully adhered to the deck. This simplifies leak detection because the leak is localized. For example, the leak in the interior will be exactly where the hole in the membrane is located. If the membrane is not adhered, the water can run under the membrane for many feet before entering the building – just like in a conventional roof.

Steel decks: For PMR installations on steel decks, a layer of insulation or other substrate (e.g., drywall) is placed first to provide a base for the membrane – exactly the same as in a conventional roof. The same type of leak detection effort is required for both PMR and conventional roofs on steel decks.

Wood decks: On wood decks with a PMR installation, the membrane is typically a felt layer and two or three plies mopped on top. In a conventional installation, the insulation is fastened to the deck and then the membrane is applied. Both of these approaches will allow the water to run to the deck joints prior to entering the building.

CONCLUSION

Not only do PMR assemblies have fewer leaks in the first place, PMR assemblies over concrete decks with bonded membranes have definite advantages when isolating any leaks that do occur. Both conventional and PMR roofs over steel or wood decks require the same leak detection strategies. In addition, because PMR roofs are easier to repair and typically all of the original materials can be reused (ballast and insulation), this environmentally friendly feature can save money.

Low Temperature Applications

THE ISSUE

PMR assemblies should not be used in low temperature applications because of the potential adverse effect on the STYROFOAM™ extruded polystyrene insulation.

DISCUSSION

In a low temperature application (e.g., freezers), the interior space has a low temperature and low water vapor pressure (humidity). In contrast, the warm outside temperature and higher water vapor pressure causes a vapor drive toward the interior space. Unless addressed, this vapor can condense in the insulation and lower the R-value of the system. It can also condense on the membrane and freeze, gradually forming a layer of thick ice.

Typically in low temperature applications, the membrane is placed on the "warm side" – or the exterior in a conventional roofing application.

CONCLUSION

In low temperature applications (e.g., freezers), a conventional roof may offer performance benefits.

High Temperature Installation

THE ISSUE

In high temperature locations, PMR assemblies should not be covered with a dark fabric prior to laying the ballast because of the potential adverse effect on the STYROFOAM™ extruded polystyrene insulation.

DISCUSSION

Like many insulations, higher temperatures may cause permanent distortion and/or long-term creep. The maximum use temperature for STYROFOAM™ extruded polystyrene insulation is 165°F for continuous use, with short-term exposure up to 190°F.

Typically, this concern arises in warmer locations (e.g., southern U.S.) when STYROFOAM insulation is placed underneath a dark fabric prior to laying the ballast. Given the right conditions, the temperature on the top of the insulation may reach close to the upper limits for polystyrene insulation and cause some distortion. Experience has shown that when the STYROFOAM insulation is exposed to both direct sunlight and an outdoor air temperature over 90°F, distortion of the foam can occur in as little as 30 minutes when a heavy fabric is over the insulation. To prevent this phenomenon during hot weather, temporarily place white opaque polyethylene film on the fabric until the ballast is laid.

CONCLUSION

In high temperature locations, the temporary use of white opaque polyethylene film laid on the fabric until the ballast is laid will prevent any distortion of the insulation.

SPECIAL CONDITIONS AND ISSUES

Membrane Seam Failure

THE ISSUE

Failures at the seams in thermoset membranes may be worse with PMR because the membrane stays damp.

DISCUSSION

Thermoset membranes (such as EPDM and neoprene) were historically seamed with a contact adhesive. Seam failure due to moisture intrusion or other contaminant was a concern for this type of membrane because the membrane stays damp in a PMR, potentially resulting in an increase in seam failure. In fact, Dow never received a complaint about this perceived concern.

In today's EPDM system, a seam tape is used. This tape has exhibited excellent performance and this is no longer an issue.

CONCLUSION

There are no documented cases of seam failure related to the PMR application.

Plant Growth on PMR Assemblies

THE ISSUE

Periodically, plant growth will occur on PMR and other low-sloped roofs. Can this be avoided?

DISCUSSION

At times, grass, weeds or small trees may grow on both PMR and conventional roofs. Good roofing practice should include a maintenance program that includes periodic inspection for this type of growth. Any plant growth should be pulled out and, if required, the area treated with a weed killer.

Roots from plant growth can sometimes damage the membrane if left unchecked. With a PMR system, there is less chance of this happening since the membrane is protected by the insulation, fabric and ballast.

CONCLUSION

A preventive maintenance and inspection program should include inspection and removal of any plant growth.

Conditions, Issues and Ratings

FIRE AND WIND RATINGS

Overview

Fire and wind ratings are required to meet building code requirements. Typically, a PMR assembly, including roof deck, membrane, insulation and ballast, is tested in exactly the same configuration as would be constructed in the field. No deviation from the component specification is allowed.

Underwriters Laboratories Inc. (ULI), Underwriters Laboratories Canada (ULC) and Factory Mutual (FM) have developed test methods to rate the fire and wind properties of assemblies.

For the most current listings, contact Dow at 1-866-583-BLUE (2583).

Test Methods

FIRE RESISTANCE RATINGS – FIRE WITHIN A BUILDING

Both ULI and ULC test roof assemblies based on the type of fire exposure. For fires originating within a building, roof assemblies are assessed using either ANSI/UL 263 or CAN/ULC S101-M.

When testing for fires originating within a building, a full-scale roof system is exposed to a controlled fire in order to assess a construction/assembly that can contain a fully developed fire. The Fire Resistance Rating represents the time it takes for the temperature on the unexposed side of the assembly to increase by 250°F.

A sample measuring approximately 14' x 17' is used, including the decking material, any suspended ceiling, hangers, insulation, etc. The sample is then exposed to a fire with temperatures reaching 1,000°F at five minutes and then 1,700°F for a specified time. During the test, a load is applied to the floor to represent the maximum load the joists are designed to support.

EXTERNAL FIRE PERFORMANCE OF A ROOF ASSEMBLY

The fire resistance performance of roof coverings exposed to simulated fire source originating outside a building is conducted in accordance with UL 790 (ASTM E108) or CAN/ULC S107-M. Three classifications are available.

Class A roof covering:

- Effective against *severe* fire test exposures
- Provides a *high* degree of fire protection
- Not expected to produce flying embers
- Does not slip from position during the test

Class B roof covering:

- Effective against *moderate* fire test exposures
- Provides a *moderate* degree of fire protection
- Not expected to produce flying embers
- Does not slip from position during the test

Class C roof covering:

- Effective against *light* fire test exposures
- Provides a *light* degree of fire protection
- Not expected to produce flying embers
- Does not slip from position during the test

Note: *PMR assemblies ballasted with a minimum of 9 lb/ft^2 of stone ballast (or pavers installed with a maximum gap of 1/4") achieve a Class A rating.*

FM TESTS FOR WIND PERFORMANCE

Factory Mutual approved roof assemblies are *only* required when the building is insured by FM Global. Building code authorities may recognize some FM standards; however, they do not require the use of FM approved or accepted products and systems.

FM 4450, "Approval Standard for Class 1 Insulated Steel Deck Roofs," and FM 4470, "Approval Standard for Class 1 Roof Covers," are two recognized laboratory test methods for determining the wind-uplift resistances of roof assemblies. FM 4450 and FM 4470 are the basis of FM's 1-60, 1-90, 1-120, etc., approvals. For example, a Class 1-60 design resists a 60 lb/ft^2 uplift pressure for one minute without loss of pressure.

Dow has a PMR system rated FM 1-90 that adheres STYROFOAM™ extruded polystyrene insulation to a BUR roof assembly with asphalt. This system can be used on both steel and concrete roof decks. Loose-laid single-ply roof membranes with ballast are not listed in the FM approval guide since there are not methods to test these systems for wind uplift. Loose-laid systems can be "accepted" by FM if the assembly is ballasted in accordance with FM Loss Prevention Guide 1-29 and reviewed by the local FM engineering office.

IBC REQUIREMENTS FOR BALLASTED ROOF ASSEMBLIES

The International Building Code (IBC) requires that ballasted roofing assemblies, including PMR assemblies, be ballasted in accordance with ANSI/SPRI RP-4. This standard can be downloaded (free of charge) at www.spri.org

Conditions, Issues and Ratings

FIRE AND WIND RATINGS

ULI Hourly Fire Resistance Ratings for PMR – Steel Deck

Assembly #	Rating (hrs)	Description
P-225, P-226, P-235 (New PMR)	1, 1-1/2	Steel deck 1/2" or 5/8" Type X gypsum (varies) Bar joists Suspended ceiling
P-404 (New PMR)	1-1/2	Steel deck 1" mineral or fiberboard Bar joists Plaster ceiling
P-801, P-805 (Retrofit PMR)	1, 1-1/2, 2	Steel deck Mineral or fiberboards Spray fiber fireproofing Beam construction
P-803 (Retrofit PMR)	1, 1-1/2	Steel deck Mineral or fiberboards Spray fiber fireproofing Bar joists
P-811 (New PMR)	1, 1-1/2, 2, 3	Steel deck 5/8" Type X gypsum Spray fiber fireproofing Beam construction Suspended ceiling (optional)
P-813 (New PMR)	1, 1-1/2	Steel deck 5/8" Type X gypsum Spray fiber fireproofing Bar joists
P-908	2	Steel deck 3-5/6" vermiculite concrete Beam construction

Note: *Always refer to the actual listing for complete details, including maximum thickness of insulation allowed. For details, call Dow at 1-866-583-BLUE (2583).*

Conditions, Issues and Ratings

FIRE AND WIND RATINGS

ULI Hourly Fire Resistance Ratings for PMR – Concrete Deck

Assembly #	Rating (hrs)	Description
P-904, P-909, P-912, P-915 (Retrofit PMR)	2	Precast concrete units Mineral fiberboard
P-904, P-909, P-912, P-915 (New PMR)	2	Precast concrete units 1" gypsum board

ULI Hourly Fire Resistance Ratings for PMR – Other

Assembly #	Rating (hrs)	Description
P-229, P-505, P-507 (New PMR)	1, 1-1/2	2' poured gypsum deck Bar joists Suspended ceiling

Conditions, Issues and Ratings

FIRE AND WIND RATINGS

ULC Hourly Fire Resistance Ratings for PMR – Metal Deck

Assembly #	Rating (hrs)	Description
R-202, R-217 (New PMR)	1	Steel deck 1/2" gypsum Beams or bar joists Suspended ceiling
R-702, R-703 (New PMR)	1, 1-1/2	Steel deck 5/8" gypsum Spray cementitious mixture Beams or bar joists
R-804 (New PMR)	3/4, 1, 1-1/2, 2, 3	Steel deck 5/8" Type X gypsum Spray fiber fireproofing Beam construction
R-805, R-806 (New PMR)	1	Steel deck 1/2" or 5/8" Type X gypsum (varies) Spray fiber fireproofing Beams or bar joists

Conditions, Issues and Ratings

FIRE AND WIND RATINGS

ULC Hourly Fire Resistance Ratings for PMR – Concrete Deck

Assembly #	Rating (hrs)	Description
P-229, P-505, P-507 (New PMR)	1, 1-1/2	2' poured gypsum deck Bar joists Suspended ceiling

FM Hourly Fire Resistance Ratings for PMR

Assembly #	Rating (hrs)	Description
RC-227 (New PMR)	1	Steel deck 1/2" Type X gypsum Gypsum board ceiling
RC-264 (New PMR)	1	Steel deck 1/2" Type X gypsum Suspended ceiling

FM Class 1 Fire and Wind Uplift

Class	Description
1-60, 1-90	Steel deck 1/2" StrataGuard[§] or 5/8" DensDeck[§§] (mechanically fastened) 3-ply BUR

Note: *Current FM wind tests cannot be used to evaluate loose-applied roofing systems. FM Loss Prevention Guide 1-29 provides accepted ballasting requirements.*

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow
§StrataGuard is a trademark of Owens Corning
§§DensDeck is a trademark of Georgia-Pacific

IN THE U.S.:
- **For Technical Information: 1-866-583-BLUE (2583)**
- **For Sales Information: 1-800-232-2436**

THE DOW CHEMICAL COMPANY
• Building Solutions • 200 Larkin • Midland, MI 48674 • **www.dowstyrofoam.com/architect**

COMBUSTIBLE: Protect from high heat sources. Local building codes may require a protective or thermal barrier. For more information, consult MSDS or call Dow at 1-866-583-BLUE (2583). In an emergency, call 1-989-636-4400.

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

Printed in U.S.A.

Form No. 179-05051-0713MCK
McKAY219202