Photo courtesy of American Hydrotech, Inc.

Green Roof PMR – A Design Primer

A protected membrane roof (PMR) design is an ideal solution for "green" roofs where landscaping or plantings are used on the top surface. Preventing leaks is critical in any roof, and even more so in a green roof, because repairing this type of roof can be costly.

In a green roof PMR, typically a fully adhered membrane is installed over a concrete deck and the desired thickness of STYROFOAM™ extruded polystyrene insulation and a root barrier are installed *above* the membrane.

Green Roof PMR*

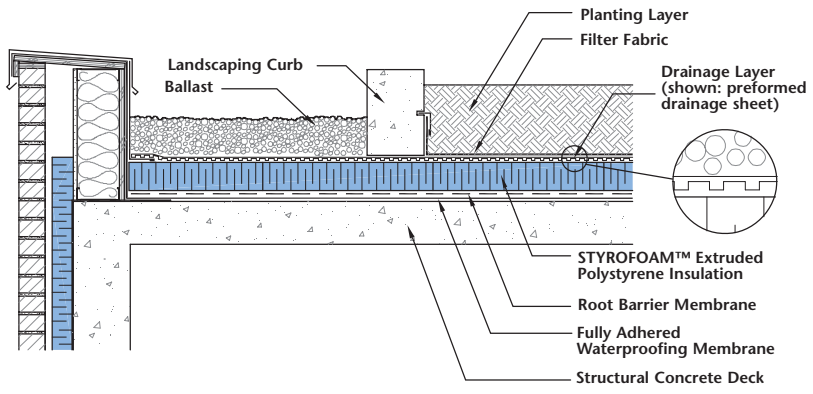

Figure 1

This layer of insulation serves a dual function of providing both long-term thermal insulation value as well as mechanical protection of the critical waterproofing membrane during the installation of the green roof landscaping, including drainage layers, drainage materials and plantings, and the assorted equipment used during the installation process.

*Not to scale. For reference purposes only.

Where should the drainage layer be located in a green roof PMR?

The location of the drainage layer should always be *above* the STYROFOAM™ extruded polystyrene insulation to ensure that any water is quickly drained away and the full value of the insulation is maintained.

In green roof PMR deck designs, a drainage layer *above* the insulation allows water to drain off the top surface of the insulation, creating a "diffusion open" assembly. If the insulation is sandwiched between a vapor retarder (e.g., saturated drainage felt) and the underlying membrane, vapor cannot escape so there is the potential for it to be driven back into the insulation (Figures 2 and 3). To create a "diffusion open" layer, ensure that the top surface of the insulation has a ventilating air space as well as provides a good slope for drainage.

Note: Never install a polyester mat or moisture retention blanket directly on the insulation. If used, ensure a clear drainage layer separates the moisture retention blanket and the insulation.

Creating "diffusion closed" situations (colder areas in North America)*

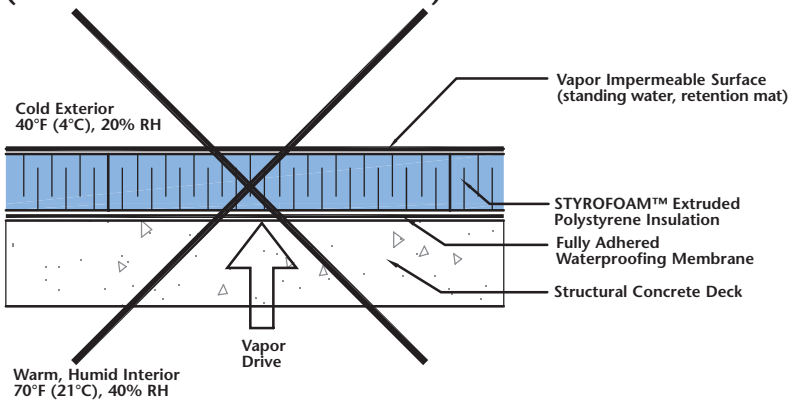

Figure 2

Creating "diffusion closed" situations (warm, high-humidity areas in North America)*

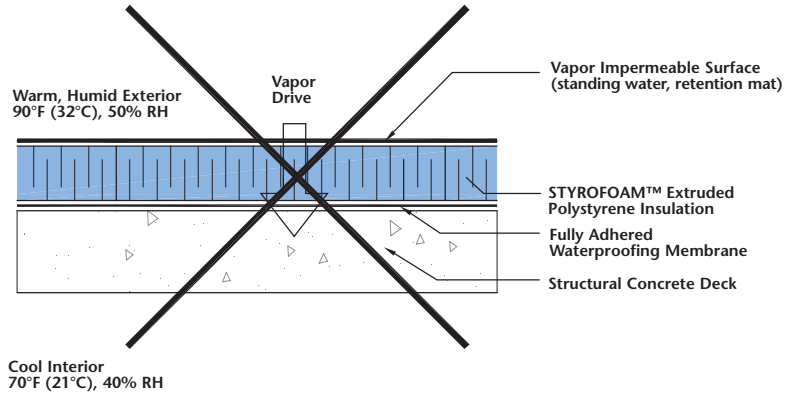

Figure 3

Potential for convective looping when installing the drainage layer *under* the insulation*

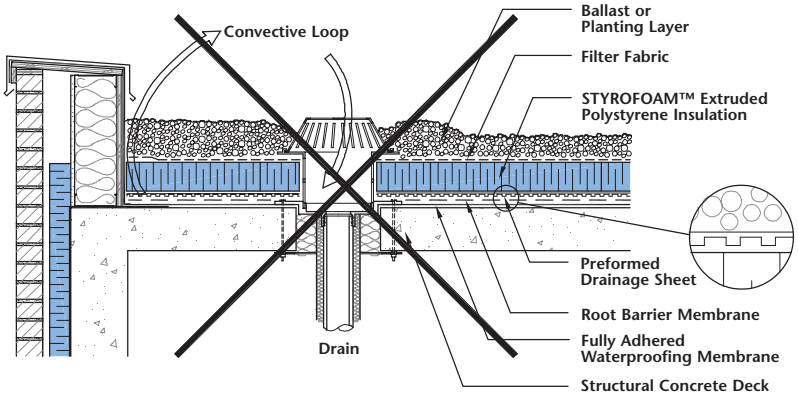

Figure 4

Installing the drainage layer *under* the insulation can potentially minimize the overall benefits of the insulation by creating a convective loop below the thermal insulation (Figure 4). In this case, air can move through the drainage layer and reduce the overall insulation value. Installing the drainage layer *above* the insulation ensures that the insulation value is maximized.

*Not to scale. For reference purposes only.

What products can be used to create a drainage layer in a green roof PMR?

A number of products can be easily incorporated into a green roof PMR, depending on the drainage requirements, budget and any other preferences. The main categories of products include:

- 1" (25 mm) (min) layer of pea gravel, free of fines, with a filter fabric above and below the ballast (Figure 5)
- 3/8" to 1/2" (12 mm to 12.7 mm) dimpled, preformed plastic drainage sheet. Where possible, specify a product that minimizes contact with the insulation (e.g., place dimpled side down) (Figure 6)
- Any other product that provides adequate drainage while providing minimal direct contact on the underlying insulation (Figure 7)

Option 1: Drainage layer consisting of 1" (25 mm) granular layer*

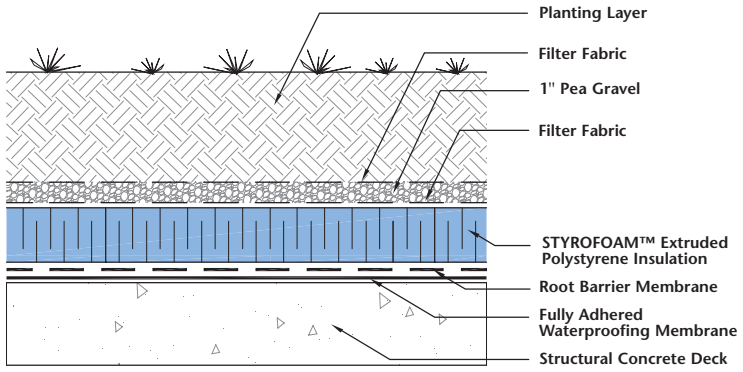

Figure 5

Option 2: Drainage layer consisting of a preformed plastic drainage sheet*

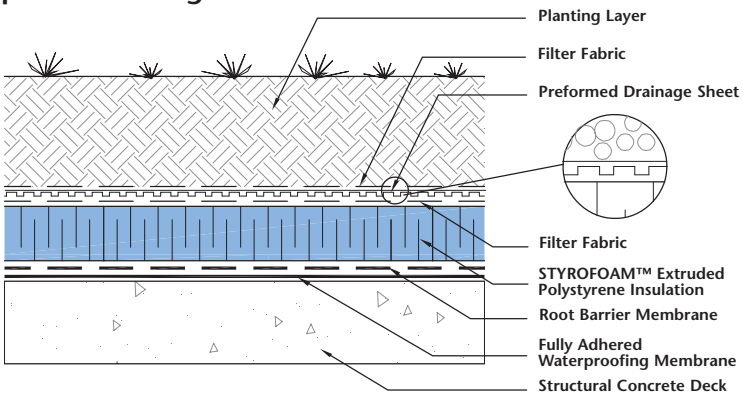

Figure 6

Option 3: Drainage layer consisting of a commercially available mat and filter*

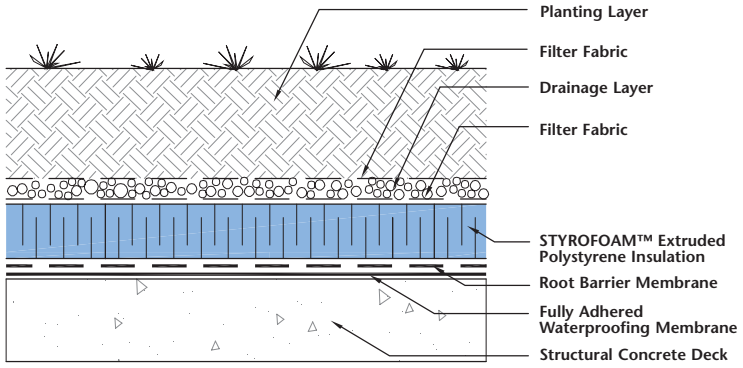

Figure 7

*Not to scale. For reference purposes only.

What type of STYROFOAM™ extruded polystyrene should be specified in a green roof PMR?

The insulation must be able to perform long term under both sustained (dead loads from plantings, planters, etc.) and cyclic loading (live loads from maintenance vehicles, foot traffic, etc.). Because the design of each green roof is unique, it is important that the designers calculate both the live and dead loads created on the insulation layer. STYROFOAM™ extruded polystyrene insulation is available in a range of compressive strengths from 35-100 psi to address the specific design loading requirements for each project.

For a green roof PMR that is exposed to limited pedestrian traffic and minor landscape maintenance using light power tools, typically STYROFOAM™ ROOFMATE™ or STYROFOAM™ Highload 40 insulation may be specified, depending on design loads from the planting layer and other dead loads. Where vehicular traffic or large design loads are anticipated, STYROFOAM™ Highload 60 or STYROFOAM™ Highload 100 may be required. STYROFOAM™ ROOFMATE™ CT (Canada only) and STYROFOAM™ PLAZAMATE™ (U.S. only) insulations are also available.

Regardless of the type of insulation, where more than one layer of insulation is required, follow these guidelines:

- The bottom layer of insulation (the layer directly on the root barrier) must be at least 2" (50 mm) thick.
- The bottom layer must be the thickest or, at minimum, equal to the top layer (e.g., 3" [75 mm] bottom and 3" [75 mm] top).
- Lay succeeding layers of insulation unbonded or unadhered.
- Stagger or offset all joints from those of the underlying layer.

Note: These are guidelines only; it is the responsibility of designers and/or engineers to calculate and accommodate live and dead loads in the green roof PMR design. If required, contact a Dow representative for additional information on the live and dead load design limits for STYROFOAM™ extruded polystyrene insulation.

What are the weight recommendations for ballast and the planting layer on a green roof PMR?

When designing a green roof PMR, the stone ballast typically specified in a PMR is effectively replaced by the planting layer to minimize any potential for flotation. As detailed in Dow literature and TechNote 508, the minimum stone ballast requirement of 10-12 lb/ft^2 (50-60 kg/m^2) can be replaced with a similar weight of a dry and unsaturated planting layer, with additional ballast required around any penetration(s) and the roof perimeter. Refer to Table 1 for either weight or thickness of additional ballast, depending on the thickness of insulation. For additional literature, call 1-866-583-BLUE (2583) or visit:
www.dowstyrofoam.com/architect (U.S.)
www.dowstyrofoam.ca/4architects (Canada)

TABLE 1

Required Ballast Around Perimeters and Penetrations

STYROFOAM™ Thickness, in (mm)	Required Weight of Stone Ballast, lb/ft^2 (kg/m^2)	Approximate Thickness of Ballast, in (mm)
Up to 2 (50)	12 (60)	1-3/4 (40)
3 (75)	17 (84)	2-1/4 (60)
4 (100)	22 (108)	3 (75)
5 (125)	27 (132)	3-1/2 (90)
6 (150)	32 (156)	4-1/4 (105)
7 (175)	37 (180)	5 (125)
8 (200)	42 (204)	5-1/2 (140)

Can a green roof PMR qualify for LEED credits?

A green roof PMR can provide valuable credits when obtaining Green Building Council's LEED** (Leadership in Energy and Environmental Design) rating. Refer to Table 2 for examples of possible credits.

For more details, refer to the "STYROFOAM™ Extruded Polystyrene And Dow Polyisocyanurate Insulations And LEED" brochure available at www.dowstyrofoam.com/architect (U.S. form # 179-05497) or www.dowstyrofoam.ca/4architects (Canada form # 178-00508).

For more information on LEED, refer to www.usgbc.org (U.S.) or www.cagbc.org (Canada).

What products can be used in maintaining a green roof PMR?

Often chemicals are used in maintaining the green roof PMR, including fertilizers, pesticides and herbicides. Because of the many different components in the roof assembly, it is recommended that chemical compatibility be checked for each component (e.g., filter products, preformed drainage layers, membranes). In general, for STYROFOAM™ extruded polystyrene insulation, always use a solvent-free product. Refer to the STYROFOAM product information sheet for a list of compatible products. If in doubt, contact your local Dow representative or call 1-866-583-BLUE (2583) for additional support.

TABLE 2

LEED Credits	
Sustainable Sites	
SS 5.1	Site Development: Protect or Restore Habitat
SS 5.2	Reduced Site Disturbance: Maximize Open Space
SS 6.1	Stormwater Management: Quantity Control
SS 6.2	Stormwater Management: Quality Control
SS 7.1	Heat Island Effect: Non-roof
SS 7.2	Heat Island Effect: Roof
Water Efficiency	
WE 1.1	Water Efficient Landscaping: Reduce by 50%
WE 1.2	Water Efficient Landscaping: No Potable Use or No Irrigation
WE 2	Innovative Wastewater Technologies
Innovative Design	
ID 1	Innovation in Design

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

IN CANADA:
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- For Sales Information: **1-800-232-2436** (English); **1-800-565-1255** (French)

DOW CHEMICAL CANADA INC.
• Building Solutions • Suite 2200 • 250 – 6th Ave. SW • Calgary, AB T2P 3H7
www.dowstyrofoam.ca/4architects

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