White Paper

# Walkable and Waterproof
## PVC Sundeck and Flat Roof Installation and Application

*By John Ogilvie, President of Duradek*

Whether it is a restaurant's rooftop patio or a townhouse complex's series of open-air terraces, a dearth of usable space means many urban projects are claiming their roof systems as pedestrian areas. Unfortunately, roofing products are rarely intended for this sort of traffic.

Protective carpeting or treated wood can be placed over an assembly, but these materials are still susceptible to damage from the elements. Similarly, applied coatings and fiberglass have been used with limited success due to the inherent deficiencies in the materials themselves.

For multi-unit residential buildings (MURBs) and light commercial projects, walkable decks finished with heavy-duty polyvinyl chloride (PVC) thermoplastic waterproofing membranes have been used successfully in Canada for several decades, and are now growing in popularity in the United States. However, these systems are not without their limitations, and design professionals must understand the installation considerations.

## PROBLEMS WITH DECK WATERPROOFING

Often built with a wood or concrete substrate, pedestrian roof decks can be waterproofed using various systems. In 'protected' assemblies, the waterproofed membranes are shielded from the elements by another surface (e.g. concrete pavers, tiles, or wood deck boards).

However, these traditional methods can result in numerous problems, ranging from deterioration to delamination, that require costly maintenance and expensive repairs.

For example, while treated wood decks can have a unique aesthetic appeal, long-term exposure to moisture can cause decking to split, warp, shrink, crack, and/or rot. Wood assemblies can also be highly combustible and slippery when wet, requiring constant maintenance, regular repainting and re-staining to ensure safety and acceptable appearance.

There are also difficulties with paver overlays since the structure has to be designed to accept the additional weight and clearance. Additionally, drainage is critical to the waterproof membrane underneath the paver system, which is difficult to get at should maintenance, repair, or replacement become necessary.

In exposed assemblies, the waterproof membrane—either a liquid-applied coating or a PVC product—is left open to the elements. However, since concrete substrates tend to shift in response to daily temperature fluctuations, the use of epoxy, urethane, and acrylic coatings can be challenging. Constant movement can put enormous stress on these waterproofing products, resulting in pinholes, blisters, or surface cracks that allow moisture to penetrate the membrane and cause further deterioration.

Even PVC is by no means problem-free. While normal pedestrian traffic should not damage the vinyl, removing snow, moving equipment, or sharp impact can cause mechanical damage, extreme ultraviolet (UV) ray exposure can fade or 'chalk' the membrane, and abrasion can scuff the printed pattern.
To combat these issues, roof-grade PVC decking membranes should withstand the same rigorous material standards testing as thermoplastic single-ply roof coverings. In high traffic zones, solid-colored products are recommended to minimize issues of scuffing or abrasion.

## VINYL ADVANTAGES

PVC membranes are extremely durable—even when exposed to heavy traffic and severe weather conditions, they do not peel, chip, delaminate, or crack. The product offers varying degrees of slip resistance as required for the particular project and can consequently be considered safer than traditional surface materials that become slippery when wet. Walkable PVC membranes are designed and tested to offer a static coefficient of friction (or slip resistance) of:

- Dry conditions: equal to or greater than 0.50 for leather and equal to greater than 0.70 for rubber.
- Wet conditions: equal to or greater than 0.60 for leather and equal to or greater than 0.65 for rubber.

Since it is pre-manufactured, the material can be fabric-reinforced to provide additional stability and multi-directional strength. Walkable PVC roof membranes can cost up to 50 percent less than conventional membranes installed with a protective overlay. They also feature benefits in terms of its easy installation and low maintenance requirements - while coated systems can require recoating, vinyl deck systems are maintainable with periodic washing to remove surface dirt. Rougher membranes can require washing with a scrub brush and mild detergent or pressure washing. Regular inspection of caulking and immediate attention to any loose seaming help ensure the PVC membrane lasts for years to come.

A properly specified PVC membrane should incorporate mildew inhibitors, be fire-retardant, resistant to chemicals, and meet all building code standards. It should also have UV ray and heat stabilizers to resist the potential of vinyl cracking, embrittlement and discoloration.

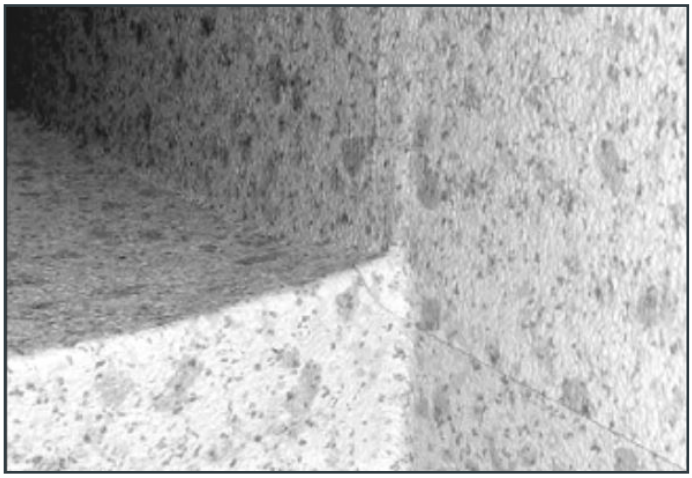
While waterproofing is the most significant attribute of a PVC membrane, appearance is also important. Vinyl products come in a wide variety of patterns, colors, and textures geared to diverse needs and budgets that can create complimentary or contrasting borders.

## DEFLECTION CONSIDERATIONS

The deck's ability to control surface water is affected by several factors, including slope, drip edges, and diverters. For the best performance, the structure should be sloped to eliminate ponding water, while accounting for building shrinkage or settlement. When the deck is designed with the correct slope, water should flow away from the building into a gutter system or over a drip edge away from the exterior wall system.

On new construction, wood-frame buildings can shrink as much as 12.7 mm (0.5 in.) per floor, which can result in the balcony sloping in the wrong direction—a situation that can have adverse consequences for controlling surface water.

Furthermore, building settling can make things worse if enough slope has not been built in. Nevertheless, given the proper grade—approximately two percent 1:50—a simple drip edge detail is usually the most expedient way of removing surface water from the deck surface. (False fascia detailing can be used to hide the gutter, fascia, railing mounts, and deck slope.)



Severe structural damage can occur when the waterproofing detail is incorrect. To address this situation, simple pre-manufactured diverters can be installed and waterproofed to steer water away from adjoining walls and other critical junctions.

## DEALING WITH DRAINAGE

Drainage is dependent on flashing, the proper sequencing of moisture barriers, and the detailing of wall openings. Special attention to flashing is

important, as incorrect detailing of these elements invariably leads to leaks and water damage. For example, curbs or knee walls higher than 76 mm (3 in.), or higher than a wall opening, result in a 'trapped' deck system that needs special drainage. Should a trapped deck occur, the top plate of the curb or knee wall must slope back toward the deck surface. The PVC membrane should also extend to the line of the outside drip edge, which, in turn, should extend well beyond the building wall surface.

Proper sequencing of moisture barriers is critical, and installing the PVC membrane after the wall assembly has been completed almost always leads to failure. In the first step, the vinyl is installed on the floor and extended up the wall at least 152 mm (6 in.), with the actual height dictated by the local building code.

Vertical surfaces are then covered by a building paper (or other wall moisture barrier) that overlaps the vinyl by at least 52 mm (2 in.). Horizontal surfaces (e.g. the top of stub walls or solid railings) should be covered with a peel-and-stick membrane, with special attention paid to the 'saddle' where they meet vertical surfaces.

Many decks have posts and columns that need proper construction and sequencing of moisture barriers to prevent water from seeping under the PVC. Water may find an entry point in the post itself and get in behind the waterproof membrane.

As wood posts or columns can crack and allow water to get into the subsurface, they should be covered with a moisture barrier and then finished with siding. Where the aesthetic effect of a rough-hewn wood post is required, special consideration must be made for post attachment.

Curbs, knee walls, posts, and wall openings must be built and detailed to ensure membrane performance. In constructing or modifying door openings, door sills should be sloped toward the deck surface for optimum drainage, and the waterproof membrane should continue into the rough door opening saddle to deflect any moisture.

Building authorities can require overflow drains or scupper boxes on trapped decks to provide a path for water to drain from the deck.

Drains and scuppers should be sloped toward the outside, and scuppers should be inserted into the deck surface to prevent ponding. Scuppers are generally quite difficult to detail in such a way that makes them impervious to wind, rain, snow, and structural deflection.

Drains should be approved roof products—acrylonitrile butadiene styrene (ABS)-shower drains are only acceptable for showers and are unsuitable for any roof deck or multiple-unit residential building (MURB) application.

PVC-coated drains or drains with a positive clamping system are suitable to allow water to drain into the building's stormwater system. With PVC-coated overflow devices, the decking membrane can be welded directly to the PVC-coated surface, without caulking.

## DRYING AND DURABILITY

Drying can be aided by the use of a rainscreen wall assembly or the venting of trapped air spaces. To reduce moisture buildup, venting of the space underneath decks, balconies, and walkways with a closed soffit or ceiling is especially important. (To be effective, the vent area should have a 1:150 ratio to the insulated ceiling area.)

If equal venting cannot be provided at both ends of the joist runs, then purlins should be installed above the joists to allow for cross-ventilation. Some manufacturers (with mesh bug screens) that allow for venting of the roof space joists in new and retrofit construction.

While drying helps prevent mildew, mold, and rot, the roofing components must also be tough enough

to stand up to foot traffic, chemicals, and other environmental conditions. The assembly's durability is affected by the quality of the waterproofing membrane and its overall maintenance.

While two membranes can have a similar appearance, the quality of their ingredients can give the product a price differential of up to 25 percent, and a difference in life expectancy of as much as 75 percent.

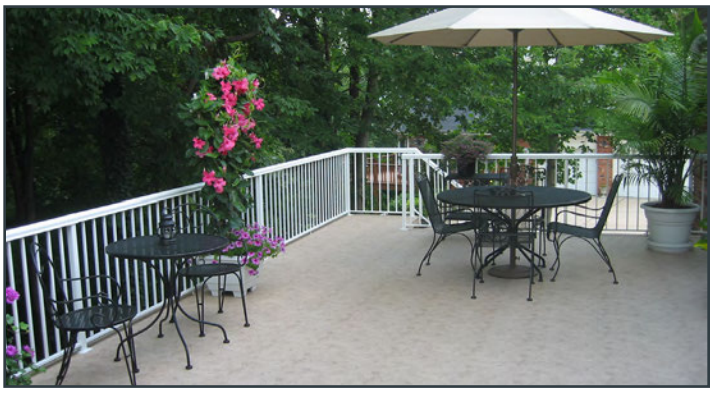
Walkable PVC roof deck membranes have to go through the same rigorous product 'material standards' and 'fire test of roof coverings' as thinner thermoplastic single-ply roofing membranes, respectively:

- ASTM International D 4434 , Standard Specification for Polyvinyl Chloride Sheet Roofing; and
- Either ASTM E 108, Standard Test Methods for Fire Tests of Roof Coverings, or Canadian General Standards Board (CGSB) 37.54-95, Polyvinyl Chloride Roofing and Waterproofing Membrane.

When evaluating a thermoplastic roofing that will face light pedestrian traffic, it should be subjected to additional abrasion and slip resistance testing.

Any alternative material, type, or method of construction can be accepted as long as it demonstrates compliance with the performance features of the applicable code. In the United States, the International Code Council Evaluation Service (ICC-ES) evaluates membranes in accordance with AC 39, Acceptance Criteria for Walking Decks. Roof and walking deck membranes can be listed by ICC as 07 18 00 – Traffic Coatings or 07 54 00 – Thermoplastic Membrane Roofing.

Waterproofing membrane products must also be manufactured under an approved quality control program with visits by an inspection agency under the International Accreditation Service (IAS). It is also important to ensure the compatibility of the waterproofing system's components (e.g. membrane, tapes, sealants, adhesives, drains, scupper boxes, flashings, perimeter fastening devices).



With proper care and cleaning, waterproof PVC membranes can be expected to last for 10 to 15 years or more. De-mountable flashing systems are one way to reduce the deconstruction required when one must eventually repair or replace a membrane. These systems are easy to remove, and allow the PVC to be repaired or replaced quickly and easily with minimum destruction. Membrane and trim panels can be replaced without disrupting the existing wall system and doors, which means one need not remove the siding or stucco or compromise the second waterproofing job.

## PRE-INSTALLATION DECISIONS

For best results, installation and seaming plans showing joints, termination details, and material interfaces should be prepared, along with two labeled samples (216 x 279 mm [8.5 x 11 in.]) of the specified PVC membrane illustrating finish, pattern, color, and backing. At least one week before installation, a pre-installation meeting should be held involving the client's representative, manufacturer's representative, contractor, and installer to discuss pedestrian deck waterproofing practices, as well as any precautions applicable to the specific project.

When it comes to the actual PVC product used for the roof deck system, there are several factors to keep in mind. It is important to specify a polyester-reinforced PVC membrane with UV resistance for fully adhered installation with heat-welded seams and perimeter attachment. One must always specify overall sheet thickness, as well as width and color.

With the exception of cap flashings (which are typically manufactured and installed by other parties), all perimeter fasteners and PVC-coated metal scuppers, overflow drains, roof drains, and trim should be provided by the membrane manufacturer. Whenever possible, the color of the perimeter fasteners should be coordinated with the membrane.

Prior to installation, an examination should be conducted to verify the existing deck is secure and solid in accordance with local code structural requirements, and that the surface is clean and smooth, free of depressions, waves, and projections, and properly sloped to drains, valleys, and eaves. Any joints, voids, or low areas of a wood deck should be filled and sanded smooth.

Any surface imperfections or variations on a concrete deck should be filled with leveling compound and the surface cleaned of any contaminants.

## SYSTEM INSTALLATION

This author recommends walking membranes be adhered directly to the structural deck, either concrete or plywood. In wood-frame construction, this can be achieved under typical 'cold roof' design, with the batt insulation installed between the roof joists. In concrete's case, when the insulation is applied atop the slab, this author recommends the plywood substrate be fastened to wood blocking/ sleeper/purlins. The concern is when the insulation is sandwiched between the plywood layer and the structural deck, it could compress (even in the case of high-density expanded polystyrene [EPS]), allowing the fastener to ride up and create a 'nail pop'.

Before the product hits the deck, there needs to be a thorough examination of the space to be covered. Sanded plywood or cement board provides the best finished surface possible. For the flattest face, it is recommended to use minimum 16-mm (0.63-in.) and preferably 19-mm (0.75-in.) plywood—anything thinner can warp due to the material's absorption of moisture from the atmosphere. The deck must also be secure, well-supported, clean, smooth, and properly sloped to drains, valleys, or eaves.

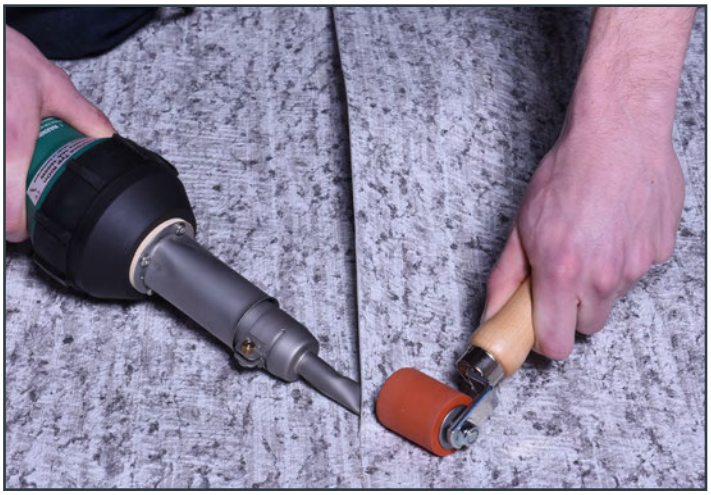
PVC deck membranes should not be applied directly to treated structural deck panels. Additives used in the various factory-applied treatments have caused 'backup' staining in the past. When pressure-treated plywood is required for deck construction, this author recommends an overlay with the aforementioned recommended plywood.

Surfaces and site conditions should be ready to receive the PVC membrane, and conform both to the membrane manufacturer's requirements and to local building code standards. If problems are seen, the installation consultant must be notified, with further inspection necessary in cases where a waterproof PVC membrane is being installed over an existing system. The deck must be thoroughly inspected for rot, weakness/delamination of plywood, loose panels, or spalling concrete hidden under the existing waterproofing membrane.

The surface must then be prepared. For wood decks, this mean filling in joints, knot holes, voids, and low areas with filler and sanding until a smooth surface is achieved. For a Class A fire-rated application, a plywood deck should be covered with a cementitious board that meets all requirements. For concrete decks, surface imperfections and variations must be filled with leveling compounds. It is also important to test for—and remove—surface contamination.

Waterproof PVC membranes should not be installed when temperatures are below -4 C (25 F), above 37 C (98 F), or when winds are more than 48 km/h (30 mph). To ensure adequate adhesion, installers should glue a small test patch of the PVC membrane (about 0.2 m2 [2 sf]) to the existing surface. After 24 hours, the adhesion should be checked. If there are any concerns about the membrane's ability to bond to the existing surface, the coating must be removed and the deck resurfaced with a suitable underlay.

The process of seaming two sheets of PVC membrane together is the most critical element of a PVC system. The vinyl sheets should be overlapped and heat-fused, with the membrane affixed to the substrate with as few seams as possible. However, all seams should be extremely strong and visible. Offering invisible butt seams, as has been done in the past, compromises the waterproofing.



To allow for a strong, hot-air-welded seam, adjacent membranes should overlap by a minimum of 19mm (0.75 in.). It is important to remember proper fusing cannot take place when the back of the overlapping piece of PVC has been glued. Seam strength and integrity should be checked every few feet—if the seam comes apart, the welding is incomplete and must be redone.

Extreme care must be used when welding a PVC membrane where the seam runs into a 90-degree corner and vertically up a wall or over an edge. All wall and corner seaming must be carefully inspected for pinholes. A strip of PVC can be welded on top of any critical junctions for added security.

Although building papers do not cause an issue, asphaltic products (e.g. peel-and-stick membranes) must be separated from PVC membranes with metal flashing, asphalt-compatible modified thermoplastic membrane, or aluminum foil tape. On projects where the deck is to be used as a staging area for other trades, protective panels should be applied over the finished membrane.

## PVC and Metal

For a roof deck installation with PVC and metal elements, the inside back corner and outside front corner of the PVC membrane are folded and welded, rather than cut. Galvanized flashing with a PVC clip holds the membrane in place, as does a roof-quality drain with clamping ring. Colored metal flashing is also used to hold the PVC membrane in place and prevent it from curling or shrinking.

*This article was written by Duradek President, John Ogilvie.*

## PVC and Coated Metal

For a roof deck membrane installation featuring PVC and coated metal elements, the PVC membrane is heat-welded to a PVC-coated flashing that provides a drip edge at the outside perimeter of the deck surface. The membrane is also heat-welded to a PVC-coated scupper box and a PVC-coated overflow drain—both allow drainage, even for trapped or curbed decks.

## L-Trim

In some roof deck membrane installations, a metal L-trim is used to secure the PVC membrane to both the outside and inside edges of the deck, balcony, or walkway surface, and extended up the wall by a minimum of 152 mm (6 in.) to meet some building codes. To ensure a waterproof installation, the PVC membrane is overlapped by the building paper and exterior finish.


**Quick Links for Duradek:** 3-Part Specifications | BIM and CAD | Testing and Approvals | AIA CES Course

## Duradek President, John Ogilvie's Bio

*John Ogilvie* is a pioneer in pvc waterproofing and has been involved with waterproofing decks and balconies with Duradek since 1976.

When the concept of a decorated, textured pvc membrane being glued to an outdoor pedestrian traffic surface was just in its infancy, Mr. Ogilvie started a contracting company focused on its sales and application.

After successfully establishing the product's introduction in the greater Vancouver market, he and his partner purchased a significant shareholding in the organization that developed the product line (they have subsequently become the sole owners).

With his contracting and marketing background, Mr. Ogilvie has been instrumental in development of the vinyl waterproofing products and installation that are currently being marketed all over North America.

Mr. Ogilvie was a key figure in developing the product line into the industry's first approved "walkable roof deck pvc system". He is currently involved in teaching new contracting firms how to install the products, certifying "journeymen" installers, as well as running "Best Practices for Deck Waterproofing" seminars to building envelope specialists in Canada and the U.S.

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