GREEN ROOFING SYSTEMS

Waterproofing Membrane

Selecting and designing a high-quality waterproofing membrane is essential since the membrane will be buried underneath layers of overburden and cannot be economically repaired or maintained. The facility manager should select a system with proven performance characteristics that incorporates multiple redundancies to reduce the possibility of leaks.

The waterproofing membrane can be a fully-adhered, mechanically-attached or loose-laid system. It is recommended to use a waterproofing membrane that is fully adhered directly to the deck substrate as it minimizes the potential for water migration if a leak occurs. For a fully-adhered membrane, the structural deck must provide adequate slope to drain.

The waterproofing membrane should have low-water absorption, low-vapor transmission, puncture resistance, chemical resistance and high-tensile strength. The following systems are recommended:

- Hot-fluid-applied, polymer-modified asphalt membranes consist of mopped asphalt reinforced with fabric, creating a continuous monolithic membrane without seams. When properly designed and installed, these systems have longevity. It solidly bonds to a properly-prepared deck substrate and has crack bridging properties. Hot asphalt used in installation can produce strong fumes and possibly create a fire hazard. Cold-process built-up systems avoid temperature application of asphalt and have fewer odors. The base coat should be 90 mils, with fabric reinforcement between a second coat of membrane at 125 mils, for a total thickness of 215 mils. A root barrier is required due to the organic (asphalt) nature of the membrane.
- SBS-polymer-modified bitumen sheet membranes are composed of overlapping sheets of polymer-modified asphalt between one or multiple reinforcing material layers. The asphalt acts as the waterproofing material while the fabric and felts provide the strength. The SBS sheet membrane should be a minimum of two layers for a green roof system. SBS membranes can be applied with hot asphalt or cold mastics. These membranes exhibit excellent puncture and impact resistance. A root barrier is required due to the organic (asphalt) nature of the membrane.
- Polyvinyl chloride (PVC) membrane consists of factory-fabricated sheets of reinforced PVC. A minimum thickness of 60 mil fabric-reinforced PVC membrane should be used for green roof waterproofing. The PVC membrane seams are thermally fused (hot air welded) to form a monolithic sheet that does not rely on adhesives for a watertight bond. These systems have a lower puncture resistance compared to the asphalt systems reinforced with felt. PVC is made from inorganic material and therefore does not require a root barrier.

Quality Assurance and Water Tests

Continuous visual inspection during green roof waterproofing membrane and green roof system application provides a complete and meaningful means of examining workmanship practices. If part-time inspections are performed, the inspections should occur at the beginning and end of significant

phases and when another construction trade's work may affect the performance of the green roof system. Before installation of overburden, a water test is conducted to evaluate whether a green roof membrane is leak-free under hydrostatic (e.g., standing water) and/or non-hydrostatic conditions (e.g., flowing water). Prior to performing a water test, all appropriate parties and trades should be notified when the water test will occur. A water test is conducted in one of two ways:

- A standing-water test is conducted by temporarily plugging or otherwise closing any deck drains and erecting temporary dams where required to retain water on the surface of the green roof waterproofing membrane then flooding the surface to a maximum depth of 2 inches at the high point and retaining the water for a minimum of 24 hours or as required by the manufacturer. Installation and removal of any temporary dams should not damage the membrane.
- A flowing-water test is conducted by applying continuously flowing water over the green roof waterproofing membrane's surface without closing drains or erecting dams for typically a minimum of 24 hours or as required by the manufacturer.

Installation and Maintenance

During construction, the waterproofing membrane will be walked by workers. It is important to install protection layers immediately after installation of the membrane to prevent waterproofing damage. Wind uplift of partially-completed roof components can occur. During construction it must be specified that contractors provide adequate ballast on components not attached to the roof deck. If plantings are installed before the remaining roof components, a wind scour protection blanket over the growing media may be required.

The waterproofing roof membrane is the most vital aspect of green roof longevity and success. These include all joints, borders or other features penetrating the roof, such as all abutting vertical walls, roof vent pipes, outlets, air conditioning units and perimeter areas.

The majority of leaks in a green roof (as with any roof) are not found in the membrane field, but in points of interruption, such as flashing, drainage and anchors. It is vital that these places of weakness be properly designed, installed and maintained. For very large green roof areas, vegetation free zones are also recommended to divide the roof into smaller zones in case of a leak or system failure.

All drains must remain free of vegetation and foreign objects. Inspection of drainage flow paths is crucial because of the severe consequences of drainage back-ups. In order to allow for regular inspections and maintenance, every drain on a green roof must remain permanently accessible. Roof outlets, drains, interior gutters, and emergency overflows should be kept free from obstruction by either providing a drainage barrier (e.g., a gravel barrier between the green roof and the emergency overflows) or they should be equipped with an inspection shaft. If an under-drain system is used, provide a clean-out for both inspection and maintenance. There is potential over the long term for the roof under-drain system to become clogged and the ability to access the underdrain system for clean-out is important.

Leak Detection

Several types of leak detection systems are available, including high and low voltage surface surveys and built-in time-domain reflectometer (TDR) sensors. High voltage methods cannot be used in wet environments and therefore are useful only as construction-phase quality control approach. Low voltage and TDR methods rely on the facts that: 1) the waterproofing membrane is an electrical insulator, and 2) water is an electrically conductive medium. The low voltage method is a survey technique that can be applied to green roof that are designed to enable this approach. For this reason there are few, if any, initial capital costs. TDR sensor arrays must be built into the roofing system. Unlike the low voltage method, however, these systems can provide real-time on-demand information about the waterproofing status and alarm owners if a problem is detected. Some manufacturers require Electric field vector mapping (EFVM) leak detection to receive their warranty. Descriptions of these techniques are provided in ASTM Standard Methods D6747 and D7007.