

ROOF GARDENS: The Waterproofing Challenge

By Douglas C. Fishburn

Photo 1: Landscape roofing located at Embassy Suites Hotel, Markham. Architects: Page & Steele Inc., Toronto

ABSTRACT

With the need to maximize investments, improve aesthetics, and create market appeal, the landscape podium has become the hallmark of prestigious commercial and residential buildings.

Roofs have often served secondary functions such as sun-decks and landscape terraces. In urban areas, there is increased interest in rooftop gardens for growing flowers, shrubs, herbs, and natural grass, which leads to the term "green roofing."

The green roof offers many technical, environmental, and social benefits. These benefits can be short lived if the roof fails to provide its principle function: watertightness.

This article focuses on factors impacting on "the green roof" waterproofing system and how, by increasing its overall durability, long-term service can be improved.

Roof Deck

Regardless of the type of roofing system, the roof deck must be designed with sufficient structural capacity to accommodate both live and dead loads. Single-ply roof membrane systems typically weigh 1 kilogram/10.24m² (2 lb. per 100 sq feet), while more traditional systems are in the 2.26 kilograms to 3.175 kilograms/10.24m² range (5 to 7 psf).

Protected membrane roofs with landscaping may range from 48.82 kilograms to 976.5 kilograms/m² (10 to 200 psf). While a deck can be designed to accommodate almost any weight, increasing the load-carrying capacity comes with a cost penalty. In addition, other parts of the structure, including the foundation, may have to be strengthened accordingly to accommodate the increased loads.

The use of lightweight materials in the design of landscape roofing extends the potential use in both new and existing buildings. Reducing gravity or live loads by the use of lightweight planters for larger shrubs and locating them over columns or at the roof's perimeter are alternative ways by which this can be accomplished.

Building up raised planters with polystyrene insulation in lieu of a full depth of soil, using drainage mats in lieu of a heavy layer of gravel, and using planting medium and plant varieties that can grow in a minimum of soil thickness (50 mm) will reduce both weight and cost. Such measures greatly increase the true potential of the "green roof."

In traffic zones, concrete-topped insulation, rubber walkway pavers, stepping stones, and wood or plastic walkways all serve to reduce weight over the more traditional methods of construc-

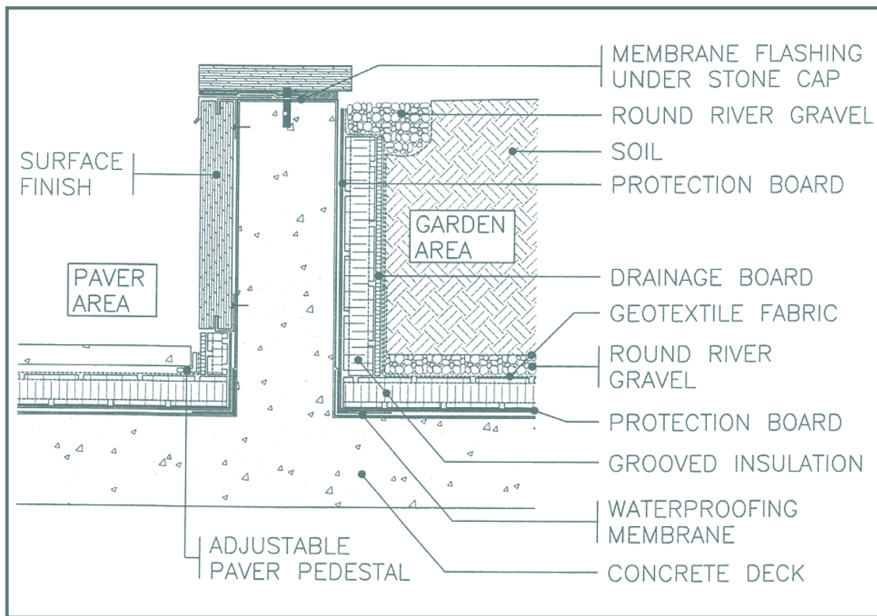


Figure 1: An example of a traditional approach to landscape roofing. The gravity load on the structure is substantial and therefore utilizes a concrete deck.

tion used in the past. While a number of roof decks can be utilized, larger construction projects typically utilize concrete due to its high strength, lower cost, and ease of providing slope-to-drain.

Protected Membrane Roofing System

Although the use of conventional roofing is possible, typically, landscape roofs are constructed from a protected roof membrane design. With this design, the membrane is placed on the deck and under the insulation, thereby shielding the membrane from the external environment and possible damage from roof traffic, either during or following construction. With this approach, the membrane serves as the waterproofing and air/vapor barrier.

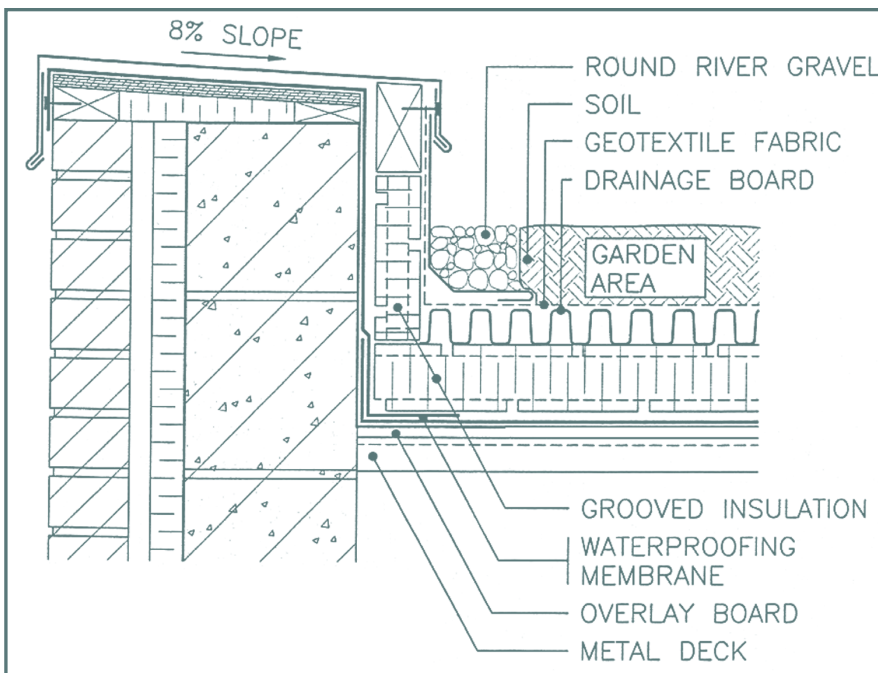


Figure 2: An example of a lightweight system using a steel deck.

Slope and Drainage

Landscape roofing increases the control of stormwater management since it absorbs rainwater and releases it more slowly into the storm drainage system or is absorbed and released through evaporation. What may be a stormwater advantage can be a disadvantage for the waterproofing system; therefore, roof decks should be designed with positive slope to shed water since top-side venting is a slow process, and water can be trapped in the system. Top-side venting is encouraged and can be built into the design by the selection of roof finishes.

Sloping the structural decks a minimum of 2% is usually adequate for drainage, providing the drains are located at the low points and recessed below deck level.

Scoring the underside of insulation with drainage grooves or providing a drainage mat will aid drainage at the membrane level and assist top-side venting. This practice is recommended to reduce the negative impact of water ponding on the roof membrane.

The use of control flow drains should be avoided since they can back up water into the landscaping and increase the effects of wetting and drying of the roof membrane. Roof drains must be accessible for regular inspection and maintenance. Heat loss from the roof drains will support the growth of moss, resulting in clogging and obstructions.

Due to constant exposure to moisture and the corrosive nature of some fertilizers, the use of drains that are corrosion resistant is preferred. Regardless of type, the additional protection of drains (by installing protective coatings such as asphalt) is highly recommended.

Factors in Membrane Selection

While most membranes, including loose-laid EPDM and PVC, have been used for landscaping roofs, great care in the design and application must be employed. These systems do not have the benefits of redundancy.

While water cut-off mastics can be used to limit the spread of water under the membranes that are loose laid, field experience has shown they have had only limited success.

Multiple layer systems that are solidly bonded to the deck (such as hot rubber, kettle-modified SEBS mopping asphalts, or prefabricated modified membranes), offer good water resistance. They also provide redundancy of a multi-ply system, and (in the case of leaks) will limit moisture ingress to localized areas since they are bonded to the deck.

Additional layers of membrane can be added if required to build up low points and eliminate water ponding on the membrane surface.

The potential disruption and cost to remove and replace roof gardens in order to gain access to a roof membrane, should a leak occur, are massive.

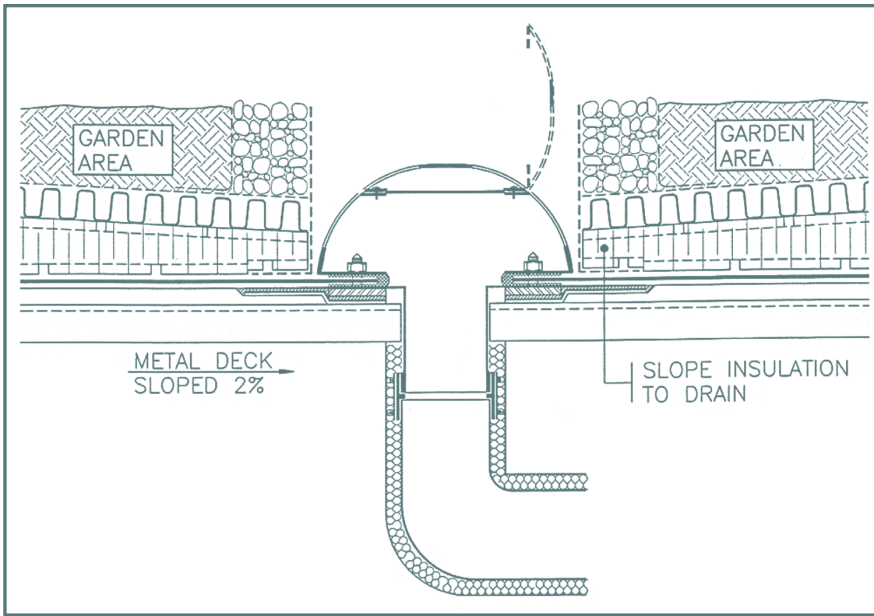


Figure 3 provides an example of a drain roof assembly.

In order to avoid this, it is prudent to increase the number of plies of membrane beyond that normally recommended for more conventional use. Increasing the number of plies will have a minor impact on cost but can have a major impact on long-term performance and roof service life.

Given prudent design, proper construction, and regular maintenance, it is technically feasible to have waterproof systems in rooftop gardens perform problem free for as long as 35 to 50 years. Water testing is recommended to confirm slope and function prior to installing the insulation and commencing any landscaping.

When incorporating ponds and waterfalls into "green roofing" designs, they should be installed with an additional, independent waterproofing system.

Large areas of green roofing should be separated into smaller sections by the installation of area dividers. This allows for precise moisture control according to the requirements of any given section, enabling a wider variety of fauna to be successfully established, which can add to the overall aesthetics.

Additional benefits include achieving the required drainage slope while minimizing the impact of elevations at wall junctions. This approach will also reduce the costs of repairs should the need arise, since the leaks will be contained within smaller areas.

Flashing

Roof design is never easy; however, the details of landscaping roofs often pose increased challenges. For example, not only do flashings have to be watertight, they must be integrated

into the other elements of the building.

The height of the flashing must be sufficient to render watertightness under wind and weather conditions. Snow accumulation against roof or wall junctions and at roof access points is of particular concern. Flashing height at roof projections must be raised to accommodate the depth of landscaping fill and still provide protection against moisture ingress due to water or snow accumulation.

Roof flashings typically represent 70% of all roofing problems and should be designed to allow for inspection and maintenance. While trade-offs are common, waterproofing should not be sacrificed for aesthetics.

In order to improve long-term performance, covering the vertical portions of the roof flashings with insulation is recommended. This approach will not only reduce the impact of the

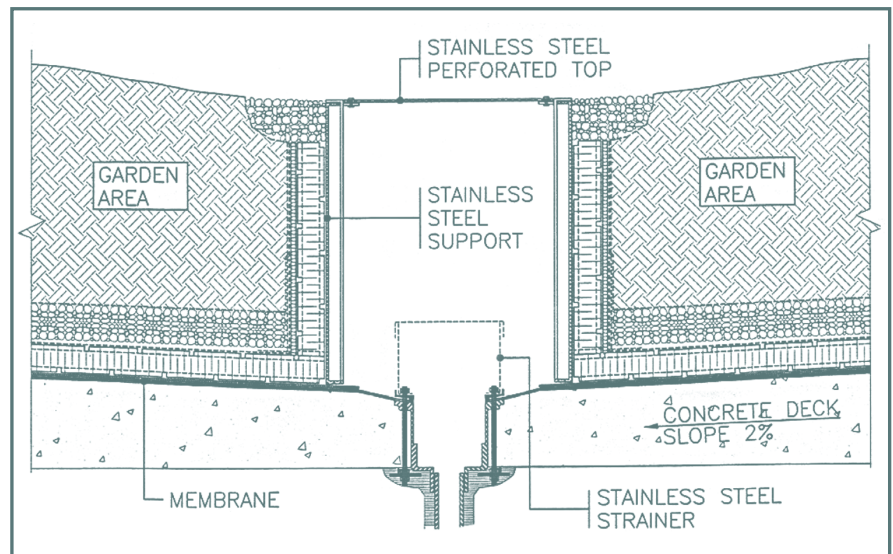
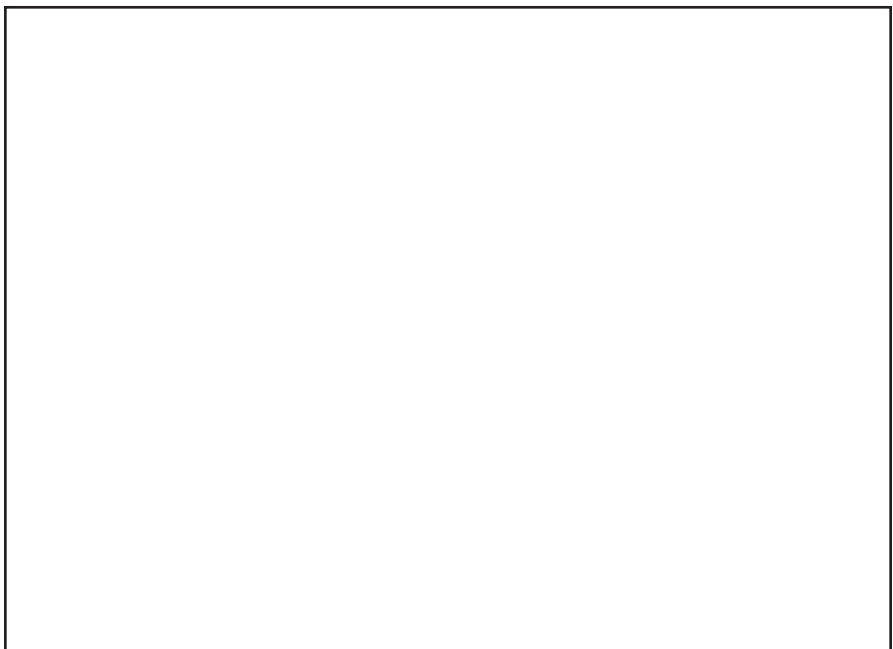


Figure 4. An example of a lightweight roof assembly.



external environment on the performance of roof flashings, it improves the roof's overall thermal performance and reduces the need and frequency of roof maintenance.

Copper or stainless steel is recommended to flash roof openings such as soil pipes or exhaust stacks, due to their ability to resist corrosion. Depending upon their location, high-grade, pre-finished metal, copper, or stainless sheet counterflashings are also recommended for the same reasons. Aluminum flashings are not recommended due to poor performance when exposed to some fertilizers.

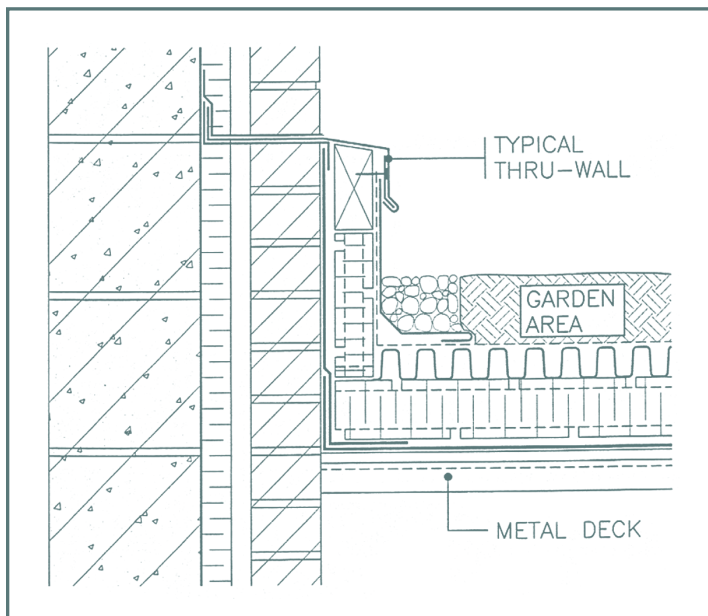


Figure 5 shows roof wall junction, lightweight assembly.

Insulations

Due to its uniqueness, the landscape roof places great demands on the insulation component. The type of insulation employed must have good physical and moisture-resistant properties, such as with extruded polystyrene.

The insulation is recommended to be loose-laid and scored on the underside to facilitate drainage at the membrane level. In this configuration, the weight of landscaping must be sufficient to prevent floatation of the insulation.

While a double layer of insulation will improve thermal efficiency on a conventional roof, it is not recommended for landscape roofing of protected membrane design.

The placement of concrete pavers in direct contact with the insulation or installing insulation in two layers will result in a build-up of moisture within the insulation and erode its thermal performance. To prevent this, top-side venting above the insulation is required.

Top-side venting can be accomplished by elevating of pavers on pedestals or by installing an adequate thickness of clean aggregate or pre-manufactured drainage material above the insulation.

Crushed screening or aggregates that will absorb sufficient moisture to freeze or break down under repeated freeze/thaw cycles are not recommended. ■

SUMMARY

Roof gardens can provide aesthetic appeal and improved moisture and thermal and sound control. Designs must focus on providing long-term service, particularly making provisions for moisture control, slope for drainage, watertight membranes and flashings, and moisture-resistant insulation. Accessibility for inspection and maintenance is also a major consideration. Otherwise, the benefits of roof gardens will not be realized and their contribution toward the improvement of the urban environment will be short-lived.

ABOUT THE AUTHOR

Douglas C. Fishburn, RRO, is a graduate of O.A.C., now known as the University of Guelph, Ontario. He is also the founder and president of Fishburn Building Sciences Group Inc., a specialized engineering firm in Hornby, Ontario, that consults on the design, inspection, testing, and maintenance of roofing, waterproofing, air barriers, and building envelope systems. Fishburn has more than 40 years of experience and has presented technical papers at international building symposia, lectured at universities, and provided training seminars for trade organizations, universities, and government bodies. He holds several patents on roofing and air barrier systems. Fishburn also sits on a number of boards responsible for setting standards within the construction industry, such as the CGSB and CSA. He is a former director of Region 8 of RCI.



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