Styroblock™ containers

the afterlife—a zero-waste solution through re-use on green roofs

| Jolyon Hodgson

ABSTRACT

Nurseries that produce a variety of plant species often grow them in Styroblock™ container systems. A major problem with these systems, however, is finding a method of disposal for "retired blocks" once they are no longer useable. One solution can be to recycle old blocks as light fill for landscaping, particularly in green roof applications. They can provide an economic and environmentally sound alternative to traditional landscaping products.

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KEY WORDS
green roof technology, Terrafill, expanded polystyrene, recycled materials

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Interest in the technology of "green" roofs, also known as "vegetative," "living," or "eco-roofs," is increasing worldwide. Although the market in North America is early in its development, green roof products and services in Germany, France, Austria, and Switzerland are well established and have become multimillion dollar industries. Modern green roof technology (GRT) started in the early 1970s in Germany, and, in 1997, the green roof industry in that country had 700 million DM in sales (GRFHC 2005; Philippi 2006). In Germany alone, it is estimated that 10 million m^2 (108 million ft^2) of green roofs have been installed in recent years, or approximately 10% of all new roof installations (Daniels 2000; Swanson 2001).

Rooftops comprise anywhere from 15 to 35% of the land area in most developed countries (Peck 2005). Green roof infrastructure has become the highest profile component of green building design, providing a unique opportunity to transform barren roofscapes into areas with economic, social, and environmental benefits.

BENEFITS OF GRT

Economic

The energy conservation that can result from the increased thermal efficiency of a green roof can provide a financial benefit for the owner or developer of a building. The cooling and shading properties of a green roof can significantly limit heat flow into a building, thus resulting in reduced loads on interior cooling systems.

Green roofs can extend the service life of roofing membranes and materials from extreme temperature fluctuations and the negative impact of ultraviolet radiation. North American roofs have an average lifespan of 10 to 15 y. Protected membrane roof (PMR) assemblies, where the membrane is buried beneath insulation, can have an average lifespan of 20 to 25 y (DOW 2009). Experience with green roofs in Germany has shown that a green roof assembly can be expected to outlast a comparable conventional roof by a factor of at least 2, and often 3 times (Miller 2003), and most commercially built roofs in Germany now include a 30-y warranty (Swanson 2001).

Property values have been shown to increase with the addition of a green roof structure. Converting barren rooftops into aesthetically pleasing green spaces can translate into increased rent revenue and resale value (Peck 2004).

For many business owners, the Leadership in Energy and Environmental Design (LEED™) rating of a building can be an important consideration. Green roofs can result in an improved rating of 7 to 15 credits, depending on the design and level of integration with other building systems (Kula 2005).

Social

A green roof system has been shown to reduce the levels of indoor sound, allowing for a healthier work and living situation. A simple 8 cm (3 in) thick green roof can reduce sound transmission by a minimum of 5 decibels (Miller 2003); a green roof with a 12 cm (4.7 in) thick substrate layer can reduce sound by 40 decibels (GRFHC 2005; Fields 2008).

Other social benefits of a green roof include the provision of aesthetically appealing space for recreation and meetings, green space to be viewed from surrounding areas, potential food production areas, and the potential to improve employee productivity (GRFHC 2005).

Environmental

The environmental benefits of green roofs may be the most important factors for installing a green roof system. Green roofs can provide a highly effective method of managing stormwater discharge from a roof by both reducing flow and filtering impurities, thereby protecting sensitive watersheds and reducing costs of other drainage structures. On an annual basis, total rainfall runoff quantity can be reduced by 50% or more for a typical 2.5-cm (1-in) rainfall event (Fields 2008; Schundler 2009). In one recent large-scale green roof installation in Washington, DC, the roof reportedly retained more than 104 000 l (27 500 gal), or nearly 75% of all precipitation, in a 1-y period (Lapides 2007).

Green roofs have the ability to moderate the Urban Heat Island Effect, defined as the temperature difference between a city and the surrounding countryside as caused by the large reflective surface found in the city environment (GRFHC 2005). Green rooftops can lower rooftop temperatures from 54 °C (>130 °F) to approximately 24 °C (75 °F) on a summer day (Swanson 2001; Fields 2008).

Additional environmental benefits from green roofs include improvement in air quality by filtration of airborne particulates and sequestration of CO_2, potential creation of wildlife habitat, and reduction in landfill disposal by the potential use of recycled materials.

DESIGNING THE GREEN ROOF

A typical green roof comprises several distinct layers (Figure 1). The layers include a lightweight soil medium that is underlain by a drainage layer and a high-quality impermeable membrane to protect the structure of the building. These structures can range from lightweight systems, containing 5 to 7.5 cm (2 to 3 in) of soil with low, succulent plant material, to heavier systems containing deeper soil to support a wider variety of plant material (LID 2007a).

The purpose of the drainage layer is to remove excess water from the roof. It must provide sufficient void space and slope to allow excess subsurface water to be transported to drainage boards, drains, and (or) pipes that will remove enough water from the roof so as not to compromise the waterproofing system or its supporting structure. This layer also promotes aerated conditions in the overlying growth medium layer, allowing sufficient water to remain in the system to sustain plant life (Wingfield 2005; LID 2007b). This portion of the design is specified by a landscape architect who is licensed in the art of planning, designing, and management of the built or natural environment, and who is responsible for the design, specifications, and cost estimates.

A filter fabric is located above the drainage layer. This fabric is a lightweight, rot-proof material placed over, or included as part of, the drainage layer to keep the growing medium in place and thereby prevent fine particles from blocking the drainage system. This may be a woven or nonwoven, nonbiodegradable landscape fabric that is tough enough to withstand unavoidable wear and tear during installation of other layers (Figure 2).

The type and amount of structural deck, waterproofing membrane, and root barrier are all specified by a building architect.

STYROBLOCK™ TRAYS IN GREEN ROOF CONSTRUCTION

One problem often faced by green roof landscape architects is how to introduce features, including mounds, ridges, and berms, to break the monotony of a flat roof without unduly increasing the physical loading. Adding more soil, unless required for the plant species, is both expensive and likely to overload the structure. The additional load of an extensive green roof can reach approximately 200 kg/m^2 (40 lb/ft^2) (ASLA 2006). Structures can be formed, or the entire soil level can be raised, by inserting a filler layer beneath the soil. If the green roof feature requires filler in order to add "topography" to the roof, then the landscape architect must decide what products to use. The characteristics of a desirable filler include being:

- lightweight, yet with a high compressive strength;
- stable, so it does not expand, contract, erode, or contaminate;
- well-drained, allowing rainfall to percolate vertically to the drainage layer of the roof;

- waterproof, so it does not absorb water and increase in mass; and
- environmentally acceptable, preferably a recycled or re-used material, such as polystyrene, recycled plastic, crushed brick, or a variety of other materials (Peck 2005; Phillipi 2006).

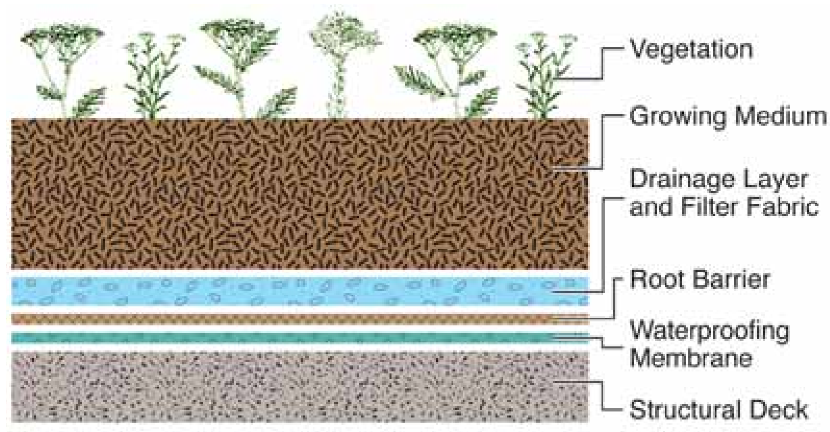

Figure 1. Principle components of green roof technology.

Figure 2. Nonwoven, nonbiodegradable landscape fabric can be used as the filter fabric above the drainage layer.

Nurseries that produce a variety of plant species often grow them in Styroblock™ containers. Although these blocks have a long service life, up to 10 y for some nurseries (Beaver Plastics 2009a), lack of effective disposal methods after their useful life has expired presents a major problem. Recycling options exist for some containers, for example, conversion to Styrolite™ media amendment, Styrogrit™ seed cover (Beaver Plastics 2009b), or even boat dock floats. While awaiting transformation into these products, Styroblock™ trays present a significant inconvenience for nurseries. Because the trays don't nest within each other, the "boneyards" of discarded trays can become quite large, creating massive storage challenges, especially for smaller nurseries.

One solution to this recycling problem may lie in a product called "Terrafill," which is a term we use for an old Styroblock™ tray that is retired from the nursery and can be sold into re-use as light fill for landscaping, particularly for green roof applications. Like traditional fill, such as lava rock, Terrafill can form the fill or drainage layer, and can be built to whatever thickness the landscape architect desires. Because Styroblock™ trays are manufactured from expanded polystyrene (EPS), they are lightweight, completely stable and inert, provide excellent resistance to freeze/thaw events, and have low moisture absorption properties (UFP 2007; Beaver Plastics 2009c). A comparison of costs and weights is presented in Table 1.

If Terrafill becomes the material of choice for a project, the landscaping contractor, who procures materials and installs drainage, irrigation, growing medium, and plant material, will require the product to be packaged for efficient delivery and placement. The convenience provided by working with Terrafill allows the landscaping contractor to be more efficient. The trays can be stacked or overlapped without concern for damage or drainage, can be wrapped for transport, and are easily transported to and placed on the site (Figure 3). Terrafill costs include transport to the building site. Although this may seem to be a drawback if the blocks are located at a remote plant nursery, transport is equally a component of every other alternative (for example, lava rock is mined in New Mexico and northern British Columbia).

Terrafill provides a unique opportunity to produce a variety of landscape features. It can simply be used to raise the level of a flat soil layer, or in a more complex manner to create a sloping feature for "hillside" landscaping (Figure 4). Once the Terrafill is in place, a filter fabric can be drawn over this drainage layer, and the entire structure can be covered with growing medium (Figure 5). Once all layers are in place, the final step of vegetating the structure can take place (Figure 6). The soil or growing medium is planted with a specialized mix of native plants that can thrive in the harsh, dry, high-temperature conditions of the roof and tolerate short periods of intense rainfall.

TABLE 1

Comparison of costs and weights for Terrafill and lava rock as a filler for green roof designs.

	Terrafill	Lava rock
Density kg/m^3 (lb/ft^3)	< 16 (< 1.0)	810 (50)
Wholesale cost per m^3 (per ft^3) (in US$)	< $36 (< $1)	> $72 (> $2)
Carbon footprint	Re-use (transport to site only)	Virgin (mining, processing, transport to site)

Figure 3. Terrafill that has been palletized and stretch-wrapped for use in landscaping.

COSTS OF GREEN ROOF CONSTRUCTION

Green roofs may not be applicable to all situations and may prove too costly for many applications. Because of the increased amount of materials needed and the intricate system involved in installation, a green roof can cost 30 to 60% more than a conventional roof system (Daniels 2000). An installed green roof system with repellant/waterproof membranes can cost between US$ 111 to 222/m^2 (US$ 10 to 20/ft^2) compared with US$ 56 to 111/m^2 (US$ 5 to 10/ft^2) for a conventional roof (GRFHC 2005; ASLA 2006). The savings in heating and cooling costs, as well as the extended life of the roof membrane, can offset this cost in the long run.

A useful tool can be found at www.greenroofs.org, where the Green-Save Calculator allows a building architect to compare roofing alternatives over a specific time period to determine which has the lowest life-cycle cost. It is excellent for determining whether higher initial costs are justified by reducing such future costs as operating, maintenance, repair, or replacement costs and (or) by producing additional benefits, such as energy savings.

SUMMARY

Recycling of "retired" Styroblock™ containers for use in landscaping projects, particularly green roof technology, can provide an economical and environmental solution to the problem of nursery waste disposal. This idea is one way to complete the cycle of manufacturing and recycling: containers can be used to grow plants to improve the environment, and spent containers can be re-used to improve the environment.

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Figure 4. Terrafill has been placed to create a stepped slope. Note the mix of tray sizes and the rough construction. Trays can be broken or cut with a handsaw to fill gaps.

Figure 5. Filter fabric is drawn over the drainage layer and covered with growing medium.

Figure 6. For a roof located in the city of Coquitlam, British Columbia, planting is initiated (A) and completed (B). The completed site in mid-August 2008, less than a year later (C). Note that only a single mortality has resulted.

AUTHOR INFORMATION

Jolyon Hodgson
Hodgson Consulting Inc
British Columbia, Canada
tjhodgson@shaw.ca

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