Moving forward: Green roofs

Environmental and civil engineers are working more with architects to realize greener designs. Geosynthetic professionals have plenty to contribute.

Green roofs have been, for the most part, absent from international architecture. Until recently, only one or two buildings in a handful of cities sported green roofs. In part, the delay, especially in North America, has been the result of cost concerns; but a lack of knowledge about soil and sealing drainage systems, including geosynthetic properties and possibilities, has been just as responsible. Judging by the number of projects recently completed and those in progress, green roofs have become a viable part of architectural design. A number of architects have taken up the challenge, and prominent infrastructure firms, civil and environmental engineers, and landscape architects have resolved the logistics of cost and material understanding. In Chicago, a major transformation of the city hall presages this new urban approach.

Following Europe

The green roof on Chicago City Hall is a multi-layer system modeled on European designs, with considerable attention paid to German designs. In Germany, green roofs are in many areas either subsidized by the government or required. Europe's aging sewer systems and commitment to maintaining architectural forms synonymous with traditional European culture have helped usher in better technologies and more sustainable approaches to stormwater mitigation.

Herein lies an often overlooked concern of stormwater management, at least among geotechnical professionals: building run-off. Construction site run-off and sediment control is spoken of with an intensity that suggests it is the only run-off concern in communities of ongoing development; but building run-off is just as much, if not more, of a concern. Conventional roofing does little to assuage the run-off taxation that storms in urban zones create; thus, grossly taxing the drainage systems and threatening stormwater infrastructures. A green roof, however, can largely mitigate run-off, and in the case of light storms (less than 25 mm) can absorb and utilize all of the rainwater.

Geosynthetics have been used extensively in erosion control and drainage system designs around the world. The success of green roofs in mitigating stormwater run-off—indeed, the success of the entire green roofing objective—is dependent upon proper incorporation of geosynthetic design.

BRUCE DVORAK, CONSERVATION DESIGN FORUM

Photo 1. The essential composition of a green roof involves three layers: sealing, filtering and vegetation. Waterproofing, root barriers, drainage media and erosion control blankets are just some of the geotechnical concerns that architects seek solutions for.

Layering

The European-inspired system in Chicago is actually a mix of systems, some of which rely on deeper soils and heavier layering in order to accommodate larger root plantings. In the green roofing field, the divisions for these plantings are referred to as *extensive*—characterized by grasses and shrubs—and *intensive*, which may incorporate root structures for trees. Semi-intensive layers inhabit some of the zones on the Chicago roof (**Figure 1**).

The vision for the city hall was to plant the roof with species indigenous to the Midwestern prairie. The end result is a publicly sponsored, 29,600 ft.^{2} (2,700 m^2) green roof that features thousands of plants representing over 100 plants types, various soil and root depths, and a few rolling hills that symbolize the region's grasslands.

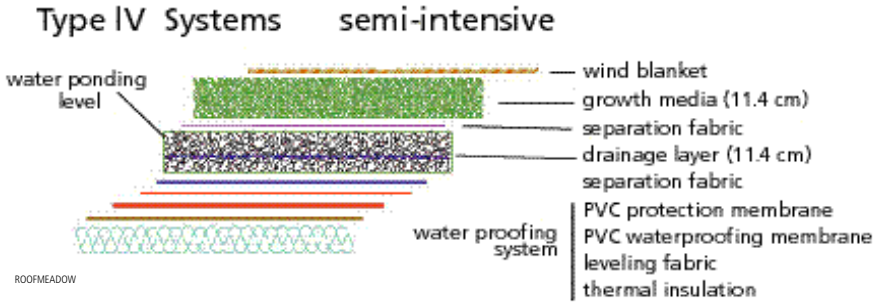

Figure 1. At its most complex points, the Chicago roof uses 10 layers and weighs approximately 317 kg/m^3, which is about 195 kg/m^3 lighter than normal soil. Growing media must be porous enough to avoid excessive water build-up, provide anchorage for plant roots, and provide plants with nutrients such as phosphorous, calcium, nitrogen and oxygen.

By Christopher Kelsey

Natural advantages

The building's structural composition and a peculiarity in its original construction aided the green roof's success. The city hall, built in 1911, was actually engineered to be one floor taller than constructed. Because of this, there were few fears about the structure's ability to take on a retrofit for which the team involved had little experience. The European system of layering membranes, aggregates, geotextiles, soils and erosion control blankets adds weight to the structure—though less than natural soil weights—so retrofit capabilities have limitations. But old, public buildings such as Chicago City Hall were often constructed with heavier materials, making European-style green roofs a retrofit choice for these older, strong structures in urban areas.

The roof features a mix of grasses and perennials laid out in radiant bands characterized by shifts in color and proximity of plantings. Beneath the surface, the complexity behind the mix of extensive, semi-intensive and intensive zones takes over. The plant variety is intended to thrive primarily on rainwater, just as in a natural, prairie environment. For a green roof to accomplish this, the hydrological design of the roof must involve the appropriate geotextile and aggregate soil to control drainage.

Resolving heat islands

Beyond the aesthetic and technological noteworthiness of the roof, the Chicago project serves as a touchstone for regulating the urban heat island effect. Standard roofing membranes and conventional blacktop roofs magnify the force of heat in a contained urban setting by either holding onto the heat or reflecting it into an atmosphere that, with its pollution, may reflect the heat back into the urban zone. Green roofs absorb the heat without magnifying it. On 89° F (32° C) summer days, the green roof remains relatively level with the atmospheric temperature while blacktop roofs operate at a temperature more than 15 degrees higher. Green roofs contribute, then, not only to urban environmental heat control but to building climate control. This, in turn, reduces building operation costs and drains less power from the city grid.

In short, it is a huge market with tremendous public benefit. Congested cities have old buildings capable of supporting lighter green roofs. New buildings can readily factor in a green roof. Geosynthetic knowledge is essential to successful design.

Looking ahead

More privately contracted green roofs are emerging. Recent examples include GAP Inc., San Francisco, and the Ducks Unlimited Canadian headquarters, Winnipeg, Manitoba. (Attendees of the 56th Canadian Geotechnical Society conference might take a side trip to see this structure.) Increasingly, cities are offering subsidized programs for retrofitting green roofs and for building them into new constructions. Portland, Ore., has one such program. New York, Los Angeles and Atlanta all have urban heat island control programs too, and there are considerable awareness efforts and designs readily observable in Canadian urban planning and architecture. With technological advancements and rising concerns with sustainability and an architecture that not only culturally represents and influences its people but also responds positively to the global environment, the wide-scale reality of green roofs, cooler urban zones, and healthier cities may not be too far off. GFR

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Maintenance concerns

- *Extensive* green roofs—primarily grasses—require little maintenance beyond initial watering. Once the vegetation establishes its roots and is healthy, normal precipation will generally be enough.
- Slow release fertilizer may be helpful once or twice annually.
- As for cutting grasses, the thin soil layer promotes horizontal growth of the grasses rather than vertical, since there is not enough soil to support the weight of tall grasses in an *extensive* design.

ROY F. WESTON

BRUCE DVORAK, CONSERVATION DESIGN FORUM

Photos 2 and 3. Top: ABC Supply and Chicago project engineers Roy F. Weston market a modular plastic system with geotextile drainage control. Plants are nursed off-site and installed when ready. Right: Simple watering and wind blankets help the vegetation take hold.

Project information

Client:
Chicago Department of Environment

Design architect:
William McDonough + Partners

Landscape architect:
Conservation Design Forum

Program manager/engineer:
Roy F. Weston Inc.

Green roof contractor:
Roofscapes

Structural engineers:
Halvorsen Kaye

Associated architect:
William Worn Architects

Associated contractor:
Church Landscape

Energy consultants:
J. Katrakis & Associates