

Green Structure

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Clockwise from left

Seattle City Hall
http://www.earthvision.net/ColdFusion/News_Page1.cfm?NewsID=27685

Living Wall, University of Guelph
www.uoguelph.ca/atguelph/04-11-10/featuresair.shtml.

Chicago City Hall
<http://www.asla.org/meetings/awards/awds02/chicagocity-hall.html>

GREEN structure comprises green roofs and green walls. These systems can be considered an unconventional form of open space that offers visual relief from the metal and concrete of our dense urban areas, while at the same time providing stormwater and pollution management benefits, habitat, and reduction of the heat island effect.

There are two type of green roofs - Intensive and Extensive. Intensive green roofs are rooftop gardens that include spaces for humans to walk and relax. Extensive green roofs have a thin soil profile and typically cover the entire roof surface. As a result, they are not meant to be walked on. Extensive green roofs provide greater overall ecological benefits primarily because they do not require irrigation.

Like rooftop gardens, foliage covered walls have been used for centuries to add to the aesthetics of designed open spaces. The new moniker, "green walls", reflects the growing awareness that vegetated walls offer significant environmental benefits, particularly with respect to pollution reduction. Green walls are even beginning to be incorporated into building interiors in order to ameliorate the "sick building" effect.

Both green roofs and green walls can be used to provide sensory continuity between more traditional open spaces. They can also serve as habitat patches and corridors for birds and invertebrates.

"What could be more inventive and resourceful than using plants to adorn our dusty metropolitan surfaces...[while] simultaneously improv[ing] the energy performance of buildings, air quality and the urban ecology - all without taking up additional land."
Katrin Scholz-Barth



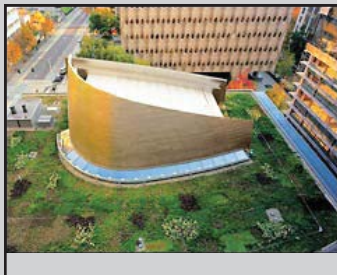
If New York City was filled with green roofs....

Context

Because green roofs and green walls do not take up ground level horizontal space, they can be used anywhere within the urban fabric. As a result, they have no special pattern of distribution. Ideally, green roofs and walls will be placed on every available surface in order to maximize the environmental benefits they provide. The flexibility of green structures enables them to be spread widely across a city, allowing planners and ecologists to set up broad areas of habitat corridors and patches without specific knowledge prior to set up as to which particular locations are most appropriate. Information gathered about habitat migration patterns reflected in green roof and green wall usage can then be used to better site habitat patches and corridors at ground level.

The only limitations on green roof and green wall usage are the qualities of the underlying building. With respect to green roofs, the roof's pitch will influence the project's cost and complexity. An additional consideration is whether the green roof is for a new building or to retrofit an old building. It is very easy to incorporate a green roof into a new building's design. Retrofitting is more costly since a feasibility study is required and structural integrity improvements may also be required to support the green roof's weight. Gravel ballasted roofs are the most suitable for a retrofit because an extensive green roof system weighs about the same as a gravel ballast roof system.

Similarly, with respect to green walls, it is often feared that using climbing plants will reduce the wall's integrity as the plants dig into the surface to anchor themselves. However, careful plant choice and the addition of metal climbing structures situated slightly away from the wall can prevent such damage.



Case: Seattle City Hall

City Hall's extensive green roof uses a complete system provided by American Hydrotech Inc.. However, the soil mix was developed locally, as was the planting design. Because the green roof would not be physically accessible, local landscape architects Gustafson Guthrie and Nichols chose to: "mingle different textures and colors, so that the roof becomes one integrated carpet of plantings when you look down on it – with squares and patches of different plantings that blend together at the edges."

The roof contains 60% grasses and 40% sedums and is currently thriving.



Seattle City Hall
http://www.earthvision.net/ColdFusion/News_Page1.cfm?NewsID=27685

Essential Elements - Extensive Green Roofs

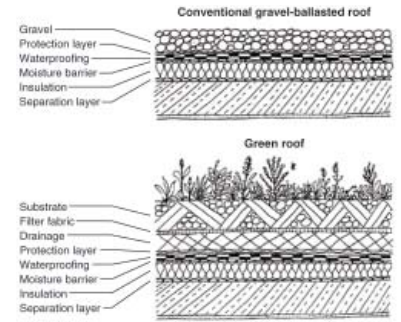
Weight, the soil mix, and the planting palette are the primary considerations in good green roof design. The designer will strive to have the roof's layers perform multiple functions whenever possible. The key green roof layers include:

Waterproof Membrane/Root Barrier A spray-on fluid form membrane is the technology of choice. Because the membrane forms a single seal when dry, the fluid layer works as both the waterproofing layer and a root barrier to prevent plant roots from infiltrating the lower roof layers and destroying the roof's integrity.

The Drainage Layer Any excess water which cannot be absorbed by the roof's growth media must be drained away from the plants' roots. A number of companies, including Hydrotech and Colbond, offer inorganic drainage mats which allow water to be stored on the green roof for future use. The excess water drains into small cups shaped like ice cube trays. The plants are then able to uptake the stored water when needed through capillary action and evaporation.

The Soil Layer The growth media is the layer with the most opportunity for manipulating weight and the most important for plant survival rates. Extensive green roofs generally have a growth media layer of 2"-6". The soil mix is primarily a light-weight aggregate, such as expanded slate, shale, pumice or perlite, mixed with heavily decomposed organic matter, such as mushroom compost.

The Plant Layer Choosing appropriate plants is the area of greatest complexity and uncertainty. Green roofs resemble alpine environments – places of intense sun and wind where plants must be able to thrive with temperature fluctuations, storms, long droughts, and relatively infertile, thin soil. As a result, alpine and rock garden plants are the plants of choice. Even within a city, microclimates can vary between rooftops. Studies are currently underway within Seattle to develop a fine grained plant palette that will take account of these microclimates.



Essential Elements - Green Walls

Green walls have a simpler structure than green roofs. High-tensile steel cables are commonly used as framing for climbing species with the plants themselves planted in large irrigated containers at heights all the way up the wall. An alternative system is to mount blocks of a synthetic rooting medium directly into the metal support frame. Water then percolates directly down the roof from rain runoff. In drier climates and during dry seasons, irrigation may be required. A more traditional approach, that is still in use for lower walls is to create a block stone wall with soil packed into gaps between the stones. Plants are then either deliberately planted within the soil gaps or allowed to freely colonize the soil.

Case: Guelph-Humber plant wall, University of Guelph

The interior "plant wall" at the University of Guelph rises four stories from the ground to balcony. The 150-square-meter wall includes 1,000 individual plants ranging from geraniums, hibiscus and fuchsia to spider plants and philodendrons. The plants' natural respiratory functions cool the building in summer and work as a humidifier in winter. Microbes on the plants roots also remove toxic compounds from the air, such as benzene and toluene, that have been shown to contribute to "sick building syndrome."

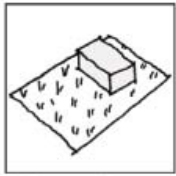


Guelph-Humber plant wall

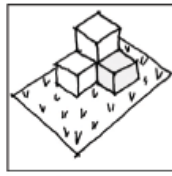
“The nature, which we have on our roofs, is a piece of earth that we have killed so that we could build a house on the spot.” F. Hundertwasser

Aquisition / Implementation Mechanisms

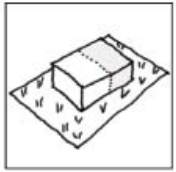
Germany has the most extensive set of policies and mechanisms to encourage the use of green structure. These policies have been in place for over a decade and have yielded substantial increases in the amount and quality of green structure within German cities. These policies fall into four general categories:



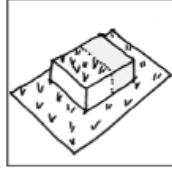
Existing condition



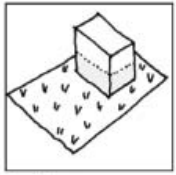
Minimization



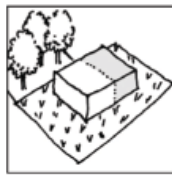
Proposed extension



Compensation



Avoidance



Replacement

Ecological Compensation Options

Ngan, Goya. “Green Roof Policies: Tools for Encouraging Sustainable Design”.



Montgomery Ward Building

Direct Financial Incentives - These incentives customarily take the form of subsidies available to developers and property owners for including green structure in their buildings. The subsidy amount is determined either by a flat sum per square meter or by a percentage of the cost of construction, usually 10-50%. The subsidies are subject to performance conditions, such as minimum runoff coefficients or substrate thickness, or maintenance commitments. Direct incentives are often used to target specific areas of the city which are considered to lack sufficient green space.

Indirect Financial Incentives - Indirect incentives are usually in the form of split wastewater fees. Wastewater fees are split into two components: sewer fees and stormwater fees. Property owners who have green structures pay only for the stormwater that leaves their site. Property owners who manage all stormwater and sewage on site can conceivably get out of paying any fees to the city.

Ecological Compensation Measures - German law requires that any intervention in nature or natural scenery must be avoided wherever possible, and if not avoidable, its impacts must be minimized, compensated for on site (such as by adding a green roof to replace the stormwater management functions performed by the site in its natural state), or replaced elsewhere (such as funding a park equal to the building's footprint nearby).

Integration into Development Regulations - Compulsory regulations commonly specify not only if green structures are required, but which kinds of structures must be greened and the minimum performance requirements for the green structures. Development regulations are used especially with respect to new building construction and public building projects. Portland, OR has been particularly successful in using development regulations to encourage the use of green structures.

Case: Montgomery Ward Building, Baltimore, MD

The Montgomery Ward Building was constructed in 1925 and over the years had fallen into disuse. A 30,000 square foot extensive green roof was installed as part of the building's renovation in 2002 in order to attract Maryland's Department of the Environment as a tenant. Katrin Scholz-Barth, a leading green roof designer, was brought in to develop a custom solution for the roof. Despite the fact that the developer made no commitment to maintain the roof and has not been maintaining the roof, the plants have thrived and the roof is performing as hoped.

Benefits of Green Roofs and Green Walls:

Increased energy efficiency – Unlike a conventional roof, a green roof forms a protective layer which prevents the roofing membrane from heating up in summer and insulates the building from heat loss in winter, thus reducing the need to use air conditioning and heating. Green walls have a similar effect.

Reduction of Heat Island Effect - The plants on green roofs and green walls absorb the sun's rays, rather than reflecting them back into the air. The air above green roofs and walls is substantially cooler than nonvegetated structures.

Stormwater Management - During low intensity rains of ½" or less, a green roof will absorb all water and completely prevent runoff. An extensive green roof of 3-4" deep can store on average 75% of annual precipitation. The green roof will also cool and filter any runoff that does occur, a particularly important consideration in Seattle due to concern over creek and stream warming.

Habitat - Green roofs are sheltered from human activities and viewable from the air, so they are particularly beneficial to migrating birds looking for resting places and food. Green walls also offer habitat to invertebrates, such as butterflies and other insects and spiders and act as corridors for animals moving from ground level habitat to green roof habitat.

Pollution Reduction. All plants reduce CO2 emissions. Green walls have also been shown to trap dust-derived pollutants, such as heavy metals, and to break down volatile organic compounds and unburnt hydrocarbons from vehicle exhaust.



Resources

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