Prokem

SPECIALTY CHEMICALS

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Prokem SPECIALITY CHEMICALS

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GREEN ROOFS

INTRODUCTION

- Green Roofs are, in short, vegetated roofs, or roofs with vegetated spaces. They are also referred to as eco-roofs and roof gardens. Green roofs have been with us for centuries ranging from the hanging gardens of Babylon to the turf roofed dwellings of Ireland and Scandinavia. However, modern green roofs have largely developed in the last 50 years, with increasing sophistication to meet a growing range of needs.

Most of this technological advance has been made in Germany ; their growth in the 1970s and 1980s has lead to £39 million industry. The modern green roof systems are highly durable and provide a number of key sustainable and environmental benefits .The German green roof Standards, known as the FLL, are very high and all systems are required to be tasted for to ensure that they perform to the highest building standards , whether that be waterproofing or fire resistance. No such standards are inforce within the UK, although the larger manufactures accord to them.

- Within the UK the growth of self-build and ecological construction processes from the late 1960s saw an increasing interest in green roofs over the following decades. However, this was never fully exploited by either the industry or policy-makers, and consequently the UK remains without incentives, standards, or policies to encourage the installation of green roofs.

- Myths still abound. In the UK there are concerns within the professions and public that green roofs are more liable to leak than traditional roofing systems. This is partly down to a preference for pitched, rather than flat roofs. However, vegetated roofs provide an extra protection to waterproofing systems from Ultra-Violet light, frost, erosion and other forms of weathering. If in the rare case that they do leak, this is largely down to poor roof construction, and not the green roof system itself.

- This requires research pertinent to the UK, policy development, and advocacy to all levels of Government, which Livingroofs.org is setting out to achieve.
- Livingroofs.org aims to promote green roofs, green walls and other similar features, at all levels, working with industry, contractors, local authorities regeneration teams, researchers, and the wider public to ensure that they become a mainstream component of building design and function.

What Is a green roof ?

- It is simply a planted area on flat or sloped roofs. Issues such as the structural roof integrity .vapor control thermal insulation, waterproofing integrity and protection / drainage layers have to be considered.
- Green roofs are becoming more popular because of:-
  - Growth is sustainable technology.
  - Aid to planning consent.
  - Massive benefits to the environment

Growth in sustainable technology

Sustainable technology uses little energy. Does not waste natural resources, does not pollute the environment and can be reused or recycled. Green roofs incorporate sedum, anural living product, making these systems extremely sustainable

DO LOOK AFTER IT

Planning consent

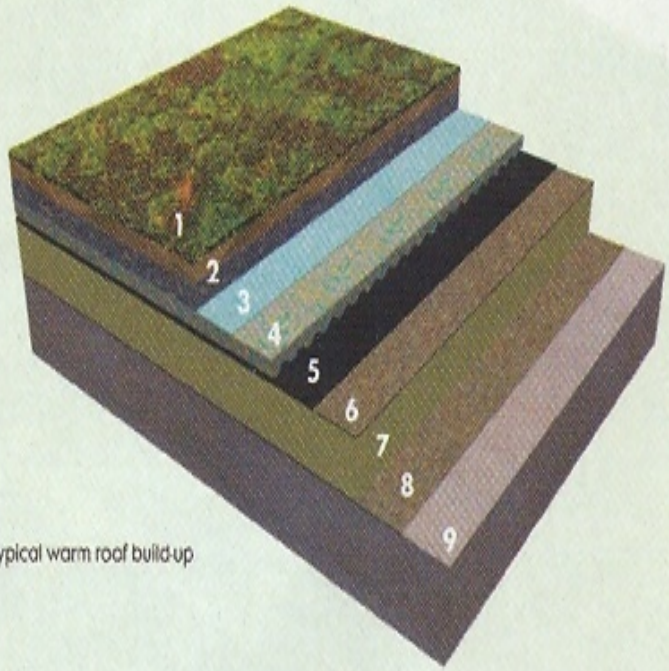
- Since the role they play in reducing CO_2 level in the atmosphere is recognized, more people support green roofs. Building owner need to make the most available land in cities, because the cost continues to rise

TYPES OF GREEN ROOFS

1. Extensive green roofs

- It provides an aesthetic, low maintenance ecological feature, which can be admired from surrounding buildings
- They are less higher in weight because they are relatively shallow growing Medium.
- They are suitable for light weight structure & low sloping roof

Extensive Green Roof System - Flat



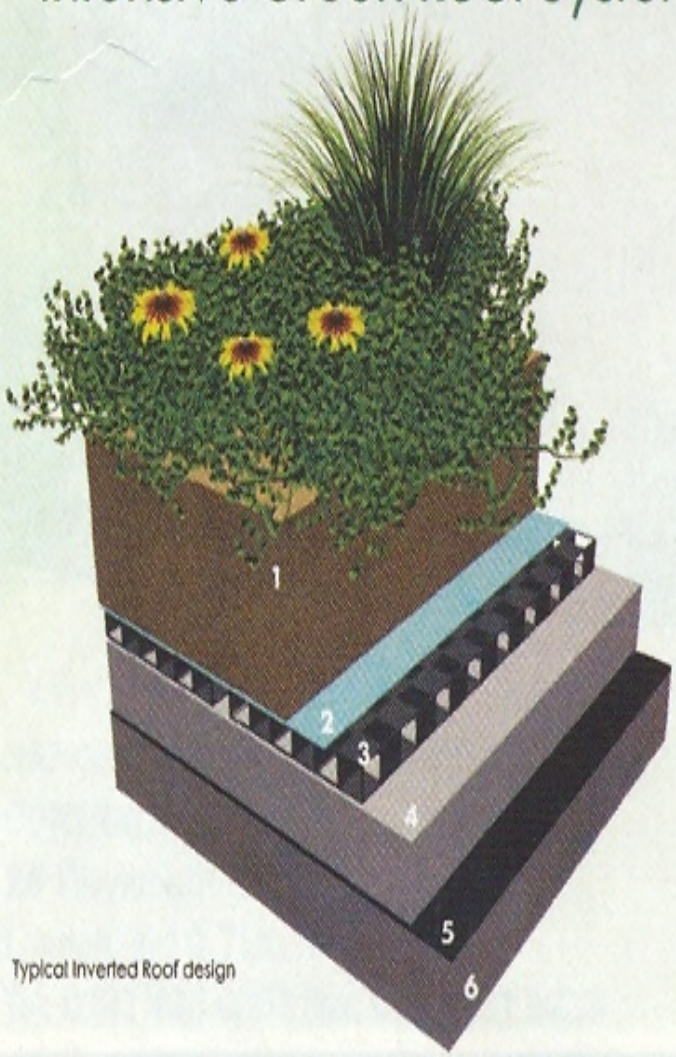
Typical warm roof build-up

1. Pre-grown Sedum Blanket
2. Sedum Substrate
3. Filter Fleece
4. Biodrain
5. Decothane EC Root Resistant Waterproofing System
6. Carrier Membrane
7. Decotherm® Insulation
8. Vapour Control Layer
9. Roof Deck

2. Intensive green roofs

- They are versatile, allowing the roof area to be used as area for recreation and public access.
- They have deeper growing medium because trees, shrubs, turf and hard landscaping can be incorporated.
- The roof structure will require extra loading capability to withstand the weight.
- Irrigation is usually required to prevent dehydration during hot weather

Intensive Green Roof System - Flat



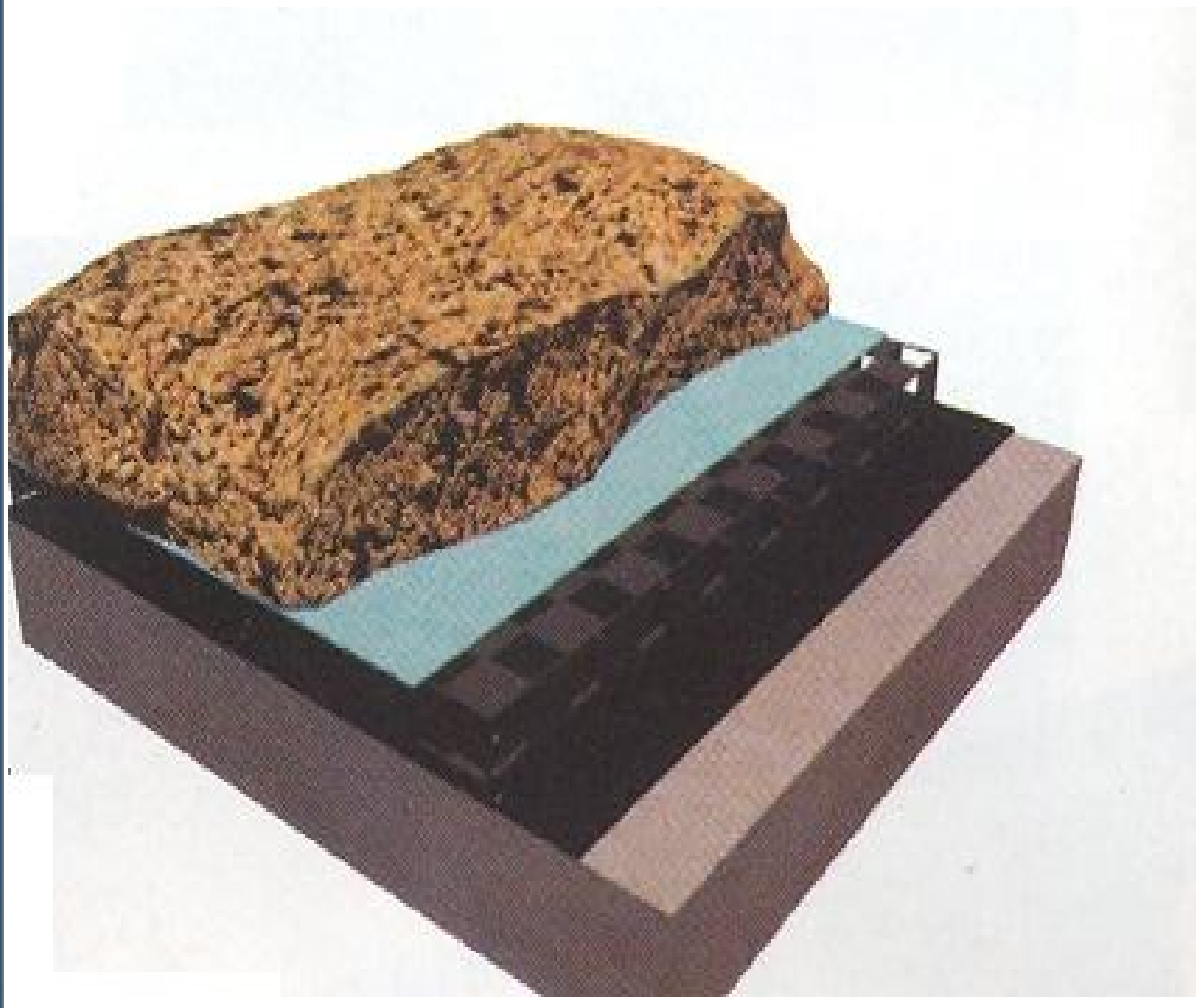
Typical Inverted Roof design

1. Soft / hard landscaping (dependent on design)
2. Filter Fleece
3. Geodrain
4. Inverted Roof Board
5. Decothane EC Root Resistant Waterproofing Syste
6. Roof Deck

3. Brown roofs (biodiversity)

- It used recycled aggregate such as crushed bricks on the roof.
- They are generally left to colonize naturally or can be seeded with an annual wild flower mix or local seed source.
- It creates aesthetic designs and adding biodiversity by creating habitats for local plants.
- This system allows the life of land fill sites to be extended as aggregate will not need to be buried and the amount of CO_2 from transportation.

Brown roofs (Bio-diverse)



What Kinds of Green Roofs are Available?

There are two types of green roofs: Intensive and Extensive.
Here are some characteristics of each.

Characteristics	Intensive Green Roof	Extensive Green Roof
Soil	Requires minimum of one foot of soil depth (30 cm deep)	Requires only 1 to 5 inches of soil depth (2.5-12.5 cm deep)
Vegetation	Accommodates large trees, shrubs, and well-maintained gardens	Capable of including many kinds of vegetative ground cover and grasses.
Load	Adds 80-150 pounds per square foot of load to building structure	Adds only 12-50 pounds per square foot depending on soil characteristics and the type of substrate
Access	Regular Access Accommodated and encouraged	Usually not designed for public accessibility
Maintenance	Significant maintenance required	Annual maintenance walks should be performed until plants fill in
Drainage	Includes Complex irrigation and drainage systems	Irrigation and drainage systems are simple

BENEFITS OF GREEN ROOFS

Green roofs provide economical & ecological benefits:

- ❖ They reduce the carbon foot print.
- ❖ They reduce the urban heat island effect.
- ❖ They increase the building thermal performance.

CARBON FOOT PRINT

- Carbon foot print is a term used as a measure of how much carbon is produced in a single action.
- The unpleasant weather in our cities is due to extremes of temperature, high humidity & air pollution.
- Vegetation is an important component in reducing the level of carbon in the atmosphere.

- A green roof also improves the climate of rooms situated beneath or facing the roof as plants reflect and absorb solar radiation and flattens the thermal gradient across the roof profile.
- Green roofs provide with a way of continuing to construct the building and utilize every chance of contributing to the natural CO2 production.

URBAN HEAT ISLAND EFFECT

- The term describes an urban area that is considered warmer than surrounding area.
- This effect is caroused by factors including:-
- Increasing heat (from fuel combustion &humus)
- Configuration streets, which do not all radiation to escape.

- By spreading green roof, the urban heat island effect will be reduced because it transfers less heat to the atmosphere than normal grey roofs.
- It is estimated that in N.Y, if green roofs cover half of all the buildings it would lead to decrease of (1 ºC) in surface

BUILDING THERMAL PERFORMANCE

- The overall thermal performance of building independent on the thermal performance of the roof, walls, floors, windows , doors and level of insulation.
- A green roof can improve this effect by keeping the temperature in the building cooler in summer period; however in winter period green roofs provide extra insulation, keeping the building warmer.

- With a mean daily temperature (10.4ºC) the temperature beneath the membrane of conventional roof (32 ºC) where the temperature beneath the membrane of a green roof is (17.1 ºC)
- With a mean daily temperature of (0 ºC) the temperature beneath a conventional roof is (4.7 ºC)
- Vegetation on green roof is able filter smog particles and absorbs gaseous pollutants through photosynthesis, therefore reduce atmospheric pollution.

- 1.5m^2 of uncut grass, produces enough O_2 to supply one human with their yearly O_2 .
- 1m^2 of green roofs, can remove 0.2 kg of airborne particulates from the air yearly .

WATER MANAGEMENT

- Flooding in cities has become more common due to moisture condensed because of temperature increase, rain clouds from above the city and more rain produced.
- A green roof reduces the risk of flooding, since50% or more of rainwater is retuned, whilst the rest is released slowly into the during system .

NOISE REDUCTION

- Green roofs system can help to reduce the level of noise entering a building.
- A green roof system would reduce noise by 8dB or more complying with international regulation.
- Soil blocks lower sound frequencies and vegetation blocks higher it, it is beneficial to building near by airport, motorways, and train lines.

DUARBILITY & AESTHETIC IMPROVEMENT

- The floor spaces are subject to annual extremes of temperature from -20 ºC to +80 ºC green roof s reduces this extreme to -5 ºC to 20 ºC.
- The correct designed green roofing system will double the expected life of roofing.
- The vegetation provided by green roofs helps to aid the mental health of these living and working in cities.
- Urban hospitals designed with this system can help to aid the recovery of patients.

RECYCLING

- The reuse of local or secondary aggregates can provide a cost saving.
- An inverted roof requires hard landscape features as paving slabs to prevent the possible flotation of the insulation.
- The required weight to prevent flotation can be achieved by the use of secondary aggregates in a green roof system.

APPLICATION

- A typical green roof will be made up of layer of water proofing membrane, a drainage layer, substrate and then a blanket of vegetation.
- The favored vegetation material is sedum, low- growing succulent plants suited to all habitats.

*Extensive:

•Also known as a low-profile or performance, this type of green roof contains only one or two plant species and minimal plant species and minimal planting medium .Its commonly designed for maximum thermal and hydrological performance and minimum weight load while being aesthetically pleasing.
Typically ,only maintenance personnel have access to this type of roof. It is installed on flat and pitched roofs (Photo 1),like the Norwegian sod.
Commercially available systems use planting media ranging in depth from 41mm(1.6 in) to 102 mm(4in),and total wet roof loads range from less than 49 kg/m² (10 lb/sf) to approximately 98 kg/m (20lb/sf).Deeper, extensive systems exist but are becoming less common .The basic components of an extensive system are shown in Fig.1

Extensive Green Roof Construction

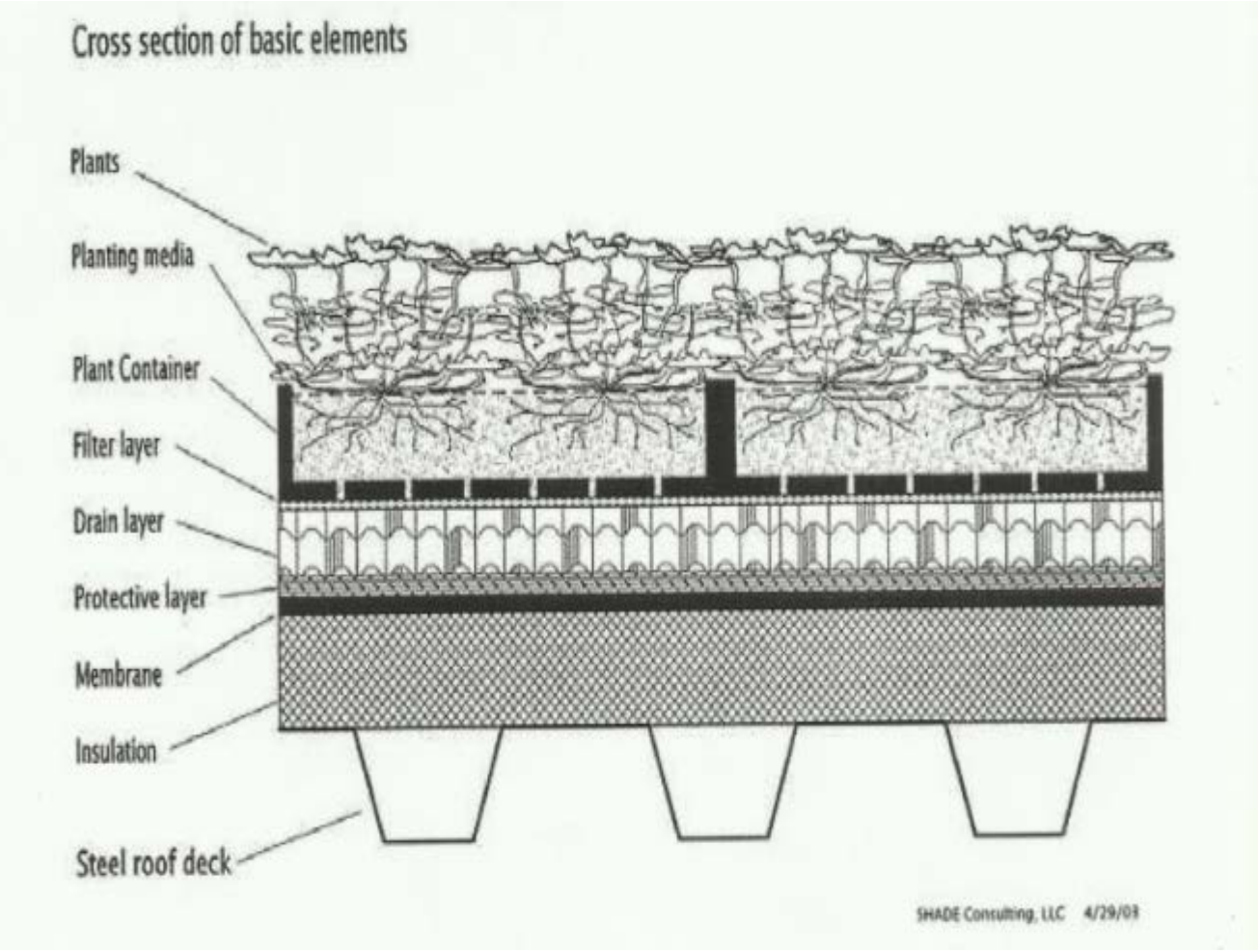


Fig.1

*Intensive:

•Also known as high-profile or rooftop garden, this type of green roof typically contains a variety of plant types and is designed as a park-like setting .
•Some rooftop gardens support fairly large trees and water features requiring substantial structural reinforcement.
•A good example is Central Park atop the parking garage at the Kaiser Center in downtown Oakland, California .
•It has public access and has been a popular place for lunch since it was built in 1961.

•The minimum planting medium depth for an intensive green roof is usually greater than that of an extensive system ,with the maximum depth dictated by the application design. The design also dictates the structural requirements for the roof, especially if the roof is to have public access. The basic components of and intensive system are shown in Fig.2.

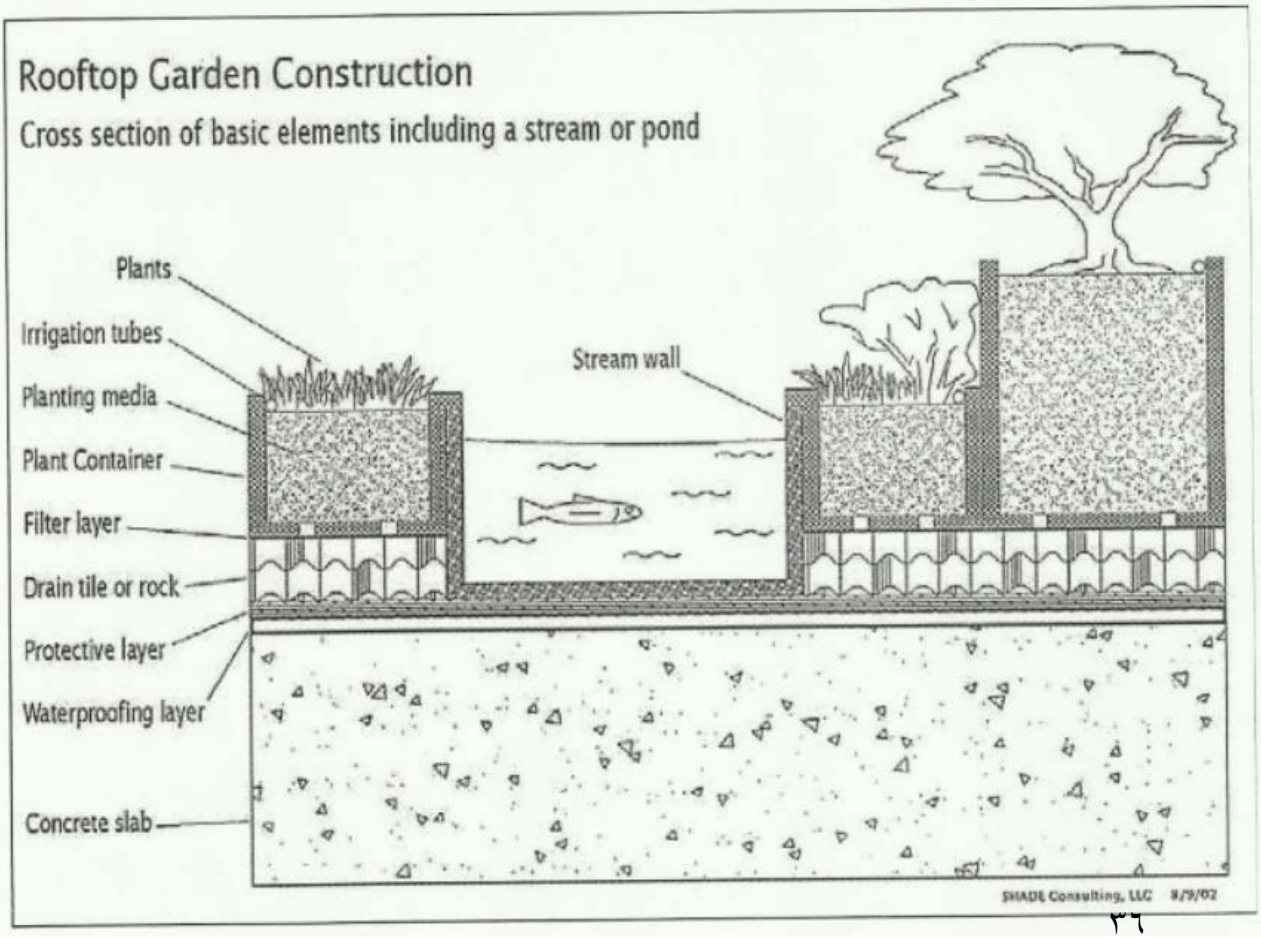


Fig.2

•Throughout the rest of this article ,the term ((green roof)) will be used for extensive systems, and ((rooftop garden)) for intensive systems. Other terminology used to describe a system includes:

Roofs cape :This describes the landscape of the rooftop or the overall appearance of the roof.

•Modular system:

In this system, the vegetation and planting medium are contained in special trays covering all or most of the green roof. In a non-modular system, the planting medium is continuous layer over the entire green roof. The rooftop garden below is a modular system.

Eco –Roof

Another name for green roof, this term is often used because many green roof designs involve plants that are not green for the entire year, particularly in northern regions.

•Description of components

•The components used in roofs are generally the same as those in rooftop gardens ,differing only in depth and project-specific design application(Fig 1&2),and include the following:

•Vegetation:

Almost any plant can be put in a roof. The only limitations are climate, structural design and maintenance budgets ,and the roofs cape designer‘s imagination. Since green roofs are typically lightweight ,they often contain ground cover that can thrive in very shallow soils with little to no maintenance. Sedum, a succulent ground cover , has become very popular for use on green roofs in North America. Also commonly used are a variety of hearty wildflowers and shallow-rooting grasses .At times, rooftop vegetation may go dormant and loser foliage , as do plants on grade.

Sedum mats

•Sedum Mats –sedum mat is a base layer of Polyester , Hessian ,or porous polythane depending on the supplier ,on which is laid the 2 cm growing medium, on to which is sprinkled sedum cuttings.
These grow into the substrate to maturity . When harvested the Sedum blanket is rolled up from the carrier upwards and delivered to site. When installed the sedum blanket (including the 2 cm of growing medium) is rolled out onto either 5-7 com of growing medium (standard method) or direct onto a moisture retention blanket (ultra light weight method).
•Sedums are used because they are wind ,frost and drought resistant not because they absorb water .Its ability to absorb water makes it drought resistant.

Planting medium

•Not to be confused with soil , the planting medium is distinguished by its mineral content , which is synthetically produced , expanded clay. The clay is considerably less dense and more absorbent than natural minerals , providing the basis for an ultra –lightweight planting medium. Perlite is a common form of expanded clay and is found in garden nursery planting mix (not planting soil).The types of expanded clays used in green roofs are also used in hydroponics.

A large number of planting medium ((recipes)) many of them proprietary, are commercially available .The bulk densities of these mixes range from 400 kg/m³ (25Ib/cf) to 900 kgm/³ (56 Ib/cf)for dry mixes where water absorbencies can be 20-200 percent by weight . Soil is also commonly used in high - maintenance rooftop gardens.

•**Containment**

•In modular systems ,containment refers to actual plant containers .In non-modular systems , the planting medium is supported by the drain layer and contained at the perimeter by a metal or plastic barrier , or the roof parapet.

•**Filter Layer**

•Somewhere between the planting media and drain layer lies a filter, which not only allows water to flow through while retaining the planting medium, but serves as a root barrier. The filter usually comprises one or two layers of non-woven geotextile , where one of the layers may be treated with a rot inhibitor (i.e copper or a mild herbicide). As in many landscaping applications , filter fabric can also be used to control erosion at the surface of the planting medium.

•Drain Layer

•Between the planting medium and roof membrane is a layer through which water can flow from anywhere on the green roof to the buildings drainage system. Some systems simply use a layer of large –diameter expanded clay , but most green roof companies now use a corrugated plastic drain mat with a structural pattern resembling an egg carton or landscape paver .The minimum drain layer thickness is usually less than 20 mm (0.8 in), but a thicker mat can provide additional insulation and root restriction.

•Protective Layer

The roofs membrane needs protection , primarily from damage during green roof installation, but also from fertilizers and possible root penetrations. The protective layer can be slab of lightweight concrete ,sheet of rigid insulation, thick plastic sheet, copper foil , or a combination of these, depending on the particular design and green roof application. Some green roof systems do not necessarily require a protective layer.

•Insulation

The thermal protection provided by the vegetation , planting medium and drain layer sufficiently eliminates the need for additional insulation in warm and dry climates. However , building codes usually require a certain level of added insulation, regardless of the overall roof design .

•Waterproofing

A green roof can be installed with any kind of waterproofing system, but single-ply membranes have become very popular in recent years and are specified by nearly all green roof companies for their cost effectiveness and simplicity .As such, the waterproofing layer is typically assumed to be a membrane .

•Irrigation

Watering systems used in landscaping can be adapted to rooftop applications , but several commercial green roof designs combine passive irrigation methods with active components. ٤٤

Passive irrigation describes the process of strong rainwater in the drain layer , which eventually

Wicks back up through the planting medium while excess is allowed to drain off. One type of water storage medium is a polypropylene fiber mat directly below the planting medium which acts as a sponge .Other types include small reservoirs in the drain mat filled with expanded clay up to the bottom of the planting medium . Irrigation is rarely necessary, however , when drought –tolerant plants like sedums are used.

•All These elements need not be acquired as individual units as some products and designs on the market combine the functions of two or more components .For instance , the contours of the bottom of a modular container may form a drain layer or a water storage mat might also be used as a filter layer.

Combination designs can often reduce the weight and cost of a system.

•Green roof system standards

•Green roods provide exceptional benefits through their thermal, hydrodynamic, and protective characteristics , but the only way their economic impact can be fully appreciated is by allowing variances to established standards and codes for roof systems incorporating vegetation.

Since the individual components of a green roof can be selected ir created for a wide range of design possibilities , complying with standers at the component level is a reasonable approach .Exception to this would include clarifications in building codes for the total dead weight (wet and dry) and live loads , fire safety is a topic still debated, partly because of misunderstandings regarding the overall construction and type of vegetation used in green roofs. For example , tall grasses are often considered a fire hazard while succulents are fire resistant.

- Currently, green roof systems are not addressed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). A Green Roof task group established in October 2001 by ASTM International Subcommittee E06.71 on Sustainability has created a statement of work to explore ways in which to assess green roofs (WK575–February 2003).

Component specifications and standards

- Vegetation
- The vegetation performs a similar function as a ((cool)) roof by transferring solar energy to the atmosphere , only more effectively.
- On a summer day, leaf temperatures on any plant are usually less than 5°C (9° F) higher than the surrounding air temperature , making total leaf coverage and approximate plant height the only significant design criteria for cooling properties .
- The other thermal design consideration is leaf retention. Many plants have an a additional advantages over cool roofs is that they lose their leaves in the winter, allowing the sun to warm the roof. Selecting plants for maximum thermal benefits is location specific. SHARE 90.1-99, Energy Standard fir Buildings Except Low- Rise Residential Buildings , currently allows fir reduced insulation in roof systems using a reflective cool roof in warm climates, but it should be expanded to include vegetation in a broader range of climates.

- . In some cases, certain plants should be prohibited from use on rooftops for health or fire safety reasons, just as in landscape designs for courtyards or areas adjacent to buildings. A set of system design guidelines for horticultural issues, primarily plant health, would be useful in educating both clients and installers on the proper component specifications (including plant type) for a certain application and its climate. Many green roof companies work with local horticulturists and nurseries to ensure the selected plants thrive.

- *Planting medium*
- The thermal mass of the planting medium plays a significant role in dampening the impact of ambient temperature fluctuations. This property can dramatically affect heat transfer through roof systems in climates where the outside air temperature tends to oscillate about the set indoor temperature. ASHRAE has been continually improving its tables for adjusting R-values for high-mass walls, but local building codes still tend to use straight R-values because of the difficulty in applying thermal mass to specific cases. With planting media, the situation is further complicated by the fact that as moisture content increases, so does their thermal mass but not their R-value, which decreases.

- . Water retention is another important parameter which can vary with the type and amount of vegetation, medium composition, and climate. Since absorption and flow rates are site and system specific, estimations of water retention characteristics must be calculated for individual cases. Planting medium depth and composition must also be appropriate for the selected vegetation. This specification would be part of the previously mentioned horticultural guidelines.

- *Filter layer*
- The geotextiles commonly used in filter layers are specified for material, flow rate, hole size, strength, and root inhibitor. Green roofs usually employ plants with easy-to-control roots, whereas rooftop gardens may contain deeper rooting plants requiring multiple filter layers. Since root and media particle diameters can vary, filters should be specified for different media and plant types to ensure adequate flow rates for a given planting mix without losing too much silt or allowing excessive root penetration.

•Drain layer

The critical specification for a drain layer is the maximum volumetric flow rate, which is determined from rainfall data.
Minimum passage area should be standardized for various locations .Since the drain layer supports the planting medium and vegetation, the compression strength should be specified .Many drain mat products are segmented or baffled to get the necessary compression strength, and hence , have insulating qualities that should be considered .(An R-value can be estimated , but an ASTM standard for measuring or calculating the wet and dry R-values for a drain layer should be established.)

•Insulation

•Results from a study done on commercial buildings in Northern California using DOE-2 and a proprietary roof heat transfer model developed by shade Consulting indicate an uninsulated green roof could reduce the building heating/cooling system demand for most of the year by 30 percent over a conventional dark roof with R-18 rigid insulation without a radiation barrier . The uninsulated energy savings would increase for desert locations and decrease for colder and more seasonal climates .

•Since current standards do not recognize the insulating qualities of green roofs , a local code variance would probably be needed to install one on an under-insulated roof. Rigid insulation can certainly by used as a protective layer.

Waterproofing Membranes

A membrane is actually protected not degraded , by a green roof. Without one a membrane is subjected to UV radiation, extreme heat cycling, wind, rain ,pollution (especially when pounding occurs), and damage from maintenance activities. With a properly designed green roof incorporating a protective layer, the membrane is subjected to nothing more than a small amount of moisture .Since a green roof keeps the membrane surface temperature much closer to the roof deck temperature, mechanical stress with the membrane is tremendously reduced .
This helps maintain joint integrity, adherence to the deck , and reduces water vapor transfer.

- Currently, no hard data exists showing the life span of a waterproofing system below a green roof. The waterproofing systems in older, well-known rooftop gardens with builtup roofs (BURs), such as those at the Rockefeller or Kaiser centers, have never required any maintenance. Membrane system maintenance for today's green roofs has yet to be reported. To be safe, roofing companies installing green roofs recommend various types of single-ply membranes, dictated primarily by application, installation, and cost considerations.

- The design criteria of the system should include provisions in case an exceptional situation develops, such as particularly invasive roots or excessive fertilizer from a rooftop garden. Here, an appropriate protective layer must be selected. Obviously, vegetation that can root through an undamaged, watertight membrane is rarely used in green roof construction. Some companies now offer membranes incorporating a layer of copper foil for added protection against root penetration.

- Existing standards and codes for membrane installation are more than sufficient for green roof applications. The only additional requirements might involve special provisions for the inspection of a membrane before and after the subsequent green roof layers are installed.

- *Vapor restriction*
- Since a green roof reduces the temperature gradients throughout the roof system, condensation is less likely to occur beneath the membrane. Situations requiring an additional vapor restricting sheet should be determined on an individual basis.

- *Irrigation*
- Irrigation requirements are specific to the climate and type of plants being used. For green roofs, plants not requiring irrigation are usually selected. The level of sophistication of the irrigation system (when required) is dictated by the client. Like all elements in construction, green roofs are as diverse as the people designing them, and are customized according to intended use, climatic conditions, building structure and financial limitations.

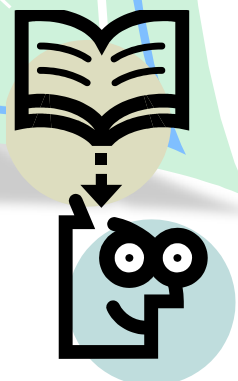
Are Green Roofs Cost-Competitive with Traditional Roofing Options?

•Currently , the up-front cost of an extensive green roof in the U.S starts at about $8 per square foot. Which includes materials, preparation work , and installation. In comparison, the cost of traditional built up roof starts about $ 1.25 while cool roof membranes start at approximately $1.5 per square foot.

•Extensive green roofs cost more than traditional roofs because they require more material and labor for installation. Another factor affecting price is that green roof contractors are limited in number. As the demand for rooftop gardens increases in the U.S., and as additional contractors come into business , up-front costs will likely decrease.

However, its widely known that up-front costs do not tell the whole story. Taking into account future summer time energy saving at the time of purchase brings the price of a green roof closer to that of a traditional roof. Depending on local construction codes, it also may be possible to do without storm water infrastructure investments. Another factor reducing the cost of a green roof is that vegetation can extend the life of a roof .This is because less solar energy reaches the roof substrate , limiting damage from UV radiation as well as daily temperature fluctuations, which cause repeated construction and expansion.

QUESTIONS & ANSWERS



- **Frequently Asked Questions about Green Roofs**
- ***Why a green roof?***
- There are generic private benefits for virtually all projects, benefits, specific to the design and type of green roof, and benefits/incentives related to public policy, which have proven to be critical to developing the market in Europe:

- **Private Benefits**
- **Savings on energy heating and cooling costs, depending on the size of the building, climate and type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one storey building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.**

- A green roof with a 12 cm (4.7 inches) substrate layer can reduce sound by 40 decibels; a 20 cm (7.9 inches) substrate layer can reduce sound by 46-50 decibels.

- **Public Benefits:**
- **Filtration of Airborne Particulates:**
- **A green roof will not only absorb heat, decreasing the tendency towards thermal air movement, but will also filter the air moving across it.**
- **1 m2 (10.76 ft2) of grass roof can remove between 0.2 kg of airbourne particulates from the air every year.**

- Aesthetic appeal, increasing the value of the property and the marketability of the building as a whole, particularly for accessible green roofs. For example, American and British studies show that "good tree cover" adds between 6 to 15 per cent to the value of a home. Green roofs offer the same visual and environmental benefits.
- Satisfying the aesthetic needs of people looking down upon the roof from adjacent buildings.

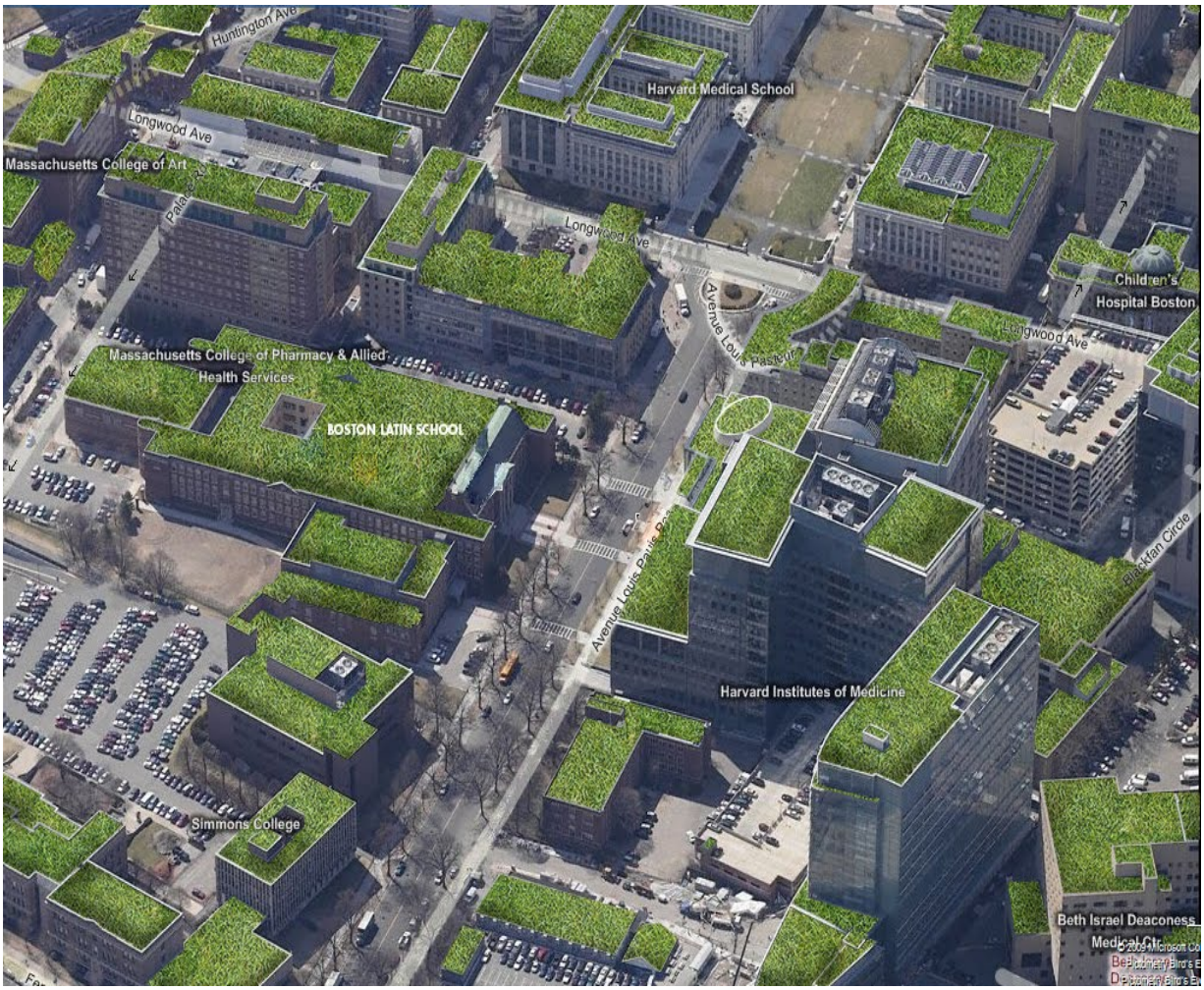
- On a summer day, the temperature of a gravel roof can increase by as much as 25 °C (77 °F), to between 60-80 °C (140 - 176 F). Covered with grass, the temperature of that roof would not rise above 25 °C (77 °F), thus resulting in energy cost savings.
- 20 cm (7.9 inches) of substrate with a 20-40 cm (7.9 - 15.7 inches) layer of thick grass has the combined insulation value of° 15 cm (5.9 inches) of mineral wool.
- Rooms under a green roof are at least 3 - 4 °C (5.4 - 7.2°F) cooler than the air outside, when outdoor temperatures range between 25-30 °C (77 - 86 °F).

- Through the daily dew and evaporation cycle, plants on vertical and horizontal surfaces are able to cool cities during hot summer months. In the process of evapotranspiration, plants use heat energy from their surroundings (approximately 592 kcal per L of water) when evaporating water. One m2 (10.76 ft2) of foliage can evaporate over 0.5 litres of water on a hot day and on an annual basis the same area can evaporate up to 700 litres of water.

NEWYORK ROOF GARDENS

KO-BOGEN /GERMANY

VIETNAM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