5th SASTech
Iran | Mashhad
May 12 - 17 | 2011
5th Symposium on Advances in Science & Technology

Green Roofs, Ecological Sustainability and Art

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Paper Reference Number: ٢١١٢- 469
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Abstract

According to increasing problems with the modern world, sustainable systems have been one of policy priorities in developed countries. These countries in implementing such policies try to solve various problems of cultural, social, environmental, etc. To achieve the goals of sustainable development "environmental sustainability" in relation to architecture has a great importance and environmental problems forced architectures to think about. Human need for nature is one of the most striking things that easily neglected. Architects and urban planners try to design a city which most of it's areas are dedicated to the significant parks and green spaces. The usage of green roofs and in other words using unused roof space to create green space is considered. This idea was introduced first in 1970 following the first oil crisis. Nowadays, implementation of green roofs is not only an attempt to create a sustainable architecture, but also in terms of aesthetics as a tool in the hands of architects and designers. This article attempts to identify the more green roofs and their implementation practices and also building of Nanyang university of Singapore, which uses green roof techniques step toward creating a sustainable environment as an example of this approach.

Key words: Green Architecture, Green roof, Sustainability, Nanyang University, Singapore

Introduction

" houses' roofs are part of the soil and the nature of the building that we've killed."
Friden Raish Hondred Vaser

Modern man is trying to feel soul and a nature and return them to their living space, he tries to link nature and green living to the manifestations of modern technology and to create innovative and beautiful scenery.
But because the land to create green space in cities is rare and very expensive so for doing this, unused surfaces such as roofs of buildings should be used.
High-tech architectures have Solutions in the efficient use of natural factors such as sun, wind, underground water, plants to adjust environmental conditions so in new architecture , eco-tech (technology + ecology) is introduced alongside the technology to exploit further the nature of the environment and provide facilities is located on human comfort.

Sustainability

Sustainability is the capacity to endure. In ecology, the word describes how biological systems remain diverse and productive over time. For humans, sustainability is the potential for long-term maintenance of well being, which has environmental, economic, and social dimensions.

Healthy ecosystems and environments provide vital goods and services to humans and other organisms. There are two major ways of reducing negative human impact and enhancing ecosystem services. The first is environmental management; this approach is based largely on information gained from earth science, environmental science, and conservation biology. The second approach is management of human consumption of resources, which is based largely on information gained from economics.

Sustainable Housing Working Group UN generally divided the city's Sustainability criteria to three areas of environmental, social - cultural and economic. (Shakibaie, 2010,481)

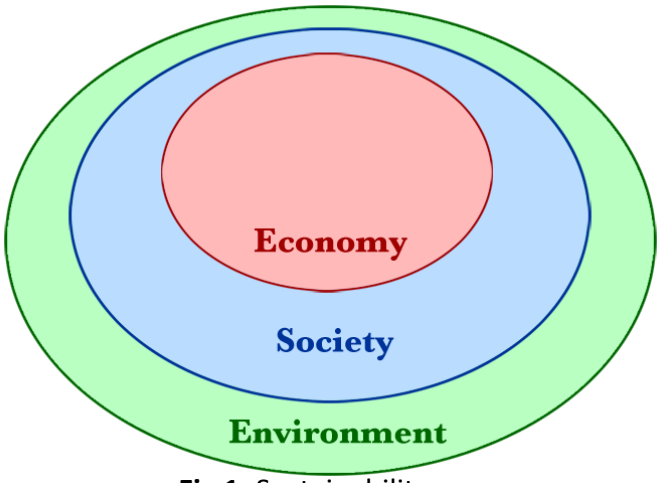


Fig 1: Sustainability

Economic Sustainability

Economic sustainability means maintaining and improving the current economic situation, without damage to natural resources, that economic activity must cause population growth and associated with justice and efficiency. (Keshtkar, 2010, 21)

Social Sustainability

The goals in the social sustainability will be emphasized such as cultural identity, social cohesion, organizational development, citizen participation, empowerment and possibility of human social movement. So in general we can say that the goal to achieve Sustainability and lasting dynamic society is to save the environment.

(Del Barrio, 1998, 242)

Environmental Sustainability

Environmental sustainability of natural resources try to reduce the use of nonrenewable energy, avoid waste of energy resources, reduce waste production and an emphasis on reusing and recycling waste, using materials back to nature and reducing pollution in industry and agriculture.

Sustainable architecture is a general term that describes environmentally conscious design techniques in the field of architecture. In the broad context, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Most simply, the idea of sustainability, or ecological design, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations. This term can be used to describe an energy and ecologically conscious approach to the design of the built environment.
(Keshtkar, 2010, 23)

Green Roof Systems

A green roof's much or all of it cover with vegetation and soil or vegetative cover.
Sometimes the term green roof to roof concept that "green architecture" are consider, such as solar panels or photovoltaic plates used.
Green roof is a roof which plant grows on its surface. Such structural variation can be covered with artificial grass to the roof garden.
The idea about garden on the roof and planting on it in ancient times to the year 600 BC was handled by the Babylonians.
In Berlin in 1890 AD, rural roofs for protection against fire covered with a layer of soil where the plants grew.
Le Corbusier was the first person in the present century used green roofs which were forgotten. (Sadr Nobari, 1992)

Create and expand green space on rooftops in cities following advantages:

1. Create beautiful and fun city landscapes and buildingsListenRead phonetically.
2. Eliminate air pollution, making cities healthy (the ability of plants is significant, not arranged in a square grass roof building in town, is able in half a kilogram a year to reduce air pollution.)
3. Create a living space and recreation for people.
4. Creating spaces for rest and refreshment.
5. Improve water quality and air.
6. Create ecological buildings - human life in the environment combined with the coordinated nature.
7. Reduce maintenance costs of the roof.
8. recovery of green areas.
9. Community mental tension.
10. Mitigation of climate change.
11. Improving the quality of life as part of building design.
12. Prevent ultraviolet radiation and extreme changes of temperature in the vicinity of the building.
13. Improved drainage systems and water balance out of town.
14. Insulated against sound and heat saving potential. (Kanter, 2005,42)

Construction of green roofs

Manufacture of garden roofs requires planning and specific knowledge.

Green roofs' capability of Weight Control dust, rain and snow trails and embedded systems require more than the usual roof engineering technology.
A green roof is composed of three parts:
1. Buildings' roof or what is now on the roof of all buildings are like a pitch-black layer of insulation, insulation or any other Tar layer and possibly drawn on the mosaic pavement or asphalt.
2. The garden roof is a protective layer of roof insulation and moisture from plants and soil layers are separated.
3. Soil and fertilizer and garden irrigation systems, each carefully placed in their place.
(www.greenroof.ir)
Materials used in garden roof construction are very long-lived that makes them not to be replaced periodically. Lasting is between 30 to 50 years. Equipment manufacturers consider typically two characteristic scales for the garden roofs. Condensed roofs, extensive roofs, employ each of these characteristics to define the type of garden roofs depends on plant diversity and levels considered for construction and maintenance costs.
Systems that build green roofs are designed lightweight and require less care. Materials applied at the time of rain and a sudden flood, absorb rainwater, slow water current and reduce the risk of flood.

New method for watering garden roofs minimizes water use and keep moisture in the soil and prevents rapid evaporation. (www.manzelmag.com)
When making, first insulating moisture layer and then proper drainage networks on the roof is installed. Creating a perfect growing environment for the success of green roofs is necessary. Unlike the natural environment soil perfectly designed to suit the environment while getting wet it doesn't become heavy. Finally, plants are planted. Resistant coating plant of heat and cold are used. Plants that are used for this purpose usually include Herbaceous perennial plants, flowers, wild grass and moss.

Types of green roof:
Green gardens or garden roofs system based on performance, depending on planting depth and amount of facilities required are three basic types:
A - Extensive system
B - Intensive System
C - Planter box system or modular system

A - Extensive system:
- The term for extensive green, roof system is used.
- The system is known as a low level run or low thickness.
- This type of green roof includes only one or two plants and the environment is shallow.
- Usually, this system is used when weight at least once is applied.
- Only maintenance personnel have access to this type of roof.
- The system can be built usually on the flat and steep roofs.
- In this system, plants with deep roots usually 40 to 100 mm are used.
- The total weight of the roof should be approximately between 50 to 100 kg m in a saturated mode.

- On the slope roof in most places 10 to 20% slope is recommended. In slope maximum 30% gradient worn out and need to use anti-erosion devices there.Listen
Read phonetically
- It has superficial and shallow medium and usually part of the roof or part of the building structure is green.
- An extensive green roof generally available to the public and is used not for a particular function. (Szewczyk, 2003, 24)

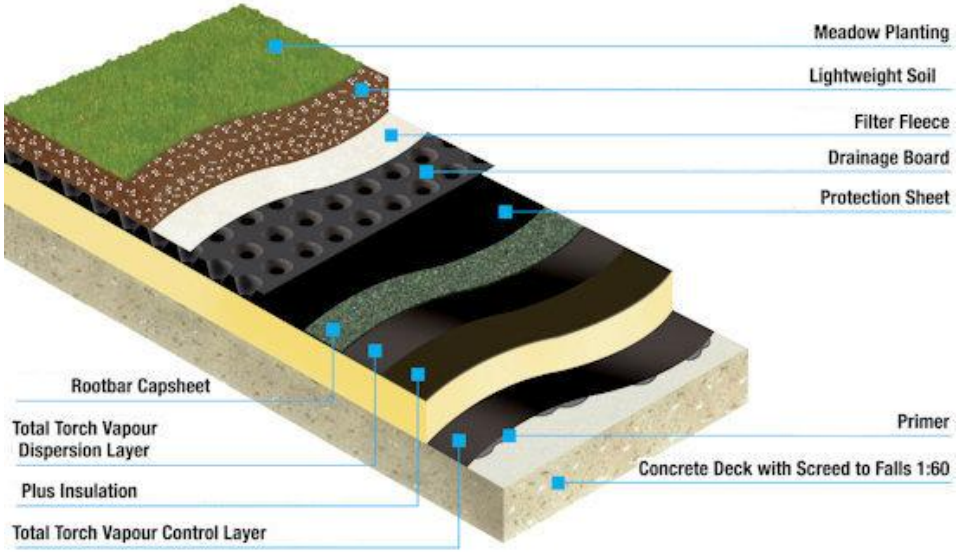
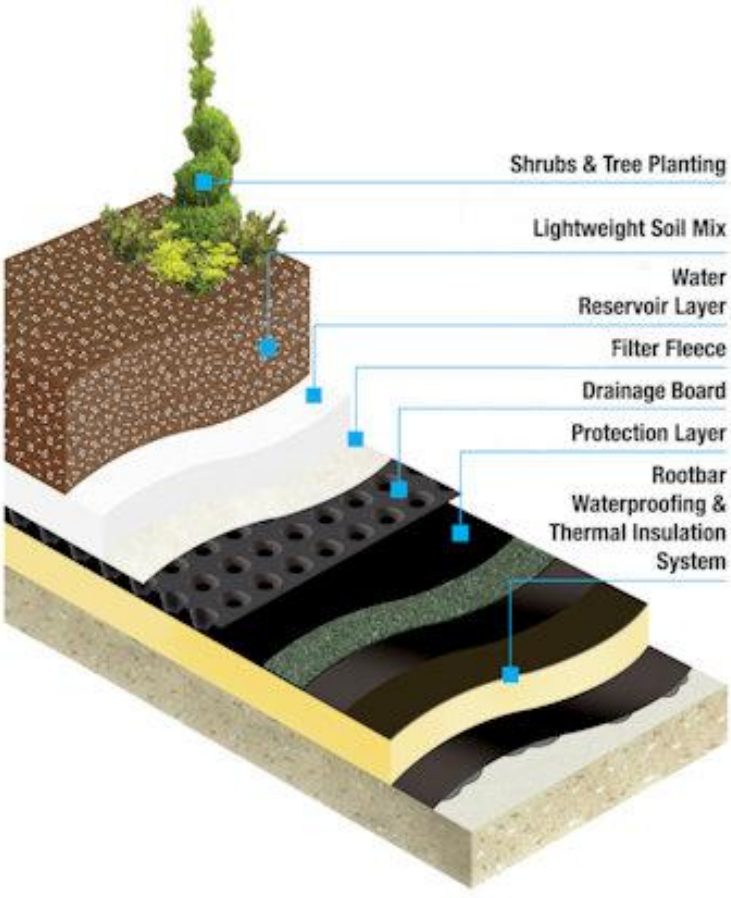


Fig 2 : Extensive green roof

The roof of the building Nanyang university of Singapore is an example of extensive green roof system.



B - Intensive System
- Roof garden term for this system is used.
- The system is known as deep level.
- Extensive roof system requires conventional depth of soil for growing large plants and regular grass.
- This type includes a variety of green roof plants and it is designed like a park.

Fig 3: Intensive green roof

- Some green roofs have great trees and waterfronts, particularly for the roofing that have public access, need to strengthen the basic structure.
- This type of roofs requires irrigation, fertilization and other care.

C - Planter box system
- In this system the plants are cultivated and maintained in boxes for all or most green roof covers.
- In this system there is a discontinuous layer on the green roof. (Szewczyk, 2003, 25)

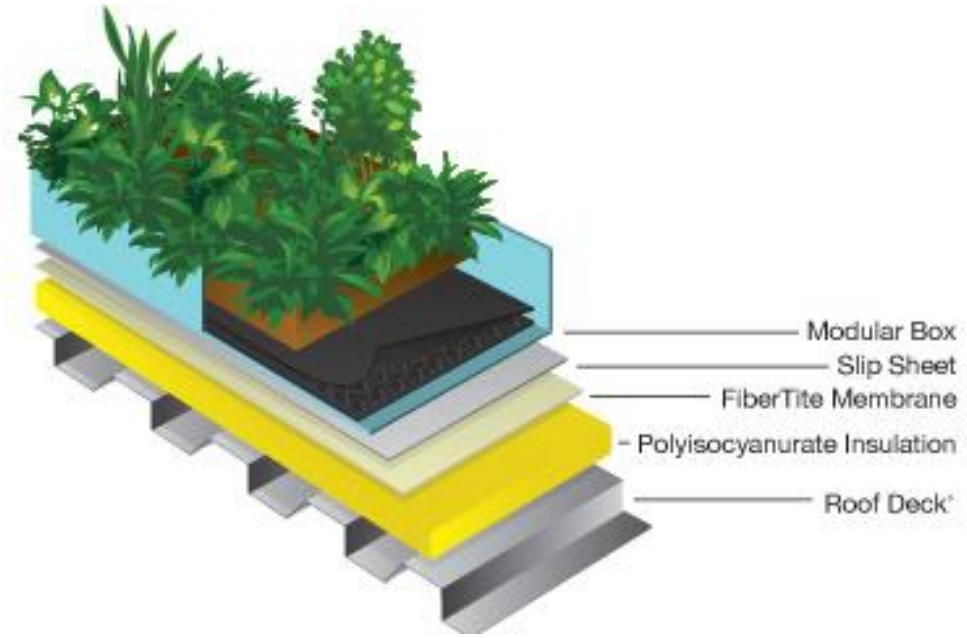


Fig 4: Planter box green roof

Green roof systems associated with sustainability areas Economic Sustainability
The use of green roof system in design can have a great impact on a community's economy. These effects can be mentioned the following:
A) reduce the cost of repair and renewal:

The life of insulation can be accelerated by the help of green roof; due to protection against UV rays, hail, storms and temperature differences are given the possibility that if the green roof is installed in a public building, the life of insulation will increase to 40 years Or more. (Keshtkar, 2010, 21)

B) Energy:

green roofs reduce the energy exchange of the building. In hot weather when the air temperature reached 95 degrees Fahrenheit, the roof temperature reaches 175 degrees Fahrenheit. While the green roof systems, plants and moisture through change heating and moisture through evaporation to steam and this process make the building to be cool. Reducing the heat and making indoors cool can reduce reflection so in average 25 percent of a massive green roof insulation increases. (Szewczyk, 2003, 30)

Considering that a large part of our country is in a hot and dry region, the energy efficiency of this system is highly regarded.

C) Inhibition of floodwaters:

Green roof drainage system and water run-off decrease in water rate of 10 to 50 percent and the rest become empty during the time. When the rain flows on the Earth and forest, it doesn't damage the ground, it goes in natural cycle.

In cities that include buildings and streets, 75 to 100 percent coverage is impossible to penetrate and rain water is destructive in a different way.

Only 5 percent of that water reaches to shallow and deep channels of the Earth and 15 percent evaporate through plants and the rest 75 percent will remain floating on the ground and are eroded. In the green roof system on average about 75 percent of water and soil remains in green roof, about 25 percent of the water will overflow that occurred hours after the rain falls. When the grass is water saturated, water slowly filtered through the soil and drainage is conveyed. Soil sediments, leaves and other parts are trapped and water improves before transferring to another location. (Keshtkar, 2010, 22)

D) Use of place:

1) the green roofs provide additional space for activities, which is necessary in the big cities overflow of buildings, population and cars. Due to the expense of the land in cities this system is used because of its advantage. (Szewczyk, 2003, 32)

2) Social sustainability: Since the concept of sustainability in the context of humans and human societies will find meaning, so achieve to sustainable development and Sustainability, regardless of social factors seems impossible.

Use of green roof systems can have many social benefits that help social Sustainability, including the cases can be outlined as follows: green roof construction creates job opportunities. There is a possibility in general green roofs to exchange culture and information between residents of the building.

In the green roofs children can play, adults and elders can exercise in the corner filled by pots and they can even break, in addition to entertainment such as circulation, reading and spending time to use the roofs more. (Del Barrio, 1998, 245)

3) Environmental sustainability: In most definitions about sustainability, paying attention to the environment, create safe spaces and less pollution and ecological environment are particularly important. Use of green roof system impact on the environmental sustainability according to the following:

a) Urban Ecology: Cities often prevent herbs and nature; Green roofs improve air quality and provide a place where the animal back to life in the city. The weather in big cities is usually

warm and dry and also trees around the cities can not carry enough water to the city to keep it cool. Air quality in both indoor and outdoor environment is important. Air quality can be provided through proper temperature outside cover. (Banting, 2004, 55)

b) Reduction of dust and smoke particles: green roofs refine dust, particles and hazardous materials. The roof is made cool and wet by the climate to improve the environment. (Johnson, 2004.122)

Polluted areas in populated cities can provide to use these advantages.

c) Noise reduction: the green roof instead of reflecting sound, absorbs it and insulates building against sound up to 8 dB. (hancook, 2006, 211)

This is suitable for noisy locations such as neighborhoods near highways, etc.

d) Natural habitats for animals and birds: natural roof can provide natural habitat by the hard coating which is destroyed.

e) Possible use of quality materials cycle: brick, clay, plant litter and soil for roofing and rubber, polyethylene and polystyrene are suitable for drainage. (Johnson, 2004.124)

Case study: Nanyang Technological University (NTU) Singapore

A new design school in Singapore's Nanyang Technological University (NTU) is creating a stir with its unique architectural concept. One of the highlights of this building is its curved turf roof. Art and design schools conjure up images of creatively designed buildings.

NTU's new School of Art, Design and edia (ADM) is no exception: only that it is more imaginatively designed than others. This fascinating building has many interesting twists; an unusual curved green roof, a landscaped garden and a sleek curtain wall. These features imbue the building with exceptional appeal and transparency, adding richness and sensory depth to the architectural form. The ADM building primarily consists of three interconnected blocks enclosing a sunken plaza, which is engulfed by a cascading pool and rich landscape. The highlight of the building is the verdant roof which weaves in and out of the ground. Design of the façade is a sleek glass curtain wall coupled with off-form concrete walls for a natural finish. On first impression the building seems to be very much a part of its lush green surroundings and comes across as a structure that grew from the ground. The main concern for the architects while designing the School of Art, Design and Media was to make the building of this school different from other conventional multi-storey buildings, in the campus and the city.

Fig 5: Site Plan of Nanyang University

Fig 6: Exterior View of Nanyang University

The site for the project was a wooded area and architects had wanted to retain the green characteristic of this site even after the woods had been removed to make way for the school. So in terms of design, the challenge was making a building that blends with its landscape rather than dominate it. Also being a school for future designers and artists the school had to have a distinctive architecture. When you look at the school you only see glass and grass, The most challenging aspect of the project was the construction of the roof, which is approximately 10,000 sqm.

Conventionally, a turfed roof requires soil as a growing medium and the extent of its coverage would impose heavy loads on the building structure and foundations. On the onset, the architects have devised an unique turfing system which allows the grass to grow and thrive on a thin layer of lightweight volcanic stones and sand. The entire composite section is barely 150mm thick and incorporates a water absorption mat that constantly provides moisture to the roots, thus reducing the need to frequently water the grass. All these sit on top of a preformed single-ply waterproofing membrane to ensure watertightness to the roof. alwitra's Evalon was chosen for its proven track record in tropical climate like Singapore's and in addition for its plant root resistance as tested to FLL standard.

It took four months to complete the installation process, having had to face two challenges: first to keep the planting material light and second to turf a roof that slopes as much as 45 degrees. This is probably the first time in Southeast Asia that a green roof with such a steep curve has been built. The groundwork done by the landscape contracting firm before the installation of this green roof included several months of mock-up experiments. The architects have designed the turf on the roof to be eco-friendly so that it can combat the hot and sunny Singapore weather with the use of limited water. The landscapers used a water mat that could absorb water during the showers and release it during a dry spell. The media used in this extensive roof also had the property of absorbing moisture as well as draining extra water. To prevent the shearing of steep roof the landscapers have used additional bracings on the roof. A fine grass called Zoysia Matrella, usually used on golf courses, was used for this project. With its heavily matted root network, this grass forms a thick mat and is ideal for tropical weather. The fact that it can withstand heavy downpour was the most important reason why it was chosen by the architects and the landscape contracting firm.

To help students of this school to take advantage of this green roof, the architects took the decision of keeping a part of the grass roof open. The grass roof of this project not only enhances its visual appeal but also creates a communal space for students to interact. At night, the building lights up like a lampshade and interior lighting streams through the glass curtain wall giving it an ethereal feel. It would not be too much to call this building "a gem in the forest". (ebookbrowse.com)

Conclusion

Sustainability is a concept of quality of life and the aim of raising the quality of life for posterity. This concept has three deep themes: environmental sustainability, economic sustainability and social sustainability. So only benefits of green roof can be used in all three areas in the form of strategic plans for sustainable development and green system directory and run track. In terms of changing black roofs to green roofs in urban areas, it should be in the form of sustainable development patterns and plan for massive conditions. Solutions also

need to create cultural attractions and improve the urban landscape to be developed by a green roof. Even if necessary, it can become a law to install green roofs.
In general the fundamental point is that the cost of designing and implementing of green roofs should not be compared with a conventional roof; but this comparison should be with soaring costs caused by water pollution, air and environment; diseases and deaths caused by this pollution; personal and social damage caused by lack of green space will be done in the artifact environment. Heavy costs of fossil fuels to the end, the deep psychological impact caused by non-beauty and vapidity cities, problems caused by flooding and flooded, the surface water control costs, the costs resulting from insulation and run multiple traditional black roofs can be added to the above costs.

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