Emerging Need for Incorporating Sustainable Principles in Buildings and Habitat Design

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ABSTRACT

As we began a new millennium, we tend to be fascinated by advance technology unfortunately at the expense of our links with nature. Most of the urban areas are usually warmer than their surroundings because of Air Pollution, Heat island effect, storm water runoff etc. These things lead to Global Warming – identified as a major climatic issue. Our battle against environmental decay, pollution depends on how we protect and preserve the plant life around us. Design and Architectural practices need to approach the current threats by integrating sustainable building design with landscape features. It is widely agreed that we can reduce the impact of global warming by implementing green roof technology. Green roof technology is a conventional roof covered with layer of vegetation. Vegetated roofs have been employed for aesthetic and practical purposes since early civilization- as evidence can be found in tree-covered temples in ancient Mesopotamia and hanging gardens of Babylon. On a wider scale, green roofs help to reduce air temperature, heat island effect, absorbing rainwater and provide shading and insulation to the building it will reduce the consumption of energy especially in air conditioning spaces, creating habitat to the building.

The purpose of this article is to provide detailed information about green roofs as influential elements of sustainable landscape. Attempts have been made to review existing literature regarding technical elements, economic feasibility and environmental impacts. The idea is to incorporate such techniques into modern architecture.

Keywords: Advance technology, global warming, green roof, heat island effect, environment.

1. INTRODUCTION

Realizing the environmental threats, to the quality of life, environmental movements have begun in virtually all sectors of industrialized countries, including business, manufacturing, transportation, agriculture, and architecture. The architect's role is central to the building design process: the most energy efficient and environmentally friendly building must also be functional, durable and aesthetically pleasing. It is now vital that the architect has a comprehensive understanding of all the facets of sustainability.

Indian cities today, amidst the wave of urbanization constantly densify its space and hence the micro and micro climate changing drastically. These changes leads too many climatic issues like temperature increase, sea level rising, ice sheets melting, floods, reduction of land to desert, draught and also the effect of global warming. According to the UN 2005 was the first year that more than half of the words population lived in the cities. As cities expands we loss most of vegetation, surfaces are paved and covered with buildings. These results moist and less shade to keep cool the urban areas, decrease in air quality, noise pollution and heat island effect. The intergovernmental panel on Climate Change (IPCC)estimate that during the20th century, the earth warmed up by between 0.3degree to and 0.6 degree C, while see level rose on average by 15 to 25cm. In urban areas the vast area is covered dark asphalt roofs which create Heat island impact at macro level and it effect climate of urban area and its surroundings. The use of green roof technology shows the multiple and documented benefits that these systems can impart to the urban environment. Green roofs can reduce heat island impact and also naturally plants play a very important role in absorbing CO2 from the atmosphere.

2. HISTORY OF GREEN ROOF

Green roofs have been in existence since ancient times from the Hanging Gardens of Babylon to the roof gardens of Le Corbusier. The first known historical references to manmade gardens were the ziggurats of ancient, Mesopotamia. France gardens planted in the 13th Century thrive atop a Benedictine abbey. Norwegians developed sod roofs centuries ago as a means of thermally insulating their buildings. Traditional houses in China and Japan, Vikings' grass-covered green roofs on residential and farm houses in Scandinavia (1600 D.C.), Terraced green roofs in Germany & Switzerland (1960's)

Photo1 Ziggurat

Photo 2.SOD roofs

Photo 3. Babylon roofs

The understanding of the motivations behind green roof usage in history broadens our understanding of their current uses. Why they became conceptually separated is uncertain: devoid of plants and inhabitants, the flat roof became a mainstay of modern design, while the roof garden was virtually forgotten. With the growth of the environmental movement, green roofs have been resurrected. More recently, Europe has adopted green roofs to improve quality of urban environments. Europeans have done a great deal of research to improve green roof technologies, focusing on root repellant, waterproofing membranes, drainage systems, lightweight growing media and drought tolerant plants. Germany is ahead in terms of studies and market growth; their market went from 247 acres (1 million m^2) in 1989 to 2417 acres (10 million m^2) in 1996.

3. GREEN ROOF

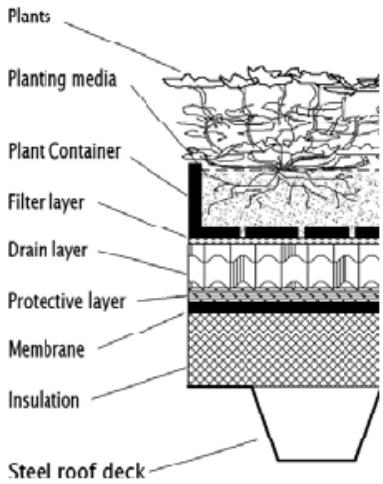
Green roofs are roofs that are covered with living plants. Recent advances in membrane waterproofing technology, lightweight thin-profile are used for most new construction. Green roofs are visually attractive because of the multicolored flowers, grasses, and wild herbs are more appealing than monolithic surfaces.

Green roofs can transform urban wastelands into urban gardens. They are cool in the summer and help in reducing the urban heat island effect. We can provide green roofs on Residential, commercial and industrial buildings. The roof top vegetation can be classified in three systems: Extensive, semi extensive and intensive roofs.

3.1 Extensive Roofs: It is also known as low profile or performance roof. These roof contains minimum planting medium, minimum weight load and for aesthetically pleasing purpose. These are self sustaining roofs and can be installed on flat and pitched roofs. They require little to no reinforcement of existing slab so are not expensive to construct.

3.2 Intensive Roofs: An intensive roof system is same as ground gardens found on the roof top. They are accessible to people to enjoy. Medium size shrubs and grasses, as well as edible garden plantings, small trees, and often stone paving or walkways can be added as additional options in the intensive gardens. Because of greater plant, varieties and deeper substrate they need greater structure support

3.3 Semi Extensive Roofs: As Extensive green roofs were designed as lightweight installations. These were not publicly accessible, while intensive green roofs were designed as amenity spaces for people and required a heavy structure support also. The boundaries between these types of roofs are now less distinct, and terms such as ‘semi-intensive’ or ‘semi-extensive’ are used to describe roofs that show elements of these major categories. This new term is used to describe in green roof that have some characteristics of both extensive and intensive design.



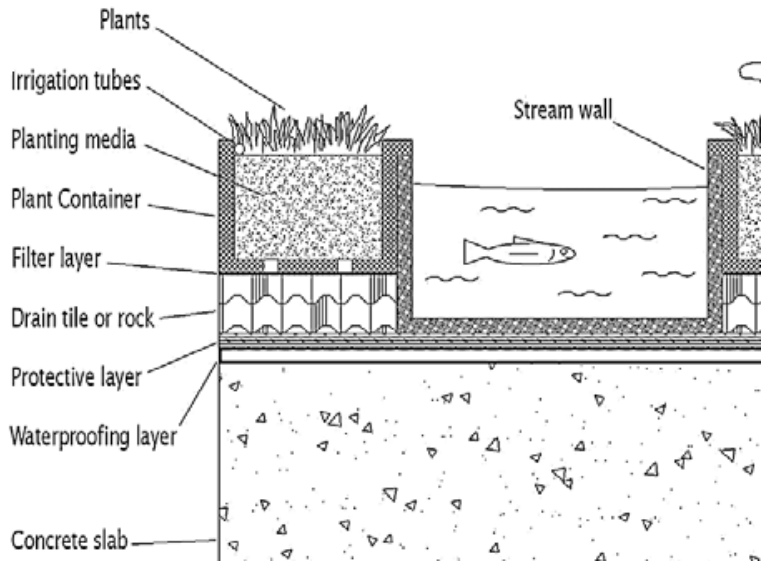


Fig.1 Extensive Green Roof Construction **Fig.2 Intensive Green Roof Construction**

Table1. Major types of green roofs and their characteristics

Characteristics	Extensive	Semi-Intensive	Intensive
Aim	The aim is to provide combine roof performance and low maintenance	To provide an aesthetic effect	To provide real landscape on the roof.
Location	Suitable for large areas	Utilizes areas with greater loading capacity	Best insulation properties and storm water management
Irrigation required	No irrigation	Often Irrigation	Always irrigated
Depth of material	150mm(6”) or less	Above and below 150mm	More then 150mm
Accessibility	Often inaccessible	May be partially accessible	Usually accessible
Fully saturated weight	Low (70-170 kg/m2)	Varies (170-290 kg/m2)	High (290-970 kg/m2)
Plant Diversity	Low	Greater	Greater

Cost	Low	Varies	Highest
Maintenance	Minimal	Varies	Highest
Use	Ecological protection layer	Designed green roof	Park like garden
Advantages	Light weight, Easier to replace, better for retrofit, best cost benefit ratio.	Combine benefits of Extensive and Intensive	Aesthetic, Plant diversty,Range of design

4. GREEN ROOF BENEFITS

Green roofs provide many benefits to the Betterment of Environmental and Human Benefits

4.1 Environmental terms Benefits of green roof

4.1.1 Energy conservation: In large peak summer utility loads are estimated to raise 1.5%-2% for each 1°increase in temperature. Green roofs can reduce urban heat island by increasing surface reflectivity it gives comfort to indoor environment which reduce the load of mechanical energy. It also reduce the impact of heat in surrounding areas as the plants cool the air by drawing moisture from the soil and evaporating through their leaves.

Columbia University Center for Climate Systems Research and NASA Goddard Institute for space studies had discovered that green roof could potentially reduce energy usage, fossil fuel consumption and greenhouse gas emissions. On average 20C reduction in indoor air temperatures were measured in building with green roofs during daytime hours and 0.30C higher at night.

4.1.2 Strom water management: Up to 75% of many urban areas are covered with hard surfaces: roof account maximum part of this. This means 75% of perspiration is not being absorbed. That amount can probably be reduced by half if the roofs are covered with vegetation. Because of their ability to absorb and retain water, green roofs have been put forward as a strategy for reducing runoff–potentially a great benefit

4.1.3 Air pollution mitigation: As air moves across the Green roofs it filtering the air and removing airborne particles from cars, factories, trucks in urban areas .through photosynthesis it produce oxygen and reduce carbon dioxide.

4.2 Benefits in human terms

4.2.1 Indoor Environment: As outdoor temperature increase by heat island effect it will also affect on indoor environment and it increase the use of higher energy consumption in building.

Green roof will reduce the Heat island effect so improve indoor environment and energy consumption of the building.

4.2.3 Open space: Open spaces are very less in dense cities. So Alternate of roof gardens could benefit many city buildings. As Green spaces have been shown to: Decrease stress, Improve recovery times, Create safe space for relaxation and recreation, Decrease noise pollution and Can be used for local food production etc.

4.2.3 Green roof durability: Due to thermal cycling, by shielding the roof from effect of Ultra Violet rays green roof protect the membrane that's why it will help in reducing cracking and leakage resulting from expansion and contraction of structure.

4.2.4 Economic benefits:

Generally in starting green roofs are more expensive than standard roofs. If green roofs really last twice as long, then over time they are no more expensive than standard roofs, which cost about half as much. The other economic benefits also as green roof reduce air conditioning and heating cost, Reduce water and sewerage charges and also attract buyers and tenants.

4.3 Other benefits:

Green roof increase the life of a roof, job oppurtunities, plants absorb sounds, habitat of species such as birds, butterflies etc.

5. FACTORS TO CONSIDER WHEN APPLYING GREEN ROOF

5.1 Planning Requirements: Structural loading capacity of the roof, Accessibility, Size, slope, height, and directional orientation of the roof, orientation of the building as it relates to surrounding buildings and shading. Rainfall pattern

5.2 Design Considerations: Water supply system, Storm water drainage system such as drains, scuppers, buried conduits, and drain sheets. Flashing details. Details for penetrations, selection of plant and Wind movement, Aesthetic appearance

5.3 Sustainable technologies: Rainwater recycling, Roof slope.

5.4 Construction: Safety issues preventing falls, Vegetation planting method, Testing & monitoring

5.5 Maintenance: External fire hazard, Safety issues, Prevention of pest intrusion.

5.6 Project Management: Green building assessment, financial incentives. Cost material and labour, Green building credits

6. INSTALLATION TECHNIQUES OF GREEN ROOF

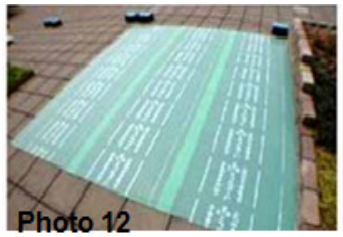
A modern green roof requires eight functional layers: sturdy roof structure, reliable waterproofing membrane, root-barrier membrane, tough protection mat, water-storing drainage layer, non-clogging separation fabric: engineered soil, appropriate plants.

6.1 Installation Techniques of Built- in green roofs

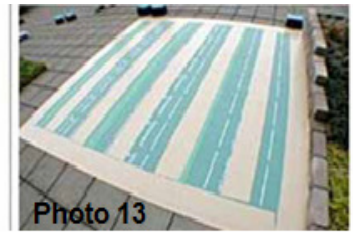
It is installing on the roof surface. Its excess weight is 180-450 kg/m2.The process of installation has been explained through the following series of Photos.

6.2 Installation Techniques of modular green roofs:

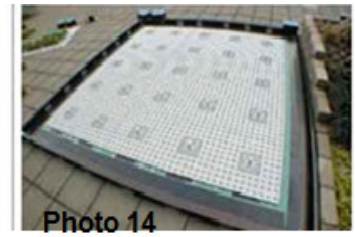
It is prefabricated at off site. The plants are pre grown with modular design. It is subdivided into standard interchangeable parts



1.Water Proofing

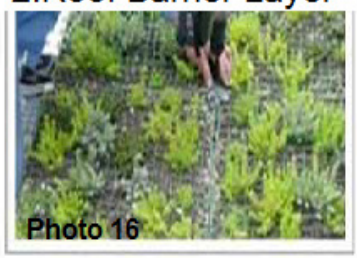


2.Roof Barrier Layer

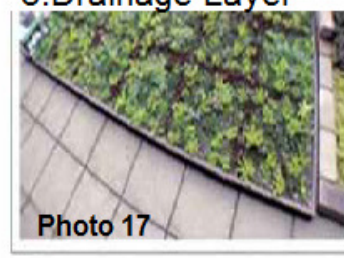


3.Drainage Layer

4.Install Modules



5.Fix Modules



6.Completed

7. BUILDING ASSESSMENT AGENCIES

Several organizations setting standards and rating the roofing products. Following is a list of resources LEED™ certification program, which has an SRI calculator, as well as established criteria

- Cool Roof Rating Council, which administers roof testing and publishes results, by type and brand name
- Energy Star®, which has established criteria and lists compliant commercial products
- Lawrence Berkeley Lab, which lists tested results for generic and specific products
- Oakridge National Lab, which has tested ref lectance / emittance over time, including SRI and calculator
- California Cool Roof Information, which hosts a Qualified Cool Roofs Products List of products that meet California's Title 24 Requirements
- ASHRAE/IES, which considers cool roof - insulation trade-offs in Standard 90.1

8. CONCLUSION

The threat of climate change demands an immediate, global reduction of greenhouse gas emissions, requiring action at every governmental level, from national to municipal level. The justification of the use of green roof technology based on a review of literature shows the multiple and documented benefits that these systems can impart to the urban environment.

The power to transform our cities from unhealthy, stressful, overheated environment to healthier, more sustainable communities is completely withimn our reach-and I believe this transformation

can be achieved within a generation. The city of Chicago, with its 3 million sq.ft of green roofs, and crowning achievement of its millennium park, demonstrates that what can be achieved in just a few short years.

"On this rooftop…I'm watching you move among your sparse, pinchpenny flowers,…that pull the sun's rays in as best they can and suck life up from one mere inch of dirt." Howard Moss, "The Roof Garden"

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