

A Study of Living Roofs and Walls In Indian Context with a Sustainable Approach

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ABSTRACT

Due to urbanization and industrialization, increased population is leading to shortage of green spaces. Due to this the world started facing some problems such as – Urban heat island, carbon foot print, storm water runoff etc. Living roofs and walls significantly contribute to sustainability by increasing energy efficiency of a building, helping our cities to mitigate the effect of heat island, provide sound insulation, give us a new ecology for various species and turn the wasted roof into various types of amenities. They are emerging as important addition into the palette of construction techniques. This paper shows the benefit of Living roofs and walls over conventional roofs and walls. Although Living roofs are initially more expensive to construct than conventional roof, they can be more economical over the life span because of the energy saved and the longevity of roof membranes. Green roofs are considered as a solution to improve the urban environment and are an ideal tool as the building choice to increase the environmental sustainability in urban setting. This paper aims to deal with living roof and wall techniques based on the strategies of sustainable development in architecture and its impact on environment and finding solution to the barriers in implementation of living walls and roof.

Keywords : Environmental Sustainability, Living Roofs, Living Walls.

I. INTRODUCTION

Living roofs and walls plays an important role in sustainability through its contribution to the natural ecosystem. The objectives of this study are to identify the barriers in implementation of green roofs and walls and finding out suitable solution to these barrier while implementation. Removing these barriers will contribute not only to the aesthetics but also to the environment.

A. Evolution of Vertical Landscape

History reveals that purpose of vegetated roof were diverse. The earliest documented garden in the 7th century B.C. was the hanging garden of Babylon In Mesopotamia, near river Euphrates. They are called Hanging Garden because of plants hanging down over the year and looks like floating in the air. In more recent times, Green roof were seen to be as turf roof,

which provide insulation and it keeps their home cool in summer and warm in winter. After a lot of researchers taken place, this phenomenon was developed in Germany in 1960 which really help on understanding green roof. After this, further research on different components was carried out including studies on root repelling agents, water proofing membrane growing media, drainage etc. In India the concept has gained popularity only in the metropolitan cities where the horizontal spaces are not meeting the environmental needs.

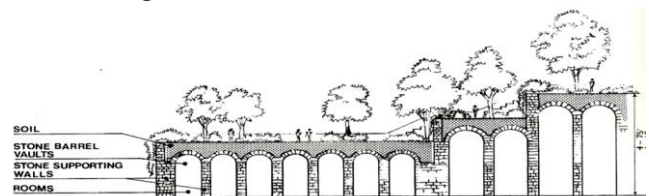


Figure 1 The section drawing of the Hanging Garden of Babylon, circa 500 B.C based on archeologist Robert Koldewey's description.

SOURCE: Roof Gardens: History, Design, and Construction by Theodore Osmundson. (Copyright © 1999 by Theodore Osmundson. Used by permission of W.W. Norton & Company, Inc)

B. Current Scenario

In India the only solution to live with plants in metropolitan cities like Delhi, Mumbai etc. was to save horizontal surface for public Garden or to grow vertical Garden. Recently vertical garden seen on the pillars of Bangalore Metro station which will help to ease pollution in city and enhance the aesthetic of the city. ¹Experts claim that pillars on which vertical gardens are erected lead to a drop of 2 degrees Celsius in the area. According to the Union environment ministry, Delhi generates over 131 tonnes of dust each day. Besides city aesthetics, these gardens also reduce the urban heat island effect. The Delhi-Meerut Expressway is the first bridge in the country as well as the world which has vertical gardens with solar power system and drip irrigation. Delhi is becoming more and more urbanized and so vertical gardens serve the dual purpose of improving air quality by trapping dust and pollutants and absorbing heat from the surroundings to provide a cooling effect. While it is easier to reduce the temperature of a building internally, you require large-scale implementation of such gardens across the capital to regulate external temperatures. But it is found that implementation of vertical gardening is very slow and facing many barriers.

II. MATERIAL AND METHOD

A. Living Roof

A roof which is covered with the vegetation and soil.. Living roof or green roof consist of several layers, including water proofing, drainage, insulation with

soil substrate, and actively growing plants. There is different type of green roof based on the depth and type of medium soil, Intensive green roof system characterized by deeper soil, high cost with professional maintenance and a regular irrigation system. Extensive green roofs are modern modification of roof – garden concept. They have comparatively shallower substrate, low cost with less maintained

Table - 1 Difference between intensive and extensive green roofing system

Characteristics	Extensive Roof	Intensive Roof
Structure	Roof does not require reinforcement	Structural improvement is necessary
Substrate type	Lightweight , suitable for large areas, low organic matter	Greater weight, deeper soil
Plant type	Low – growing communities of plants , vegetation grow spontaneously	Greater diversity of plants and habitats
Maintenance	Little or no maintenance required	More maintenance is necessary
Cost	Relatively inexpensive	High cost, more complex system and need expertise.
Efficiency	Less energy efficiency and storm water retention benefits.	More energy efficient – storm water management, thermal insulation.

¹ Source : Paras Singh, Times of India; How green was my Delhi : Vertical gardens withering my heat , jun 8, 2018, 01:12 IST

Green roof consist of Roof structure, waterproof membrane act as root repellent, Drainage, Insulation, substrate and plants. One of the most important elements in a roof is the bearing structure. Green roofs must typically support 25 to 100 pounds more load per square foot than conventional flat roofs. The roof's membrane needs protection, primarily from damage during green roof installation, but also from fertilizers and possible root penetrations. For this purpose generally large sized soft PVC foils are used. It is desirable to store water in green roofs to help plants survive through periods of dry weather. Excessive water drained from the plant zone. Rapid drainage can be provided by several water storing drainage product and its thickness depends on the type and vegetation of Green Roof. Beneath the growing media & above the drainage system, the filter fabric keeps the media from clogging up the drainage while allowing water to flow freely. The uppermost layer is growing medium which hold the vegetation.

B. Living Walls

Living wall systems are composed of pure vegetated, vertical modules or planted blankets that are fixed vertically to a structural wall or frame. It can be grown and supported in two ways without soil (hydroponically) and with soil. Soil based wall are rarely used due to their heavy weight. Hydroponics (the process of growing plants in sand, gravel, or liquid wth added nutrients but without soil.) Hydroponically living walls are available in three system – Modular Panel system, Container and trellis and Felt system. Living wall consist of waterproofing membrane, Growing media ,vegetation, irrigation system and drip trays. These wall filter the air and provide thermal insulation. A variation of this concept could be applied to green façade systems as well, and there is potential to apply a hybrid of systems at a large scale.

III. ROLE OF VERTICAL LANDSCAPE IN SUSTAINABLE DEVELOPMENT

Sustainability is a term first time coined in Brandt Land's commission defines –“Meets the need of present generation without compromising and providing better environment for future generation”. Sustainability stands on three pillar – environment, social and economic. This research focuses on environment, social and economic benefits of Green roof and walls. Vertical landscape provides both public and private benefit. These are developed with the concern of environmental factors like Temperature and humidity, Wind, Rainfall and irrigation, solar radiation and orientation etc. It replaced the footprint of building with Green roof with no net loose of green open spaces or habitat. They contribute to the reduction of number of air particles and reduce carbon di oxide in the atmosphere reduces the heat island effect.

A. Environmental Benefits

i. Reduces Urban Heat Island Effect

Urban areas have large number of reflective surface which absorbs solar radiation and reflect this heat back into the atmosphere. Roof and walls are a significant part of urban hard surfaces. Green roofs and walls absorbs heat and pollution. This results in reduction of urban temperatures and improvements in air temperature. A Regional simulation model using 50% green roof coverage distributed evenly throughout Toronto showed temperature reductions as great as 2°C.

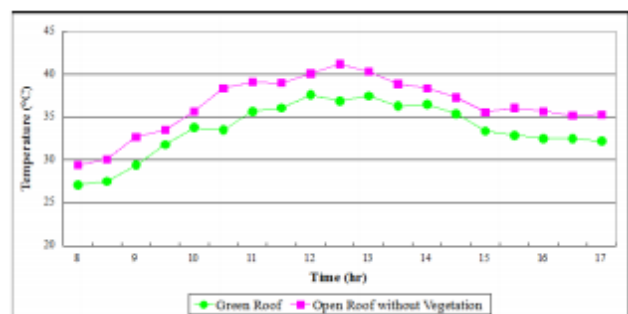


Figure 2 Rainfall runoff response of the green roof and conventional roof

SOURCE: Jurnal Teknologi, Urban heat island mitigation using green roof approach , Published online on 1 April 2018

ii. Storm Water Management

Green Roofs are ideal for storm water management because roofs contribute to heavy runoff due to hard and non porous surfaces which leads to sewage overflow into lakes and rivers. Green roofs absorb and retain water helps in reducing amount of runoff. It store water in plant's foliage and evaporates off the substrate surface. The type of plant species, depth of growing substrate and structure of drainage layer, slope of the site and rainfall patterns affect the rate of runoff.

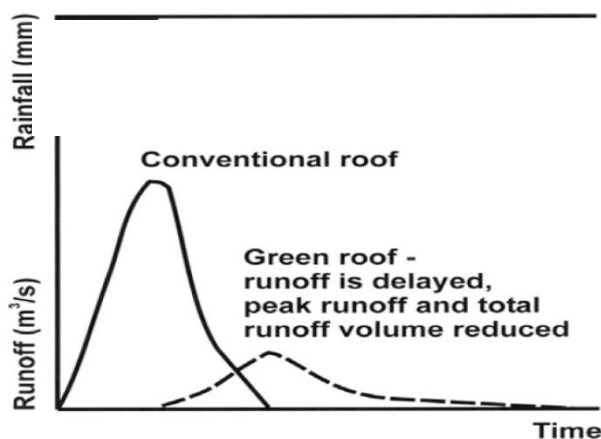


Figure 3 Rainfall runoff response of the green roof and conventional roof

SOURCE: Muhammad Shafique, Reeho Kim and Kwon Kyung-Ho, Green Roof for Stormwater Management in a Highly Urbanized Area: The Case of Seoul, Korea, 26 December 2017; Accepted: 21 February 2018; Published: 26 February 2018

iii. Improved Air Quality

Due to urbanization, industrialization, population and number of vehicles increased which leads to air pollution.. Green walls reduce number of polluting air particle. Plants are natural filter absorbs carbon di oxide from the atmosphere and block the dust particle by filtering the air . It plays a important role in improving air quality. Studies have shown that urban

streets with trees have less dust particles than streets without trees. It also improves indoor air quality.

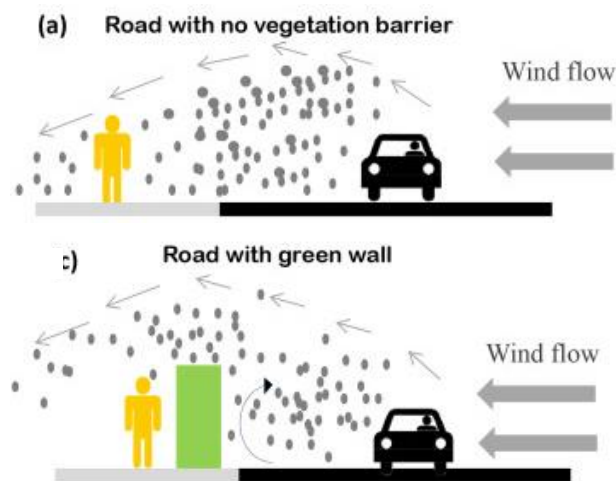


Figure 4 Dispersion patterns of road pollutants under open road configurations (a) without vegetation barrier (b) with green wall.

SOURCE: Review article Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments - A review, Atmospheric Environment, ELSEVIER

iv. Improved Thermal Performance

Living roof and wall reduces the amount of heat transferred through the roof and energy consumption of urban buildings through cooling the city. It provide insulation between indoor and outdoor environment. Green wall can reduce temperature up to 15 F , so that cooling load is also reduced by 10 % for the entire building. Green roof reduce heat flux through the roof by evapotranspiration, physically shading the roof. In winter, it also reduces conventional heat loss from the building.

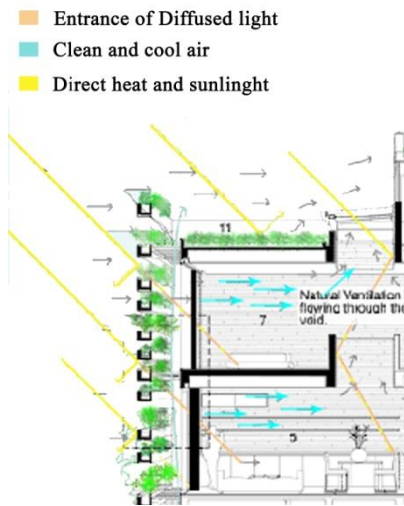


Figure 5 Thermal performance of Building

SOURCE: (<http://www.dezeen.com> 2013).

v. Increase in Green Spaces and Urban Habitat

Green space provide ecological function, visually softening the built environment, supporting biodiversity, improve human health. Green roofs are commonly inhabited by various insects, ants, bugs, used by nesting birds. These findings have mobilized local and national conservation organization to promote green roof habitat.

Green roof if implemented in small scales but serving and involvement of large section of society. The various study carried out and confirmed that green roofs have more sustainable advantages than convention roof. The following table 2 compares the positive aspects of a green roof installation with a conventional roof.

Table 2: A comparison of benefit between a green roof and a conventional roof. Basic formwork is courtesy (Peck, 2008),

Benefit	Green Roof	Conventional Roof
Storm water volume retention	10-35% during wet season, 65-100% during dry season	None
Temperature	In hot season	Achieved

mitigation		with insulation
Improved water quality	Retains atmospheric deposition and retards roof material degradation. Reduced volume reduce pollutant loadings	None
Urban Heat Island Mitigation	Prevents temperature increases	With Light colored roof ,e.g. white roofs
Air Quality	Filters air and increases evapotranspiration	None
Energy Conservation	Insulate building roof	Through Addition of insulation, light colored roof and shading reduction in energy consumption may be achieved.
Vegetation	Allows seasonal evapotranspiration; photosynthesis,	None
Green Space	Replaces green spaces lost to due to the building footprint	None
Habitat	For bird and insects	None

Other advantages None	Buffers noise, alternative aesthetic, offers passive recreation	None
Cost offsets	Reduced storm water facilities, energy savings, higher rental values, increased property values, reduced need for insulation materials, reduced waste to landfill	None
durability	Waterproof membrane protected from solar and temperature exposure lasts more than 36 years; membrane protected from maintenance damages.	With Little protection and exposure to elements, roofs may last less than 20 years.

IV. DISSCUSSION

A. Barrier to Implementation

The main objective of this study is to implement sustainable technique like green roof and wall in order to improve the quality of life, make sustainable cities, urban areas that are jungle. But as a new technology, green roofs and walls face many barriers. The major barriers to the more rapid diffusion of these sustainable development are technologies are lack of

knowledge and awareness people don't know about green roof and walls, lack of specialized products on the market; few examples of roof and vertical garden installations; and no industry technical standards for green roofs, which means no standards in building codes. There is also a risk associated with uncertainty. Cost on the other side a big barrier to implementation of green roof. Cost is affected by the system of roofing, market development, in this process of implementing green roof and walls, it is also necessary to fight against false areas ideas or misconception. Due to lack of knowledge people believe that green roof and wall cost more and requires costly maintenance. Many of these barriers represent fairly standard challenges facing the adoption of new technologies. The significant environmental benefits are attainable, in the absence of government policy, do not find expression in the market place.

B. Solution to these Barriers

It also seen that green roof installation needs to be done by professionals. There should be national policy for encouraging the living roofs and walls. Global awareness should be increased with increase in number of international seminar and conferences. In Indian context, some small incentives for developer can be put for increasing them, due to lack of demand and supply, cost of green roof is also high.

Make it mandatory through legislation, planning instruments to the building code to fit new building with green roofs and vertical garden technologies. Aware people and builders to use wasted spaces in the normal flat roofs of the building by making it green roof in order to enhance more sustainable environment. There is also a perceived need of decision- makers to enter long – term investment that often yield the greatest degree of public benefit. Standardization and certification of green roof product and the introduction of complete process.

V. CONCLUSION

Increased pollution, temperature threatens the health of people in big cities, considering the environmental effect green walls and roofs are necessary. Researchers should be carried out more on native plants around the world so that the use of green roofs can become more successful, gain more acceptance. Green roofing is an important factor that cannot be neglected when trying to achieve sustainable environments because of its numerous importance to urban areas and the world at larger scale.

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