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GREEN ROOF BUILDING

Aher Shweta[1], Wankhede Snehal[2], Deshmukh Minal[3], Shimpi Smita[4]

[1,2,3,4]Civil Engineering , Guru Gobind Singh Polytechnic (India)

ABSTRACT

A green roof is a roof partially or completely covered with Vegetation . Growing medium, planted over a waterproofing membrane. It includes additional layers. Root barrier and drainage and irrigation systems are additional layers. Container gardens on roofs, plants are maintained in pots, are not generally considered to be true green roof. Rooftop ponds are another form of green roofs which are used to treat grey water. it serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, increasing benevolence and decreasing stress of the people around. The roof provides a more aesthetically pleasing landscape. It also helps to lower urban air temperatures and mitigate the heat island effect. Green roofs and roof gardens date back to thousands of years. A green roof is a combination of abiotic and biotic components, engineered to function as a green space . There are several types of green roofs like intensive, extensive, eco roofs.

Keywords: extensive green roof , global warming , green roof , intensive green roof , structural evaluation.

I .INTRODUCTION

A green roof or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a water proofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Containergardens on roofs, where plants are maintained in pots, are not generally considered to be true green roofs, although this is debated. Rooftop ponds are another form of green roofs which are used to treat greater. Green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat forwildlife, increasing benevolenceand decreasing stress of the people around the roof by providing a more aesthetically pleasing land scape, and helping to lower urban air temperatures and mitigate the heat island effect. They effectively utilize the natural functions of plants to filter water and treat air in urban and suburban landscapes. There are two types of green roof: intensive roofs, which are thicker, with a minimum depth of 12.8 cm (5.0 in), and can support a wider variety of plants but are heavier and require more maintenance, and extensive roofs, which are shallow, ranging in depth from 2 cm (0.79 in) to 12.7 cm (5.0 in), lighter than intensive green roofs, and require minimal maintenance. The term green roof may also be used to indicate roofs that use some form of green technology, such as a cool roof, a roof with solar thermal collectors or photovoltaic panels. Green roofs are also referred to as eco-roofs, oakstages, vegetated roofs, living roofs, green roofs and VCP_H (Horizontal Vegetated Complex Partitions)

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II. HISTORY

2.1 An Evaluation Of Green Roofing In Buildings (Mr Rufai MohammedAhemad 1 Jan 2016)

Green roof has been in existence for over 3000 years, the earliest green roofs were seen to be as form of a turf roof. The turf roof contains growth of grasses and plants roots and this kind of roof is still in existence in Norway and Iceland. In warm climatic region green roof was first identified as roof garden which was seen in the ruins of Pompeii after the volcanic eruption of Vesuvius Mountain in AD 79. Green roof was also seen in the famous Hanging Garden of Babylon which was constructed around 500 B.C. During Middle Ages green roof was also found in Guinigi Tower, Lucca, Italy (Stater, 2008). Figure1: Turf Roof (Magnusson 1987) Figure2: Farm house with Turf Roof (Nancy Marie Brown 2001) Modern green roof emanated from Germany and Switzerland in 1960s after a lot of researches were taken place about terraced green roof technologies. A German researcher Reinhard Bornkamm published his works in 1961 on green roof which really helped on understanding green roof more. In 1961 Geno Haus was also built and it was functional until 1990 (Metropolis Magazine). In 1970 other important researches were also taken place on green roof especially on its components like, root repelling agents, water proofing membrane growing media, drainage etc. Some of these researchers were Gerda Gollwitzer and Werner Wirsing. In 1980 green roof market gained so much acceptance with annual growth of 15% to 20%. In 1989 about 1 million square meters of green roof were used in Germany and by 1996 that number rose to 10 million square meters. This success was achieved as a result of help and encouragement from the German Government which it contributes 35 to 40 Deutsh Marks per square meter of roof. Such kind of gesture was copied in other European countries with some of their large cities and urban areas incorporating roof and vertical greening in their planning regulations and these gave birth to a new green roof industry for supplying plants and materials, installers and maintenance crew and green roof professionals. In countries like Germany, France, Austria, Norway, Switzerland and other European countries green roofs have been accepted widely in their construction industries and urban landscape (Peck et al, 1991). Countries like Germany, Switzerland and Scandinavia have the highest contribution on Europe's earlier green roof researches and they were not written in English (Dvorak, 2010, Koehler, 2007, Mentens et al., 2006). Furthermore, Dvorak (2010) stated that the wide experience about green roof led to improvement of guiding principle based on academic research, product improvement and field research. These guiding principles were developed by research group called FLL meaning G

2.2 Energy Conservation And Green Roofing (Mar. Michael Meskin 12 Feb. 2013)

In the past, people were concerned with having enough resources to survive individually and in a community, but today there is a great unease that the resources used will have negative impacts on the environment on a global scale. The threat of global warming has come from resource consumption and the emissions of waste products by a perpetually growing world population. The Intergovernmental Panel on Climate Change (IPCC) projects that the population will grow to about 9.4 billion people by the year 2050. The trend of rural to urban migration has also led to increased concentrations of people in cities and suburban areas. The US Energy Information Administration (E.I.A.) states that for over 100 years, the dominant energy source has been fossil fuels: petroleum, natural gas, and coal. The E.I.A also suggests that world consumption will still be dominated

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by these fossil fuels by at least the year 2035. The use and development of new energy sources have been motivated by the observed negative impacts from energy waste product emissions, and if the population will be reaching nine billion people in the near future, there is a need for change in energy consumption. This immense amount of energy consumption has led to high concentrations of greenhouse gasses and aerosols in the atmosphere, which raises global average temperatures. Much of this increase is due to industrial activities and anthropogenic changes. A major change is that natural habitats have been replaced with human environments and impervious landscapes, and, "Before human development began disturbing natural ha bitats, soils and vegetation constituted part of a balanced ecosystem that managed precipitation and solar energy effectively" (Getter and Rowe 2006, 1276). This rise in global average temperatures and change in natural habitats show the need for mitigating effects in urban areas. 14 Anthropogenic changes in landscape cover have detrimental results on the environment. "In the United States, it is estimated that 10% of residential developments and 71% to 95% of industrial areas and shopping center are covered with impervious areas. Today, two-thirds of all impervious area is in the form of parking lots, driveways, roads, and highways" (Getter and Rowe 2006, 1276). These impervious areas absorb more solar radiation and store more heat much better than rural environments. The solar radiation striking many natural environments turns the radiation into latent heat of evaporation through evaporation and transpiration. In the urban landscapes, more solar radiation is turned into sensible heat because of reduced moisture on impervious surfaces and less vegetation. There is a need for change in metropolitan and suburban areas because the lack of trees, grass, or water bodies adds to the energy absorption and heat storage.

III. METHODOLOGY

Green roofs are emerging in North America as an aspect of sustainable urban ecology. An understanding is needed of the components and benefits of these systems. A green roof is a combination of abiotic and biotic components, engineered to function as a green space in a harsh environment. There are several types of green roofs divided into the categories of intensive, extensive, modular, and brown or eco roofs .A green roof defined is; a flat or sloped rooftop that supports vegetation (Dvorak, 2010, p. 198), on a roof or deck designed to provide urban greening for buildings, people or the environment (Dvorak, 2010, p. 197) while acting as a storm water management system (Anderson, et al., 2010, p. 319). A green roof consists of a vegetation layer, a substrate layer (where water is retained and in which the vegetation is an chored) and a drainage layer (to evacuate excess water) (Mentens, 2006). A green roof covers a building with vegetation and soil-like substrate, a filtration layer, drainage layer, root barrier, membrane protection layer, waterproof membrane, and finally insulation (Dunnet &Kinngsbury, 2004, Snodgrass, 2006, p. 33). There is much variation in the usage and composition of these layers. While green roofs have higher initial costs than traditional roofing, green roofs have a diverse array of potential benefits which counterbalance the high cost (Dunnet & Kingsbury, 2004), such as; reducing building loads by preventing excess heat from entering buildings, mitigating the urban heat island effect when many green roofs are installed by providing a medium that uses excess heat to evaporate water, reducing storm-water runoff by retaining precipitation, sequestering carbon dioxide and pollutants in biomass, improving aesthetic

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values or providing recreational benefits, creating wildlife habitat, and providing noise reduction in buildings (Dunnett & Kingsbury, 2004).

IV. CASE STUDY

4.1 Overview

Vegetated Roof Systems (aka: green roofs) are used extensively in Europe to manage storm water, reduce energy consumption, and for aesthetic appeal. They are gaining popularity in the United States especially in larger cities that are required to meet stringent requirements to manage storm water. Green roofs can be installed on new construction or retrofits to existing buildings as long as the facility has the necessary structural integrity (check with a structural engineer). There are variety systems available for commercial to residential applications. The two types of green roofs are: intensive and extensive. Intensive green roofs are typically more elaborate systems while extensive roofs can still be lush, but require less material (see table below for specifics).

Table 4.1.1 Intensive And Extensive Green Roofs

Characteristic	**Intensive Green Roof**	**Extensive Green Roof**
Soil	Requires minimum of one foot of soil depth	Requires only 1 to 5 inches of soil depth
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 1-2 years during plant establishment and periodically for weeding and planting as needed

4.2 Plant Selection

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Plant selection is very important to green roof systems. Intensive roofs can be planted with larger, deeper growing plants (2-3 ft deep) because of the depth of soil medium. Extensive roofs should use relatively low-growing, fibrous plants because the soil medium is so thin (1”-5” deep). The plants will need to be hardy enough to survive the seasonal elements, wind pressures, and intense heat—especially when installed on tall buildings. Succulents are commonly selected including sedums, delosperma because of their tolerance and water storage abilities, but other plants are being researched (including moss, ferns, and even strawberries). In either system, plants should be selected that are able to withstand periods of drought, and are acclimated and hardy to the growing zone of your region. This is crucial to their growth and survival.

Fig 4.2.1 Container with Plants Featured on The NC Arboretum Green Roof

V .IDEA AND MECHANISM

5.1 Motivation

A green roof that can’t be seen by building occupants loses its most valuable benefit. Many high-rise buildings have terraces or roof sections that can be seen from within the building, even from C-suite offices. A decision maker who is unsure about a full- scale green roof may be more receptive to a work smaller initial project with strong visual appeal. That initial success will lead to participation as an option demonstrates creadditional projects.

5.2 Advantages Of Green Roof

- Increase the aesthetic value of a building
- Being a natural habitat for many species of birds and insects
- Keeping the air fresh
- Creating energy efficiency

5.3 Disadvantages Of Green Roof

- Structural limitations
- Installation and maintenance costs are high
- Susceptible to damage and leakage
- The limited number of plants

5.4 Mechanism

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Green roof waterproofing membrane tests faces critical limitations of being overly reliant on visual inspection. This result from the absence of a method which allows clear observation of plant roots during its growth.. Shortcomings of this test include long duration, high loss of minute root information due to the method of root exposure, heavy reliance on visual observation and low reproducibility. Modified aeroponics and close-circuit television surveillances system are put together to solve this problem. It was determined that plant cuttings are preferred over seedlings because of higher survival rate and had better structure. It is also established that plant root growth can be expressed as a function of dry root mass and the quantification parameters of plant roots.

VI. RESULT AND TESTING

Green roofs are increasing in popularity in the US because of the benefits they provide over traditional roofs such as reducing storm water runoff and improving runoff quality; reducing air conditioning costs; lengthening roof membrane life; and providing an aesthetically pleasing roof. Green roof media testing is important for characterizing the physical and chemical properties of the medium to ensure that it meets the requirements of the intended use.

The Agricultural Analytical Services Laboratory employs test procedures recommended by the FLL in its Guideline for the Planning, Execution and Upkeep of Green-Roof Sites (Release 2008) or equivalent ASTM methods when available.

6.1 Green Roof Media Test Packages

Service	Includes the following:	Fee
GR01A	Samples are analyzed for particle size distribution (< 0.002 to > 12.5 mm) with graphical display of results relative to FLL limits, dry weight density, density at maximum water-holding capacity, total porosity, air-filled porosity at maximum water-holding capacity, water permeability factor (hydraulic conductivity), pH, total soluble salts, organic matter, phosphorus, potassium, calcium, magnesium, nitrate and ammonium. Methods followed are those specified in the FLL Guideline for the Planning, Execution and Upkeep of Green-Roof Sites or equivalent ASTM methods (ASTM E2399) with the exception of total porosity which is determined using a measured, not estimated, particle density. This test package meets the FLL requirement for intensive and extensive multi-course and multi-layer systems.	$260.00
GR01B	Test GR01B is the same as Test GR01A but provides results for pH, total soluble salts, phosphorus, potassium, calcium, magnesium, nitrate-nitrogen and ammonium-nitrogen using the saturated media test procedure instead of FLL test methods. Saturated media test results for boron, copper, iron, manganese, sodium, and zinc are also provided.	$235.00
GR02	Test GR02 is the same as Test GR01 but without the plant nutrients phosphorus, potassium, calcium, magnesium, nitrate and ammonium. It may be used alone or in combination with alternative tests to those recommended by FLL for plant nutrients (see Optional Tests below). Methods followed are those specified in the FLL Guideline for the Planning, Execution and Upkeep of Green Roof Sites or equivalent ASTM methods (ASTM E2399) with the exception of total porosity which is determined using a measured, not estimated, particle density. This test package meets the FLL requirement for.	$210.00
GR03	Samples are analyzed for the percentage of silt-sized (< 0.05 mm) particles; dry weight density,	$180.00

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	density at maximum water-holding capacity, total porosity, water permeability factor (hydraulic conductivity), pH, and total soluble salts. Methods followed are those specified in the FLL Guideline for the Planning, Execution and Upkeep of Green Roof Sites or equivalent ASTM methods (ASTM E2399) with the exception of total porosity which is determined using a measured, not estimated, particle density. This test package meets the FLL requirement for drainage courses for extensive multi-course systems.	

VII. CONCLUSION

Through our project we discovered that it takes about 300-400 years to payback the initial costs of a green roof. We decided that Miami would pay back in the least amount of time or in 309 years. We found that the payback period is shorter in warmer climates. This is mainly because in the winter the insulation for a green roof has a greater R-value but because the solar reflectance is greater than an assphalt roof the rooms below are not warmed by the sun, thus requiring more energy spent for heat. This is the reason why New York City has the longest payback period.

It is possible that the calculator we used to find the savings was not accurate. So using a more detailed calculator or writing out the calculations would give an accurate measure of the energy savings of a green roof with a smaller error percentage. Alternatively we could use a different sized roof and/or use an extensive green roof instead, in order to decrease the payback period.

In a further investigation of roof design we might want to compare different types of high reflectance roofs, with green roofs and conventional roofs. "Surface heat budget on green roof and high reflection roof for mitigation of urban heat island," is a journal article by Hideki Take bayashi and Masakazu Moriyama high, which gives a detailed comparison between those types of roofs. By starting of with that article we could expand on it and find the energy savings of each in multiple cities in the United States.

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