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GREEN ROOF TECHNOLOGY

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ABSTRACT

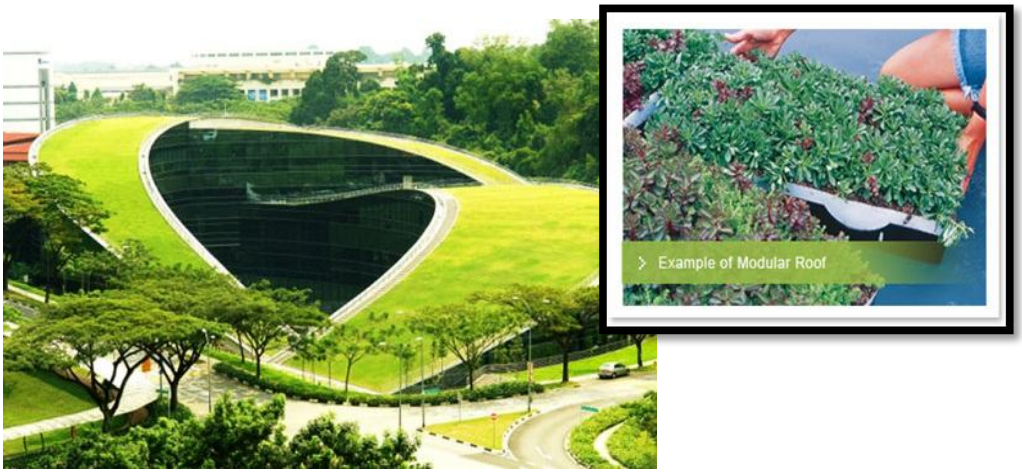
Here we have designing the building which will be smart Vegetated Roof Systems (aka: green roofs) are used extensively in Europe to manage stormwater, reduce energy consumption and for aesthetic appeal. They are gaining popularity in the United States especially in larger cities that are required to 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.

Keywords: ***Roof, Stringent,Structural integrity.***

I. INTRODUCTION

To filter water and treat air in urban and suburban landscapes. There are two types of 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 waterproofing membrane. It may also include additional layers such as a root barrier and drainageand irrigation systems. Container gardens 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 greywater. Green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, increasing benevolence[citation needed] and decreasing stress of the people around the roof by providing a more aesthetically pleasing landscape, and helping to lower urban air temperatures and mitigate the heat island effect. They effectively utilize the natural functions of plants 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, vegetated roofs, living roofs, green roofs .



II. HISTORY

History of green roofs Green (vegetated) roofs have been in existence since ancient times. "The first known historical references to manmade gardens above grade were the ziggurats (stone pyramidal stepped towers) of ancient Mesopotamia, built from the fourth millennium until around 600 B.C." In France, gardens planted in the 13thCentury thrive atop a Benedictine abbey. Norwegians developed sod roofs centuries ago as a means of thermally insulating their buildings. In fact, sod homes are still used as protection against extremely cold winters in Norway and the United States. Five roof gardens were installed atop the seventh floor of the Rockefeller Center in New York City, New York, between1933 and 1936. Designed to be 'viewscopes' for the enjoyment of skyscraper tenants (at higher rents, of course), these gardens continue enhancing the view in New York City.

III. METHODS OF GREEN ROOF

Modular – A modular system usually combines several of the green roof's layers into pre-manufactured and often pre-planted systems that are placed directly on a roof that has been prepared with a proper water proofing membrane. There are a number of manufacturers of green-roof modules allowing for choices in size, weight and plant variety. A modular green roof allows for fairly easy alterations and additions, instant green and easy access to the roof surface below.

Mats – Like the modular systems described above, the mat method uses green roof plantings grown off site and later installed on the green roof after proper waterproofing has occurred. Mats are laid much like a carpet or grass sod. They are placed on the roof to provide complete coverage, and often instant green. Over time, mats will grow

together, seams will disappear, and with proper care, a solid looking green roof will appear. Mats are frequently used on extensive portions of a green roof.

Built-Up – This type of green roof allows for greater flexibility in design and plant choice. After installing proper water proofing and root barriers and building the designed rooftop infrastructure, such as planter boxes, irrigation, pathways, cisterns, and trellises, the planting medium is spread on the roof, and then plants are added. This is often called "planting in place."

IV. TYPES OF GREEN ROOF

Extensive Green Roof - Extensive Green Roofs are well suited to roofs with little load bearing capacity and sites which are not meant to be used as roof gardens. The costs are lower than Simple Intensive or Intensive Green Roofs. The mineral substrate layer, containing little nutrients, is not very deep but suitable for less demanding and low growing plant communities.

Sun, wind and drought are additional stress factors for plants on buildings. Drought-tolerant plant communities, such as, those found in dry mountain environments, coasts, semi-deserts or dry meadows, are visibly adapted to the natural extremes of the local conditions and are preferred species. Mixtures of mosses, succulents, herbs and grasses create pleasant plant communities.

Semi-Intensive Green Roof - Semi-Intensive Green Roofs in terms of requirements fall in between Extensive and Intensive Green Roof systems. More maintenance, higher costs and more weight are the characteristics for the intermediate Green Roof type compared to that of the Extensive Green Roof.A deeper substrate level allows more possibilities for the design; various grasses, herbaceous perennials and shrubs such as lavender can be planted while tall growing bushes and trees are still missing.

Intensive Green Roof / Roof Garden - Lawn, perennials, bushes and trees are possible on Intensive Green Roofs. Walkways, benches, playgrounds or even ponds can be established as additional features on the roof. There are no limitations in design and individuality, but a few things have to be considered.The Intensive Green Roof system build-up and the selected plant communities have to be harmonious with one another. In addition, the amount of maintenance of Intensive Green Roofs is higher than on Extensive Green Roofs and permanent irrigation and fertilization have to be ensured.

V. LAYERS OF GREEN ROOF

Roof construction - Can be constructed from wood, metal, concrete, plastic, gypsum, or composite. Concrete decking will provide the most sturdy roof structure.

Water proofing membrane - To protect the building from water penetration. Some rubber and plastic sheet-applied and liquid-applied membranes meet these criteria.

Protection and storage layer - To protect the roof membrane from aggressive plant roofs.Mats with enhanced water storage and capillarity are preferred for some green roof systems.

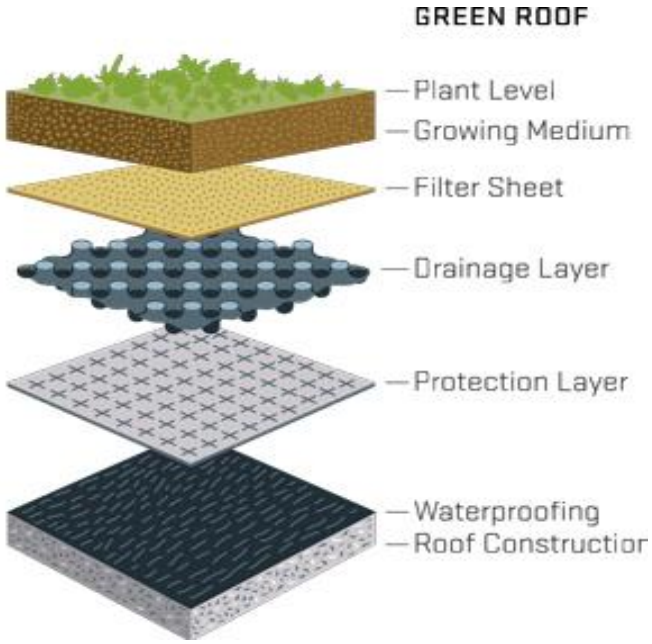
Drainage layer - To help the excess water from the growing medium to flow to the roof drain.

Filtration membrane - Allows excess water from the growing medium to flow out, while preventing the fine particles from washing away and clogging the roof drain.

Growing medium - Engineered soil: It must be lightweight, have good water storage characteristics, cheap.Organic composts are also included in it.Natural soil: plants and insects adapt to it easily.

Vegetation

- Minimal input plants should be selected (water, fertilisers, etc.) .
- Drought tolerant & cold tolerant.
- Resistant to pests.
- Low maintenance.
- Root systems should be shallow.



VI. CHARACTERISTICS

- Plant communities
- Minimum maintenance required
- Adapted Supply of water and nutrients mostly by natural processes
- Shallow built up height
- Weight approximate 50-150

VII. GENERAL CALCULATION FOR GREEN ROOF

Trees in Roof Gardens

When including trees in roof gardens the following key aspects should be considered.

- Provision of adequate soil volume for healthy growth and anchorage is critical. A simple rule of thumb is that 1.2m soil depth should be provided, although smaller trees may grow in shallower depths, provided that the lateral extent of soil is widened to compensate.
- Soil depth may be locally deepened at tree locations (either by mounding the soil surface or locally deepening the planter). Trees may be located over structural columns to take advantage of loading efficiency.
- Tree anchoring may be by staking or tying down of the root ball but in all cases must not interfere with the integrity of the waterproofing.

VIII. USES OF GREEN ROOF

The primary functions a specific green roof is required to perform will have a profound effect on its overall design. For example, a green roof designed to retain storm water may look very different from one whose main purpose is to brighten a hospital courtyard. Along with the question of aesthetics are inherent differences in the required depth of growing medium, the ongoing maintenance program, and overall cost. This is not to say that a green roof designed to retain storm water cannot or should not also be aesthetically pleasing. Indeed, it can be both, but limiting factors in the budget or the building structure, among others, may concentrate the focus on one or another of these functions.

IX. ROOF CONSTRUCTION

1. **Roofs without thermal insulation -** On roofs without thermal insulation, above non-heated rooms (e.g. garage roofs, porch roofs, etc.) all types of Green Roof system build-ups are possible.
2. **Roofs with thermal insulation -** Depending on the roof construction, specific criteria are to be considered when planning and installing a roof with thermal insulation. Generally, the installed the Green Roof system build-up.

- **Non ventilated roof ("warm roof"):** Depending on the design load, different types of Green Roofs are possible. A high-quality vapors barrier should be emphasized right from the design or planning stage.
- **Ventilated roof ("cold-roof"):** The low load bearing capacity of the upper layer allows for low weight Green Roof constructions. The cooling effect of the Green Roof system build-.
- **Inverted Roof:** The up influences the aeration between the layers of the roof construction thermal insulation for inverted roofs is installed above the waterproofing, and therefore in an area with variable moisture levels. The sheets and layers used for the Green Roof build-up must not prevent vapors diffusion processes from the insulation.
- **Roof Slope -**Using modern technologies it is possible to install a reliable Green Roof system build up not only on conventional flat roofs, but also on saddle roofs, shed roofs and barrel roofs. Special technical precautions for the mitigation of existing shear forces and erosion are only necessary for a roof slope over 10°. Roofs with a slope of more than 45° are normally not suitable for a Green Roof system build-up. Roofs with a slope of less than 2% are special roof constructions on which puddles often develop. In order to avoid Extensive Green Roofs from being damaged by water retention, specific arrangements for the roof drainage are necessary.

X. GREEN ROOF DESIGN AND CONSTRUCTION

Here are a few details about some of the most useful green roof designs:

- **Roofs without any thermal insulation:**This is the best choice to cover non-heated areas of your property, like porch roofs and garage roofs.
- **Roofs with thermal insulation:**Green roofs are installed after proper examination of the load-bearing ability of a traditional roof; thermal insulation roof installation can be done on:
- **Non-ventilated roofs:**They are also known as warm roofs; for them, we need a very-high-quality vapor barrier that is implemented right from the planning and design stage.
- **Ventilated roofs:**These roofs possess low weight-holding capacity, so we need to design a lightweight green roof construction; the cooling effect of these cold roofs is maintained with the help of specific layer construction.
- **Inverted roof:**Here the thermal insulation is installed directly above the waterproofing layer; it contributes to the area with variable levels of moisture.
- **DUO roofs:** These roofs consist of additional thermal layers that work like an advanced drainage mechanism.

Factors affecting green roof installation are:

- Vapor control layer that is placed directly above the roof structure.
- Rigid insulation of slab so that it can handle additional loads.
- Waterproof root barrier that must be created using specific materials such as polyethylene, slate-surfaced type layers, bitumen, rubber mats, etc.
- Drainage layer must be capable of controlling rain water runoff.
- Filter layer must add proper prevention in terms of soil placement and drainage.
- Growing medium must be used as per the type of roof.
- Vegetation selection must be done as per the weight handling capacity of the roof.

XI. PRECAUTIONS TO BE TAKEN WHILE CONSTRUCTING GREEN ROOF

- **Waterproofing Integrity**–Every reputable roofing company will guarantee and provide a warranty for the waterproofing integrity of their membrane(s), including green roofing providers. Water leakage from drainage backups or possible root puncture could lead to interior damage if the correct waterproofing membrane system, root barrier, and drainage layer are not selected. Of course, when choosing a greenroom system and/or contractor, it is advisable to check references on completed projects for waterproofing success. Vulnerable areas where leakage is possible include abutting vertical walls, roof vent pipes, outlets, air conditioning units, perimeter areas, etc.
- **Pesticide Leakage from Roof Materials** - Recently, an environmental science magazine began testing drainage from green roofs in an effort to measure any pesticide runoff. The potential does exist for certain

elements, such as iron and aluminum, to seep out and infiltrate our ground water. Care must be exercised in selecting thick membranes to ensure no release of pollutants, and the materials used in foundations and pathways on a green roof should not leach carbonates. This would also be a good opportunity to choose green roofing companies who use environmentally friendly roofing components.

- **Additional Support Considerations -** For extensive and intensive green roofs with projected live loads of higher than 17 pounds per square foot, consultation with a structural engineer is a requirement. Additional growing media depths, large plants such as trees, walkways, seating areas, parking areas, etc. will command greater structural support, and a greater layer build-up of the green roof system.
- **Unwelcome Wildlife Problems** - I have had people ask be about the possibility of attracting rats, raccoons, squirrels, spiders and the like with green roofs. Because of their watertight quality, I would suspect it would be extremely difficult (or impossible) for these larger animals to enter a home through the roof. But because a natural habitat is created, perhaps some undesirable critters would be invited, and then their proximity might put off some folks.

XII. MAINTENANCE

Maintenance varies according to the type of system installed (intensive or extensive) and primary purpose of the green roof (aesthetics, energy reduction, crop production).

- Weeding can be performed twice a year or once a week depending on how natural or manicured the system is designed to be.
- If the green roof is placed on a sloping rooftop, materials may need to be positioned if shifting occurs.
- Installed Irrigation system is optional but if desired, using drip irrigation or a sprinkler system is common. Supplemental watering will be required during first 3 – 6 months of establishment and then during extended periods of drought.
- Low rates of fertilizer can be used during the establishment period and later if plant growth is not sufficient for coverage. Note that use of fertilizers may interfere with water quality.

XIII. ADVATAGES AND DISADVANTAGES

ADVANTAGES

- **Improve the drainage system** - Sustainable drainage is an important component of any building, as a way to counter flooding in the event of excess rainfall. Traditionally, a network of pipes connected to the sewage system has helped control water. However, as a result of increasing urban development, as much as 75% of water is running off into urban areas.
- **Increase the lifespan of the roof** - A rooftop is continually under attack from the elements and has plenty to cope with throughout the year. Not only will a roof need to sufficiently deal with wind and rain, but ultraviolet

light and fluctuating temperatures too. As such, it's common for both homeowners and businesses to consider an alternative option for the roof.

- **Boosting thermal performance -**Without doubt, one of a green roof's most beneficial advantages is thermal performance and it's staggering just how much of a difference this can make. One of the biggest problems facing a typical roof is poor insulation, leading to substantial heat loss in winter and sweltering conditions over the summer months.
- **Helping out the environment-**The release of carbon dioxide is one of the key contributing factors to global warming and as such, the government has been charged with meeting stringent EU targets by 2020. Green roofs are ideal for doing exactly this. According to the UKQBC, 44% of total CO2 emissions are released from buildings. Both air con and the generation of heat create CO2.
- **Supporting wildlife habitats -**Green roofs also help support wildlife and in turn, can create a healthy habitat. Whilst they won't directly replace ground environments, they're perfect for attracting birds and other wildlife to create a thriving eco-friendly habitat. According to a survey in Switzerland, the study of 11 green rooftops found there to be an incredible 172 separate species.
- **Aiding air quality** - Air pollution remains an important issue in the UK and staggeringly there are some 24,000 who die from this every year. A green roof helps to improve the overall air quality. According to a study, green roofs help reduce up to:

  - 37% of sulfur dioxide
  - 21% of nitrous acid
  - 0.2kg of dust particles / square meter each year

DISADVANTAGES

- **A greater expense than traditional roofs** - Unfortunately for green roofs, they do tend to be slightly more expensive than the traditional option. One of the significant reasons for this being the extra support required to handle the increased load. However, despite the greater initial setback, over time these green roofs more than make up for the outlay. When you consider the range of incredible benefits highlighted earlier, there should be no reason to allow cost to play a determining role in your decision.
- **An increase in weight load** - There's no doubt about it, green roofs are heavier and as such, require more structural support to be implemented. Typically, the addition of a green roof will add between 50 and 200kg/meter squared to an existing rooftop. Although some rooftops will need to be retrofitted to cope with the increase in load, fortunately flat roofs are often able to handle this capacity.
- **Require extra maintenance-** There seems to be much debate as to the full extent of maintenance required for a green roof, however what's clear is you'll need to do some work to ensure it remains a thriving atmosphere.

XIV. CONCLUSION

It has been proven that green roof could provide numerous benefits to the environmental performance of the building. However, in context of India, this is not commonly practice. Therefore, a progressive effort should be induced among the India researchers to conduct more research on green roof technology.

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.

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