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Experimental Study on Pro-green Intensive Roof System in an Institutional Building

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Abstract - *Greeneries the greatest asset to the planet Earth. The rapid population growth and urbanisation encourages the reduction in greeneries and also rapid development of concrete surfaces. This factor affects the storm water retention capacity. The term greenery is often associated with nature but it can also be composited with artificial technique. The drastic change in climatic condition which are caused due to greenhouse gases give way to extreme weather condition. The loss of greeneries makes this situation worse. Hence a demand for a practices to overcome these limitations is developed. Green roofing is a part of green technology which throws an idea of forming greenery with water holding media over the concrete structures. There are three types of green roofing system namely intensive, semi-intensive and extensive. Intensive roofing system is the practice of setting up greeneries like shrubs and trees. This technology helps us to composite nature and artificial. It gives a solution to attain the green balance through engineering practices. It provides insulation to the building and also ensures retention of stormwater.It also forms an environment supporting bio-diversity in urban areas. Even though this system has many advantages it has not become popularized due to practical difficulties. This project also gives the guidelines to make an efficient green roof system.*

Keywords: Greenery, Green roofs, Storm water,Intensive, Insulation, Guidelines.

1. INTRODUCTION

Earth is only known living planet in the galaxy. The life on earth is based on three fundamental factors namely optimum temperature, fresh water and clean air. These are the factors which are not available other planets hence the life is possible there. The term life is always associated with colour green which denotes the importance of plants and trees for existence of life.

In the modernized society, greeneries have been reduced to great extent, this leads to an increase in pollution which leads to many health defects in all living beings. Greeneries are the assets of this planet which helps to maintain the biological balance. The rapid development in industrial and scientific field has paved way for the various threat to existence of life such as global warming, air and water pollution and depletion. This started the process of converting this planet less suitable for life.

When the humans constructed dam to stop the water, created fire for their safety thousands of year ago the artificial approach towards nature came into exists. The term greenery is often associated with the nature but it can also be composited with the artificial. The solution for survival cannot be brought only by nature at these circumstances where the world is mostly covered by artificial structures. A solution which has artificial approach thanks to the vegetation and growing media. The basic principle involves the distribution and storage of water in the element cells which is then drawn upward by evaporation, thus reducing water runoff. By applying green roofs peak loads on the sewage network are reduced, which prevents flooding in the streets. The structure of a green roof will depend on the underlying roof specifications and the building's support structure.

2. ENVIRONMENTAL NEEDS

Life on earth has dependency nature hence all small organism has a significant role in maintaining the balance. Greeneries form the basic element of the bio-diversity.

The extent use concrete houses and pavement increase the storm water run-off during wet season. Hence the peak load to sewage is achieved within a short span of time. This results in wastage of storm water. The increase in emission of greenhouse gases encourages global warming which results in drastic climatic change. This makes an uncomfortable living surrounding thanks to the extreme thermal conditions. This paves way for the extreme heat in summer, extreme cold in winter and unexpected rainfall. The loss of greeneries which are responsible for absorption of carbon-di-oxide makes the situation worse.

The depletion of ozone layer paves way for ultra violet radiation to reach the roof. Concrete roofs allows partial penetration of the radiation. The increased food demand requires a large food production which affects the quality of food. The food requirement of each house is not

been able to satisfy by themselves because of inadequate land availability.

3. SYSTEM INSTALLATION

The installation of green roof system is seven steps namely – parapet construction, laying of impermeable membrane, drainage mat, filter media, growing media, vegetation and drainage layer.

3.1. PARAPET CONSTRUCTION

The parapet wall was constructed using hollow blocks of size 16"x 4"x 8".It is raised up to a height of 2 ft. The inner and outer wall are constructed as per required dimension.

Fig-1 Parapet Construction

3.2. LAYING OF IMPERMEABLE MEMBRANE

The water impermeable membrane protects the roof from water absorption. Some of the water impermeable membranes are Ethylene propylene diene monomer (EPDM) membrane, Butyl rubber membrane etc. The water impermeable membrane used in this project is banner flex since it is easily affordable. The chemical composition of banner flex is generally a combination of polyester and polyvinyl chloride (PVC). The edges of the flex are being fixed.

Fig-2 Laying of impermeable membrane

3.3. LAYING OF DRAINAGE MAT

The drainage mat is made of Acrylonitrile Butadiene Styrene (ABS)-plastic with water retaining troughs and opening for ventilation. The dimensions of the mat is 1.5 x 1 ft. Water retaining capacity of the drainage mat is 8l/m^2.

The drainage mat is provided to store water in green roofs. It helps plants to survive in dry weather. The thickness of the drainage mat provided in this green roof system is 1cm. the entire area where the growing media is to be placed is covered with drainage mat.

Fig-3 Laying of Drainage Mat

3.4. LAYING OF FILTER MEDIA

Geo-textiles are permeable fabrics which is used as a filter medium. Typically made from polypropylene or polyester. It allows for adequate liquid flow with limited soil loss. Some of the types geo-textiles are woven fabrics, Non-woven fabrics, knitted fabrics etc.

Fig-4 Laying of filter media

3.5. LAYING OF GROWING MEDIA

The growing media performs several functions. In addition to providing a suitable rooting zone for the selected vegetation, the medium should be of low density and have high water holding capacity. The lighter weight allows for retrofit installation on existing buildings, and also reduces the need for extra structural support in new buildings.

This media also provides some insulation, depending on the thickness of the medium, properties of the medium, and its water content. The thickness of this layer also plays an important role in storm water retention. Usually peat, compost, or another light-weight material is mixed with the base to form the media used on a green roof. The depth of the growing media used in green roof system is about 1.5 feet.

Fig-5 Laying of Growing Media

3.6. VEGETATION

For vegetation, minimal input plants should be selected. The plants should be drought tolerant and cold tolerant. The root systems should be shallow in depth. It includes herbaceous plants and vegetative plants. The plants include Tomato, Brinjal, Chilly, Bandaras, Tulsi, Mint, Mexican Mint and some varieties of spinach.

Some plants are planted as saplings and others are planted by seeding. The red earth along with manure provides sufficient nutrients along with stability to the plant.

Fig-6 Vegetation

3.7. SETTING UP OF DRAINAGE LAYER

The drainage layer is provided to help the excess water from the growing medium to flow to the roof drain. Some of the materials used for providing drainage layer is gravel, dimpled plastic sheets , ribbed fabric laminates. The material used for drainage layer is gravel.

Fig-7 Setting up of Drainage Layer.

4. STUDY ON TEMPERATURE

Rapid urbanization and an increasing number and duration of heat waves possess a need to mitigate extremely high temperatures. Green roofs cool down the temperature because of the direct coverage of plants and the opening of stomata that allows transpiration during daytime. The vegetation stores the heat and cools down the air. The daily maximum temperature on the vegetated rooftops was reduced and dampens diurnal temperature fluctuations. The intensive green roofing system help decrease air temperatures of the building.

4.1 ALBEDO EFFECT

Albedo is the extent or area to which an object diffusely reflects light from the sun, or it is the ratio of light reflected by a planet or satellite. It is dimensionless and measured on a scale from 0 to 1. 0 for no reflecting power and 1 for perfect reflection.

Snow, ice and clouds have a relatively high albedo so generally reflect more of the sun's energy back to space which has a cooling effect on the earth. It is well known that there is a negative correlation between albedo effect and surface temperature.

The greater the albedo, the lower the surface temperature. Moreover, Albedo increases with higher peak cover and biomass on the green roof. Albedo is an important concept in climatology, astronomy and environmental management.

Global warming is the result that Earth's **temperature** is increasing due to high carbon dioxide and other chemicals. If more of the ice melts and becomes dark ocean water, the albedo in this area will be lower and have a warming effect, adding to global warming.

DATE	EXTERNAL (°C)	INTERNAL(°C)
06/02/19	34.2	29.4
07/02/19	33.5	29.3
08/02/19	34.1	29.4
09/02/19	33.4	29.1

Table-1 Temperature before installation

DATE	EXTERNAL (°C)	INTERNAL(°C)
11/02/19	34.2	27.9
13/02/19	33.0	27.1
14/02/19	31.0	27.0
15/02/19	33.5	27.0
16/02/19	34.0	27.5
18/02/19	33.2	27.3
19/02/19	33.8	27.0
20/02/19	34.2	27.3
21/02/19	34.1	27.0

Table-2 Temperature after installation

5. STUDY ON WATER RETENTION

Even though two third of the world is covered by water only 2.5% of it is found to be fresh water. There three major sources of water namely glacier, precipitation and ground water. Due to global warming the rate of melting of fresh water reaches a peak and the formation of concrete deserts throughout the world has halted conversion of rainwater to ground water. The rapid and drastical improvement in construction field has paved way for the conversion of storm water to sewage water thanks to the impermeable nature of the concrete floors. The decrease in forest and cultivable areas add oil to this burning crisis. A 2003 study from the University of Connecticut indicated that the percent of impervious land in a watershed significantly affect water characteristics and suggests that paving more than 20 percent of land surface is bad for water. Hence there increasing demand for the permeable surface which can hold water. The soil layer over the roof have the capacity to hold water thanks to water retention capacity of red earth and coconut coir.

5.1 EXPERIMENT

In order to find the water retention capacity of the system installed a mould was set up. The mould is a cylinder of diameter 28 cm. The mould was set up by placing the drainage mat at the base followed by filter media. The coco coir, red earth and compost of same composition as it is used in system is filled in the mould.

After setting up the mould the water is add to the mould by sprinkling throughout the exposed area. Eight litres of water is added to the set up. Then it is allowed to drain out for 10 minutes and the drained water is collected. The retended in the drainage mat is collected separately.

Total water taken = 8 litres
Water drained out = 3.1 litres
Water retended in drainage mat = 0.9 litres
Water retended in growing media = 8-3.1-0.9 = 4 litres
Water retention capacity of system = $\frac{4.9}{8}$ ×100= 61.25%

Fig-8 Water Retention Testing Mould

6. CHALLENGES

1. Variation from roof design weight can result in structural failure.
2. Improper plant handling techniques can lead to plant mortality and unsuccessful establishment of the green roof.
3. Improper maintenance of waterproofing layer results in leaking.
4. The growing medium should be strong enough to hold plants at high wind.
5. Foot traffic leads to loss of plants in the green roof
6. Wind scour can results in loss of growth medium and in extreme cases green roof delamination.
7. Structural frame should be strong enough to hold all plants and growing medium.

7. RECOMMENDATIONS

i. Proper designing of growing media and drainage medium.
ii. In case of week slab it can be strengthen by using carbon reinforced polymer fibre.
iii. Extreme sun light and wind scour can be overcome by using agro based green shade.
iv. For the new slabs to be laid the load of green roof also be taken in account.
v. The geo-textile prevent media migration and facilitates air circulation in the roots.
vi. Proper impermeable membrane along with slope prevents entraining of moisture into the slab.

8. CONCLUSION

The green roof paves the way to attain the nature in terms of artificial approach. The basics of life such as water, optimum temperature and clean environment can be attained by large scale implementation of this system. It also brings out the biological as it can be made as home of some domestic faunas and place growing the floras. The health of the mankind remains in good state as close as we to the nature.

Fig-9 Green Roof System

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