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A COMPREHENSIVE REVIEW OF GREEN TECHNOLOGY

Muhammad Wasim Khan, Roohi Naeem, Aisha Khan, Muhammad Ahmad, Muhaddas Hussain, Sahifa Saleem

Abstract

Many developed and developing nations are facing continuous pressure and increased environmental impacts from growing urbanization. Rapid and increased growth of population and urban development have altered natural and physical environments into zones and areas of extremely engineered setup and infrastructure. Generation of heat from automobiles like cars, and from industrial and commerce sector have joined with the preservation and retention of the solar energy which is renewable energy source by buildings as well as flagged surfaces, these all circumstances generates mysteriously atmosphere of urban area hot and can be named as urban heat islands. This causes various negative effects on physical as well as social environment. The conversion of land-uses from the natural landscape to the built environment has also created large areas of impervious paved surfaces, creating problems such as loss of vegetation and habitat, increased surface flow and heavy flooding. Each of these issues is being aggravated by a progressively variable change in climate. In the research case studies of different south Asian countries have been discussed to strengthen the view point of different various authors, significance of green top of buildings have also been explained and then conclusions are made accordingly.

Introduction

Green roofs, green walls and green facades are attractive as a method of addition of green substructure to a city and its surroundings as they can be comprised on new-fangled structures or retrofitted onto existing old buildings, and require little, if any, space at crushed and ground level. Green roofs can be installed on a wide range of buildings, including industrial, educational, and government facilities; offices; other commercial stuff and residential areas. [1] Green roofs are engineered to integrate the use of vegetation and soil on conventional building top structures. Presently it is prevailing already present roofs. These green roofs have different system, main parts are drainage system, filter cloth and the presence of a lightweight growing medium and the most essential part is a plant. Green roof is the living system that contains the ecosystem of vegetation that contain lightweight soil and vegetation that are self-sustain. It is alive in the biological prospective as is gives the protection to the building from the elements that exists naturally like wind, sun, rain, and storms, it pabulum itself. These roofs have many layers and each layer has specific function. The main components of green roof include two layers such as, filtration and drainage layers, growth media and a substrate that contain another layer which is

the vegetative layer for the growth of the plants. The plants that used for vegetation from ferns. lichens and mosses, to stonecrop and juicy substances to herbs and grasses [2]

The main purpose of green rooftop is to grow the plants on the upper structure of the roof that can either be partially replaced the vegetative part which was defected during construction of buildings. Numerous benefits are present in these green roofs as they help to reduce pollution, especially in the cities where vegetation is at its verge to end. The other important prospective of green roofs are that they can manage the water during the happening of the storms. They absorb the heat of the roofs and increased its longevity. In some perspective they are used to reduce the noise pollution and even reduce the carbon dioxide level in cities. They provide the natural environment to some insects and even birds, and biodiversity can be retrieved by using these roofs. They provide the pleasing environment to the workers and return the investment as compare to the traditional roofs. [3] The various types of green awning are as follows:

- green roof which is intensive in its nature
- green roof which is partially intensive
- Extensive type of green roof

Literature Review

Green roofs have largely contributed for the betterment of thermal performance of building, because they have capability of reducing the solar radiations, daily temperature can also be varied by using these roofs. A mathematical model was developed so that the pleasant and chilling effect given by the green roofs can be examined by creating different principles and philosophies, the main mechanism that found to be effective for thermal performance is the mechanism of evaporation. The biological process that include transpiration, evaporation, respiration, photosynthesis soak a huge portion of radiations of the sun. But to control the thermal coverage of the green roofs it is significant to maintain healthy amount of moisture in the materials. [4]The plant species that is used during this experiment was **sedum**. It was noted that oxygen level and air quality is increased in the area where green roofs were presented. Sedum specie was used because it is a fluctuating plant that are used in the garden for covering which belongs to the biological family which are sell-generating and green plants that are capable to withstand with extreme climate conditions. [5]

The sound exposure can be also decreased by the green roofs by the way of mitigating the diffracting waves of sound and by the transmission of the sound waves from the roof system. Absorption curves of green roof substrates reported show a large variety in behavior, suggesting the possibility for optimization. Substrate moisture content has a strong effect on absorption as is shown by a set of well-controlled impedance tube measurements. However, a long-term real-life experiment near a building's edge showed that this not necessarily leads to a significant reduction in road traffic noise shielding. A re-analysis of measured spectral insertion losses at 5green roofs showed that road traffic noise insertion losses are expected in between 2.3 and 5.5 dB at a (partly) shielded building facade. Recent findings state that there is no need for competition for roof space between green roofs and solar panels. Numerical simulations further show that the presence of such acoustically rigid panels enhances the green roof's noise reducing performance at larger solar panel inclination angles. The new idea of shapeable and grow able foams as substrates is numerically evaluated in this work. The existing literature on the acoustic insulation of green roofs stresses its potential owing to the low inflexibility and large density of the mass and damping properties. Their performance in the range of low frequency is worth

mentioning. Damped cavity lying beneath the green roof strongly increases the overall insulation performance [6]

Intensive type of green roof

In this roof system deepest soil is used, it has the greatest impact on the structural design. This green roofing provides all type of planting, small shrubs to trees. This system allows designing the park like appearance on the roof. They referred as the roof gardens. The weight ranged for these roofs were from 35 pounds to beyond 100 pounds per square foot. Tray system cannot be used for this roof system as it is deep and its weight is more that cannot be beard by the tray. [5]

Semi-intensive

This type of roofing requires a deeper soil layer, but it depends upon the type of planting that has been used. Planting that is included this type of plantation are herbs, flowering plants, taller grasses and small shrubs. The weight of semi intensive roof system is between 25 to 40 pounds per square foot. It is the weight when the soil is dry. The layer constructed system is used to make semi intensive green roofs. Trays can also be used to install this system. The plants that used in it require a bit more maintained because they need to be irrigated pruning and fertilization for proper growth.

Extensive Type of Green roofs

These roofs are composed of a soil which has a very svelte layer at is not more than 5m deep and it can be grown in the tray system. Due to its shallowness mostly, small plants are grown in this system plants that likely to be grown in this system are sedum, grasses and mosses. They don't require large area or deep soil for growth. Tray system that used in it provides the protection against excessive growth. It protects the membrane of roof and interlocks the whole system to prevent the damage that can be occurred due to wind. The main importance of this system is that it did not require a large scale maintained. The correctly chosen plant rarely needs to be watered and so for this irrigation system is not required. Fertilizers are only required when we'd need to be controlled, otherwise there is no extensive use if fertilizers in this system. Inspection is needed to check whether the plants are flourished perfectly or not. The main key point of these roofs is that they are cheap and their installation and maintenance is not expensive. Temperatures of green roofs were cooler as compared to the conventional roofs. It is cooler by 37^{o}C at the membrane of the roof and 17^{o}C inside, with minute variation found in between of green roofs. Maximum retentiveness was about 89% and 44% for the medium size and for the large rain occasions but limited characteristics of retention are also showed by green roofs. [7]

Benefits & Significance

- Green Rooftop are a real device in managing of storm water by reducing the daily temperature it also slows down flow rate, and decrease the quantity of water excess into native water schemes.
- Plants behave as a strainer it removes water and air pollutants in storm water and save it from smog after converting CO^2into oxygen.

- While relating green and conservative rooftop, confined management of storm water appears as an important distinguishing factor. Whereas conventional rooftop just shed down water
- The vertical building of any downtown zones often hinders aeriation and ventilation it also reduces speed of wind and deceiving amount of heat. Pollutants present can remain deferred for long eras of time. Green roofs absorb CO^2, a major vehicle emission, through it naturally clean the ambient air. The air cleaning ability of green rooftops has straight forward benefits for people who agonize from asthma and other respiratory sicknesses.
- Monitoring sound is another factor and reason to select green rooftop. Soil, plants, and the air layer stuck between the green rooftop assemblage and the building surface provide sound lining.
- Green rooftop influence both moisture and temperature conditions. High rise temperatures are accountable for urban warmth islands.

How It Works

In relation with urban heat islets, green top of structural buildings work by shielding of roof exteriors surfaces and through evapotranspiration. By the use of green rooftop whole over a city it can help reduce surface collective heat the city is facing and also cool down the air. The plants of a green rooftop and the related growing of. Still plants and vines may not be mutual on green roofs and green infrastructure but they specify about other flora and fauna on green roof structures. Plants and trees get in and absorb water over their roots and release it through their leaves, this motion of water is named as transpiration. Whereas, the change of water from a liquid to a gas, it also take place from the outsides of vegetation and the adjacent upward growing stuff. [8]

Material and methods

The materials and methods that are used for this green roof projects are that they have not any impact on the environment. The other side of this project is that they cover all the harms of the environment that can be happened due to the constructions. An experiment was done by using renewable materials in the installation of green roofs. The material used is polyurethane resin waterproofing derived for the castor oil. The implementation of the green roofs is to make contribution with regards to the energy efficiency of the infrastructure which ultimately reduces the meeting and conditioning requirements of the comforts aligned with the environment and at the same time decreasing the internal temperature of the air and the roof system. These two things also decrease the health issues such as respiratory issues and increases the production which encourages the working conditions, most importantly for the buildings which has reduced operating cost. As the green roofs composed of a substance which is the mixture of grass with soil a waterproof layer and a draining layer. [9]

International examples

A study was done in Guam that is the tropical region. Sunlight falls more nearly vertically in the tropical regions that are why most of the solar energy is received by the roofs of the buildings. Most houses in Guam is made of concrete that why heat directly radiate into the living areas. Due to the high average temperature around the year that is between 28 to 29 Centigrade powerful AC used all around the year that not only pollute the environment but also use the high amount of energy. In this region green roofs were installed that contain algae, it decreased the

roof temperature meaningfully and it decreased the need of the AC. Roof vegetation decreased the use of AC that decreases the consumption of energy around 64%, that has positive impact on environment. Biodiversity is revived in Guam by using these green roofs. Use of electricity becomes less. [10]

A research studies on green roof structures has been carried out since 2002 in Hong-Kong with an objective to use particle knowledge for the application of green roofs in urban cities such as Hong-Kong. Factors that determine the work efficiency of the system have been estimated. The install all three types of green tops. The green rooftops installation gives a huge range of advantages that starts from civility to technical, ecological benefits to fiscal impacts. Both private and public advantages of green top system are given in table mentioned below [11]

Taipei and Chiayi areas were selected for the investigation of thermal effectiveness under different climatic conditions. These regions were selected because they have variations seasonal behavior. The roof type that was installed for experiment is extensive green roof. These were installed roofs in all the to the trial areas of the Chiayi and Taipei. Reservoir, Protective pads, a substrate layer, a drainage board planting layer and permeable pads were used during the construction of these roofs in these areas. For the study of each roof 10 different types of modules whose thickness and size are 10 cm and 2.5 m^2 were taken. The combination of soil that was used with ratio of 6:1:1:2, peat soil: coir: perlite: sand. An automated sprinkler system was installed the chosen plant layers which may include the following plant species which are used in Taiwan such as Liriope spicate, Acalephan Walkerian, Asiatic and many more. Effectiveness of the thermal of large green roof on the infrastructures is watched to check the thermal effectiveness of these roofs. The outdoor temperature of the module can be defined as the temperature of below surface of the module which are covered. while the indoor temperature can be the temperature of the indoor ceiling slabs. The outdoor reference temperature is the temperature at the reference point and the indoor reference temperature is the temperature beneath the surface. Both are monitored in synchronous way and data was collected according to these temperatures and the references. For the period of 11 months both experiments were checked. [12]The data that was collected for 11 months reveals that the thermals impacts was different in Chiayi and Taipei. The thermal effectiveness in Chiayi was greater as compared to the Taipei. A significant thermal effectiveness was present in the regions of Taipei and Chiayi that cleared that it is associated to the climate of the regions.

The large green rooftop and its cooling effects are now more important when the environmental temperature is high which is about 25.1^{o}C in summer in Chiayi and 22.5^{o}C in summer in Taipei entirely different from the calculations that are observed in India and other countries which are the consequences of the green rood style, climate change. In a variety of the regions green roof has the remarkable importance in terms of the cooling impacts. And for the managing storm water it is recognized by means of potentially useful. The most significant advantage of the green rooftop is the decrease level of pollutants. As compared to the conventional one it can absorb and release water slowly and discharges the storm water more rapidly. For this study, a room type of vegetative roof model was being made. [13] As per the Malaysian climate grass sort of thing was made. A vegetative and non-vegetative model was created with a size of 1 x 0.75 m and area of 0.75 m^2 and slope of 6% for both the models. Vegetative model's depth is 200mm and non-vegetative is of 50mm with ±80 mm of layer in vegetative part and in non-vegetative 2.2 is the layer size. The roof model of vegetative part was composed of drainage layer, filtration layer and protection layer. After the rain fall flow rate and retentions were calculated. For both, models

storm water runoff was being taken in the specific time interval, it totally depends upon the availability of the retention of water storm runoff water. Without using any electronic automatic device flow rate and total storm water runoff retention was performed manually on site. The number of samples that were taken is three and it was taken on different day. During the period of study vegetated roof model retain the satisfactory amount of storm water. For all rainfalls that were recorded, vegetated roofs retained all the storm of about 50%. Although the much storm water was not retained by the vegetative roof, but still they serve as the efficient tools for management. In context of water quantity, quality and the habitat storm water was proved successful when the impervious surfaces were disconnected. The alternative roofs are provided by the green roofs when the limitations are being directed over the natural hydrology and impervious covers. Vegetative roof efficiency for storm water runoff can be increased by using grass plantation. [14]

Case study areas

In UK a research was made to affect the configuration and substrate of green roof on the performance of hydrology. Data of rainfall is continuously collected for four years in nine different extensive green roofs that is implanted as the test subject. The test beds that are making have different level of porosity, substrate and moisture retention characteristics. Three different vegetation are used that are Meadow Flower Sedum, and un-vegetated. [15]Un-vegetated and vegetated regions were studied together; in this study it was clear that vegetated part has high retention of water while un-vegetated region has the high rate of detention. The periodic Meadow Floret beds had been observed parallel hydrological presentation to Sedum-vegetated beds. About 28% the decrease was found in the performance difference between the vegetation and substrate. The lowest rank of detention and retention was showed by the porous substrates. The most complex type of the green roof systems such as sedum vegetation was shown by this study. To provide the holistic Suds solutions, the roof system need to be linked with the retention and detention so that cab will decrease the highest storm events. For stimulating the green roof, the parameterization has been developed with TEB which is reliable for the SUFEX [16] While the transformation of heat and water in the scenario of natural substances of the green roof TEB is linked with the transfer in artificial layers. As the green roof is composed of two things through which the heat flux is made between the artificial and natural layers of the roof. Vertical design of the green roof with 2 options in greening are available. As the case study is based upon the green roof plot which is situated in the France. In the start, calibration practice is necessary to identify the best soil along with the hydrological behavior that was used for the drainage purposes. The hydrological behavior shown by the calibration that the extended granules of the clay are closely related to the pea which shows the modeling community as the layers of draining which are in turn not related to the green roof models. With the power of overestimate type of the drainage while producing the water content in the substrate is served as the reproduction of green rood as shown by the calibrations. The main difference between the water contents and modeled things were given in the statistical ranks. [17]

Thermal level

Soil temperatures are overestimated by the green roofs tends. Owing to the thermal inertia present between the soil layers, the thermal level of drainage and its layers permits a well thermal coupling. Taking into the considerations the results of this study, experimental green roof plant along with the flux data of the surface, plots with retention and drainage layer all these

are included in the development of green roof. At the scale of the cities, the frequently implemented green roofs are typical substrate, sedum lawn etc. The impact of the whole study is study is to have the green roofs as adaptation of sustainable nature for urban areas. As the several things which are available in ISBA, other effects can also be studies such as their efficiency for carbon dioxide sequestration. Garden of cities is referred towards the Singapore. But due to the increased rate of population and limited area for residency the government is pressured to acquire a density and residential strategy. owing to the increase rate of urbanizations thermal factors are thus increased. And this impact can be minimized by making harmony between surroundings and the buildings. The main adaptation to reduce the heat stock and create harmony with nature they adopt the green roof technology. Extensive and intensive systems installed and mostly drought resistance plants are used [18]

The rank of **Malaysia** for the consumption of global electricity is 33rd and for the emission of carbon dioxide it stands on the 25th position. It is observed and stated that if energy is used at this rate the reservoir of petroleum will be extended from some areas of Singapore until 2020. Due to the large demand of energy consumption green roofs in technology in the urban areas of Singapore and Malaysia become high in demand. There is the high impact and graph changing in temperature by installing the roofs in urban areas. [19] The impact came not only in the urban climate and microclimate it came as well as inside the buildings beneath them temperature is reduced. Green roofs also absorbed he sounds, so they will be used as the reduction of noise pollution, they absorb the sound waves. Some researcher's claims extravagate that a green roof with the substrate layer of 4.8 inch miraculously reduces the sound by 40 decibels. If it is considered they can easily be used against noise pollution. [13]

The factor of planting green roofs in **Singapore** is more visible because the land has more demands because of the population factor leading towards the rise in the developments. As there will be no positive impact environment and the ambience related to the Garden city has been natured over last 40 years in case of failure of providing the greenery to keep pace with a rise in glass, concrete and other things. The solution for space is to incorporate the greenery onto the built structures, on decks and roof. Green roof gives its emphasis on building self-sustaining which don't require intensive type of maintenance, a technology used for the rooms. Worldwide implementation can be expressed in the terms of greening and improvements of physical environment including heat island and its effects [20]

Installation of green rooftop decreases the surface temperature conditions therefore the heat being trapped and transmitted as per the Singapore data analysis. Which also shows that the glare arising would also be helped by the green roof from the reflection, quality of the air and vicinity of roof. [8]In Singapore the basic challenge faced by the researches was the factors that are influencing that effect the green roofs were unknown and this is related to the non-irrigated type of roof along with the shallow substrate of 10cm in depth. while the other components are the physical components that are linked with the specific performance criteria like nutrient retentions. [21]

In Singapore, the non-irrigated type of the green roofs in spite the fact of rainfall and humidity, the water availability is still limited. According to an estimate, the green roof substrate was decreased within 4 days larger in 8 to 12 months over the period when the green roof project was made. The water stress was resulted in the consequences in the green roof. as per the Singapore report the annual report n the humidity and the rainfall, green roof has experienced the xeric

growth owing to the rainfall. Plants that are used have the quality of drought-tolerance, so that they can be used for non-irrigated green roofs. [22] CAM plants use for this environment because they contain adaption of morphological nature like the succulence, volume ratio, stomatal frequency that would be helpful in decreasing the water loss.

It has been proven that green roof has positive prospective and many benefits. The main benefits that can be obtained from the installation of green roofs are reduction of energy consumption, heating of roofs is decreased, storm water runoff mitigation, lower the air temperature around it. It can be act as the noise pollution reduction in the urban regions. Designing of green roof require the extensive knowledge of engineering because building design should be in this manner that support the vegetation [23]
Proposed plant's sustainability weight and environment are included in critical impacts of design while further researches are required in south east region regarding this installation. Because as in some areas rainfall rate is high but temperature is also high, so such plants and infrastructure of green roofs should be selected that can survive in harsh conditions like drought and flood [16]
In the Malaysian society there is not awareness about the implementing of the green roofs. Many expert and practitioners had been improved the importance of the green roof system. Every aspect of installing the green house was studied. The correct method that had the use is of recyclable materials and waste materials, plants and vegetation and the method to mitigate the runoff of storm water. The aspects of law and regulations, design techniques were also studied before installation [24]

Green Roof design criteria that was implemented in Chicago may not magnificently explain to a roof in Sacramento. Local climatic factors must be kept in mind when estimating and evaluating choices in various species of plants and their need of water. The green roof of Sacramento is much helpful for providing with plants especially in areas with less water and areas which experience drought in the summer or which die out in the summer season and easily decompose to provide nutrients for winter plants. If not used it will require additional organizational provision and additional costs. If the purpose is to allow public accessibility to a roof garden then safety measures and features are need to be calculated and considered into the roof construction. In the case of GBI assessment, maintenance, life cycle and monetary analysis shall be made. Seasons are also needing to be studied in the tropical regions before the installation of green roof. The most suitable green roof is intensive and extensive system that is suitable for south-east environment. As per the cultural and social factors in making the roof designs and building further studies can be conducted [25]

Conclusion

It can be concluded from the above literature that the foremost stages in promoting Green roofs and green walls is a responsibility of organizational and administrative setup of any city, authority need to acknowledge Green Rooftops as a viable and sustainable development decision. Most of the administrative sections of cities have implemented Green Tops policy for the management of storm water as well as to encourage energy and resource efficiency. Approximately many of the cities for example Massachusetts, Cambridge, Los Angeles and Chicago have adopted Green Roofs as a policy for saving them from severe changes in climate. Likewise, Germany is known to be the front-runner and initiator in up-to-date operation of

installing Green roof top. Sacramento's auspicious climate and rural history makes it an perfect applicant for Green Rooftop to embellishment and also benefit.
Most of the proponents and Developers are using it. The charges for installation of Green tops are not much high its creation, maintenance costs are much less. Further, Germany also permits proponents to shape Green Rooftop as extenuation and mitigation measure for providing with open space at a ratio of 40-60%. Additional advanced practices in Germany comprise founding zoning and land-use regions that need Green Roofs to be fitted on flat roofs as well. [17]
Munich has encompassed Green Rooftops in its building control regulation and it suggest grants for the investment cost of fitting a Green Roof top. Japan in its new construction projects which are larger than 10 thousand square feet to provide 15-20% of roof tops to be developed as a green space. Moreover, In Portland, buildings that are 500-600 square feet of resistant surface are mandatory to lessen storm water contamination and pollution. Portland also suggests a Floor Area Ratio advantage which allows a constructor and developer to build 3 extra square foot of Green Rooftop. Enhancement and motivation plans has stimulated a rising interest in Green Rooftop technology. This advanced method tends to provide energy saving in large amount whereas it is helpful in storing and utilizing storm change of climate can be controlled through it and it also carry many public benefits.

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