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Techniques To Increase Thermal Performance Using Passive Strategy

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Abstract: This paper focuses on Thermal performance and efficiency refers to a building's ability to maintain a comfortable temperature by utilizing just the right amount of energy. Passive cooling systems do not employ mechanical or electrical technologies to keep a building cool. Integrating landscaping features into house design is one method for improving passive cooling. Trees, green roofs, and bodies of water, For example, can protect buildings from direct sunlight while also channeling cool air toward them. This reduces the amount of heat that enters the structure while also helping to dissipate existing heat. Trees, for example, provide shade while cooling the surrounding air. Green roofs can insulate buildings and absorb heat by releasing water vapor through their leaves, which is known as evapotranspiration. Water bodies can also be used for evaporative cooling because they have a cooling effect on the air.

IndexTerms **– Thermal Performance, Passive cooling systems, Green Roofs, Living wall system.**

I. INTRODUCTION

Building thermal performance is a key factor in their energy efficiency and comfort. Traditional mechanical cooling systems can be expensive to operate in hot and humid conditions and contribute to indoor air pollution. Passive cooling systems can help lessen the demand for mechanical cooling while improving building thermal performance. Techniques like green roof and vertical greenery system can be used to achieve better temperature and air quality as well as increasing the aesthetics of the built environment and facilitating local habitat. These strategies use thermodynamics, heat transport, and environmental design concepts to create comfortable interior settings that do not rely primarily on mechanical cooling systems.

II. AIM

To explore and analyze the effectiveness of using various landscape elements in achieving passive cooling and improving thermal performance in the building.

III. OBJECTIVES

- To study various aspects which help to improve the thermal performance of the built form
- To study elements that can enhance the thermal performance of the building.
- To study impact of green roofs and vertical greenery system on the built environment.
- To study how they are applied.

IV. LIMITATIONS

- Passive cooling techniques based on landscape elements are highly dependent on variables such as temperature, humidity, wind patterns, and sun radiation.
- Particular options can be hindered by factors such as building orientation, surrounding topography, vegetation density, and available space.
- Passive cooling systems mostly rely on natural processes like shade, evapotranspiration, natural ventilation, and so on, which have inherent limitations in terms of cooling capability.
- Landscape elements applied for passive cooling, such as plant or water features, require regular maintenance to maintain their efficiency. These elements' lifespans decrease over time, potentially affecting their cooling powers.
- Cost, maintenance, cultural obstacles, and composite climate challenges constitute a few of the obstacles to utilizing passive cooling solutions.

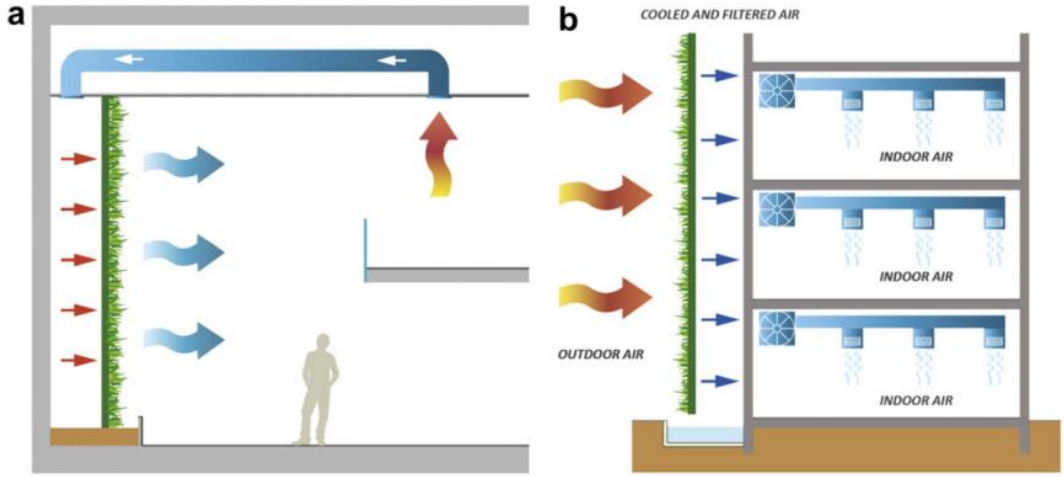
V. TECHNIQUES IDENTIFIED

Different types of landscape elements benefit and improve the thermal comfort of the building and help in reducing the mechanical power required to achieve thermal comfort in the building:

- Green roofs
- Vertical greenery systems

This is the system that comprises roofs covered with vegetation, that act as insulation and helps to regulate the building temperature thus, reducing heat transfer through the roof and facilitating the additional cooling effect.
Also known as the green façade or live wall system, it is the type of landscape element that incorporates the integration of vegetation on vertical surfaces with different media. It provides numerous benefits for thermal comfort and building performance

Figure 1:Operation of active living walls: (a) Indoors; (b) Outdoors. (Franco-Salas, 2012)

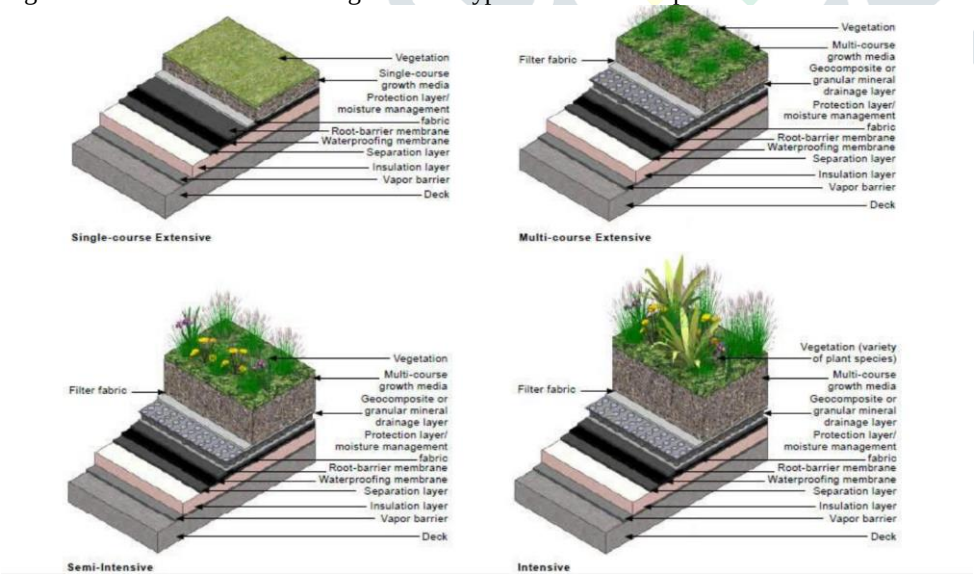


VI. TYPES OF GREEN ROOFS

There are several different varieties of green roofs, each with its own set of qualities and applicability for various purposes. The following are some examples of common forms of green roofs.

- Extensive Green Roofs
- Intensive Green Roofs
- Semi-intensive Green Roofs
- Bio-Diverse Green Roofs.

Figure 2: an illustration of the 4 green roof types and their components



VII. DIFFERENT COMPONENTS OF THE GREEN ROOFING STRUCTURE

Roof Deck: The roof deck is the basis of the green roof system and provides structural support to the entire assembly.

Waterproofing Membrane: The waterproofing membrane is an important component of a green roof system because it prevents water from accessing the roof and causing any damage to the structure of the building.

Insulation: Insulation in a green roof refers to a layer that can be applied to improve the thermal performance of the system

Drainage System: The drainage system is intended to remove excess water from the green roof, preventing waterlogging and guaranteeing proper moisture levels for plant growth

Growing media: A green roof's growing medium is a carefully constructed soil mixture that creates a favorable environment for growth of the plant.

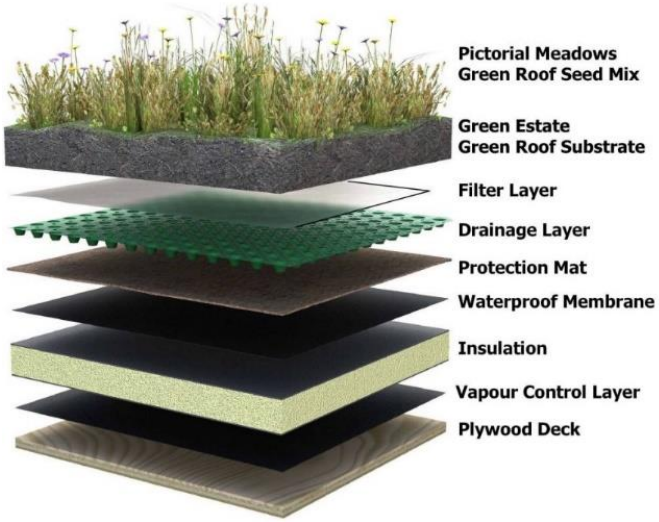
Vegetation: this is an essential component of a green roof system, providing several benefits and contributing to the overall performance and aesthetics of the roof, and the surrounding.

Mulch: it is a layer of material spread on top of the growing media to provide numerous benefits in a green roof and protect vegetation also.

Aeration: green roof refers to the technique of introducing air movement within the growing media. It is critical for maintaining healthy root systems and stimulating plant growth.

Watering system: A green roof watering system is intended to deliver water to the plants on the green roof system. It ensures that the vegetation gets enough moisture to thrive and survive

Figure 3: isometric view showing components of green roof



VIII. HOW THEY ARE APPLIED

VIII.I NEW CONSTRUCTION/RETROFITTED

Figure 4:new construction (LIVROOF, n.d.)

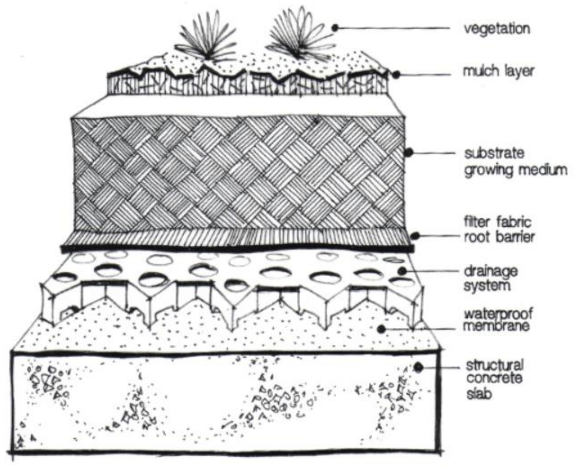
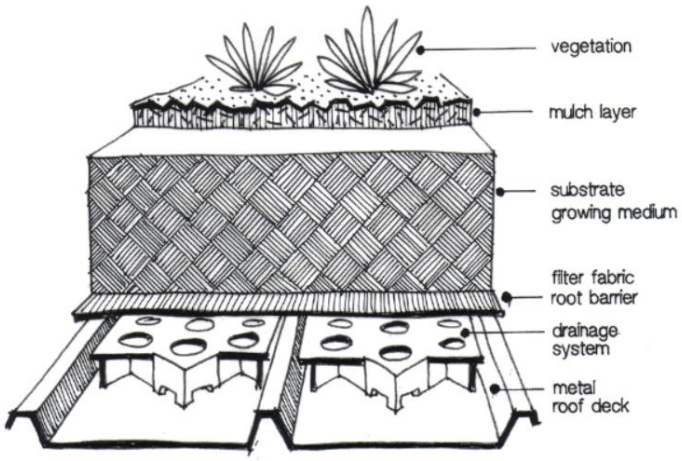


Figure 5:retrofitted (LIVROOF, n.d.)

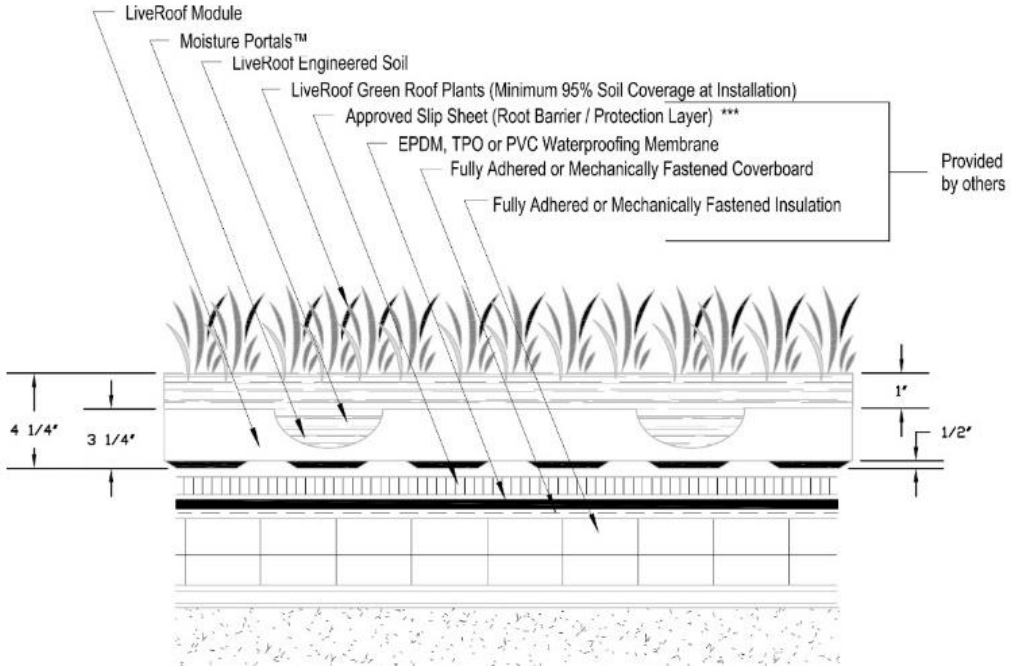


Green roofs installed in several steps:

- Installing a waterproofing membrane, a thin sheet that is the most crucial layer of the apparatus as it keeps the water from entering or penetrating the structure. This membrane is often constructed of rubber or plastic.
- Making a drainage layer. This layer collects and is responsible for distributing the water across the green roofs. It is most probably constructed of gravel, rock wool, or other porous and hard materials.
- Adding a growing medium. This is the stratum or the base where the plants will grow. Eventually, It is usually composed of dirt, compost, and other organic elements.
- Planting the plants. The sort or type of plants we will choose will ultimately determined by the amount of sunlight and water received by the roof.
- Watering the plants. Green roofs must be irrigated at the regular period of time or at a particular duration, especially during the first few months after installation.

VIII.II GREEN ROOF _ CONVENTIONAL ROOFING ASSEMBLY

Figure 6:section (LIVROOF, n.d.)



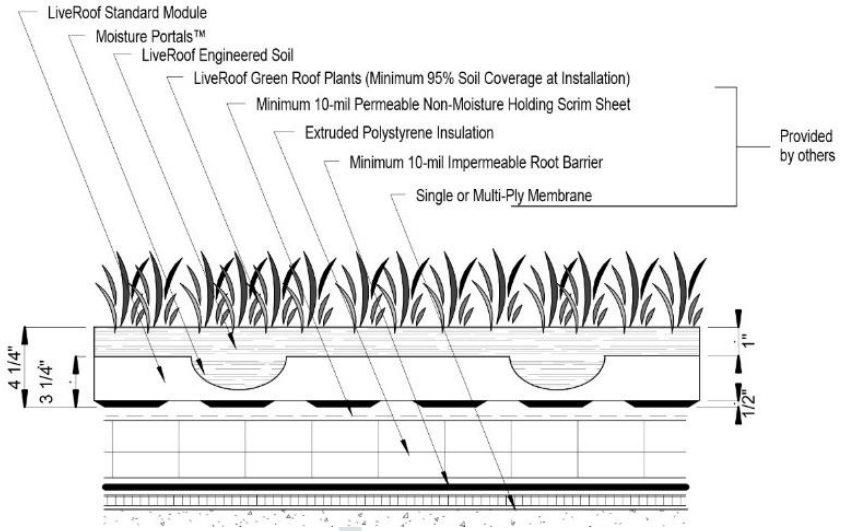
Green roofs are classified into two types: intensive and extensive. Intensive green roofs are more difficult to maintain as compared to extensive green roofs They usually have a larger layer of growing medium and may sustain a wide range of plants, such as trees, shrubs, and flowers. Extensive green roofs are easier to install and maintain than intensive green roofs. They are often planted with succulents, and other low-maintenance plants and have a very thin layer of growth medium.

A PMRA roof installation is a difficult process that should be performed by a certified specialist. However, the fundamental steps are as follows:

- The existing roof must be carefully evaluated to ensure that it is structurally sound and capable of supporting the weight of the green roof.

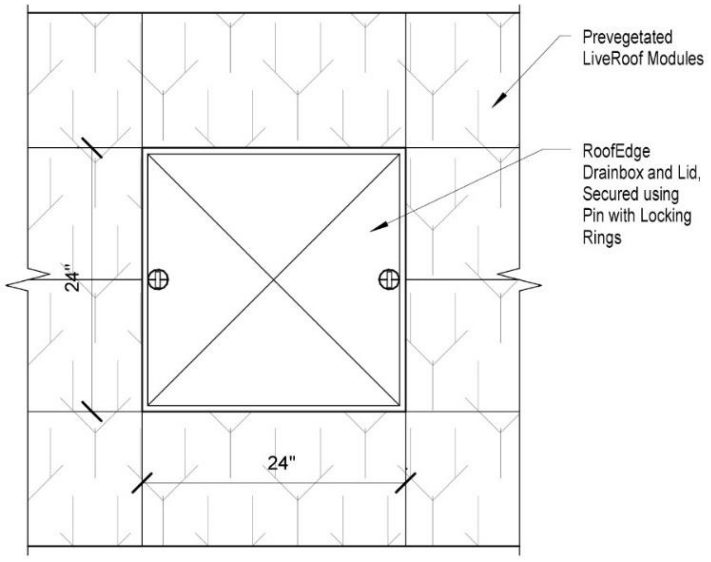
- To prevent water from leaking or seeping into the building, for that purpose waterproof membrane must be placed.
- To collect and transport water across the green roof, a drainage layer should be placed.
- To provide a adequate substrate for the plants to grow in, a growing media must be installed.
- Suitable plants must be chosen and planted accordingly.
- The green roof should be watered and cared on the regular basis.

Figure 7:section over the protected membrane (LIVROOF, n.d.)



VIII.III GREEN ROOF _ TYPICAL DRAIN

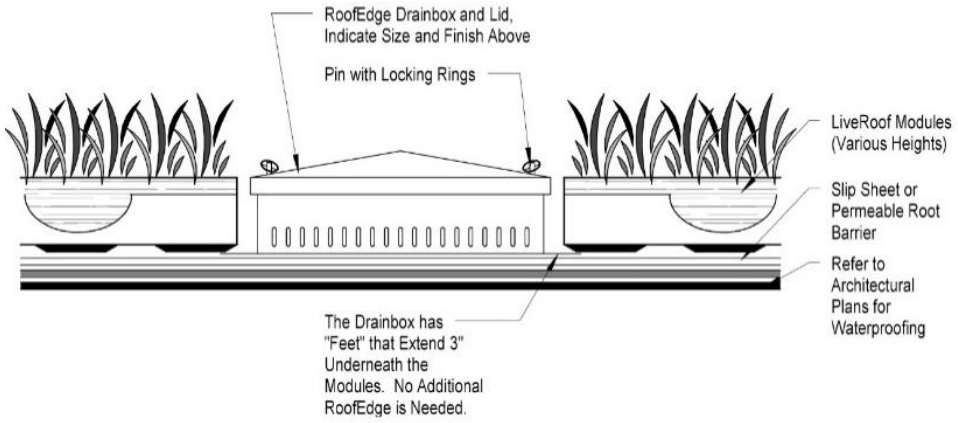
Figure 8:plan view (LIVROOF, n.d.)



Some of the variables to consider while constructing a green roof drain detail are as follows:

- The size of the drain pipe and sump will be determined by the size of the roof.
- The slope of the roof: will determine how much water flows through the drain.
- The plant species: The type of plants grown on the green roof and will influence the amount of water will be absorbed by the soil

Figure 9:section of drain (LIVROOF, n.d.)



VIII.IV BENEFITS

- Green roofs helps in stormwater management by absorbing and holding rainwater.
- Green roof flora and soil absorb and dissipate heat, lowering ambient temperature and finally improving city microclimate.
- They operate as natural theme barrier.
- The plants absorb dust and toxic gases.

IX. VERTICAL GREENERY SYSTEMS.

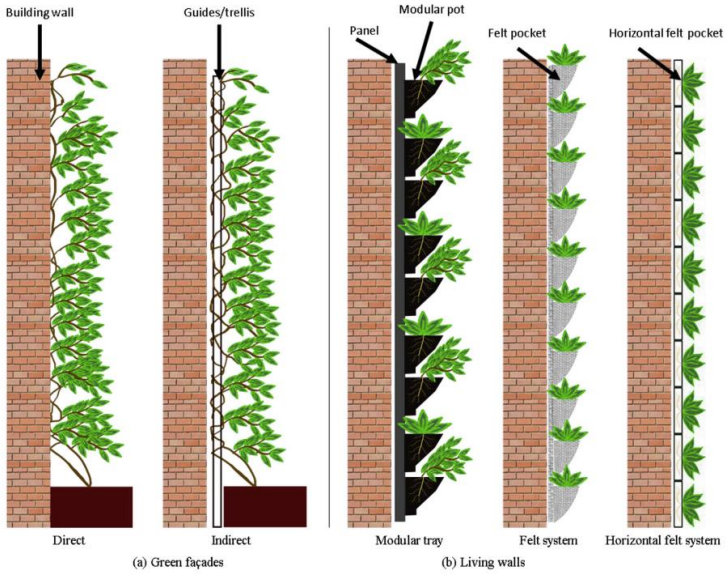
Vertical greenery systems, often known as living walls system, are creative and sustainable structures that allow plants to grow vertically on the surfaces of buildings or other structures with help of the pods on which they are attached. These systems have gained appeal in metropolitan and very cluttered settings where space is restricted and there is a significant need for green spaces.

IX.I TYPES OF VERTICAL GREENERY SYSTEMS

Vertical greenery systems are classified into various types, each with its own set of qualities and benefits. Here are some examples of common types:

- Green facades
- Living walls
- Pocket gardens
- Modular system

Figure 10:Schematic diagram of examples of different VGS types (Rosmina A. Bustami, 2018)



IX.II TYPES OF VERTICAL GREENERY SYSTEMS

Living wall systems are made up of modular panels or the pods and these systems that are designed to support and sustain plants in a vertical position. These systems often include a support framework or structure, as well as an irrigation and drainage system to ensure plant health. The plants are put within the system in discrete modules or pockets, making maintenance and replacement simple.

IX.III DIFFERENT COMPONENTS OF THE LIVE WALL SYSTEM.

Plant Selection: The selection of plants for a living wall system is very important and critical. It is crucial to select plants that are ideal for vertical growth, have shallow root systems**.**

Support structure: Several elements should be addressed when selecting a framework support for a living wall system.

Soil selection: Choosing the correct soil for a living wall system is critical for the health and growth of plants. The soil should be light, well-draining, and rich in nutrients.

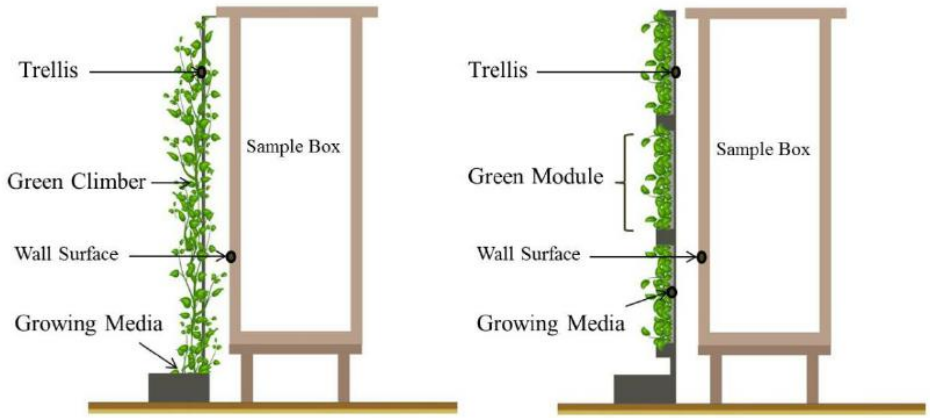
Panel or modules: Panels or modules are essential components of a living wall system. These modular units or pods house the plants and growing material, providing the structure of the vertical garden.

Growing media: A green roof's growing medium is a carefully constructed and soil mixture that creates a favorable and suitable environment for plant growth.

Maintenance: Regular maintenance is required to guarantee the health and lifespan of a living wall system. Pruning, trimming, and removing dead or damaged foliage are required for maintaining its health.

Irrigation system: The irrigation system is an essential element of a living wall system, ensuring that the plants receive enough water and nutrients for their optimal growth.

Figure 11:figure (a)Green façade and Figure (b) living walls (Sahihan Tabassom and Baharvand Mohammad and Abdullah, 2014)



X. HOW THEY ARE APPLIED

X.I MODULAR SYSTEM

Modular system solutions are applicable on almost every surface like concrete and in any environment. They are extremely wind and rain-resistant.

Figure 12:A modular green wall horizontal section (GSky Plant Systems, Inc., n.d.)

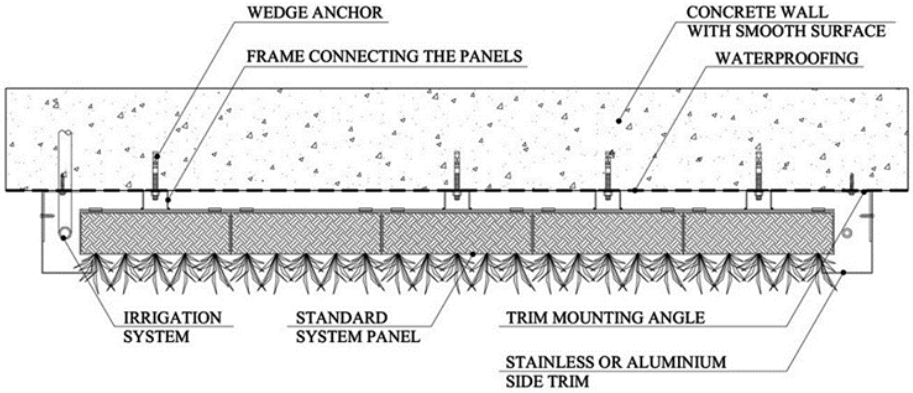
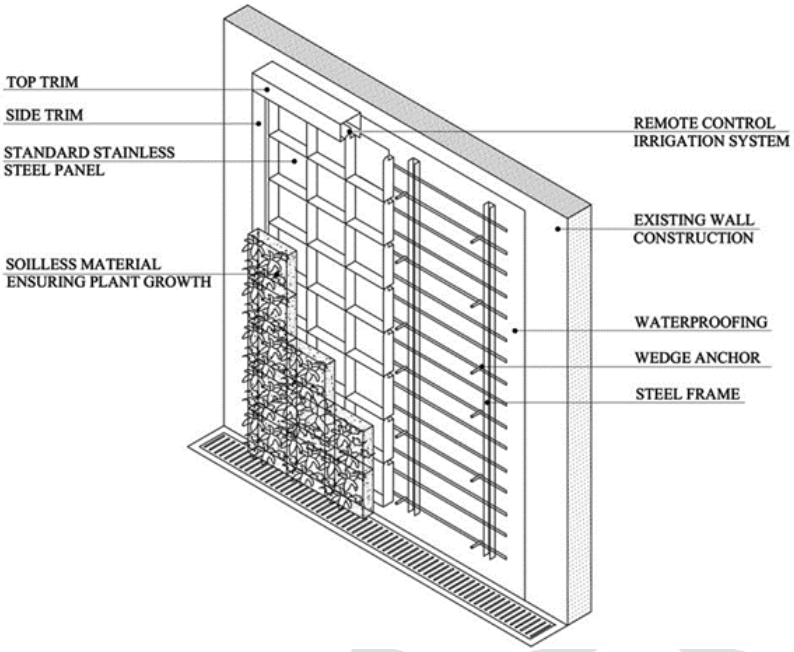


Figure 13:A modular green façade solution (GSky Plant Systems, Inc., n.d.)



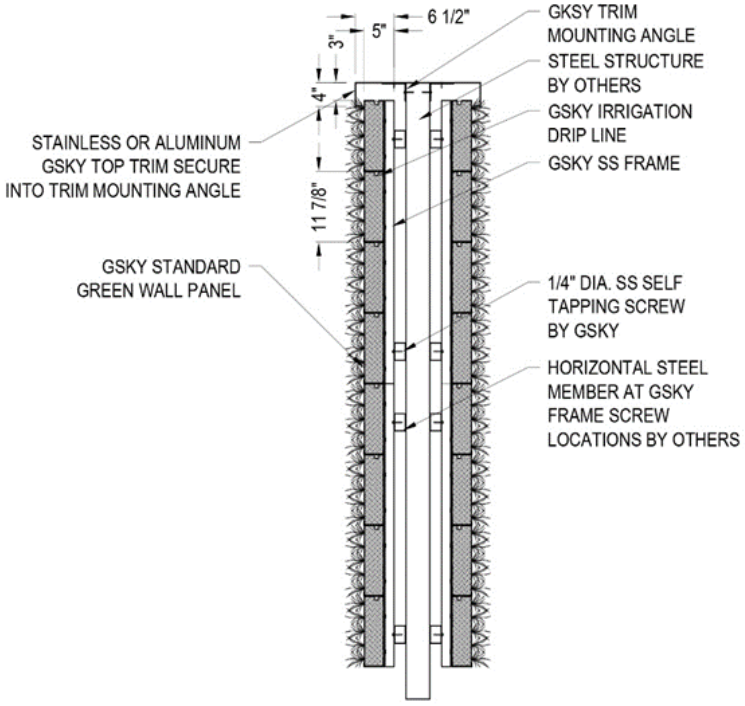
This system is made up of five fundamental components:

- Stainless steel panels.
- Soilless substance that promotes plant development.
- Carefully bred plants that are resistant to the impacts of environmental variables.
- a computerized vertical irrigation system with temperature and moisture sensors
- wall frame assembly.

In situations where the size of the building is not defined by the size of the plot, then the solution that increases the size of its dimensions can be applied to building elevations. A distinct system is built beside the walls and then is attached to the building's structure. On this system, planters are fastened by bars. This system is typically built with stainless steel post and lintel technology.

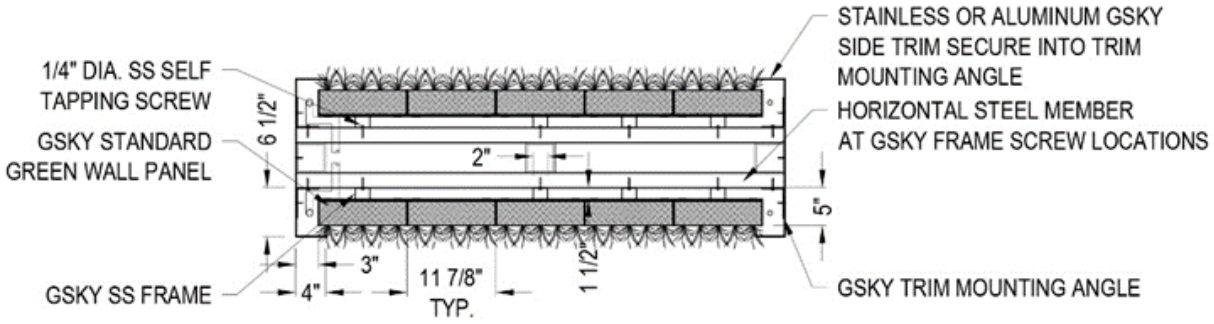
X.II LIVE WALL_DOUBLE SIDE INSTALLATION

Figure 14:section (GSky Plant Systems, Inc., n.d.)



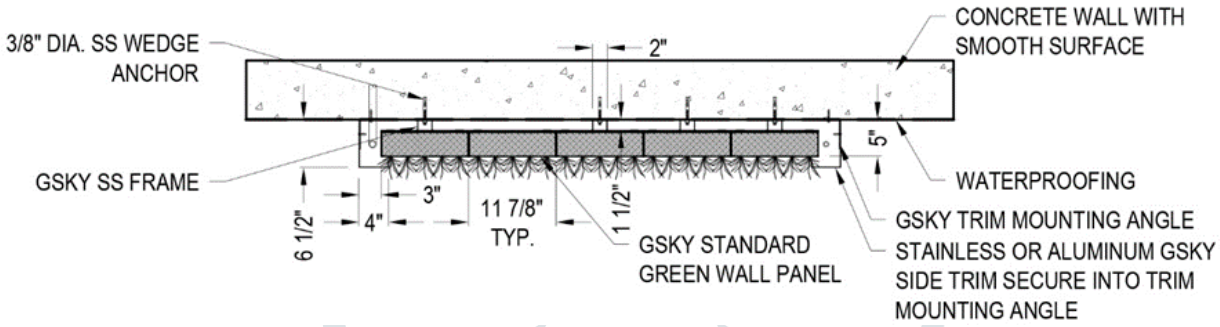
A vertical garden that is put on both sides of a wall is known as a double-sided live wall. This style of living wall can be used to give beauty and greenery to a tiny room or to create a focal point in a bigger space.

Figure 15:plan (GSky Plant Systems, Inc., n.d.)



X.III LIVE WALL_CONCRETE WALL

Figure 16:plan (GSky Plant Systems, Inc., n.d.)



Live wall system installed in several steps:

- Getting the wall ready. The wall should be clear of loose dirt and should be clean. We may also need to drill drainage holes in the wall.
- Setting up the planters. The planters should be securely fastened to the wall. Masonry screws or other fasteners may be required for fastening.
- Fill the planters halfway with soil. Using the high-quality potting mix made specifically for live walls.
- Planting the plants. The sort or type of plants we will choose will ultimately determined by the amount of sunlight and water received by the walls.
- Watering the plants. Live walls must be irrigated at the regular period of time or at a particular duration, especially during the first few months after installation.

XI. BENEFITS

- Improved Air Quality: Living walls help to purify the air by filtering contaminants and releasing fresh oxygen through photosynthesis.
- Improved Aesthetics: Green walls are the visually appealing and addition to buildings and public places
- Noise Reduction: The dense vegetation of living walls can operate as a natural sound barrier, lowering noise pollution from traffic, construction, and other urban activities.
- Stormwater Management lowering stormwater runoff and easing the load on urban drainage systems. This can reduce the likelihood of flooding and water contamination.

XII. CONCLUSION

As a result of this research, we can conclude that green roofs and live wall systems are effective and feasible best management practices (BMP) for combating urbanization urban density in highly populated areas. The advantages of a green roof and live wall system are numerous, and some of them have been thoroughly explored, used, reliable and verified. There are even discoveries that allow green roofs to be integrated with other BMPs and thus helps in contributing to a green environment. When using live wall systems for their temperature reduction capabilities, adding ventilation to the systems can improve system efficiency; however, there is very limited research and study on integrating the performance of ventilation and live wall systems.

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