

Green Building-A Future House with Living Plants

J. Shankaraswamy

Assistant Professor, College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University, Wanaparthy, Telangana

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Green is existence and considerable in nature, inexperienced indicates increase, renewal, health, and surroundings. Green design includes energy conservation, however that's no longer what it's all approximately. It's about having appropriate air quality both interior and outdoors, making the environments wherein we paintings, stay, have a look at and play more healthy and greater cozy and maintaining all herbal sources around us. A green building is one wherein the indoor and out of doors (house and panorama setting) environmental characteristics have been taken into consideration and guarded for the duration of its layout, production, maintenance and use. According to the Environmental Protection Agency (EPA) defines green building as the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or 'high performance' building. A green building is one where the indoor and outdoor (house and landscape setting) environmental qualities have been considered and protected during its design, construction, maintenance and use.

Exterior scaping for green building: Current systems for greening the buildings envelope are not just surfaces covered with vegetation. There are several greening systems in the market, like green roofs and green walls, which technology involved is being developed to increase their performance and longevity.

Green wall system: In fact, the concept of green walls refers to all systems which enable greening a vertical surface (e.g., facades, walls, blind walls, partition walls, etc.) with a selection of plant species, including all the solutions with the purpose of growing plants on, up or within the wall of a building (Newton et al., 2017).

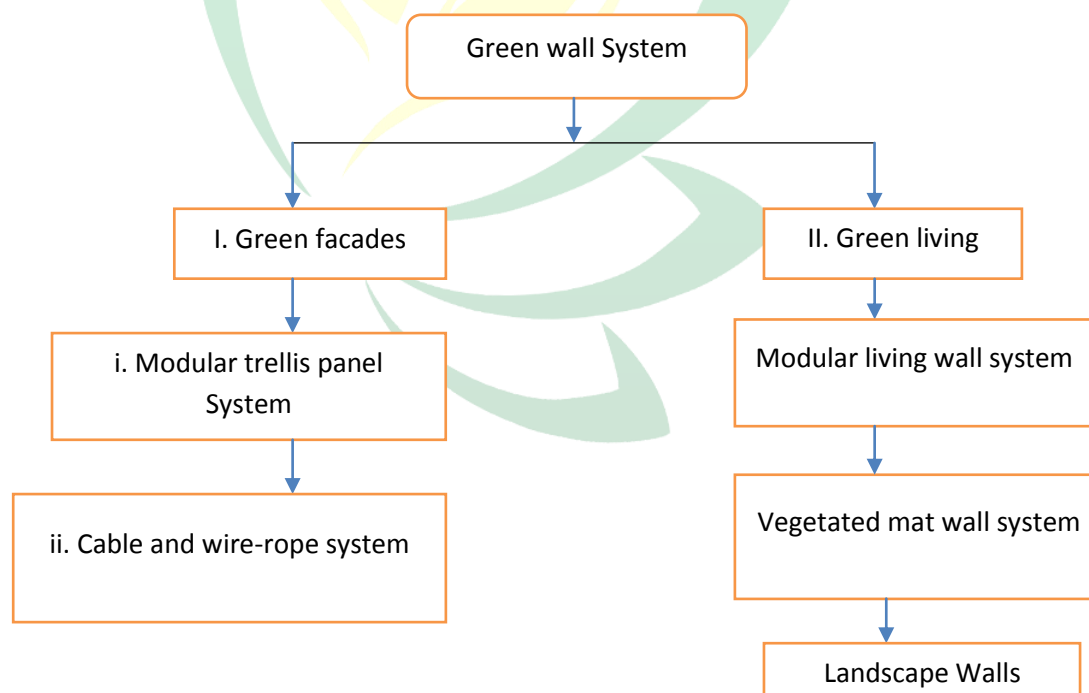
It contributes to indoor air quality and providing oxygen and humidity. Vegetation can be seen as an additive (construction) material to increase the (multi)functionality of facades of buildings and vegetated wall surfaces.

A green wall is a system to attach plants to walls of buildings and homes. This system can be distinguished into two categories; support system and carrier system.

1. The support system: refers to plants which were guided to climb up through the structures like wires or cables.
2. Carrier system: In this system plants which were put into boxes and contain the media for planting on the vertical surfaces and attached directly to the wall (Rahman et al., 2011).

Apart from the systems, there also two major types of green wall which are green façades and living walls. Under the green façades category, there are two sub-categories which include modular trellis panel system as well as cable and wire-rope net system. As for the living walls category, there are three sub-categories fall in within which are modular living wall, vegetated mat wall and also landscape wall. These categories and sub-categories will be further explained and illustrated as follows (Green Roofs, 2008)

Fig 1. Classification of Green wall System



1. Green façades: Green facades are a type of green wall system in which climbing or tendrillar plants or cascading groundcovers are trained to cover specially designed supporting structures. They are rooted at the base of these structures, in the ground, in intermediate planters or even on rooftops. The plants normally take three to five years to achieve full coverage. Green facades can be fixed to existing walls or built as freestanding structures, such as fences or columns. Self-clinging plants are normally used for this green façades as their sucker root structure enables them to attach directly to a wall and growing on the entire surfaces.

As mentioned above, two green façade systems that are frequently used are modular trellis panel as well as cable and wire-rope net systems.

- i. **Modular Trellis Panel System:** The building block of this modular system is a rigid, light weight, three dimensional panel made from a powder coated galvanized and welded steel wire that supports plants with both a face grid and a panel depth. It is designed to hold a green façade off the wall surface so that plant materials do not attach to the building. It is also important to provide a “confined” growing environment for the plant with multiple supports for the tendrils and helps to maintain the integrity of a building membrane. The panels are almost rigid; they can span between structures and can also be designed.
- ii. **Cable and Wire-Rope Net Systems:** The cable and wire-rope net systems can be used either one or with the presence of both system. Cables on green facades are designed to support faster growth of the climbing plants with denser and thicker foliage. Wire-rope nets are frequently used to support slower growing plants. This system is rather flexible and possesses a better degree of design applications than cables. Both systems use high tensile steel cables, anchors and supplementary equipment.

2. Green Living wall systems: Green living walls are composed of pre-vegetated panels, vertical modules or planted blankets that are fixed vertically to a structural wall or frame. These panels can be made of plastic, expanded polystyrene, synthetic fabric, clay, metal, and concrete, and support a great diversity and density of plant species. Due to the diversity and density of plant life, living walls typically require more intensive maintenance such as supply

of 5 nutrients to fertilize the plants than green facades. There are various forms of living walls and they can be designed for interior and exterior purposes.

- i. **Modular Living Wall systems:** consist of square or rectangular panels that hold growing media to support plant material. Most of the nutrient requirements for the plants can be found in the growing media within the modules. Irrigation is provided with these systems at different levels along the wall, using gravity to move water through the growing media. Modular systems are often pre-grown, providing an 'instant' green effect upon completion of the installation.
- ii. **Vegetated Mat Wall:** Vegetated mat wall is a unique form of green wall coined by Patrick Blanc. It is composed of two layers of synthetic fabric with pockets that physically support plants and growing media. The fabric walls are supported by a frame and backed by a waterproof membrane against the building wall because of its high moisture content. Nutrients are primarily distributed through an irrigation system that cycles water from the top of the system down.
- iii. **Landscape walls:** Landscape walls are normally sloped as opposed to vertical and function to noise and stabilize the slope area. They are normally structured from stacking material made of plastic or concrete with room for growing media and plants.

Selection criteria for choosing plant species and types for green walls:

In order to be able to make a successful and low-maintenance choice of climbing plants, certain conditions must be kept in mind. In order to have as little maintenance as possible it would be opportune to choose a plant with a natural growing height which is equal to the desired growth height on the facade.

Green roof system: The plants that go into a green roof are usually sedum or other shallow-rooted plants that will tolerate the hot, dry, windy conditions that prevail on most rooftop gardens. With green roofs, the plants layer can buffer as much as approximately 87% of solar radiation while a bare roof receives 100% direct exposure (Wong et al, 2003).

- I. **Classification of green roofs:** Green roofs can be installed on a wide range of buildings, from industrial facilities to private residences. A green roof, or rooftop

garden, is a vegetative layer grown on a rooftop. Green roofs provide shade, remove heat from the air, and reduce temperatures of the roof surface and surrounding air. Using green roofs in cities or other built environments with limited vegetation can moderate the heat island effect, particularly during the day. Green roof temperatures can be 1.1-4.4°C lower than those of conventional roofs and can reduce city-wide ambient temperatures by up to 15°C. In addition, green roofs can reduce building energy use by 0.7% compared to conventional roofs, reducing peak electricity demand

II. There are two types of green roofs: extensive and intensive.

- i. **Extensive green roofs:** Extensive green roofs are simple with hardy plants and a growing medium depth of two to four inches and require the least amount of added structural support since they are lightweight and need little maintenance once established.
- ii. **Intensive green roofs:** Extensive roofs are tend to be more complex, such as a fully accessible park complete with trees. These green roofs resemble conventional gardens or parks and require more structural support since they are heavier Require a higher initial investment, more intensive maintenance.

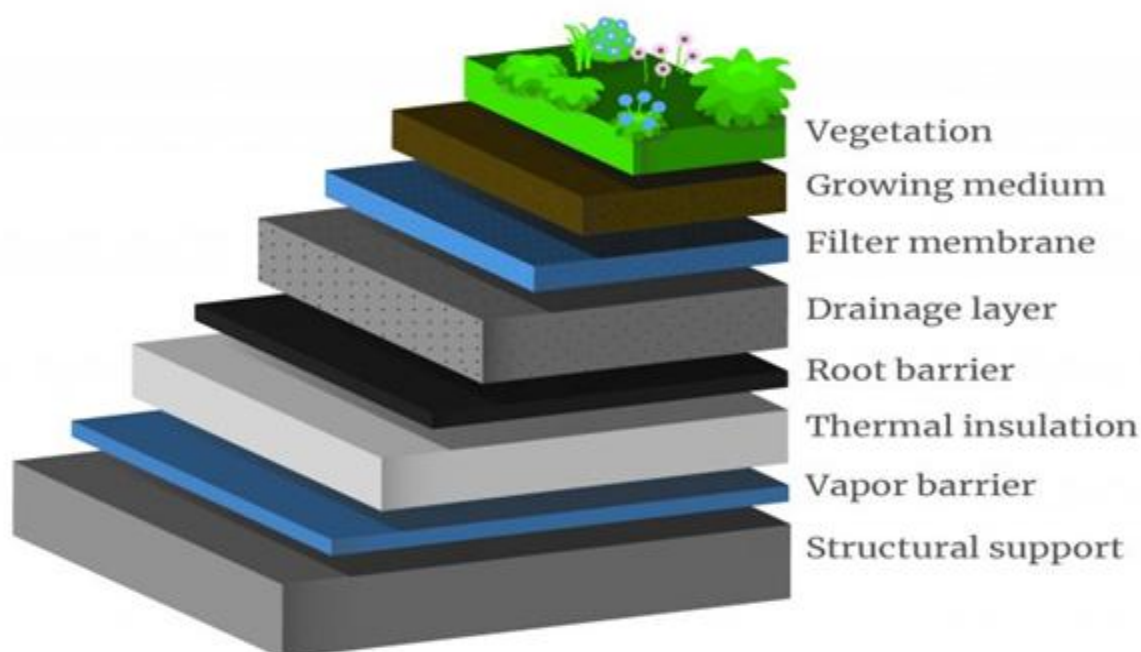

















Fig 2. Green roof layers for designing of green roof





Table 1. Different plant species suitable for green Façade




Group	Plant Category	Image of the plantSpecies
I	Self-bonders with a growing height up to 30 m	
	Common ivy (<i>Hedera helix</i>)	
2	Three leaved creeper (<i>Parthenocissus</i>)	
II	Self-bonders with a growing height from 8 up to 25 m	
1	American trumpet creeper	

2	Old man's beard (<i>Clematis vitalba</i>)	
3	Staff vine (<i>Celastrus orbiculatus</i>)	
4	Russian vine (<i>Fallopia baldschuanica</i>)	
5	Chinese Wisteria (<i>Wisteria sinensis</i>)	
III	Self-bonders and climbers with a climbing construction and growing height from 5up to 15m	

1	Kiwi (<i>Actinidiachinensis</i>)	
2	Birthworts (<i>Aristolochia</i>)	
3	Wild hop (<i>Humulus lupulus</i>)	
4	Honeysuckle (<i>Lonicera</i>)	

5	Five leaved creeper (Parthenocissus family)	
6	Japanese wisteria (Wisteria floribunda)	
IV	Small climbers with a growing height up to 5 m:	
1	Old man's beard hybrides (Clematis vitalba)	
2	Japanese spindle (Euonymus)	





3	Black Bryony (Dioscorea communis)	
4	Climbing rose	
V	Small climbing plants:	
1	Red bryony (Bryonia dioica)	
2	Field Bindweed (Convolvulus arvensis)	





3	Larger Bindweed (Convolvulus sepium)	
4	Bittersweet (Solanum dulcamara)	
5	Sweet pea (Lathyrusodoratus)	

(Hermly, 2005)

Selection of suitable plants for green roofs: selecting a suitable plant for green roofs is difficult. Each green roof should be survivable in the regional climate in addition to its own particular microclimate. Appropriate selection of plant species guarantees the survival of each

plant and stability of their population, which impacts the extent of advantages that is received from a green roof

1	Cotulahispida	
2	Sedum dasyphyllum	
3	Sedum acre	
4	Sedum reflexum	

5	Sedum rupestre	
6	Sempervivum ingwersenii	
7	Creeping thyme	
8	Thyme serpyllum	

Interiorscaping for green building:**Biofilter:**

There is another type of green wall, known as 'Active living walls' or 'Biofilter', which is used in indoors incorporating with building's HVAC system based upon the sciences of biofiltration and phytoremediation. Living walls with biofilters increase the capacity of air filtration. These biofilters replace high-tech, energy consumptive air filtration systems with living walls that harness the natural phytoremediation capabilities by drawing air through the root system of the wall of tropical houseplants to effectively remove common airborne pollutants. Beneficial microbes actively degrade the pollutants in the air before returning the new, fresh air back to the building's interior. In the breathing wall filtration takes place right in the active Living Wall. Basically, dirty air, drawn in from indoor space, makes close contact with the constantly-flowing water within the wall, pollutants are moved from air to water. Water flows over a lava rock wall covered by moss and other plants, then into a small pond. Contaminants in the air are absorbed by the vegetation and consumed by micro-organisms in the soil, improving air quality. Once dissolved into the water, pollutants are attacked by biological components on the wall itself, and are metabolized into a harmless state. Any excess waste is carried to the pond, where it is eaten by fish, frogs or insects.

Indoor plants for green inner:

Plants are important building accessory, The main reason is, indoor plants look attractive – people get charmed by the graceful arch of palm leaves or the exotic beauty of orchids. Plants are actually good for the building and its occupants in a number of subtle ways and are an important element in providing a pleasant, tranquil environment where people can work or relax. Plants can be used to decrease noise levels in an office. According to Green Plants for Green Buildings, if plants are placed strategically, they can help to quiet down the office. A small indoor hedge placed around a workspace will reduce noise by 5 decibels (Jacobs, 2008). People spend on average 80% of their time indoors (WHO, 2010), therefore, the health risks due to indoor air pollution may be greater than outdoor air pollution. At present, the use of indoor greenery offers several benefits such as producing oxygen through photosynthesis, generating humidity and providing an aesthetical pleasant environment to work and live as well as visual performance to indoor environment. In active vegetation systems (vegetation systems combined with mechanical systems), air-cleaning

rates have proven to be significantly higher than in passive vegetation systems because of the use of active fan-assisted hydroponics technology that draws the air through the root rhizomes of the plants.

Conclusion

In reality, continuing to assess the contribution of latest in experienced wall systems and different components of green buildings to enhance buildings performance and evaluating the environmental impact of those structures with different construction solutions can lead to an increase of their utility in homes and consequently bring about a discount on these structures fee

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