

Green Walls: A Boon for Sustainable Environment

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Abstract

Man's desire to create a pleasant environment is probably as old as our civilization. Today a clearer identification of the designer activity leads many people to refer to the field as interior designing, architecture and more recently all those concerned with the shaping of manmade environment, refers to the total field as environment design (Fredmann, et. al., 1970). Green Wall concepts offer numerous economic, social and environmental benefits such as greenhouse gas reduction, adaptation to climate change, air quality improvements, habitat provision and improved aesthetics, where as a lot of these benefits are claimed or not well investigated yet. Walls can form an ideal substrate for partial or complete vegetation of several plant species. By allowing and encouraging plants to grow on walls the natural environment is being extended into urban areas; the natural habitats of cliff and rock slopes are simulated by brick and concrete (Johnston, et. al., 2004). The present paper is the outcome of a research conducted to assess the awareness of the Architects regarding the concept of Green Wall. An educational package (booklet) for enhancing the knowledge regarding the Green Wall is also included in the paper. The current paper would help the Architects and interior designers and other masses to understand the specification of Green Wall, the need for garden to improve environment and the utilization of walls as greenery.

Keywords: Green Wall, sustainability, architects

Introduction

In India, rapid population growth and expansion of developmental activities have both greatly aggravated resource depletion and degradation of the environment (Shaw 1989; Jodha 1990; and Harte 2007). The extent of environmental degradation varies across countries and regions of the world (Shafiq and Bandhyopadhyay 1992; Holtz-Eakin and Seldon 1995). After the industrial revolution, carbon dioxide emissions from industrial production greatly increased, resulting in climate change and global warming effects that have altered agricultural production in many ways (Wittwer, and Strain, 1985).

In today's age of shrinking land spaces and multiplying high rise, the space available for one's private garden is limited. Increasing concretization in urban areas, hardly see any greenery around. The concepts of "sustainability" and "green" building practices have generated a great deal of interest in recent decades. Concerns and practices regarding the environment those were at one point considered to be marginal and associated with counter-cultural are now considered mainstream. (Henneman, 2006).

A new innovative, yet environment friendly solution to these shrinking horizontal spaces in a "Green Wall" which, as the name suggests, offers the option of having greenery growing vertically. Living walls are those covered in some form of vegetation. Generally they are comprised of climbing plants of one kind or another, and are designed so as to support such vegetation. More radically, living walls are now being constructed that provide an additional structure into which vegetation can actually be planted. Depending on the species used living walls can provide environmental benefits in the form of biodiversity, thermal insulation and cooling benefits to the building, and noise attenuation.

A green wall as define: "a wall, either free-standing or part of a building that is partially or completely covered with vegetation and, in some cases, soil or an inorganic growing medium. The creator of a large green walls concept (vertical gardens) is the French botanist Patrick Blanc. (Bjerre, 2011)The vegetation for a green façade is always attached on outside walls; with living walls this is also usually the case, although some

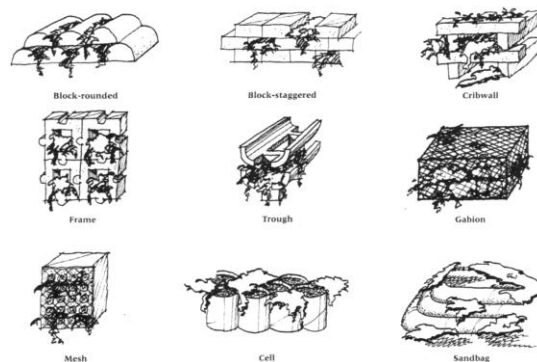
living walls can also be green walls for interior use.”²

Green Wall with the another name Vertical Garden is the term of used to refer to all form of vegetated wall surfaces (Green roof organization 2008). Green walls are not only spectacularly beautiful, but also helpful in enlivening the ambiance. Green walls can absorb heated gas in the air, lower both indoor and outdoor temperature, providing a healthier indoor air quality as well as a more beautiful space (Yeh 2012). They holds or slows rainwater, providing food and shelter for wildlife (Thompson and Sorvig 2000).

A Green Wall is a facade of a building or structure which is designed to accommodate substantial plant growth. Environmental benefits include absorption of rainwater, cleaner air, and a reduction of the heat island effect in dense cities (Blanc, 2010).

A Green Wall is simply a garden that grows vertically, rather than in the traditional way in garden beds or pots. There are different types of Green wall, from as simple as a few hanging baskets or a vine growing up a wall through to as complicated as a wall installation that is made up of a frame, a backing, and a special layer in which the plants are embedded².

Some plants are able to grow on walls by taking root in the substance of the wall itself. Typical of these are the small herbaceous species such as ivy-leaved toadflax, wallflower and plants such as mosses, lichens and grasses. But other species are naturally adapted to climbing up and over obstacles such as rock faces, trees and shrubs. For these to grow successfully on walls and buildings some kind of support structure is usually essential (Johnson and Newton 2004). Also Green walls can be constructed with many systems. These systems include the following structural concepts (fig 1) (Thompson and Sorvig 2000).



Block : Engineered with gaps where plants root through the wall

Crib Wall : In this system, elements like tile, concrete, wood stacked log – cabin style

Frame : In this system, interlocking floor coverings stacked like masonry

Trough : Used soil filled tubs

Gabion : Used wire baskets filled with Stones to provide strong

Mesh : Like mini gabions

Cell : Used flexible and strong honeycombs which filled with soil

Sandbag : Make with geo textiles wrapped around soil. These systems formally called “vegetated georgic”

Figure 1. Structural concepts of Vertical Garden (Thompson and Sorvig 2000).

Green walls can examine two major categories: Green Facades and Living Walls. These categories can be divided into other categories: Green façades are made up of climbing plants either growing directly on a wall or in specially designed supporting structures. The plant shoot system grows up the side of the building while being routed to the ground. On the other hand, in a living wall the modular panels are often comprised of polypropylene plastic containers, geo-textiles, irrigation systems, a growing medium and vegetation (Green roof organization 2008, Sharp R. 2007).

Landscaping is important for improving the quality of life. It creates the relationship between the man and the environment. The interior designing of any residential or commercial area is not complete without planning the garden. The study would be very helpful to the architects and interior designing students, as they can learn to design environment friendly areas which are green and can reduce the global warming. The study will serve fruitful to the younger student who want to enter into the architecture, interior designing or civil engineering as their profession, as they will know how to construct need based areas of greenery to overcome present environmental problems. The current study would also help the architects and interior designers to understand the specification of green wall, the need for garden to improve environment and the utilization of walls as greenery.

Objectives

1. To assess the awareness of the architects regarding the concept of Green Walls.
2. To prepare an educational package (booklet) for enhancing knowledge regarding Green Walls concept and application.

Methodology

The present study had a descriptive research design. The questionnaire was selected as the tool for data collection for the present study. The tool was selected keeping in mind the objectives of the study. For the present study, for selecting Architects convenience sampling technique was used. Those architects willing to be respondents for the study were selected as sample, 30 Architects were selected as respondent. The questionnaire comprised of two sections: Section I: Background Information: This section dealt with the background information of the respondents. Section II: Awareness scale: This section dealt with the feedback from the respondents regarding the extent of awareness regarding vertical garden. The response pattern was correct, don't know, incorrect and the ascribed scores were 3 to 1. To obtain the categories of extent of awareness, the score range was divided on equal interval basis.

Major Findings

This deals with the findings of the study obtained through the data.

Section I: Background Information of the Architects

More than one-half of the Architects had monthly income between `10,000- `30,000. The mean income of the architects was `37,333. One tenth Architects were Diploma holders. A little less than one-fifth Architects had Bachelor degree. A little less than one-tenth Architects had Masters Degree. Less than three-fourth Architects were employed. Less than one-fourth Architects had 13-23 years of experience.

Section II: This section dealt with the frequency and percentage distribution of the architects regarding awareness about green wall (vertical garden).

Table 1: Frequency and percentage distribution of the architects according to their awareness about Green Wall.

Sr. No.	Statement	Architects (n=30)					
		Correct		Don't know		Incorrect	
		f	%	f	%	f	%
1.	Vertical gardens are not a new concept.	20	67	0	0	10	33
2.	Vertical garden have been refined and developed to maximize the use of space.	24	80	5	17	1	3
3.	Vertical garden is also known as green wall.	26	87	2	7	2	7
4.	Vertical garden increase the property value.	26	87	2	7	2	7
5.	There are two main categories of green walls: green façades and living walls.	23	77	2	7	5	17
6.	Green façades are made up of climbing plants either growing directly on a wall or, on specially designed supporting structures.	18	60	4	13	8	27
7.	The best location for a vertical garden is on the south or west side of a house or building.	11	37	5	17	14	47
8.	Vertical garden makes best use of available space.	15	50	3	10	12	40
9.	Vertical garden are the innovative way of growing plants.	18	60	8	27	4	13
10.	Vertical garden needs only approximately one foot of depth and can be as tall as its desired.	24	80	3	10	3	10
11.	Watering vertical garden takes less time due to gravity.	20	67	2	7	8	27
12.	Vertical garden hides the ugly walls.	22	73	1	3	7	23
13.	Vertical garden reduce the physical stress of the human being.	22	73	2	7	6	20
14.	Vertical garden reduces wall maintenances.	17	57	3	10	10	33

15.	Vertical garden acts as air filters.	25	83	3	10	2	7
16.	Vertical garden produce oxygen.	25	83	3	10	2	7
17.	Vertical garden increase energy efficiency.	22	73	3	10	5	17
18.	Vertical garden provide additional layer of insulation.	21	70	2	7	7	23
19.	Vertical garden reduce the noise level inside the building.	21	70	2	7	7	23
20.	The vertical garden purifies slightly polluted water (such as grey water) by absorbing the dissolved nutrients.	19	63	5	17	6	20
21.	Vertical garden involves less weeding.	12	40	6	20	12	40
22.	Tasks such as pruning, harvesting, and checking for bugs are easier in vertical gardens.	13	43	5	17	12	40
23.	The most popular plants for vertical trellising are vine or creeping plants.	18	60	5	17	7	23
24.	Vertical gardens contribute to a pure environment by taking up CO ₂ .	24	80	2	7	4	13
25.	With the evaporation of water, vertical gardens have a cooling effect especially in indoor areas.	25	83	1	3	4	13
26.	Vertical garden can be a source of fresh air.	29	97	0	0	1	3
27.	Vertical gardens can be source of organic food.	25	83	2	7	3	10
28.	Vertical garden softens the hard look of concrete in urban dwelling.	23	77	4	13	3	10
29.	Vertical garden holds moisture in hot weather.	18	60	4	13	8	27
30.	Excess of the heat causes plants to get dry.	13	43	5	17	12	40
31.	Vertical garden can be created in small balconies and decks of the apartments.	11	37	9	30	10	33

32.	Vegetables, herbs and fruits can be grown in vertical gardens.	12	40	8	27	10	33
33.	Vertical garden does not mean only creepers grown on walls through planted in pots.	17	57	6	20	7	23
34.	Vertical garden can boost energy efficiency of the building.	17	57	7	23	6	20
35.	Vertical gardens can improve indoor environmental quality in several ways.	21	70	2	7	7	23
36.	Vertical garden forms additional layer of the building.	22	73	2	7	6	20
37.	Vertical garden consists of U-concrete ditch planters perched on aluminum frame.	6	20	5	17	19	63
38.	Vine and sprawling plants, such as cucumbers, tomatoes, melons, and pole beans are obvious choice for vertical gardens.	26	87	4	13	0	0
39.	Vertical garden are considered cost effective.	28	93	1	3	1	3
40.	The plant supporting system used in vertical garden very light and thus can be implemented on any wall.	23	77	5	17	2	7
41.	Some plants grown in vertical garden entwine themselves onto the support, while others may need to be tied.	19	63	7	23	4	13
42.	A vertical planting provides a shadow on the walls.	13	43	8	27	9	30
43.	Vertically growing plants are in more exposed to natural elements than non-staked plants; hence they dry out quickly and may need to be watered frequently.	4	13	9	30	17	57
44.	Vertical gardens need more frequent watering and fertilizing to keep up with the air and sun.	14	47	3	10	13	43

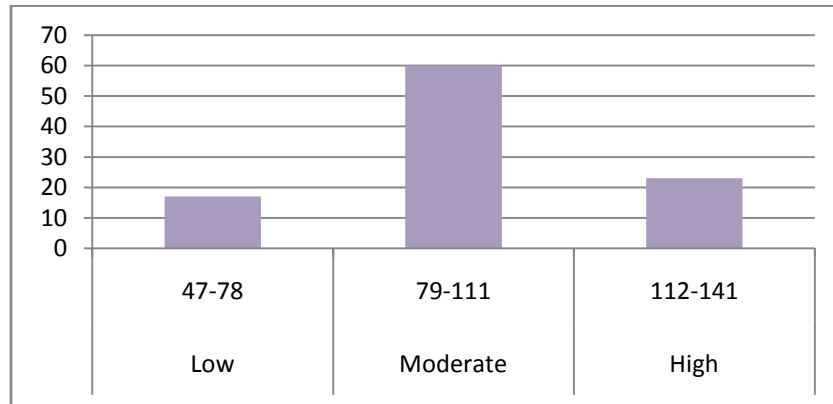
45.	Some vertical garden plants can damage the walls.	20	67	7	23	3	10
46.	Waterproofing has to be done if the vertical garden is on large area of the wall.	16	53	10	33	4	13
47.	Water logging cause death of certain plants due to air blockage.	13	43	7	23	10	33

Two third of the architects were aware that green wall (vertical garden) is not a new concept. Architects (80 per cent) were aware that vertical garden have been refined and developed to maximize the use of space. High majority of the architects were aware that vertical garden increases the property value. Architects (37 per cent) were aware that the best location for a vertical garden is on the south or west side of a house or building. Two third of the architects were aware that watering vertical garden takes less time due to gravity. Little less than half were unaware that vertical garden involves less weeding. Little more than half of the architects were aware that vertical garden holds moisture in hot weather. Majority of the architects were aware that the plants supporting system used in the vertical garden are very light and thus could be implemented on any wall. Little more than half of the architects were unaware that waterproofing has to be done if the vertical garden is on large area of the wall. Architects did knew that water logging causes death of certain plants due to air blockage. It was found that extent of awareness regarding vertical garden among the architects was (43 per cent). They were in the moderate extent of awareness.

Table 2: Extent of awareness regarding Green wall of the architects

Extent of Awareness	Range of Score	Architects (n=30)	
		f	%
Low	47-78	5	17
Moderate	79-111	18	60
High	112-141	7	23
Total		60	100

Graph: Distribution of the Architects according to the Extent of Awareness regarding Green Wall



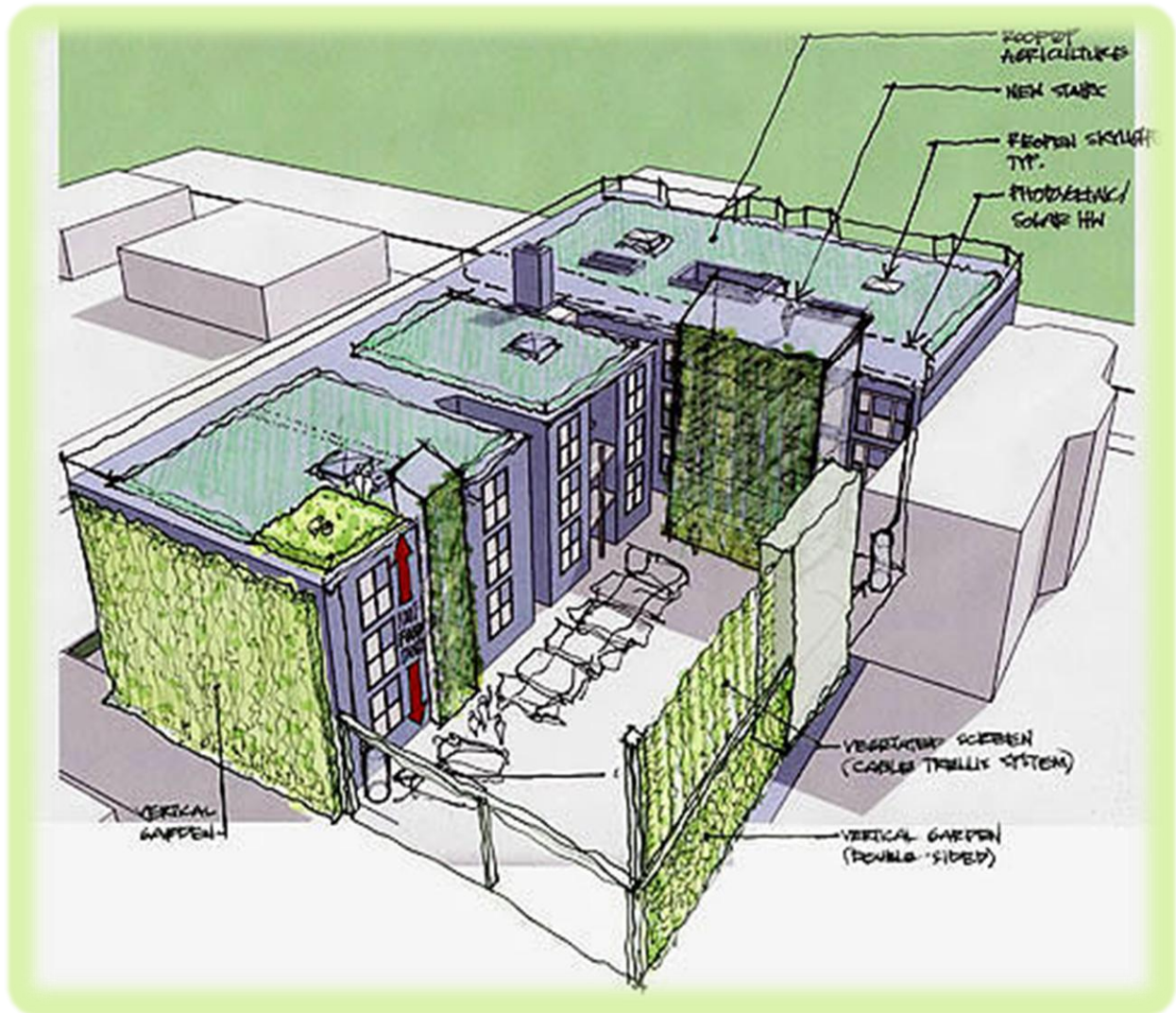
It was found that majority of the architects (60 per cent) were in the moderate extent of awareness regarding the Green Wall, whereas (23 per cent) had high extent of awareness and only (17 per cent) were having low extent of awareness regarding the Green wall.

Implications of the study

This study will help the architects and landscape designers to understand the needs of the vertical garden users regarding the vertical garden and provide them with satisfying garden design based on their expectations. The findings of the study will help to give students an insight about vertical gardens and designing of a Green wall. The study will provide students with guidelines of designing a Green Wall and strengthen them as future landscape designers. The findings of this study will help the homeowners to opt for better vertical garden designs for their residence.

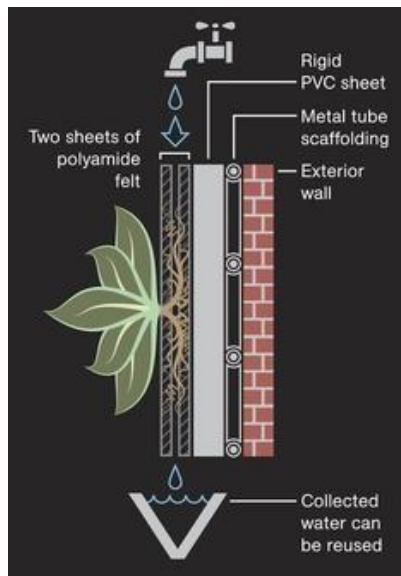
CONTENT OF BOOKLET FOR ENHANCING AWARENESS REGARDING GREEN WALLS

(VERTICAL GARDEN)



DEFINITION

- ✿ The term 'vertical garden' is used to define the growing of plants on, up, or against the façade of a building. Strategies for vertical garden development include: planting 'in the ground' at grade; planting in planter boxes (at grade, attached to walls, on window ledges, balcony rails and as part of horizontal and vertical sun screens over windows, doors and glazed areas); and planting in a vertical hydroponic system.



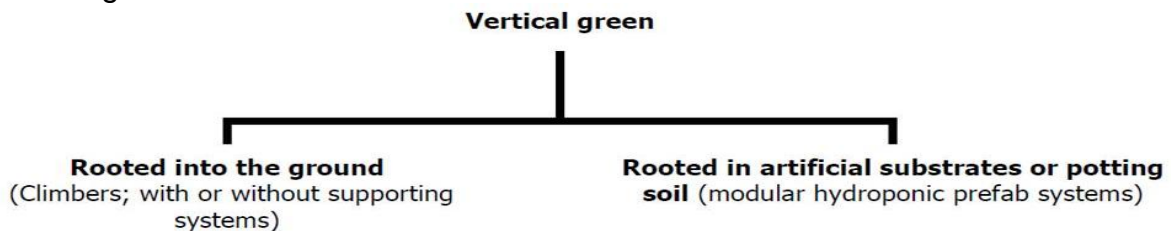
- ✿ A vertical garden is a wall partially or completely covered with vegetation that includes a growing medium, such as soil. Vertical garden also features an integrated water delivery system. Vertical garden are also known as living walls, biowalls, ecowalls, or green wall.

BENEFITS OF GREEN WALL

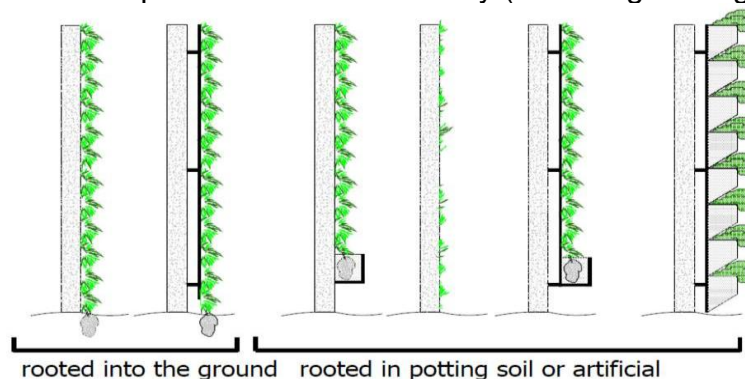
- Beauty abounds and adds visual drama
- Takes a fraction of the space that horizontal gardening does
- Conserves water
- Watering takes less effort
- Weeds are controlled
- Reduces CO2 levels and increases oxygen
- Acts as natural insulation for hot and cold air
- Increases value and salability of home or office building
- Covers up views of plain or ugly walls
- Fresh production of vegetables and fruits is possible
- Plants are less accessible to diseases and pests
- Live plants decrease stress levels, create peaceful ambience

METHODS OF GREEN WALL

Vertical gardens are descriptive terms which are used to refer to all forms of vegetated wall surface. From the ground rooted traditional green walls and modern techniques to create green walls or vertical garden ensure that fundamental differences arise in vegetation types. Basically one can understand systems rooted into the ground and based on hydroponic system (not rooted into the ground). Vertical garden technologies may be divided therefore into two major categories namely: rooted into the ground and rooted in artificial substrates or potting soil. The system that are based on the “artificial substrate and potting soil” principle are dependent on irrigation systems and adding nutrients to the substrate.



Both basic principles can be classified according to their application form in practice, within the categories a distinction is made between; whether if the greening system uses the wall as the guide to grow upwards (direct greening) or if the greening system and the wall are separated with an air cavity (indirect greening).



DESIGN CONSIDERATIONS FOR GREEN WALL

- Protection of the integrity of the structural support system and waterproofing protection of that system.
- A long-term, lightweight planting medium that is not subject to deterioration through decomposition. Normally this is a synthetic or manufactured product.
- Irrigation and fertilization systems to promote optimum plant growth and sustainability.

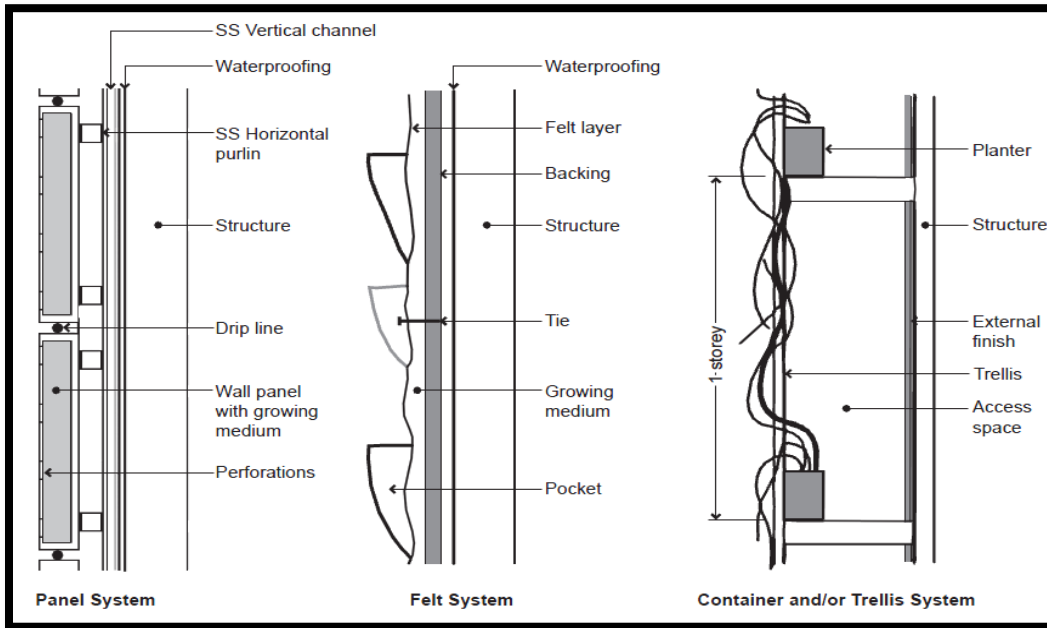
- Irrigation water must be captured at the base of the vertical garden. Anytime water free-flowing through the plantings there is bound to be some dripping from the plantings themselves that cannot be avoided.
- A vertical garden system generates humidity and it is possible through routine operation and maintenance that some dripping or splashing may occur. Have hard surfaces around a vertical garden.
- Storage - provisions should be made for the storage of gardening materials, supplies and irrigation controls.
- Maintenance - regular professional maintenance of the plantings and facilities should be accounted for budgeting and planning.

TYPES OF GREEN WALL

Vertical garden can be internal or external to the building envelope and can be broadly classified into three systems (Loh, 2008).

1. **Panel systems:** This is normally comprised of pre-planted panels that are brought on site and connected to the structural system and a mechanical watering system.
2. **Felt system:** Here plants are fitted into felt pockets of growing medium and attached to a waterproofed backing which is then connected to structure behind. The felt is kept continually moist with water that contains plants nutrients.
3. **Container and/or Trellis system:** Here plants grown in containers climb onto trellises. Irrigation drip-lines are usually used in the plant containers to control watering and feeding.

Vertical garden can be built out of any of the above three systems. Some of these walls are specifically integrated with the building's mechanical system.



Despite vertical garden being such a niche element, there is some variety in their methods of plant attachment. Whatever the method used, plants have a few common needs that cannot be compromised: sunlight, water, nutrients and something to support their weight (Loh, 2008).

LOCAL INDIAN PLANTS FOR GREEN WALL

Euonymus microphylla variegata
(Dwarf Variegated Boxleaf)



Baccharis viminea
(Mule's Fat)



Umbellularia californica
(California Bay Laurel)



**Tradescantia
Spathacea**



Golden fern



**Peperomia assorted
varieties**



**Bougainvillea
assorted varieties**



Golden Rhoeo



**Elaeocarpus
decipiens**



A vertical garden is a wall partially or completely covered with vegetation that includes a growing medium, such as soil. Most vertical garden also features an integrated water delivery system. Vertical garden are also known as living walls, biowalls, ecowalls, or green wall.

It is hoped that the booklet will be very helpful to the students, general masses, homeowners, architects and interior designers to enhance their knowledge regarding vertical garden.

References

- Bjerre. Laurent Aupetit.,(2011) “ GREEN WALLS” 7 Semester Dissertation Bachelor of Architectural Technology and Construction Management, VIA University College, Horsens, Denmark
- Blanc, P. (2011) “Green Wall Benefits – Sustainability”, greenovergrey.com
- Friedman, A., pile, F. I., Wikon, F. (1970), Interior Design – An introduction To Architectural Interiors, New York: American Elsevier, Inc.
- Green Roof Organization, 2008. Introduction to Green Walls Technology, Benefits and Design.
- Greenscreen,(2008) “Introduction to Green Walls Technology, benefits & Design”, greenscreen.com.
- Harte J. (2007). Human population as a dynamic factor in environmental degradation. *Popul Environ.* 28:223–236.
- Henneman, Linda. (2006). "Feasibility of Rainwater Harvesting in North Georgia's Humid Climate."
- Holtz-Eakin D, Seldon TM. (1995). Stroking the fires? CO2 emissions and economic growth. *J Public Econ.* 57:85–101.
- Jodha NS. (1990). Depletion of common property resources in India: micro level evidence. *Popul Dev Rev.* 15:261–284.
- Johnston, J., Newton, J. (2004). Building Green “A guide to using plants on roofs, walls and pavements”, Greater London Authority. London ISBN: 1 85261 637 7.
- Loh, S. (2008), A way to green the built environment, BEDP environment design guides.
- Ottele, M. (2011) “The Green Building Envelope vertical Greening” Arch M.Sc, Netherlands.
- Shafix N, Bandhyopadhyay S, 1992. Economic growth and environmental quality: time series and cross country evidence. Washington (DC): World Bank.
- Sharp,R. (2007). “6 Things You Need to Know About Green Walls”, Building Design and Construction, BD&C News, Web Article; <http://www.bdcnetwork.com/article/CA6459410.html>

- Shaw RP. (1989). Rapid population growth and environmental degradation: ultimate versus proximate factors. *Environ Conserv.* 16:199–208.
- Thompson, J.W. and Sorving, K. (2000). *Sustainable Landscape Construction, A Guide to Green Building Outdoors.* Island Press, Washington D.C. p.105-131.
- Wittwer, H. and Strain, R.(1985) “Carbon dioxide levels in the biosphere: effects on plant productivity.” *Critical Reviews in Plant Sciences*, Vol.2, Issue 3, pp. 171-198.
- Yeh, Y.P. (2012). *Green Wall-The Creative Solution in Response to the Urban Heat Island Effect.* National Chung-Hsing University.

WEBLIOGRAPHY

1. Wikipedia.com, retrieved on 9.8.2015
2. [http://www.homeimprovementpages.com.au/article/what can i plant in a vertical garden](http://www.homeimprovementpages.com.au/article/what_can_i_plant_in_a_vertical_garden), retrieved on 7.7.2013
3. <http://eprints.qut.edu.au/28173/1/c28173.pdf>, 2014
4. [http://en.wikipedia.org/wiki/Green wall](http://en.wikipedia.org/wiki/Green_wall), 2013
5. <http://www.verticalgardenpatrickblanc.com/>, 2013
6. <http://www.greenworldgl.com/verticalGarden.aspx>, 2013
7. [http://en.wikipedia.org/wiki/Green wall](http://en.wikipedia.org/wiki/Green_wall), 2013
8. <http://eprints.qut.edu.au/28173/1/c28173.pdf>, 2014
9. <http://www.greenworldgl.com/verticalGarden.aspx>, 2013
10. <http://www.verticalgardenpatrickblanc.com/>, 2013