VERTICAL GREENERY SYSTEM

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What is vertical greenery system?

Vertical greenery system (VGS) can be defined as greenery integrated into built forms in the city includes balcony gardens, sky terraces and green roofs (Chiang & Tan, 2009).

VGS can also be defined as the way that plants can be grown on, above, or in the walls of the building (Bass & Baskaran, 2003).

VGS is also known as vertical landscaping, vertical gardening and green wall.

Thus, VGS basically is techniques used to grow plants on vertical surfaces.

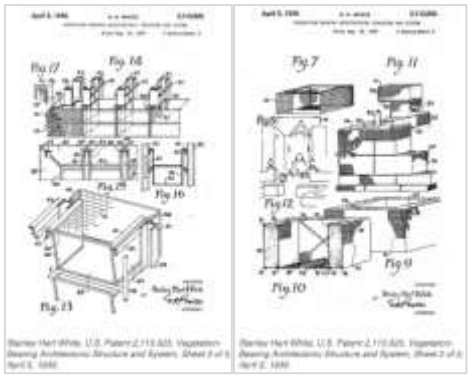
Reference:

1. Tabassom Safikhani, Aminatuzuhariah Megat Abdullah, Dishan Remaz Ossen, Mohamad Baharvand, *Thermal Impacts of Vertical Greenery System*, Environment and Climate Technologies (2014)
2. Bass, B. & Baskaran B. (2003), *Evaluating rooftop and vertical gardens as an adaptation strategy for urban areas, CCAF Impacts and Adaptation Progress Report* (p.111). Toronto, Canada.
3. Chiang, K. & Tan, A. (Eds.). 2009. *Vertical greenery for the tropics* (First Edit.). Singapore: National Parks Board.

History of VGS

Circa 600 b.c.

The first vertical garden system is believed to be the **Babylon Hanging Garden**, which was constructed by King Nebuchadnezzar II, who ruled between 605 and 562 BC



1938

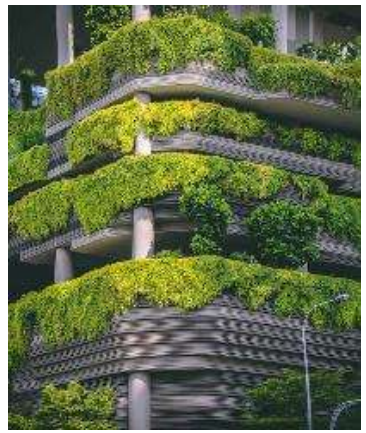
Prof. Stanley Hart White, a landscape architect invented 'Vegetation-Bearing Architectonic Structure and System' or '**botanical brick panel**' (modern version of VGS)

1988

Dr. Patrick Blanc, a botanist innovated the '**green wall**' into the invention of the modern 'vertical hydroponics garden' or '**green wall**' using felt fabric pocket system with automated watering and nutrient system made at the Museum of Science and Industry in Paris

2007

First '**Green curtain**' installed at Kyocera factory in Okaya, Japan



2008 - Now

Green initiatives using **VGS** upsurged because city leaders are recognizing that a cleaner environment is needed both to provide residents with good quality of life and to compete in the global economy.

Reference:

1. *https://en.wikipedia.org/wiki/Green_wall* accessed on 16 Feb 2021.

VGS can be divided into 2 broad categories

Categories of VGS

SUPPORT SYSTEM

The support system is designed to guide plants up on the vertical surface.

Support system is commonly known as '**green façade**' and allows climbing plants and cascading ground covers to grow up the façade on specially designed support structures.

Vertical greenery systems (VGS)

The selection of systems is guided by the types of plants to be planted.

CARRIER SYSTEM

The carrier system is designed to contain the media for the planting on the vertical surface.

Carrier system is commonly termed as '**living wall**' or '**vertical garden**' and able to hold more diverse plant types including ground covers, shrubs, ferns, grasses, sedges and even mosses.

Reference:

1. Tabassom Safikhani, Aminatuzuhariah Megat Abdullah, Dishan Remaz Ossen, Mohamad Baharvand, *Thermal Impacts of Vertical Greenery System*, Environment and Climate Technologies (2014)
2. Badrulzaman Jaafar, Ismail Said, Mohd Nadzri Md Reba, Mohd Hisyam Rasidi , *Impact of Vertical Greenery System on Internal Building Corridors in the Tropic., Procedia – Social Behavioral Sciences 105 (2013)* (p.558-568).

Comparison Of VGS systems

SUPPORT SYSTEM

Green facade

i. Inexpensive as it requires less component for plants to climb upward or downward on vertical surfaces.
ii. Easy to install as installation of the system does not requires any experience.
iii. However, if one of the plant dies, the whole system has to be replaced.
iv. Plants that can be used in this system is limited to climbers and creepers.

CARRIER SYSTEM

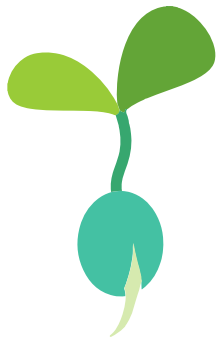
Living wall

i. Quite expensive as it requires more components for plants to be planted in pots or pockets on vertical surfaces.
ii. Installation depends on the design on suppliers/contractors, which could range from easy stacking up to complex system with automatic timed-watering system.
iii. Slightly easier to maintain; if one of the plant dies, only the plant in affected pot or pocket should be replaced.

Reference:
1. Tabassom Safikhani, Aminatuzuhariah Megat Abdullah, Dishan Remaz Ossen, Mohammad Baharvand, *Thermal Impacts of Vertical Greenery System*, Environment and Climate Technologies (2014)
2. Badrulzaman Jaafar, Ismail Said, Mohd Nadzri Md Reba, Mohd Hisyam Rasidi, *Impact of Vertical Greenery System on Internal Building Corridors in the Tropic.*, *Procedia – Social Behavioral Sciences 105 (2013)* (p.558-568).
3. Hazril Sherney Basher, Sabarinah Sh Ahmad, Abdul Malek Abdul Rahman, Nuruhusna Zamaruz Zaman, *The Use of Edible Vertical Greenery System to Improve Thermal Performance in Tropical Climate*, Journal of Mechanical Engineering Vol.13. No1. UiTM (2016) (p.57-66).

Components of VGS

There are many variations of VGS available in the market. However, VGS basic components remain the same, which are:

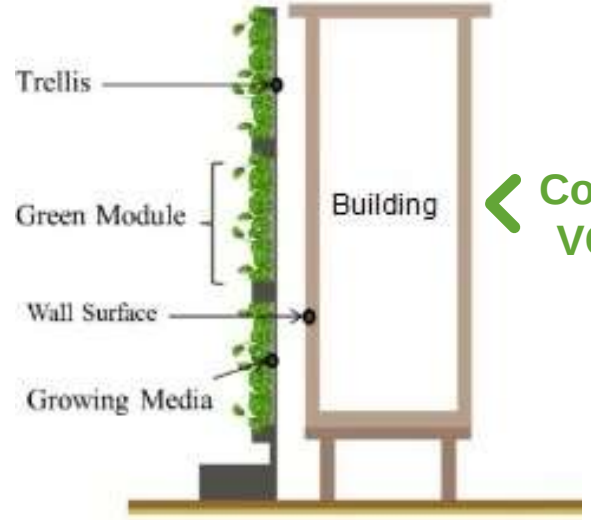


PLANTS

SOIL/ GROWING MEDIUM

SUPPORTING STRUCTURE/ PLANTER POTS WITH IRRIGATION

Components of VGS – Support System



Components of VGS – Carrier system

Reference:

1. *A Handbook on Developing Sustainable Highrise Gardens*, *Bringing Greenery Skywards*, National Parks Board (2017) Singapore.

Common VGS System Available In Market

Reference:
A Handbook on Developing Sustainable Highrise Gardens, Bringing Greenery Skywards, National Parks Board (2017) Singapore.

Carrier system

Cassette system

The cassette system consists of modular units containing growing media that can be easily mounted on structure framings as standalone system or attached to wall surface.

Planter system

The planter system consists of individual pots mounted at regular intervals onto a structure or frame. When placed closely together, they form a continuous wall of greenery.

Pocket System

The pocket system comprises of moisture retention fabrics that are used to hold the plants in place on a board. These plants are placed in pockets made of the fabric.

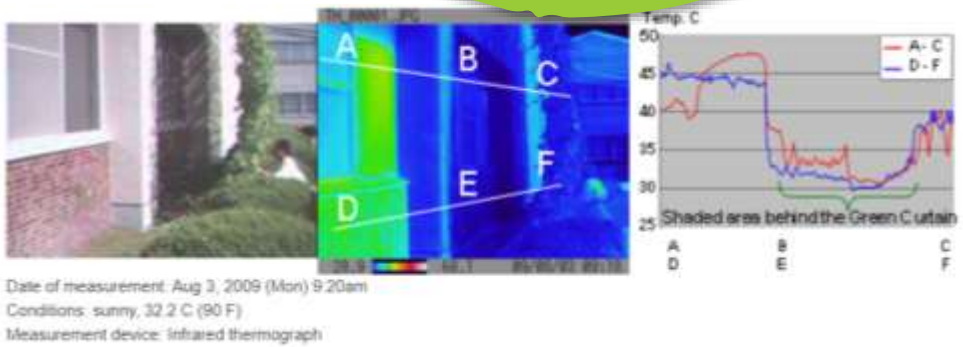
Support system

Support system

The support system consists of plants in planters placed at regular interval. Wire mesh and cables attached to them allows plants to climb up creating a green screen.

Case study of Buildings with VGS Using Support system

- Since 2007, Kyocera Corporation, a Japanese manufacturer of electronic components and photovoltaic systems, factory has been covering the outer façades of its buildings with Green Curtains to lower indoor temperatures, save energy, and reduce pollution.
- These ‘green curtains’ are installed firstly at a factory in Okaya on the exterior wall and made of planter boxes with rope installed onto frames and external wall, with decorative or edible climbing plants, such as morning glory and bitter gourd.
- Kyocera documented the energy savings impact by conducting thermographic testing to compare the temperature in areas with and without Green Curtains. The green curtain helps to cool the air through water evaporation with reduced 2°C of indoor temperature, reduced 15°C of outdoor building surface temperature, reducing the use of air conditioning up to 1.5 hours per day while at the same time providing natural shade and reducing carbon monoxide (CO^2) emissions.
- The company uses food from these plants for cafeteria meals and distributes some to employees for free as a promotion to healthy diets.
- By 2017, it has spread to 27 Kyocera factory locations in Japan and in 2016, Kyocera’s Green Curtains has covered an area of more than 31,000 ft², resulting in significant summer energy savings and positive aesthetic effects.
- Kyocera also created guidebooks, DIY kits and distributed seedlings to its employees and local residents to spread the system.



Green Curtains at Okaya Factory and Kiita Factory with worker harvesting bitter gourds from it.

Reference:

1. *https://img.climateinteractive.org/wp-content/uploads/2018/01/Green-Curtains.pdf*
2. *https://www.kyoceradocumentsolutions.com/company/csr/pdf/csr_report2011.pdf*

Case study of Buildings with VGS Using Carrier system

- Menara Etiqa, developed by Etiqa Life Insurance Berhad, is in Kuala Lumpur, Malaysia. The office tower sits in a 1.15 acres site, adjacent to two medium/high rise commercial towers and the Bangsar LRT station.
- It is a 38-storey building designed by Veritas Architect which incorporated a lush green wall into its building design and other green features towards achieving dual green building accreditation of the Green Building Index (GBI) Gold rating and the GreenRE Platinum rating.
- The beautiful green wall covers approximately 1,000 square meters façade to promote biophilia in the urban landscape, which wraps one corner of the 8-storey parking podium.
- The green wall is made of *VersiWall GP* mounting panels, shaped like trays for planter system, installed on the corners at an angle to create an enveloping aesthetic on the façade. The mounting base for the VGP consist of aluminum panels.
- These panels allow each tray to be serviceable from behind via access from the multistorey carpark, which made greatly ease maintenance of the whole system. A total of 1,200 VGP trays were used with 34 species of plants suitable to the year-round tropical climate.
- Anti-lift arms and multi-point mounting features of each VGP tray significantly reduce the risk of dislodgement, even during wind speeds of up to 108 km/h.
- Irrigation was established via piping that feeds into each individual tray and sectioned into zones, feeding water and fertilizer directly into each.

Reference:
1. *https://www.greenroofs.com/2020/06/22/featured-project-menara-etiqa-living-wall/*

Case study of Buildings with VGS Using Carrier system

- G Tower Hotel is a 30-storey building, of 180-rooms of business hotel, a 12,000 square feet club and offices located at a crossroad of Jalan Ampang and Jalan Chan Sow Lin in Kuala Lumpur.
- It was built in 2010 and has won a Green Mark Gold Award from Building Construction Authority (BCA) in Singapore.
- It was designed to incorporate green elements starting from the design phase to include proper orientation to the sun, water features, overlay green wall, koi pond and a few types of green walls system to help cool the building.
- G Tower uses less 25% less energy compared to other buildings of similar sizes due to its efficient air-conditioning and lighting system.
- The extensive landscaping, which included the sky gardens and green walls, has also help to cool down the building from urban heat island.
- There is a gap in between the double glazing façades and the green walls which further reduce heat gain into the building.
- It also has rainwater harvesting system, which is used to irrigate plants and vertical green walls throughout the building.
- There are mix types of VGS system designed as part of the exterior and interior green walls of G Tower, which is the support system using plastic trellis and carrier system made of cassette system.

Reference:
1. *https://www.designcrucial/G_tower_in_Malaysia_Wins_GReen_Mark_Gold_Awards_From_Singapore BCA*

PROS & CONS OF VGS

In conclusion, researches done regarding VGS indicated that VGS have more pros than cons.

Reference:

1. *A Handbook on Developing Sustainable Highrise Gardens, Bringing Greenery Skywards*, National Parks Board (2017) Singapore.
2. Tabassom Safikhani, Aminatuzuhariah Megat Abdullah, Dishan Remaz Ossen, Mohamad Baharvand, *Thermal Impacts of Vertical Greenery System*, Environment and Climate Technologies (2014)
3. Badrulzaman Jaafar, Ismail Said, Mohd Nadzri Md Reba, Mohd Hisyam Rasidi , *Impact of Vertical Greenery System on Internal Building Corridors in the Tropic., Procedia – Social Behavioral Sciences 105 (2013)* (p.558-568).
4. Abu Bakar, N.I, Mansor, M., Harun, N.Z. *Approaching vertical greenery as public art: A review of potentials in Urban Malaysia (2013)*. Architecture & Environment Vol. 12, No.1, April 2013 (p.1-26)
5. *https://www.designandarchitecture.com/article/how-to-design-a-high-rise-vertical-greenery-system-in-the-tropics.html* accessed on 16 Feb 2021.
6. Sunakorn, P., Yimprayoon, C., 2011. *Thermal Performance of Biofacade with Natural Ventilation in the Tropical Climate*. Procedia Eng. 21, (p.34–41)

PROS

VGS provides cover shielding, lowers surface temperature maximum to 11.58°C, reduce ambient temperature from 3.3°C and air temperature of 4.71°C. Living wall reduced temperatures better than green façade.

VGS can reduce noise level by up to 10dB by acting as a ‘padding’ or sound insulation.

VGS can improved the ventilation in a naturally ventilated room.

VGS can beautify a space and bring greenery to the community. For vertical greenery at communal areas in high-rise building, VGS create a good ambience for social interactions and add appeals to streets and alleys.

VGS is also explored by landscapers and architects as a form public art on building and temporary structures, especially for urban beautification.

CONS

VGS can increase humidity to building surface. The humidity of green façade cavity is higher that living wall.

VGS system requires constant maintenance of plants, irrigation, drainage and proper access to the system, which maybe costly and burdensome.

Growing enough plants on VGS to cover the whole façade takes times.

Thank you