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A Review on Green Wall, Classification and Function

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ABSTRACT

Green walls are self-sustaining garden systems that can be designed on the walls of a building. The purpose of this paper is to review all types of green wall systems so as to classify, organize their main features and investigate the benefits of green wall systems to improve buildings performance. It can be determined that green wall provide great potential in reducing energy intake in buildings, especially in the cooling periods. The study has been conducted on the basis of literature survey with Library, Journals, Internet, Various seminar papers, reports of research organization. In this paper a classification of green wall systems and the main requirements of different green wall systems are investigate. It concludes that some characteristics must be studied in depth, such as classification and benefits of green wall.

Keywords: Living Walls, Vertical Garden, Bio Wall, Green Facade

I. INTRODUCTION

History of green wall

A green wall is a wall partially or completely covered with greenery that includes a growing medium, such as soil. Most green walls also feature an integrated water delivery system. Green walls are also known as living walls or vertical gardens (Wikipedia.com, 2010). The first green wall suggested in 11 century and the Viking's era. The Viking used stones timber and peat's bricks to construct their habitations. Peat is an accumulation of incompletely decayed vegetation matter; it is formed in marshes or equally environment. When the Vikings used peat's brick, grass naturally grew on this organic material. The habitation was covered with vegetation. The grass's roots helped the bricks to join in one huge brick and made the walls durable. These kinds of construction could be found in the north hemisphere wherever went the Vikings: from Canada to Norway via Island, Ireland, Sweden, and Denmark. But there is no evidence found that these early green walls were created on purpose. Natural settlement of walls by plants is happening with or without men's help. Everyone knows a building which is covered or partially covered by vegetation. In humid tropical zones, the plants from the jungle grow on any kind of buildings and covered with vegetation in Central America and South East Asia.

Patrick Blanc's green wall

It is in 1988 that Patrick Blanc filed a patent for the creation of a "device to grow plants without soil on a vertical surface"; the modern green wall was then created. On a bearing wall or support structure is placed a metal frame that supports an expanded PVC plate 10 mm thick, on which are stapled two layers of polyamide felt 3 mm thick each. A network of pipes controlled by valves provides a nutrient solution containing the dissolved minerals needed for plant growth. The felt is soaked by capillary action of the nutrient solution, which descends along the wall by gravity. Plant roots will collect the nutrients they need, and excess water is collected at the urban green space, including the greening of buildings involving both green roofs and green walls, is just one piece of the puzzle. Modern cities provide giant areas of roof and wall space, in many cases extending high above the street. Not all of this space is suitable for growing plants, but much of it

is, certainly much more than has been applied in recent years (Johnston et al., 2004).

II. METHODS AND MATERIAL

The study has been conducted on the basis of literature survey. Library, Internet, Various seminar papers, taskforce reports of research organization, journals and some periodicals on green wall have been surveyed for the purpose of accumulating information. Throughout the years, replacement of vegetated surfaces with paved and impervious surfaces in the urban area have caused the temperature in the area to increase comparing to the surrounding rural area. This is because the paved surfaces absorbs, retain, and reradiate more solar energy than grasses and trees. The ambient temperature in urban area can be as much as 6ºC warmer than the air in rural areas (Loh, 2008). Green walls or also known as vertical greenery is actually introducing plants onto the building facade. Comparing to green roof, green walls can cover more exposed hard surfaces in the built environment where towers are the predominant building style (Jonathan, 2003). If a tower has a plant ratio of one to seven, then the facade area is equivalent to almost three times the area. If the building is covered two thirds of the facade, this have contributed to doubling extend of vegetation on site. A tower can become green, thus increasing the organic mass on the site (Wilmers, 1990). The green walls can be divided into three fundamental types according to the species of the plants; types of growing media and construction method (Sheweka et al., 2011).

A. Wall-climbing Green wall

The wall-climbing type is the very common and old-fashioned green walls method. It is intense process, climbing plants can cover the walls of building naturally. Sometimes they are grown upwards with the help of supporting systems (Wilmers, 1990; Jonathan, 2003).

B. Hanging-down Green Wall

The hanging-down type is also another standard method for green walls. It can easily form a complete vertical green belt on a multi-story building through planting at every story compare to the wall-climbing type (Wilmers, 1990).

C. Module Green Wall

The module type is the latest concept compared to the previous two types. It requires more complicated design and planning considerations before a vertical system can come to place. It is also possibly the most expensive green walls method (Jonathan, 2003).

D. Benefits of Green Walls

Plants in a city can provide quantitative benefits, in the form of financial returns, as well as qualitative environmental, social and aesthetic benefits. Although the benefits are discussed separately, they are actually inseparable and should be appreciated in the built environment (Loh, 2008).

E. Environmental Benefits

Plants can offer cooling benefits in the city through two mechanisms, direct shading and evaporate transpiration. The green walls used plants which provide shading to the building. It is very straightforward and is very much depends on the density of the plants in the green walls. As a result, not only the shaded building, but the ambience also will experience a relatively low temperature. The temperature reduction will not only affect the building, but also to the urban environment. Trees can improve the air quality by filtering out airborne particles in their leaves and branches as well as by absorbing gaseous pollutants through photosynthesis (Loh, 2008; Dwyer et al., 1994). Storm water in the urban area is traditionally routed off impervious surfaces and transported in drainage pipe systems to an adjacent receiving water body. Flooding may occur when the drainage is unable of storing and distributing the storm water from the land. A degraded aquatic ecosystem is usually associated with the discharge of the storm water. Green wall is actually a mulching technique as it covers the waterproof surface of the building with plants and soil or planting medium. The green wall is able to retain water to control the water runoff from the roofs. Urban green area and plants around the buildings can be viewed as an acceptable alternative habitat for urban plants and native wildlife. The presence of wildlife may improve the ecological quality and health of the environment as well as provide additional emotional, intellectual, social and physical benefits to humans

(Johnston and Newton, 1996). Plants also release oxygen to the atmosphere through its unique photosynthesis, which troubles carbon dioxide and water to create sugar and oxygen. This attains not only oxygen generation, but also carbon dioxide reduction. Plants roots also play a role in filtering the impurities in the water before it enters a groundwater aquifer. Impurities, such as nitrogen and phosphorus, will bond together with some type of soil. Plants can reduce the amount of these impurities in the soil by taking up nitrogen and phosphorus to be used in the plant growth (Johnston and Newton, 1996). Plants can be used as sound barrier as the can reduce the noise perceived by the receiver. In the case of green walls, plants in the green walls will absorb the frequencies of the sound. Thus, reducing the noise pollution in the urban area (Dunnet and Kingsbury, 2004).

F. Economics Benefits

All economics benefits are associated with the environmental benefits of the green walls. The ability of the vegetative surfaces to retain storm water and water runoff from the roofs can help in reducing extend of the storm water drainage infrastructure. Plants introduced around buildings can improve construction integrity by decreasing the weather effect. The use of green walls can reduce the climatic stress on building facades and prolong the service and practical life of buildings and also not to mention reduced cost on the painting materials (Johnston and Newton, 1996). Energy saving is another significant economic contribution brought by greenery in the cities. Studies have been done where the energy used for cooling in a building can be vastly reduced. Greenery can also add value to the property. Landscaping is often used to improve the aesthetic value of the urban area. Vegetation can provide visual contrast and relief from the highly built-up city environment (Dwyer et al., 1994).

G. Social Benefits

Plants can fulfil various functions. Plants provide places for playing, sports and recreation, meeting establishing social contacts, isolation and escape from urban life, aesthetic enjoyment, viewing buildings from a distance and so on. It has been proved that visual and physical contacts with plants can result in direct health benefits. Plants can produce medicinal effects leading to reduced stress; improve patient recovery rate and higher resistance to illness. The benefits of vertical greening include noise reduction (Van Renterghemet al., 2013), filtering of airborne dust and pollutants (Ottele et al., 2010; Sternberg et al., 2010), and reduction of temperature close to the area of vertical greening (Onishi et al., 2010; Wong et al., 2010; Perini et al., 2011a). The thermal aspects of vertical greening are, however, still under debate (Hunter et al., 2014). One particular type of green facade is living wall systems, which are vertical green-ing systems where plants are grown without the need for contact with the ground (Koehler, 2008; Francis and Lorimer, 2011; Perini et al., 2011b).Living wall systems can be seen as an alternative way of introducing urban greening in dense urban areas in the same way as e.g. green roofs, which have shown to support a high arthropod diversity (Rumble and Gange, 2013; Madre et al., 2013). Like plants on green roofs (Emilsson and Rolf, 2005; Emilsson, 2008), plants in living wall systems must be able to cope with extreme conditions, such as high irradiation, significant differences in temperature and possible water shortage. According to Wong et al., 2010, green wall involve any way to set plants in a building facade. Traditionally these systems consisted of climber plants that climb directly on the material facade. On a more updated approach, these systems tend to separate the plants from the facade surface in order to avoid potential problems accompanying with linking the building with living organisms. This suggests the need to implement support structures to ensure the whole development of plants throughout the facade surface. With the aim of achieving this goal, different designs have been developed in recent years giving different construction systems. In this regard Perez et al., 2011, proposed a classification of green wall for buildings. In this classification the authors differentiate these systems in extensive and intensive systems according to the requirements of implementation cost and further maintenance. On the other hand, this classification differentiates Green Vertical Systems into two big groups, the Green Facades and the Living Walls. Green facades are green wall in which climbing plants or hanging port shrubs are developed using special support structures, mainly in a directed way, to cover the desired area. The plants can be planted directly in the ground, at the base of the structure, or in pots, at different heights of the facade. Green facades can be divided into three

different systems (Pérez G, et al., 2011) Traditional green facades, where climber plants use the facade material as a support; double-skin green facade or green curtain, with the aim of creating a double-skin or green curtain separated from the wall; and perimeter flowerpots, when hanging shrubs are planted around the building as a part of the composition of the facade to constitute a green curtain. In the case of double skin green facades, the systems used are modular fences, wired, and mesh structures (Pérez G, et al., 2011). Modular fences are very light trellis metal modules mounted on the building wall or on independent structures, which become the support for climbing plants. In wired structures a system of steel cables, anchorages, separators, and other features are used to constitute a light structure that serves as support for climbing plants. Mesh structure consists of a very light structure that provides support for the climbers, made with a steel mesh anchored to the building wall or to the building structure. Living walls are made of geotextile felts and panels, sometimes pre cultivated, which are fixed to a vertical support or on the wall structure (Pérez G, et al., 2011). The panels and geotextile felts provide support to the vegetation formed by upholstering plants, ferns, small shrubs, and perennial flowers, among others. The classification proposed by Pérez et al., incorporates and complements other classifications or system descriptions carried out by other authors as those that can be found in the Building Greener Guidance from CIRIA (Dunnet and Kingsbury, 2008; Kontoleon and Eumorfopoulou,2010); Ottele, 2011).

III. RESULT AND DISCUSSION

- The benefits of vertical greening include noise reduction. Plants can be used as sound barrier as the can reduce the noise perceived by the receiver.
- Green facades are green wall in which climbing plants or hanging port shrubs are developed using special support structures, mainly in a directed way, to cover the desired area.
- Plants provide places for playing, sports and recreation, meeting establishing social contacts, isolation and escape from urban life, aesthetic enjoyment, viewing buildings from a distance.
- Energy saving is a significant economic contribution brought by greenery in the cities.
- Green wall can improve the air quality by filtering out airborne particles in their leaves and branches as well as by absorbing gaseous pollutants through photosynthesis.

IV. CONCLUSION

Green wall can be built outside (green facade, living wall) or inside a building cover in variety country and under various weather. These structure are not limited by their viability, they are well design and quick and easy to create. Green wall are developmental, there is several that can confirm a large variety of functions. Green facades can depend of the system, cover large facade section. A green facade will also bring vegetation into busy spaces. Living walls are modified for both indoor and outdoor living condition. The difference between them is the media use to carry the plant. The structural media is the most common system, the strongest, but also the more expensive. Living walls have the same function as green facades and even more. They are called bio wall when they are used to treat polluted air; they can serve as sound barrier. Green wall benefits consist of Environmental benefits, Economics benefits and Social Benefits.

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