Green Wall: A compelling architectural element for sustainable contemporary cities

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World's arable lands are rapidly transforming into cities where the built environment is accounted to be responsible for 75% of the world's annual GHG emissions. Buildings are solely accountable for 39% out of these emissions, which has incontrovertible impacts for the environment and human health [1, 2]. Apart from the alarming repercussions on climate change, the rising levels of indoor and outdoor pollutants are adversely affecting human longevity by creating permanent health impacts such as decreasing lung capacity and diseases such as asthma and bronchitis [3].

Even though trees and vegetation could play a major role in alleviating these environmental stresses, there exists a need to reevaluate the ways of incorporating elements that recreate nature into modern cities. One major reasons for the difficulties in integrating the urban green space into cities is the limited space available in built environment. Especially, the percentage imperviousness in urban land use is quite high and the space available for green landscape is considerably limited in such areas [4]. One of the solutions architects and engineers have recommended in addressing this issue is incorporating green features to the building envelope itself. In recent years, green walls have become one of the most popular and vibrant ways to incorporate plants and greenery into buildings, within its interior and exterior [5].

Green Facade

Green walls and green facades could be identified as internal or external components of a building which are partially or completely covered by small plants. These plants can change in size from a few square meters to an entire building and grow directly from the ground soil or vertically supported

Green Wall System with a growth media

soil. Green walls are also known from various terms such as 'living walls', 'bio-walls' or 'vertical gardens. It incorporates vegetation, growing medium, irrigation and drainage components into a single structure [6]. Even though, commonly seen green facades are also a subset of the vertical gardens, there are significant structural differences between the green facades and green walls. Green facades are created by growing climbing plants up and through the facade of a building from the ground. The plants of a green wall grow in a structure which is filled with growing substrate and this structure acts as a skin between the building envelope and the plant layer thus is known as a double skin structure [7] .

Green walls provide an attractive aesthetic value to the building and provide shading to the surface of the wall. In addition, green wall systems create cooler microclimates and improve local air quality around the building. A wide range of plants could be used on green walls (herbaceous and small shrubs) in order to achieve aesthetic appeal and other ecosystem services as required. However, adequate light provision is an important consideration in constructing and plant selection for green walls [8]. When planning an interior green wall, artificial lighting may be necessary based on the indoor lighting conditions.

The plants in green walls act as a layer of thermal protection and help to reduce the overall temperatures of the building which could in turn reduce the need for air conditioning energy requirements to cool the building. This can contribute to a substantial reduction in building energy usage especially for tropical countries. Green walls help to improve air quality and filter the surrounding air by adsorption of air pollutants such as particulate matter [7]. Based on the precise and optimum design of the green wall, multiple environmental benefits can be obtained and these benefits depend on factors such as,

- Geographic location of the building

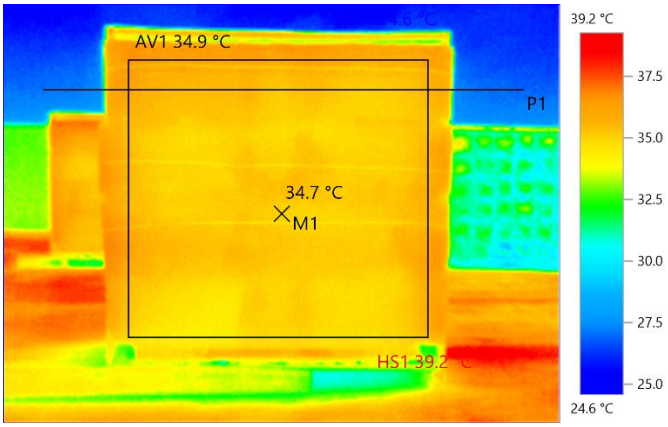
- Local climatic conditions
- Geometry of the building
- Orientation of the building
- Selected plant species and
- Components of green wall and related systems

The importance of Green Walls for Sri Lanka

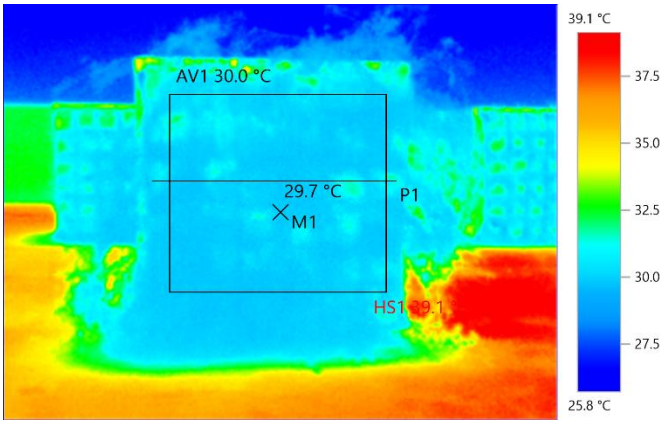
Colombo, the capital city of Sri Lanka has been experiencing rising population density and rapid urbanization throughout past few decades. Due to the rapid urbanization in the capital city and many other urban areas in Sri Lanka, a considerable percentage of natural green cover has been transformed into built environment which consists with roads, paved surfaces, high rise buildings and apartment complexes. Furthermore, Sri Lanka is a tropical country that receives ample sunlight throughout the year. Due to these conditions, majority of the urban areas in Sri Lanka are subjected to microclimatic changes and phenomenon such as Urban Heat Island (UHI) effect. Due to the limitations of land in enhancing the natural green cover, green walls can be identified as one of the most feasible solutions to introduce green cover into urban areas, by integrating vegetation in to building envelope. Apart from the heat reductions, aesthetic benefits, air pollution reduction and habitat creation, green walls can provide substantial economic benefits in long term by reducing energy consumption for cooling buildings during the daytime. Integrating vertical greening in a building also contributes in receiving credit points under Sustainable Sites category, in GreenSL® Rating System of Sri Lanka Green Building Council (SLGBC) for green building certification.

Thermal performance of Skygrow vertical gardening systems

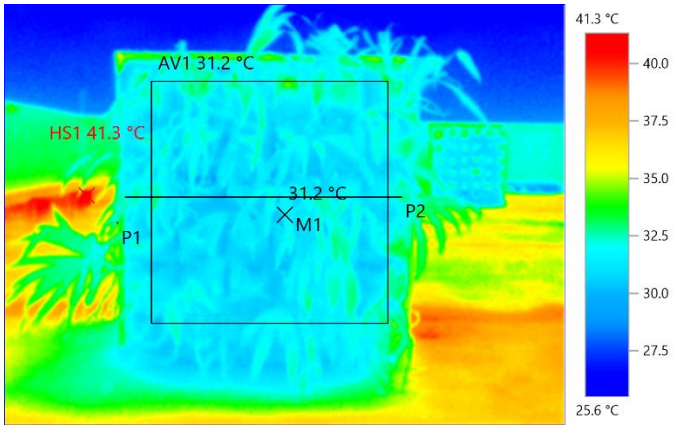
A comparison of a Skygrow vertical gardening system in reference to a regular south facing cement wall shows a surface temperature reduction upto 5^0C in a an ambient temperature of 32.1^{0}C and a relative humidity of 73.4%.



Control Experiment: Temperature at Measuring Point 1 (M1) – 34.7^{0}C, 15/08/2019, 12.00 p.m.



Experiment A: Temperature at Measuring Point 1 (M1) – 29.7^{0}C, 15/08/2019, 12.00 p.m.



Experiment B: Temperature at Measuring Point 1 (M1) – 31.2^{0}C, 15/08/2019, 12.00 p.m.

Plant selection for the vertical gardening or green wall systems plays a major role in achieving its thermal performance. Plant coverage and Leaf Area Index (LAI) are some of the important parameters in selecting suitable plant species for the optimum thermal performance of a green wall. The plant species selected for the experiment A and experiment B shows a surface temperature reduction up to 5^0C and 3.5^0C respectively in reference to the cement wall. However, these values could vary based on the orientation of the wall and local climatic conditions. As south facing walls in countries located in northern hemisphere receives daylight throughout the day, a better building thermal performance can be achieved by implementing green walls on the south side of a building. However, this should be done with caution as it may be difficult for the plants to cope and survive with the heat that they receive throughout the day.

References

1. Privitera, R., et al., *Towards lower carbon cities: Urban morphology contribution in climate change adaptation strategies.* European Planning Studies, 2018. **26**(4): p. 812-837.
2. Teng, Y., et al., *Reducing building life cycle carbon emissions through prefabrication: Evidence from and gaps in empirical studies.* Building and Environment, 2018. **132**: p. 125-136.
3. Cipolla, M., et al., *Air Pollution and Lung Diseases*, in *Clinical Handbook of Air Pollution-Related Diseases*. 2018, Springer. p. 327-339.
4. Feltynowski, M., et al., *Challenges of urban green space management in the face of using inadequate data.* Urban forestry & urban greening, 2018. **31**: p. 56-66.
5. Collins, R., M. Schaafsma, and M.D. Hudson, *The value of green walls to urban biodiversity.* Land Use Policy, 2017. **64**: p. 114-123.
6. Sadeghian, M.M., *A Review on Green Wall, Classification and Function.* International Journal of Scientific Research in Science and Technology, 2016. **2**: p. 47-51.
7. Coma, J., et al., *Vertical greenery systems for energy savings in buildings: A comparative study between green walls and green facades.* Building and environment, 2017. **111**: p. 228-237.
8. Jain, R. and T. Janakiram, *Vertical gardening: A new concept of modern era.* Commercial Horticulture. New Delhi, India: New India Publishing Agency, 2016: p. 527-536.