INTEGRATION OF DOUBLE SKIN GREEN WALL AS A SUSTAINABLE DESIGN APPROACH IN TROPICAL CONTEXT

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DECLARATION

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ABSTRACT

Global warming and energy crisis are two of the biggest issues the world faces today which require immediate mitigatory actions. Building sector plays a major role in contributing to these issues due to the high energy consumption and carbon emissions. Highly dense urbanities directly contribute in urban heat island effect thus local warming. Therefore, researchers have given considerable interest on the building envelop design with the concerns for energy efficiency, aesthetic appearance and sustainability. As a result, integration of green facades with buildings has rapidly evolved due to the aesthetic appeal and sustainable benefits such as uplifting the urban environmental conditions by promoting air quality, reducing heat island effect and etc. However, adaptation of vertical greenery is still at an initial stage in Sri Lanka.

The research was initiated to introduce vertical greenery to a broader context and to develop an innovative modular green wall system for building facades as a sustainable building envelop in Sri Lankan context. Field studies were conducted in identifying the potential of introducing a vertical greening system and benefits of existing vertical greening systems in tropical Sri Lankan context. Modular panel and green wall system development was conducted as on-site experiments and the thermal performance evaluation and long-term benefits of the proposed modular panel vertical greening system was conducted as on-site investigations combined with software simulations.

Results of the field investigations on the perception on vertical greening in local context demonstrated that general public, building occupants and the building designers are willing to accept the vertical greening as a sustainable approach for buildings. Yet, lack of knowledge on the vertical greening systems, maintenance methods and their benefits and misconceptions on related costs have impeded the popularization of vertical greening. Identified existing vertical greening types in local context; living walls, indirect and direct green facades are beneficial in reducing the surface temperature of buildings where living walls recorded the highest temperature reduction of 10.15^{o}C. Internal air temperature reduction was recorded to be 2.21^{o}C, 1.82^{o}C and 0.66^{o}C by living wall, indirect green façade and direct green façade.

Pilot and extended field investigations on plant selection for the proposed vertical greening system resulted in shortlisting two species, from which *Axonopus compressus* was selected as the best plant species where a maximum 10.08^{o}C external wall surface temperature reduction and 3.15^{o}C internal surface temperature reduction was recorded. The experimental studies on finalizing growth media resulted 1:1/2:1/2: 1/4 coir: sand: compost: soil ratio as the growth media with the best compaction and the permeability for the plant growth in the proposed vertical greening system. Proposed system is advantageous as it can be easily introduced to existing structures and as the panels can be handled separately allowing easy installation and easy replacement with minimum technical support. Size of the modular panel was finalized as 600mm (width) x 900mm (height) for easy handling and the fiber was selected as the material due to strength and durability.

Developed walling system recorded a surface temperature reduction of 17.26^{o}C, 7.89^{o}C in external wall and internal wall surface and a temperature reduction of 2.89^{o}C of internal air temperature. Simulation studies conducted in building scale and urban scale resulted significant indoor air temperature reduction, cooling load reduction and urban air temperature reduction when integrating the proposed modular panel green wall whereas the quantifiable long-term benefits are achievable in terms of savings from energy consumption and façade maintenance and numerous un-quantifiable benefits related to sustainability and health.

Keywords: *Green facades, Living walls, Building envelop, Double skin, Sustainable buildings*

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