Design and development of an innovative green vertical system

Summary

Urban centres are facing several challenges resulting from their quick expansion and from climate change. As a consequence, some areas have been experiencing flash floods, degradation of air quality, and an increase in temperatures. Buildings also represent a high burden in terms of greenhouse gas emission and energy consumption. In this context, the European Commission has encouraged countries and regions to adopt nature-based solutions, particularly green vertical systems (GVSs), that can improve daily living and environmental conditions. Green vertical systems are construction solutions that use vegetation to cover a building surface. The benefits that have been attributed to them include an improvement in buildings' thermal insulation, the mitigation of the urban heat island effect, better air quality, the restoration of urban biodiversity, and the support of rainwater management. However, several questions have also been raised concerning the sustainability of these solutions. The use of materials with high environmental burdens and the high irrigation and maintenance needs of such systems are being pointed out as key aspects.

Additionally, the design and implementation of GVSs can be much more complex than other green infrastructure since the plants and/or growing media must be fixed to a vertical surface. The main goal of this research work was to design and develop an innovative green vertical system, with improved environmental performance over its life-cycle. The expanded cork agglomerate was the main material. Thermal insulation and water retention are two of the characteristics recognized in this natural material that turned it into a suitable option. Tests were initially performed to quantify the water retention capacity and drainage capability of the insulation cork boards (ICB). The results showed that the material allows a suitable moistening and a good retention capacity, and at the same time it can quickly drain the excess water. A new ICB module was then designed, based on a set of environmental and functional aspects discussed beforehand. The ICB modules then underwent a series of mechanical tests to evaluate the behaviour of the proposed solution in wet conditions and after wetting-drying cycles. These experiments also intended to help to choose the most suitable material density to use in the new GVS. The results showed that the medium density ICB modules (140–160 kg/m^3) fully meet the environmental and functional requirements, and are therefore an appropriate choice. Afterwards, a real-scale prototype was built, consisting of four façades (facing north, south, east, and west) and two plant species (*Thymus pulegioides* and *Festuca glauca*) were selected for the system. The prototypes were monitored for one year to check the coverage area, carbon sequestration capacity, and thermal behaviour. The results showed that the system and the plant species performed well. The overall environmental profile of the system was evaluated through a life-cycle study and it was found that the new modular living wall can be an eco-friendly choice, contributing especially to mitigate global warming.

Keywords

Green vertical systems, expanded cork agglomerate, water retention, life cycle assessment, carbon sequestration, thermal performance.

Real-scale prototype of the innovative green vertical system.

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