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RESEARCH REVIEWS

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Plant-covered walls improve indoor and outdoor thermal conditions and are an asset to buildings in dry, alpine and continental Mediterranean climate zones during the cooling period.

Original Study Title: "The effect of the orientation and proportion of a plant-covered wall layer on the thermal performance of a building zone"

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Hypothesis: The appropriate use of vegetation in the built environment can adequately adjust the urban microclimate and improve the thermal behavior of individual building envelopes.

Objective: To analyze the influence of the orientation and proportionate plant cover of a vegetated wall on the thermal behavior of typical buildings in the Greek climate region, considering construction parameters such as insulation and masonry layers.

Method: A thermal network computer model is used to simulate the subject building. Its accuracy has been validated using actual conditions from earlier experimental and computer simulation studies. The model provides for data from the heat-flow paths of leaf area cover, heat transfer through the building envelope and natural ventilation. The data used is representative of a building located in the urban environment of Thessaloniki, with 10m X 3m high walls facing each compass direction (Fig. 2). The materials assumed are: multi-layers of brick, reinforced concrete, insulation and plaster coating on both interior and exterior surfaces to a constant thickness of 30 cm. The slabs of the building consist of a multi-layer structure of concrete, granite, insulation and tile and are 25 cm thick (Fig. 3). The plant coverage on each wall varies

from 0% to 100% using parthenocissus tricupidata (Boston ivy) of sufficient density to prevent direct solar radiation (25 cm.). The study does not distinguish between living walls or green façade systems and embraces both categories. The thermal analysis is for the summer period in the mild Mediterranean region based on actual climatic conditions of Thessaloniki.

Results obtained from this study:

1. The peak temperatures on the exterior and the interior surface of a bare wall (plant cover 0%) and a plant covered wall (cover 100%) are examined with respect to wall type, orientation and configuration.
2. The reduction of the developed daily peak temperatures (cooling effect) on the exterior and interior surface of the examined wall
3. The minimum and the maximum daily temperatures within the building zone, as a function of the leaf cover percentage, orientation and type of wall.
4. The daily energy requirements of an active building zone, (where A/C is run from 08:00 to 20:00) as a function of the leaf cover proportion (plant cover 0% and 100%), orientation and type of wall.

Conclusions:

1. Temperature differences between exterior and interior surfaces of plant-covered walls are essentially reduced when compared with bare walls. Consequently, the temperature variations within the building zone that include a plant-covered wall lead to superior thermal comfort conditions.
2. As the percentage of foliage cover increases, so the positive effect is also increased. The influence of a vegetated layer on the wall surface is more pronounced for East- or West- orientations.
3. The inclusion of insulation in a masonry layer leads to lower temperature variations. Nevertheless, the cooling effect of a foliage covered wall on interior and exterior surfaces is more profound.
4. The strategic use of vegetation on inadequately oriented or insulated walls can compensate for poor passive design or enhance the efficiency of air conditioning units at that location.
5. The adequate incorporation of a plant-covered wall on a building envelope is a positive step toward energy conservation, while it improves and regulates the micro-climate at the building surface by reducing solar heat gain.

Recommended Design Strategies:

1. Design adequate, strategically located soil beds (for green façade systems) or provide adequately reinforced, accessible and serviced structured areas (for living walls) on the building envelope.
2. For all green wall systems choose plants that perform well in the growth zone, micro-climate and orientation of the site, with the objective of maximizing the leaf area coverage in the cooling season.
3. Orientate the green wall system for the maximum solar exposure on the building (usually East and West) and if possible provide trellis support (for green façade systems) in proportion to the optimum growth pattern of the climbing plants selected.
4. Locate green wall systems on the exterior of walls that have inadequate integral insulation or are exposed to maximum solar heat gain in the cooling period.
5. Use green façade systems with deciduous climbing plants in relation to plaza / patio areas or fenestrated walls to create shade in the cooling season and allow sun to penetrate the trellis as the leaves fall.