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Green façade (Vertical Greening): Benefits and Threats

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Abstract. In the challenge of development in dense urban areas and environmental preservation, sustainability is a significant requirement where green facade (vertical greening) is one of those approaches that flourished during the last decade although it is not a new concept. Hanging or vertical garden, vertical vegetable farms, balcony garden, container or planter box greening, green or eco building, green roof or rooftop garden, wall planter, and green envelop are all different aspects of this idea that demonstrate how wide this landscape can be.

Greening the building envelope with vegetation can be used as a mean to restore the environmental conditions in dense urban areas. Designers can look for enhanced solutions where the façades are more than tinted glass barrier. Several researches have proven the environmental benefits of green facade on both new and existing buildings. They can be applied for mitigating the effect of urban heat island, increasing biodiversity and ecological value, insulating against environmental impact, outdoor and indoor comfort, social and psychological wellbeing and enhancement of air quality for city dwellers. This article discusses different systems of the green facade as a method of sustainable development.

Introduction

Vertical greening, which is also frequently mentioned as vertical garden, is the result of greening all forms of vertical surfaces by vegetation. It is an important solution for today's engineering practice to be incorporated with ecological principles. They are appropriate for urban environment where vertical space is abundant, but space on the ground is very limited and that is why this term referred to as urban gardening.

Vertical greening is a worthy instance of merging nature and structures (connecting diverse functionalities). A variety of plants as wonderful green envelops can be grown-up on a small quantity of growing medium in order to solve today's environmental and ecological issues in dense urban areas [1]. They can naturally convey life to an old ignored building in the centre of the downtown areas or be designed as new projects and they are becoming more and more popular because of their natural air purification properties, cooling effect and appealing beauty [2].

According to growing methods, green walls (vertical greening) can be categorized into green façades and living walls systems [3],[4]. This article will explain different types of green façade.

Green façade

Green façades are defined according to the application of climbers (deciduous or evergreen), as attaching themselves directly to the building elevation (in traditional architecture), or indirectly supported by steel cables, mesh or trellis. Fig. 1 illustrates different kinds of green facades. Climbers planted at the base of the buildings, in the ground, or in the intermediate planter boxes or even on the rooftops, provide a relatively inexpensive façade greening. The plants normally take 3-5 years before reaching full coverage. When planning a green façade with this method, it is important

to consider that the climbers can raise to a maximum of 25 meters height, but it may take a number of years [3].

Fig. 1 (left), (a) Direct system, (b) Indirect system, (c) Indirect system that is combined with planter boxes, [5]

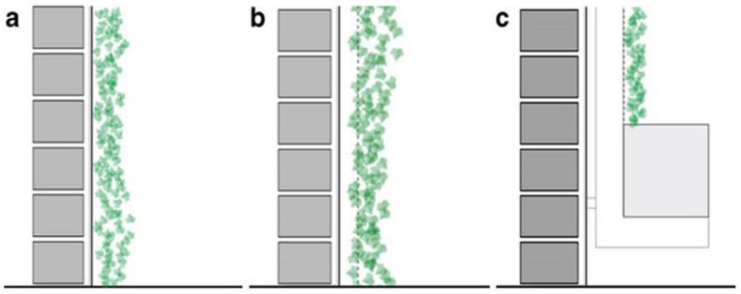

Fig. 2 (right), Modular trellis panel system, (Source: Green roofs organization 2008)

Direct system of green façade

In the first case, climbers planted in the ground at the base of the building as in traditional architecture, allow to obtain a cheap façade greening work. Self-clinging plants, which have been used frequently, have sucker root structure allowing them to attach directly to a wall and covers the entire elevation. But they cannot be applied for all building facades. These aggressive climbers can decay inappropriate walls and cause some problems for maintenance or when the time comes for plant removal [6].

Indirect system of green façade

In this case, vegetation is supported by cables or meshes while keeping them away from the walls and other surfaces of the building. Different materials such as aluminium, plastic, wood, steel (stainless steel, coated steel, galvanized steel) can be used as supporter for climbing plants. Each of the materials causes changes on the functional and aesthetical properties due to cost, profile thickness, different weight and durability [6].

The indirect greening system can be integrated with planter boxes at different levels of the façade. In this case, the system requires nutrients and a watering system if the rooting space is not adequate and can be defined as a kind of living wall system [3],[4] but two indirect green facade systems which are commonly applied are "modular trellis panel" and "cable and wire-rope net" systems which will be explained in the next section.

(i) Modular Trellis Panel System

This modular system consists of a three-dimensional, rigid, lightweight, panel and designed to hold a green facade off the building membrane because plant materials do not attach directly to the buildings' façade. Panels are normally made from a powder coated, galvanized and welded steel wire and prepare a captive rising environment for the climbing plants with numerous supports for the climbers. Panels are usually made from steel and rigid enough to both span between structures and be applied as freestanding green facades. They can be fixed and combined to cover large parts and designed to form different shapes (Fig. 2).

(ii) B: Cable or Wire-Rope Net System

Cable or Wire-Rope Net System applies high-tensile steel cables, anchors and also complementary equipment. Numerous pattern and sizes can be accommodated as flexible vertical and horizontal wire-ropes are joined through cross clamps. Wire-nets which are more flexible than cables and provide a greater degree of design utilization, are often used for slower growing plants, but for green facades that are designed to support the faster growing climber with denser foliage, cables are employed (Fig. 3).

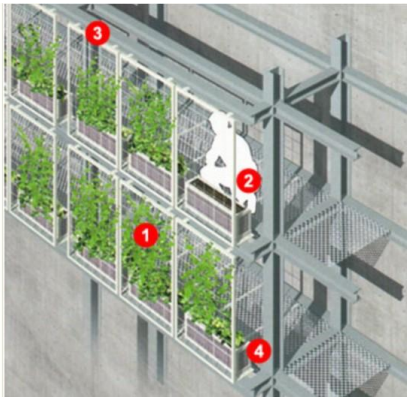

Fig. 3 (left), Cable and wire-rope net systems, (Source: Green roofs organization, 2008)
Fig. 4 (right), Indirect greening system combined with planter boxes, 1.Containers 2.Insulated container 3.Maintenance remote monitored irrigation / fertilization system 4.Wall mounting system (source: http:gsky.com)

Indirect greening system combined with planter boxes

If planter boxes at different heights are combined with indirect greening systems, greenery can cover a vaster area of façade. In this case, if the rooting space is not satisfactory, the system requires a watering and nutrients system therefore can be defined as a living wall system [7], (Fig. 4).

Benefits and threats

Aesthetic enhancement and sound reduction are the common benefits of green facades. They can also serve as an "extra insulation" of the building envelope [8]. In winter, evergreen vegetation layer decreases the wind flow around the building façade. In addition heat radiation of the external walls is insulated by the dense plant foliage and thus help prevent building to be cooled down [6]. Of all sun light that falls on the leaves, merely 5–30% of energy is passed through the leaf. The others may be reflected, transformed into heat, used for photosynthesis or evapotranspiration. This blocking of the direct sunlight disposal ensures a cooling effect in warmer climates and help the reduction of heat island effect especially in urban areas (fig.5), [5], [9]. Due to the evapotranspiration, green façades cool the heated air through evaporation of water [10]. A research in Australia quantified energy saving and indicated that the green façade can save 9.5-18% of the cooling energy consumption in commercial buildings [11], [12]. Relevantly improves the buildings' energy efficiency and produces ecological benefits for a more sustainable urban environment, [3], [13]. The green envelope also reduces the quantity of UV light and cause a positive effect on building durability [10].

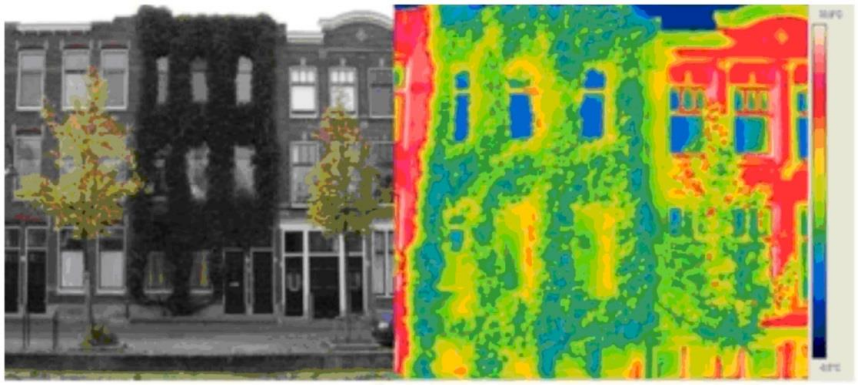

Fig. 5, Urban Heat Island Effect, [5]

On the other hand the installation costs of direct green façade as well for indirect greening are climbing plants, and a dig at the base of the façade and the supporting system and steel mesh cost should be added to indirect green façade. For the indirect green façades combined with planter boxes the costs are higher because besides these systems they require an irrigation system.

Maintenance cost depends on the type of the green façade. For the direct and indirect green façades, which is planted at the base of the façade, maintenance covers only pruning every year. These costs are different for the first four years and for the other remaining years of service life. For the indirect greening system combined with planter boxes, maintenance needs include also the plant species substitution and water pipes substitution [7].

Conclusion

Greening systems should be chosen wisely according to the climate, budget and design criteria's. Vegetation and plants should be selected carefully according to their natural supporting mechanism and their adaptability environment. For receiving full sunlight at the highest possible time, façades should be oriented accordingly. In addition, plants grow on the vertical plane constantly, so they need frequent maintenance: regular pruning, sufficient watering and so on. Regards to all these aspects vertical greening will be a significant component of sustainable architecture in future.

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