

Vegetation on tensioned cables and membrane structures

"The knowledge of climbing plants in landscape architecture is limited, but the potential is significant and partly unexplored." Martin Brattström

Introduction

In urban environments, trees and plants provide shade, lower temperatures, reduce heat gain, improve air quality, reduce noise and regulate wind. In densely populated areas (inner cities, commercial zones etc.), vegetation helps to reduce peak temperatures and noticeably improves the urban climate. As well as being beautiful, the benefits of greenery also translate into significant cost savings for

society. Urban environments need vegetation, but space to grow plants is at a premium.

Tensioned membranes and cable nets are stable structural systems. They also have good weather resistance. For these reasons, gardening and landscaping professionals use tensioned systems to support plants. Popular climbing plants such as clematis, wisteria and viburnum can be used to provide greenery in urban areas.



Valladolid Green Shades

Green Shades vegetative awnings are tensioned sails covered with plants, opening up new possibilities for urban landscaping. The sails, anchorages and supports are structurally analysed. The sails are covered with a special substrate and an irrigation and water collection system is integrated. The irrigation system starts on the highest side, from where the water falls by gravity, soaking the entire substrate. In

addition to water, fertiliser is added to keep the vegetation in perfect condition. Excess water is collected at the lowest point. Once the installation is complete, the seed mix is sprayed onto the fabric.

In cities where heat is a problem, Green Shades is the solution for commercial streets, terraces and squares. The lightness and ease of installation means that these shades can be placed where it is difficult to grow trees.

Arbory from Nola

The form of Arbory (design 2022) is inspired by the world of trees. The result is a structural system of horizontal rings suspended by wires from a central post. This provides support for climbing plants with all the conditions necessary to create the three-dimensionality required for a range of ecosystem services, including shade.

Arbory doesn't replace a tree, but it is a viable alternative in some situations. It becomes another option alongside trees, shrubs, green roofs, meadows and more, expanding the possibilities for creating greener cities. The height above ground is 455cm, while the total height is 505cm. The central pillar is a steel tube of Ø 121mm x 5008mm. The diameter of the large ring, made of a Ø 60mm steel tube, is 480cm. The weight of an unplanted Arbory is 240kg. Once the system is installed, it will require maintenance and care as well as supervision and attention.

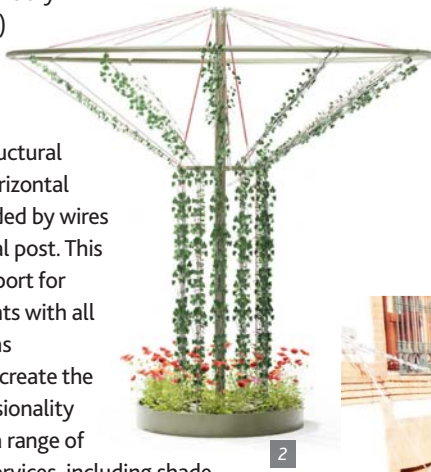


Figure 1. Arbory, with climbing plants © Martin Brattström
Figure 2. Arbory, design drawing © Martin Brattström



Figure 3. Valladolid Green Shades, top view, © SingularGreen
Figure 4. Valladolid Green Shades, front view, © SingularGreen



Innenhof Westpark Zürich

The garden in the Innenhof Westpark in Zürich (originally the Zürich-West project) was created in 2002.

A dense, narrow office courtyard was transformed into a three-dimensional garden that can be experienced on all office floors. A cable stretched diagonally across the upper floors is

braced like a harp with other cables on a concrete frame at the bottom of the courtyard. The plan and elevations are shown in Figure 5 and Figure 6. The main suspension cable is 50.5m long and 30.5mm in diameter. The vertical cables are 8mm in diameter, and each is fitted with a turnbuckle to adjust the tension (see Figure 7).

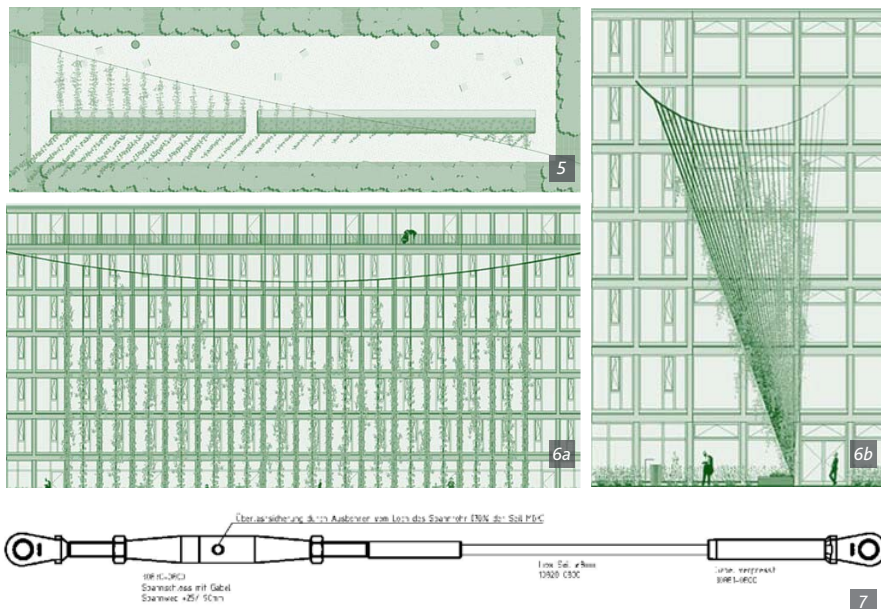


Figure 5. Plan view of the cable system, © raderschallpartner

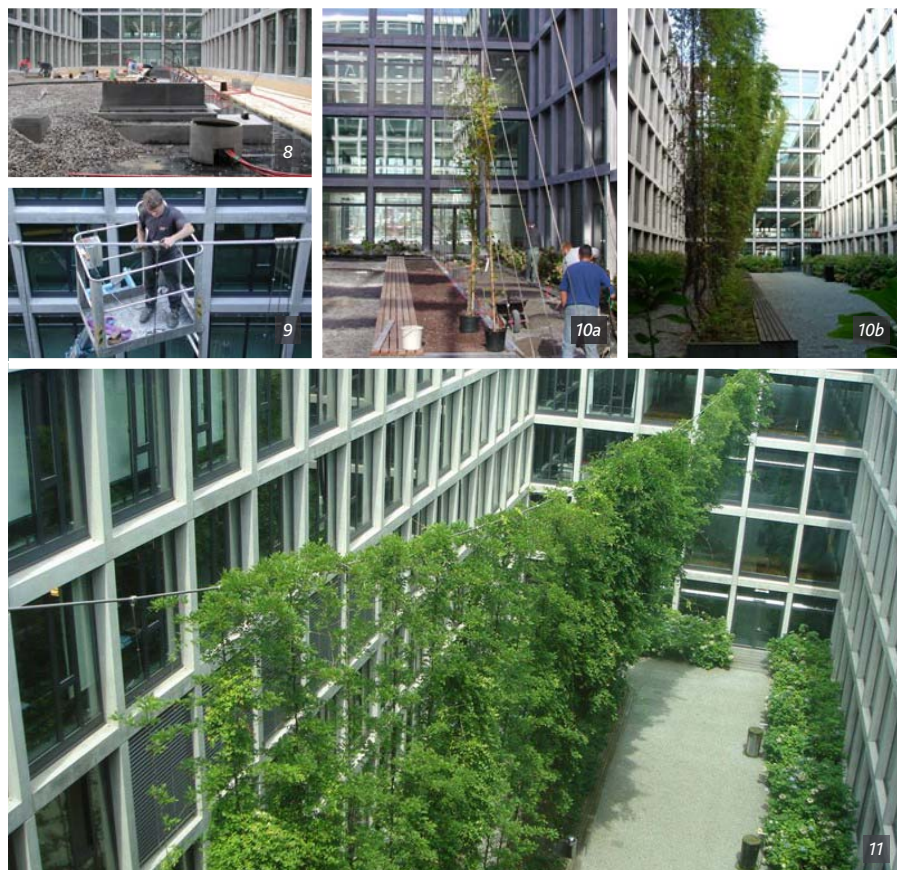
Figure 6a: longitudinal elevation, © raderschallpartner, b: transversal elevation, © raderschallpartner

Figure 7. Turnbuckle for the vertical cable, © Jakob Rope Systems

Figure 8. Layout of the foundation for the cable net, © Jakob Rope Systems
Figure 9. Attaching the vertical cables, © Jakob Rope Systems

Figure 10a: installation of the plants, © Jakob Rope Systems / b: grown up plants, © Jakob Rope Systems

Figure 11. Vegetation reaches the suspension cable, © Jakob Rope Systems



The concrete base and the installation of the cables are shown in Figure 8 and Figure 9. Once installed, fragrant and flowering climbing plants grow upwards on the frame. After a while the plants have reached the height of the suspension cable. During an inspection in 2016 the cable force was measured and was much higher than expected. This because the greening was growing well. Consequently, some of the plant had to be cut.

The aim of creating a three-dimensional design that embraces the artificial situation without resorting to a traditional garden image, was successfully achieved, filling the space with natural green and tranquillity. In addition, the structural system is very lightweight because it works in tension and uses the surrounding building for its anchorage.

Final remarks

The importance of incorporating greenery into the built environment is not new. It is said that the Hanging Gardens of Babylon were created by Nebuchadnezzar to cheer up his dejected new wife, Amytes.

It is a good approach to consider the integration of vegetation already at the architectural draft phase.

New systems are being proposed. Good estimates are important to ensure the structural safety of the design, as the Eurocodes do not specify the weight of (climbing) plants to be considered. For evergreens, the weight of water and snow should be considered. For vertically growing plants, the wind load should be checked. For membrane structures, ponding should be avoided.

Periodic inspection of the structures must be provided for, as plants will grow over time and affect the permanent load and eventually the wind load.

Even when plants grow on structural systems, gardens are born. And as Melissa Marshall says, "A garden is no more a collection of plants than a poem is a collection of words".

References

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