Researches Regarding the Landscaping of a Former Industrial Area, Using the Vertical Gardens' Technique

Silivășan M.¹; Berar C.¹; Bala Maria¹

Banat’s University of Agricultural Sciences and Veterinary Medicine Timişoara, Faculty of Horticulture and Forestry

*Corresponding author. Email: marius_silivasan@yahoo.com

Abstract The first part presents the origin and the types of vertical gardens that exists until now. Also will see, the materials forming part of the support.

In Part 2, are presented the results of the proposed development, and the costs necessary to achieve its. And at the end are presented the conclusions.

Key words roof gardens, vertical gardens

Research aims the possibility of introducing of vertical gardens in industrial areas of Timisoara, also setting up technology and its benefits.

Another point, it will be the decorative effect in landscape planning.

With the increasing concern about climate change, increased interest to use plant walls as a sustainable strategy for urban areas. Because it is a developing technology, the resources related to her are now limited.

The advantages of of vertical gardens, such as lowering indoor temperatures of buildings (in climates with higher temperatures) and increased indoor air quality, have been documented in several case studies, made by Patrick Blanc in France. With the increasing the knowledge base on the subject, designers have increasingly more evidence to convince them of increased value of the incorporation of this technique in future buildings.

Vertical gardens term is sometimes replaced by "green walls", "green facade", "bio wall" or "vertical vegetation". usually the term refers to vegetation that grows directly on the facade of a building or to the vegetation that is grown on an adjacent structure stand alone or attached to wall.

Key words

River banks, strongly weathered soils create a scar, almost vertically.

Cliffs, that represent another vertical surface covered with green.

Caves are environments with constant temperature and luminosity, or with fluctuations of these two low natural conditions. It resembles with the interior of buildings. Species that grow here are protected against bad weather, but most of the times also against the direct light of the Sun, so that they had to be chosen according to these conditions.

Types of vertical gardens

Vertical gardens can be inside or outside the building's cover, and they can be classified on three systems:

• Panel system, consisting in previously planted panels that are brought on site and connected to the building's structure and to a mechanised irrigation system.

• System on felt, in which plants are inserted in felt pockets attached to a waterproof panel which is also attached to the wall's structure. Felt is kept moist permanently with nutritive water.

• Containers and/or systems on trellis: in which plants grown on containers climb on trellis. Controlled irrigation shall be made with dropping belts placed in containers.

• Internal vertical gardens can be realised on every of the three systems mentioned above. Some of these walls are specially integrated into the mechanical systems of the building. Recycled and fresh air can be introduced inside the building through the green wall so that this is purified and humidified by plants and the growing vegetal environment.

Method

Origins of vertical gardens, Natural habitat

Waterfalls represent a specific microclimate favourable for the development of herbaceous plants, such as: Asplundia, Begonia, Besleria, Pilea and Pitcairnia in America; Begonia, Brillantaisia, Impatiens and Elatostema in Africa and Madagascar; Begonia, Curculigo, Colocasia, Cyrtandra and Impatiens in Asia; in temperate Eurasia a smaller number of species can be found, but some of them are remarkable like Acorus gramineus and Chrysosplenium.
Structure. Facilities. Maintenance

The main idea of these structures consists in the usage of some new materials for the realisation of the substratum (felt or in case of Blanc a synthetic substratum), instead of using some heavy supports, over-charged with soil (clay, peat, mineral cotton, coconut fibres).

The difference may seem indistinctive, but the weight of a vertical system is crucial considering the fact that a 3 mm moist felt layer weighs 3kg/sqm in regard to a 2 cm moist substratum that weighs 40 kg and a 10 cm layer that weighs 100 kg. Moreover, a thinner material, as the synthetic substratum shall not distort due to temperature modifications. Micro-perforations from the synthetic substratum’s fibres shall widen in case of frost without changing its structure because it is not a sewn material, therefore unstructured. The material shall not decompose because it is made of recycled acrylic textiles. Among all elements of a vertical garden, the synthetic layer is the only that affects the growth and development of the plant, the roots develop into the fibres of the synthetic layer, fact which determines longevity and absorption of water and nutrients. Any epiphyte species or that live on rocks planted in a vertical garden shall make roots exactly in the same manner as they would do in a mass of moss or on a rocky surface. For the easy plantation of plants, two synthetic layers are used, that shall be vertically stapled with stainless steel staples. Incisions of 5-10 cm shall be made into the surface layer, according to the plant’s size, and the freshly removed from the soil and cleaned roots of the plant are inserted in the created spot. Initially, these pockets into the synthetic layer are attached with staples, until the moment in which the plant's roots begin to grow and tail away among the substrata and allow the plant to develop within the vertical garden. Plants have the freedom to grow on all the surface of the synthetic substratum, being edged only by its surface and not by containers as in the case of containers and trellis.

Within a vertical garden, the foliage and the entire surface formed by the synthetic substrata include dust from the atmosphere. Once caught, dust is decomposed by water and micro-organisms into basic elements and plants absorb them easily.

Synthetic substrata can absorb waste water and action on them as a filtration mechanism comparable to filters which separate water from organic materials and unwanted suspensions. The difference consists in the fact that filters must be constantly clean while synthetic substrata helped by plants have the property to decompose and use the using substances, concrete examples are the vertical gardens in the Floral Park in Paris, that didn’t need cleaning from 12 years, and another right at Patrick’s home, which has not been cleaned from 25 years.

In this manner, synthetic substrates in which plants have roots become micro-organisms who, through biological processes, recycle either substances from inside (dead roots with new grown ones), either from outside (dust particles, rainwater, suspensions from water, pollutants and other polluting volatile organisms).

Substrats are irrigated through a simple plastic tube, most of the times made of low density polyurethane in order to allow any type of expansion caused by freezing water. Due to a sufficient pressure of water (3 bar) along the tube’s segments not longer than 10 meters, wetting shall be made 3 to 5 times a day, according to season and exposure (orientation) of the vertical garden. Each irrigation process lasts from one to three minutes (seldom 5 minutes) according to the height that needs to be wet. In order to maintain a mineral balance to the plants' roots, a very diluted nutritive solution (maximum concentration of 1%) shall be mechanically dispersed. According to sun, wind exposure, period of the year and type of water recycling, a vertical garden needs between 0.5 and 5 litres of water per square meter per day. In a temperate climate, during summer, outside, the vertical garden shall need about 3 litres per square meter, and inside one litre, due to the fact that the wall is protected against wind. These quantities are small in comparison to those used for the irrigation of urban gardens and parks.

After several attempts it reached to PVC foam, which was lighter, with a density of 0.7, which means that a 10 mm plate weighted only 7 kg per square meter. Also, besides other rigid plastics, this honeycombed material is resistant to the action of a stapler. With 10 mm long staples, the plate can resist to a mechanical force of almost 100 kg/sqm., fact which represents a much higher pressure than the one borne by bushes used for vertical gardens, even during a storm.

Panels in PVC foam can be assembled directly on the desired wall, but Blanc recommends the attachment of a frame in aluminium, galvanised steel or stainless steel in order to leave the wall breath.

The entire weight of a vertical garden remains low: 7 kg per square meter, structure in PVC foam with 10 mm thick panels, between 3 to 5 kg per square meter of synthetic substrata, according to the quantity of stored water and another between 1 to 5 kg per square meter for plants, according to the used species.

All these lead to an average of 15 kg per square meter.

Results
Horizontal landscaping

The total surface of the land is 56 348 sqm. From which the surface of the building is of 16 793 sqm and that of the green curtain near the railway 14 874 sqm. The surface of the land for which the project is realised and that is to be re-organised is of 24 682 sqm.
The aim is the realisation of a simple, modern organisation, formed of many straight lines which shall interknit very well with the buildings' forms.

The entrance into the park shall be made from Circumvalatiunii Way on three important alleys, but it can be also made by car in the parking arranged for this purpose.

An important area is the main entrance. It is a relaxation area that comprises water basins and benches made of thick wire cartons filled with rocks …

Passing through the building benches can be noticed for the visitors’ rest in any moment.

The main element of this re-organisation is wood. The surface presents three areas with this material, totalising 2586 sqm. These terraces are designed for outdoor art exhibitions.

**Vertical re-organisation**

The buildings from this surface are not in the best shape, but can be rehabilitated and used for other purposes than industry, offices or living. They can host different artistic exhibitions and various cultural events.

It is intended to cover them in plants, at the same time an aestheticization of building facades.

Facades that are considered for this type of re-organisation are situated right near the entrance to the complex of buildings.

The total surface of vertical gardens is of 2120 sqm. The buildings shall be covered in greenery in various ways, either by using the organic technique, as for the façade in the right part of the entrance, or by using the geometry as for the re-organisation of the building in the left.

The two types of re-organisation harmoniously interknit with the other parts of the re-organisation on ground, but also with the rest of vertical re-organisations.
A third vertical re-organisation shall be realised on a smaller wall, of 70 sqm. This is made of river stones caught in square metal net, alternating with square forms and moss.

The project of vertical gardens comprises also the re-organisation of an interior, but also of a partially uncovered hall.

**Style of re-organisation and used composing principles**

Re-organisation is performed by considering the regularity of the buildings’ forms; therefore the geometrical style is predominant, very few elements belonging to the landscaping style.

Free style is represented by the tree curtain protecting the area against the noise resulted from the railways.

The geometrical style is predominant, both by the ground landscaping and also by the vertical one.

From the point of view of the composition, a series of compositional principles are observed, such as functionality, unity, harmony, proportion.

Functionality is represented by the good usage of land for recreational, cultural and artistic purposes. It is an entire mosaic of ways to spend times within this area.

Means of access, alley, their functionality

The area where the space is situated is intensively circulated. It is a continuous flow of passers-by. From this reason there are three main entrances within the arranged area.

Alleys are made of paving, with a surface of 2400 sqm. and they are realised by using various widths according to their importance.

On an 800 sqm surface there shall be built grass-covered alleys, and the car parking lot shall be made of ecologic paving.

Utility and aesthetic endowments

Utility and aesthetic endowments are important elements within the re-organisation of a park or a garden. These represent lifeless elements of the green areas. Nevertheless, their choosing must be well-made.

For the re-organisation benches are realised from cubes in metallic net, within which river stones are inserted. On top a wooden plate is placed. L-benches placed on the three terraces are realised in the same way.

<table>
<thead>
<tr>
<th>Suprafata</th>
<th>sqm</th>
<th>%</th>
<th>Total</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>56348</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paved driveway</td>
<td>3800</td>
<td>6.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking</td>
<td>2000</td>
<td>3.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driveway slabs</td>
<td>2586</td>
<td>4.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructions</td>
<td>16792</td>
<td>29.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curtain plant</td>
<td>13874</td>
<td>24.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical gardens</td>
<td>2120</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planted with woods and grass</td>
<td>17296</td>
<td>30.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1**

**Summary of surface**

<table>
<thead>
<tr>
<th>Estimation for works</th>
<th>UM</th>
<th>Quantity</th>
<th>Price per unit</th>
<th>Total [RON]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil preparation by plowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Mechanized excavation by mechanical mulling</td>
<td>sqm</td>
<td>17296</td>
<td>0.07</td>
<td>1210.72</td>
</tr>
<tr>
<td>Land leveling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Mechanical leveling and finishing</td>
<td>sqm</td>
<td>17296</td>
<td>0.07</td>
<td>1210.72</td>
</tr>
<tr>
<td>Building pathways</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Paving sand</td>
<td>sqm</td>
<td>5800</td>
<td>0.5</td>
<td>2900</td>
</tr>
<tr>
<td>4 Paving slabs / pavement</td>
<td>sqm</td>
<td>5800</td>
<td>12.5</td>
<td>72500</td>
</tr>
<tr>
<td>Planting trees and shrubs in containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Manual digging the holes in the field</td>
<td>units</td>
<td>130</td>
<td>6.4</td>
<td>832</td>
</tr>
<tr>
<td>6 Planting trees</td>
<td>units</td>
<td>66</td>
<td>5.2</td>
<td>343.2</td>
</tr>
<tr>
<td>7 Planting shrubs</td>
<td>units</td>
<td>64</td>
<td>1.2</td>
<td>76.8</td>
</tr>
<tr>
<td>8 Watering</td>
<td>units</td>
<td>130</td>
<td>0.5</td>
<td>65</td>
</tr>
<tr>
<td>Vertical gardens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Installation of irrigation system</td>
<td>sqm</td>
<td>2120</td>
<td>220</td>
<td>466400</td>
</tr>
<tr>
<td>Lawn installation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Lawn installation</td>
<td>sqm</td>
<td>17296</td>
<td>2</td>
<td>34592</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>545538.44</td>
</tr>
</tbody>
</table>
Vertical gardens are the proof that concrete is not an obstacle to biodiversity, on the contrary is a very good support, allowing the growth and survival of many species of plants.

Such walls of cities, can become fragmented as true botanical gardens, each showing one aspect of the flora of the area.

Research shows that incorporating green walls, in the building project has several advantages:
- Reducing energy consumption and greenhouse gas emissions;
- Reducing the urban heat island effect;
- Increasing the thermal performance of buildings (reducing energy costs);
- Positive effect on hydrological system;
- Improve air quality;
- Noise reduction;
- Improving the health and welfare.

References
1. BĂLA Maria - Floricultură generală și specială, Editura de Vest, Timișoara 2007;
2. BERAR C. - ARCHICAD manual de utilizare, Editura Orizonturi Universitare, Timișoara;
4. DUNNET, N. - Planting Green Roofs and Living Walls. 2003