Architectural structures for the formation of vertical landscaping of buildings

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Abstract. "Green architecture" is becoming more widespread all over the world. This is largely due to the need to improve the environmental quality of urban development. Often for the purpose of greening resort to greening the building surfaces, including vertical or having a significant slope. This article is devoted to the study of issues of landscaping vertical surfaces of buildings. The research is aimed at identifying technical features of designing elements of vertical gardening. The subject of the study is architectural structures for the formation of landscaping. We study their potential in the formation of objects of "green architecture". The main method of research is to study the normative and scientific basis for designing vertical gardening. An analysis of existing experience in the design of fotofashion. Scientific novelty consists in systematization of applied design and engineering solutions. As a result of the research, 2 types of vertical gardening solutions were identified: green facades and green walls. Considered forming capabilities of the types of constructive solutions to fotofashion.

1. Introduction
Improving the quality of the urban environment is currently one of the priorities of both the city authorities and the professional community. In the context of this work, improving the quality of the urban environment is understood as improving both the visual and environmental components of building [1,2]. The role of gardening for the harmonization of space is great. This has been repeatedly noted in works [3,4] and many others. In the aspect of a significant reduction in the territorial resource and significant compaction of development against the background of a significant increase in the average number of floors, forms of non-traditional landscaping are of particular importance [5,6]. Vertical gardening is one of them.

Vertical gardening is the cultivation of various plants on the vertical surfaces of buildings and structures in order to improve the urban environment [7]. Elements of vertical gardening can also be implemented on slope structures of various sizes.

Usually, climbing and climbing plants are used to form vertical gardening. Climbing plants are attached to the structures of buildings and structures using suckers and adventitious roots. At the same time, climbing plants do not require the formation of supporting structures. Climbing plants, on the contrary, require the formation of a supporting frame.

The architecture of non-capital buildings can be subordinated to climbing plants. However, when designing capital structures, the formation of special architectural structures is required. The main tasks of structures are not only supporting, but also forming function.
2. Subject, tasks and method

The purpose of this work is to study the features of vertical gardening formation, including in the aspect of shaping modern architecture.

The subject of research is the technical means of forming vertical gardening-architectural structures.

The research objectives are to analyze the experience of forming structures for vertical gardening.

The main method of research is the analysis of existing experience in landscaping buildings and structures. Technical solutions for vertical gardening are also systematized.

3. Results and discussion

Depending on the care needs of the plants being planted, there are two types of gardening:

- intensive (involves the use of a wide range of plants that require the necessary growing conditions and care);
- extensive (provides for the use of a limited range of plants that are not required for growing conditions and care).

When forming an extensive type of vertical gardening, people's access to the ground floor is restricted. When forming a vertical gardening intensive type, access to the plant is required. We are talking not only about the availability of earthen clods, which can be achieved by appropriate placement of planting containers-flower beds, but also availability for pruning ground shoots.

Technically, the formation of landscaping entails the need for special technological layers (waterproofing, root protection), supporting structures or the development of attachment points, protective and life-supporting structures. However, the need for each solution is determined by a specific construction project [8]. At the same time, technical equipment has a decisive influence on the architectural concept.

The choice of technical solutions determines the concept of gardening, planting assortment of plants and their needs for environmental support. Depending on this, vertical gardening solutions are divided into the following types:

- green facades (figures 1-2);
- green wall (figures 3-4).

Green facades are called wall supporting structures with planted plants. Structures must be made of durable and fire-resistant materials. If wood is used in them, it must be pre-impregnated with flame retardants. In places where the structure is attached to the facade, the external fences of the greened object must be secured [9].

Figure 1. Fragment of a green facade with a cellular frame.

Figure 2. Fragment of a green facade with a rectangular mesh frame.
Depending on the forming elements, green facades are divided into the following types:

- single cable system;
- trellis type system;
- mesh type system.

The range of plants for green facades includes both self-supporting plants and climbing or climbing species.

Below is a comparative table 1 of design solutions for green facades.

Green walls are called greening structures that consist of planting containers with pre-planted plants in them. The shape and design of the landing tanks can be different. They must correspond to the concept of the planned construction object and the architect's idea. At the same time, the tanks are subject to requirements to ensure operational safety. The selected material must be resistant to negative impacts from landscaping, as well as fire resistance [10].

Placement of landing tanks on the facade of buildings can be different: directly on the facade, on the protruding elements of the facade (balconies, loggias, terraces), on special structures attached to the facade. In this case, the orientation of the landing tanks may be different.

The range of plants used for green walls is quite wide. This solution is suitable not only for climbing and climbing plants, but also for ground cover species. Often, ornamental and deciduous crops are selected for planting. Planting flowering plants can also be implemented, but requires additional care for pruning inflorescences. The variety of plants allows you to form expressive not only in form, but also in coloristic solution and structure of the composition (table 2).

![Figure 3. A fragment of a modular green wall.](image1)

![Figure 4. A fragment of a container-type green wall.](image2)

However, the variety of the assortment entails the need to organize the care of plants. Thus, it becomes a task to provide both unhindered access to planting material and automation of engineering systems. The most important is the system of irrigation and irrigation, but also we are talking about systems of sun protection, wind protection, lighting and radiation, and others.

In modern construction, green walls are not widespread enough. Most often, this solution is unique. This is primarily due to the complexity of implementing and operating a "green" solution, as well as the material costs at these stages.

However, there are a number of technical solutions that are used to create green walls in construction practice. Let's look at the main ones:

- Container system
  It differs by placing containers (mobile or stationary) on the facade plane. Installation of containers can be provided directly on the building structures of the building, or on specially created structures. Less often, hanging baskets or planters can be used.
### Table 1. Design solutions for green facades.

| Type of frame | Form         | Material                          | Appearance |
|---------------|--------------|-----------------------------------|------------|
| Single cable  | Horizontally stretched | Synthetic rope, ropes       | ![Synthetic rope](image) |
|               | Vertically stretched |                                | ![Vertically stretched](image) |
| Trellis       | Rectangular  | Galvanized steel wire, wooden rail with protective coating | ![Rectangular Trellis](image) |
|               | Diagonal     |                                   | ![Diagonal](image) |
|               | «Ladder»     | Galvanized steel wire            | ![«Ladder»](image) |
|               | Bellows      |                                  | ![Bellows](image) |
|               | Semicircular | Galvanized steel wire            | ![Semicircular](image) |
| Wire mesh cage | Rectangular  | Galvanized steel wire, synthetic rope | ![Rectangular Wire mesh cage](image) |
|               | Cellular     | Galvanized steel wire            | ![Cellular](image) |
Table 2. Design systems for the creation of green walls.

| Type of frame  | Underlying cause | Appearance               | Recommended range of plants                      |
|---------------|------------------|--------------------------|--------------------------------------------------|
| Container system | yes              |                          | Basket or climbing plants                         |
| Pocket system  | no                |                          | Basket, herbaceous plants                         |
| Modular system | yes              |                          | Herbaceous, groundcover plants                    |

- **Pocket system**
  Implies the use of a fabric cloth with pockets for planting plants. Most often, felt is used for this purpose. As a rule, to simplify the care of plants, a stationary system of automatic watering and irrigation is provided. While the use of felt contributes to the long-term moistening of the soil substrate.
Fixing the web is provided more often on building structures. Less often, a special construction system can be used. In addition, it becomes necessary to create a separation protective layer-vertical waterproofing. This contributes to the safety of the building structure.

- **Modular system**

  Involves the use of bicomodules. Photomodule represent individual items (pots or cassette), which are fastened after landing. They can be placed either on a special sub-base, or directly on the structure of the load-bearing wall. As a rule, this solution provides for an integrated irrigation system [11,12].

**4. Conclusions**

The external vertical surface of buildings has a huge potential in terms of forming a biopositive urban environment and its greening. The formation of vertical gardening elements is becoming popular in modern construction. Architectural solutions with the use of landscaping is very diverse.

The article presents an analysis of structures for the formation of vertical gardening. These structures allow you to form vertical landscaping in the form of green facades and green walls. The formation of green facades is the easiest solution. However, its use is allowed for limited heights. The formation of green walls, on the contrary, is more technologically advanced. This allows you to create extensive types of landscaping elements.

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