The Planting of Greenery for Retaining Walls as a Direction in the Design of Vladivostok

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Abstract. The article the problem of landscaping (greening) retaining walls in Vladivostok is considered. The Vladivostok city is in a territory with a monsoon climate has a difficult relief. Therefore, the city has many high vertical retaining walls that support the formation of terraces and horizontal surfaces. The vertical retaining walls areas in the city are comparable to the area of facades of buildings. These walls are currently mostly not landscaped (greened). Natural colors and texture these walls are not expressive and don't contribute to the formation of an integral visual environment of the city. It was found that; problem can be solved as a result of an integrated approach with the help of full or partial greening of retaining walls. Here the types and examples of stationary and mobile greening of the Vladivostok city retaining walls are presented. A number of plants that can be used for landscaping urban retaining walls have been identified. The proposed concept contributes to solving local problems of landscaping (greening) individual urban objects. It's also expands the possibilities of forming for a holistic concept of greening in the Vladivostok.

1. Introduction

The Vladivostok city is a young city that combines European and Eastern styles. It has a unique appearance and topography and is often compared with San Francisco and Istanbul [1]. The specificity of the city is in the difficult relief and monsoon climate. The long duration of the warm season in the year is combined with severe winters and strong winds. The development of the urban environment in the Vladivostok has not been widely discussed for a long time. Currently, the status of an outpost of Russia and the capital of the Far Eastern region obliges the development of the urban environment as friendly to humans, and the shapes of European style in a port city [1; 2]. Therefore, it's relevant to study the possibilities for landscaping (greening, gardening) the Vladivostok retaining walls that make up the majority of the city's engineering structures. It is very important to give them an aesthetic appearance, to enhance their decorative function through the decoration with living flora and other natural and environmentally friendly materials. This is an urgent problem for urban landscaped [3-5].

Currently, in the Vladivostok, about a thousand objects have been identified that belong to retaining walls. In 2015 there are it was 967, it 60,902 linear meters [6]. According to media reports, there are about 1,500 of them [7]. Retaining walls in the Vladivostok are often involved in the formation of the visual environment of the city in a negative context. They have expressionless colors (from dark gray to light gray), often they have brown streaks from rusting reinforcement. There are a
few exceptions. For example, let's point to the walls on the guest route of Zarya and Magnitogorskaya streets that are decorated with paving stones with concrete inserts.

Local artists, due to their abilities and artistic tastes, are trying to fight the unattractive appearance of retaining walls, they paint graffiti on them. This approach seems to be quite controversial, since the bright colors of the using materials have conflict with the surrounding color. The same problem is with the content and style of these paintings. Not all of them have aesthetic appeal.

There is a concept for decorating the retaining walls of Vladivostok, that tested by students of the Department of Design and Arts of the Vladivostok State University of Economics and Service on the campus of the university. They offered monumental decoration with broken tiles, glass, metal and asbestos pipes [6]. Such decoration can partly solve the problem of a more aesthetic appearance of retaining walls. However, the possibilities of living plant material, which change color and decorative qualities depending on the seasons, are more diverse and aesthetically pleasing.

This article discusses the possibilities of landscaping (greening) retaining walls in the Vladivostok.

2. Discussion and results
The study of the possibilities of landscaping (greening) retaining walls in the Vladivostok can be solved by an integrated approach. It's solves a number of problems in different directions:
- ecological - the formation of green spaces in conditions of spatially limited and dense urban development;
- decorative - giving an aesthetic appearance to vertical walls that built of rough and colorless materials (mostly from reinforced concrete structures);
- design - the creating of links between the architectural and landscape areas in the city and participating in the creation of the color of urban environment. The living material that using in the landscaping of retaining walls makes it possible to visually connect densely built-up areas and industrial, infrastructural objects with the surrounding hills and sea surface, and smooth out the achromatic appearance of the city [4; 8].

Thus, the problem has interdisciplinarity of the and the multiplicity of its solutions. Therefore, it's necessary to consider a number of issues:
1. Location of the walls, their technical condition, the need and possibility of landscaping (greening);
2. Seasonal or permanent landscaping (greening);
3. Total or partial decoration of retaining walls by plants;
4. Biological species of Primorsky Krai, that suitable for planting retaining walls.

2.1. Location of the walls, their technical condition, the need and possibility of landscaping (greening)
First, a retaining wall is a building structure, an artificial structure that keeps the mass of soil from collapsing. They near houses, other buildings and roads are installed, where have a sharp difference in height [9]. The predominant material for retaining walls in the Vladivostok is iron-reinforced concrete. The periods of retaining walls building are coincide with the periods of intensive development of districts of the city. In the Vladivostok it's happened more than half a century ago. Therefore, there is a serious problem. At present, the old retaining walls of the Vladivostok are in an extremely unsatisfactory condition under the influence of downpours, floods, soil sedimentation, rusting of reinforcement and destruction of the face elements of the wall and require reconstruction [10].

Let's pay attention to the fact that the greening of retaining walls can be performed only if the object is examined for its safety and functionality. This is because retaining walls can unexpectedly collapse along with greening and auxiliary structures, that poses a danger to city residents. In any case, in order to determine the possibilities of landscaping, a preliminary examination of the object and the conditions of its location and surroundings is necessary.

In this case, there is a possibility of optimal choice of the type of landscaping (greening) and the possibility of installing auxiliary structures (their weight, configuration, material of execution). For example, if the retaining wall is surrounded by solid hard artificial turf and there is no possibility of
planting plants, then hanging containers or hydroponic systems should be used. Also, if the vertical loads on the wall for objective reasons are close to the limit, then additional structures that increase the vertical load should be excluded. In this case, the own weight of the wall, loads from the weigh on it and the pressure of the backfill soil on the wall and its foundation, etc. are considered.

At the same time, the reconstruction of the retaining wall can be carried out with the replacement of its constituent elements with more durable and modern ones; it is also possible to transform it into a system of modules. This will provide an opportunity for the use of nutritious fill soil and plant placement. If we turn to the experience of foreign countries, then, in particular, in the USA there is a system of container-type concrete modules of different sizes for the formation of retaining walls.

For example, the successful application of such modules that form a retaining wall is the greening retaining walls complex in St. Louis. Here, the artificial structure, which is overgrown with native flora, it's creates the illusion of a naturally formed slope (Figures 1-2). Similar constructions are offered by Verdant Technologies. Largest cast concrete module weighs 340 lbs. and has 4 square meters. Verdant Technologies claims that the constructions of the modules can be any height.

![Figure 1. Scheme of the formation of a retaining wall based on concrete modules. Available from: https://verdtech.com/structural-wall/ [Accessed 6th august 2020]](image1)

![Figure 2. Retaining wall based on concrete modules in St. Louis, USA. Available from: https://verdtech.com/structural-wall/ [Accessed 6th august 2020]](image2)

2.2. Nature of greening (seasonal or permanent)
The choice of gardening method is based on a number of conditions and can be transformed. Natural and man-made conditions can lead to a limited use of species diversity and life cycles of flora. In this case, to make optimal use of seasonal greening it is recommended. Annual plants with fast vegetation and abundant flowering as material are selected. Planting in containers of rare irrigation (they retain moisture as much as possible) or hydroponic structures (here instead of soil, other nutrient media are used), it can provide them with great vitality. Also, in the case of mechanical or atmospheric causes of damage or death of plants, they can be painlessly replaced during the season.

Seasonal landscaping (greening) of retaining walls can be achieved with mobile systems. These are easily assembled systems that are mobile and portable. They allow the city's environment to change regularly. They create a diverse, heterogeneous and interesting environment for city residents. "Mobile greening systems are one of the ways to introduce green elements so necessary for a person into the structure of the city" [11]. Mobile systems can be easily and quickly erected, moved and dismantled. They can be used already with placed and even formed plants. If there is sufficient space next to the retaining wall, they are the optimal form for decorating an object without direct impact on it (Figure 3).
Permanent landscaping by planting woody vines or perennial ivy, their support is carried out using trellises or supports can be achieved [12-13] (Figure 4).

Full landscaping (greening) of the retaining wall can be performed based on vertical landscaping technologies. This is where the plant containers are attached to a vertical surface. An example of this greening is the total decoration of a retaining wall by plants in San Francisco, USA (Figure 7).

This vertical wall is opposite the residential building. Its area is 330 square feet - that's about 30 square meters. 50 plant species are used here. They were selected to form a coherent composition and compensate for the small size of the plot in front of the house. Plants was selected for their decorative properties and foliage texture. After planting in the modules, their inclination was mechanically changed for a month in order to teach the plants to stay on a vertical wall.

Now, we will voice a number of proposals on the possibilities and types of vertical gardening in the Vladivostok, that by the authors earlier were mentioned [15]. So, let's see to the types of partial landscaping (greening). For example, Eco-graffiti. Eco-graffiti (or green graffiti) using a special emulsion that contains moss spores is performed. The composition of the emulsion is very simple. It consists of moss, water, hydrogel are added, in different versions sugar and kefirin are using. The composition is applied by brush or spray and can be refilled. The emulsion is sprayed onto the surface.
of the façade or retaining wall, predominantly damp and shaded. As a result, the moss germinates and lives during the season.

Figure 8. An example of total greening of a retaining wall. Available from: https://gardenmagic.by/item/testimonial-11 [Accessed 6th august 2020]

Figure 9. Example of partial greening of a retaining wall. Available from: https://gardenmagic.by/item/testimonial-11 [Accessed 6th august 2020]

Eco-graffiti appeared in Europe in the 1970s. The British Anna Garforth is considered. Currently, this technique is used in different countries, including Russia. For the Vladivostok, this technique is relevant. We believe that an organic emulsion can replace poisonous paint in graffiti sprays, as well as an opportunity for citizens to realize themselves in street art or provide up-to-date infographics.

Figure 10. An example of total greening of a retaining wall. San Francisco, USA Available from: https://www.designboom.com/art/moss-graffiti-grows-on-walls-by-anna-garforth-09-30-2013/?fbclid=IwAR2qax9AgSjWSSa6Kx7Kywe8t xQKaKjU-2jXNA_zPSSq0QHQxBy2eouDhnQ [Accessed 6th august 2020]

Figure 11. An example of total greening of a retaining wall. San Francisco, USA Available from: https://www.designboom.com/art/moss-graffiti-grows-on-walls-by-anna-garforth-09-30-2013/?fbclid=IwAR2qax9AgSjWSSa6Kx7Kywe8t xQKaKjU-2jXNA_zPSSq0QHQxBy2eouDhnQ [Accessed 6th august 2020]

2.4. Biological species of Primorsky Krai, suitable for planting retaining walls

Plants, that suitable for greening retaining walls in Primorsky Krai, are diverse in morphology and physiology. Some of them were originally intended for life in difficult natural conditions (high humidity or low insolation). Other plants can be acclimated and prepared for horizontal conditions.
Scientists of Primorye studying the species diversity of woody and herbaceous lianas (E V Golovan, N I Denisov). They note that, vines are suitable for greening, including within the city. For vertical gardening, climbing and climbing plants are recommended, such as Parthenocissus tricuspidata, Parthenocissus guinquefolla, Vitis amurensis, lianas of the genera Clematis and Actinidia [16;17].

M N Koldaeva studied the rocky vegetation in the Botanical Garden of Vladivostok (in city drawings). She's notes that there is a significant variety of rocky ferns, 9 species of ferns have been identified [18]. We believe that the use of rock ferns could solve the problem of landscaping (greening) the retaining walls of the Vladivostok. Especially for those retaining walls that are limited by the conditions of the adjacent territory and experience extreme soil loads. On such retaining walls, the use of additional structures on them is impossible. It is also possible to use different types of moss.

For seasonal and modular gardening (greening), the entire range of annual crops, which are well known and used in Vladivostok greening, can be used. For example, Petunia. Let's pay attention to the fact that their ampelous species have special opportunities for greening retaining walls. Begonias and viola also tolerate vertical transition well. You can use Calibrachoa, Coleus, Salvia, Sedum, Syngonium, Cineraria, Festuca, etc. The use of annual plants opens up wide opportunities for the formation of color-textured compositions that are in harmony with areas of the urban environment.

3. Conclusion
To study the possibilities of retaining walls, it seems necessary to use the resource potential of the botanical garden and arborets. There is a need to continue the search for plants for retaining walls in terms of their bio and decorative properties.

Thus, the landscaping (greening) of the retaining walls of the Vladivostok is based on the forms and principles that are characteristic of vertical gardening (greening). Depending on the location of the landscaped object, the characteristics of its aeration, insolation, environment (proximity to the ground or hard artificial turf), and an individual landscaping tactic is developed. Here, the using plant material is one of the main concept for creating a friendly surrounding urban. The main criteria are the achievement of the environmental, aesthetic and decorative goals. The proposed approach makes it possible to solve the problem of combining retaining walls, as industrial objects, with artistically rich facades of buildings of various architectural styles.

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