Preservation of the natural landscape during construction

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Abstract. The issues of preservation of existing green spaces and other elements of the natural landscape during new construction are considered. The methods of preserving perennial plantations throughout the entire progress of construction are proposed. If it is impossible to save the tree on the construction site, a method of transplanting it to another place is proposed. A tree transplant scheme and a method for calculating its weight for the selection of equipment for digging and transportation have been developed. The methods of solving the problems of preserving the landscape needed by a person, maintaining the stability of the created infrastructure, a comfortable urban environment, as well as studying, analysing and predicting human actions on the natural landscape are proposed. The balance of the city's territories has been developed, which provides a comfortable ratio of different zones of urban development for a person. When building in cramped conditions, it is proposed to lay out gardens on the roofs of houses, apply vertical greening of facades, and use the "garden city" construction method for large areas of development. The possibility of installing playgrounds and sports grounds in an already existing landscape without completely cutting down trees is described. The positive experience of updating the DSTU Student Park is given. The negative experience of the city of Rostov-on-Don is also given: the breakdown of a new park near the stadium built on the left bank of the Don.

1 Introduction

Currently, preservation of the natural landscape during the construction and development of new territories should be a priority goal of the construction industry. We will consider the natural landscape as significant natural spaces that have preserved their natural character, opposed to buildings, engineering and technical structures. The natural landscape can include forests, rivers, ravines, hills. It is difficult to imagine the complete preservation of the natural landscape during the urbanisation of territories, so we should talk about finding harmony between the development of the urban environment and the preservation of nature.

A few works are devoted to the study of the topic of preserving the natural landscape during the construction of buildings in an urban environment. The largest number of works on the topic belongs to Chinese authors; there are also works from the USA, Iran, Turkey,

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Poland, Vietnam, Germany, Sweden, and Canada. All authors agree on the unambiguous beneficial effect of urban greening on the physical and mental health of a person [1-5, 8, 9]. Thus, studies by Australian and Chinese scientists agree on the need for greening the walls and roofs of houses in densely populated cities with a shortage of planting area to increase the accessibility and attractiveness of urban green spaces [6, 7, 8].

2 Main Part

The works of a group of scientists from Spain and Australia tell about the cooling effect and the weakening of heat waves during the greening of cities [2, 3]. For greening in order to reduce the thermal effect in conditions when tall trees cannot always be planted, it is necessary to know that grasses and shrubs are also necessary to solve this problem [10], and watering plants enhances the effect. Thus, an article by Spanish scientists talks about the connection of greening roofs and territories of educational institutions with the optimisation of sustainability and ergonomics of the environment [4].

The studied spatial-temporal dynamics of the relationship between urban sprawl and landscape changes [11, 12, 13] suggests that the topic under study remains and will remain relevant for a long time. As far as authors know, the topic of preserving the existing greening of the territory during new construction at the construction site has not been studied.

Therefore, first of all, we will consider the problem of preserving green spaces during construction work.

Currently, when planning a construction site, the method of total clearing of the entire territory allocated for construction is used. Firstly, it is easier to carry out construction and installation work in this way, due to the fact that trees standing on the land will not interfere with the work. Secondly, a substantial amount of money can be invested in the project for the subsequent greening of the territory of the constructed object. So, at first, money is mastered by uprooting perennial plantings, even if they do not grow in the place of the excavation to be excavated, namely in those places that will then have to be planted at the stage of landscaping. And then the money is mastered actually at the stage of landscaping before commissioning of the facility through the purchase of seedlings and planting new trees. At the same time, the environmental factor is completely ignored, which leads to a deterioration in the quality of the air that people breathe who have settled in the commissioned new building or come to work in it in the first years of the operation of this facility.

To eradicate such a vicious practice, it is necessary, first of all, to introduce into technical regulations and other normative acts a norm that, while maintaining existing perennial plantings during construction, instead of planting new ones after completion of construction, the construction budget does not decrease, but on the contrary, increases by the coefficient of work production in conditions constrained by existing perennial plantings.

In addition, we propose at the stage of design and survey work identifying healthy trees that do not grow on the site allocated for the building (structure) under construction. Then the problem of the location of the object on the ground should be solved to preserve healthy perennial trees as much as possible. To do this, it is necessary to carry out the removal of the object to the terrain, as far as possible from healthy trees. The distance required to protect the tree from external influences during the work is equal to the projection of the crown on the ground surface plus 1.5 m. At this distance, it is recommended to make stationary fences for each tree. Fences should be made stationary, without the possibility of their movement by builders, with a height of at least 1.5 m. Fences, first of all, protect the tree trunk from external damage, as well as the soil from being flooded with waste during

the production of various building mixes, which, when dried, form a dense crust on the soil cover, preventing moisture from penetrating into the soil.

However, it is often impossible to preserve the trees existing on the land plot intended for construction, since they will greatly interfere with the progress of work or they generally fall into the pit area. However, the need to remove a tree from a construction site should not necessarily mean its destruction.

The next way to preserve trees is to transplant them from the construction zone to other places. However, there is a peculiarity here: the age of the tree should not exceed 15 years. With the help of a truck crane and dump trucks, it is necessary to dig out and transfer the tree to a prepared hole in a new place.

To achieve this goal, the main task should be solved: a reasonable activity to transform the landscape to ensure maximum functionality and comfort of a person in it.

There is a special technique for transplanting trees, usually expensive. Based on the calculation of a more cost-effective option, we offer tree transplanting using a crane.

With the help of an truck crane and a dump truck, it is possible to dig out and transfer the tree to a prepared hole in a new place.

Transplanting trees in the Rostov region of Russia should be carried out in the autumn-winter period, in more northern regions of Russia, transplanting is also possible in early spring. However, the rooting of the tree will be better in the autumn-winter period before the onset of hot summer. An excavator carries out the excavation of the tree by pruning the soil layer along the perimeter at a distance of at least the projection of the crown of the tree on the ground. Then the tree is laid on its side, wrapped with geotextile, two slinging cables are threaded: one around the rhizome of the tree, the second around the trunk, having previously wrapped the trunk with geotextile to prevent its damage (Fig.1). Also at this stage, ropes on geotextile should be fixed to the trunk of the tree to centre the tree after planting.

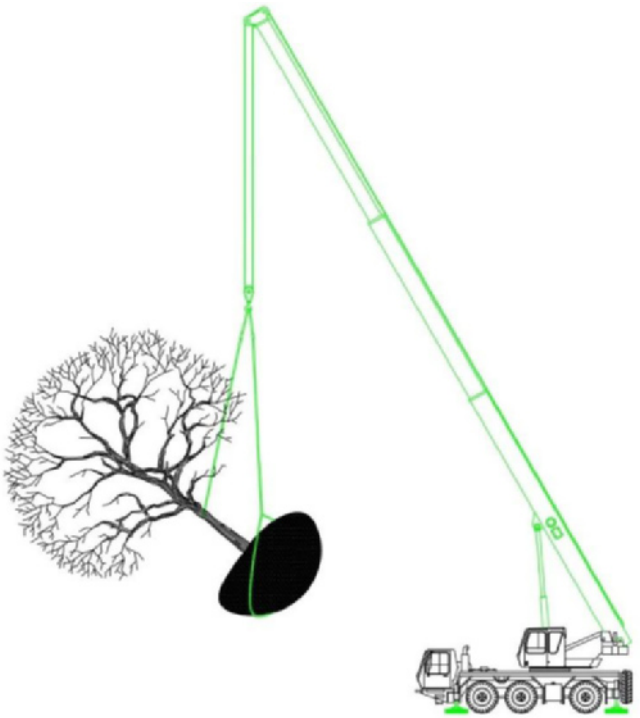

Fig.1. Transplanting trees with a truck crane.

To select a crane by load capacity, it is necessary to calculate:

1. The weight of the trunk with branches.
2. The weight of a lump of earth with roots.

When determining the weight of the trunk, it is necessary to know the type of tree. According to the density of wood at a humidity of 12%, all breeds are divided into three groups:

1. With low density – 540 kg/m^3; spruce, pine, fir, juniper, cedar, alder, aspen, chestnut, linden, willow.
2. With an average density of 540-740 kg/m^3; larch, beech, oak, walnut, rowan, fruit trees.
3. With high density – more than 740 kg/m^3; acacia, iron birch, hornbeam, boxwood, pistachio, ash.

To determine the volume of the trunk V_1, you need to measure the radius of the trunk at a height of 1 m r_1 and, if possible, at a height of 6 m, the radius r_2. The volume of the trunk will be equal to:

$$V_1 = \frac{\pi \times r_1^2 + \pi \times r_2^2}{2} \quad (1)$$

The volume of branches V_2 according to the methodology we use in LLC "Master" is taken as a share of the trunk volume. For coniferous trees – 8%, for deciduous ones– 11%.

Therefore, the weight of the trunk with branches is calculated by the formula:

$$P = (V_1 + V_2) \times \rho \quad (2)$$

where ρ is the density of wood depending on the type of wood.

The weight of the lump of earth is defined as the product of the projection area of the crown on the ground, the depth of the roots and the density of the soil. Because the specific gravity of the roots is lower than the specific gravity of the soil, we do not take it into account.

The sum of the weights of a tree trunk with branches and a lump of earth with roots will give an understanding of the crane's load capacity.

After loading the tree onto a dump truck, it should be transported to a prepared place for a new planting. Under the prepared place, a hole is meant wider than a lump of earth with roots at 1 m, at a depth of 0.5 m. At positive temperatures, water is poured into the hole to moisten the soil in the volume of half of the excavation and time is given for water absorption. Stakes are being prepared to secure the newly planted tree and center it.

Next, it is necessary to conduct the same procedures in reverse order: the tree is unloaded by a truck crane, installed in a hole, ropes are fixed on prepared stakes for centering the tree and fixing it in a vertical position. After that, according to our suggestions, it is allowed to backfill the soil into the hole with layer-by-layer ramming.

Excavated trees, as a rule, should be transported to the places of the completed construction of new facilities for planting there as part of landscaping works as an integral part of the landscaping of the territory of the facility being commissioned.

However, not all problems of preserving the natural landscape can be solved by preserving or transferring existing green spaces.

It should be noted that when people influence the landscape, they are an external factor that applies new elements into the existing ecosystem. These elements are alien to this system, unable to exist without constant human support. If people do not support the

created objects, they fall into decay: buildings are destroyed without repair, trees dry up without watering, canals are silted up, cultivated plants are displaced by wild ones peculiar to this natural landscape. The second task to achieve this goal will be to maintain the stability of the created infrastructure and, in general, a comfortable urban environment.

Of course, the third task is the study, analysis and prediction of human actions on the natural landscape.

The planning, development and improvement of urban and rural settlements in the Russian Federation are regulated by the codes of rules on urban building, planning, improvement and development of urban and rural settlements.

Guided by these norms, as well as by the research conducted by us within the framework of the scientific work of the "Organisation of Construction" department of the Don State Technical University in the field of urban improvement, we offer the most comfortable ratio of various zones of urban development for a person. The proposal is presented in the form of a balance of territories shown in Figure 2.

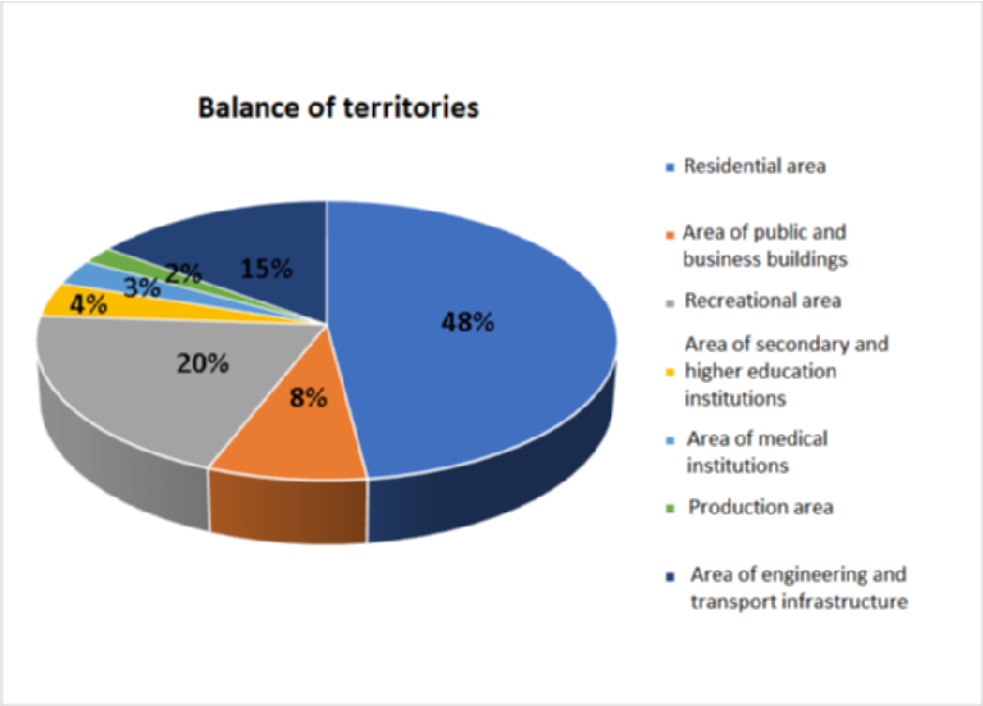

Fig. 2. Recommended balance of territories.

Figure 3 shows the existing balance of the territories of the city of Rostov-on-Don, the data for which are taken from the decision on the approval of the General Plan of the city for 2007-2025.

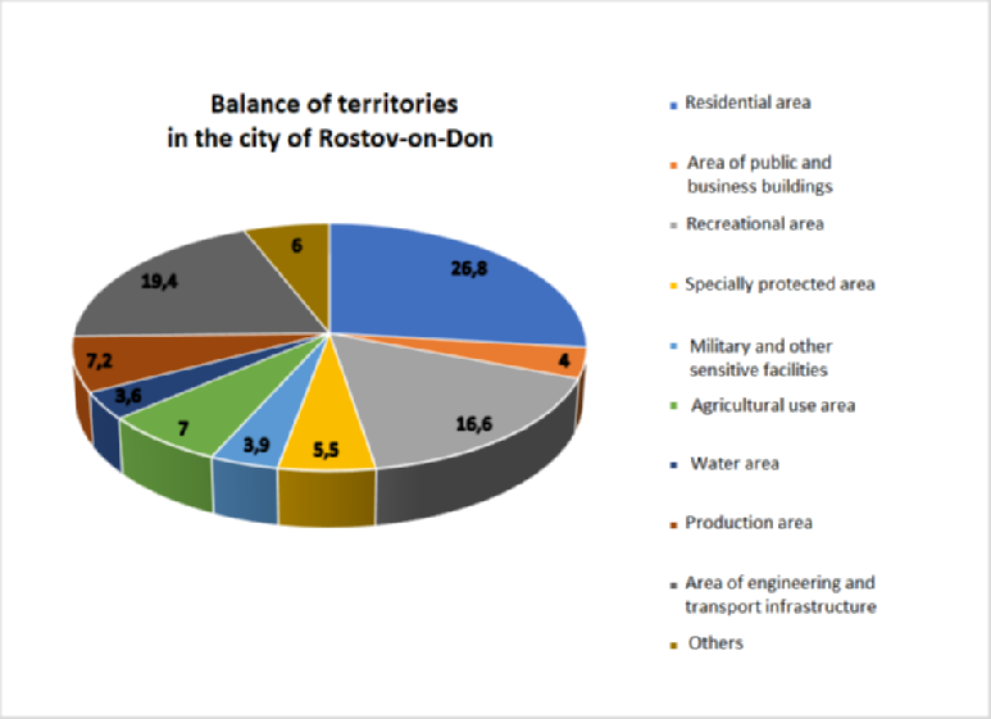

Fig. 3. Balance of territories in the city of Rostov-on-Don.

The zone of transport infrastructure, which is a source of dust, noise, pollution, makes up a fifth of the entire territory of the city, and the production zone, although it has been moved to the outskirts of the city in recent years, still occupies 7% of the city's territory. The transport system, being an important component of the infrastructure of a modern city, is also its main source of pollution. Another area of pollution of the city is industrial facilities that negatively affect the environment, violate urban planning proportions, generating an increase in traffic flows. To reduce the impact of pollution on humans and the environment, it is necessary to arrange green corridors between large highways and residential areas, between industrial areas and citywide. When choosing plants for greening the city, it is necessary to be guided primarily by the natural and climatic factors of the region. Use plants that are characteristic of the area. Rostov region is a zone of forest–steppe with a temperate continental climate, with hot dry summers and little snow in winter with an easterly wind. Therefore, the plants must be resistant to drought. In addition, plants must be resistant to vehicle emissions, reduce noise levels, maintain photosynthetic activity and bactericidal properties. Plants can perform two main functions: protective and decorative. Protective gardening includes: snow-proof, noise-gas-dust-proof, sand-proof, anti-erosion. Decorative greening performs an architectural and artistic function.

Taking into account the climatic features of Rostov-on-Don, in order to maintain and preserve the landscaping created by man, it is necessary to arrange in advance a system of watering and caring for young trees and shrubs. Irrigation of urban areas can be carried out both with the help of vehicles and a pre-organised water supply system of the territory. As practice shows, the second method is more effective. Plant care includes a set of measures for pruning plants, mulching the soil, installing fences for young trees, and fertilising [14].

More than a quarter of the city's territory is occupied by a residential development zone, which continues its active growth. At the moment, the territory of the city of Rostov-on-Don is being actively built up both by detached apartment buildings and entire residential

blocks with new infrastructure (schools, kindergartens, recreation areas). Residential buildings are being built both on the site of demolished houses, former industrial facilities, and on the territory of groves and forest parks. If the use of the territories of former factories or dilapidated housing for new construction is a common and useful practice for the appearance of the city, provided that the number of floors inherent in a particular area of the city is observed, then the construction of residential complexes on the territory of groves and forest parks with the cutting of perennial trees is categorically unacceptable, since this worsens the already difficult ecological situation of the city. It should be noted that the construction in the historical center with two- and three-storey multi-storey buildings spoils the appearance of the city. Experience of the city of St. Petersburg may be an example, where the number of cultural heritage sites is one of the largest in Russia. Thanks to the residents, in the historical center of St. Petersburg, the public and business complex “Lakhta-Centre" was not built, which is the tallest building in Russia and the fifteenth in the world.

Although the zone of social and business significance occupies a small percentage of the city’s territory, but the duration of a person's stay there during the day is quite long. Therefore, greening of this territory also needs to be paid attention. The experience of other countries shows that it is possible to find a place for planting plants in densely populated business centres. Vertical landscaping projects have already been implemented in Italy, Singapore, Spain, and China. The construction of such business and community centers in Singapore stands out in particular. This is both the WOHA Art School and the “Vertical Forest” complex. In general, Singapore is developing the concept of a “garden city”. In the south of China, in the Liuzhou area, for example, a whole “forest city” is being built, during the construction of which the features of the landscape and the local ecosystem were taken into account. Therefore, residential buildings covered with trees, office centers, state institutions, hospitals, schools, and cultural and entertainment centers harmoniously integrate into the environment without disturbing the existing natural balance.

Using the experience of individual projects already implemented in the world, when building in cramped conditions, gardens should be laid out on the roofs of houses, vertical landscaping of facades should be applied, and for large areas of development, the “garden city” construction method should be used. The same can be said about the construction of small architectural forms and the breakdown of parks in new territories. Fitting playgrounds and sports grounds into an existing landscape without completely cutting down trees will reduce both economic and labor costs, and ensure a comfortable stay for a person. The breakdown of parks and gardens, as a rule, is carried out by bringing the territory to a flat area, freed from all vegetation and further planting of young trees and the construction of sidewalks and paths. This practice does not give the proper effect: in summer it has been hot in such parks for many years, in spring and autumn the territory is blown by winds, the fertile layer is disturbed or in some cases disappears completely. Another thing is the use of the natural landscape for the breakdown of the park: adult healthy trees give protection to young immature trees from the wind in the cold, from the scorching sun in the summer; undisturbed fertile layer gives nutrients to young trees; well-organised care for young trees for several years gives rapid growth of trees with minimal losses. There is a world experience of laying paths and sidewalks in an already broken park, when people are given the opportunity to walk in the park before laying sidewalks, thus determining the main directions of the human flow. After that, a system of sidewalks and paths is organised. Moreover, natural materials in the form of wooden decking are used for modern arrangement of paths. So, in the Kronstadt Park on the shore of the Gulf of Finland, builders and architects made a whole system of wooden bridges instead of concrete sidewalks, thus solving the problem of not using the park for its intended purpose in case of flooding of the territory. For the city of Rostov-on-Don, it is possible to cite a positive

experience of the breakdown of the park: the Student Park of DSTU. When updating the park, it was decided to preserve healthy trees and plant young trees of noble breeds. The planting of trees was carried out with the help of manual labour, i.e. the fertile soil layer was not disturbed. After planting, care for trees is competently organised by fencing them, mulching the soil, as well as careful watering. All this gave a good result: almost one hundred percent survival of trees led to greening of the territory in a short time.

Another experience of Rostov-on-Don is negative: it is the breakdown of the park near the new stadium on the left bank of the Don. The stadium was built for the FIFA World Cup. Here you can observe how the violation of the initially fertile soil, disorganised watering and tree care lead to the death of more than half of the planted trees, and planting new trees does not change the situation. The ill-conceived radical change of the natural landscape in the area of the construction of the new stadium, the total felling of poplars and other unpretentious trees that have been growing there for decades have led to disastrous consequences that have been felt for the second decade.

When creating modern residential areas, priority is also given to sunlight. For example, light-saturated building projects are proposed, in which a large number of glass and mirror surfaces are used.

The Ministry of Construction, together with the Ministry of Emergency Situations of the Russian Federation, has approved an action plan for the development of wooden housing construction. After all, wood is a natural, cheap material, and with proper processing it is also durable, almost not inferior in its characteristics to concrete. In Rostov-on-Don, the unique design of the H2O water park, built on Mikhail Nagibin Avenue, serves as an example of construction from wooden structures and successful operation.

The main task of landscape design should be the maximum preservation of sites with a natural environment, a combination of modern architectural forms with a system of green spaces.

Creating a comfortable environment for a person in a modern city is possible with the use of eco-friendly materials in construction, the use of secondary raw materials. The problem of accumulation and recycling of waste plays a big role. Developments are underway in the use of secondary raw materials. In the construction industry, this area is also developing and sometimes completely innovative developments are offered. Therefore, it is proposed to use eggshells, which are formed after the consumption of eggs, in the production of concrete. With the optimal dosage of eggshells in concrete, the operational characteristics of the latter are improved due to rational waste disposal. Research continues in the field of the use of secondary raw materials in the production of building materials, which would improve the properties of these materials and at the same time make it possible to reduce waste from human activities [15-17].

3 Conclusion

Making a conclusion about all of the above, it should be noted the great positive impact of the natural environment on a person's stay in the city. Observing the balance between urban development and natural landscapes during new construction or reconstruction of old facilities, a person first of all makes his living environment comfortable for life. Plants have a great positive effect and perform such important functions as snow protection, noise-gas-dust protection, sand protection, anti-erosion, decorative. For greening the urban environment, it is possible to use "vertical gardening", the breakdown of gardens on the roofs of houses, the construction of a "city in the garden". A comfortable stay of a person is the use of eco–friendly materials and recycled raw materials during construction. Landscape design should be a priority area in the planning of the territory and urban planning. And the positive experience of domestic and foreign architects and builders in

landscaping territories makes it possible to carry out a comfortable stay of a modern person in an urban environment with the least labor and economic costs.

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