

PROCEEDINGS ARTICLE

New Approaches and Methods of Engineering Improvement as a Tool for the Regeneration of the Historical Urban Environment

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ABSTRACT

Actual problems of complex development of historical cities, which nowadays should take into account the requirements of preservation and protection of architectural monuments, valuable urban environment, and in some cases use potential of recreation of landscapes of historical zones, are considered. The methods for improving the functional and spatial organization of the development in the improvement of historic districts of different morphotypes, the reserves of effective use of the territory, the possibility of reducing the proportion of paved surfaces and landscaping improvement, and other results of the improvement are shown. It is proven that among the problems which should be solved in the projects for the improvement of historic areas of cities along with the replacement or repair of pavement, reconstruction of lighting systems, landscaping, the full reconstruction and relaying of engineering networks, as well as measures to improve the geo-ecological conditions of the territory, protection of architectural monuments from waterlogging and other unfavorable geological processes should be designed. The need for new approaches and methods in the improvement of historic areas, which in the future should form the core of a specialized design methodology that uses interdisciplinary scientific and design research and justification, was substantiated. The research was carried out in 2014–2021 at OOO "IGBI" and in 2019–2020 at the TsNIIP Ministry of Russia under the plan of basic research of the RAACS and based on the analysis of the authors' experience at scientific survey and design of beautification in the historic areas of Moscow in 2014–2021 in numerous projects carried out by OOO "Alfamik", OOO "PB CRIS", OOO "Piramida", most of which are implemented.

ARTICLE DATA

Article History

Received 31 January 2022

Revised 1 February 2022

Accepted 7 December 2022

Keywords

Historic cities (city zones)
Integrated landscaping and
gardening
Cultural heritage preservation
Methods of engineering
landscaping
Improvement of functional and
spatial organization
Reducing the proportion of
paved surfaces
Recreation of relief geoplastics
Engineering protection and
waterlogging control
Reconstruction of engineering
networks
Specialized design methodology

1. INTRODUCTION

The urgency of the problem of complex landscaping and gardening of cities is confirmed by its inclusion in some of the most important strategic national projects and programs. However, contemporary scientific methodology and design procedures have not been developed yet. Considering the domestic and foreign experience of research, design and results of improvement, it can be argued that the obvious trends of globalization which do not take into account the natural, climatic, urban, historical, cultural, landscape

and stylistic features of cities do not always benefit comfort, ecology and socio-cultural needs of the population and aesthetic qualities of the environment. In some cases, they literally destroy it, changing the appearance and features that have historically made the city recognizable, different from other cities in our country and the world [1].

Russia at all stages of development of urban planning, landscaping and greening of cities, historically used foreign experience, but used it creatively, considering our conditions. Almost always in research, design and practical activities it was preceded by in-depth

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scientific analysis of climatic, functional, spatial, planning, environmental and architectural features of cities and there was always an assessment of practical applicability of specific approaches, methods, technologies of landscaping and greening [2,3]. Unfortunately, the traditions of interdisciplinary scientific substantiation of projects have recently been lost and the narrowness of approaches to landscaping is gradually becoming unprecedented. This is especially evident in results of the landscaping of historic cities, which increasingly resemble experiments from the field of landscape design.

2. CONSIDERING THE REQUIREMENTS OF CULTURAL HERITAGE PRESERVATION IN THE IMPROVEMENT OF HISTORIC CITIES

It is known that during the Soviet historical period, the theory and practice of landscaping and urban development for a long time, despite the well-known shortcomings had a social, environmental, and systematic nature. Moscow, as we know, has long been a leader among the greenest capitals of the world and is an example for others, including Paris and Budapest [1,4,5]. An integrated approach to the organization of natural and landscaped areas was distinguished by the first general plan of Moscow of the Soviet period, approved in 1935 (by Semenov and Chernyshev), and subsequent general plans. According to statistics, in 1961, there were about 5m² of green spaces per capita in Moscow, while in Paris at that time there were only 0.5m² [5].

Indicators of the standard provision of greenery in the capital maintained for the last two decades (Moscow urban building standards MGSN 1.01.99, including the updated version of 2020 [6]). It should be noted that at present this normative document defines the most important planning preconditions for the design of improvement and landscaping of historic areas, and today we can evaluate the important role of urban planning regulation in the area in question.

Unfortunately, during the last decade, the practice of improvement of historic areas of cities is mainly used to focus on "foreign experience", and sometimes without the necessary analysis of its applicability in specific urban conditions. As a result, the new development of the "globalization" era sometimes too "aggressively" invades the historic environment, and this applies not only to significant public spaces, but also to ordinary objects that form the "fabric" of the city. It not only unifies the appearance of historic cities, but also loses landscape identity, stylistic features, and insufficient consideration of natural,

engineering, geological, hydrogeological features of territories, adversely affects the longevity of the improvement and the preservation of the historic and urban environment.

Foreign experience should be critically appraised and used with a scientific basis for its use in specific urban conditions. Similarly, domestic experience of previous years should be considered and contains examples of quality solutions to the improvement of historic areas, which ensured longevity of operation [1,4,5]. Studies at the turn of the 20th–21st century proved the importance of urban factors, including the effectiveness of engineering methods of protection of areas from hazardous and adverse engineering-geological processes, including those associated with waterlogging of urban areas [7,8]. They suggest that many geo-ecological problems of the state of territories of historic cities can be solved by engineering methods in the improvement of historic areas, which allows solving problems of preservation and conservation of historical and cultural heritage.

Many years of experience in the design, examination, and analysis of the implemented projects show that in the actual conditions in the improvement projects the requirements of the status and modes of protection zones should be met, special scientific engineering measures which exclude physical, vibrational, and other effects on the architectural monuments and valuable historical buildings within the boundaries of works and in the adjacent areas should be developed.

However, the improvement of historic areas must not only meet the requirements of the legislation, ensuring the preservation of architectural ensembles, monuments, historical landscaping and minimizing the impact of the works, but it is also important to solve more general, already quite tangible tasks of engineering and environmental rehabilitation of the historic environment, including zonal ones.

This is facilitated by the dramatically increased territorial coverage of works related to the phased reconstruction of landscaping and greening of the central historical part of Moscow and intracity natural-historical areas that bear the main recreational loads of the multimillion city.

It is obvious that only engineering landscaping in isolation from its other types, such as landscape composition and architectural and artistic design, cannot fully solve the problems of regeneration and reconstruction of historic areas, but can create real geo-ecological and engineering prerequisites for conservation and preservation of cultural heritage, valuable urban planning, and natural environment.

Summary of the data on the objects of improvement in the historical part of Moscow is carried out in Table 1.

Objects of Improvement	Purpose and Functions of Landscaping Objects	Work Area	Pavement Materials	Main Types of Work
City roads, streets and squares. Protected area status may be possible (cultural heritage object ¹).	External traffic flows set up, pedestrian ways to maintenance facilities and public transport stops	up to 100 ha	Asphalt, asphalt concrete, artificial and natural tiles, paving stone	Changes in longitudinal and transverse profiles. Replacement, reconstruction, construction of road pavement, relining and replacement of drainage networks. Lighting reconstruction, greening, traffic management and CCTV installation. Equipment for people with limited mobility.
Public spaces, pedestrian streets and squares in the city center, including operated roofs, protected area status may be possible (cultural heritage object).	Organization of pedestrian traffic in multifunctional public and tourist zones	2 to 25 ha	Asphalt, artificial and natural tiles, paving stone	Changes in longitudinal and transverse profiles. Replacement, reconstruction of road pavement, drainage networks, lighting, landscaping, traffic management and CCTV installation, flower arrangement, equipment for people with limited mobility, small architectural forms.
Public gardens, including those with cultural heritage object status and nature complex status ²	Environmental function, nature complexes territory, short-term rest, through pedestrian traffic, tourism	0.15 to 2.0 ha	Tiles, paving stone, composition, granite carving	Reconstruction, regeneration of greening, lighting, road pavement, replacement of soil-vegetative layer, flower arrangement. Installation of small architectural forms and equipment for people with limited mobility. Reconstruction or renovation of lawns, fountains, drains, fencing.
Gardens, including those with cultural heritage and nature complex status	Multifunctional (specialized) recreational greened territory for periodic rest	2.0 to 5.0 ha	Tiles, paving stone, compositions, granite carving, sandwich system ground	Reconstruction, regeneration of greening, lighting, road pavement. Selectively: replacement of soil-vegetative layer, installation of small architectural forms, installation of equipment for people with limited mobility. Flower arrangement, renovation of lawns, playground and recreation areas equipment. Replacement and renovation of fencing, drainage and gutter.
Avenues and greened embankments, including those with cultural heritage status and nature complex status	Transit pedestrian traffic, walking, periodic short-term rest, tourism	0.15 to 50 ha	Tiles, paving stone, compositions, granite carving, sandwich system ground	Reconstruction, regeneration of greening, lighting, road pavement. Selectively: replacement of soil-vegetative layer, renovation of lawns. Flower arrangement with small architectural forms, installation of equipment for people with limited mobility. Playground and recreation areas equipment. Replacement and renovation of fountains, drainage, fencing.

¹ Cultural heritage objects – territories, which are works of landscape and garden art, holding a status of cultural heritage objects of federal or regional importance, and have an established regime, regulated by specific GOST (Russian National Standard) for design and pre-development studies during restoration and landscaping.

² Nature complex status – greened territories, which hold an established regime for urban planning, regulated by legislation of the city of Moscow, and specific requirements for landscaping design.

Objects of Improvement	Purpose and Functions of Landscaping Objects	Work Area	Pavement Materials	Main Types of Work
Parks: specialized and multifunctional, including those with cultural heritage status and nature complex status	Greened recreational territories for periodic rest with customer service systems and developed landscaping, designed for mass recreation and tourism	no less than 5.0 ha	Tiles, paving stone, compositions, granite craving, sandwich system ground, wooden walkways and embankments on 'screw piles'	Reconstruction, regeneration, renovation of greening, networks of paths, alleys, fountains, park sculptures, water features, hydraulic structures and bridges, flower arrangement, and installation of small architectural forms and equipment for people with limited mobility. Playground and recreation areas equipment. Reconstruction, renovation and installation of stairs, bridges, pavilions, embankments, bank protection.
Natural and historic parks, including those with nature and greened territories status ³ , cultural heritage, and valuable nature complexes status ⁴	Large natural and greened territories of periodic rest with recreational load and landscaping, regulated and zoned depending on status and regime	no less than 100 ha	Tiles, paving stone, compositions, granite craving, sandwich system ground, wooden paths, embankments on 'screw piles'	Reconstruction, regeneration, renovation of networks of paths, green plantings, flower arrangement, design and installation of small architectural forms and equipment for people with limited mobility, equipment of nature trails, construction of pedestrian embankments, playgrounds and recreation areas, reconstruction and construction of stairs, bridges, beaches.
Intradistrict territories of historical core situated in the area of mixed residential development, residential block		0.05-1.0 ha	Asphalt, sandwich system ground, tiles, compositions	Reconstruction, renovation, replacement of coating, construction of passages and platforms, construction of drainage with exit to intradistrict passages, drainage, reconstruction of plantings, flower arrangement, installation of small architectural forms and equipment for people with limited ability. Construction of playgrounds and recreation areas.

Table 1. Common types of landscaping objects in historical zones of cities, their possible functions, status, landscaping area and types of work.

³ Natural and greened territories, which have an established regime of urban planning, regulated by the legislation of the Russian Federation and the city of Moscow, including landscaping with regard to fulfilling specific laws and requirements in terms of obligatory studies and justifications.

⁴ Valuable nature complexes (landscape, biological, hydrological, hydrogeological etc.), that require specific studies and research.

3. THE ROLE OF LANDSCAPING IN THE TRANSFORMATION OF FUNCTIONAL AND SPATIAL ORGANIZATION OF HISTORIC DISTRICTS: REGULATORY REQUIREMENTS AND URBAN PLANNING "BLUNDERS"

Analysis of contemporary practices of reconstruction of historic cities shows that the spatial organization of the central core includes a set of sections of different building morphotypes. In Moscow, the building morphotypes are associated with the following historical periods: Old Moscow "low-rise sparse", which combines the building of the first half of the 19th century, the traditional "various-story" of the 19th and beginning of the 20th century, the "perimeter compact" of the turn of the 19th–20th century, as well as "constructivism" of the twenties and thirties, "neoclassicism" of the forties and fifties, "contrasting story" morphotype, which includes buildings at the turn of the 19th–20th century and the late 20th century. Classification of historic morphotypes of buildings is presented in MGSN 1.01.99, including the updated version.

Over the past decade, there has been an ongoing debate about the "normative" classification. Many believed that by now the historic quarters with the buildings described in accordance with the listed morphotypes have not survived, especially within the Garden Ring. Even if this is true and the morphotypes in the historic areas are lost, the scientific value of this classification is undeniable, and it can be creatively used in the design as a tool to shape the spatial organization not only in the regeneration of buildings but also the improvement of historic areas. For the design of improvement in the historic areas of the cities, it is extremely important to observe such spatial characteristics as the ratio of open and built-up spaces (land-use ratio), the observance of the line of development of the quarter, and the character of the architectural design of intervals along the line of development, stable form of the yard and stable size of the side of the yard.

Striving to comply with the parameters of morphotype characteristics in the improvement of areas is quite justified because with the exception of "perimeter compact" morphotype, in which the proportion of buildings may vary from 50% to 75%, in other morphotypes of blocks it is significantly less – up to 50%, and in the areas of old Moscow "low-rise sparse" – not more than 30%, "constructivism" – 30%, "neoclassicism" – 25%. The proportion of development in the quarters of the "contrasting story"

morphotype is not less than 30%. Thus, there is a real possibility of forming the spatial organization of the historic quarters, increasing the share of undeveloped space, greening, and shaping normative areas of residential and public buildings in accordance with the requirements of MGSN 1.01.99. In order to substantiate proposals to improve the functional and spatial organization within the framework of the development of improvement projects, it is necessary to carry out "urban planning calculations", which in practice is never done. It is considered sufficient to refer to the "opinion of the inhabitants", but in fact, we get "town-planning miscalculations" and insufficient efficiency of the design.

With appropriate justification, it is possible to optimize the ratio of paved and landscaped surfaces of blocks based on the features of the historical morphotypes using authentic and historically justified coatings. Prospects for the use of hard clay locks, slopes with rolled lawns, and filter pavements can be considered. Today, the range of pavement types that can be applied within historic districts has expanded substantially to accommodate the new capabilities of fire equipment that does not require hard pavements.

In historic districts, there are usually many one-story capital and non-capital structures of economic, technical, and "obscure" purposes on the building line between the side facades and in the intra-block areas. Such structures worsen the "permeability" of the territory, hinder pedestrian connections, close interesting views and sometimes even street panoramas; their appearance is usually disharmonious in relation to adjacent architectural monuments and the valuable urban environment.

In the development of historic cities, it is advisable to include in the programs of works reasonable demolition of buildings and structures that do not represent historical value, reconstruction and decoration of historically valuable buildings and structures. Such approaches create additional territorial reserves for the transformation of the functional and spatial organization of the historic quarters and meet the regulatory requirements. The results of the scientifically grounded development can be the improvement of the inner space planning, a significant increase of the efficiency of the use, the increase of the comfort, and improvement of the ecological condition of the territories.

Reducing the built-up area of historic quarters can solve the problems of recreating landscapes and the formation of an authentic historical environment, which is especially important in surroundings of valuable architectural ensembles, protected areas,

and quarters with preserved morphotypes of historic buildings. Contemporary methods and technologies of engineering improvement make it possible to recreate the historical geoplasic relief, marks, and lost microforms, apply authentic or historically justified elements of improvement without damaging the surrounding buildings and plantations. However, such decisions and works should be carried out only on the basis of archival data, special research and with the appropriate historical, cultural, landscape, and urban planning substantiation.

In carrying out landscaping in historic areas of cities, it is also often justified to recreate the microforms of relief, marks of the day surface, marks of historic buildings and structures, reconstruction of ponds and hydraulic structures, slopes, retaining walls, the recreation of traditional shore protection, stairs, and viewpoints in an authentic version.

Experience in dendrological research at the Moscow improvement sites has shown that the age of green spaces on the intra-block territories is mostly 50–60 years. Examples of valuable trees aged 100 years or more are extremely rare, and as a rule, occur in intra-block squares. When improving the historical quarters, the regeneration and reconstruction of the intra-block landscaping should take into account the peculiarities of the historical building morphotype (MGSN 1.01.99).

In the site development of the Old Moscow “low-rise sparse” morphotype, courts of honor, green spaces, fences shall be applied. In the site development of the traditional “various-story” morphotype should be used lawns, fences. In the “perimeter compact” morphotype, where landscaping was lacking inside the courtyard spaces, vertical and container planting could be used, in the “constructivism” morphotype should be provided lawns, in the “neoclassicism” – courts of honor and park greenery, in the “contrasting story” – lawns, green spaces, small shapes.

In greening of intra-quarter areas, it is advisable to use plantings of local species (lime, rowan, maple, birch, rose hips, lilacs) adapted to grow in urban conditions at the age of at least 10 years with observance of the allowable distance to buildings and utility networks. In landscaping replanting of plants under the age of 20 years is considered acceptable, it is possible to use container planting. The arrangement of lawns may be carried out without dismantling the existing hard pavement with the use of structures, methods, and technologies similar to the greening of operable roofs and with the use of lawn grids.

4. COMPREHENSIVE RECONSTRUCTION OF INTRA-BLOCK UTILITY NETWORKS IN THE IMPROVEMENT IS A PREREQUISITE FOR THE PRESERVATION OF CULTURAL HERITAGE AND ACTUAL USE

Currently, in Moscow and other historic cities, comprehensive landscaping is carried out without a comprehensive upgrade and re-laying of engineering networks. At best, local upgrades are made to lighting, drains and drainage. The unsatisfactory condition of engineering networks is an almost ubiquitous problem in the territory of historical zones of cities. Water supply, sewerage, drainage networks, heat supply, and the leakage of water-bearing communications is about 10% of the volume.

In many historic cities, including Moscow, significant waterlogging is formed, which negatively affects the state of the territories, architectural monuments, historical buildings. A significant part of the historic areas in the districts of Arbat, Khamovniki, Zamoskvorechye do not have satisfactory drainage from the intra quarter territories.

On some historical territories, including Manezhnaya Square near the Kremlin, there are still recently functioning 19th-century ceramic drains. Solving the issues of technical and moral modernization of water-bearing engineering networks in the performance of landscaping works could help improve the geo-ecological conditions and overcome the widespread waterlogging, and thus protect the historical and cultural heritage.

We must not forget that the lack of an integrated approach to tracing and carrying out works on engineering networks on historical territories, frequent and repeated excavations in connection with works carried out on one and other networks can have a negative impact on the preservation of cultural heritage. If on the valuable natural areas, the works on laying or relaying of the networks are often carried out without any digging, on the historical territories of Moscow this has not been observed, and I believe that it is worth considering their use, maybe then there will be an opportunity to remove from the intra-block areas numerous surface outlets of gas pipeline networks in the central core, which from temporary have long been permanent, and not always cheap landscaping around.

Unlike Moscow, where the flow of the river basin is regulated, in some cases in historic cities the problems of flooding are relevant, in others karst, erosion, and landslide formation; there are other threats to the preservation of cultural heritage and

historic urban environment. Improvement works in these cities are often carried out within limited boundaries, not affecting dangerous areas, and almost never involve engineering-geological and engineering-environmental surveys. They do not put and, therefore, do not solve the problems of engineering protection of the territory and the safety of architectural monuments and valuable historical and urban environment.

5. CONCLUSION

For the historical cities (zones of cities) the concept of “complex beautification and greening” should be significantly expanded to include the requirements of conservation, preservation, and, in some cases, recreation of a historical and urban environment using contemporary engineering methods. The implementation of the proposed approach involves the development of a specialized design methodology that uses scientifically based technical solutions and technologies, but also authentic and historically justified methods and techniques that have proven themselves in practice.

Actual requirements for the improvement of the functional and spatial organization of the historic buildings on the basis of urban planning calculations and urban justification of the improvement. In accordance with the requirements of the historic building morphotypes and historical and cultural substantiation, it is necessary to optimize the inner space planning, where possible to reduce overbuilding and increase the greening of territories.

While planning complex landscaping in the historic cities it is advisable to consider the issues of recreation, partial recreation of the geoplasmic relief and marks of the historic buildings, to use the authentic or historically justified elements of landscaping and range of plantings.

The actual tasks of the complex improvement of the historic areas of cities should include special measures to improve the geo-ecological condition of territories, including the prevention of waterlogging and other adverse and dangerous engineering-geological processes.

An important task of comprehensive improvement is the reconstruction of intra-block engineering networks, which should provide a mutually coordinated solution to the problems of

reconstruction (regeneration) of historic buildings and reducing the negative impact on the architectural monuments and valuable buildings in the operation and maintenance of works.

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