

Bases of the scientific conception of the “green frame” designing in urban areas for providing ecological safety of the urban environment

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Abstract. In modern conditions of a stable urban areas development special place is occupied by the problem of ecological security of built-up areas, including residential, recreational, industrial areas and objects of transport and engineering infrastructure. The main results of the study are to establish the basis of formation of the concept of choice of energy-efficient technologies and tools of forming an ecologically efficient "green frame" of urban areas on the basis of a single integrated scientific concept. Analysis allowed us to divide the measures for improvement into the following main groups: organizational and planning, engineering and technical and special engineering and environmental. The significance of these results for the construction industry, including transport infrastructure, is to increase the level of environmental safety in the construction and reconstruction of urban areas due to the organization of their improvement on the basis suggested by the authors scientific approach. Its basis is integrated accounting of the natural and climatic features of the landscaping territory, the types and level of environmental impact of negative anthropogenic factors, the features of architectural and planning solutions of the existing or projected on the studied area, the structure and types of green spaces and their functional ecological properties.

1. Introduction

In modern conditions of a stable urban areas development special place is occupied by the problem of providing ecological security in built-up areas including residential, recreational, industrial areas and objects of transport and engineering infrastructure [1-5]. At the same time, an important place is occupied by the problems of improving the areas adjacent to the development sites: intrashell space zones, yard and surrounding areas, public areas, etc. Existing newest up-to date research and developments in the fields of energy efficiency of construction technologies [6, 7], preservation of the landscape [8], reduction of air pollution [9], etc., have not solved the problem of comprehensive assessment of potential resource and energy conservation in the planning and organization of works on improvement and landscaping of built-up areas.

From our point of view before implementing all area improvement projects pre-project environmental engineering investigations should have been completed along with the scientific bases applying in projecting and further activities. It must be noted that such justification should be based on a complex single scientific conception which should be designed and in the long run be improved for each regional urban agglomeration according to the main natural climatic and landscape ecological features of the considered part of area.



Absence of these actions from scientific and professional communities can lead to the increase of unfavorable ecological consequences of economic activities based on not enough thoughtful project decisions [10]. There is an irrefutable fact that following generations will have more ecological restrictions for opportunities and maintenance of the necessary level of social and economic development, first of all such as the lack of natural resources, poor quality of the resources suitable for using (clean drinking water), unfavorable for a number of characteristics environment. In this regard science-based approach towards solving the range of tasks on improving adjacent to the development sites areas is the necessary part of complex scientific conception.

2. Methods

Carried out analyses of a wide range of mentioned above activities connected with the urban areas improvement let us divide these activities into the following main groups:

- organizational planning, connected with the implementation of activities on areas vertical planning and further designing in the considered part of area architectural and compositional solutions for spatial placement of the elements and improvement objects (access routes, exits, car and cycle parking, paths, children's playground, sports ground, artificial ponds, fountains, elements of landscaping, small architectural forms, etc.);
- engineering technical, connected with the technical providing of the elements and improvement objects reliable operation (building materials for covering the paths, children's playground, sports ground, engineering equipment (tubes, pumps, compressors, sprayers, etc.) for area drainage (if necessary) ponds, fountains, etc.);
- special engineering and ecological, connected with the providing the ecological safety of each element and improvement object though preventing their negative effect on the urban environment for each necessary factors (noise, vibration, electromagnetic field, thermal field, microclimate, illumination (insolation), dusting, gas content, storm drains, ponds wastewater, fountains, etc.).

Among the most sufficient not only from the ecstatic but also from the functional point of view area improvement elements there are greening roofs, which necessity of applying in area improvement projects could be used in each listed above group of actions:

- choice of the type, kind, parts of placement and types of planting (wood and bush group, alley, solitaire, hedge, etc.) the plants for each considered part of area could be easily included into the system of greening roofs in the group of organizational planning activities;
- defining the system of plant care namely first of all in the right choice of soil, necessity of using stretching for fixing new rooter trunk, scheme of watering and using fertilizers, and also designing drainage system for providing normal activities and effective growth considered system of greening roofs are without doubt related to engineering and technical activities;
- biological functions of the chosen greening roofs system aimed at reduction of sound pressure level, dust suppression, carbon dioxide uptake, providing oxygen, providing certain microclimatic conditions according to temperature, humidity and air mobility, etc. allow to relate this system to the group of special engineering and ecological activities.

Thus greening roofs should and must be considered as a special element of urban areas improvement, scientific-based using of which allows to provide implementation of the activities complex mentioned above. In developing the projects on urban areas improvement it is necessary to consider that the tasks of greening directly connected with the tasks of providing the quality of the air, acoustic comfort, comfortable parameters of microclimate, reduction of vibration effect, insolation level control in considered built-up parts. Physiological processes typical of plants (photosynthesis, phytoncides, transpiration, etc.), directly influence on the implementation of the tasks mentioned above. Practically in any large urban agglomeration we can identify five main functional zones:

- residential, including both denser development of the city center (historical part), new neighborhoods of multistoried development and zones of individual as a rule single-family private homes;
- industrial zones including operating enterprises, warehouses, etc.;

- transport and engineering infrastructure zones;
- public and business zones designed for trade objects, education, business, healthcare, etc.;
- recreational zones and nature complex dividing into virgin and fallow lands, gardens, parks, boulevards, squares and also forest parks.

3. Results

Scientific-based use of greening roofs in different functional zones allows to increase sufficiently the environment security level in these areas. However in each functional zone conditions for growth and development of different types of plants are absolutely different. The percentage ratio of the main functional zones in a nominal large city is shown in Fig. 1.

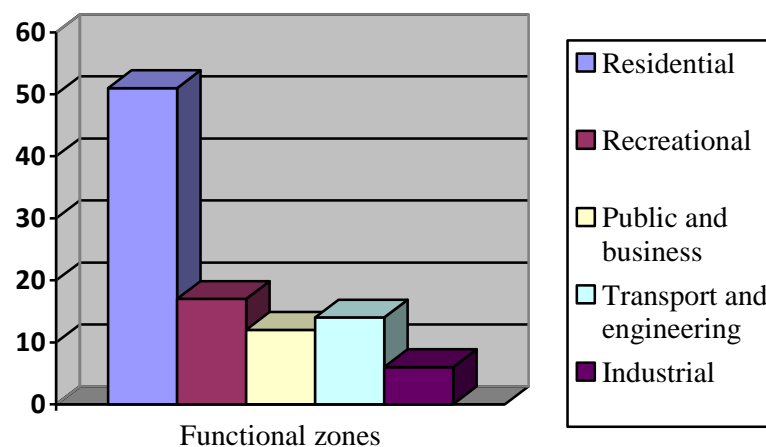


Figure 1. The percentage ratio of the main functional zones in a nominal large city

For example the most favorable in this aspect are recreational zones: parks, squares, boulevards, gardens [11].

In residential zones plants location by the level of providing them with the necessary nutrients is considered to be medium favorable. This is connected with the high level of soil sealing in root zones. This negatively affects their porosity, moisture and air permeability. Soil pollution as the result of human activity also has negative effects. However enough greening roofs in residential zones are the necessary condition for creating convenient, healthy and comfortable environment for the residents. That is why city dwellers unwillingly buy apartments even by attractive price in new neighborhoods where greening includes only lawns and several rooters

Greening roofs placement in public and business zone could be both favorable if the object has a special recreational zones and also medium favorable if greening must be placed in a narrow passing area.

Transport and engineering zones especially in central Russia as a rule have greening elements grown on their own without human factor.

And the most unfavorable from this point of view are industrial zones where greening roofs should be named as a special engineering and ecological activities. At the same time factor assessment should be completed and the level of negative effect from the particular industrial object should be considered for choosing and realization appropriate engineering and ecological activities that are able to provide wellbeing of the chosen plants.

Usually in the industrial enterprises areas plants which are sensitive to one or another kind of pollution disappear and “man-made” environment appears. For preserving and maintaining recreational functions of the plants not far from the sources of pollution it is necessary apart from careful monitoring of the condition and defining affected plant areas to carry out scientific-based

plants choice for greening the considered area. According to the authors of the research [12] one of the main preliminary stages in decision making of the optimal for the prescribed conditions greening kind is the prediction of industrial enterprises effect on the environment change in the considered area on the bases of mathematical modeling methods or creating ecosystem model with the further comparison of the received results with analog for the areas located in similar soil and climatic conditions.

At the stage of a pre-project research in the considered area vegetation should be analyzed in the terms of hygiene, forest sites and soil quality conditions taking into account orography, climatic parameters and aerodynamic effectiveness. The most important features of greening roofs are their airing defined on the bases of completeness and density of the undergrowth and wood mass. In respect of lawn parts their construction and size should be built on the bases of aerodynamic laws providing the best airing and air exchange that will provide turbulent change of the clean and polluted air and also wind-blown the latter into external nature space.

Multi-year research of foreign and Russian authors confirms the assumption that preserving greening roofs method in the considered area from one side has favorable influence on the air quality but from the other hand health role of wood mass declines fast and in a certain period of time the landscape around built-up objects degrades. This gives us the reason to stay that passive use of greening roofs without their periodical reconstruction is less effective. The most intensive degradation is in the areas adjacent to industrial enterprises. It's known that in such areas the following affected areas of natural vegetation are defined:

- the first zone is characterized by all vegetation loss;
- the second and third zones are characterized only by stable growth of grass;
- the fourth and fifth zones are characterized only by stable enough growth of wood and bush vegetation.

One of the important pre-project researches is also the evaluation of soil and vegetation in the considered area when the proportion of eroded soil is defined and the level of soil degradation is determined by the set of evaluation criteria. In urban conditions soil is polluted mainly by solid waste, their components and chlorides. Soil pollution is caused through air or intentionally through soil substrate. The largest sources of soil pollution are industrial enterprises and the main polluting substances are dust, ash, slag, lead, manganese, sulfuric acid, arsenic, fluorides. One of the most dangerous toxic substances polluting soil is mercury which is accumulated in the upper soil layer (up to the depth of 40 cm.) and weakly migrates into deeper layers.

Soil pollution by chemical substances has negative effect on soil generated processes which normal development is possible only by a certain (break-off) soil pollution level. In case of exceeding maximum permitted polluting substances concentration in soil nitrofit activity declines, the quantity of useful micro-organisms reduces, microfauna of soil substrate degrade.

Vegetation digression depends on a number of factors among them are recreation, soil pollution level, air environment in the considered area and also on irrational use of vegetation.

In a limited populated area processes of man-made transformation proceed quite intensively, as a result in a very short period of time irreversible problems appear and they lead to greening roofs and landscape value of wood planting loss and also to worsening of urban soil quality [13].

Thus in the area of urban developments architectural and designing solutions with the complex of scientific-based formation of "green frame" should provide the creation of favorable and comfortable conditions for population viability positively influencing on health and citizens' well-being.

4. Discussion

Scientific bases from the environmental protection point of view and ecological safety provision of planning development of urban agglomerations and their separate districts will allow not only to preserve literarily chosen complexes of greening roofs but to consider them either as the main component of recreation zones or as the basic elements of improving residential development.

The main characteristics of plants which they should have for inclusion in "green frame" list for urban development are:

- high frost resistance;
- high drought resistance;
- disease and pests resistance which are typical for considered nature climatic region;
- resistance to negative man-made factors of urban system.

Under this approach, from our point of view, not only savings of greening the area with the new plants is provided but also meaningful improvement of ecological and hygiene situation is being watched as already formed kinds of vegetation have significantly large functional ecological features comparing with newly formed parts of greening. However under the current density of development and necessity of arrangement of a large amount of engineering communications it is impossible to avoid granularity of the vegetation parts, but from our point of view, our approach will allow to minimize such situations with appropriate account of evaluation and vegetation choice results. As proof experience shows that under the conditions of a high population density with relatively tight neighborhood planning it is possible to preserve up to 30% of adult trees [11].

Unfortunately currently in the development of new areas for urban construction there is a tendency of full vegetation removing from the zones of development that eventually leads to the full vegetation absence on being put into service buildings in a new neighborhood. With this as the improvement elements of already built-up area as a rule the cheapest annual lawns are used. They are characterized by the lowest ecological and hygiene functional features comparing with other possible to use in greening urban environment plants.

As it was stressed above in the process of improving and greening outdoor and indoor parts of residential complexes it is necessary to consider the ability of certain kinds of greening roofs to complete the functions of noise reflection and noise insulation barriers providing the reduce of negative effect of noise pollution which is inherent in urban environment on residents. This is confirmed by the latest scientific research [14]. The results of our carried out researches confirm given in the works [15, 16] data that greening roofs located between sources of noise (ex. highways) and residential houses reduce the level of sound pressure by 7-12%. With this different kinds of plants are characterized by different ability to absorb or reflect sound waves. While the wider greening line the more is their sound protection function [17].

In a comparatively limited urban area which is a specific focus of ecologically dangerous man-made factors processes of negative man-made influence proceed significantly faster. In a rather short period of time these intensive actions can lead to greening roofs degradation and common urban environment worsening

With choosing the structure of “green frame” for urban environment greening, its placement in the considered area it is necessary to consider the following nature and climatic peculiarities of a region:

- wind rose defining predominant course and average speed of the wind;
- monthly average and annually average rainfall taking into account their kinds (rain, snow);
- climate-controlled seasonal regime;
- soil quality based on its structure, morphology and a number of other characteristics;

And also kinds and effect level in the environment negative man-made factors defined in the considered area.

5. Conclusions

Thus scientific approach offered is based on the complex considering of nature and climatic features of the improved and subjected to greening area, kinds and effect level on the environment negative man-made factors, peculiarities of architectural and planning solutions of the development existing and planning in the researched area, structure and kinds of greening roofs and also functional ecological features [11, 15].

Our offered approach allows us also to choose optimal “green frame” structure for recreational zones (squares, gardens, parks, etc.) in built-up areas with the considering of their architectural and planning features and solutions. For related nature and climatic conditions we can choose lawn surface square and choose the kind of lawn plants, define optimal “construction” of bushes and trees [18], and

also planning solutions on their placement in the considered area. As the result of applying such approach when developing project solutions for recreational zones of built-up areas high ecological effectiveness of such “green frame” and maximum energy efficiency of technology and resources of its formation will be achieved. This effectiveness will significantly contribute into creating comfortable living conditions in the considered area.

The growing importance of functional ecological features of “green frame” of urban environment in architectural and planning solutions based on territorial zones of urban agglomerations is one of the factors of forming the most favorable conditions for residents’ living on the bases of optimal nature and society effect and defines sufficiently high level of ecological security in the urban areas.

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