

Gardening as vector of a humanization of high-rise building

Nina Lekareva^{1*} and Anna Zaslavskaya¹

¹Samara State Technical University, 443100, Molodogvardeyskaya St., 244, Samara, Russia

Abstract. Article is devoted to issue of integration of vertical gardening into structure of high-rise building in the conditions of the constrained town-planning situation. On the basis of the analysis of the existing experience of design and building of "biopositive" high-rise building ecological, town-planning, social and constructive advantages of the organization of gardens on roofs and vertical gardens are considered [1]. As the main mechanism of increase in investment appeal of high-rise building the principle of a humanization due to gardening of high-rise building taking into account requirements of ecology, energy efficiency of buildings and improvement of quality of construction with minimization of expenses and maximizing comfort moves forward. The National Standards of Green construction designed to adapt the international requirements of architecture and construction of the energy efficient, eco-friendly and comfortable building or a complex to local conditions are considered [2,3].

1 Introduction

The issue of the most effective introduction of gardening to our cities doesn't lose the relevance for more than 100 years. Projects and Howard and Le Corbusier's theories considering a city conglomerate as the developing organism which is separately taken complex, unfortunately, are almost not applicable to already developed infrastructures of the modern cities. How to be with dense multystoried building of such megalopolises as Shanghai, Tokyo, New York, Kuala Lumpur, Moscow, London? It is almost impossible to find free areas for high-quality and effective gardening in such cities. Here theoretical researches of Le Corbusier find new value: "gardens on roofs" extend to facades, "green fingers" enter interiors of skyscrapers, turning them into dynamically changing architectural organisms with the energy saving and the developing resources characteristics.

2 Materials and methods

The world community recognized efficiency of roof gardens for a long time. So for example, in Germany one of indispensable conditions at design of buildings – gardening of the roof including having a considerable slope. In Switzerland allocated under lawns 25%

* Corresponding author: nalec1950@bk.ru

of flat roofs while in Japan owners of the real estate are obliged to lay out gardens on flat roofs more than 100 sq.m .

Today technologies have allowed to go further to the fields of gardening of architectural objects and to transfer a landscape from horizontal to the vertical plane [4,5]. Peter Blanca who has presented to the world Vertical Gardens technology in the project of gardening of walls of the Museum of Modern Art in Paris on a wall with a total area of 800 sq.m has placed more than 170 types and 15000 plants. Ecological efficiency of similar projects strikes. For example, application as dressing of a facade, vertically focused "green" modules of Emilio Llobato has allowed to disinfect 2,6 million air cubic meters a year thanks to what 400 thousand people in 200 buildings could breathe fresh air.

Example of use of natural gardening in high-rise building are so called "green" high-rise buildings of Ken Yeng, the creator of bioclimatic approach in design of high-rise buildings (figure 1). According to Yeng: "The building must be integrated in environment in physical, system and time aspect. I mean integration into physical characteristics of the place: topography, underground waters, hydrology and vegetation. System integration is rational use of water systems, energy, waste, the sewerage and so on. Time integration is a ratio of use of resources and construction materials with their ability to be restored or be replenished" [6].

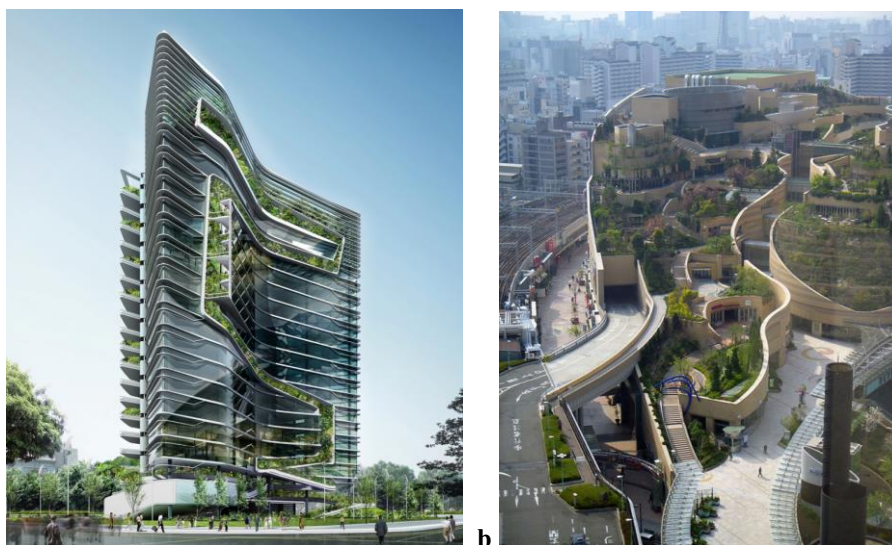


Fig.1: Bioclimatic approach in creation of contemporary buildings: a - EDITT office complex in Singapore, arh. Ken Young [2], b - Multi-storey Garden in Osaka, Japan [4].

3 Results

The organization of gardens on roofs and vertical gardens in high-rise buildings most often is connected with rise in price of construction which is perceived by the customer as excessive expenses. However these expenses are often justified not only for esthetic or ecological reasons. There are several exclusively practical aspects which can often convince the customer. And it is first of all the design features keeping designs of a roof and walls from temperature changes [7,8].

First, "green roofs" with respect to technology are often much more durable than usual due to multilayered modern materials "pie" with a covering from plants serves as the best waterproofing and thermal insulation for the rooms located under him. Usual roofs are

getting dry, become wet, roof slabs experience contrast change of heating and cooling and in such conditions are exposed to far bigger corrosion stress, than the roof which is constantly covered with a lawn blanket. In gardens on roofs the amount of soil is minimized, because soil – the heaviest part of a garden giving big overloads on roof slabs design. Therefore the first step when developing a roof garden is determination of the maximum loads which the roof design can sustain. According to minimum settlement load of 500 kg of sq.m (the soil, a drainage, snow) the scheme of the device of "a green roof" can be the following:

- a waterproofing with root protection layer.
- the drainage plates representing plates of the perforated polystyrene passing moisture.
- a filter-bed for prevention of a contamination of a drainage particles of the vegetable soil. Geotextiles.
- a soil layer with vegetation: qualitative and light soil.

Ecological advantages of gardening of roofs and the inclusion of gardens in structure of skyscrapers which concern to increase in microclimatic and sanitary and hygienic indicators of building aren't less important [9,10].

Plants on roofs promote dust content reduction. In hot days air streams with dust are caught in crowns and the bushes having a rough surface of leaves. Even in a dry state small strips of a lawn with a bush catch up to 50% of dust from the air streams passing over them, and when watering and moistening plants the effect is even higher. The vegetation layer, besides, reduces also harmful electromagnetic radiations, protecting roof designs from ultraviolet rays. Researches proved also considerable noise-protective effect of the planted trees and shrubs roofs which is a little decreasing, but not eliminated in the winter. Sound waves are absorbed by soft and rough plant material, and it is especially essential to the top floors of buildings

The advantages of the social plan, including esthetic comfort, come down to obtaining the additional area of a recreation and communication. The flat planted trees and shrubs roof or a green terrace besides that is pleasing to the eye of those who look at them from higher floors, become useful area and can be used depending on gardening type for the most different purposes. Besides it is a possibility of disclosure of panoramas on the environment, increase in esthetic indicators of the interior spaces opened on the planted trees and green spaces [11].

Savings of building area due to the lack of territorial reserves comes to the forefront now. In this regard economic and town-planning advantages of the roof gardens and vertical gardens which aren't demanding additional urban areas are available. Being the powerful compensator in the field of an environment humanization in the conditions of close building, vertical gardens and gardens on roofs make the building more attractive to investors.

4 Discussion

The humanization of high-rise building due to ecocentric approach to formation of its structure regarding her gardening and the organization of additional recreational spaces increases its investment appeal. Considering the large volume of input of the new areas and reduction of free platforms under construction, the investor needs to take all factors influencing final project cost into consideration: requirements of ecology, energy efficiency of buildings and improvement of quality of construction at minimization of expenses and maximizing comfort.

The huge areas of roofs industrial, inhabited and public the building, underground constructions represent an irreplaceable reserve of the urban area. They can become some kind of artificial basis for gardens, boulevards, squares and other objects of a landscape city

architecture. Protecting designs of a roof of buildings from damages, and having raised as they say, their wear resistance, green plantings absorb moisture, reduce loading to the stormwater drainage system and as a result it will be able to prevent floods.

Absolutely not incidentally program point of new architecture" the world famous architect Le Corbusier who, like many outstanding architects of the present, has repeatedly confirmed this principle in the creativity considered use of roofs., having declared that: "Really it contradicts any logic when the area equal to the whole city isn't used, and slate needs to admire stars!"

For formation of a complex of requirements and an assessment of design of the steady, ecologically healthy and comfortable environment for accommodation of the person introduction of voluntary certification of real estate objects - Green Standards are offered. Green Standards are designed to establish a level of "complex efficiency of all life cycle of the artificial habitat of the person integrated in natural". The objects certified according to "The green standard" provide the minimum environmental pollution and high level of ecological safety for people. At the same time they increase investment appeal of the territory of their dislocation[12]. The term "green building" was strongly included into professional terminology.

Use of "green" technologies in construction and operation of high-rise buildings bears unconditional economic benefits as energy consumption level decreases. reduction of costs of the electric power is reached, and also water consumption decreases. Use of environmentally friendly materials and high level of comfort of green buildings promotes preservation of health to their inhabitants. Besides tax benefits and grants are presented to the buildings which have undergone certification on Green standards that promotes increase in their investment appeal and forms public opinion.

As a result of modeling with use of the innovative methods directed to decrease in dependence of consumers on energy resources the architectural concept of an object with system integration – rational and autonomous use of water systems, energy, heat, waste, the sewerage and so on with necessary reduction of scales of environmental pollution can be created. Similar experience of design with use of methods of replacement of traditional sources of heat has been applied in the project of the Energy efficient building "Ekody Solar-5".

Increase in attention and interest in creation of artificial ecosystems which could imitate properties, processes and the device of ecological systems in the nature, including creation of autonomous energy efficient buildings with inclusion of gardens in its structure is steady tendencies in the field of green construction [13].

Gardening of "the fifth facade" or construction of gardens on roofs belongs to the hi-tech decisions increasing the level of comfort of high-rise buildings, durability of their designs and answering to a number of ecological requirements of Green Standards. Construction of gardens on roofs is for the present poorly widespread in our country though in the world there is a vast experience of such construction. Our severe climate brings the restrictions and narrows possibilities of gardening of a roof. Besides because of a set of agrotechnical and engineering devices it is quite expensive. However, these expenses are often justified not only for esthetic or ecological reasons, but also from the point of view of a practicality.

Green Standards assume rather high level of efficiency of design and construction which achievement is very complicated. However the possibility of creation of energy saving, ecologically effective buildings in the cities is absolutely real irrespective of climatic conditions [14,15].

Thus, investment appeal of urban areas and the architectural objects located on them can be considered as a complex multicriteria and multiple-factor challenge which solution will demand step by step repetition of calculations of urban planning and economical value of

the city earth on the basis of the updated data of town-planning monitoring. It is proved by the fact that eventually requirements to the factors entering a method of calculation of economical value of urban areas to ponderability of each of them in the general assessment change, and also that standards of norms, and first of all the ecological, focused on improvement of quality of lives of citizens change [16,17].

5 Conclusions

Creation of the native habitat in the conditions of high-rise construction requires complex gardening in and outside of the building which becomes possible due to use of the planted trees and shrubs atriums and the yards, green floors, green walls, green roofs, artificially created natural landscapes and other landscape elements uniting the main directions and ways of gardening of high-rise buildings [18].

The terrace solution of the gardens included in skyscrapers is the most widespread and functionally justified way of gardening of high-rise buildings of terrace type. Terraces carry out a role of open recreational space.

Gardens - "whatnots" are a way of deeper integration of gardening into structure of the high-rise building. Development of this direction gives the chance of the construction of "through gardens" on certain floors of the high-rise building and additional spaces for communication and a recreation of its inhabitants.



Fig. 2. Types of city gardening: a - Roof Garden - MOMA museum in New York [10], b - Vertical Garden - L'Oasis D'Aboukir, Paris [12].

Gardening of roofs – perspective and now actively mastered way of gardening of high-rise buildings. Among a set of examples of the planted trees and shrubs roofs, it is possible to note the modern project on a roof of the Museum of Modern Art in New York created by the landscape architect Ken Smith. The new roof garden of the building belonging to the Museum of Modern Art is an innovative construction which successfully supplements green space of the territory of the Museum with a garden of sculptures. It is available to

visitors and is well looked through from surrounding high-rise buildings of Manhattan (figure 2, a).

Vertical gardening. The live green carpet promotes increase in microclimatic indicators of building and according to increase in comfort of the building, reducing thermal radiation, increasing relative humidity of air that improves climate feeling of the person. Vertical gardening plays also decorative and esthetic role as allows to overcome monotony of urban development substantially. Application of the way "green wall" can turn the building into the present work of art (figure 2, b).

The principle of **modular gardening** of high-rise buildings is the most economic and universal way of gardening as it can be applied in various climatic conditions and various constructive systems of the building. Use of ready modules allows to save means and time when gardening buildings [19].

In conclusion, there is a wish to note the general world tendency to a humanization of the architectural environment of the large megalopolises striving for eco-friendly technologies, "clean" materials and correct design methods, delicate in relation to nature. For already developed multy-storied architectural complexes the technology of vertical gardening of facades as it is almost autonomous seems to be the most perspective, and the constructive decision can be realized with the minimum transformation of the existing planning of buildings [20]. At the same time the effect of similar decisions is maximum when it is used for a "green" surface, turned vertically, it is perceived by pedestrians and inhabitants of the next high-rise buildings entirely and practically without distortions, unlike horizontal surfaces of the operated roofs. however, it wouldn't be desirable to exclude the principles of creation of many-tier gardens and gardening of roofs from the general scenario of return of "human face" to the urbanistic centers. Only an integrated approach in a humanization of the urban environment, taking into account ecological, esthetic and technological aspects in the choice of constructive and composite decisions is capable to give "the second life" to densely built up multilevel megalopolises [21, 22].

References

1. V. A. Nefedov, City landscaping, 318 (Saint- Petersburg, 2012)
2. <http://greenroofing.ru/novosti/2014> (last accessed 2017.06.26)
3. N. A. Lekareva, Territorial and spatial resource of the city, *Volga scientific magazine*, **3(31)**, 107-110 (2014)
4. N. A. Lekareva, Landscape architecture and design, *Unity and variety*, 247 (Samara, 2011)
5. N. A. Lekareva, Green standards in training architectural town-planning to design. In the collection: Questions of science and education: theoretical and methodical aspects the collection of scientific works on Proc. of Int. Sci. Conf.: in 11 parts, 94-95 (2014)
6. Richards Ivor. Groundscrapers + subscrapers of Hamzah & Yeang. - John Willey & Sons Ltd., 84 (Great Britain, 2001)
7. V. P. Generalov, E. M. Generalova, Prospects of development of typology of high-rise buildings, *Future of the cities*, **4** (SGASU Vestnik, 2014)
8. E. M. Generalova, V. P. Generalov, A. A. Kuznetsova, Modular Buildings in Modern Construction, *Procedia Engineering*
9. A. Y. Zaslavskaya, E. M. Zaslavskiy Natural analogies in a design of contemporary architectural objects, *Town planning and architecture*, **2(19)**, 19-23 (2015)
10. A. Y. Zaslavskaya, Evolution of organic architecture, *Architecton: news of higher education institutions*, **19**, 3 (2007)

11. A. A. Romanov, S. V. Evdokimov , A. A. Orlova, Results of Survey of Reinforced Concrete Structures of Drainage Gallery in Earh-fill Dam, *Procedia engeneering*
12. www.verticalgardenpatrickblanc.com (last accessed 2017.06.23)
13. Berrizbeitia Anita and Pollak Linda, Inside Outside, 189 (Rockport Publishers, Inc. USA, 1999)
14. D. V. Zelentsov, K. L. Chertes, O. V. Tupicina, Theoretical Basis and Experimental Study of the Aeration Characteristics of the Composting Mixtures during the Design and Construction of the Aeration System of the Oily Waste Biodegradation Complex. *Procedia Engineering* **153**, 903-908
15. Advanced architectural studio 6. Merging Landscape and Building Abstract, *Columbia Architecture Planning Preservation*, 62 – 65 (New York, 2001)
16. Architecture and Landscape *the Design Experiment of the Great European Gardens and Landscapes*, 410 (THOTH publishers, Bussum, 1996)
17. M. Simonova, N. Shekhova, S. Kolesnikov, Strategic directions of personnel potential forming of a building complex, *MATEC Web of Conferences* **86**, 05008
18. Betsky Aaron, Landscrapers, *Building with the land*, 387 (Thames & Hudson, London, 2002)
19. Jodidio Philip, *Building a new millennium*, 559 (TASCHEN, Rotterdam, 1999)
20. Landscape (9+1 young dutch landscape architects) *essays by Henk van Blerck and Jorg Dettmar*, 137 (NAI Publishers, Rotterdam, 1999)
21. A. O. Mateyko, History of development and current trends in high-rise construction, **3** (Samara, SGASU Vestnik, 2016)
22. The organic Approach to Architecture *edited by Deborah Gans, Zehra Kuz*, 190 (willey Academy, 2003)