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Research paper

Implementation of Principles of Biospheric Compatibility in the Practice of Ecological Construction in Ukraine

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Abstract

The article considers current trends in ecological construction based on the principles of biospheric compatibility. The necessity of an integrated, multi-level approach to addressing the environmental safety of urbanized areas and the renovation of the urban environment is shown. Generalized indicators of biosphere compatibility of territories and the level of implementation of city functions are proposed, a method for calculating the components of the humanitarian balance is developed on the basis of a comprehensive analysis of existing methods for assessing pollution of the city's environment and the adopted concept of improving the environmental safety of construction sites. The presented algorithm for monitoring the quality of the urban environment makes it possible to evaluate indicators of biosphere compatibility and to implement the reconstruction of natural and man-made systems based on biosphere-compatible technologies. Implementation of the expanded reproduction of the Biosphere and the creation of a comfortable living environment for the harmonious development of man; Improving the quality of life based on innovative biosphere-compatible resource-energy-efficient technologies ensures the positive dynamics of the components of the humanitarian balance of the Biotechnosphere, which increases the Life Potential of the Biosphere through the implementation of non-pathological programs of the city - programs of ecologo-oospherical transformations aimed at restoring disturbed humanitarian balance. In preparing these proposals, modern foreign experience was analyzed, and legal mechanisms for supporting economic actors in the field of ecological construction in the USA, Great Britain, Germany, Austria and the Nordic countries were studied.

Keywords: *organizational and technological reliability, uncertainty of environment, construction project, biosphere compatibility, organization of construction .*

1. Introduction

It was not only scientists who understood the recklessness of the destruction of vital sources (air, water, energy, etc.) stored by the ancient biospheres, and the realization of the finiteness of its reserves. Today, this problem is becoming global in scope, affecting all the main areas of human activity. It is not only about architecture and town planning, but also about life activity in settlements, cities and megalopolises, i.e. about the functioning of the productive and managerial spheres and about human development in all respects.

If you look at modern pollution maps, it is easy to see that the source of pollution are large cities that have a developed industrial structure in their territories. Cities, as carriers of civilization, acquire a prevailing function — destroyers of civilization, since they destroy Nature, and with it their own population. In Ukraine, cities concentrate 76% of the population and emit the overwhelming majority of all pollution [1]. A significant contribution to environmental poisoning is made by the construction industry, as it participates in the creation of all types of technological systems - industrial facilities, life support systems, transport, etc. Building technologies are the basis of man-made transformations of cities and settlements that provide not only qualitative but also quantitative development of the population i.e. life of future generations.

In this paper, we study the methodology and calculation methods for implementing one of the stages of this transformation in relation to the technological reconstruction of industrial enterprises of the city infrastructure from the standpoint of environmental safety based on the paradigm of biosphere-compatible cities that develop people.

The purpose of the article is to formulate methodological and analytical requirements for the introduction and construction of tools for organization of construction and organizational and technological support of construction projects on the basis of biosphere compatibility.

2. Organizational and technological reliability

In recent years, the Kiev National University of Construction and Architecture (Ukraine) has conducted fundamental research on the creation of interdisciplinary technologies in the field of architectural and construction activities under the common title "Biosphere-compatible cities and human development" [2]. The general trend in applied sciences related to the national economy (including construction) has become their abrupt as the requirements of the times change and the accumulation of new knowledge develops and integrates with related disciplines while preserving its specificity. Thus, the organization of construction, while preserving the traditional areas of analysis and regulation of construction

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processes (construction organization projects, work production projects, scheduling, preparation and construction priority, duration regulation, etc.), targeted at contracting organizations [2, 3], As the market economy developed in Ukraine, it began to include a wider range of problems - a system-technical representation of the investment process as an integral mechanism.

The organization of construction now solves a number of new methodological issues:

• expanding the scale of designing a construction organization for an investment process in
general, covering all stages and stages of investment: pre-project studies, land acquisition,
design and construction stages, implementation or operation [3];

• structuring the system of regulatory requirements for the organization of construction, composition, content and form of organizational and technological documents for mandatory state requirements that ensure the safety of buildings, buildings and structures, the processes of their construction, operation, implementation in accordance with technical regulations; recommendatory norms (ensuring high consumer properties of building products); intracompany rules of planning, management and organization of production (which include most of the traditional issues of construction management: the development of flow methods, network and other models of organization construction; justification of rational organizational structures; production definition power; increase of organizational and technological reliability and product quality, etc.) [4];

• orientation of construction organization with predominantly state capital investments (gratuitous, interest-free) to private investors: commercial firms, banks, individuals, taking into account credit systems and inflation [5];

• consideration of the exclusive role of land use in a market economy, since the location of the site in the urban environment or in the system of agglomeration determines the value of real estate (besides, the land plot largely determines not only the operating conditions of the constructed on it the object, but also the conditions of construction) [6];

• change the criterion base for making decisions on the organization of construction depending on final interests of the owner, using the estimated return on invested capital, which should take into account all the costs of the investor (price of land; costs of pre-project development, design, construction; advertising; operating costs; taxes; inflation; lost profit on invested capital) and the cumulative investment results taking into account the time factor throughout the life cycle [7].

2.1. Concept of boisterous construction

The modern trend of ecological construction is a large-scale transition from a separate building with an adjacent land plot to whole “green” quarters and cities built on the principles of sustainable development. From the elemental green technologies of the present (passive houses and zero energy consumption) city planners are moving to the cities of the future. At the level of quarters and houses, this is expressed in the principle of “triple zero” - zero external energy consumption, lack of greenhouse gas emissions and complete waste-free activity [7].

A more comprehensive development was the theory of protecting the planet and humanity in the 80s and 90s in the form of the concept of sustainable development, which is to ensure the safety and favorable conditions of human activity in the implementation of urban planning activities, to limit the negative impact of economic and other activities on the environment and ensuring the protection and rational use of natural resources in the interests of present and future generations. This concept is currently the only one adopted in the Russian legislation in the field of green building and "green" standards. The concept of sustainable development has three components: economic, social and environmental, or 3P in English - Profit, People, Planet.

Green building:

• reducing the cost of operating the building by saving energy and water;

• increase in efficiency and the absence of harm to people's health by improving the microclimate in the building;

• reducing the negative impact of the building on the environment.

Ecological construction uses renewable energy sources (sun, wind, heat and cold of the earth and water), collects rainwater, uses environmental and secondary materials, handles garbage, reduces emissions and pollution, cares about the health and well-being of building users.

Interestingly, the signs of an ecological building can be divided into visible (solar panels, wind turbines, greening of roofs) and implicit (saving energy and water, reducing the environmental impact, building microclimate). Quite often, “intelligent” buildings (where efficiency is achieved by controlling and saving energy and resources) and “passive” buildings (with minimal energy consumption) are not always fully “green”. The ideal "green" building does not consume energy and water from outside, but produces and collects them; the shell lets in the necessary light and heat and provides natural ventilation; its emissions to the environment are minimal; after its physical aging, the structure can be completely utilized. In Europe, Life cycle assessment (LCA), which is one of the European Environmental Product Declaration (EPD) standards, is used more often. The EU Directive on Construction and Energy Efficiency (European Union's Energy Performance of Building Directive) requires that all buildings have an energy consumption label that will inform consumers and influence the future development of the industry.

The system of weight assigned to various categories is also significantly different. For example, in Japan, Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) assigns 2-3 times more weight to land use than in certification systems in Western countries.

Another example is Australia, whose Green Star system is based on BREEAM and LEED, but modified to suit the hot climate. This system uses a rating system in 9 categories, some of them — internal air quality, water, energy, materials, site use, transportation, and innovation — are similar to LEED categories. Green Star also assigns points depending on the reduction of greenhouse gas emissions and the application of sustainability principles at all stages, from the idea to the operation of objects. The system assigns a rating to the object prior to its operation, then the actual environmental efficiency is measured by the National Australian Built Environment Rating System (NABERS). New Zealand and South Africa recently adapted the Green Star system for their countries.

China used LEED, but in 2007 the government of the country (Chinese Ministry of Housing and Urban-Rural Development - MOHURD) developed the official Three Star Green Building Assessment System. . It consists of six categories - land, energy conservation, water, resources, environment and operation - and forms an estimate in three categories, One-, Two- or Three-Star, based on achieving the minimum values for each component, and not by the total score.

Most of the world systems have a rating structure by category, similar to LEED - points are assigned for each category, and the rating is based on their sum. At the same time, a significant difference in LEED is freedom, which is given to the architect when choosing criteria to be taken into account. If the building does not have any parameter, it will not lose the right to a rating.

In Japan, each category is most rigidly assessed due to the unique structure of the certification system, which is at the same time strict in its assessment and clear in describing the balance of positive and negative impact of buildings. Japanese CASBEE was created to combine two long-term industry goals: to increase the comfort of living and reduce the impact on the environment.

The system establishes a hypothetical border around the building and its site. Within this bounds, the task is to maximize the quality of consumer benefits (Q). Q measures, for example, acoustic and light comfort, durability and compatibility of interior elements and the beauty of the surroundings. Beyond the limits, the goal is set to

minimize the negative load on the environment (L), and factors such as energy efficiency, recycled materials and pollution reduction are taken into account. The ratio Q / L is defined as the efficiency of ecological construction (Building Environmental Efficiency - BEE). The higher the score, the more positive parameters the project has. This graphic image rating system clearly shows the advantages of greener buildings, but a direct comparison with LEED is difficult.

In South Africa, the Sustainable Building Assessment Tool (SBAT) certification system includes consideration of economics, health, education, and community involvement in processes related to improving social sustainability. Buildings are viewed in terms of how they affect broader goals. The system includes 15 parameters in three categories:

- social sustainability (comfort of living, availability of goods, control, education, health, safety);
- economic sustainability (local economy, efficiency of use, costs, capital costs, etc.);
- environmental sustainability (water, energy, waste, territory).

The system is now used on pilot projects.

In Germany, one of the first successful countries in terms of energy efficiency in construction, the Sustainable Building Certificate from the German Sustainability Building Council (DGNB) has recently emerged. This is a voluntary certification system built on six categories - ecology, economy, society and culture, functionality, technical quality, processes and territory. Built on the basis of local regulations and rules, the system assesses the overall effectiveness of the building and the life cycle, not individual metrics.

In the United States, the process of incorporating LEED standards into building codes and regulations is underway. Thus, the International Green Construction Code was recently released, prepared by the International Regulatory Council (International Code Council), which meets the established goals of achieving carbon neutrality (C-zero) by 2030.

Currently, the process of developing common metrics for rating systems is underway within the Sustainable Building Alliance (SBA), located in Paris.

In research conducted in the framework of fundamental research work carried out at the Kiev National University of Construction and Architecture (Ukraine) "Development of science-based criteria for assessing the biosphere compatibility of settlements and the preparation of proposals for improving human development criteria from the standpoint of the architectural and urban complex" developed national standard provisions that establish a rating system for assessing the sustainability of the human environment, on Candlelight purposes of the present generation to meet its needs for a comfortable living environment and the performance of public functions by the use of residential and public buildings without compromising this possibility for future generations). [6]

3. Formalized model

At the same time, when calculating the functions of a city and specific places to meet human needs, principles of functioning open dynamic systems are considered fair, taking into account the influence of neighboring adjacent areas of urban infrastructure on the considered microdistrict, quarter, or other explored territory [4]. Formulated by academician V.A. Ilyichev principle of compiling and calculating the triple balances of the biotechnosphere megasystems [1] should be valid for calculating the humanitarian balances of limited urban areas using a multi-level iterative scheme assuming the openness of the dynamic man-city-environment system. In this case, the boundary conditions for assessing the humanitarian balance are taken based on the results of the calculation of the balance of neighboring territories, taking into account the synergistic effect.

It is proposed to perform a quantitative assessment of the components of the balance of the biosphere and the technosphere of the territory within the framework of the concept of expanded reproduction of the main productive force - the pure part of the biosphere;

- indicator of the biospheric compatibility of the territory;
- indicator of the level of implementation of the functions of a biosphere-compatible settlement (city functions).

The value of the relative indicator of the biospheric compatibility of the territory can be determined by the formula:

$$\eta = \sum_{n} \sum_{i} (Д_{in} \cdot \xi_{in} \cdot \Theta - A_{in} \cdot \gamma_{in} \cdot m_{in}) \quad (1)$$

where, the first term in the right part is the quantitative value of the environmental biosphere; the second term is the quantitative value of pollution from the technosphere with maximum concentrations that allow for developmen; Дin - the relative value of the required area of the biosphere in relation to the area of the calculated area of the microdistrict of a city or settlement, necessary to neutralize pollution from the technosphere to the level of the maximum concentrations that allow for development per one i-th job in the n-th function of the city; ξin is the coefficient of homogeneity of the biosphere, to take into account the different intensity of absorption of pollutants; Θin - the required number of jobs, the pollution from which must be absorbed by the biosphere in the calculated territory; Ain - the value of the pollution parameter from the i-th source in the implementation of the n-th function of the city, calculated for the territory of distribution of pollution; γin - coefficient of bringing pollution parameters to one source; min is the number of jobs in the i-th source when implementing the n-th function of the city.

The adopted formalization provides a clear logical sequence of the whole mechanism, allowing to combine individual target projects into a single industry program and carry out the overall management of environmental safety projects of construction sites in the structure of urban development. This algorithm uses the concept of "habitat sustainability", which is identical in its meaning to the concept of "sustainability in building" adopted by international ISO standards:

- ISO 15392: 2008 Sustainability in building construction - General principles;
- ISO / TS 21929-1: 2006 Sustainability in building construction - Sustainability indicators for building;
- ISO 21930: 2007 Sustainability in building construction - Environmental declaration of building products;
- ISO / TS 21931-1: 2010 Sustainability in building construction - Part 1: Buildings - Basics of methods for assessing the environmental performance of construction work.

When developing a national standard for biosphere-compatible construction in Ukraine, the requirements of national standards, building and sanitary norms, rules and methodological documents, as well as the main provisions of the foreign rating systems for assessing LEED (USA), BREEAM (UK), DGNB (Germany) and HQE should be taken into account. (France).

4. Conclusions

The system of monitoring the quality of the urban environment as a socio-nature-technical structure aims to ensure environmental safety construction objects from the standpoint of taking into account all negative factors and counteracting them, and, according to the new paradigm, from the standpoint of human unity, the technosphere and the urban environment. In this context, the monitoring system includes the following components: production, social, and in their composition and component of environmental safety. The construction object is formed as a single ecological and economic space, interacting with the surrounding natural environment (biosphere) and the external environment (the technosphere and the noosphere).

The requirements of the rating system are aimed at reducing the consumption of energy resources, the use of unconventional, renewable and secondary energy resources, rational water use, reduction of harmful effects on the environment during the construction and operation of the building, including the local area, while ensuring a comfortable human environment and architectural, constructive and engineering solutions.

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