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Environmental Aspects in High-Rise Buildings

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Abstract: *For ensuring comfort conditions of staying and habitation, high-rise buildings have a significant amount of engineering equipment, operation of which significantly damages the human environment. Architects and specialists working in the sphere of high-rise building construction make great efforts to reduce the negative effect of high-rise buildings on the ecology. The passive measures include the creation of atriums in the building that ensures natural lighting and ventilation in the premises without the use of engineering equipment. Active measures for reducing the negative impact on the environment include the use of renewable sources of energy: wind turbines, solar units, terrestrial heat, bio-fuel. All this leads to the significant reduction in the energy consumption from urban networks. The generation of this energy is connected with processing of natural fuel and emission of the great amount of carbon oxide. All active and passive methods are aimed at reducing the level of impact on the ecological situation and, finally, at the preservation of natural riches of the environment.*

Keywords: *bio-climatic architecture of high-rise buildings, atriums, "green" high-rise buildings, renewable resources of energy, solar and wind units, ecological standard, secondary processing, "grey" water*

The construction of high-rise buildings in world construction is expanding, this is especially noticeable in countries with large populations - in China, India, in a country with a crowded territory – Japan and rich countries such as the United Arab Emirates, Kuwait, etc.

One of the most important problems that arise during the construction of high-rise buildings is environmental safety. Skyscrapers have a large volume and a large capacity, as a result, they consume a huge amount of all kinds of energy, water, which ultimately leads to a negative impact on the environmental environment of the construction area. It is not for nothing that the term sustainability has emerged in the international practice of design and construction, meaning the efficient use of energy and environmental protection not only during construction and operation during the residence and activity of people, but also during the extraction and production of building materials, i.e. covering the full life cycle of a building.

In order to introduce environmental assessment systems into the design and construction of buildings, to promote the development of environmental construction around the world, the World Green Building Council was established in 2002. In Russia, the Green Building Council was registered in 2009 and is part of the WGBC councils, where more than 90 councils from different countries operate.

In accordance with the definition proposed by the American Council for Environmentally Friendly Construction (USGBC), the concept of "eco-friendly (green) design" has been introduced, which consists of three advantages over conventional buildings: environmental, economic, ensuring the preservation of the environment [1-4].

China occupies a leading place in ecological construction, it also occupies one of the highest places in terms of pollution of the natural environment. Rapid population growth, high rates of industrial production development - all this contributes to the ecological instability of the built-up areas.

Currently, the design of high-rise buildings is developing in several directions: actually ecological, economic and social.

The environmental direction includes the creation of "zero" high-rise buildings that fully provide all the necessary energy, heat and water and other needs without connecting to urban outdoor networks. This can be achieved by using renewable energy sources (solar, wind, Earth heat energy, biofuels), the secondary use of water, as well as the use of rain moisture. In addition, the use of

atriums that provide the building with natural light, natural ventilation, protection from climatic influences and other ways.

The economic direction of construction is to reduce energy consumption while increasing energy saving by using double facades. The social aspect of ecological high-rise buildings is to increase the comfort of living by bringing the service network closer to the consumer - the placement of service enterprises inside the building.

In Bahrain, a 50-storey office complex was built in Manama, consisting of two identical towers with a height of more than 240 m. The towers stand on a three-storey stylobate, which houses: a shopping center, restaurants, a business center and a parking lot. Both towers are equipped with wind turbines and solar installations that will generate and accumulate electricity for the complex. The towers have the shape of a sail, the profiles of which work like wings, forming a funnel; similar to the wing of an airplane, the towers direct and increase the wind speed between them, which in turn allows you to increase the number of revolutions of the screws of wind turbines. In addition, this shape of the towers leads to the appearance of negative pressure from the rear side, thus increasing the wind speed between the towers. Reducing the volume of the towers upwards reduces the aerodynamic pressure, which provides almost the same speed mode for the screws of three 29-meter wind turbines located at different heights. The use of wind turbines will generate approximately 1,100-1,300 megawatts of electricity per year and reduce the energy demand of the towers by about 11-15%.

The Hearst Tower in New York is a recognized ecological skyscraper; the Hearst Tower is notable for being the first "green" skyscraper in the metropolis, in the process of creating which a number of environmental innovations were used. About 90% of the metal structures used in the construction contain recycled materials, i.e. construction is based mainly on recycled materials.

The peculiarity of the building's design is that it is assembled from special triangular frame templates (diagrid), which allowed saving up to 20% of materials already during construction compared to if a classic steel frame were used. In general, this skyscraper is designed to use 26% less energy during operation than the current minimum requirements for New York. The building has an innovative energy-saving system based on the maximum use of sunlight during the day: huge windows and a sensor system are installed that automatically adjust the on/off of artificial lighting. The glazing area exceeds one mile. Each glass panel has a height of four floors. The glass has a special coating that transmits light, but reflects invisible infrared radiation, thus creating comfortable conditions for staying indoors. The walls of the atrium of the Hearst Tower, located in

the lower floors, are made of limestone with high thermal conductivity. Special polyethylene pipes with water are installed in the floor, providing rapid cooling of the room in summer and replacing the heating system in winter. A system for collecting rainwater is installed on the roof of the skyscraper, which is then collected through a system of pipes in a tank installed in the basement. This water is used for fountains, watering plants and cooling systems. Thus, the skyscraper has a minimal impact on the environmental situation.

Taipei 101 was built in 2003, but in 2007 a complex of works was carried out to bring the skyscraper into compliance with environmental standards. The building was improved by specialists from EcoTech International, Siemens Building Technologies and Steven Leach Associates. The reconstruction took three years. As a result, the cooling system was completely replaced and the energy consumption system was updated. This made it possible to reduce electricity costs by a third (almost 700 thousand dollars of savings). Carbon dioxide emissions have been reduced by 40%. In addition, measures were taken to reduce the waste produced, which also contributed to reducing the harmful effects on the environment.

The Bank of America Tower, built in 2007 in New York, has undoubted environmental advantages. The building contains 54 floors, while the total area of the interior is about 200 thousand m2. During the construction of the tower, materials harmless to human health and the environment, including recycled industrial waste, were used. For example, the foundation is made of concrete with 55% slag content, which is a waste of metallurgy. In addition, it is a cheap material that is not inferior in its properties to classical cement, while it is also environmentally friendly. Its manufacture does not require the combustion of oxygen, and therefore, excess carbon dioxide does not enter the atmosphere. The skyscraper also provides water savings and uses a number of modern energy-saving technologies, including "green" heating and air conditioning systems. One of the most disadvantaged countries in terms of the environmental situation is China. The rapid development of the economy, industry, population growth - all this leads to an unfavorable ecological environment in cities. China's urbanization program indicates that 60% of the population will live in cities within the current decade. At the same time, 16 of the 20 most polluted cities in the world are located in China. Therefore, the Chinese authorities are doing everything possible to reduce the negative impact on the environment during the mass construction of high-rise 40-60-storey buildings. One of the latest achievements of an environmentally neutral building is the "Pearl River Tower" (architect G. Gill), erected in Guangzhou in 2010, the 310 m high tower was designed by American engineers using the most modern environmental developments. A distinctive feature of this building is that it is completely autonomous and provides itself with energy. This is the first building in the world where wind turbines were installed inside. Two technical floors were allocated for these purposes. At the same time, air is supplied to the power plant through openings in the facade. The facade also generates energy through photovoltaic panels. Special windows not only accumulate energy, but also protect the building itself from overheating, creating the most comfortable conditions inside the building and allowing you to save energy on air conditioning. The blinds on the windows are also special: they automatically change their angle to ensure optimal lighting throughout the day. The design of the floors provides a cooling system – cold water flows through special pipes, which provides rapid air conditioning in the premises. Water for this system comes from the roof, where special rainwater collectors are installed, from where, after purification and treatment, it will flow into thermal collectors heated by solar energy and heat the building. To reduce water consumption in the building, waterless urinals are used, which outwardly do not differ from the usual one: they have no water supply and drainage. A replaceable cartridge is used as a receiver, through which biowasks pass, completely leaving a sediment on it. Subsequently, the biowaste seeps through a hydraulic gate consisting of a liquid lighter than water, which closes after passing the biowaste treated by the cartridge. After a certain time of use, the cartridge changes

rapidly, while the cartridge itself is subject to biodegradation and does not harm nature. According to the developers, such a urinal allows you to save up to 100 m3 of water per year.

The start of the construction of a pilot energy-efficient rural house in the Tashkent region has been launched. On February 15, 2013, the decision on this was made in the information and analytical Department for Public utilities, transport, capital construction and Construction Industry of the Cabinet of Ministers of the Republic of Uzbekistan.

The relevant instructions on the design and co-financing of the construction of the first pilot rural house in the Tashkent region were sent to Gosarchitectstroy, a specialized bank for financing the construction of rural housing "Kishlokkurilishbank", to the service of a single customer "Kishlokkurilishinvest", to the design institute "Kishlokkurilishlikha" and to the project "Improving the energy efficiency of social facilities in Uzbekistan".

"Green" Buildings in Uzbekistan the task of the project "Improving the energy efficiency of social facilities in Uzbekistan" is to perform contractual procedures for designing an energy-efficient house. It is planned to cooperate with experts from the Organization for Rehabilitation in Eastern Europe (IWO, Germany). The consent of this organization has already been obtained to provide consulting services free of charge.

A 51-storey building of The One business center has been built in Tashkent, which will receive a Very Good certificate according to the Breeam environmental standard assessment system. The main modern ecological technologies are used in this building: a modern equipment automation system is installed; energy-saving lamps, light sensors and water meters are installed; separate waste collection and recycling is organized. Thanks to these measures, the energy consumption of the building was reduced by almost 35% compared to the previous year.

One of the interesting promising developments is the Ecogorod project proposal in Yakutia. This is an unprecedented project, the implementation of which will take more than one year. The area of this city will be about 2 million m2, it will be able to accommodate a modern three-level city with residential areas and recreation and entertainment areas with a capacity of more than 100 thousand people. The construction is planned on the site of the Mir kimberlite pipe– one of the world's largest quarries, with a depth of more than 550 m and a diameter of about 1.2 km. The construction is supposed to be closed with a transparent dome covered with solar installations to receive energy from the sun's rays, all this will create a favorable habitat underground.

A similar project was proposed for construction in the capital of Mexico - Mexico City. Since most modern megacities do not have enough office and retail space, especially in historical centers, architects are looking for opportunities, while preserving historical buildings, to meet the growing needs for these premises. As a project proposal, the idea of erecting an underground structure 300 m deep with 65 floors in the center of the capital was put forward. It is planned to place six sections of various functional purposes underground; between these sections there will be special landscaped floors for recreation and entertainment of people living in an underground metropolis. As in Yakutia, the underground city is supposed to be covered with a huge transparent roof, which will allow daylight to penetrate into the underground structure, providing insolation of the upper floors of the city. All this will serve not only to preserve the surrounding buildings, but also to reduce the negative impact of residential areas on the ecological situation of the places of settlement.

The examples of buildings that have already been built and promising projects show ways to protect the environment, confirming the possibility of constructing bioclimatic high-rise buildings that will improve the state and protection of the environment, preserve natural resources, increase the biological diversity of protective measures through the use of renewable energy sources (sun, wind, Earth heat, biomass), reduce operating costs, they will reduce the volume of various wastes from the

building and ultimately reduce the negative impact on the environmental situation and increase the level of comfort of living and staying in skyscrapers.

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