MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

**O. M. BEKETOV NATIONAL UNIVERSITY
of URBAN ECONOMY in KHARKIV**

O. V. Smirnova

ARCHITECTURAL ECOLOGY

LECTURE NOTES

*(for applicants of the first (bachelor) level of higher education
full-time study in specialty 191 – Architecture and urban planning)*

**Kharkiv
O. M. Beketov NUUE
2024**

УДК 72.01

Smirnova O. V. Architectural ecology : lecture notes for applicants of the first (bachelor) level of higher education full-time study in specialty 191 – Architecture and urban planning / O. V. Smirnova ; O. M. Beketov National University of Urban Economy in Kharkiv. – Kharkiv : O. M. Beketov NUUE, 2024. – 60 p.

Autor O. V. Smirnova

Reviewer PhD in Architectural sciences S. P. Shkliar

Recommended by the department of Architecture of Buildings and Constructures, record № 1 on August 28, 2023

CONTENTS

INTRODUCTION

Students' knowledge of the main environmental problems and compositional planning and constructive means of optimizing the environmental parameters of the architectural environment of modern cities is necessary for the formation of an appropriate level of training of an architect specialist.

The lecture course "Architectural ecology" provides students with an understanding of the factors of mutual influence in the "architecture – environment" system, their role in shaping the level of comfort of environment and means of their optimization. The purpose of the lecture course for students is to acquire knowledge about the influence of the architectural and urban planning industry on the state of the environment, about the main environmental problems of the architectural environment and the means of overcoming them, as well as about the methods of ecological reconstruction of buildings and urban territories.

In accordance with the formulated purpose, the following tasks are the most important in studying this discipline:

– identifying the role of the architect in the formation of an environmentally sustainable architectural environment;

– determination of the main negative factors affecting the state of the architectural object or the environment, and compositional planning and constructive means of overcoming them;

– identification of optimal methods of regulating the parameters of the internal environment of architectural objects, taking into account specific natural, climatic and urban planning conditions;

– recognition of the main features of modern directions of ecological construction;

– identification of the role of compositional planning and artistic-architectural properties of buildings and open areas in the visual perception of the environment;

– determination of the essence of eco monitoring and assessment of environmental impacts.

CONTENT MODULE 1 BASICS OF ARCHITECTURAL ECOLOGY

LECTURE 1 Historical preconditions for the formation of ecological principles in architectural activities

Lecture plan:

1. History of the interaction of architecture and the natural environment.
2. The concept of sustainable development of the urban environment.
3. Regulatory and legal support for the regulation of environmental parameters of the architectural and urban planning industry in Ukraine and in the world.
4. The main issues of architectural ecology and its role and place in the training of modern architects.

At the initial stage of urban development, architecture was a means of protection from natural phenomena. Over time, it became a means of increasing the level of comfort and ensuring water supply. Construction of aqueducts began. Aqueducts were invented in the Middle East, where the Babylonians and Egyptians built complex irrigation systems. Experience in water supply and the construction of aqueducts was acquired in parallel with the experience of building complex irrigation systems. The problems with the water regime were especially acute for Mesopotamia. A large part of it was flooded by annual floods. The irrigation system was built in the 2200s BC. It consisted of a whole complex of structures. These were canals, aqueducts, dams to protect fields from being flooded by floodwaters, water intake structures and reservoirs. The water that flowed through canals built on an area of thousands of square kilometers irrigated the lands starting from Nineveh in the north to Ur in the south.

In addition to water supply, the problem of elimination of household waste was urgent. This problem led to the creation of a new type of urban engineering facilities – sewerage. The earliest structures that functioned as sewers were found in the cities of the Indus civilization. The first public toilets known to archaeologists as the city sewerage system were discovered in Mohenjo-Daro around 2600 BC. The Romans, who were great supporters of hygiene, took a big step in the matter of removing liquid domestic waste. In ancient Rome, a grandiose sewerage engineering project "The Great Cloaca" was implemented. The main channel in this system was the

Cloaca Maxima, which is the prototype of ancient sewerage. The channel is up to 3 m wide and more than 4 m high. After the fall of the Roman Empire, the first covered stone sewerage in Europe was built in 1370. In addition to engineering structures, builders developed rational urban planning solutions that allowed solving the problems of insolation and aeration of cities, their protection from excessive overheating and strong winds. The orientation of the cities of Mesopotamia by corners according to the cardinal points is related to the direction of the prevailing winds and provided protection from them. In India, back in the III-II millennia BC, in the city of Mohenjo-Daro, the streets were strictly oriented according to the cardinal directions. There were two streets from west to east and three streets from north to south, in accordance with the direction of the north and south winds. In Ancient China, scientific treatises appeared with instructions on the placement of streets around the world (in latitudinal and meridional directions). In Ancient Greece, in the city of Miletus, the main streets were oriented from southwest to northeast. Such orientation prevented excessive overheating.

At the same time, people allocated for themselves the energy saving powers of architecture. A long time before the invention of electric heating and cooling systems, people were forced to improvise. They used simple tools and natural materials to construct buildings to protect against the temperature factor and related overloads. Mud houses and igloos are just two examples of primitive but ingenious designs still in use today. The society’s attitude to energy resources that most accurately reflects its relationship with the environment. In the early stages of the development of civilization, people did not understand natural phenomena. They were dependent on them. Later, up to the Middle Ages inclusively, people used natural resources in limited quantities to satisfy their vital needs without cause significant damage to the environment. The active development of various branches of science, which began since the Renaissance, as well as the perception of man as the master of nature, dramatically changed the situation.

The New Age with its industrial development required resources that were used not only to meet needs, but as a means of enrichment. The development of industry led to an increase in the number and size of cities, which also negatively affected the state of the environment. People subjugated nature by all possible means, including architectural and urban planning. The understanding that natural resources should be used sparingly began to emerge in the middle of the 19th century. Therefore, the industrial revolution not only changed construction technologies, but also contributed to the awareness of new problems. The earliest examples of complex climate control were created in the vaulted roof of the Crystal Palace in 1851. And the first publications about the negative impact of the environment on architectural objects and structures appeared already at the end of the 19th and the beginning of the 20th centuries. During the 20th century humanity continued to mercilessly exploit natural resources and pollute the environment. The load on the environment from growing cities has increased many times. In the most industrially developed countries, urban agglomerations were formed almost without natural components and with the deviations from the normative sanitary and hygienic parameters of the environment. However, the lack of energy resources turned out to be the biggest problem. Large cities and powerful industry used resources in extremely large volumes. Therefore, there was an awareness that all branches of production should be energy efficient. The oil crisis of 1973 led to an even broader revision of construction principles. In this regard, the famous architects of our days started creating projects that have since become landmarks of environmental design.

At the turn of the XX–XXI centuries' tendencies to increase the natural components of the urban environment have spread. Plants have become components of the external and the internal environment of buildings. There were also changes in public consciousness and awareness of the need to preserve the environment for future generations. So, only when faced with the real threat of global ecological disasters, humanity came to the idea of the need to actively fight against environmental pollution. Architecture and urban planning have had a negative impact on the environment for a long time. Now they also suffer from an aggressive external environment. Therefore, in the future, they should become an effective tool in creating a sustainable balance in the anthropogenic and natural environment.

The concept of sustainable development of the urban environment. The concept of sustainable development became a logical transition from the environmentalization of scientific knowledge and socio-economic development of the 1970s. Sustainable development is a process of change in which the exploitation of natural resources, the direction of investments, the orientation of scientific and technical development, the development of the individual and institutional changes are coordinated with each other and strengthen the current and future potential for meeting human needs. The concept of sustainable development emerged because of combining three main points of view: economic, social, and environmental.

The economic approach to the concept of sustainable development involves the optimal use of limited resources, ecological, nature-, energy-, and material-saving technologies, including the extraction of raw materials, the minimization, processing, and destruction of waste.

The social component of sustainable development is focused on preserving the stability of social and cultural systems, reducing the number of destructive conflicts between people. The concept of sustainable development assumes that a person should participate in the processes that shape the sphere of his life, contribute to the adoption of decisions, and monitor their implementation.

From an ecological point of view, sustainable development should ensure the integrity of biological and physical natural systems. Of particular importance is the viability of ecosystems, on which the global stability of the entire biosphere depends.

Regulatory and legal support for the regulation of environmental parameters of the architectural and construction industry in Ukraine and the world. In the modern world, excessive urbanization has caused the deterioration of the ecological situation in large cities. Therefore, the design of architectural objects, reconstruction of buildings and territories cannot be carried out without considering environmental standards.

At the end of the 20th century international events aimed at developing the concept of balanced development of cities and the environment began to be held. In 1992, at the conference in Rio de Janeiro, the UN International Action Program "Agenda for the 21st Century" was adopted. In 1993, at the World Congress of Architects in Chicago, the "Declaration of Relationships for a Sustainable Future" was adopted. In this declaration the main goal of architectural activity is recognized as ensuring the sustainability of the natural environment, conducting educational, legislative and industry work to create conditions for ensuring ecological design and construction. In 1994, the "Charter of Sustainable Development of European Cities" was adopted in Europe. It contains rational guidelines and recommendations for solving urban-ecological problems.

At the turn of the XX–XXI centuries several international congresses and conferences on issues related to architectural ecology were held. In 2002, the European Organization of the Construction Industry decided to implement a set of environmental protection measures in the construction process.

Several international conventions and agreements have been ratified in Ukraine, many laws, codes, and regulations have been adopted in the fields of natural, social, and man-made environment protection. The basis of all environmental protection measures is the principle of normalizing the quality of the natural environment. The main environmental standards of quality and impact on the environment are divided into sanitary and hygienic, industrial, and economic and complex indicators.

Modern world standards on the regulation of environmental parameters of the architectural and construction industry relate to the environmental, energy and economic efficiency of "Green Buildings" and are developed as a system of voluntary rating certifications. The most famous of them are the English (BREEAM) and the American (LEED) systems.

The BREEAM (BRE Environmental Assessment Method) was developed in 1990 by the British company BRE Global. It is used all over the world. A feature of the evaluation system is the method of awarding points in several sections regarding various aspects of life safety, environmental impact, and comfort. The points are multiplied by the weighting coefficients reflecting the relevance of the aspect in the building site, then summed up and translated into the resulting assessment. This technique allows the BREEAM system to be adapted to different regions without loss of efficiency. Assessment categories are following: 1) management; 2) health and social welfare; 3) energy; 4) transport; 5) water supply; 6) materials; 7) waste; 8) effective management of built-up areas and ecology; 9) fight against environmental pollution. The assessment according to the BREEAM standard is carried out in accordance with the following criteria: management (commissioning and subsequent management of the building; efficient use of resources during construction, etc.), health and social welfare, the fight against environmental pollution, energy, effective management of built-up areas and ecology, transport, water supply, materials, waste.

LEED (The Leadership in Energy & Environmental Design) is a rating certification system developed in 1993 by the United States Green Building Council (USGBC) as a standard for measuring energy efficiency and environmental friendliness of projects and buildings for the transition of the construction industry to the design, construction, and operation of such buildings. The LEED standard consists of six sections: ensuring environmental sustainability of projects (adjacent territory); efficiency of use of water resources; energy saving and atmosphere; materials and resource base; indoor air and environment quality; new strategies in the project and innovation. These sections contain a different number of requirements, in accordance with which the evaluated project receives credit points. Below are some examples of the requirements of the LEED standard: ensuring environmental sustainability of projects (adjacent territory); efficiency of use of water resources; energy saving and atmosphere; materials and resource base; indoor air and environment quality. The LEED system also considers the use of innovations in design, operation, marketing, and promotion of the green trend in society and among professionals, as well as additional assessment options specific to one or another region. The system is arranged in such a way that without considering at least one requirement, the applicant for the certificate will not be able to obtain it due to non-compliance with the standard. The final certificate is determined by the total number of points on a flexible certification scale and has several gradations. In countries where ecological construction is developing, national standards are created that consider the socio-economic and natural conditions of the country: legislation, state policy regarding energy resources and ecology, climatic conditions, the degree of awareness of energy efficiency and environmental issues by professional communities and the population.

The development and implementation of environmental standards are carried out by the Green Building Councils. The coordination of the activities of councils and other environmentally oriented construction and management companies is carried out by the World Green Building Council (WORLDGBC). Green Building Councils have been established or are being established in the following countries:

1. Asia Pacific: Australia, India, Japan, New Zealand, Taiwan, United Arab Emirates, China, Georgia, Hong Kong, Indonesia, Israel, Jordan, Korea, Malaysia, Oman, Philippines, Qatar, Saudi Arabia, Singapore, Thailand, Vietnam.

2. Europe: Germany, Romania, Great Britain and Northern Ireland, Albania, Austria, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Montenegro, Holland, Poland, Russia, Spain, Sweden, Turkey.

3. America, Caribbean: USA, Canada, Argentina, Brazil, Colombia, Mexico, Chile, Costa Rica, Dominican Republic, Ecuador, Panama, Paraguay, Peru, Uruguay, Venezuela.

4. Africa: South Africa, Egypt, Mauritania, Morocco.

Unfortunately, the Environmental Construction Council has not yet been established in Ukraine.

The main issues of architectural ecology and its role and place in the professional training of a modern architect. In modern world science, culture and practice, the concept of “Architecture” is defined as a sphere of human activity that deals with the construction of buildings and the organization of space. It is aimed at the development of new and optimization of existing volume-planning solutions for the environment, necessary for normal human functioning. The main sections of the architecture are:

1) urban planning is a branch of architecture that solves the tasks of designing and developing the urban environment, in particular comprehensively covers the development of the city’s planning solution, the construction of new facilities, sanitary-economic and environmental problems;

2) three-dimensional architecture is the main section of architecture related to the design and construction of buildings and structures;

3) interior design is a section of architecture related to the design of the interior of buildings, i.e. directly the place of human existence;

4) landscape architecture is a section of architecture dedicated to the organization of gardens, parks and other environments, in which the material is the landscape and natural vegetation.

Architecture has a close connection with ecology. Ecology is the science of the relationship of living organisms and their communities with each other and with the environment. The term was first proposed by the German biologist E. Haeckel in 1866 in the book “Generelle Morphologie der Organismen”. At present, ecological issues are often understood as issues of environmental protection. In many ways, such a change in meaning took place due to the increasingly tangible consequences of human influence on the environment. Ecology is increasingly understood as a science that studies the natural environment and its relationships with human activity, as well as ways to reduce anthropogenic pressure. Due to this, the “greening” of other fields of knowledge is taking place. Also new sciences as geoecology, urboecology, and architectural ecology are emerging.

Architectural ecology is a science that studies the relationship between architectural objects and their internal and surrounding (external) environment. The emergence of architectural ecology as a new field of knowledge can be said to have started in the 1980s and 1990s, when the first scientific works on this topic by A. N. Tetior, K. K. Shvetsov, S. B. Chistyakova and others are appeared.

At the beginning of the XXI century environmental, architectural, and town-planning problems became particularly acute. Pollution of the human environment by emissions from industrial enterprises and transport, deforestation and pollution of the World Ocean led to a decrease in oxygen in the atmosphere. These problems in turn, causes the development of diseases in the urban population. Attempts to move industrial enterprises outside the city limits and regulate traffic flows cannot completely solve the problem. The air inside the premises of residential and public buildings is also polluted. Because of this, architectural ecology should study the interaction between the artificially created architectural and natural environment to achieve an optimal compromise between them.

Thanks to the study of architectural ecology, a specialist should know the ecological consequences of the negative impact of architectural and urban planning activities on natural ecosystems and the impact of negative processes in the environment on architectural objects; means of ensuring environmental safety of housing; environmental requirements for building materials and products; the basics of the environmental management system (normative and technical documents, environmental monitoring, other aspects of environmental law).

Thus, the role of the architect in the formation of an environmentally sustainable architectural environment is as follows: eco-reconstruction of architectural and town-planning objects and components of the natural environment in cities; development of environmentally safe architectural and planning solutions; use of environmentally safe building materials and constructures; design of energy-saving buildings; attention to the aesthetic component of the urban development complex; forecasting and assessment of the negative consequences of the construction and operation of new and reconstructed architectural and urban planning objects for the environment; timely detection of objects harmful to the environment using ecological monitoring.

Self-test questions:

1. What ancient architectural and urban planning means of improving ecological (sanitary and hygienic) environmental parameters do you know?
2. What ideology became the leading one in the architecture of the end of the 20th – beginning of the 21st centuries?
3. What is sustainable development of the city?
4. What is the essence of the environmental and energy efficiency standards of BREEAM and LEED buildings?
5. Define the terms “architecture”, “ecology” and “architectural ecology”.

LECTURE 2 Modern tendencies of ecological formation of architectural environment

Lecture plan:

1. Eco-architecture.
2. Architectural bionics.
3. Organic architecture.

A city is a complex organism, all components of which are closely related to each other. The formation of comfortable living conditions for the urban population based on environmental friendliness involves the creation as individual buildings so and the full architectural environment of the city at all. Environmental awareness must be formed among architectural specialists and the population. This is facilitated by the development of new directions in architecture, which popularize the ideas of preserving and reproducing nature, using energy-saving technologies, environmentally friendly building materials, etc.

Architectural currents, the main concept of which is unity with nature, began to emerge in the middle of the 20th century.

Eco-architecture involves the saving of electricity, the use of ecologically compatible building materials and constructures, alternative energy sources and the correct disposal of waste. The main principle of eco-architecture in the field of urban space organization is the pursuit of an optimal relationship between the architectural object and the natural environment and their specific conditions. Eco-architecture is close to another science – bionics. This is related to the relationship between living and non-living nature and architecture. Bionics is an applied science of the application of principles of organization, properties, functions, and structures of living nature in technical devices and systems. There are several more definitions of bionics: science that investigates biological processes and methods for solving engineering problems; the doctrine of the creation of technical systems, the characteristics of which approach the characteristics of living organisms.

In architectural bionics, the interaction of architectural form and nature manifests itself in three aspects:

1) structural and tectonic (study of structural systems and the basic structure of plants and living organisms and their transfer to architectural forms);

2) climatic (study of the reaction of natural forms to the climate and their use in architecture);

3) aesthetic (study and comparison of aesthetic properties of natural and architectural forms). Because of this, many architectural structural and tectonic systems (beams, columns, frames, folds, shells) resemble natural forms (branches and trunks of plants, skeletons, and shells of animals etc.).

Organic architecture is conceptually close to eco-architecture. This is a direction in the architecture of the 20th century. The main principles of organic architecture are the individual character of architectural objects, determined by a specific function and natural environment, rejection of urban industrial methods, construction from natural materials, connection with the surrounding nature. Representatives of the bionic direction take as a basis the physical properties of natural analogues, applying a fundamentally constructive approach. Architects working in the direction of organic architecture achieve their goals using natural materials and special spatial solutions to achieve the effect of unity with nature.

The term “**bioclimatic architecture**” contains a complex of design and technical solutions that allow providing comfortable conditions for human life in the house, while using a minimum amount of energy (mainly based on bio tectonic systems using renewable energy sources).

In terms of their ideology and methods, all the above-mentioned architectural directions are somewhat different from each other. But their common feature is the desire for a sustainable balance between natural and artificial components of the environment, the creation of harmony between architecture and ecology.

Plants are an important means of greening buildings and the architectural environment. It is generally known about the ability of plants to improve the quality of the ecological parameters of the environment. In addition, plants have a positive effect on the psycho-emotional state of people, mitigating the aggressive effect of the urbanized environment. Because of this, the world is actively developing a trend towards greening all surfaces of the building. Buildings organically connected to living nature (with a green roof, walls, etc.) are called **biopositive.**

During the reconstruction of the existing buildings and the construction of new biopositive structures, it is advisable to provide for the following measures: landscaping of the basement floors (biopositive constructions of extensions and plinths, creation of phyto-screening wall coverings, etc.); greening of free areas of the territory and above-ground territories above the objects of underground urban planning; vertical landscaping of walls (verandahs, terraces, hanging systems); equipment of winter gardens in buildings; organization of roof gardens; creation of special “green floors” in high-rise buildings.

High-rise construction opens interesting prospects for the organization of recreation areas in conditions of relatively clean atmospheric air. To create such zones on different levels of the building, functional floors combined with technical floors are equipped. On these floors a garden-children’s playground, a garden-sports ground with exercise equipment and a swimming pool, a garden-cafe, a winter garden can be created.

The attractiveness of high-rise buildings from an ecological point of view lies in the fact that citizens could breathe cleaner air. Many toxic compounds have a rather large specific gravity and accumulate, mainly, near the surface of the earth. With increasing altitude, the concentration of harmful substances in the air decreases. At a height of 30-35 m from the surface of the earth, there are almost no harmful substances in the air in a dangerous concentration. The idea of organizing roof gardens is also based on the understanding of this facts.

A green roof better absorbs noise and dust. The use of landscape design tools (plants, water surfaces, decorative coverings, small architectural forms) on the roofs of exploited buildings can enrich the city landscape, increase the aesthetic qualities of the architectural environment, and expand the possibilities of organizing people’s leisure time. Green floors, winter gardens, greening of roofs should be considered as components of one process and applied comprehensively, combining the aesthetics of the interior and exterior, reducing the visual aggressiveness of the urban environment.

Wall landscaping is also important. At the same time, traditional technologies are used, when plants are woven along the frame on the facade. The latest technologies illustrate the facade, which is formed from special hinged “green containers”. Greening of the roof and walls reduces overheating of the building in the summer and reduction of heat losses in the winter, improves the microclimate, and reduces the noise level.

Also, in modern architecture, “ecological agricultural farms” objects of the greenhouse construction industry are being created. They are in free urban areas, inside residential areas, on the roofs of buildings. These are light-transmitting sections connected by passages with the surrounding buildings. To grow plants in them, multi-tiered low-volume technologies are used. Oxygen-saturated air from the greenhouses is supplied by fans to the surrounding buildings, and carbon-saturated warm air from the buildings is supplied to the greenhouse by exhaust fans. Indoor courtyard spaces enclosed by light metal structures and glass can be used as winter gardens, greenhouses, or places to relax.

Self-test questions:

1. What is eco-architecture?
2. On what principles of interaction of nature and architectural form is architectural bionics based?
3. What are the features of organic and bioclimatic architecture?
4. How do the visual characteristics of the architectural environment affect the physical and psycho-emotional state of a person?
5. What is a homogeneous and aggressive environment?
6. What can be the compositional role of architectural objects?
7. What are biopositive buildings?

CONTENT MODULE 2 BASICS OF FORMING ENERGY-EFFICIENT ARCHITECTURE

LECTURE 3 Principles of designing ecological energy-efficient buildings

Lecture plan:

1. Eco buildings, energy-efficient and energy-active buildings.
2. Passive and active energy supply systems of buildings.
3. Environmental benefits of underground urban planning
4. Energy saving and protective properties of a relief.

One of the main principles of ecological architecture is the preservation and efficient use of energy resources. At the same time, modern eco-houses must be energy-saving and energy-efficient, i.e. independently provide themselves with the energy necessary for all life processes.

Eco-house, energy-efficient house or passive house is a building with the absence of the need for heating or low energy consumption. The idea of a passive house is to create a building, which could maintain comfortable living conditions for people for a long time without supplying external energy. This is an example of a closed system that does not require external intervention for its existence. The main advantages of eco-house include:

1) use of solar energy for heating the house and preparing hot water;

2) lighting from solar batteries;

3) disposal of organic waste using bioreagents;

4) the use of energy-saving and aesthetic principles inherent in the historical, national, and cultural features of its inhabitants and territory in the architecture of the house.

The first successful “passive” house equipment scheme was developed about 20 years ago. Its author is Dr. V. Falst from the Darmstadt (Germany), which became the founder of the Passive House Institute.

Usually, the amount of energy (Kilowatt-hours) per square meter serves as an indicator of the facility’s energy efficiency. On average, this value is 100-120 kWh/m^2. A building is considered energy efficient where this indicator is below 40 kWh/m^2. For European countries, this indicator is even lower – about 10 kWh/m^2.

In Europe, there is the following classification of buildings depending on their level of energy consumption:

– “Old building” (buildings built before the 1970s) – they require about 300 kWh/m^2 per year for their heating;

– “New building” (erected from the 1970s to 2000) – no more than 150 kWh/m^2 per year;

– “Low energy consumption house” (since 2002, the construction of houses of a lower standard has not been allowed in Europe) – no more than 60 kWh/m^2 per year;

– “Passive house” – no more than 15 kWh/m^2 per year;

– “Zero energy building” (a building that architecturally has the same standard as a passive house, but is engineered to consume only the energy it produces) – 0 kWh/m^2 per year;

– “Active building” (a building with installed engineering equipment in it (solar panels, collectors, heat pumps, recuperators, ground heat exchangers) produces more energy than it consumes).

According to the nature of energy production, eco-houses are divided into the following types: solar-energy-active, bio-energy-active, wind-energy-active, etc.

The Energy Performance of Buildings Directive, adopted by EU countries in 2009, requires that all new buildings be close to energy neutrality.

In Ukraine, the first passive house was built in 2008. It is "Passive House in Kyiv" in the database of the Passive House Institute in Darmstadt. A reduction in energy consumption is achieved due to a reduction in heat loss of the building. The architectural concept of a passive house is based on the principles of compactness, high-quality and maximally effective insulation, absence of cold bridges in materials and junctions, correct geometry of the building, zoning, orientation according to the cardinal points. Of the active methods in a passive house, it is mandatory to use a supply-exhaust ventilation system with recuperation.

A passive house should be an independent energy system that does not require costs to maintain a comfortable temperature. The heating of a passive house should take place thanks to the heat emitted by people and household appliances. If additional heating is necessary, it is desirable to use alternative energy sources. Hot water supply can also be provided by renewable energy installations (heat pumps or solar water heaters). Solving the problem of air conditioning of the building is supposed to be done at the expense of the appropriate architectural solution. If additional cooling is needed, alternative energy sources, for example, a geothermal heat pump, can be used.

Thus, during the construction of an eco-house or a passive house, the following basic directions and methods of their implementation can be distinguished:

1. Thermal insulation:

– building structures with maximally increased thermal insulation (heat transfer coefficient no more than 0.15 kWh/m^2 strives for the ideal of 0.10 kWh/m^2);

– butt and transition joints without heat leakage (correct calculation or hermetic execution).

2. Airtightness:

– creation of a hermetic protective shell;

– ensuring the tightness of all buttock and transitional connections;

– carrying out a test on the tightness of the building during the construction process, n 50 = 0.6 V normal/hour.

3. Controlled ventilation:

– mechanical method of ventilation;

– heat recovery: installation of appropriate devices near the thermal envelope of the building, the degree of recovery is not lower than 75%;

– if necessary, additional thermal insulation of the central device and heating element;

– “comfortable” ventilation: controlled by the user;

– as an alternative option – installation of an earth heat exchanger.

4. Windows:

– qualified installation of window structures;

– use of triple glazing and super insulating window frames.

5. Location and direction of the building:

– the southern direction of the main facade (permissible deviation +/-30°) and large window openings directed to the south;

– absence of shaded areas in order to ensure passive accumulation of solar energy;

– vegetation that does not provide shade.

6. Compactness of the building form.

In contrast to traditional housing organization schemes, the concept of "smart building" with the integration of systems that ensure the comfort and safety of human habitation (self-monitoring of water supply systems, heating, energy saving, etc.) has recently been developing. The scheme of remote control of intelligent systems from a computer or mobile phone has become relevant. In the first case, they create a web page with which home appliances are controlled. And in the second case, they use a server that converts phone signals into signals for the processor. Such buildings are becoming common in the world because they fully correspond to the rational use of energy resources.

Ecological advantages of underground urbanism. Underground structures are more protected from the effects of many harmful factors (noise, air pollution, etc.). There are more than 100 types of underground structures located at different depths. Compared to above-ground structures, underground structures have the following environmental advantages:

1) they can be located almost on the entire territory of the city due to minimal impact on the landscape and environment;

2) they do not disturb the existing structure of urban development;

3) they save energy resources during their operation;

4) they are characterized by increased vibration resistance and acoustic insulation.

In Europe, the USA and Japan there are many examples of the use of underground space. Technically, the easiest underground construction is in cities with developed subway construction. The presence of such organizations allows us to use their methods and capacities for the development of underground space. The main types of construction of underground structures are an open pit (the main disadvantage is that it requires large areas and is therefore almost unacceptable for urban development), overhanging (a disadvantage is limited by soil types), "wall in the soil" and the down well method. The last method is optimal for the construction of underground garages. It does not require the participation of special construction organizations and allows the construction of an underground structure near existing buildings. But when developing underground space in urbanized areas, several complex engineering problems arise:

1) the need to arrange complex systems of ventilation, waterproofing, lighting, sewerage, special signaling;

2) use of complex equipment;

3) ensuring the safety of underground works;

4) soil utilization.

In addition to these exclusively technological problems, we should not forget that the construction of underground structures is possible only in areas not prone to flooding. Even if the underground structure is well insulated and will not suffer from flooding, it can significantly change the hydrogeological regime of the surrounding areas and provoke flooding of the existing surrounding buildings.

Energy conservation and protective properties of the terrain. Conservation of energy resources in the architectural and construction industry can be achieved thanks to the construction of buried residential buildings. In this case, the principle of energy saving is simple: the earth protects the house from wind, cold, etc. The energy-saving effect of buried residential buildings is determined by the protective layer of the soil. In the summer, buried structures practically do not need to cool the air in the premises. It cools due to heat transfer through the structures (floor, walls, covering) to the soil fill. Special cooling measures may be necessary only in particularly hot periods. In winter, soil fill significantly reduces the heat loss of the structure due to the additional thermal resistance created, the practical exclusion of uncontrolled infiltration of cold air due to the leakage of structures, significant changes in the amplitude of daily and seasonal temperature fluctuations. As a result, buried buildings function, as a rule, in conditions of a favorable thermal regime, which contributes to their preservation.

From an ecological point of view, sunken buildings are also interesting for the possibility of using for development areas that are unsuitable for placing above-ground buildings. These are areas with large slopes or located along transport highways and near airfields. The main requirements for the site are the presence of dry, not prone to erosion, preferably sandy soils; low level of groundwater; availability of relief; low relative humidity. The steepness and orientation of the slopes, the general nature of the relief determine the possibilities of a favorable orientation of the building. Preference is given to south-facing slopes, which allow the most efficient use of solar energy for heating the premises. With steep slopes, it becomes possible to design a sunken building in two levels, which also contributes to energy savings.

When designing sunken buildings in the system of existing buildings, it is necessary to consider the need for gaps between buildings, especially if the structure has a courtyard, to avoid its shading.

Energy-saving sunken buildings are divided into semi-sunken (slope), sunken (shallow and deep) and cut into slopes, and according to the nature of the volumetric and spatial solution – into elevated, cut into slopes, buildings with courtyards and through-type buildings.

The most common elevated buildings. They are erected on flat or with a small slope to the south side of the terrain, if a large volume of soil excavation is undesirable for economic reasons or impossible due to the hydrogeological conditions of the construction site. The building should rise above ground level by no more than 30 %. Rooms without mandatory natural lighting are in the depths of the building. Kitchens and dining rooms can also be located there as part of residential premises. To ensure the necessary light front, the building must be made elongated.

Submerged residential buildings cut into the slopes are built with a steep slope of up to 50º, provided that the soil has sufficient bearing capacity. The planning decisions of such buildings are approximately the same as in the previous version. Buildings cut into the slopes are characterized by opportunities for a wide view of the surrounding area. A special feature is the need to protect the structure from water flowing down the slope.

In sunken buildings with an inner courtyard (atrium), rooms are grouped around it. All residential premises that require natural lighting directly open on it. The building may have one or several courtyards. The yard can be the only open part of the building with an entrance to it, and the entire outer perimeter is filled with soil. The entrance can be organized along the outer perimeter, then the courtyard is used as an element of the passive solar system for heating the building. In the summer, when a pond and a fountain are installed in the yard, it can serve to cool the air in the premises due to the use of moisture. Interconnection of residential premises of an atrium-type building can be organized along corridors passing along the outer perimeter of the building or along the perimeter of the courtyard, as well as directly along the courtyard. Atrium buildings are convenient for areas with a hot climate.

Buildings of the through-type can have unfilled areas along the outer perimeter of the building, oriented to different sides of the horizon, which allows you to organize lighting and ventilation. At the same time, more favorable firefighting conditions are achieved, the possibility of organizing emergency exits. Planning decisions of a through-type building may not differ from the planning of a ground house. From the outside, the building looks more attractive than the elevated one. At the same time, reducing the perimeter of backfill with soil adversely affects the energy-saving qualities of the building.

The elements that characterize each of the above-mentioned buildings can be combined depending on the specific conditions for which the building is designed.

Since sunken residential buildings are built with compliance with the conditions of natural lighting and insolation, they are not built more than one or two floors. When designing buried buildings, it is also necessary to consider fire safety requirements. Solving these problems largely depends on the correct selection of the area and location of the window openings, which should provide the necessary evacuation conditions in case of fire. Windows intended to serve as emergency exits should be located so that the height of the windowsill does not exceed 110 cm.

Thermal insulation is installed to reduce unwanted heat transfer from the premises to the soil. It is most rational to place it on the outer surface of structures. The building seems to be covered with a heat-insulating shell, which prevents rapid temperature changes inside the building in peak conditions – in winter and summer.

In regions with complex topography, buried buildings can be used as the main ones in the construction of eco-settlements. In cities, they can be erected on the slopes of beams. At the same time, buried houses will have almost all the advantages of underground structures, but, unlike objects of underground urbanism, complex technological problems will not arise during their construction.

Self-test questions:

1. Name the types of eco-houses and define their advantages.
2. What ecological advantages of underground structures do you know?
3. Name the main types of construction of underground structures.
4. What engineering problems should be considered in underground construction?
5. What types of buried buildings do you know by depth?
6. What are the types of buried buildings according to the nature of the volume-spatial solution?
7. What are the features of compositional planning and volume-spatial organization of each type of buried buildings?
8. What are the special structural requirements for the construction of sunken buildings?

LECTURE 4 Structural and planning means of ecological formation of architectural objects

Lecture plan:
1. Factors of comfort of the architectural environment.
2. Rational design and planning solutions to improve the environmental parameters of the building.

Factors of comfort of the architectural environment. Houses are an artificially created ecosystem. This ecosystem closely related to the environment. Gases, dust and living microorganisms enter the premises from polluted outdoor air. Any architectural object must be considered as an integrated ecological-anthropogenic system that functions and changes over time. All components of this system are interdependent and are under the influence of a complex of internal, external, natural, and anthropogenic factors. The main requirements of "environmentalism" include compliance with sanitary and hygienic standards, the use of rational structural and planning tools, energy-saving technologies, and environmentally friendly building materials.

Given the fact that residential and public buildings are places where people stay for a long time, they must be comfortable and safe. The environmental safety of buildings is determined by their ability to provide standard values of comfortable living conditions and not to have a negative impact on people's health. The system of requirements that determine the comfort of staying in a building from the point of view of architectural ecology combines several groups of factors: capital factor, functionality factor, hygiene factor.

The capital factor as a means of assessing the rationality of the internal environment is considered at the initial stage of studying the requirements for this environment. This concept unites the prestige of the building, which depends on its appearance, the quality of construction and decoration, the comfort of the volumetric planning solution. Capital depends on fire resistance and durability.

Functional comfort is the convenience of a person's stay and his activities in the artificial environment of the building. Spatial connections arise in this environment, which are studied in two aspects: anthropometry and psychology of human behavior in space. The anthropometric (ergonomic) aspect provides that the planning and volumetric elements of the house are adapted to the physiological characteristics of people. Psychological comfort is achieved when the dimensions of the premises correspond to their functional purpose.

Environmental hygiene affects people's health. The main indicators are regulated at the legislative level. The artificial environment of buildings is equated with microclimate. The main parameters of the microclimate, which are considered during the ecological and hygienic assessment of the internal environment of the premises, include: heat and humidity regime (air temperature, temperature of the inner surface of enclosing structures, relative air humidity, air movement speed), insolation level, ecological cleanliness of environmental components, sound, and visual comfort, etc.

The heat-humidity regime is a complex parameter. All its components are strictly regulated. The following indicators are considered optimal for the microclimate of residential and public buildings in the warm period of the year: air temperature – 20–25 °C, relative air humidity – 30–60 %, air movement speed no more than 0,25 m/s, average temperature of the inner surface of enclosing structures – 26–30 °C. In the cold period of the year, these indicators are, respectively: 20–22 °C, 30–45 %, 0,1–0,15 m/s and 17–21 °C.

The calculation of structures and the internal environment for compliance with these regulatory parameters is a mandatory component of the project of any architectural object.

The insolation regime (direct solar radiation of building surfaces and the surface of the earth) is one of the most important conditions for building hygiene. The criterion of insolation is the duration of solar radiation. This value is determined by modeling and calculation and graphic methods.

Natural lighting brings ultraviolet and thermal infrared radiation into the room, which regulates the metabolism in the body, increases immunity and improves the psycho-emotional state.

In addition to requirements for the duration and intensity of insolation, there are norms for the orientation of apartments. There is also a dependence of the planning structure of houses and apartments on the orientation of the sectors of the horizon and the meridional or latitudinal placement of buildings. Measures to improve the insolation regime of buildings are aimed at increasing the duration of irradiation in unfavorable areas of the territory and in the premises of buildings. They are reduced to certain planning techniques:

1. Internal remodeling in a shaded house. As a result of changes in the planning structure, apartments oriented on two sides of the horizon are created.

2. Opening of shaded facades by demolishing shading buildings. The solution is possible when the gap between opposite buildings is less than the height of the shading object and the yard is built on four sides.

3. Demolition of one or two floors of the shading building, which will allow lighting of the lower floors on the shaded facade.

4. Elimination of residential premises on the lower floors, which have the lowest level of insolation.

Ecological cleanliness of environmental components is primarily associated with air cleanliness. There are more than ten internal sources of chemical air pollution in residential and public buildings. The main of them are release of toxic substances from building and finishing materials and constructures (especially products of destruction of polymeric materials); filtration of toxic gases and dust from polluted atmospheric air; penetration of radon, methane, and other harmful gases from basements. The main danger of technogenic building materials (mainly the results of recycling secondary raw materials) is high toxicity. The main danger of natural origin building materials (natural stones, etc.) have a high level of radioactivity.

The ionic composition of the air (the balance of positive and negative ions (aerons) of oxygen) is also of great importance for human health. It is known that air after a thunderstorm is considered “fresh”, as well as mountain, forest, and sea air. Because this air has an increased content of negative oxygen ions O2 (aerons). Computer displays, TV screens and filters of modern air conditioners not only destroy negative oxygen ions, but also generate positive ions. The excess of positive ions in the air is harmful to the human body. A well-adjusted room ventilation system is necessary to ensure a balanced ionic composition of the air.

Sound comfort is one of the leading factors that determine the hygiene of the architectural environment.

More attention is paid to visual comfort. Visual isolation of rooms, especially individual rooms, plays a positive role, satisfying the need for privacy. To ensure this condition, the premises are made not only sound-proof, but also visually insulated by architectural and spatial means.

Rational design and planning solutions for improving the environmental parameters of the building. Modern ecological houses should be energy-saving. The main volume-planning and constructive means of greening and energy saving of buildings should include:

– application of rational compositional planning and constructive solutions (in accordance with specific climatic conditions);

– maximum use of underground space;

– use of the protective properties of the terrain;

– construction of “eco-house” and “intelligent structures” type buildings;

– landscaping of all surfaces of the building (walls, roof) and the surrounding area.

Effective and rational means in the field of energy-saving architectural and planning solutions include:

1) simplification of the configuration of buildings (reduction of the area of enclosure structures relative to the total area);

2) construction of attic floors in existing buildings;

3) optimization of architectural forms (in accordance with climatic features);

4) optimal orientation of buildings according to wind and sun.

Simplifying the configuration of buildings is relevant for both southern and northern regions. It is allowing reducing heat exchange with the environment due to a reduction in contact surfaces. It is advisable to build houses with a complex plan shape mainly in middle latitudes. Building attic floors on existing houses, especially those with a flat roof, also reduce heating costs. This is because additional insulation of the attic reduces heat transfer to the air. Optimization of architectural forms in accordance with climatic conditions is the choice of constructive and planning solutions that allow to protect the building from the influence of the external environment as much as possible.

The issue of the optimal orientation of buildings to the wind and the sun must be considered in two aspects. On the one hand, the minimum regulatory level of insolation and natural ventilation of the premises must be ensured. On the other hand, placing the house in areas with high wind speeds (on hills, drafts, etc.) can lead to increased air infiltration inside the building. As a result, it is an increase in the speed of air movement in the room above the legally permitted. One of the planning means of protection is the placement of the building relative to the prevailing direction of the wind with an end façade. The vertical communications and technical premises can be led on this façade. Likewise, protection against overheating of the premises must be ensured by planning or constructive means.

Prevention of excessive insolation (overheating of premises) in the southern regions is one of the main problems that must be solved to ensure comfortable ecological and hygienic conditions. The most common constructive means of regulating the level of insolation is sun protection equipment. It is divided into horizontal and vertical according to the planning structure. The horizontal type of sun protection equipment includes visors (solid and slatted), horizontal blinds (stationary and mobile), awnings, sunscreens. A group of vertical sun protection equipment consists of vertical blinds, solar screens, vertical ribs (straight and obliquely directed). In addition, sun protection will be facilitated by the northern orientation of windows and bay windows, the saw-shaped shape of the external walls, and shade coverings.

Self-test questions:

1. What effective energy-saving architectural and planning solutions do you know?
2. What should be the ventilation schemes and orientation of buildings?
3. What types of sun protection equipment do you know?
4. What groups of factors determine the comfort level in a building?
5. What factors are considered during the ecological and hygienic assessment of the internal environment of the premises?
6. What is insolation? What are the standards for insolation and orientation of apartments?
7. What planning methods do you know for improving the insolation regime in unfavorable areas of the territory and in the premises of buildings?

CONTENT MODULE 3 THE SPECIFICS OF ECOLOGICAL FORMATION OF ARCHITECTURAL AND URBAN PLANNING OBJECTS

LECTURE 5 The main principles of formation of eco-cities

Lecture plan:

1. The concept of the eco-city.
2. Architectural and urban planning tools and methods of forming eco-cities.

An eco-city is a city designed with environmental impact in mind. Eco-city is populated by people who strive to minimize energy, water, and food consumption, eliminate reckless heat generation, CO_2 and methane air pollution, and water pollution. The word “eco-city” was first used by R. Register in 1987 in the book “Berkeley Eco-city: Building a City for a Healthy Future”. Other prominent figures who foresaw the emergence of eco-cities include the architect P. Downton (who later founded Ecopolis Pty), and the writer T. Bithley (who wrote extensively on the subject). It is possible to single out the main principles of sustainable development of urban areas:

1. Humane number of floors of residential buildings: not higher than 5 floors.

2. Optimal building density: absence of heat islands.

3. Development according to the “cells” principle: creation of green yards and playgrounds; separation of business districts with high-rise buildings from residential green areas.

4. Coordination of the architectural appearance of buildings with the features of the local landscape and national architectural traditions.

5. Planning decisions that consider the improvement of the public transport system and the increase of pedestrian zones to reduce car emissions (integration of business, industrial and residential zones).

6. The most environmentally acceptable transport: trolleybuses, trams, funiculars, overhead and ground electric trains; encouraging and supporting the use of bicycles.

7. Calculation of parking lots near residential areas and administrative, business centers, considering the demographic and economic development of the region.

8. Arrangement of territories: creation of artificial reservoirs, parks, alleys, arrangement of embankments, etc.

9. Use of renewable energy sources: wind generators, solar batteries, or biogas.

10. Use of local sources of renewable energy in each quarter during creating engineering infrastructure.

11. Use of internal energy-saving technologies (a device to ensure natural ventilation and lighting) in connection with the capabilities of the regional energy system.

12. An effective water supply and drainage system in a complex with local systems of recirculation of used water (sewerage with maximum primary cleaning before discharge into reservoirs).

13. Creation of various agricultural structures within the city (in the center or suburbs): small private agricultural plots or large-scale vertical agricultural buildings of the type “agro-skyscrapers”.

Examples of ecological cities (that exist or are being planned) in many countries: Australia (Moreland district in Melbourne), Brazil (Porto Alegre and Curitiba), Great Britain (St. Davids, Leicester), Germany (Freiburg), India (Tes-City Gujarat, Manimekala), Ireland (Clonburris – a suburb of Dublin), Canada (Calgary – the first city in the ranking of eco-cities on the planet), China (Dongtan, Huangbaiyu), Korea (Sondo, Kwange City), New Zealand (Whiteaker), USA (Arcosanti, Coyote Springs, etc.), Sweden (Gothenburg, Elvstran den), Ecuador (Loya), France (green districts in the cities of Bordeaux, Marseille, Grenoble, Nice and Strasbourg).

The landscape and ecological approach to the organization and use of urban lands based on their comprehensive assessment is presented as the most important tool in the formation of their sustainable development. The central link is the ecological frame of the territory. It functions in the system of elements of the urbanized landscape with area that goes beyond the administrative boundaries. The greening of modern projects in urban planning is based on the theory of planning zoning. Its essence is the mutual location of urban structures and the optimization of territorial connections of industrial, residential, communal, transport and other functional zones by methods of territorial structural and functional regulation of anthropogenic loads. The ecological situation in the city largely depends on the extent to which its functional and planning structure corresponds to the landscape features of the territory. In the landscape and ecological approach to the placement of functional zones, the criterion of eco compatibility or eco polarization becomes decisive in the functional zoning of the urban landscape. That is the maximum separation of ecologically incompatible types of territory uses and the convergence of ecologically complementary functional territorial structures. Buffer (compensatory) zones are created between natural and ecological elements and economic structures, which ensure the ecological well-being of the urban landscape. Special purpose territories (sanitary and protective zones, technical corridors and forest park belts, city boulevards) and territories with the functions of forestry and agriculture act as buffers. The principle of allocation of the eco-framework and buffer zones is the basis of the formation of the composition of urban territories, regardless of their zonal and regional location.

The concept of ecological frameworks provides for the specific use of areas of the urban landscape with the most valuable ecological properties. The ability to reproduce natural components, support of natural mass-energy exchange, and neutralization of technogenic pollution are stand out. Recommendations for the placement of urban planning objects based on the landscape and ecological approach make it possible to increase the efficiency of urban territory planning. The implementation of landscape planning in the practice of managing territorial units (primarily at the municipal level) will allow preserving the landscape structure of the city. Landscape and ecological analysis allow to use a complex approach in management when the landscape and ecological features of the territory will be considered to make each specific decision.

Self-test questions:
1. Define the term "eco-city".
2. What examples of ecological cities do you know?
3. Name the main methods of formation of eco-cities.

LECTURE 6 Factors of urban pollution in the system of mutual influence "architecture – environment"

Lecture plan:
1. Noise as a factor influencing architectural objects and the environment.
2. Vibration pollution of the human environment.
3. Air pollution and water pollution.
4. Electromagnetic pollution as a factor influencing the environment.

Factors of pollution of the urban environment. There is an opinion that many environmental problems of modern cities are related to architectural and urban planning activities. At the same time, it is known that a modern large city is a complex system where natural and anthropogenic components are inextricably linked. The quantitative predominance of the anthropogenic component determines the dominance of technogenic influences on the environment and architecture.

However, the unsatisfactory characteristics of the environment (air pollution, etc.), caused by other types of human activity, also negatively affects the state of architectural objects. In general, the environmental problems caused by architectural and urban development activities include the reduction of biological diversity (in terms of quantity and nomenclature), pollution of atmospheric air, soils, and water surfaces, increasing volumes of wastewater, shallowing and disappearance of small rivers, intensification of flooding, landslides, karsts. Thus, all factors that determine the state of the ecological situation in the city can be divided into two groups:

1) pollution factors (air and water pollution, noise, radiation and electromagnetic pollution);

2) disturbance factors (disturbance of the earth's surface, hydrogeological regime, characteristics of climatic values or other parameters, the change of which is caused by anthropogenic influences).

The most common type of negative anthropogenic impact is pollution. Pollution can be physical, chemical, biological, mechanical, and aesthetic. In the "architecture – environment" system, physical and aesthetic pollution prevails. Aesthetic pollution is divided into types of violations of natural and urban landscapes, destruction of architectural monuments, monotonous and monochrome architecture. Physical pollution can be thermal, noise, radiation, vibration, electromagnetic and light.

Noise as a factor affecting architectural objects and the environment. One of the most common factors of pollution of the architectural environment of human life is noise. This is a collection of numerous sounds that rapidly change in frequency and strength. Noise is also called an unpleasant and inharmonious sound, which at high intensity can cause a violation of a person's physiological activity, cause stress and nervous disorders. So, if noise is a type of sound, then it should be noted what sound is.

Sound is mechanical waves with a frequency of oscillations from 16 to 20,000 Hz, which propagate in various media (elastic, solid, liquid, and gaseous) and are perceived by the human ear. At the same time, sound waves with a large amplitude of change in sound pressure are perceived by the human ear as loud sounds, and with a small one – as quiet.

The conventional unit of decibels (dBA) is used to measure sound strength and power. Decibel is a relative unit. Sound power, measured in decibels, is determined by the logarithm of the ratio of this sound power to some other, conventionally accepted as unit. So, talking about the power of sound in decibels it is not the amount of energy carried by a sound wave through a unit of area per unit of time that is meant, but the level of sound power. The next sound parameter is its frequency (f) i.e. the number of oscillations of the source (and, accordingly, the sound pressure) in 1 second. The unit of measurement of sound frequency is hertz (Hz). By frequency, sound is divided into three ranges: infrasound ($f < 20$ Hz), ultrasound ($f > 20{,}000$ Hz) and the audible range (16–20,000 Hz), which is perceived by the human ear.

People are most vulnerable to noise in living spaces, especially at night. Hygienic standards in all countries of the world allow noise levels in production facilities of factories up to 80–85 dBA, and in living rooms – only 25–30 dBA at night and 40 dBA during the day. Because of this, during the development and implementation of projects of replanning and construction of new and reconstruction of existing urban areas, among many environmental problems, great attention should be paid to ensuring acoustically favorable conditions for the population's residence. According to the results of research, 30–50 % of the population of modern cities are exposed to constant or periodic (during the day) exposure to noise (the level of it exceeds the normative indicators). Thus, the population are in zones of acoustic discomfort.

To protect against noise and plan and implement measures to eliminate areas of acoustic discomfort, the architect must first consider that there are two types of noise in architectural and building acoustics:

1) "air" noise that arises and spreads in the air;

2) "impact" noise that occurs directly in the enclosing structures because of mechanical impact.

To protect against "air" noise, there are three main methods of sound attenuation:

1. Increasing the massiveness of the elements of the fencing structures.
2. Use of sound-absorbing elements.
3. Sealing of all possible ways of penetration of air sound waves.

The first method is sound attenuation due to mass. It assumes that to protect the interior space of the room from external noise, the enclosing structures must be sufficiently massive. Special attention should be paid to such phenomena as "critical frequencies" and "acoustic holes". It is about the fact that at a certain frequency, which is called critical, a "hole" appears in the sound insulation (loss of soundproofing properties) in a homogeneous panel. Moreover, if this "acoustic hole" is in the range of frequencies that are well perceived by the human ear (conversation, music, etc.), then the sound spreads almost without interference. The value of the "critical frequency" depends on the material of the enclosure structure. Materials such as lead, rubber, or polymer lead, which have a high dissipative capacity, do not have "acoustic holes" in the frequency range that humans can hear. For traditional building materials (concrete, brick), "holes" in sound insulation at the "critical" frequency can be from 6 to 10 dBA. To reduce the effect of the "critical frequency" of walls made of traditional building materials, it is necessary to increase the mass of enclosing structures. The best option for brick walls is to divide them into two parts, or even better, to cover them with different materials. Then the noise will also be muted in different frequency ranges. The protective effect can be improved by placing sound-absorbing materials between the shells. At the same time, each centimeter of the layer of sound-absorbing material improves the sound-insulating properties of enclosing structures by 1 dBA.

The second method to reduce "air" noise (to weaken the sound due to its absorption) is to use sound-absorbing materials. At the same time, the amount of scattering depends on the thickness of the material, its density and elasticity. Mineral wool, thermo-sound insulation are most often used. It should also be considered that materials with a closed porous structure (cork, foam, polyethylene, polyurethane, etc.) are designed mainly for protection not from "air", but from "impact" noise.

The third method of protection against "air" noise is sealing. It consists in covering all gaps in the enclosing structures with special acoustic sealants. An important characteristic of "air" noise is also the fact that it can cause the phenomenon of resonance. Meeting any structure, sound waves cause its forced oscillations. If the frequency of the natural vibrations of the structure coincides with the frequency of the sound wave, acoustic resonance occurs. In architectural and building acoustics, a resonator can be any structural element. To reduce this effect, the wall is divided into two parts with different masses so that they do not resonate at the same frequency.

The negative effect of "impact" noise is that any mechanical vibrations in structures caused by external forces spread throughout the building at a very high speed. They cause vibration of other structures with which they have a hard contact and become a source of "air" noise. The main task that must be solved in the fight against "impact" noise is the prevention of the propagation of sound waves through structural elements, i.e. blocking of vibration. This is achieved thanks to the use of shock-absorbing materials and the breaking of “sound bridges” between structural elements. Another constructive means is the equipment of a “floating” floor (isolated from the main structure of the screed on an elastic material).

To optimize the level of the noise regime in buildings and in urban areas, reduce the noise load and eliminate zones of noise discomfort, the following architectural-planning, construction-acoustic and organizational-administrative measures are necessary:

1. Stopping the construction of acoustically unprotected housing in areas with a very high level of external noise. In developed countries, there is a lot of practical experience in solving these problems. It boils down to three architectural and construction methods: the construction of non-residential strip buildings along highways; construction of shielding structures with the use of landscaping and a high level of artistic and architectural expressiveness; acoustic protection of rooms facing noisy facades of buildings.

2. Production and use of soundproof windows.

3. Implementation of various measures to combat noise at all stages of project development, reconstruction and operation of architectural objects and noise sources.

4. Inspection of architectural objects, especially residential ones, regarding the quality of internal and external noise insulation of enclosing structures relative to external and internal noise sources.

Measures to reduce the noise level in residential buildings should be divided into:

1. Reduction of noise in the residential buildings themselves.

2. Reduction of the noise level on the way of its movement to the houses.

3. Creation of special noise-proof buildings.

To reduce the noise level in residential buildings, lift shafts are moved beyond the external enclosing walls. Lift and ventilation shafts are equipped in the form of self-supporting structures resting on an independent foundation.

Measures to reduce the level of noise in the way of its propagation include removal of noise sources (industrial enterprises, etc.) beyond the boundaries of residential buildings; creation of noise protection greening strips; equipment of special noise protection structures and soundproof screens (walls, embankments, etc.). Measures such as the construction of noise protection structures and soundproof screens are the most common to reduce the level of noise from transport highways in the countries of Western Europe, the USA and Japan. They are because, meeting an obstacle on its way, the sound wave is reflected from it. And when the sound passes through any medium and reflected, the energy of the sound waves is partially absorbed, due to which the sound weakens.

Since the biggest sources of noise in cities are highways, structures that can significantly reduce the level of penetration of sound waves into inter-highway areas are traditionally called noise barriers (walls, ditches, embankments). For example, the soundproofing efficiency of a wall 2.4 m high is 16 dBA, while green spaces 40–60 m wide have an efficiency of 5–6 dBA. In addition, leaf cover persists for 4–5 months of the year, so a green barrier cannot be a decisive protection measure. The effectiveness of artificial shielding recesses and embankments depends on their design parameters. With the correct selection of parameters, they can reduce the sound level by 14–20 dBA.

At the same time, the angles of incidence and reflection of the sound wave are equal and lie in the same plane. If an obstacle is created in the path of a sound wave, the dimensions of which can be compared to the wavelength, then diffraction occurs. Diffraction is partial bypassing of this obstacle by the sound wave. Due to this, there are no sound shadow behind the obstacle and noise protection effect.

Urban planning activities also include the construction of noise-proof buildings with screens capable of protecting the rest of the neighborhood from noise. Usually, this is a special type of residential building, in which the stairs, utility and technical rooms are oriented towards the highway. The noise-proofing capacity of the constructures of these buildings is increased. Noise-proof houses are placed on red lines, with the maximum approach to transport highways. The noise protection building should be long (at least 100 m) and high. The height of the screen house depends on the level of traffic noise (at least 16 floors on main roads, 12 and 9 floors on city and district streets, respectively). The house can have a U-shaped plan. In this case the purpose of the elongated end wings is to protect the courtyard facade and the inner quarter territory. The noise-proofing effect of the house should not be reduced due to internal block entrances. They are arranged underground or in the structure of the first floor of the end wings.

Houses with increased soundproofing capacity of enclosing structures and with the use of soundproof (glazed) balconies, loggias are called noise proofed. The soundproofing ability of structures (the degree of absorption of sound energy) is characterized by the “sound absorption coefficient” (SAC). Materials that dissipate most of the energy within themselves are called absorbing. These are acoustic tiles, carpets, curtains, furniture, and other materials. Their SAC can reach 100 %. And such materials as plaster, brick, glass, concrete, and others are reflective. Their SAC can be in the range of 5–10 %.

Thus, in the “architecture – environment” system, the factor of noise pollution occupies one of the main places. This factor requires special attention because the two-way nature of relationships in the system is fully traces in it. On the one hand, architectural objects and urban areas need protection from noise caused by other components of the urban environment. On the other hand, architectural objects, especially at the construction stage, are themselves powerful sources of noise. Measures to eliminate areas of noise discomfort can be effective only in the case of a comprehensive approach to the problem, under the conditions of their application at the city or district level.

Vibration pollution of the human environment. Complex protection of buildings from technogenic and natural vibration is one of the most urgent tasks of the architectural and urban planning industry. The need for vibration protection has especially increased recently due to the mass transition to economical and light structures with quite high the sensitivity to vibration. In addition, the areas of “profitable” construction are almost exhausted: either the suburbs or inconvenient areas remain vacant in cities (exclusion strips in the area of subway and railway tracks, sites near sources of intense dynamic loads, etc.).

Vibration loads have a very dangerous effect on a person. The most dangerous oscillations are in the subsonic spectrum (less than 20 Hz). They can disturb spatial orientation, cause dizziness and impaired vision. The human body is a system of interconnected vibrating elements. Its individual parts and organs have their own vibration frequencies.

Therefore, the coincidence of the specified frequencies with the frequency of external vibration or infrasound (the phenomenon of resonance) can significantly harm the vital organs of a person. The frequency of external oscillations of 7 Hz coincides with the L-rhythm of the biotopes of the brain. Frequencies of 1-3 Hz disrupt the rhythm and frequency of breathing. Frequencies up to 5 Hz can cause mechanical damage to internal organs. Frequencies of 7–8 Hz are the cause of heart attacks (provoke the phenomenon of resonance of the circulatory system). Frequencies up to 15 Hz cause pain in the chest, abdomen, back, and muscles. Prolonged exposure to low frequencies provokes depression.

“Microdefects” develop in buildings subjected to increased vibration. They can eventually lead to a loss of structural strength and their gradual destruction. Particularly dangerous is the vibration effect from the operation of vibratory compactors, vibratory rollers, pile driving units and some other devices in the immediate vicinity of residential buildings. It is relating to the possible coincidence of their vibration frequencies with the frequency of the buildings' own vibrations (14–25 Hz). To prevent the spread of vibration to the nearest residential buildings, acoustic seams are arranged around the perimeter of the foundations of vibrating units and filled with loose material. The construction of buildings and structures equipped with vibration and seismic protection systems (including those based on the use of elastomers) in the leading countries of the world (England, Japan, the USA, Canada) began in the 60s and 80s of the 20th century. Now dozens of vibration-isolated buildings have been erected there.

Vibration protection against vibrations in the zone of influence of the metro and railways requires special attention. In such situation, vibration isolation of the building should be carried out by installing it on replaceable rubber-metal (layered) vibration isolators. They are placed, mainly, between foundations and supporting structures (walls, columns) of the basement floor. Schemes with the placement of vibration isolators under individual floors and between the top of the column and the floor are also used.

To protect against vibration in the vertical direction, vibration isolators are installed in the openings of the walls of the basement floor, under the columns or on them. To protect the building from horizontal vibration in the soil and to absorb horizontal wind load, a vibration isolation system is installed along the vertical faces of the outer walls of the basement floor at the level of the foundation and the floor. The basement floor of the building is recommended to be made in the form of a spatial frame structure made of monolithic reinforced concrete with a floor and partitions included in the frame.

This design provides increased rigidity of the building, which will compensate for its decrease due to placement on elastic vibration insulators. In conditions when there are almost no "profitable" areas for construction in cities, the creating of vibration-protected buildings opens huge territorial reserves for this. The exclusion zone along the subway lines is almost 65 m (25 m on both sides of the tunnel wall plus the width of two tunnels), that is, 6,5 hectares per 1 km of the track. At the same time, it is possible to build exclusion zones along the lines of the subway and railways with buildings and structures without limiting their number of floors, location, and purpose.

The use of vibration protection systems allows to provide for the isolation of surrounding buildings and equipment from powerful sources of technogenic vibration (crushers, hammers, quarries, explosive stamping, etc.). It also allows protection of precise electronic productions by using local vibration protection systems and comprehensively for the building. This makes it possible to protect environmentally dangerous production in seismic areas and oil and gas processing facilities. Special attention should also be paid to the problem of vibration during new construction or reconstruction near architectural monuments and valuable buildings. In such situation, the use of construction technologies that cause vibration is extremely undesirable. Permanent or periodic exposure to vibration can be destructive for the structures of buildings erected several centuries ago.

Therefore, if the use of vibration devices is necessary due to the technical or structural features of the construction or reconstruction project (for example, according to the characteristics of the soil), then first it is necessary to make a technical conclusion about the condition of the main supporting structures of buildings in the zone of vibration influence. Then it is necessary to take precautionary measures (arrange acoustic seams or other) and after that start the construction process.

The impact on architectural and city-building objects of vibrations of natural origin (earthquakes) is the most destructive. Therefore, appropriate protection measures are mandatory in seismically dangerous areas.

At the same time, the influence of architecture on the environment and ecology on architecture is bilateral. Therefore, many scientists believe that some of the earthquakes are technogenic (caused by the influence of nuclear or hydropower plants). That is, the activity of some architectural objects is the cause of the destruction of others.

Air pollution and water pollution. Gas and dust pollution of the atmosphere is primarily related to the production of building materials and structures. Significant dust emissions occur during the production of cement, concrete, silicate, and clay bricks, reinforced concrete, wooden and metal structures, heat-insulating materials. In addition, the architectural objects themselves are polluters of the environment. At the same time, dangerous substances in the atmospheric air, due to infiltration, can enter the internal environment of buildings and structures and harm people's health. The best way to improve atmospheric air parameters is to increase the area of green spaces capable of absorbing harmful substances and producing oxygen.

According to the World Health Organization, 50 m^2 of urban green spaces and 300 m^2 of suburban green spaces are needed to ensure the optimal amount of oxygen per inhabitant. Contaminated water bodies, both surface and underground, on the contrary, pose a danger to the architectural environment of people's life. Groundwater may contain various impurities of mineral and organic origin, including hydroxides of some metals, various toxic compounds, and hydrocarbons. So, the use of groundwater for the technological needs of construction is quite dangerous. It relates to dangerous pollutants (as lead, nickel, cadmium, phenols) after all technological operations to produce building materials can enter the internal environment of residential and public buildings and have a toxic effect on humans.

Electromagnetic pollution as a factor affecting the environment. Electromagnetic pollution of the environment is environmental conditions under which the population is constantly in electromagnetic fields of anthropogenic origin. And due to long-term exposure to electromagnetic fields, the endocrine system, metabolic processes, functions of the brain and spinal cord, etc., are disturbed in people.

The maximum electric field strength (E) for the internal spaces of residential premises is 0,5 kV/m, and for the territories of residential buildings is 1,0 kV/m. To reduce the intensity of the electric field along high-voltage power lines (PL), sanitary protection zones (SPZ) are designed. They should be from the projection of the outermost wires to the ground at 30 m for lines with a voltage of 330, 500 kV, 40 m for 750 kV and 55 m for 1150 kV. The construction of residential and public buildings is prohibited on the territory of the SPZ. In the conditions of excessive urbanization of modern cities and the growth of building density, these are quite large areas. Therefore, the main task of the architect-town planner is the exact "calculation" of the master plan in compliance with the norms regarding the placement of buildings and structures and, at the same time, the most effective use of the SPZ. The best option is to create strips of protective landscaping (noise, dust, and wind protection, etc.) on the territory of the SPZ (at the permitted distance from the projection of PL onto the ground). This will simultaneously optimize both environmental and visual-aesthetic parameters of the city's architectural environment.

Self-test questions:
1. What is noise? What are its main characteristics?
2. What means of protection against air noise do you know?
4. List the measures to reduce the level of noise in residential buildings.
5. What are noise-proof houses?
6. What is the negative impact of vibration on architectural structures and human health?
7. What means of protecting buildings from vibration do you know?
8. How can water pollution affect building structures?
9. What effect does electromagnetic pollution of the environment have on people's health?

LECTURE 7 Factors of urban environment violation

Lecture plan:
1. Flooding as the main ecological factor of disturbance of urban areas.
2. Violation of the aeration regime of urban areas.
3. Architectural and planning means to reduce the negative impact of a set of factors.
4. Geodynamic zones as a special factor in the system "architecture – environment".

Flooding as the main ecological factor of disturbance of urban territories. One of the main reasons for the emergence of emergency buildings and the reduction of sanitary and hygienic parameters of the architectural environment is geological processes in the soil and the development of flooding of built-up areas. Flooding of the territory is an increase in the level of groundwater to critical levels (less than 1–2 m from the surface of the earth).

The process of flooding is a reaction of the geological environment to the unbalanced influence of technogenic factors related to human economic activity. The hydrogeological regime changes with the elimination of swamps, which are a natural evaporator of groundwater. Large, asphalted areas and filled-in beams also change the natural conditions of water evaporation and the movement of filtering effluents in the area. Covering the soil with asphalt or cement slabs removes the soil from the cycle of substances, disrupts the moisture regime of the built-up area and contributes to the development of flooding. Flooding negatively affects the ecological state of the natural environment.

In the field of architecture and urban construction, the process of flooding is dangerous not only due to the flooding of buried premises and structures. It provokes other dangerous engineering and geological phenomena – precipitation, subsidence, soil swelling, increased soil corrosion activity, etc. As a result of technogenesis processes, groundwater in the built-up area acquires aggressive properties towards concrete and metals.

This leads to the destruction of the foundations, the occurrence of suffusion and subsidence phenomena. It also leads to accelerated aging of buildings, shortening of their service life, occurrence of deformations and destruction of architectural objects, deformation of building structures. The process of flooding is also dangerous because it provokes the development and intensification of several phenomena related to it: suffusion, landslides, karstization of soils, etc.

Sufosis is the destruction and removal of separate components and large masses of dispersed and cemented clastic rocks, including those that form rock massifs, by the flow of groundwater.

Landslides are the descent of land masses down the slope under the influence of their own weight and loads (filtration, seismic, vibration).

Karst is a geological phenomenon associated with the dissolution of rocks by water, with the formation of underground cavities and, as a result, depressions of the earth's surface.

Recently, due to the general violation of the ecological balance in cities, the process of flooding is becoming massive and poses a danger to existing buildings. This issue is especially acute in the historical parts of cities, where many monuments of architecture and culture are concentrated. Flooding creates a real danger to the physical preservation of historical buildings. So, reconstruction and restoration work cannot be carried out without taking this factor into account.

In order to prevent the destruction of existing architectural objects, all means of protection must be directed to the implementation of the following measures: reducing the vulnerability of the architectural monument to flooding (block with water drainage, waterproofing, securing soils and foundations, wall drainage, etc.), neutralization of sources of flooding (elimination of the impact surface runoff and shielding asphalt coatings, etc.), prevention of the influence of underground and surface water on the architectural monument (curtains, vertical planning of the site, circular drainage.

Technical means of protection against flooding during new construction can be divided into two groups.

The first includes measures performed at the construction stage of the facility, horizontal wall and ring drains, stratum, and vertical siphon drains, as well as filter curtains. The projects provide for the use of concrete and other materials resistant to an aggressive environment, soil compaction, waterproofing of underground structures.

The second group is preventive measures for the protection of objects of new construction: organization of surface runoff; preservation of natural drains (laying of filters along the thalwegs of the beams); equipment of clay castles and abutments. When developing this group of measures, the most difficult task is forecasting the process of flooding in the territories of new construction.

These measures of engineering protection can be individual or general territorial. Means of protection at the territorial level include means of evacuation from the territory of valuable development of surface and underground waters, i.e. regulation of the river network, vertical planning, drainage. Local measures include measures to protect individual architectural monuments, their complexes, and groups: drainage, screens and curtains, waterproofing, soil consolidation.

Thus, the system of engineering protection of buildings and territories against flooding should consist of the following blocks:

1. Control over the water regime in the historical part of the city, soil and structure deformations (local level of protection).

2. Regulation of the regime of underground and surface waters (a complex of technical means of protection at the general territorial level).

3. Management of dangerous situations.

Thus, the protection of architectural and town-building objects from flooding and the hydrogeological environment from the influence of architectural and construction activities must necessarily take place in the "control – regulation – management" mode.

Violation of the aeration regime of urban areas. The nature of the wind regime in the city is determined by the topography of the area, the number of floors of buildings, the width and orientation of avenues and streets to the direction of the prevailing winds, and the degree of greening of the territory. The aeration regime of the building primarily depends on the direction and speed of the wind. They are determined based on long-term observations. Based on the results of the analysis, special schemes of repeatability of wind directions and speeds are built for a certain period of the year (wind rose).

Other factors on which the aeration regime depends are the density of buildings and the number of floors of buildings. Aerodynamic disturbances are a special group of anthropogenic aeration effects associated with architectural and urban development activities: disturbances, rarefaction, and temperature inversions. Disturbance is a change in the direction and speed of air flow. It can be of natural origin (due to the topography of the territory) or anthropogenic (related to the construction of high-rise buildings).

During the construction of high-rise buildings, the aerodynamic characteristics of the territory change dramatically. Vortex-like atmospheric flows of enormous force are formed, capable of damaging the facade systems of buildings. Snowdrifts are formed in the areas adjacent to the buildings in winter, creating uncomfortable conditions for pedestrians. Rarefaction zones are zones of aerodynamic shadows caused by the poor flow of buildings and structures: the taller the buildings and the less streamlined their shape, the worse the aeration regime and the higher the surface concentration of pollutants. Temperature inversions are atmospheric flows caused by intense heat release (air movement between areas with different temperatures).

Special requirements are placed on the aeration regime of residential areas. Wind speed within residential buildings should be from 1 to 4 m/s. The territory with a wind speed of less than 1 m/s is considered not ventilated. With a speed of more than 4 m/s it belongs to the zones of active blowing. However, the most favorable aeration conditions are created in squares and gardens with well-developed greenery. The wind speed on the green part of the street is 1,5–2 times lower than on the non-green part. For wind protection of urban areas, it is necessary to highlight several requirements and features. The most important of them are:

1) the same level of protection of the city from the wind throughout the year;

2) formation of wind protection strips of maximum height (up to 25–30 m), because already at a height of 20 m, effectively formed green zones can reduce

wind speed for residential groups with 5-story buildings;

3) the width, height, dendrological composition and other structural and constructive parameters of protective strips should depend on their location on the terrain, relief, distance to territories that need protection (buildings, recreational areas), the value of the strips in the functional complex of the city's plantations;

4) the aesthetic parameters of the city's windproof landscaping should be subject to increased requirements.

Thus, the tasks of the architect regarding the wind regime should be divided into several components:

1) planning city-wide and local systems of wind protection landscaping to protect existing and project objects from dominant winds of natural origin;

2) organization of the planning system of the city taking into account the wind rose;

3) considering the peculiarities of the wind regime of a specific territory when choosing the shape and number of floors of individual buildings or their groups.

Architectural and planning means of reducing the negative impact of a complex of factors. One of the important environmental problems of modern large cities is the degradation of their natural landscape framework and the decrease in the percentage of green spaces in the overall balance of urban areas. At the same time, it is known that landscape areas and their components (trees, bushes) are one of the most effective architectural and planning means of reducing the impact of pollution factors on the city's architectural environment.

Most residential areas of cities, quiet recreation areas in parks, simultaneously need protection from noise, gas pollution, dust, wind currents and other factors of anthropogenic or natural origin. Therefore, in these areas, the choice of protective landscaping is of particular importance. There is no general pattern regarding all factors of discomfort. An effective position for noise protection is the maximum approach of the strip to the source. It does not meet the conditions for realizing the gas-protective properties of landscaping. The degree of dust protection of a single strip remains quite high and does not change significantly depending on its placement. When the factor of noise pollution dominates, the maximum approach of the protective strip to the object of protection (building, etc.) does not contribute to significant noise protection. In the case of insufficient aeration and frequent calms, the most expedient is the maximum distance of the green strip from the object of protection.

A multifactorial impact on the object of protection, combining various uncomfortable phenomena, requires the simultaneous reduction and regulation of all factors. An example can be a buffer building near transport highways or industrial zones, on the territory of which maximum permissible concentrations (MPCs) for noise, atmospheric pollution and dust are increased. The selection of possible solutions for protective greening strips is built in the following sequence:

1. The composition and levels of all environmental discomfort factors are analyzed in comparison with normative indicators.

2. A dominant factor is revealed, the degree of reduction of whose influence is a primary task.

3. The problem of choosing the optimal position of the protective landscaping area based on the maximum impact on the dominant pollution factor is solved.

Most often, the dominant factor consists of two or more uncomfortable influences. In the central part of the city, an example can be a combination of the gas noise factor and weak aeration. In peripheral areas, the dominant factor may be the tasks of dust and wind protection. Hence, the criterion for evaluation and selection of discomfort factors is their quantitative ratio with normative indicators of atmospheric pollution.

The most important factor is the initial level of environmental pollution. On most highways of large cities with an intensity of traffic exceeding 1,000–1,500 vehicles per hour. noise levels reach 65–80 dBA, exceeding the concentration of CO and other ingredients – 5–25 MPC, dust levels – 1,5–5 MPC. The initial conditions with this degree of intensity of aero technological pollution cannot be completely optimized. With normative noise indicators of 45–55 dBA, protective landscaping is not enough, and other organizational or constructional measures are necessary. Therefore, the main feature and requirement for the protection of urban areas or architectural objects from the influence of several factors should be a comprehensive approach. And the task of the architect is to determine the priority areas of protection (and the corresponding construction queues) and to choose the optimal architectural and planning means of protection.

Geodynamic zones as a special factor in the "architecture-environment" system. All the factors can be characterized as those that can be directly perceived either by the human senses or by architectural objects. However, there are very specific and much more complex factors influencing both the architectural and urban environment and the person as the creator and main consumer of this environment. These factors have almost no external manifestations and are related to the structure of the Earth.

According to modern ideas, the entire Earth's crust is divided into blocks of different sizes. They are in constant motion. There is not a single point on the surface of the Earth that remains at rest and does not undergo some movement. Some parts of the Earth's crust are gradually sinking, others are rising, others are pushing one on top of the other or diverging. Such processes occur very slowly – at a rate of several millimeters or centimeters per year.

Different tectonic activity of moving blocks of mountain massifs determines the zonal-block structure of the Earth's crust and the entire lithosphere. The tectonic movements of blocks have a rhythmic (cyclical) character, determined by the rhythmicity of processes inside the Earth, as well as the rhythmicity of external (space) processes, the most important of which are lunar-solar tidal variations.

The cyclicity of the manifestations of internal and external processes provides variations in movements and changes in the signs of the direction of movement of the same blocks of the Earth’s crust. This determines the pulsating, sign-changing nature of tectonic movements of specific rock massifs and the corresponding variable in direction and intensity impacts on the soil foundations of any engineering structures.

The boundaries between blocks of the Earth’s crust of different tectonic activity are geodynamic zones. Through geodynamic zones, especially those connected with deep faults, various types of energy, as well as steam-water and gaseous flows of various chemical elements and compounds, including those aggressive to engineering structures, rise to the surface from the depths of the Earth. Geodynamic zones exist everywhere and threaten all technogenic objects. Buildings that cross the geodynamic zone or are located within its boundaries are exposed to significant danger.

The most dangerous intersections of geodynamic zones. Structures are involved in deformation processes together with rocks. At the same time, buildings and structures are exposed to various radiations and aggressive chemical compounds and elements.

In addition to the loss of mechanical strength that occurs in technogenic objects, there are side effects and processes that cause environmental damage that significantly exceeds the damage from the destruction itself. Thus, when considering geodynamic zones, two main aspects arise: engineering-geological, related to the mechanical loss of strength of engineering structures within the influence of active geodynamic zones, and medical-biological, related to the impact of various types of radiation on human health and animals (geopathogenic zones). From the point of view of architectural ecology, geodynamic zones are the most dangerous because they are almost never considered by architects in their practical activities.

At the same time, the danger of destruction is an acute problematic issue mainly for large industrial or energy enterprises, which can cause significant damage to the ecological state of the environment. Therefore, pre-project studies are being conducted for them.

But in the field of residential and public construction, there are no studies on geodynamic and hepatogenic zones, which causes the emergence and development of many complex diseases of the population. The knowledge and aspirations of architects alone are not enough to fully solve this problem. Groups of scientists formed from specialists in various fields of knowledge should work on this issue. However, data on the presence and activity of geodynamic zones in the given territory should be used by architects at least at the level of developing master plans for new or reconstruction of existing cities.

Self-test questions:

1. What are flooding, suffusion, landslide, and karst?
2. What planning and technical means of protection of buildings against flooding do you know?
3. What aerodynamic disturbances do you know?
4. What are the requirements for wind protection of urban areas?
5. How is the planning solution of protective greening strips chosen?
6. What are geodynamic and hepatogenic zones?

REFERENCES

1. Цигичко С. П. Екологія в архітектурі і містобудуванні : навч. посіб. / С. П. Цигичко ; Харків. нац. акад. міськ. госп-ва. – Харків : ХНАМГ, 2012. – 146 с.

2. Мигаль С. П. Біоніка в дизайні просторово-предметного середовища : навч. посіб. / С. П. Мигаль, І. А. Дида, Т. Є. Казанцева. – 2-ге вид., перероб. – Львів : Вид-во Національного університету «Львівська політехніка», 2022. – 228 с.

3. Вотінов М. А. Методичні основи впровадження поняття «гуманізація міського середовища з архітектурно-містобудівною інфраструктурою» / М. А. Вотінов, О. В. Смірнова, Д. С. Чубарова // Комунальне господарство міст. – Харків : ХНУМГ ім. О. М. Бекетова, 2022. – Т. 3. – № 170 – С. 77–82

4. Проблеми та перспективи розвитку житлової забудови в умовах комплексної реконструкції міста : монографія / Ю. І. Гайко, Т. В. Жидкова, Т. М. Апатенко та ін. ; за заг. ред. Ю. І. Гайка, Т. В. Жидкової ; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О.М. Бекетова, 2019. – 247 с.

5. Вотінов М. А. Гуманізація транспортно-пішохідної інфраструктури крупнішого міста : монографія / М. А. Вотінов, О. В. Смірнова ; Харків. нац. ун-т міськ. гос-ва ім. О.М. Бекетова. – Харків : ХНУМГ, 2020. – 99 с.

6. Крижановська Н. Я. Основи ландшафтної архітектури та дизайну : підручник / Н. Я. Крижановська, М. А. Вотінов, О. В. Смірнова ; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2019. – 348 с.

7. Смірнова О. В. Формування інноваційних будівель засобами ергодизайну в контексті сталого розвитку міського середовища / О. В. Смирнова // Комунальне господарство міст. – Харків : ХНУМГ ім. О. М. Бекетова, 2020. – Т. 6. – №159. – С. 103–107.

GLOSSARY

Aeration – ventilation, saturation of buildings with air – organized natural ventilation of premises. It is carried out through windows or aeration lanterns.

Architectural ecology is a branch of science that studies the environmental problems of the architectural and construction industry. It was formed at the end of the 20th century on the border of architecture, construction physics, construction, ecology, environmental ethics, urban planning, and architectural physics.

Architecture is an artistic organization of space based on building structures.

Assessment of environmental impacts – determination of the scope and levels of impacts of planned activities on the environment, measures to prevent or reduce these impacts, acceptability of project decisions from the point of view of environmental safety.

Climate is the average state of the atmosphere in the Earth, which is characterized by features that are almost constant during one generation (about 30-40 years).

Comfort of the architectural and landscape environment is the main indicator in the system of assessing the quality of the residential environment, which reveals the degree of satisfaction of natural and climatic, urban planning, functional, aesthetic, psychophysiological, ergonomic, and other factors.

Concept is a system of views on something. The main idea in determining the goals and objectives of the research and indicating the ways of its implementation.

Impact – introduction into the environment or removal from it of any material substance or other actions that cause changes in its state.

Insolation is the arrival of solar radiation on the Earth’s surface. Its intensity depends on the latitude of the area, cloudiness, and transparency of the atmosphere. Insolation plays a leading role in climate formation.

Microclimate is a complex of physical factors of the internal and external environment of the premises, which is determined by temperature, humidity, speed of air movement and affects the heat exchange of the body and human health.

Noise is disordered fluctuations of various physical nature, characterized by the complexity of the temporal and spectral structure. According to the nature of occurrence, acoustic and radio-electronic noises are distinguished. A person with normal hearing perceives auditory vibrations with a frequency of 16 to 20 kHz and an intensity of 0 to 120–130 dB. Prolonged or excessive noise has a negative effect on the human body.

Risk is the degree of probability of a certain negative impact on the environment that can occur at a certain time or under certain circumstances from the planned activity.

Style is a set of artistic techniques that determines the nature of the organization of the architectural and landscape environment and helps reveal its bright artistic image.

Technogenic environment is an artificially created part of the environment consisting of technical and natural elements.

The environment is a set of natural, social (including the environment of human activity) and technogenic conditions of existence of human society.

The environment of human activity is the environment of the territory of settlements, resort and recreation areas, water bodies intended for economic, drinking, and recreational use, agricultural land.

The surrounding natural environment is a set of natural factors and objects of the environment that have a natural origin or development.

The surrounding social environment is a set of social and everyday living conditions of the population, socio-economic relations between people, groups of people, as well as between them and the material and spiritual values they create.

Електронне навчальне видання

СМІРНОВА Ольга В’ячеславівна

АРХІТЕКТУРНА ЕКОЛОГІЯ

КОНСПЕКТ ЛЕКЦІЙ

(для здобувачів першого (бакалаврського) рівня вищої освіти денної форми навчання зі спеціальності 191 – Архітектура та містобудування)

(Англ. мовою)

Відповідальний за випуск *Г. О. Осиченко*
За авторською редакцією
Комп’ютерне верстання *О. В. Смірнова*

План 2024, поз. 63Л___

Підп. до друку 12.03.2024. Формат 60 × 84/16.
Ум. друк. арк. 3,5.

Видавець і виготовлювач:
Харківський національний університет
міського господарства імені О. М. Бекетова,
вул. Маршала Бажанова, 17, Харків, 61002.
Електронна адреса: office@kname.edu.ua
Свідоцтво суб’єкта видавничої справи:
ДК № 5328 від 11.04.2017.