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Concept of Microclimate in Russian Legislation

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Abstract

In the constantly changing conditions of the external environment, the microclimate is supported by the stabilizing systems of the building in the overall system "building - exterior fences and engineering equipment". To create a comfortable microclimate in the room, special systems are used: heating, ventilation, and humidification. To create thermal comfort indoors means ensuring its complex meteorological conditions in which the thermoregulatory system of the body is in a state of the least tension, and all the other physiological functions occur at the level most beneficial for the body. In the modern world the quality of the indoor environment is a priority, part of the requirements is reflected in the modern standards of green building, part in the national standards. So the Russian Federation has legislative and normative-legal acts, reflecting the characteristics of environmental quality: GOST (State Standard) 30494-2011, SanPiN (Sanitary Regulations and Norms) 2.1.2.1002-00, GOST R ISO (Russian National Standard) 7730-2009, SN 2605-82, SNiP (Construction Standards and Regulations) 23-05-95 and others. Normalized microclimatic indicators include temperature, humidity and air velocity, surface temperature of building envelopes, objects, equipment. But at the present stage, the formation of a harmonized and safe environment of the room depends on many factors, which should not only reflect functional, social, climatic, urban planning, construction design, architectural-artistic and economic characteristics, but also socio-psychological and environmental components of the room.

Keywords: microclimate, green building, environmental quality

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1. Introduction

Green building (also green construction, eco-building, eco-development) is the construction and operation of buildings, which impact on the environment, is minimal. The purpose of this construction is to reduce the consumption of energy and material resources throughout an entire building's life cycle: from siting to design, construction, operation, renovation, and demolition [1].

Modern technology for the construction of green buildings are constantly being improved, the main objectives are to reduce the overall impact of development on the environment and human health, which is achieved by solving the following tasks.

- Reducing the total (over the entire life cycle of the building) harmful effects of construction activities on human health and the environment, which is achieved by the use of new technologies and approaches.
- Creation of new industrial products.
- Reducing the load on regional power network and improving the reliability of their work.
- Reducing the cost of maintenance of buildings of new construction.

In the late 1990s and early 2000s, the collective efforts of developers formalized integrated approaches or the so-called Green Building Standards. So in 1998, the first LEED rating system appeared. From 1998 to 2005, innovative approaches to construction are being promoted and the transition from integrated efficiency to zero impact buildings and zero emissions. In 1999, the first meeting of the World Green Building Council was held with the participation of 8 countries: USA, Australia, Spain, Great Britain, Japan, UAE, Russia and Canada. To date, the main standards in the world are American LEED and British BREEAM, which account for 80% of all certified buildings.

In countries where Ecological Construction is developing, national standards are being created that take into account the country's socio-economic and environmental conditions: legislation, state policy regarding energy resources and the environment, climatic conditions, the degree of awareness of energy efficiency and environmental issues by professional communities and the public. The adaptation of international green standards is designed to give the construction sector a methodological basis for activities for the construction of energy-efficient, environmentally friendly and comfortable housing.

The development and implementation of the Green Standards is carried out by Green Building Councils, specially created non-profit organizations. Coordination of the councils' and other ecologically oriented construction and management companies' activities is carried out by the World green building Council (WorldGBC).

Also one of the main goals of green construction is the preservation and improvement of the quality of buildings and comfort of their internal environment, which are expressed in the following positions:

- Creating more comfortable conditions in indoor air quality and also thermal and acoustic performance.
- Reducing the level of contaminants that occur in water, soil and air, and as a result reduction of burden on the urban infrastructure.
- Improving the quality of life through the optimal urban design (the close proximity of residential areas and social infrastructure).

In the Russian Federation, by the end of 2018, several dozen buildings had been built according to LEED and BREEAM standards. Among them, there are commercial, residential, and sports facilities. The main incentive in Russia is the presence of demand, and in the world - ethical reasons and market transformation [1]. The cost of green construction is 7% more expensive for the newly designed building and 10-15 % higher for implementation in an existing project. The proportion of "green certification" is 20% of the project cost. Laws No. 111730-5-ФЗ ``On Energy Saving and Improving Energy Efficiency'', No. 384-ФЗ ``Technical Regulations on the Safety of Buildings and Structures'' were adopted. However, the motivation for green building is weak because of low energy prices in the country. In St. Petersburg, a regional methodological document ``Recommendations on ensuring the energy efficiency of residential and public buildings'' was adopted, which is mandatory for budget construction and reduces energy consumption in new homes. [2].

2. The Concept and Requirements for Microclimate

If we consider the concept of microclimate from a linguistic point of view, this word was formed by the merger of the Greek μικρός (mikros) и κλίμα (klimatos) - the climate in small spaces, due to the peculiarities of the area.

Since the beginning of the twentieth century, this term has been applied to the room - it is a set of physical factors of the indoor environment that affects the heat exchange of the body and human health.

In the Russian Federation, according to GOST 30494-2011, the microclimate of a room is defined as the state of the indoor environment of the room, affecting a person, characterized by indicators of air temperature and building envelope, humidity and air mobility. [3]

Microclimatic indicators include temperature, humidity and air velocity, the temperature of the surfaces of building envelopes, objects, equipment, as well as some of their

derivatives: the temperature gradient of the air vertically and horizontally, the intensity of thermal radiation from internal surfaces.

If the parameters of the environment in which the person occurs is normal, then the person will not experience any discomfort, neither heat, nor cold, nor stuffiness.

The microclimate of the room is formed as a result of the influence of the external environment, the features of the building construction and heating, ventilation and air conditioning systems. Thermal conditions and the composition of the air in a room are especially strong for humans.

The impact of complex micro-climatic factors affect warmth of a person and determines physiological reactions of the organism. The activity of each individual is accompanied by a continuous release of heat into the environment. Its amount depends on the degree of physical stress, that is, energy consumption in certain climates, ranging from 50 watts at rest to 500 watts during exercise. To physiological processes in the body proceeded normally produced by the body warmth should be fully discharged into the environment. Violation of thermal balance may lead to overheating or overcooling of the organism and, as consequence, to loss of working capacity, fatigue, loss of consciousness and heat death. Temperature effects beyond neutral fluctuations cause changes in muscle tone, peripheral vasodilation, activity of sweat glands, heat production. In a poor microclimate, allergic diseases and disorders of the central nervous system often occur.

Human tolerance to temperature and its thermal sensations are largely dependent on humidity and air velocity. The more relative humidity, the less sweat is evaporated per time unit and the faster overheating of the body takes place.

A particularly adverse effect on the thermal state of a person is exerted by high humidity in combination with high temperature - more than 30 °C, because in this case, almost all the heat released is released to the environment during the evaporation of sweat. When humidity increases, the sweat does not evaporate, and flows down in drops from the surface of the skin. There is a torrential flow of sweat, exhausting the body and not providing the necessary heat transfer.

Lack of humidity is unfavorable due to intensive evaporation of moisture from the mucous membranes, their drying out and cracking, and then the contamination by pathogenic microbes For humans, it is permissible to reduce their weight by 2-3% by evaporation of moisture - dehydration. Dehydration of 6% entails a violation of mental activity, and decreased visual acuity. The evaporation of moisture by 15-20% is fatal.

High intensity thermal radiation - infrared radiation and high temperatures can have a damaging effect on the human body. Thermal radiation intensity 350 W/m^2 does not

cause unpleasant sensations, with 1050 W/m^2 already in 3-5 min an unpleasant burning sensation appears on the surface of the skin, skin temperature increases by 8-10 °C, and at 3500 W/m2 a few seconds can cause burns. The irradiation intensity 700-1400 W/m^2 cause heart rate increasing by 5-7 beats per minute. The time spent in the heat radiation zone is limited primarily by skin temperature, pain occurs at skin temperature 40-45 °C, depending on the area of the body.

In addition to the direct impact on humans, radiant heat heats the surrounding structures. These secondary sources give the heat to the environment by radiation and convection, causing the temperature inside the room increases.

Comfortable environment, closed by walls of the building, is estimated by criteria, which can be divided into three groups: hygiene, comfort and safety. Hygienic requirements are aimed at providing the most favorable microclimate for people in the premises. Indicators of climatic environment are: heat and humidity mode, air quality, visual and noise comfort. The environment settings are chosen based on the functional state of people, considering the conditions necessary for recreation, work, etc. The optimal combination of these factors ensures the normal physiological state of a person dwelling on the premises. The specific features of the microclimate indoor are formed under the influence of air flow, moisture and heat.

2.1. Temperature requirements

The main requirements to the parameters of microclimate in premises in the Russian Federation are set out in the sanitary-epidemiological rules and regulations. State sanitary-epidemiological rules and regulations is the standard legal acts establishing sanitary and epidemiological requirements (including safety criteria and (or) harmlessness of factors of an inhabitancy for the person, hygienic and other norms), the violation of which endangers the life or health of a person, and also threat of occurrence and spread of diseases. [4]

SanPiN 2.1.2.1002-00 "Sanitary-epidemiological requirements to residential buildings and premises" establish the sanitary requirements that should be observed when designing, reconstruction, construction, and maintenance of exploited residential buildings and premises intended for permanent residence, except for hotels, hostels, specialized homes for the disabled people, orphanages, and camps. The basic requirements for the microclimate are described in the fourth paragraph of the normative document. [5]

A more detailed analysis of Annex 1 SanPiN 2.1.2.1002-00 "Sanitary-epidemiological requirements to residential buildings and premises" shows that the norms of optimal microclimate in the premises differentiate for warm and cold periods of the year: temperature in the warm period of 23 - 25 ˚C, cold -- 20 -- 22 ˚C, relative humidity -- 60 - 30% in warm period, 45 to 30% during the cold period; the velocity of the air in the warm period -- not more than 0.25 m/s, in the cold period -- not more than 0.1 -- 0.15 m/s.

The admissible sanitary norms of microclimate in the premises in warm period of the year are not more than 28 ˚C, in the cold period 18 -- 22 ˚C, relative humidity of 65% (in areas with the calculated relative humidity over 75% this figure, is respectively -- up to 75%), the velocity of air in the warm period -- not more than 0.5 m/s, during the cold period -- not more than 0.2 m/s.

The gradient of air temperature at the height of the room and the horizontal should not exceed 2 ˚C. The surface temperature of the walls may be lower than the air temperature in the room - not more than 6 ˚C, floor --- 2 ˚C, the difference between the air temperature and the temperature of the window glass in the cold period of the year shall not exceed an average of 10 --- 12 ˚C, and the thermal influence on the surface of the human body flow of infrared radiation from the heated heating designs is 0.1 cal/cm^{2}min.

Human sensitivity to thermal conditions is mainly related to the thermal balance of his body. This balance is influenced by physical activity, clothing and environmental parameters: air temperature, average thermal radiation, the speed of movement and humidity.

The GOST R ISO 7730-2009 standard establishes methods for predicting sensitivity to temperature and the degree of discomfort (dissatisfaction with temperature) of people exposed to moderate thermal environments. This standard helps to conduct an analytical assessment and interpretation of thermal comfort based on the PMV (Predicted Mean Vote - predicted average air quality rating) and PPD (Predicted Percentage Dissatisfied - predicted percentage of dissatisfied with the temperature of the environment), as well as local thermal comfort criteria. Thanks to this assessment, it is possible to assess the acceptability of environmental conditions to ensure the thermal comfort of a person. [6]

The Predicted Mean Value (PMV) is an indicator that predicts the average temperature sensitivity of a large group of people based on a balance of human body temperature on a 7-point scale (table 1). The temperature balance is achieved when the heat produced

by the human body is equal to the loss by the body of heat in the environment. In a moderate environment, a person's thermoregulation system is able to adjust automatically skin temperature and sweating to maintain a balance in body temperature.

Table 1: Temperature Sensitivity Scale.

Scoring	Human Feelings
+3	Hot
+2	Warm
+ 1	A little warm
0	Neutral
-1	A bit cool
- 2	Cool
- 3	Cold

PPD indicates the predicted mean value of the estimated thermal environments for large group of people exposed to this environment. Individual grades are around the middle value, so useful is the ability to predict the number of people in this environment are likely to feel uncomfortable.

PPD is an indicator that establishes the predicted percentage of dissatisfied temperature environment people who are too warm or too cold. For purposes of this standard, under dissatisfied with the temperature of the environment by people who understand those people, who will assess the environment as "hot", "warm", "cool" or "cold" on a 7-point scale temperature sensitivity, is shown in table 1.

The PPD index predicts the number of dissatisfied ambient temperature people among a large group. The rest of the group will experience a neutral impact on the environment, light warmth or coolness. Projected distribution estimates are shown in table 2.

Table 2: Distribution of individual estimates for different values of average ratings.

PMV	PPD	Percentage of ratings having a specified value,%		
		0	-1, 0, +1	-2, -1, 0, +1, +2
+ 2	75	5	25	70
+ 1	25	30	75	90
+ 0,5	10	55	90	98
0	5	60	95	100
- 0,5	10	55	90	98
- 1	25	30	75	90
- 2	75	5	25	70

PMV and PPD indicators reflect discomfort from cold or heat for the body as a whole. But dissatisfaction with the ambient temperature can be caused by unwanted cooling or heating of one particular part of the body. In this case, they talk about local discomfort.

Thermal comfort is a state of satisfaction with the thermal environment. Dissatisfaction can be caused by discomfort from heat or cold affecting the whole body, which is described using PMV and PPD, or unwanted cooling (or heating) of one part of the body. Due to individual characteristics, it is impossible to establish a thermal environment that would satisfy everyone. There is always a percentage of people dissatisfied, but you can establish environments that are acceptable to a certain percentage of people.

Often, one person may be sensitive to various types of local discomfort. For example, a person sensitive to drafts may also be sensitive to local cooling caused by asymmetry of thermal radiation or a cold floor. Such a person sensitive to cold may feel discomfort from the cold for the body as a whole. Therefore, PPD, DR or PD values calculated for various types of local discomfort should not be added up.

Due to the presence of local or national characteristics in priorities, technical development and climatic conditions, in some cases, higher requirements (lower percentage of dissatisfied) or lower requirements (higher percentage of dissatisfied) may be set as acceptable. In such cases, for the assessment and design of the thermal environment, PMV and PPD indicators, draft models, the relationship between the parameters of local temperature discomfort and the expected percentage of dissatisfied should be used to determine various ranges of environmental parameters.

2.2. Air quality

The well-being of people in a room depends primarily on the composition of the air in the room, on the main burden of indoor air, similar to the pollution of outside air by harmful substances and microorganisms, on burdening of waste products. A serious burden of indoor air from life is caused by living, cooking, bathing, breathing, sweating and active activity. As a result of these processes, odorous gases and vapors, bacteria, fungi and viruses, dust particles from clothes, carpets, upholstered furniture are released. Pets and ground from flower pots with indoor plants also burden the air. The quality of the microclimate depends on the amount of moisture that is present in the room air in the form of invisible steam.

In order to reduce air pollution and to achieve its purification, it is necessary to provide air exchange in the following volumes: 3 m3 / h per 1 m3 of the living room, 60 m3 / h in the kitchen with a two-burner stove and 90 m3 / h with a four-burner, 25 m3 / h

in the bathroom and the toilet through ventilation ducts, through vents and transoms in residential and utility rooms. The air velocity in the rooms in cold weather should be 0.05 - 0.07 m / s, and in the summer - 0.10 - 0.15 m / s. Slower air speeds cause it to stagnate in rooms, and larger ones cause drafts. In order to provide the required volume of air in hygienic conditions in a residential building, the floor height must be taken not less than 3 m.

2.3. Light environment

Light is an important biological factor influencing human health. Light regulates metabolism in the body, affect its immunological condition resistance to adverse factors. Light conditions largely determine the emotional state of the person, his mood and health. For a person especially valuable biologically complete natural light. Direct sunlight and scattered light are in the home not only the flow of visible light, but necessary for the health of ultraviolet rays and infrared radiation. UV rays contribute to a healthier environment, decontaminate the air and surfaces of objects, killing pathogenic microflora.

Formation of environment in residential areas include the optimal and correct use of natural light, insolation, and the rational artificial illumination.

In the modern city, a man loses a considerable part of biologically active natural light. Multi-storey city buildings and ambient air pollution in cities reduce natural light and UV radiation at ground level by more than 40 %. Construction of low-rise buildings reduces this negative figure in more than half.

The amount of daylight entering the room is determined by the size of the windows and the presence of their shading by opposing buildings, landscaping. Contaminated glass traps from 50 to 30% of the light. Orientation of windows to the northern directions of the horizon also reduces the illumination of rooms and 40 times reduces the natural ultraviolet radiation.

Insolation, direct solar radiation, is a necessary favorable natural factor that has a healing effect on the human body and a significant bactericidal effect on the microflora of the environment. The favorable effect of solar radiation is also manifested indoors, however, only with a sufficient dose of direct sunlight, characterized by the duration of insolation. [7]

The standard duration is set for a certain period of the year. For example, for the northern zone of the Russian Federation, continuous insolation of living rooms is recommended for at least 3 hours a day from April 29 to August 22; for the central

zone - at least 2.5 hours per day from March 22 to September 22. When the territory and buildings are irregularly irradiated, partially obscured by neighboring objects, the norms provide for an increase in the total duration of insolation by 0.5 hours per day. In conditions of dense development in the existing territories of the city, the minimum duration of insolation can be reduced by 0.5 hours

Equally important is the rational, from a hygienic point of view, artificial lighting. The main requirements for artificial lighting are that there should be enough light, it should not dazzle; the nature of the interior lighting should correspond to their functional purpose. The average level of general illumination in residential premises should be at least 100 lux with the combined action of all lamps installed in the room, except for tabletops. [8]

2.4. Sound comfort

Sound as a physical phenomenon is a wave motion of an elastic medium, and as a physiological process is a sensation that occurs when sound waves affect the hearing organs and the body as a whole.

From a physiological point of view, sound waves are divided into useful sounds and noise. Noise causes an irritating effect on the body. The maximum level of sound pressure, the long-term exposure of which does not lead to damage to the organs of hearing, is 80-90 dB. Noise comfort is necessary for a person to have normal functioning of his nervous system. Noise is divided in intensity into three groups. During sleep and passive rest, a person needs relative silence, and the first group includes noise from the sound threshold to the sound pressure level of 40 dB. During wakefulness and work, silence is not needed, the noise of medium strength does not prevent a person from working and resting, because the body is partially adapted, and the ear is able to differentiate sounds of such strength. The second group of noise with a sound pressure level from 40 to 80 dB corresponds to these states of people. This group includes the bulk of environmental sound signals. When designing and constructing a residential building, it is necessary to identify elements of the building that are unreliable in terms of acoustics and to make them soundproofed in accordance with regulatory requirements.

2.5. Visual comfort

Visual comfort, or the sense of comfort of visual perception by a person in a building, depends on the appearance of the environment surrounding the house, the visual

isolation of the rooms and their lighting. The environment surrounding the home is an important factor affecting visual comfort. A beautiful view from the window contributes to a good mood. With this in mind, family-wide collective-use zones are placed in such a way that nature can be contemplated from a window and a horizon line can be seen that allows observing a change in the time of day. The windows of the bedrooms and work rooms can overlook the courtyard, preferably landscaped. This solution does not contradict the requirements of sound comfort, as the rule is observed: the bedrooms are facing the quiet side.

2.6. Functional comfort

Functional comfort is characterized as the convenience of using the building. In creating functional comfort, such parameter as the aesthetic characteristic of the building takes place, i.e. architectural and artistic expressiveness of the building facades and interiors, furniture and equipment design, room structure. The structure of the premises is the basis of the convenience of the building. The structure is subordinated to the function for which they create a residential building.

2.7. Security

Safety belongs to the category of comfort, because a person cannot psychologically recognize a house that is a potential danger as a place to live. Unsuccessful planning of travel routes, insufficient structural strength or poorly functioning engineering systems can cause accidents. A malfunction in the gas or electric facilities can cause an explosion or fire.

The architectural and planning decision of the building affects the safety of using it. Here, not only the general principles laid down in the layout are important, but also every detail. For example, such a ``trifle'' as a step of a ladder located close to the exit can lead to a fall, and a door that opens into the corridor can injure a person passing by. The design decision plays a paramount role in the safety of the building. The strength and stability of the structure depend on the choice of the general structural scheme and the selection of parameters for each element. [9]

The negative side of life in the urban space surrounding the housing is the poor quality of the natural environment (water, air, soil) and change of its physical properties. Pollutants of the urban environment include technogenic factors of anthropogenic

origin. The sources of physical contamination include vehicle, aviation, electrical appliances and generation of electromagnetic radiation of various frequencies, industrial plants and urban electric transport. Sources of chemical contamination of the urban environment are industrial emissions (effluents), household cleaning products, products for the control of insects and rodents. Specific urban pollutants are solid wastes.

The lower quality of the urban natural environment, compared to rural areas, is the cause of the deterioration of the health of the urban residents. Science-based pollution levels should fully guarantee the safety of the environment for the health of not only the living but also future generations.

In the largest settlement (the city), a kind of natural-technogenic system of life is formed with a new biogeochemical processes of exchange of energy and substances. They largely determine the quality of the living environment from the point of view of comfort and safety. [10, 11]

3. Conclusion

The formation of a harmonized and safe environment of the room depends on many factors: functional, social, climatic, urban planning, construction, architectural, artistic and economic. The socio-psychological well-being of a person is determined by the shape, size, orientation, functional saturation of the room and the environmental component of the environment as a whole.

In modern Russian standards, the concept of environmental quality is given extremely little attention, mainly as a standardization of microclimate parameters. This, in turn, does not fully meet modern human needs. One of the latest trends is the development of green standards that allows the most detailed consideration of the impact of a building or structure on the environment in general and on the quality of the internal environment in particular. Normalized microclimatic indicators include temperature, humidity and air velocity, surface temperature of building envelopes, objects, equipment.

The development of standards is often based on medical and biological indicators of the body, and not on the sensations of a large sample of people. Also, not all international standards when assessing the quality of the internal environment take into account national aspects. These facts lead to the fact that in different countries, different people perceive the microclimate parameters differently.

Conflict of Interest

The authors have no conflict of interest to declare.

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