

Analysis of the insolation regime of the territory for various types of residential development

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Abstract. The characteristics of insolation, favorable and unfavorable effects are analyzed. The requirements for insolation in Russia and the subjects of the Federation are reflected. The methods of investigation of insolation in the program complex "Citys: Solaris" are reflected. The calculation and analysis of insolation of the residential areas of the city of Tyumen.

1. Introduction

At present, the increase in density and number of storeys in the planning and reconstruction of residential buildings is at a rapid pace, which in turn should maintain a comfortable and safe living conditions. One of the most important environmental and hygienic factors in town planning [1], providing environmental improvement and comfort in urban spaces and buildings is insolation. According to [2], the provision of regulatory parameters of illumination and insolation is an indicator of the consumer quality of housing. Compliance with sanitary rules is mandatory for citizens, individual entrepreneurs and legal entities involved in the design, construction, reconstruction and operation of facilities in Russia.

The erection of new buildings and structures on the territory of existing buildings should not worsen the lighting performance. The magnitude of gaps between buildings is mainly determined based on the conditions for ensuring the standard values of insolation and illumination, as well as in accordance with the requirements of fire safety. Thus, it is mandatory to follow the norms of sanitary rules and norms, building codes and regulations, as well as territorial building codes that determine the required level of insolation and natural lighting. Insolation is an important health factor and should be used in all residential and public buildings and in the residential area. Optimal effectiveness of insolation - its general health, psychophysiological, bactericidal and thermal action is achieved by providing a daily continuous 3-4-hour exposure to direct sunlight in rooms and territories.

Local territorial construction norms (TSN) can be adopted on the territory of the constituent entities of the Russian Federation. In the territory of other subjects of the Russian Federation such documents lose their legal force and can only be taken into consideration, and be considered as recommendations. An example is "Natural, artificial and combined lighting. MGSN2.06-99 "and" Standards of outdoor lighting of urban and rural settlements. TSN 23-330-2002 KhMAO.

2. Methodology

Learning of regulation and standard technical documentation makes it possible to sum up the main insolation requirements:

- buildings should be designed so as to provide sufficient duration of insolation aiming at creating safe living conditions regardless of term (Federal Act №384);
- standard duration of continuous insolation for accommodations is set for certain calendar periods depending on types of dwellings, functional specification of buildings and latitude;
- standard duration of insolation should be ensured in one room in one- or two-bedroom apartments, and in at least two rooms in three and more-bedroom apartments (SRaN 54.13330.2011);
- standard duration of insolation on the territories of playgrounds, recreation grounds, playgrounds of pre-school facilities should be no less than 3 hours on the 50% of the lot independent of latitude (SRaN 2.2.1/2.1.1.1076-01)

So, providing standard insolation of constructions is realized through the following:



1. Location and orientation of dwellings and public buildings should provide continuous insolation required by sanitary standards.
2. Spacing of buildings is determined by the light conditions and according to number of stories in the opposite building but no less than 2.5 of the height.
3. Insolation routing does not take into consideration some raised parts of buildings.

Location and orientation of dwellings and public buildings (excluding pre-school institutions, comprehensive schools, boarding schools) should provide continuous insolation of accommodations and areas: to the north of 58° of latitude north of the equator – no less than 3 hours a day for the period from the 22nd of April till the 22nd of August; to the south of 58° of latitude north of the equator – no less than 2 hours a day for the period from the 22nd of March till the 22nd of September.

The insolation regime of territories and premises mainly depends on the climatic region of the locality of the locality and can vary according to the regulated insolation time both in the large and in the smaller direction. This is due to the assessment of the effect of the established time of action of the sun's rays on the microclimate of the premises. So, when the established norm is exceeded, the overheating of premises is often observed, which in turn creates discomfort to the population. Most often this occurs in one- and two-bedroom apartments with the arrangement of windows on one side of the building. However, such layouts of apartments in the greater part suffer from a lack of sunlight. Such a violation of the insolation rate is observed in windows directed to the north, north-west, north-east and west directions. In such directions, insolation of living quarters is much lower than the established norm or it is intermittent, which can not have the desired health-improving effect for the microclimate of the room.

Year-round shadowing of facades of buildings and residential areas is not allowed. Semiannual shades (from the 22nd of September till the 22nd of March) should not exceed in general 10% of undeveloped residential areas, healthcare centers in localities to the south of 58° of latitude north of the equator, and 20% to the north of 58° of latitude north of the equator

Single intermittency of insolation in domestic premises is permissible while housing with 9 and more-storied blocks. However, this can be conditioned only by half an hour increase of overall length of insolation during the daytime for each zone correspondingly.

Favorable effect of insolation on sanitary and hygienic atmosphere in rooms is achieved through a bacterial and biological quality of UV light to kill microorganisms or to slow down their multiplication. Hygienic effect of insolation is important for the purpose of letting in some certain daily amount of UV sunlight during some continuous period of time. biological quality of UV light to kill microorganisms or to slow down their multiplication. Hygienic effect of insolation is important for the purpose of letting in some certain daily amount of UV sunlight during some continuous period of time. Getting inside solar radiation forms some sanitary and hygienic conditions which can be either favorable or unfavorable [2,3].

Unfavorable effect is connected with overheating of rooms in summertime. The heat getting inside the rooms with solar radiation through light transmissive and lightproof screens causes air temperature rise inside.

Actual insolation is always different from the theoretical (presumable) one and can be defined only while observing it. Actual insolation depends on housing orientation and layout, aperture of windows, location of rooms, balconies and recessed balconies.

Duration of permanent and interruptive insolation of buildings and territories can be calculated with the help of program complex "City's Solaris". It allows to make calculations for any geographic values and for a given date. The program provides opportunities to create, edit, copy objects, change their spatial altitude, and present objects as 3D models.

Calculations of insolation examination can be visualized in diagrams, display of shadows, as well as in drafts with design parameters of insolation of constructions and areas.

3.Results

Tyumen and its green zone are situated in the southern part of West Siberian lowland plain. The climate in Tyumen is not quite favorable for air pollutants dispersion. It is characterized by low annual total insolation. Accumulated temperatures are also relatively low above 10°C. More detailed information can be found in [4].

A study was made of the territories represented by different types of residential buildings. The first option of development is a 17-storey building with single-entrance houses, which are located on an area of 164,161 m². The second option is presented by residential buildings with a height of 9 and 10 floors of various shapes located on an area of 134974 m².

Calculation of insolation was carried out with the help of the program "Sitis Solaris" on the date set by the standards - this is March 22 on the day of the equinox. The estimated time was chosen in view of the territory's designation, namely the most probable time for walking with children at 11:00 and 16:00 (Fig. 1, 2).



Fig. 1. Model shading the territory of residential development № 1, March 22.

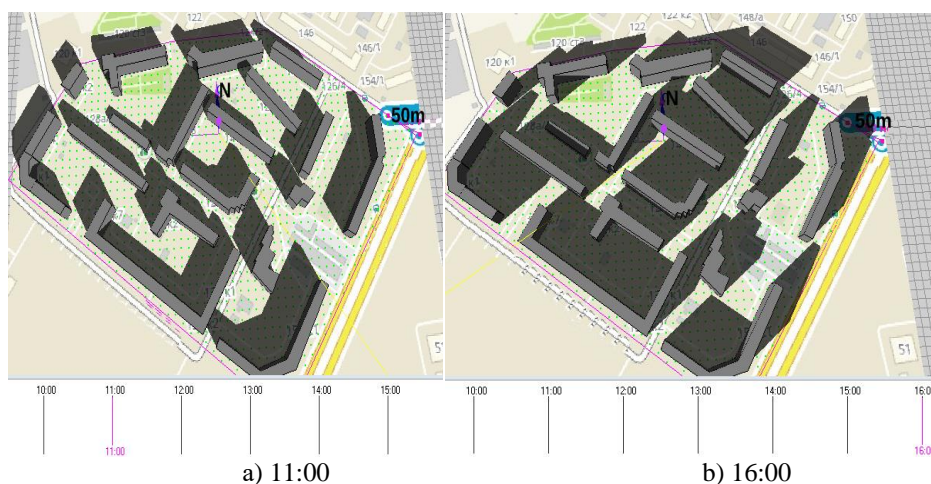


Fig. 2. Model shading the territory of residential development № 2, March 22.

Also, the calculation of the insolation of the territory No. 2 was made in the case of a change in the direction of development (Fig. 3, 4).

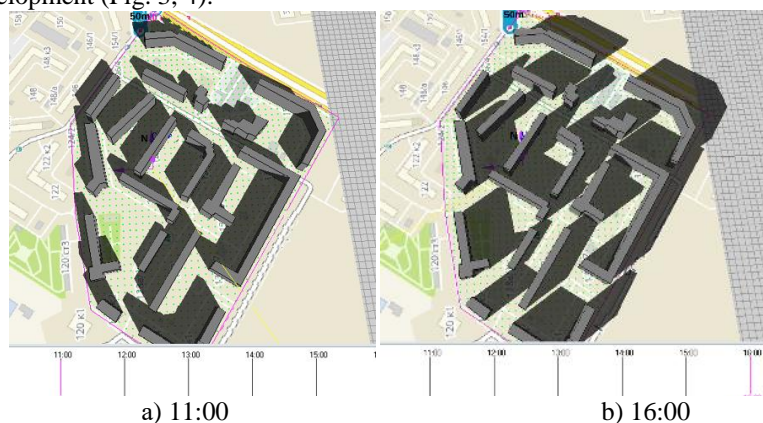


Fig. 3. Model shading the territory of residential development number 2 when the direction of the north is changed to 90^0 , March 22

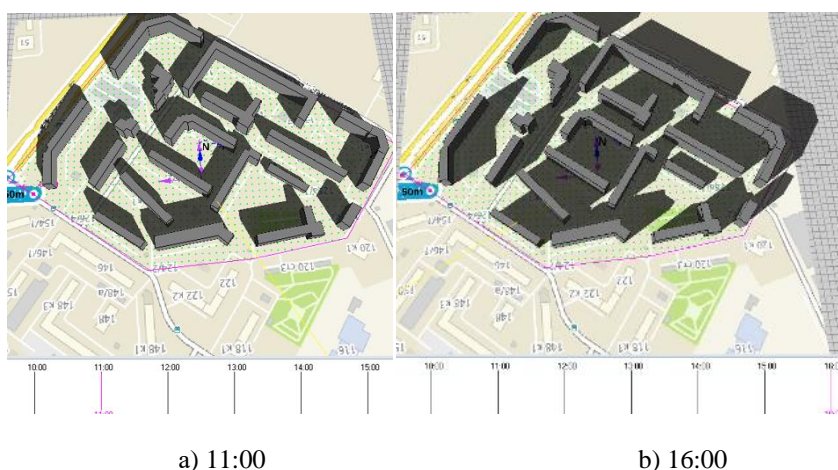


Fig. 4. Model shading the territory of residential development number 2 when the direction of the north is changed to 180^0 , March 22

Based on the results of the calculation, one can draw a conclusion about the light comfort of the territory and the adjacent construction. In the construction presented in option number 1, the shading of the facades is the same for all residential buildings. With the variant of development of territory No. 2, shading in the interior corners of buildings is almost constant regardless of the direction of development, which is an unfavorable factor [5,6].

4. Discussion

The requirements for insolation of premises in different climatic regions are not the same. In the southern regions, where there is an excess of solar radiation during a long hot period, insolation of premises in the summer months is a negative factor. In these areas insolation is favorable mainly in the relatively cold period of the year. In the central zone of the Russian Federation, insolation of the premises of residential buildings, children's and medical institutions from March to September is considered mandatory [4], in the rest of the period - desirable. In the northern regions, where there is an acute

shortage of solar radiation, it is necessary to make full use of the favorable effect of insolation of premises.

Conditions for year-round shading are calculated on the day of the summer solstice (June 22), and half-yearly on the days of the spring and autumn equinox (March 22 and September 22).

Irradiation of premises with solar beams (insolation) and natural lighting are important components of the microclimate of the apartment.

For the organization of literate natural lighting and insolation of buildings, the calculation technique is very important, it allows correctly to determine the gaps between buildings under natural lighting conditions [7,8], which is especially important in connection with the mass building in the cities of the Tyumen region. Thus, it can be concluded that a competent calculation of insolation is necessary in the planning of the territory.

5. Conclusion

As a result of the carried out researches of insolation of territories presented by two variants of building in the city of Tyumen it is evident that the most appropriate architectural solution is building No. 1, regardless of its orientation to the north. In the case of building No. 2 - the insolation regime of the territory is observed in the actual location of the building in the afternoon of the day. If you change the orientation to the north for 180° building number 2 - in the afternoon, the insolation regime is observed, but in the afternoon the area is almost completely obscured. This may serve as a favorable factor in the summer, but in the calculated winter period affects negatively.

Similar studies of the territory at the stage of the project make it possible to give the necessary recommendations on the direction of development in a particular case, as well as on a possible change in the designation of the territory.

Accounting for the period of insolation in the construction of the city's territory will positively affect the health and working capacity of the population, which reduces the cost of hospital sheets and treatment of adults and children.

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