

Peculiar features of light environment formation in northern urban planning

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Abstract. The article presents the results of studying some problems arising in the development of the infrastructure of northern regions. We considered architectural and constructive solutions to the formation of a favorable light environment in order to accelerate the adaptation process and to reduce stressful human exposure in high latitude conditions. We presented the prerequisites of environmental, bioclimatic architecture: creation of architecture, adapted to the existing climatic conditions, causing minimal environmental damage and reducing the pollution of the surrounding space, compliance of the used building materials with the existing climatic conditions in order to significantly reduce energy consumption and improve the life quality of the people living in the building; careful use of the energy resources, even in the conditions of high-latitude construction. Taking into account today's trends, the aspects, highlighted in the article, are becoming relevant, and the proposed lines of solution take an increasingly high priority.

1. Introduction

Today's far-reaching plans in the development of the Arctic regions require innovative approaches to ensuring the life quality in the Arctic and the revival of the projects of northern cities, towns, individual dwellings, which previously seemed fantastic.

The creation of a focal settlement system in the northern regions is possible only with the involvement of a part of the population, whose physiological and psychological features have evolved in other regions with a more favorable environment. Significant difficulties in solving this pressing problem arise because of the failure of the new residents of the North to adapt to its harsh conditions. An individual is exposed to a unique combination of unfavorable climatic factors [1-3].

2. Methods

The climatic features here are well known: extremely low air temperatures, long and severe winters, short and cold summers, lack of ultraviolet radiation, sharp violation of photoperiodicity, light deficiency during the polar night and light excess during the polar day, pronounced gravitational and magnetic disturbances, hurricane winds, oxygen deficiency and rarefied air, sharp changes in the atmospheric pressure, atmospheric electricity, temperature and humidity [4]. But it is not just about a harsh climate and special illumination conditions (polar day and polar night). In the Arctic Circle, many factors influence the human body, which have a much less pronounced effect in the central part of the country. For example, numerous cosmic factors are active, since the Earth's magnetic field in the northern latitudes protects it much worse than in the middle latitudes. The combination of these



factors forces an individual to live in the most stressful conditions, the social and psychological consequences of which have not been sufficiently studied yet. Meanwhile, the architect, fully aware of his/her task, cannot but take this into account [5,6].

3. Analysis of the chosen aspects

Professor Norbert Schonauer's analysis of the historical types of settlements in the Subarctic revealed five types of settlements [7,8].

He considers dwellings of the indigenous population of the North, who lived by hunting, fishing and gathering berries, to be the first. At this stage, the natural environment was preserved, energy saving was a natural condition for the existence of people - the shape of the reindeer skin tent, its anti-wind and snow-free construction, preserving the positive temperature inside.

Settlements of the second generation created by explorationists were temporary, uncomfortable, destroying the natural environment, led to excessive energy consumption and waste of capital.

The third generation of "new settlements" built by large mining companies repeated small built-up areas of large cities of temperate climate with highly developed technologies and excessive energy consumption, with a full disregard for local specific conditions.

The fourth generation, for comfort gain, was distinguished by the merger of various public and commercial facilities into contrasting conglomerates of buildings located in the downtown. In this "core of the new city", internal corridors with an artificial climate united various consumer services enterprises depriving them of natural light, creating intersecting pedestrian flows, crowding and psychophysical inconveniences caused by over-population. (see Figure 1)



Figure 1. The village of Fermont, designed with due regard for the reasonable use of the natural environment.

A positive example of the fifth generation of population centers is Fermont workers' settlement, which was designed and built up taking into account the use of solar radiation, energy saving, rational use of the natural environment and a thoughtful architectural and planning decision of the master plan. [9].

Fermont is located above the 52nd parallel, in the same latitude as Siberia. It has a severe subarctic climate characterized by long, harsh winters and short, mild summers. In winter, there are predominantly strong northern winds. When the town plan was developed in the late 1960s, Montreal

architects Maurice Desnoyers and Norbert Schoenauer, who were invited to do this, realized that the town would need something that could protect its residents from cold northern winds. But instead of building a special wind barrier, Desnoyers and Schoenauer decided to unite the functionality of the wall and the residential development (see Figure 2). The result was a unique architectural building, 1,3 km long and 5-storey high, which became a landmark of Fermont. The experience of foreign colleagues was taken into account when designing the village for 15 thousand residents in Yamal [10].



Figure 2. Fermont's business card. A unique building 1.3 km long and 5 meters high.

Thus, the depressing influence of the environment - huge, ubiquitous, all-pervasive, up to the psychosomatic consequences for an individual - cannot be resisted by building separate, detached houses, no matter under how good projects they are built and what highest quality they have [11,12]. It is necessary to apply a comprehensive approach to building the entire social infrastructure of the urban organism:

- state programs in the issues of northern construction and assistance to small peoples of the North in creating "warm housing";
- high level of technical and technological equipment of construction;
- serious economic examination of projects, from the point of view of energy saving, environmental measures and expediency;
- search for new methods of town-planning solutions that meet severe northern conditions, new architectural forms of individual structures, abandonment of established stereotypes of construction (Sweden);
- careful elaboration of a plan for organizing the construction of future facilities over time, often exceeding the production schedule of the works themselves (although construction is carried out in a short time);
- subsidizing research and experimental work by government and private firms;
- purposeful preparation of a new generation of "polar scientists" in all fields of science related to the study of the problems of the development of the territories of the Far North;
- high level of technical and technological equipment of construction;
- search for new methods of town-planning solutions that meet severe northern conditions;
- new architectural forms of individual structures;
- abandonment of existing town development stereotypes;
- careful planning of the organization of construction of future facilities;

- wide use of color in the development of cities and villages.

The organization of a favorable light environment contributing to the human adaptation to the high latitude conditions depends on the complex solution of the following tasks:

- maximum use of the positive natural light properties by maintaining the links with the environment;
- protection against the negative influence of the light conditions of the northern latitudes;
- creation of the conditions, which are necessary, but absent in the natural environment.

The connection between the interior and the environment, and hence, the solution of one of its main elements – area lights in the conditions of a prolonged period of low temperatures puts forward the requirements to glazing [13].

Glass plays a very important role in maintaining the thermal equilibrium of the building. The existing modern technologies allow us to solve an important problem: window glass should perform the function of catching and "saving" solar energy, and heating the house in winter during the hours when it is also used for natural lighting of the room, as well as stopping to dissipate. The most famous solution to this problem is the use of double glazed frames and movable window screens. There is a great variety of options for these techniques [14,15].

It is possible to use hinged movable screens, both internal and external, made of various materials with insulating properties, wrapping or folding manually or mechanically. Screens used to maintain heat in winter are usually used to reflect solar radiation, which is undesirable in summer. For example, one very interesting solution is that the Venetian blinds consisting of long narrow strips are inserted into the space between the two frames, and they can be controlled from the inside. Some strips are covered with a layer of insulation material, and you can open the window in all possible ways if you turn them differently: you can open it completely or close it completely in a summer way by turning the silvered sides of the strips inward, you can also close the window in a winter way by turning the strips with the silvered side outward. In addition, numerous intermediate combinations are possible. It is also necessary to mention different types of sputtering, which is applied to glass surfaces in order to change their optical properties. Here, one cannot but mention the so-called "thermal mirror". It is the thinnest metal film, which retains an increased transparency with respect to the sun rays, and also has an increased degree of reflection of far infrared radiation [16-18].

Some changes in the spectral composition of sun rays at low altitudes (decrease in the number of purple, blue, green rays, absence of black and white variety when the radiation is scattered during the polar night and the day and at artificial light) also belong to the drawbacks of the external environment, which must be replenished [19,20]. One of the traditional ways of introducing the color diversity - the use of stained glass windows - has its own specifics in the conditions of uneven northern lighting. Here, you need to highlight all types of stained glass. The functions of artificial light also include the task of the corresponding influence on the interior greenery, which plays the role of a necessary element of interior outfitting [21-23].

4. Conclusion

The architecture of the northern territories should meet all the individual's requirements, as well as change dynamically together with him/her and his/her needs. The higher the level of the residents' comfort - housing, developed trade, public catering, recreation and entertainment - the more effective the practice of retaining specialists working in the North. The light environment will adapt to our needs and expectations, because changes are a constant process of our time.

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