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GEOMETRIC ASPECTS IN DESIGN OF ENERGY CONSERVATION BUILDINGS.

We consider geometric problems arising in design of energy conservation buildings.

First, we discuss how the form of a building impacts on its energy efficiency. It is no accident that houses of aborigines on territories with very hot or very cold climate have a semi-spherical form.

Let us consider a geometrical body of a fixed volume that is heated by a light source located infinitely far. Let p be the value of thermal energy arriving from this light source to a unit square that is perpendicular to its rays. Let q be the value of thermal energy radiated by a unit square on the body surface. Let the form of this body is defined by the following condition: its temperature must be maximally stable. Then it is a sphere if $p = 0$. If p increases from 0 to $2q$ then the body deflates gradually to a circle of infinite radius. If p increases from $2q$ to $4q$ then the body transforms gradually to a sphere. At the further increase of p it transforms gradually to a cylinder extending along thermal beams. We also consider the case of a finitely located light source.

The optimal form of a building satisfying the above condition can be found by solving some variation problem. To state this problem one must know the value of thermal energy incoming to a unit square depending of its orientation. We constructed an application package in matlab that represents in table form this dependence and takes into consideration the direct, diffuse, and ground-reflected solar radiation, and also the thermal radiation of atmosphere.

Next, we consider the problem of optimizing the form and size of windows. This is important, in particular, because of a significant loss of heat through windows. We analyze methods used in different countries for calculating the necessary area of windows. We develop a procedure of calculating the natural illumination of houses, which is approved as standard in ukraine.

We also devised a method that for each form of a window finds how many hours of sunlight the room receives. This method is based on some spatial transformation that transforms the window into a point; the size of each building that may obstruct the light reduces on the window size; the transformation of lighttight shields is more complicated. The method uses the solar map.

The solar map is constructed as follows. The sky over the looker is stereographically represented on the plane. Each pair (*a*,*b*), in which *a* is a day of year and *b* is a time of day, is assigned to the point on the map that represents the corresponding position of the sun on the sky at time (*a*,*b*). It is conventional to draw only the lines that represent the sun trajectory on 22th day of each month. We suggest to say that the insolation from the point that correspond to (*a*,*b*) is unlimited, inadmissible, or limited if the temperature at time (*a*,*b*) is cold, comfortable, or hot, and to partite the solar map into 3 zones of sky, correspondently. Designing the form of balconies, loggias, and sun-protection devices outside of a building, one may use the partitioned solar map so as to satisfy requirements to insolation from each zone.

We constructed nomograms for calculating the value of thermal isolation of a double-glazed window depending on its thickness, angle to horizon, and internal and external temperatures. Constructing the nomograms, we used the criterion equations from thermodynamics.

lastly, planning a new building that may shade the existing houses next to it, one must choose its form and height so that the insulation standards for those houses are hold. We propose a geometrical method for solving this problem. It is based on mapping of the greatest possible shadow masks of the new building on the solar map.

The methods that we consider help to design energy conservation buildings.