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Building Designing With Passive Solar Heating System

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ABSTRACT: Current paper work presents modern materials on the features of designing houses with solar heating for the conditions of the Republic of Uzbekistan. Requirements of solar thermal affecting the space-planning solutions of solar houses aimed at ensuring the optimal functioning of solar heating systems are considered. In the design it is also necessary to take into account the technical requirements of thermal protection and its accumulation in the building, which excludes overheating of the premises during the summer period and ensures the necessary temperature conditions with intermittent solar heat input. The functional diagram of the solar house for the geographical conditions of Uzbekistan is given.

KEYWORDS: solar heat, energy efficiency, energy autonomy, solar collector, energy efficient buildings

I. INTRODUCTION

The quantitative evaluation in this current paper designs architectural composition of buildings with solar energy. It provides a distinction between the activities of the architect and the “objective” area, where the effect is provided by quantitatively measurable energy efficiency. Values of architectural solutions and into the “subjective” area conditioned solely by the architect’s personal program goal.

When using passive solar heating systems, the architectural form of the building is shaped according to the utilitarian conditions of the building, special solar requirements and actinometrical conditions aimed at the effective functioning of solar energy systems. The objective field of creativity is to search for a rational synthesis in the architecture of a building of elements. Helios system depending on the given values and the values of the energy autonomy are most favorite building instruments.

In the subjective field of creativity of the architect, the form while maintaining its energy-saving qualities is enriched with aesthetic content.

It should be noted that, the saturation of the stages in the objective field of creative design depends on the complexity of the designed object and the planned value of the energy autonomy of the building. In some cases the mean values of energy autonomy, the architectural design of a building differs little from the methods of designing ordinary types of buildings. So, in ordinary homes in the conditions of Uzbekistan, as shown by the energy audit carried out under the Norwegian ENSI program. Share of solar heat can be up to 20% of the total energy consumed for heating. With an increase in the share of solar heating, due to a corresponding increase in the geometric dimensions of solar energy-absorbing elements of a passive solar heating system. Choice of architectural design is greater degree, fir direction in optimal placement of these elements of the building’s volume. For the meeting the more stringent requirements of thermal protection of the building’s outer shell.

The factors influencing the space-planning solution of a building with solar energy supply, its location on the site and orientation to the countries of the world, by purpose can be divided into four categories:

1. The amount of optimization tasks for solar requirements aimed at maximally capturing solar energy during the heating period and thermal protection of the building by elements of a passive solar heating system.
2. Requirements for architectural - planning and design solutions to ensure the necessary thermal stability of the building and reduce heat losses during the winter period and heat gains inside the building during the summer period with accumulation of "night cold" to maintain a comfortable air temperature in the room.
3. Requirements for the planning scheme for the optimization of passive solar heating technology.
4. Urban requirements for building buildings with solar energy.

The optimization of solar requirements is the sum of the external requirements aimed at ensuring maximum solar radiation to the surface of the solar heat receiver. In homes with a passive solar heating system, a south-facing glazed veranda (aivan), a winter garden, a helio-wall Tromba, or simply larger windows used for direct solar heating

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serve as a receiver for solar heat. The nature of the solar requirements varies depending on the geographic latitude of the terrain, the apparent trajectory of the sun, the architectural decisions taken and the features of the solar heating technology.

The Republic of Uzbekistan is located in the northern hemisphere of the Earth within $38^0 – 42^0$ United States. If we take into account that changing the latitude of the area by 1 - 2 degrees practically does not affect the solar radiation intake, then the average value of 40^0 US is possible to use as characteristic geographical latitude for the Republic of Uzbekistan in designing buildings with solar energy. In the process of architectural designdue to increase the efficiency of solar heating, options for increasing the density of solar radiation using architectural elements as flat reflectors - reflectors can be considered. As mentioned above, the optimal orientation of the solar receivers is the southern orientation with a possible deviation from the south to 20 degrees in the east or west rhombus. Since, in passive systems, the receiver of solar heat is the architectural elements of the building itself.Its orientation is optimized for ensuring maximum access of solar radiation to the part of the building that performs the role of a solar receiver.

In designing, it is also necessary to take into account the sector of solar radiation along the path of the sun during the winter period, to take into consideration the conditions for shading the solar receiver when the sun is low in the morning and evening (Figure 1).

The formation of the spatial structure of the building is influenced by the calculated values of the height of the sun at noon (30^0), the calculated azimuth of the sunrise (125^0) and sunset (235^0). Design should be carried out from the conditions of the coldest month of the heating period.

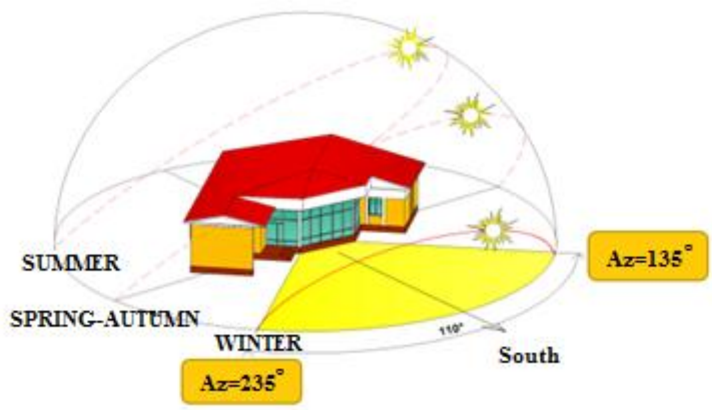

Figure 1. Sector of solar irradiation in the heating period

Insolation of the solar radiant energy receivers of passive solar heating systems in the summer period leads to discomfort, causing overheating of the premises, which leads to the installation of powerful conditioning systems leading to excessive energy consumption. This is contrary to the principles of design of energy-efficient buildings. It is absolutely not admissible that the projected building using modern technologies of passive solar heating can be energy-consuming in the summer.

In energy-efficient buildings, the general requirements for protection against summer overheating should be observed and new conditions should be developed to exclude direct solar irradiation of solar receivers. Since these units are oriented to the south with some tolerable deviation from the optimal orientation. Horizontal sunscreens are an effective sunscreen, in this regard, it is effective to use visors over solar receivers. The task of the architect is the correct design of the sun protection elements, while not interfering with the penetration of sunlight during the heating period.Insolation should exclude of the solar collectors during the summer solstice.

The height of the sun at noon at any time of the year, depending on the geographical latitude of the area is determined by the formula

$$h_{\circ} = 90^{\circ} - \varphi\ (\pm\delta),$$

Where φ is the geographical latitude of the area, for conditions of Uzbekistan it equals 400;

- Declination of the sun.

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The latitude of 40° C is characteristic for Uzbekistan and, if one considers that the declination of the sun in January is 20^0 and in summer + 23.5^0, then the solar receiver of a passive solar heating system should be maximally intonated in winter, with a sun height of 90 - 40 -20 = 30^0. In summer the sun rises high 90 - 40 + 23.5 = 73.5^0 the surface of the solar receiver must be protected from direct solar radiation (Fig. 2).

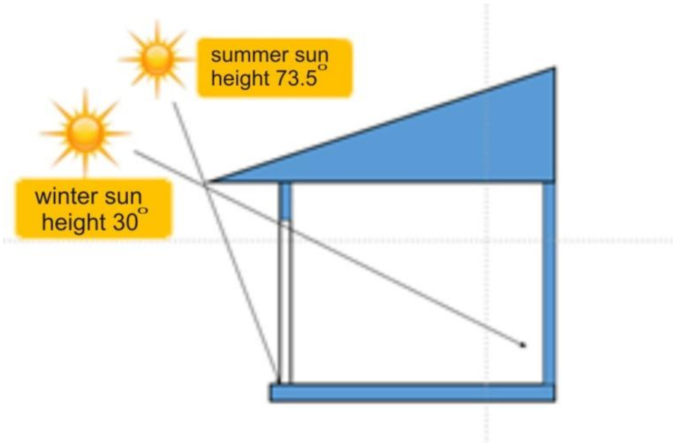

Figure 2. A visor in the winter without interfering with the penetration of low-standing sunlight into a room, in the summer completely excludes its insolation. Regarding the unfavorable orientation of the apertures for the conditions of Uzbekistan, it is important to pay attention to the proposals of I. Sukhanov [one].

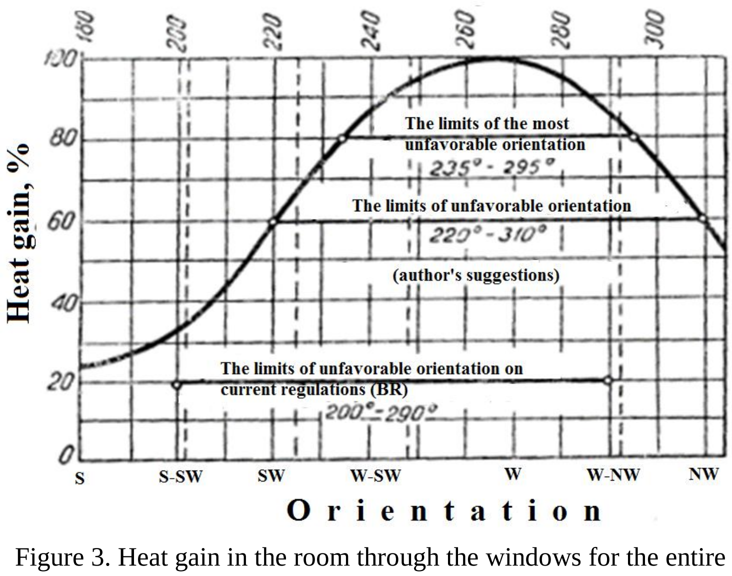

Figure 3. Heat gain in the room through the windows for the entire summer period with different orientations (according to Sukhanov I.S.) [1].

As can be seen, the highest heat gain of 100% is observed at the western (W) and close to it orientations (W - SW) and (W - NW). In the southern orientation, this is the orientation of the solar receiver in the absence of sun-protection devices; the heat gain is five times less and amounts to slightly more than 20%. From the graph it can be seen that with a deviation from the south by + 15 - 20% leads to an increase in summer heat gains up to 27%.

The trajectory of the sun in different periods of the year and the need for maximum insolation of solar receivers in the winter. It completely shade in the summer period should be taken into account in landscaping when planting trees and plants in the nearby area of the building.

Under certain geographical conditions of the area with high frequency of cold winter winds, heat losses must also be reduced, protecting the building from cold winds. Here the solution can be purely planning, or the organization

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of protective screens that prevent cold winds from accessing the building. For example, with a tambour device, the issue of restricting access to cold air is being addressed. It is possible to use the well-known methods of adjoining to a building of non-heated volumes, for example, adjoining a garage to a building.

The location of the rooms should be done in such a way that morning sunlight can be used to illuminate the kitchen and possibly the bedroom. Winter sunlight for the living room and, moreover, use the utility rooms, garages as additional northern and western buffer spaces, as shown in figure 4.

Significant effect in the use of solar heat gives the location of the greenhouse to the south of the living room.

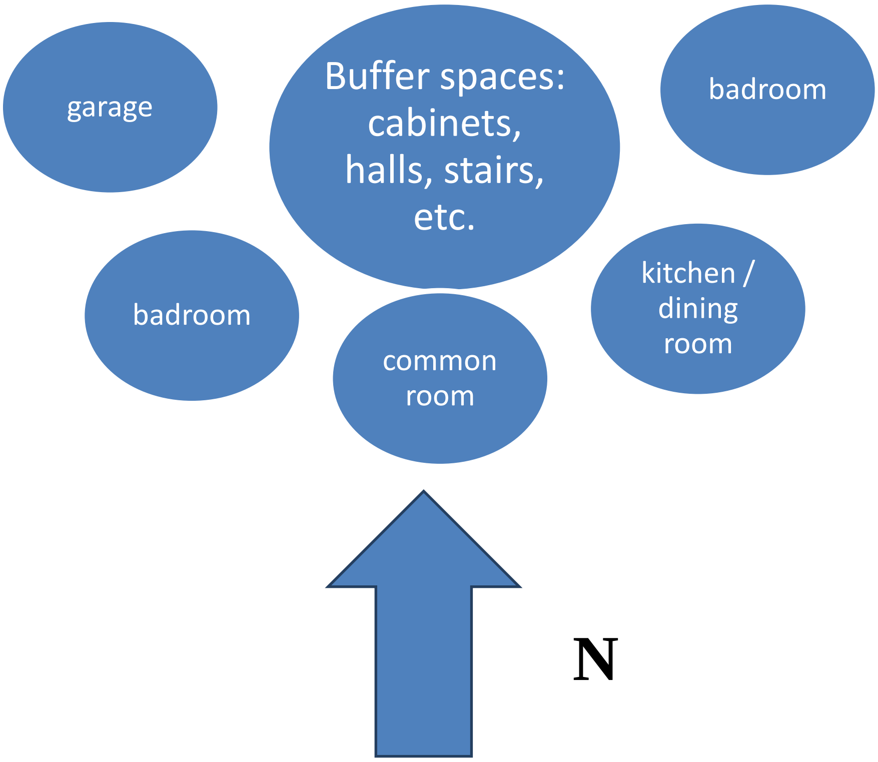

Figure 4. Recommended location of the premises (by Ben Luce) [2].

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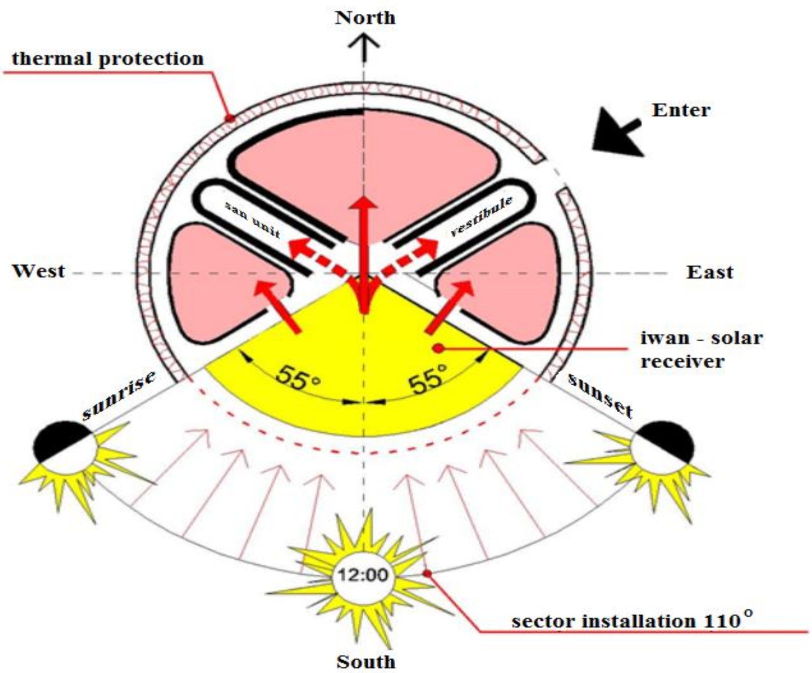

Figure 5. Functional diagram of a solar house for geographical conditions of Uzbekistan.

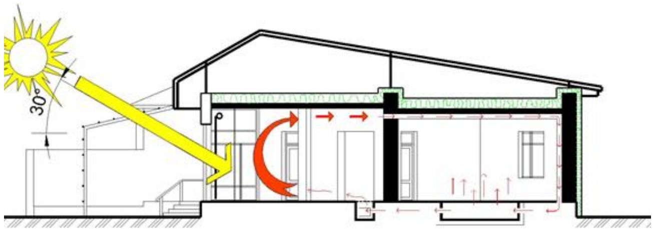

Figure 6. The vineyard in front of the avian solar collector in winter is not prevents its isolation in the winter.

It is necessary to take advantage of the extensive experience gained in building people's housing, which, thanks to a rational planning solution, skillful use of the properties of local building materials, gardening of the area and planting shading trees, created a favorable microclimate in the house during the hot summer (Figure 7.).

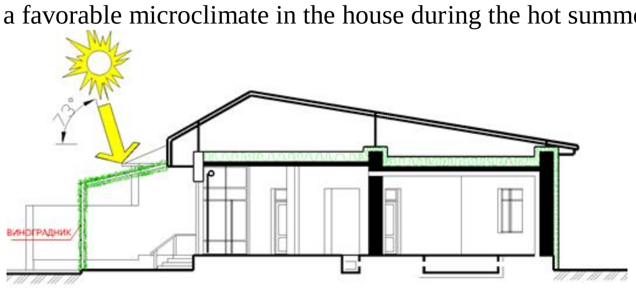

Figure 7. Vineyard in front of the avian (courtyard) - solar collector in summer period protects it from overheating.

In the design process, the architect performs a creative search for organic synthesis of architecture and solar technologies in the process of modeling space-planning decisions. In the initial design stage, the architectural composition, as a first approximation, is formed for the classic-original type of passive solar heating technology. Without taking into account the architectural and planning requirements and design conditions of a particular building (Figure 8).

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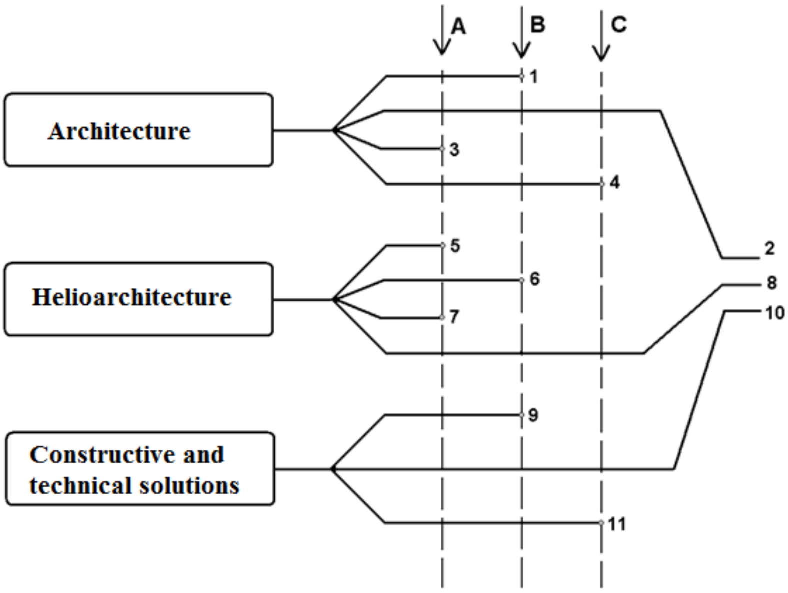

Figure 8. Formation of a space-planning solution as ensuring the main requirements for the effective functioning of passive solar heating technology. A, B and C are the design stages.

Based on the architectural concept and ideas, the architect has "contradictions" between the architectural and compositional solution and the conditions for the optimal integration of solar heating technology into the structure of the building. In the design process there is a need for some modification of solar systems to adapt to the architectural conditions of the building design. Further simulated possible volume-compositional solutions. The final form of the system is formed taking into account the new requirements that have arisen in the process of synthesizing architecture with a modified system. The objective area of creativity ends with the refinement of the architectural composition that meets the values in specified of solar requirements and the unique purpose of the object which heating solar system.

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