



"Traditional Architecture of Uzbekistan: Passive Solar Heating and Climate Adaptation"

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ABSTRACT

Already at the early stages of the development of human society, architecture was closely connected with the climate and natural environment. Man was forced to solve construction problems put forward by climatic conditions at the site of the construction of structures. For example, Vitruvius (I century BC) in his work "Ten Books on Architecture" wrote that buildings in their style, obviously, should be different in their style, in Egypt and Spain, in Pontus and Rome and in countries and regions differing in characteristic features. For one part of the earth lies directly under the sun, another is far from it, and a third is exposed to it at a moderate distance [2].

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Also, the great Abu Ali ibn Sina in his book "Canons of Medical Science" paid great attention to issues related to taking into account natural, climatic and geographical conditions when choosing a place for the construction of cities. Turning to the home, Ibn Sina considered it obligatory to insulate and ventilate the premises: he recommended that windows and doors face east and north, and the sun should

reach any place in them, because it improves the air [1].

The centuries-old development of Central Asian architecture provides examples of amazing coincidences with the scientific provisions of Ibn Sina. For example, the folk craftsmen of Uzbekistan, wisely taking into account the natural and climatic conditions with the rational use of their positive qualities, created various types of dwellings, distinguished by favorable living during the hot summer. The space-planning structure and structural solutions of dwellings are a set of techniques selected and tested by many centuries of experience [4].

There are many studies of the structure of the people's dwelling in Uzbekistan [3, 6]. Most of these works are descriptive in nature, and only a few are devoted to identifying the role of architectural and planning solutions in improving the microclimate in the summer. However, Uzbekistan is characterized not only by hot summers, but also by cold long winters. On the territory of the Republic of Uzbekistan,

the duration of the heating season is 3-5 months.

Despite this, the bulk of the population in the past lived in houses that did not have equipment for heating the premises. On frosty days, residents gathered around a device that allowed heating only their bodies - a *tancha*, which was a hearth placed under a table of low height, on top of the table was covered with a cotton blanket. The exception was some houses of wealthy people, in which the rooms were heated by fireplaces. In folk architecture, there were methods of using heat from the hearth of the kitchen. In winter, the cooking process was carried out in a niche built directly into one of the walls of the living room, and the cooking tool itself - *uchak* - in the wall separating the kitchen with the living room is typical for the types of dwellings in the Fergana Valley. They are often found in Margilan and Chust.

It should be noted that during the construction of winter stay premises, special attention was paid to reducing heat demand. For this reason, the height of the rooms was taken to be minimal, which contributed to a decrease in the cooled surface of the external walls. Often there is a wall structure consisting of a double frame with an air gap - "*kushsinch*", which is distinguished by high heat-protective properties.

The architects of the past were well aware of the possibility of using the thermal effects of the sun's rays for the purpose of heating premises. For this purpose, during the design, a clear division of rooms was made according to their purpose: rooms for winter stay and summer rooms, which differed not only in the nature of the construction of the volume, but also in the orientation of the light openings. If the summer rooms were oriented to the north, then the rooms of winter stay were turned strictly to the south, which made it possible to irradiate them as much as possible with the winter rays of the sun. Such differentiation of the orientation of premises is characteristic of most types of dwellings found on the territory of Uzbekistan. It is especially often traced in the Bukhara and Fergana types of folk dwellings.

If there are several rooms in the house, then the plan is broken at right angles with the façade to the south and east, but at the same time the winter rooms retain their southern orientation. The shape and arrangement of the *iwan* along the southern façade, which shelters the openings from the sun's rays in summer, but in winter does not prevent the penetration of the rays of the low-standing sun, has a certain meaning. A similar function is performed by canopies over openings.

Due to the low level of the sun in winter, with the existing compositional structure of a folk dwelling with a courtyard, there is a danger of shading the heated rooms by opposing rooms and *aivans* of summer residence. The author carried out a number of graphic studies to analyze the compositional structure of the dwelling in order to determine the accessibility of winter rooms for direct learning by the sun in the cold period of the year. Fig. 1. The results of research conducted on common types of dwellings in Bukhara and Samarkand are presented.

An example of house No 1 on Frunze Street is a two-storey space with a courtyard, which is connected to the street by a dark corridor - *darvazakhana*. In the lower tier there are auxiliary rooms. Winter ones are on the second floor and are oriented strictly to the south. The height of these rooms is minimal. The light openings are organized only on one south side of the premises and overlook the courtyard. The shading angle of the light openings is 300, which coincides with the average height of the sun for January. Consequently, the rooms of winter accommodation at noon and around noon in January, the coldest month of winter, have the opportunity to be completely irradiated by direct sunlight. And in December, there is a slight shading of them by opposing summer rooms. As is known, at noon and around noon, the intensity of solar radiation takes its maximum value equal to 2900-3200 kJ/(m².h.) In this regard, at this time not only the internal space is illuminated, but also it is heated.

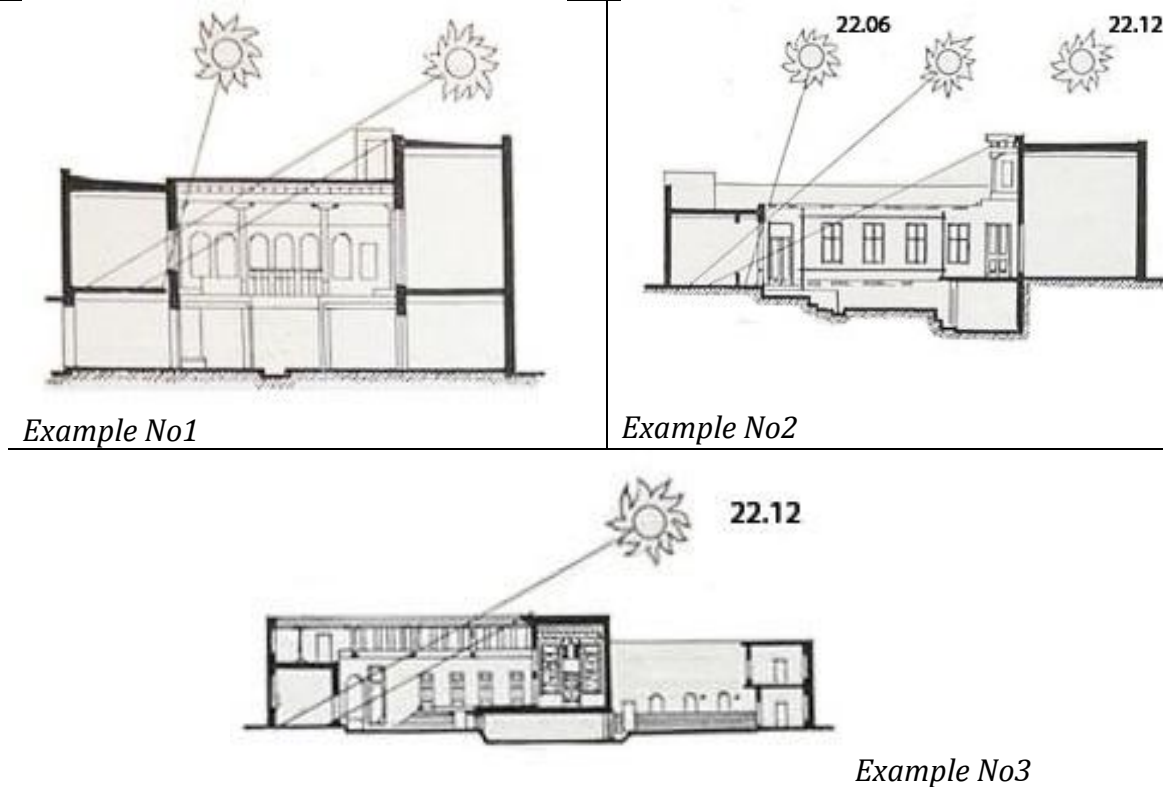


Fig.1.

The spatial structure of house No 2 is distinguished by the fact that the optimal ratio of the height of summer rooms to the depth of the courtyard is established here, due to which the winter room is freely insolated during the entire heating period. The shading angle of the light openings is 260, which corresponds to the minimum height of the winter solstice observed on December 22. On the courtyard side, the winter rooms have aivans of shallow depth, which, as can be seen from Fig. 1, do not interfere with insolation in winter, but completely exclude it in summer, when the sun is high. Similar methods of solar heating of winter rooms were used in house No 3, where at noon on December 22, heated rooms are irradiated by direct sunlight to the entire depth.

Thus, it can be seen that the architects of the past were well aware of the possibilities of using solar energy for the needs of heating premises. They had the necessary data to determine the position, coordinates and apparent orbit of the sun, as evidenced by repeated cases of striking coincidences of the angle of shading of the openings of winter rooms with the height of the sun observed in the

cold period of the year. This guaranteed, despite the complex compositional structure of the folk dwelling, the insolation of winter rooms at noon and the noon hours.

A small excursion into the past showed that even in those ancient times, the possibility of passive heating of premises with the help of a natural, natural source of heat - the sun - was taken into account.

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