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Skillful Geometric Techniques in the Architecture of Central Asia of the Ix-Xii Centuries

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Abstract: The article examines the skillful geometric techniques in the architecture of Central Asia of the IX-XII centuries. The geometric analysis of the architectural composition of the mausoleum of the Samanids of a special design of buildings built in the IX century is presented.

Keywords: architecture, Central Asia, mausoleum, facade, constructive basis, analysis, plan, harmonization.

The historical cities of Central Asia have a large number of historical architectural monuments. The world-famous masterpieces of medieval architecture of Samarkand, Bukhara and Khiva are the object of constant research by domestic and foreign specialists.

Analyses of the proportionality of architectural monuments of the IX-XV centuries allow us to trace the formation and development of skillful geometric techniques, the presence of a connection between medieval architectural theory and practice. They expand ideas about architects, skilled craftsmen of a particular architectural school, and about the architecture of the epoch itself.

The Samanid Mausoleum is the oldest architectural monument on the territory of Bukhara and the first burnt brick building in Central Asian architecture. The three–dimensional composition of the mausoleum is simple and locanical – it is a small "cube" (about 10 m on the side), covered with a hemisphere of a large dome and four domes at the corners. Its square plan is oriented according to the countries of the world. The building is placed on a low plinth and ends with an arched gallery encircling the top. The corners of the building are fixed with massive three-quarter columns. All the facades of the mausoleum are identical; along the axis of each of them there are rectangular openings in niches, the pointed arches of which are supported by three–quarter columns.

The constructive basis of the mausoleum is represented by a three–stage structure - a quadrangle, an octagon and a dome. The arches of the octagon are placed on the inner edge of the powerful walls of the quadrangle.(with thin walls of 35 – 50 cm). These arches at the castles are supported by semi–arches, resting: some on the outer walls of the building, others on the corners of the quadrangle, forming tromps. A narrow bypass corridor at the tromp level is blocked by a semicircle and domes at the corners. The dome of the mausoleum is made of different bricks with sides of 31, 27 and 23 cm on alabaster mortar, has a stepped section and rests directly on eight arches and on eight semi-arches supporting them. The forces from the expansion of the dome are transmitted diagonally to the corner pylons of the quadrangle, and in the axial directions – to the outer walls of the gallery, where the stresses from the expansion are at the limit.

The stability of the structural system of the structure, the relative strength of its elements, the deep laying of the foundation foundations, the use of structural belts of large–sized bricks for a better connection of the cladding of the building with the body of the masonry wall, the thinning and lightening of the structures located in the upper part, with the replacement of the loess mortar used for the masonry walls of the quadrangle, more durable and the balance of the volumetric - the spatial structure of the entire structure as a whole ensured the monument's millennial existence.

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With the height of the plinth about 1m, obviously, there must have been entrance steps or a ramp that could not disappear without a trace, rather they could be under cultural layers. However, no signs of the existence of entrance steps or a ramp have been found during archaeological excavations.

The ancient ground level around the monument could be restored according to structural features - according to the lower edge of the belt of large-sized bricks. At the same time, the entrance threshold will be three bricks high flat, just as it was in other mausoleums: Arab-Ata, Alamberdara, Talhatan-bobo, Tekesha, Fakhraddin Razi, Babaja-khatyn, Aisha-bi bi, etc. With the most detailed analyses of the proportions of the Samanid mausoleum, both variants of the ancient ground level around the monument are taken into account: the first with a large basement and the second with a small one, having a lining and including a belt of large–sized bricks.

The analysis of the proportionality and methods of constructing the architectural forms of the Samanid mausoleum allows us to draw the following conclusions.

1. The initial parameter in determining the proportions of the structure was a square plan, the main components of which, as well as the height of the "cube" were expressed by a module equal to a large-sized brick 60 × 60 cm.
2. To establish the proportions of the Samanid mausoleum, the architect used the derivatives of three squares: the inner and outer ones at the level of the basement and the inner one at the level of the tromp tier.
3. Along with the harmonization of architectural fromes based on the relations of the side and the diagonal of the square, the architect also uses the division of the segment in the extreme and middle ratio, i.e. the derivatives of the side in the diogonal half-square, which can be traced in the proportionality of the plan and in the division of the walls of facades and interior.
4. A comparative analysis of the proportionality of the height of the mausoleum with a large and small plinth leaves no doubt that the hypothesis of the presence of a small plinth has the right to exist.
5. The proportions of the mausoleum include similar rectangles with an aspect ratio of 1÷2/2. This similarity of rectangles on the facades and in the interior was achieved thanks to a single method of their construction, and the initial ones for them were, respectively, external and internal (at the field level and at the ascendant level) squares.
6. The proportional structure of the Samanid mausoleum is based on the geometric harmonization of architectural forms. However, there are also arithmetic proportionalities. But this circumstance is not a mixture of two themes, but the development of one system of proportionation based on a square and a half–square expressed in modules, on the sequential division of the sides and diagonals of the square in half.

The totality of facts allows the hypothesis that the mausoleum of the Samanids was built according to a pre-compiled and deeply thought-out project in the form of a drawing and model.

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