

THE ARCHITECTURAL AND DESIGN FEATURES OF THE RUSSIAN ORTHODOX TEMPLES THOSE HAVING AN IMPACT ON MICROCLIMATE PARAMETERS.

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Abstract: The features of the establishment and maintenance of the required parameters of the microclimate in the Russian orthodox churches discusses. Constructive features of the orthodox churches of various architectural forms and styles, which affect on design of natural ventilation systems is considered. The features of the selection of feature points for research in the wind tunnel are described. The issue of internal aerodynamics studies is considered.

Keywords: orthodox temples, microclimate, internal aerodynamics, exterior aerodynamics, aerodynamic coefficient, aeration.

Creating and maintaining the required parameters of the microclimate in the orthodox temples - is the actual problem, whose solution requires a large amount of theoretical and experimental studies. Each temple is a unique structure that requires an individual approach. It is possible to develop a common approach to data collection and their processing, but due to the architectural and constructional features each of the temple, as well as other factors, it is impossible to develop a single standard project.

The use of modern mechanical ventilation in the temples is not a rational decision for several reasons: the high cost of the systems themselves, maintenance costs, electricity consumption, and disturbance of aesthetics of interior decoration of the temple. All these drawbacks are absent in natural ventilation systems, representing a system of supply and exhaust transoms located in the window apertures of the temple, the area which are determined by calculation [1, 2, 3]. This calculation is influenced by many factors, some of which can only be determined experimentally on a full-scale model or in the laboratory.

Conventionally, these factors can be divided into two groups: factors affecting the external aerodynamics of the temple; factors affecting the aerodynamics inside the temple.

The first group includes architectural and design features of the temple, as well as the climatic conditions; the second also includes architectural and design features, as well as the heat of the candles, heating systems and parishioners.

In the scheme of movement of air currents (Fig. 1) is seen that air coming from the street to the temple 2 is heated by the heating device 1 and by natural convection rises and is removed through the window aperture in the drum of a temple 5.

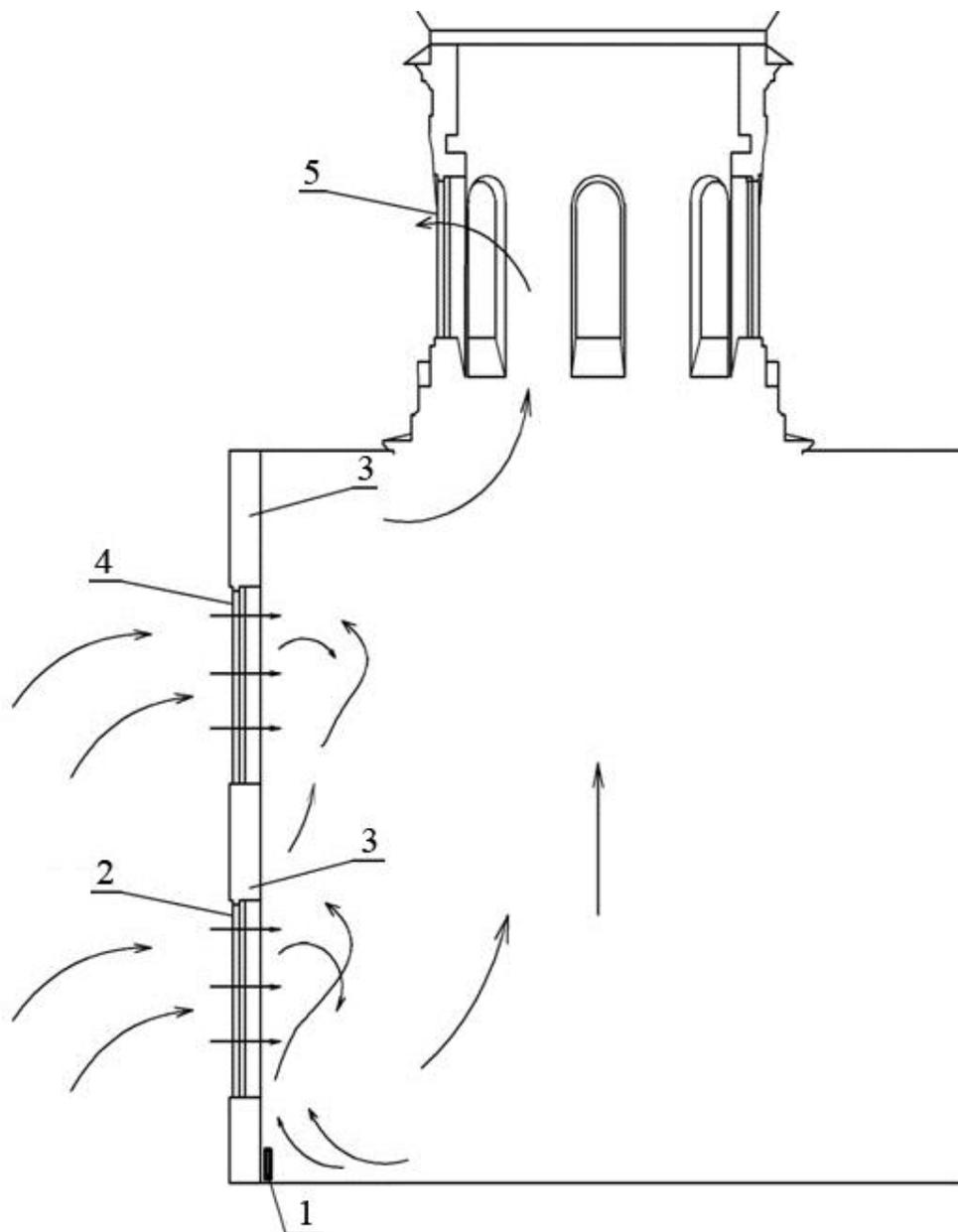


Fig. 1. The scheme of movement of air currents in the Orthodox Church: 1) the heater; 2) the window aperture the first tier; 3) part of the wall with no windows; 4) The second tier of the window aperture; 5) the window aperture in the drum of the temple.

This scheme of circulation is possible when there is no partition between the room and the prayer hall a temple drum. In the case of this partition the air out of the prayer hall can be removed through the second tier of the window opening 4, but such a scheme is already less effective.

Knowledge of the possible places of accommodation supply and exhaust transoms is necessary to carry out experimental research in wind tunnel. As a result of these studies are determined the field of aerodynamic coefficients - dimensionless quantities characterizing the part

of dynamic pressure which become a static pressure. The versatility of aerodynamic coefficients is connected with their independence from the weather conditions, i.e. aerodynamic coefficients for one temple in the same climatic conditions, can be used with sufficient accuracy for engineering calculations for the temple of similar geometry and architectural style in other climatic conditions. For carrying out aerodynamic tests by us the appropriate preparations for the four Orthodox churches in Nizhny Novgorod were held: the church of Zhen-Mironosic, Rozhdestvenskaja church, Krestovozdvizhenskij cathedral, Spasopreobrazheniskij cathedral.

In their time the church of Zhen-Mironosic (str. Dobrolyubova) (Fig. 2) become a new type of orthodox churches in Russia - "ship". The altar, prayer hall, the refectory and the bell tower on the western exit was strictly axially arranged. Combining warm and cold church in one building on different floors was an unusual decision. Before the advent of the church in the parishes cut two temples: small, usually klet type for doing winter service and spacious (mostly marquee-type) - in the summer [4, 5].

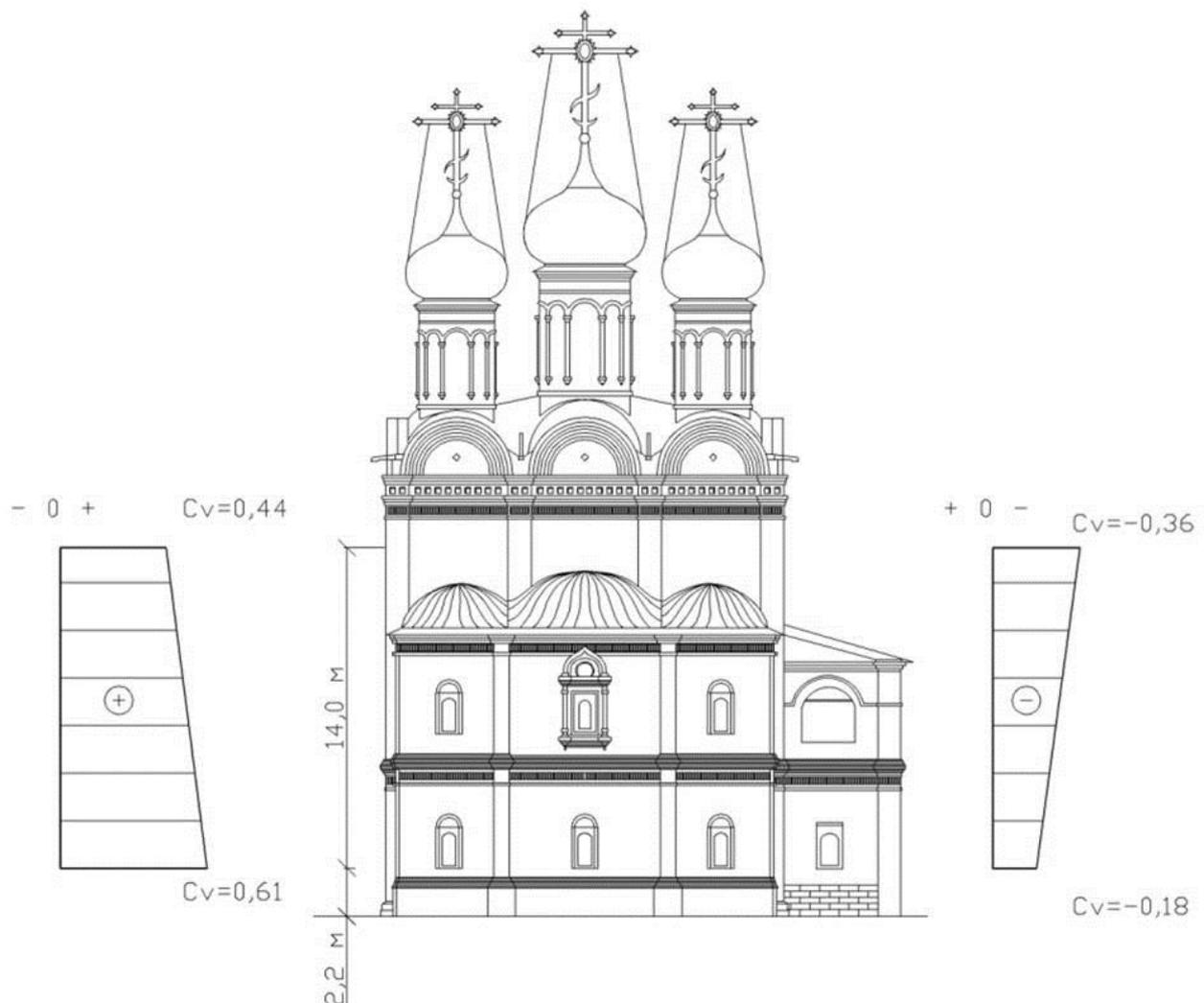


Fig. 2. The values of aerodynamic coefficients for the church of Zhen-Mironosic (South West wind direction).

Despite the fact that the best option arrangement of supply and exhaust holes in the Orthodox churches is the lower tier of the of window apertures and the window apertures in drums respectively - an approach for the church of Zhen-Mironosic not suitable, due to the absence of windows in all five reels. Thus, as the exhaust vents in the present Orthodox Church can take the upper tiers of windows.

In the church of Zhen-Mironosic were performed 39 specific study points (Fig. 3). North Side: 14 points, of which 7 - intake ports located in the first (lower) tier of the windows of the temple, and 7 - exhaust openings located in the second (top) tier of the church windows; south side 12 points, of which 5 - intake ports located in the first (lower) tier of the temple and the 7 points that act as exhaust ports, 4 of which are in the second tier (the top in their field), and 3 in the third tier (top); east side (of the altar): 9 points, 4 of which holes serve as air supply openings arranged in the first tier of the windows of the temple, and 5 - supply holes arranged in the second tier of the temple window; west side: 4 points that serve as exhaust holes.

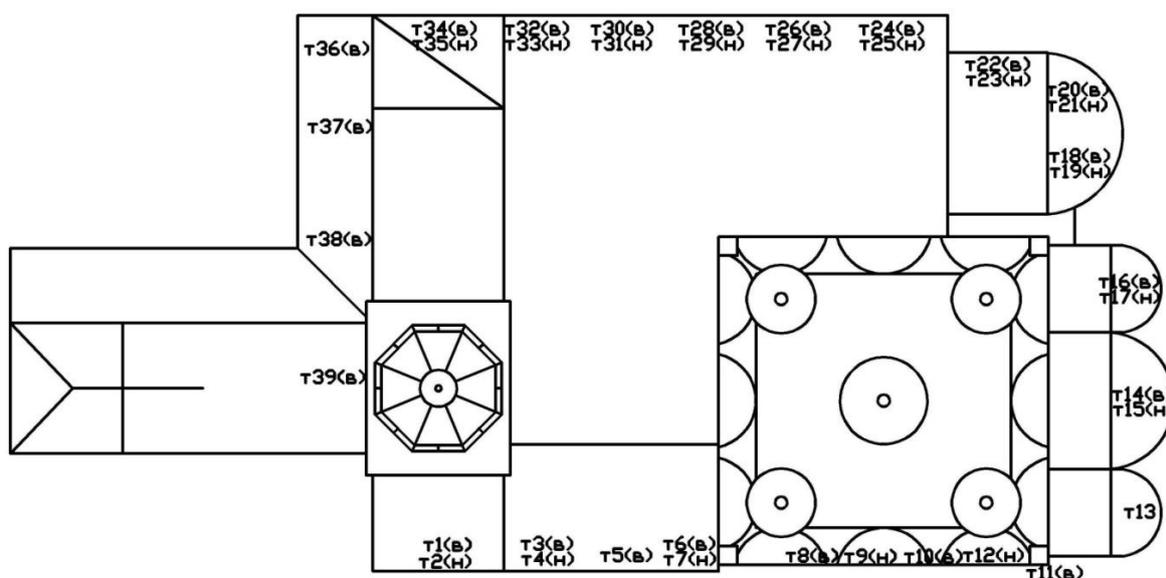


Fig. 3. Location of characteristic points on the plan in church of Zhen-Mironosic.

Among all churches built by Stroganov in Nizhny Novgorod "The Church of the Nativity of the Blessed Virgin Mary" (Rozhdestvenskaja church) (street. Rozhdestvenskaja), which built in 1653 is particularly monumental image, an organic relationship lush decoration with the completion of the central head with two wrought iron crowns. A unified approach to the solution of all buildings erected in different cities of the country, with the money of Stroganov [5] was the research literature related to the same styles and was called "Stroganov baroque".

The Rozhdestvenskaja church, in the study of external aerodynamics is impossible not to take into account the peculiarities of the relief, as well as the bell tower, connected to the temple one tier. Holes are performed only in the main part of the temple. It is worth noting that in the

Rozhdestvenskaja church all the drums are connected to the prayer hall, and the window above the altar in the drum can also play the role of exhaust vents. However, in contrast to Krestovozdvizhenskij cathedral, in Rozhdestvenskaja church the drums are located close to each other, which significantly limit the number of window openings, which can be effectively used as an exhaust hole. On the other hand, since all the drums are connected to the prayer hall, the number of window openings to accommodate the exhaust openings is much higher than the number in Krestovozdvizhenskij temple, which will consider various options for placement of exhaust vents.

44 specific points of the study was performed in Rozhdestvenskaja church (Figure 4.). 21 air-supply hole located at the bottom of the orthodox church (7 in the North, 3 in the east, 7 in the south, 4 west); 23 suction holes, 3 of which are located in the drum above the altar in the east, north and south window openings, 3 holes in the window openings of auxiliary drums and 8 holes in each window opening of the main drum.

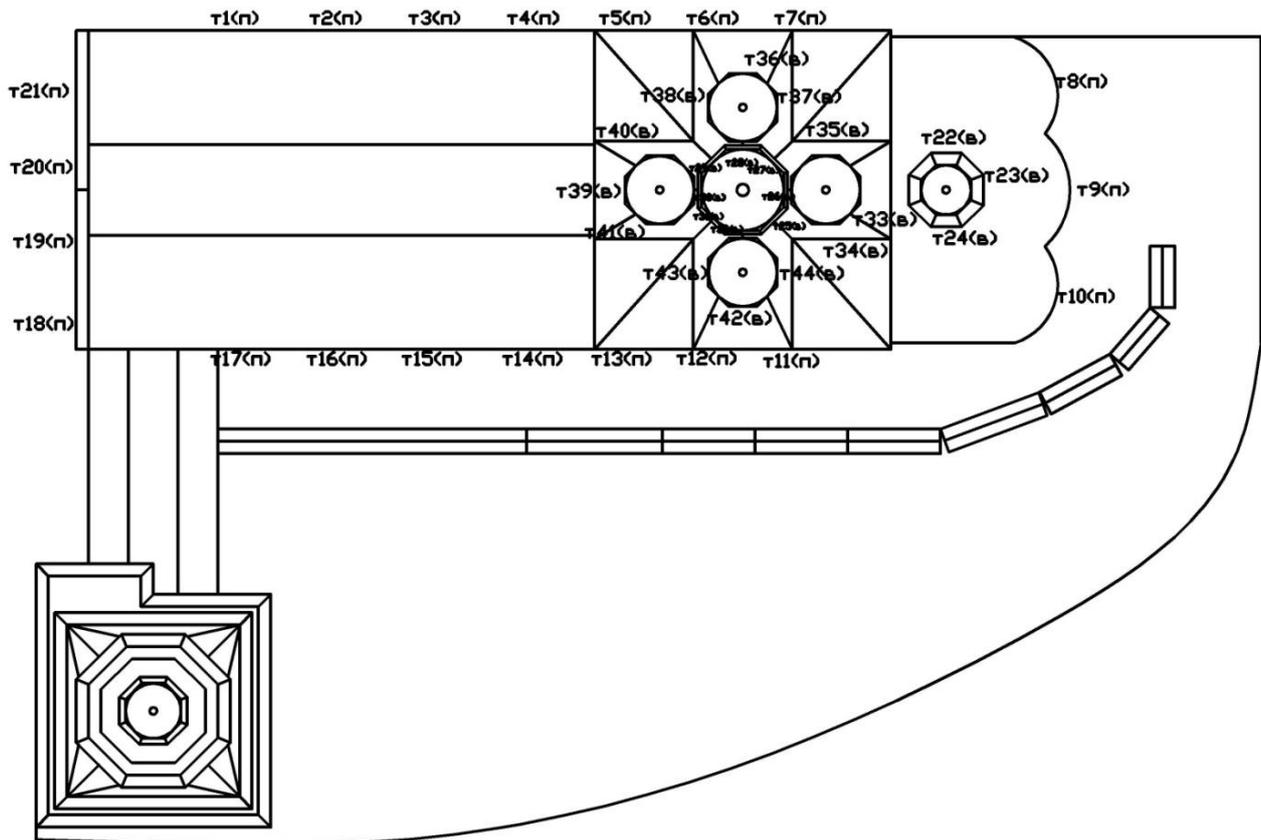


Fig. 4. Location of characteristic points on the plan of Rozhdestvenskaja church.

Krestovozdvizhenskij cathedral (1811-1823) (Liadov area) in terms represented an equilateral cross (35h35m) with four internal pillars that support the central dome. Above the wings were placed 4 small head. The architect of the cathedral in the forms expressed the main symbols of Christianity: a huge cross, the ends of which fit into a circle - a sign of eternity and permanence.

In Krestovozdvizhenskij temple is worth noting the presences of the domes are not connected to the prayer hall, which makes it impossible to implement remove air through them. Only the central drum is connected to the prayer hall. Thus, the 24 feature points of research (Figure 5.), which was carried out in the Krestovozdvizhenskij temple: 16 air-supply hole located at the bottom of an Orthodox church (2 in the west, in the south of 6, 6 in the East, 2 in the north); 8 are exhaust holes located at the top of each window opening of the central drum.

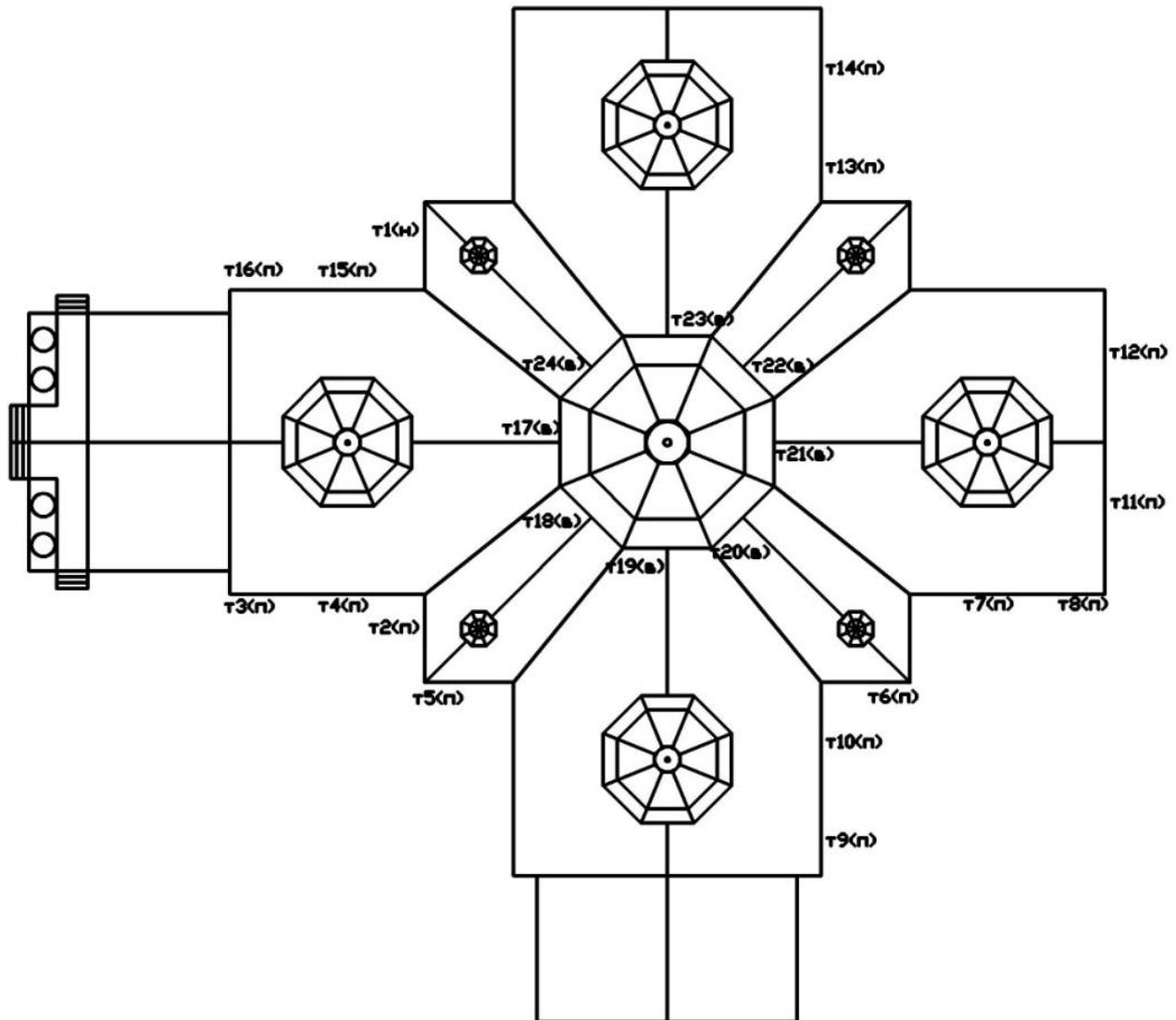


Fig. 5. Location of characteristic points on the plan of Krestovozdvizhenskij cathedral.

Among the temples of Byzantine Revival architecture worth noting Spasoprebrazheniskij cathedral (1900-1903), built in Sormovo (now Nizhny Novgorod region) under the direction of architect Malinowski. The height of the temple to cross is 43m. The huge dome supported by a semi-dome placed on the sides and transfer the pressure on the top corner of the reinforced masonry. Reduced bell tower is emphasizing centricity of composition.

The Spasoprebrazheniskij cathedral (st. Shcherbakova, Sormovo district) form of drums differs from Krestovozdvizhenskij cathedral and church of Zhen-Mironosic, at the base of which is

not an octagon, but 16 angles figure. The side drums for exhaust openings available 9 window openings, and it is worth noting that in this temple window openings practically do not overlap other drums or other structures (except for a western drum, overlapped the bell tower).

Detailed experimental results are given in the literature [3].

Considering the factors affecting the internal aerodynamics of the church cannot fail to note the dominance of the vertical dimension above the horizontal. As a rule, the height of the vertical walls of the prayer hall is located several tiers of window apertures. The partitions separating the one layer from the other are absent. Between the window apertures are frescoes and icons, making it impossible to placing heaters beneath each tier of windows.

Unlike civil buildings where the distance from the heater to the sill averages 0.2 m in orthodox temples it may be in the range of 0.5 - 1 m. The temples also hold heat as from crowded, and from burning candles. Rising convective flow from the heater draws soot from candles, which subsequently remains on the wall, resulting in damage to the frescoes and icons located above the heater. It is therefore recommended a distance of 0.2 m from the heater set the plate size will be mapped to the horizontal dimensions of the device, which will be protected from black church plate, located above the radiator. Hence, we get the same conditions for the heaters, as for public buildings, especially the installation of radiators in the predominantly orthodox temples open type.

In the characteristic points, in the church "Vozneseniya Gospodnya" in Nizhny Novgorod measurements of temperature fields of the inner surfaces of the outer walls have been carried out using an infrared thermometer Raytek Raynger ST20. In the initial points were measured temperature and air velocity field using hot-wiring anemometer TTM-2 / 1-06-2A. Against the wall without windows the air temperature reaches 18,6 °C, velocity takes the value of 0.05-0.2 m / s. Above the heater (near a window) air temperature amounts at 20,1 °C, and air velocity - of 0,14-0,32 m / s. In the case of freestanding radiator air temperature was 21,5 °C, and the speed was 0.37 m / s.

These values of velocity and temperature fields over the heating devices in the Orthodox churches have been determined experimentally, however, it is not always possible, so the physical and mathematical modeling of natural convection flowing in the prayer hall of the places of worship is use.

In the calculation of internal and external aerodynamics associated with using excess quantities of heat removed by aeration systems, revised subsequently on the mass flow of exhaust air, taking into account climatic parameters. Under the excesses of heat understand the total value of the thermal emissions from heating systems, parishioners and candles less any heat loss.

Thus, for the calculation of natural ventilation systems, in addition to the reference data must be known the following values: the volume of the prayer hall, and other geometrical

parameters of the temple; power of heating systems; the number of parishioners (minimum, average number, maximum); the number of candles (depending on the number of parishioners); prevailing wind direction and speed for the calculation period of the year; the location of the of window apertures for aeration systems and the ability to perform exhaust transom windows of the temple drums.

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