Techniques for designing a mini house on a garden plot

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Abstract. The problem is that comfortable housing is usually designed in such forms that make it inaccessible to people even with average incomes by Russian standards. This leads to the task of reducing the volume and area of the house while maintaining the requirements for completeness of functions and architectural expressiveness. This social order is reinforced by the fact that the housing problem for people with middle and low incomes in Russia is solved in suburbia, on the territory of garden associations, where housing becomes an alternative to urban housing. The article solves the following problems: minimization of floor space, landscape-like architecture in conditions of a significant slope; development of expressiveness techniques for log cabins in combination with a wooden frame; architectonics of parts of a wooden building while ensuring maximum compactness.

Design techniques and the author's experience in using them in the construction of a small residential building made of timber with stained-glass windows on the terrace are given. Small house-on a site of 6X6 meters performs all the main residential and additional guest functions. The house was built according to the author's project and carried out by the builder under constant supervision of the author.

The topic of this work is relevant for two reasons. First, modern settlement processes include the development of suburbia. As part of this process, numerous garden associations are gradually turning into residential settlements. Round-the-year water supply and electricity networks are being laid, and sewage issues are being resolved autonomously through the construction of septic tanks. People get a residence permit and live in gardening all year round. This is reinforced by the new legislation in force. Secondly, the city life is available for the reason that in the city, citizens with ordinary Russian income can not afford a large comfortable apartment. A mini-house in the suburbs on its site is more comfortable than a single-room apartment in the city. An apartment of 36 m2 cannot be developed to the size of 108 m2 because of neighbor cells in a multi-story building.

Therefore, it is important to study and develop architectural principles that allow you to develop the space of a residential building without going beyond the boundaries of a square of 6X6 meters. And as a result, the house should get a set of necessary functions and even architectural representation. This work shows the possible order of project actions in this direction.
Figure 1. General plan of the plot with a house, a barn and a greenhouse

General topography. The plot of 5.2 acres is located on the South-Eastern slope of the Yershov mountain, 500 m from the bay of the same name. The contour of the site has the form of a parallelogram with sides of 28 m and 18 m. The relief drop is 5 m diagonally, drawn from the northern top of the parallelogram (452 m above sea level) to the southern top (447 m). That is, for each meter of the diagonal, the relief drop is approximately 17 cm.

The principle of terrain organization is terracing. The issues of terrain organization for functional requirements and for reclamation purposes are discussed in [3] and [4]. On the plot formed six terraces. The highest terrace on the northwest section. This is the smallest terrace – 15 m². There is an entrance to the site from the street side and a concrete septic tank with a depth of 3.5 m is installed under the parking lot. The retaining walls of the parking lot terrace for 1 car are also reinforced concrete.

The principle of terracing is combined with the principle of maintaining a smooth slope along the edges of the site: partially on the eastern and western borders. That is, the section along the slope is divided into three longitudinal panels parallel to the longitudinal axis: Western, Central and Eastern. The Western panel is divided into three terraces, the Eastern panel is divided into 4 terraces. The Central panel has 6 terraces (including the greenhouse). The side panels (West and East) in their topography are inclined terraces with an almost unmeasured smooth slope. The central strip contains six terraces that have retaining walls and horizontal work surfaces. Thus, the plot is divided into 13 cells.

The house and parking lot occupy two adjacent northwest cells. Together with the parking lot in front of the street fence, a green room is formed, with plants that can withstand the start (rhododendron Daursky, chubushnik).

The South-Eastern cell of the site is a natural landscape. There are pine trees and a mixed-grass lawn.

The central terraced strip is a vegetable garden for growing vegetables. On the southern border of the central strip – there is a greenhouse 9X2,8 m.

Western panel – trees and shrubs. At the bottom of the panel, the cell is occupied by a shed with a toilet.

Eastern panel – shrubs and low-growing trees. In the lowest cell of the Eastern panel is a utility area with lumber and a compost box.

Functional program of the house. The dependence of the housing structure on the demographic composition of the family and on the schematic scenario of its life is considered in many works, for
example [2]. The house is designed to accommodate a single family and guests, for which a guest room is included in the premises. In fact, the older generation-husband and wife – live in the house on a permanent basis. The guest room is intended for adult children, other relatives and friends who come occasionally during the summer.

Nuclear functions for the family: kitchen, dining area, bed, bathroom with shower - located on the first floor. See figure 2. The glazed terrace serves as a vestibule and stairwell. Stairs lead to the second floor. There is also a wardrobe for outerwear and shoes on the terrace. A special purpose of the terrace is a summer tea party.

The second floor is reserved for guests. See figure 3. A staircase from the first floor leads to the gallery. From the gallery, the entrance to the second floor room. The gallery also serves as a viewing platform, since the house is located on a high slope facing the bay.

![Ground floor plan](image)

**Figure 2.** Ground floor plan

The second-floor room has two beds and a work desk in the bright south corner. There are two 90X100 windows in this corner.

At the junction of the roof and side walls (North-East and South-West), the upper-side glazing is built in. See figure 11 and 12.
Spatial and design solutions. Internal space. The house is located on a hillside. The slope faces South-East. The difference in marks between the extreme North-Western point (the corner of the parking lot) and the South-Eastern corner of the house is one and a half meters (451.5 – 450.0). The spatial structure is based on a crate – a two-story frame house made of timber on the underlay in combination with a frame structure.

Figure 3. Second floor plan

The underlay is a ribbon concrete Foundation. See figure 4. The depth of the foundation is 2.4 meters at the highest North-Western point. There is a concrete floor on the bottom of the foundation. The foundation square of 6, 4X6, 4 m is divided into three sections so that the walls are separated from each other by 1900, 1800 and 1450 mm in internal dimensions. The basement sections are connected by passageways. The picture in figure 4 was made before the openings were cut. The North-West wall of the foundation is connected to a septic tank for wastewater disposal. Under the north wall, a water pipe
is connected to the basement. On the middle inner wall, a pylon of 800X700 mm was made for the stove, which later had to be temporarily abandoned.

![Figure 4. Ribbon foundation-underlay. View from the northwest corner, from the septic tank wall and parking lot](image)

Many authors, including [7], have considered low-rise rural housing construction in its engineering and structural aspects.

For figure 5 shows a section 1-1. The middle wall is supported by two wooden columns made of timber with a cross section of 18X18 cm and a height of 5.72 m. The columns are located on axes 2 and 3 at their intersections with axes B and C, respectively (see figure 2 and figure 3).

The peculiarity of inter-floor ceilings on beams in this house is that they are solved by short spans. The ratio of the cross-section of the beam (18 cm) to the length of the span does not exceed the ratio of 1:10. This makes the overlap rigid and does not allow for breaks.

The basement ceiling is made with the support of beams on the foundation walls. The length of the beams in this case fit into the specified proportion when using a 10x18 bar placed “on the butt”.

The overlap of the first floor is solved with deliberately excessive rigidity. On the long side of the log (6 m), the main beam-matrix is laid. Traditionally, matrix plays an important constructive and spatial role in the Russian home [1]. It is a double beam, each rod of which consists of two 10x18 bars compressed by pins. In addition, matrix is supported by two columns on the axes “2”, “3” and “B” and “C” of the first floor plan. See figure 6.

The combination of the spatial system of the frame with the wall structure of the log house is most evident in the portico, which in the course of the evolution of the house turned into a two-story gallery, see figure 7. The interior of the gallery and the view from the gallery to the garden see figure 15.
The facade in figure 7 is the main architectural property, since it faces the bay. There is a glazed terrace facing the bay. Accentuated roof over-hangs are visible. Unfortunately, an unscrupulous neighbor put his house right on the bridge and 90% blocked the view from the terrace to the bay.

Figure 5. Section 1-1
Figure 6. Load-bearing system for covering the first floor. Interior

The architectural properties and dimensions of the facade in the orthogonal drawing are shown in figure 8.

The frame rack-and-beam system is carried out from the inside of the cage to the outside, thus forming a portico and at the same time a two-story glazed gallery.

For figure 2, photos 7 and drawing 8 show that the entrance is made under the stairs from the border of the site to the opening adjacent to the column on the fourth axis. The staircase could be moved to the first axis, but this would completely block the view from the window to the bay. Therefore, the staircase is located between axes 3 and 4, the window is saved next to the first column.

Connection of internal and external spaces. The connection between the internal and external space of the house for low-rise construction on a private plot is of particular importance [6]. The first and main block that implements the transition from the interior space to the garden space is the glazed terrace. The portico on the facade turned into a two-story gallery during the five-year construction. The frame system from the inside of the house came out on the exterior facade. The same block - glazed terrace - implements the connection of the first and second floors. The exit from the warm contour of the cage is carried out on the terrace.
The second element that connects the space of the house with the space of the garden is an open terrace patio. The outdoor patio terrace is raised by retaining walls encircling the house, the height of the walls varies from the thickness of the blind to 80 cm. The patio terrace has a concrete surface in which lawns are inscribed. Entrance to the house from both the street and the garden is via a terraced patio. Since the plot has a slope of about 17%, the patio surface is inclined, but the slope is halved to 8%. Due to the noticeable slope, a decision was made on the location of the entrance to the house. The entrance to the house is made on the edge of the foundation, which, first, is located below the other above ground level, and secondly, is closest to the entrance to the site from the street. See figure 8.

For this reason, the connection of the house with the garden is a “fork”. From the entrance, a path along the top of the patio leads to a path along the west panel. After descending from the patio via a staircase between axes 2 and 3, the path leads to a path along the east panel.

Both paths, paved with red brick, are closed by a greenhouse in the south of the garden plot and lead to its opposite sides and to a grass path along the southern border of the plot. See figure 1. Thus, the topological scheme of the internal and external space is a ring around the garden with a linear section attached to it along the patio and the node of the entrance to the house [8].

Figure 7. East facade, axis 1-4
Artistic image. The basis of the artistic image is the idea of a brutal roof over the house. Roof slopes are supported by rafters of increased cross-section, roof overhangs have a removal of more than 70 cm. One of the two large sloping ramps is paired with a small gable. The use of multi-gable roofing is traditional and is described in [5]. In the interior of the second floor, the inner surface of the roof (ceiling) gets a complex “CES-zoned” surface.

Figure 8. Facade in axes 1-4
Figure 9. The entrance facade in the axes A – G. The glazed terrace at the side, the axes A – B

The edges of the gable's interface with the main ramp resemble the ribs of a “Gothic” vault. See figure 10.

The structural system laid down on the first floor-columns, the main beam-matrix and ordinary beams is repeated in a modified form on the second floor by the upper part of the same columns, closed by a bridge of double beams, double sub-rafters and rafters ribs. Along the line of conjugation of the roof slopes with the upper crown of the frame, the upper side glazing is arranged. See figure 11.
Figure 10. Interior of the second floor

The edges of the interface of the small gable with the main surface of the slope. In the foreground on top of the sub-truss beam and the bridge between the columns, on which the beam rests.
The upper side glazing creates a line of visual support of the roof slope on the light strip above the upper crown of the wall. Thanks to this, the heavy roof seems to hover over the wall.

Section 2-2 figure 12 shows two floors and a roof slope. The transition link between the interior and exterior spaces is a two-story glazed terrace. The main staircase on the terrace connects the two floors. Under the stairs is a wardrobe for outerwear. In the depth of the section on the first floor, a sliding partition is visible. The far left entrance leads to a bathroom with a shower. The right entrance leads to the bedroom. See also plan figure 2.

Log house-the whole on figure 13 and pictured figure 14 is paired with a glass body that complements the main volume to cubic proportions. The curved slant line at the base shows the interface between the patio wall and the slope surface.

For figure 16 shows the branching paths from the house to the garden to the west (the top patio) and medium (through natural cell) garden lanes (see general plan figure 1)
Figure 12. Section 2-2
Figure 13. Facade in G-a axes

Figure 14. Photo of the southern facade (in g-a axes)
Figure 15. The first floor of the glazed gallery. Interior. A view of the garden

Figure 16. Axonometry of a mini-house on a garden plot with a slope of 17%
1. The task of achieving the fullest possible implementation of residential functions on a site with a minimum size requires compact solutions and a flow of spaces based on the “Studio” principle.

2. The need to separate technical, residential, and guest functions on a small site required vertical zoning and the construction of three floors.

3. Complex node: portico, aka two-storey glazed terrace performs at least four functions: summer recreation with a view of the landscape and tea; winter vestibule and thermal protection of the house; vertical communication between the two floors by stairs; entrance hall and wardrobe for outerwear.

4. The combination of the log wall configuration with the frame system makes it possible to make the boundaries between functional zones (kitchen, dining, entrance and living areas) permeable. The borders are marked with columns-supports. The frame system allows you to make a portico-terrace. Elements of the frame system on the second floor allow you to make upper-side glazing.

5. The main beams resting on the pillars by holding down the columns with two sides of the beams with the device pin long cords allow you to run a bearing without loosening of the sections and carried by bearing elements, i.e. without frames.

6. The use of a system of consecutive supports of the matrix on the pillars, secondary beams on the matrix allows to achieve an architectonic effect in the composition of a wooden house with a combined (frame and wall) structure.

7. In addition to the above-mentioned architectonics, the artistic image uses the technique of a large roof overhang with the strengthening of the truss beams that are cantilevered behind the frame. The image of the “floating roof” is the final one in the artistic theme of the house.

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