Promising technologies of dry low-rise housing

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Abstract. The technologies of low-rise housing construction with the use of small blocks of a special type, which make it possible to build the above-ground part of a building without using “wet” processes are described. It is shown that the presence of labyrinth grooves in the walls provides protection against blowing and makes it possible to ventilate the internal cavities.

Introduction
Low-rise housing construction is currently one of the promising areas of development of the construction industry in the Russian Federation. At the same time, various systems and materials are offered, including wood, metal, artificial stones and composites.

Most domestic homeowners prefer buildings with capital walls of brick or small blocks. The construction of such houses can take several years, so the urgent task is the possibility of reducing the time of construction of the object. Some customers are trying to build a "dream house” on their own, which means there is a need to develop systems that minimize potential errors. Further in the article two similar systems are proposed, proposed for year-round construction and maximally excluding “wet” processes.

Formulation of the Problem
The main task of the construction industry in Russia at the present stage is a significant increase in the volume of commissioned housing. It is mainly solved in two ways - the construction of multi-stores buildings and low-rise individual residential buildings. Traditional methods do not allow to significantly reduce the construction time, and new mass progressive technologies have not appeared over the past few years.

The introduction of industrial approaches to housing construction can be the impetus for the development of relatively cheap and simple in the construction of houses, designers, having bought that, a person could independently build a building on the existing site [1, 2]. At low prices for a set, such a proposal could involve new strata of poor consumers in housing construction. The “dry” method of constructing such objects will allow, if necessary, to rebuild them or transport them to a new location. The use of universal sets of elements, ensuring the multivariate structure and its
architectural expressiveness, will give a new fresh look to the cottage villages.

**Proposed Solution**

One possible solution could be the system of bulk building elements «Rossi» described in [2] for erecting the walls, floors and etc. of the using the dry method, for which a RF patent for a utility model was obtained. The main element of the system is a small ordinary wall block, the general view of which is shown in Figure 1. It is formed from five rectangular parallelepipeds, joined by side faces and shifted relative to each other vertically and horizontally with the formation of grooves and ridges parallelepipeds, additional grooves and ridges are provided for bandaging elements of adjacent rows. The presence of grooves and ridges facilitates the installation of elements in the design position and eliminates the possibility of errors. In the system of elements, additional and angular wall blocks are also provided, having grooves and ridges for joining between themselves and other products that are consistent with their sizes.

![Figure 1. System «Rossi» ordinary wall block](image)

The dimensions of an ordinary wall block are coordinated with the dimensions of the brick, so the length and thickness of the block are assumed to be equal to 380 mm, and the height is 260 mm, which makes it possible to organize window and door openings close in size to the standard. The main problem of the proposed system is a rather complicated form of the block, which can cause an increase in the cost of houses, therefore, another system of wall elements «Dovetail» is proposed further.

The product is a rectangular parallelepipided having grooves and protuberances of a trapezoidal shape, which allow the blocks to be connected to each other due to the latching of the protrusions of one element into the grooves of the other. The general appearance of the product and its possible dimensions are shown in Figure 2.

![Figure 2. System «Dovetail» wall block](image)
Various materials as, for example, ceramic stones, cellular concrete, various composites and etc can be used for the manufacture of blocks. In the manufacture of products by extrusion, the author recommends the use of wood-polymer composite, and in the case of their manufacture using formwork - fibro-concrete. The wall of the building is double-layered with the layers shifted vertically by half the block’s height and a reliable interlocking connection of elements with each other. As an example, Figure 3 gives an idea of the connection of two perpendicular walls.

![Figure 3. Connection of two perpendicular walls](image)

The regular arrangement of grooves and ridges makes it possible to ligate the blocks not only along the length, but also along the height of the wall. This fact is confirmed by Figure 4, which shows the relative position of the adjacent vertical rows of the Dovetail block masonry.

![Figure 4. Ligation of two adjacent vertical rows of masonry](image)

Another important issue in the construction of walls is their intersection or junction with each other. Of course, the shape of the proposed blocks does not allow organizing polygonal or round jetties, which is a direction for further research, but otherwise “Dovetail” has practically no limitations. Figure 5 shows two variants of T-shaped mating walls with each other and the corner joint. It is easy to notice compliance with the ligature in this case. As for the “extra” protrusions or cavities shown in this figure with a thin line, the former, in the case of manufacturing blocks of fibro-foam concrete, are easily cut off with a regular hacksaw, and the latter can be filled with a cut protrusion. If necessary, it is possible to manufacture additional elements for filling cavities.

For ease of assembly, the crests of the blocks are proposed to be two to three millimeters smaller.
than the grooves. The resulting gap can be formed automatically in the manufacture for casting formwork sheet metal of similar thickness. In this case, it is necessary to take into account possible rounding of the steel sheet in the places of the bend, however, this will not affect the principal shape of the block, but can only slightly alter the appearance of the walls, giving them the appearance of masonry with seaming.

Figure 5. Adjacent walls to each other

For convenience of assembly, the protuberances of the blocks are made two millimeters smaller than the grooves. Despite the emerging gaps, the blowing of the walls is not expected. As a proof of the last statement, the three-dimensional model of the wall was blown through the virtual wind tunnel. To do this, SolidWorks and Flow Simulation use. Figure 6 shows, as an example, the wind flow paths for the middle part of the wall. Figure 7 shows the distribution of wind in the slots of the outer layer of blocks. It is easy to see that the air moves along the vertical gaps between the layers, without getting inside the building. Thus, airing of the wall cavities is additionally provided.

It should be noted that low-rise buildings usually have an exterior finish, which will also serve as an additional barrier to weathering, but the most demanding customers can use building glue or mounting foam to join the blocks.

Another possible area of application of the proposed blocks can be walls and partitions of high-rise monolithic-frame buildings, the massive construction of which is currently observed in Russia.

The proposed block sizes are not the only possible and can vary widely. Obviously, in this case, there will be a need to develop new or adjust existing projects of houses for an appropriate module; however, such changes are not extremely difficult or costly, and the possibility of year-round assembly of objects and the use of unskilled labor can significantly accelerate the pace of
construction and reduce the cost of buildings. It is also possible the production of a kit with small-sized, reduced by 10 times blocks, from which potential customers could first build a model of their dream home, assess its advantages and disadvantages, and only then proceed to full-size construction.

Figure 6. Wind flow paths

Figure 7. The movement of air inside the wall of the «Dovetail» blocks

Summary
The variants of wall blocks for “dry” construction described in the article have several advantages over traditional systems. These include:
- the possibility of year-round work due to the lack of “wet” processes;
- a significant reduction in construction time. Abroad, a one-story building with slightly different shape block was erected per day [3];
- the form of products eliminates the possibility of errors, therefore, no skilled workers are
required - the customer can build a house on his own.

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