

Organizational and Technological Solutions for the Construction of Enclosing Structures Made of Cellular Concrete of Multi-Storey Buildings

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ABSTRACT

In housing construction, autoclaved aerated concrete began to be used in 1924 by the Swedish company Skovde Gazobeton AB, and later it spread to other countries like Denmark, Norway, France, the USA and others. In the USSR, for the first time, a batch of domestic aerated concrete was produced by the Latvian SSR, and later in 1959 the DSK-3 Leningradstroy began to operate. For more than 90 years, the development of the science of cellular concrete has been the subject of numerous scientific works by scientists from both the USSR and Russia. Currently, the leadership of Sturan is providing all possible assistance to domestic factories, also a joint venture of foreign investment (capital). Modern plants for the production of cellular concrete were built in almost all regions of Russia. It should be note about the importance of scientific and research work on the management of structure formation, operational reliability, crack resistance during moisture exchange and carbonization processes, the use of chemical additives, frost resistance and other indicators. The ability of a material to withstand the effects of various atmospheric factors for a long time, without significantly changing the appearance and physical and mechanical properties, is a very difficult task, since it constantly changes, depending on the weather and climate of the construction area, and affects objects in the atmosphere. Positive quality of the material, and its ability to perform work at low temperatures.

Keywords: cellular concrete, technology, operational reliability, crack resistance, enclosing structure, multi-storey buildings, housing construction

1. INTRODUCTION

The use of cellular concrete according to the forecasts of analysts and experts of the construction market, the demand for cellular concrete (aerated concrete, foam concrete) due to the low price has always been, is and will be. Moreover, a number of their positive characteristics and durability, sound insulation, thermal insulation, erected from the cellular concrete of the building and structures according to all over Russia. The use of cellular concrete in the enclosing structures of residential multi-story buildings is still used to an unprecedented popularity due to the optimal ratio of the price-quality parameter. The possibilities of its application in technological processes, the construction of buildings at low temperatures [1-12].

1.1. Related Work

Masonry walls made of aerated concrete are prepared access roads, storage areas and vehicles at the construction site are the best prerequisites for a quick and efficient construction process. Blocks must be stored in advance on a level, dry platform in the transport area of a crane or forklift truck.

1.2. Our Contribution

Masonry from cellular concrete blocks with a geometric accuracy of $\pm 1.5 - 2.0$ mm is perform using an adhesive mortar based on a dry mixture (sand, cement, water-retaining, plasticizing and hydrophobic additives). The thickness of the seam should not exceed 2 - 3 mm.

Masonry of cellular concrete blocks with geometric accuracy of $\pm 3-4$ mm is perform on a light (warm) solution. Masonry on cement-sand mortar is possible, but in this case, the thickness of the seam is 8 - 10 mm, which entails a decrease in the heat transfer resistance of the wall. When using ordinary masonry mortar, in dry weather, preliminary wetting is necessary. At the beginning of the first row, corner blocks are laid (Figure 1).

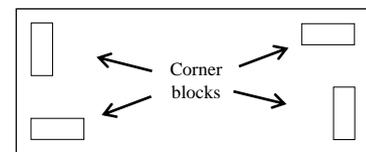


Figure 1 Laying of corner blocks of the first row
The side faces of the blocks are laid on the adhesive mixture based on a dry mixture. The first row of blocks is the

"foundation" for all subsequent rows, so when laying it, you should work especially carefully. After laying the first row, it is necessary to remove all irregularities with a special planer, a mixture of dust and small fragments.

To prepare the glue solution, it is necessary to fill a clean container (for example, a plastic bucket) with water in the amount indicated on the package (bag with the mixture), add the dry mixture and move with a low speed of rotation with the mixer fixed in the electric drill. To apply solution on a vertical seam with the help of a special trowel. The consistency of the solution is good if it flows easily and over the entire area through the trowel, teeth and the visible grooves of the solution do not merge [8, 9].

Each nested block is levelled with a rubber mallet and spirit level. After the first row of blocks is neatly laid, you can proceed to the laying of the second row. To do this, apply the solution with a trowel to the horizontal seam. When laying, it is necessary to comply with the dressing rules. The solution protruding from the seam is not overwritten, but removed using a trowel.

The installation of small-sized bar jumpers is carried out manually, and large-sized with the help of a traverse or soft spores. The jumper is laid on a normal or glue solution. The depth of the support part should be 20 cm on each side. See. (Figure 1^a, 1^b) photo of the author of the article.



Figure 1^a Photo of the author of the article.



Figure 1^b Photo of the author of the article.

When arranging U-shaped jumpers above the window or doorway, formwork is performed (Item 3 in Figure 2).

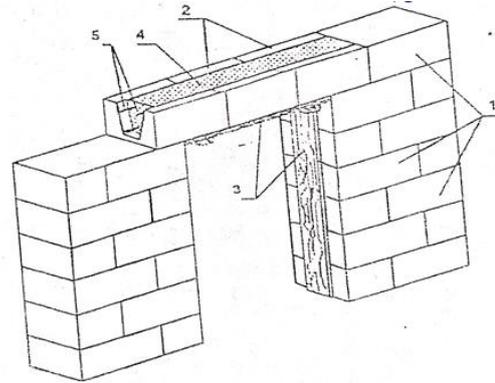


Figure 2 U-jumper device:
 1- Aerated concrete blocks;
 2- U-shaped blocks;
 3- Formwork;
 4- Heavy concrete;
 5- Reinforcement cage.

Then it is necessary to lay the U-shaped blocks so that the sidewall of the U-shaped block, having a large thickness, is outside. On each side of the aperture, U-shaped blocks should go onto the wall not less than 25 cm thick. Prefabricated reinforcement cages are placed in the recess in the U-shaped blocks, and then this cavity is poured with heavy concrete and sealed with bayonet.

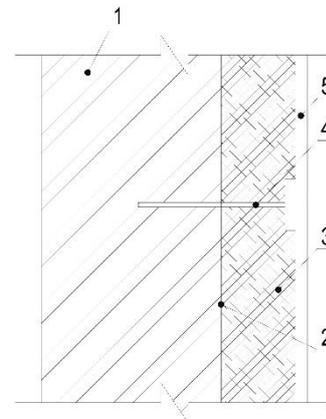


Figure 3 The design of wall insulation with cellular concrete products:
 1- Insulated wall made of aerated concrete.
 2- Glue composition.
 3- Insulation from mineral slabs.
 4- The expansion bolt shield a clamp.
 5- Decorative - protective layer (facade system with a ventilated air gap, porcelain stoneware facades).
 After laying blocks of one row, pull the mooring cord for the next row of masonry.

In case of forced breaks, regardless of the type of mortar, the masonry must be performed in the form of an inclined bar.

The device of vertical shabby is not allowed. To close the openings in the masonry of the external insulation system, squared or precast-monolithic jumpers made in fixed formwork from tray blocks should be used.

The use of non-reinforced products to use them as jumpers is prohibited. Cellular lintels made of aerated concrete are laid manually on the mortar mixture.

The length of the lintels is assigned depending on the length of the span to be covered and taken from the calculation of the depth of support on the masonry of at least 150 mm for lintels that accept the load only from the window-sill areas within one floor, at least 250 mm in other cases [10].

Jumpers from the tray blocks are laid manually on the formwork installed above the opening. The sidewall of the tray block, which has a large thickness, must be on the outside. A reinforcing cage is insert into the recess of the chute block, which is pour with heavy concrete. Heavy concrete is compacted with bayonet. Tray blocks on each side should go less than 250mm into the wall.

The last row of masonry is laid out by the so-called "levelling" blocks. If it is necessary to install cornices in the masonry of the external insulation system, it is necessary to comply with the requirements of clause 7.26 of SNIP (СПИП) 3.03.01.

2. BACKGROUND

2.1. Methods and Materials

The blocks fixing to the wall can only be done with dowels, fixators or in combination: dowels and strip anchors. The installation of dowels-clamps is made after a set of a solution of at least 50% of the design strength. To ensure the stability of the fresh masonry before fixing it with dowels, the height of the area of the loose masonry should not exceed 6 rows (1.5 m).

To install the dowel, a hole is pre-drilled, the diameter of the drill is equal to the diameter of the dowel, the hole depth should be 2 cm more than the required embedment depth of the dowel.

Depth of embedding the dowel into the wall is taken depending on the type of materials: - for concrete - not less than 50 mm; - for brick, cellular concrete blocks, etc. - not less than 100 mm [7].

The dowel is sent to the hole with a hammer. The fixing block of the dowel head must be recessed into the block or jumper to a depth of 20-30 mm and struck with the composition of the dry mortar mixture immediately after installing the dowels. The dowels and fasteners of the masonry of the insulation system should be installed by calculation and should be arranged according to two main schemes: in a cellular or checkerboard pattern **Figure 4**.

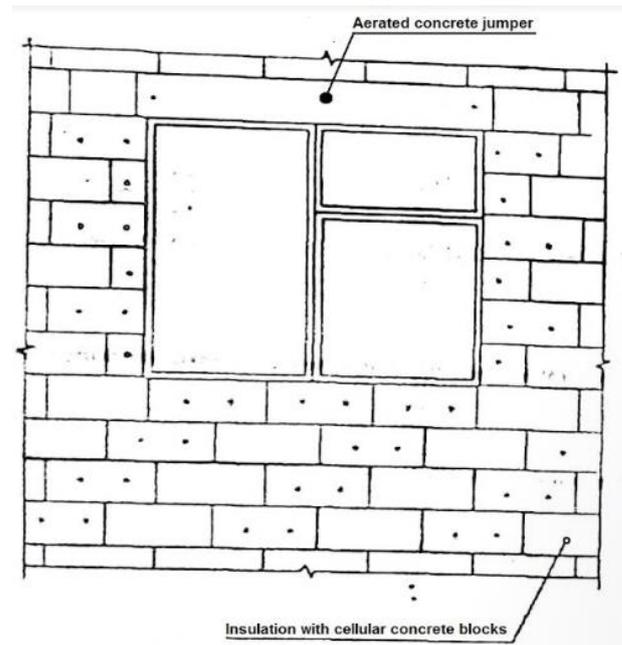


Figure 4 Installation diagram of dowels.

Installation of dowels-clamps requires compliance with the following requirements:

- a) In the corners of buildings along the perimeter of the openings and along the edges of the heat-insulating layer within the temperature compartment (between expansion joints), dowels are installed in each block with a size of at least half the length of the base unit; blocks longer than 500 mm are fasten with two dowels, blocks less than 400 mm can be fasten with one dowel;
- b) In places where the heat-insulating layer from the blocks adjoins the heat-insulating insulation areas, the arrangement of dowels is adopt in accordance with the requirements set forth above;
- c) The horizontal distance between the fixing blocks of the dowels horizontally should not exceed 600 mm; it is allow to increase the specified distance to 1200 mm through a row under the condition of chain (row) bandaging of blocks with a length of at least 400 mm;
- d) In all cases, dowels-clamps must be install in each horizontal row, and the number of blocks fixed by dowels must be at least 1/3 of the total number of blocks in this row. To exclude the formation of cracks caused by deformations of the masonry of the insulation system from shrinkage and fluctuations in the temperature of the outside air, vertical and horizontal temperature-shrink (deformation) joints should provide [8,9]. Expansion joints arranged in places of possible concentration of temperature and shrinkage deformations, combining these joints on the masonry of the insulation system with expansion and sedimentary joints of the

exterior walls of the building. In buildings with external walls of large (including hinged) panels, expansion joints are combined with panel joints. The distance between vertical and horizontal expansion joints, regardless of the results of thermal deformations, is more than 9m and from the corners of the building to the nearest vertical expansion joint (not more than 4.5 m).

Between two adjacent corners of the building (with a distance between them greater than 6 m), at least one expansion joint must be located. At shorter distances, expansion joints should be made in corners.

Expansion joints should be continuous throughout the entire height or length of the compartment only in masonry areas. The installation of expansion joints with light stucco mixtures at the masonry joint is not allowed. For the device of expansion joints, cellular concrete products with profiled ends "per dowel" or a quarter are used."

To exclude blowing of expansion joints, their internal cavities are filled with gaskets or other products and materials, and the mouth of expansion joints is left empty [9, 10].

The structure of cellular concrete makes it easy and precise to saw, plan, drill and mill, using tools commonly used for wood processing. For processing and aerated concrete products, also use special saws and tools for scraping. The planning structure of a Multi-storey building is sectional. Floors in sections 10 - 22 floors. The height of the residential floor is accepted - 3 m, the height of the first floor is 3.3 m. Figure 5 Photo by the author of the article.



Figure 5 Multi-Storey Building

Residential building with underground parking. The supporting structures of the building are made of reinforced concrete. Interroom walls - columns of monolithic reinforced concrete with filling from tongue-and-groove blocks in 2 layers, with insulation between the layers. Interior partitions from cellular or tongue-and-groove blocks. Partitions of bathrooms made of ordinary brick or

moisture-resistant tongue-and-groove blocks. External walls - facade system with a ventilated air gap (Internal, Kraspan) with the use of cellular concrete blocks with a density of at least 600 kg /cu. m Overlapping - monolithic reinforced concrete slab. Stairs- precast - monolithic reinforced concrete. Facade decoration - granite. Windows and balcony doors are PVC blocks with double-glazed windows [8].



Figure 6 Photo of the author of the article.

2.2. Results

According to the forecasts of the National Association of Autoclaved Aerated Concrete Manufacturers (NAAM), they planned to increase the production of cellular concrete in Russia by 6.9% in 2019, i.e. (12.4 million cubic meters). The autoclaved cellular concrete industry remains one of the fastest growing construction industry materials. One of the main conditions, for the successful implementation of the national program "Affordable and Comfortable Housing for Russian Citizens", which provides for an increase in housing construction by 2020–2025, to 120 million square meters, is a significant increase in the production of building materials for the construction of external building envelopes, the volume of which is 56 - 65% of the total volume of the building. According to Rosstat-Moscow increased housing commissioning in 2018 by 3.6%. Up to 3.54 million square meters. In total, in 2018, 75.3 million square meters were commissioned in Russia, residential real estate. In Russia, it was planned to build. 88 million square meters housing in 2019, and in Moscow, built more than 8.0 million square meters real estate [11, 12].

3. CONCLUSIONS

The main assessment and achievement of weather resistance and operational reliability of multi-storey buildings of different functional purposes, is provided by a reasonable choice and strict accounting of changes in the listed basic physical and technical properties and parameters of cellular concrete at the stages of design and construction. The only wall material that can currently be used in construction practice without additional insulation is cellular concrete.

This unique, universal product fully meets the modern requirements for building materials.

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