Comparison and analysis of the main building materials’ characteristics for construction

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Abstract. The choice of material for the walls of the house is an important issue during construction. Walls take up a quarter of all the costs of building a house. If you carelessly take this choice, you can incur serious expenses in the future. When choosing materials for building a house, you need to measure your capabilities with a number of conditions and factors: functional load and purpose (summer house, housing for temporary or permanent residence); the climate of the area where the construction of the house is planned; project scope and number of storeys; the type of future exterior decoration of the facades; the presence and possibility of delivery of building materials to the facility; own budget. The article presents detailed comparative analysis of the most popular building materials (bricks, ceramoblocks, aerated concrete blocks, rounded bar, glued profiled beam, wooden frame, sandwich panels, wood). Each of them has its own advantages and has characteristics that may seem to someone as disadvantages.

1. Introduction

Before agreeing on the question of what materials you would like the house from, you need to decide on a number of important nuances. As a rule, the main requirements for a home for future owners are: beauty and aesthetics; warmth, coziness and comfort; reliability, quality factor, workmanship.

The main types of materials from which houses are being built today are stone, wood and concrete. If we are talking about stone, then these are foam and aerated concrete blocks, expanded clay concrete (also in blocks) and brick. Wooden houses are timber buildings made of profiled timber of natural moisture and chamber drying, glued profiled timber, logs, manual logs. Also extremely popular today are frame-panel constructions, for the construction of which a solid board is used.

2. Materials and methods

In order to understand the main characteristics and choose the best materials for the construction of the walls of the house we use the comparative method.

The choice of material for the walls of the house is an important issue during construction. Walls take up a quarter of all the costs of building a house. If you carelessly take this choice, you can incur
serious expenses in the future. Therefore, we will take into account and consider the most important criteria and factors that must be considered when choosing a material for erecting walls of a house.

1. Price. Costs can be reduced by taking lightweight material for walls. Then you do not have to build a powerful and expensive foundation.

2. Thermal insulation. Cold walls cost too much in winter. Therefore, before choosing a material, you need to do all the calculations, focusing on local climatic conditions. You can achieve the desired degree of thermal insulation by resorting to heaters. If you take material with good heat-insulating properties, then the walls cannot be insulated, but it all depends on the region of development.

3. Labour costs. The cost of time and effort can be reduced by folding the walls of large blocks, and not of small pieces. Such walls are erected 3-4 times faster and easier. The highest speed - in the construction of frame panel walls.

4. Subsequent finishing costs. Modern smooth and aesthetic materials do not require additional wall decoration. You can save on this.

Let's conduct a comparative analysis of materials for building a house. Consider the main types of suitable building materials, determine their characteristics of advantages and disadvantages.

Traditional brick

The brick house is able to stand for 100 - 150 years. He will survive well and rains with hurricanes and hail, and severe frosts, and searing heat. Brick walls have been laid since ancient times, so the technology of their construction is worked out to the smallest detail. Accordingly, it is easy to find a good master.

Ceramic brick

Ceramic brick has a red colour. It is made of fired clay, therefore it is very durable and has high environmental friendliness. Such material is not afraid of a cold and does not let water through. It can be full-bodied (no more than 13% of voids) and hollow (up to 49% of voids). The shape of the holes in the brick can be round, square, oval, with horizontal or vertical arrangement. With an increase in their number, the insulating properties improve.

Silicate brick

Silicate brick is white. Its main components are lime, sand and a small fraction of additives. This type of brick is also produced both solid and with cavities inside. The latter is lighter, and the walls from it are much warmer (because air is an excellent heat insulator). But a solid silicate brick can pamper the developer with a variety of colours. For the strength of a brick, it does not matter if it is solid or with cavities inside.

Private and front bricks and their purpose

Both types of bricks come in various applications:

Ordinary brick is also called building brick - it is used for internal masonry of walls. For him, small cracks are not considered marriage. It doesn’t matter if the corners or ribs are slightly broken off, there are notches in the corners.

The front (Facing) brick should have a flawless appearance, not have notches and flaws.

Brick strength and frost resistance

Strength determines the brand of brick. There is a special marking for this indicator: the letter M and the number next to it (from 75 to 300). This number is the load maintained by this brand per one square centimeter. The larger this number, the heavier the brick. For the walls of a two-story or three-story house, the brands M100 and M125 are suitable. The base or foundation is laid with brick M150 or M175.

When choosing which brick to build a house from, one should also take into account frost resistance (the ability to freeze and thaw without being damaged at the same time). The letter F is selected to indicate this indicator, next to which is a number from 15 to 100. It means the number of freezing and thawing cycles without damaging the material. In warmer areas, F15 is sufficient for external walls, where it is colder - F25. The cladding is usually made with brick of the brand F50. The main advantages and disadvantages of bricks are presented in table 1.
Table 1. Main advantages and disadvantages of bricks.

| Advantages                           | Disadvantages                       |
|--------------------------------------|-------------------------------------|
| Looks good                           | Big weight                          |
| Durability                           | Difficulty in laying                |
| Ability to realize any complex project | Large costs to pay a good master    |
| Resistance to corrosion, mold and mildew | The requirement of a solid foundation |
| Incombustibility                     | The need for a heat insulator       |
| Noise protection                     |                                     |
| Good heat retention                  |                                     |

Ceramoblock - durable and modern material

In Europe, when deciding what material to build a house from, a ceramic block is often chosen. It is environmentally friendly (consists of a burnt clay mixture with sawdust), and it can be built cheaply and quickly. Such a house will stand for at least 150 years, and it can be made multi-story (safety margin allows this). On the sides, the surface of the ceramic block is corrugated, and inside there are pores. Separate the individual elements using the groove-comb connection.

Dimensions and characteristics of ceramic blocks

The sizes of ceramic blocks are different, but their height is standard, equal to brickwork. This is convenient - you can build a brick house project. A block measuring 50 x 24.8 x 23.8 cm weighs 25 kg, and its volume is 15 bricks of 3.3 kg each. One such plate is easier and faster to put, and less solution is needed. The width of the blocks is 23, 24 and 25 cm. Their length (which determines the thickness of our walls) can be from 25 to 51 cm. A tongue-and-groove castle is located on this side.

For masonry of the load-bearing wall, blocks are taken, whose length is from 30 cm. And if you make walls 38 cm thick or more, they will not have to be insulated. Indeed, porous blocks have a low thermal conductivity - from 0.14 to 0.29 watts per square meter per degree Celsius. Thicker blocks (38, 44 and 50 cm long) are marked as M100. If thin, but reliable walls are planned, then you can take blocks of the M150 brand. Ceramoblock withstands up to 50 cycles of freezing and defrosting. This corresponds to the F50 brand. Main advantages and disadvantages of ceramoblocks are presented in table 2.
Table 2. Main advantages and disadvantages of ceramoblocks.

| Advantages                                                                 | Disadvantages                                                                 |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Light weight, coupled with high strength even allows the construction of multi-story buildings quickly and without unnecessary labor | High price - this material for the walls of the house belongs to the elite group. |
| The mortar is used more sparingly than for masonry - there is no need to use it in vertical joints | It is difficult to find a good master for the construction of walls, since the material is quite new |
| Frost resistance at a high level                                           | Ceramic blocks are very fragile, so they must be transported and stored very carefully |
| The walls of these blocks "breathe", regulating humidity and creating an excellent microclimate |                                                                                |
| The material is able to withstand fire for at least 4 hours                |                                                                                |
| Due to its porosity, the ceramic block perfectly absorbs noise and also keeps heat |                                                                                |
| Such a house serves up to 150 years, while the thermal characteristics of the walls do not deteriorate |                                                                                |

Aerated concrete blocks - material for warm walls

Externally, aerated concrete blocks look worse than a ceramic block, but they excellently hold heat. Walls of aerated concrete with a thickness of 30 - 40 cm. Built in one layer have the same characteristics as multi-layer made of brick or ceramic blocks. At the same time, a rather comfortable microclimate is kept in the room, since aerated concrete effectively resists fluctuations in temperature and humidity. This material will not rot and deteriorate from time to time - after all, it has an unlimited service life. And in thermal insulation, it is 3 times better than brick. This is due to the air pores inside the material.

Characteristics of aerated concrete blocks

Aerated concrete is cheap to transport and easy to install. If you need to cut the block, then an ordinary hacksaw copes with it perfectly. Mortar or special glue is needed a little, construction is fast. If the masonry is made with glue, then it turns out to be thin-knit, which contributes to better thermal insulation of the room. Made in the factory, lightweight blocks have a perfect cut, so that the walls are quite smooth. This saves on interior decoration.

Aerated concrete blocks are lightweight, which reduces the cost of their transportation, and this material can be used at various stages of construction. Due to the fact that the material is very easy to process, has a small weight and large dimensions, the bricklayer does less labor.

Aerated concrete is not a combustible material, which has a good indicator of compressive strength. It is made exclusively from natural ingredients and is absolutely environmentally friendly. This material is quite frost-resistant, and the level of vapor permeability of a house made of aerated concrete can only be compared with a house built of wood.

For aerated concrete, density (D) is the most important characteristic. It can vary from 350 to 1200 kg./m³. Depending on the density, grades of aerated concrete are distinguished, denoted by the letter "D" and a number. For the construction of the cottage, it is better to take the brand D500 - D900. A block with standard dimensions (20 x 25 x 60 cm) weighs 18 kg. It will replace up to 20 bricks (total weight up to 80 kg). Therefore, if you have not yet decided what to build a house from, take a closer look at this material. The main advantages and disadvantages of bricks are presented in table 3.
| Advantages                                                                 | Disadvantages                                                                 |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| The geometric dimensions of the blocks are accurate                        | Over time, the material may crack                                              |
| Resistance to fire is high                                                | Low bending strength                                                           |
| Compressive strength is excellent, thermal conductivity is very small      | Keeping aerated concrete blocks on the street, you need to well protect them   |
| Smooth surface eliminates the need for additional alignment               | from the weather                                                               |
| Due to the porosity, the material can withstand frost well, and steam passes no worse than wood | The requirement of a solid foundation                                          |
| Thanks to only natural components in the composition of aerated concrete, toxins are not released during a fire |                                                                               |

Wood is comfortable but troublesome

People thinking of what it is better to build a private home often come to mind with this particular material. After all, a wooden house is health and comfort. Its walls not only “breathe”, but also make the air healing, delaying all harmful substances. Walls made of wood create optimal humidity in the room and smell pleasantly.

The walls of a house made of wood have good thermal insulation and retain heat in the winter and cool in the summer. The cost of heating a wooden house can be significantly lower compared to brick walls.

Manual cabin felling

This method is the oldest, it was used by our grandfather’s and great-grandfathers. We are talking about a log house made by hand. The tree trunk is cut to the desired length, and then locks and grooves are made on it. Next, the logs are connected, laying out the outlines of the house. You must wait for shrinkage - this is about a year, no less. Then they crack the cracks and sheathe the boxes of windows and doors.

Today, this method of building a wooden house is not used. Everyone can build a house out of logs. Such a structure is going, like a constructor, we will talk about this later.

Building a house from a bar is easier and faster

Neat smooth logs are processed in production conditions and marked. Ready-made parts from which the walls are assembled are delivered to the construction site. The beam can have different sizes and cross-sections (rectangular, square, in the form of the letter D). If it is profiled, it has protrusions and grooves for connection. An oblique cut helps drain excess water. A house of this material can be built with your own hands.

There are several varieties of timber for building a house:

Sawn timber is made of logs with a moisture content of 50 to 70%. As soon as they saw him, he immediately goes to the construction site. Because of this, the house is subject to shrinkage, (up to 10 cm). And sometimes cracks appear on the walls.

Planed timber is dried under production conditions. The humidity of the finished product is from 20 to 25%. After drying on a special machine, the products are rounded off. As a result, the shrinkage of the house, although it exists, is very small.

Glued beam is made of several layers of lamellas (special boards, dried to 6 or 10% humidity). They are glued together under pressure, while the fibers of adjacent layers are perpendicular to each
other. Finished products have a length of up to 12 m and a thickness of 7.5 to 30 cm. They do not shrink, do not deform and do not crack. Therefore, many believe that glued beams are the best material for the walls of a wooden house.

Advantages and disadvantages of wood as a material for walls of a house are presented in table 4.

**Table 4. Main advantages and disadvantages of wood in construction of the walls.**

| Advantages                                                                 | Disadvantages                                                                                     |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| The geometric dimensions of the blocks are accurate                        | The tree burns, can rot and "eaten" by a fungus. To prevent this, all details must be treated with special preparations |
| Resistance to fire is high                                                 | Shrinkage of the log house can take from 3 to 5 years                                             |
| Building a wooden house is not so expensive than a brick one              | Sliced timber and log houses can crack                                                             |
| This is one of the most environmentally friendly materials                 |                                                                                                |
| In terms of thermal conductivity, wood is significantly superior to brick |                                                                                                |
| The wooden house is very beautiful. Often, it does not require decoration  |                                                                                                |
| this is either inside or outside                                           |                                                                                                |
| The foundation is lightweight and inexpensive. For example, columnar      |                                                                                                |
| House made of wood, especially felled by hand, serves for a very long time |                                                                                                |

Lightweight and inexpensive frame house

The basis of such buildings is a frame made of wood or metal. It includes rafters, racks, trusses and other elements. Then the insulation is put, and on top of it all is sheathed with thick sheets of chipboard or OSB. The wall of such a house weighs 15 times less than a brick one. There is not much expensive wood for the frame - 5 or 10 times less than for a log house. Insulation is the main expense item. However, even the best one, it gives the cost of the wall 1.5 times cheaper than from timber, and 2.7 times compared to brick.

In addition to the low cost of the frame material, the assembly speed is also impressive. Just a few weeks - and you can move into a five-room house, which will be warm and comfortable.

Frame houses can be of two types:

Frame-panel house - assembled from finished panels. First connect them, then make partitions between the rooms. The final stage is the construction of the roof.

Frame-frame house - made on the basis of the "frame" - a frame of beams and logs, based on the foundation. Then they put the rafters and make the crate. After the manufacture of the roof, sheathe the frame with a heater (mineral wool or PPS). At the end, external cladding is performed.

Since the main material in the construction of a frame house is a heater, when carrying out the correct calculations of the required amount, the structure turns out to be quite warm. That will allow you to significantly save on heating. The advantages and disadvantages of bricks are presented in table 5.
### Table 5. Main advantages and disadvantages of aerated concrete blocks.

| Advantages                                                                 | Disadvantages                                                                 |
|----------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Good heat saving (when the heating is turned off in the cold at minus 10 °C, the temperature will decrease by 2 °C per day) | The walls are not very strong - they are easy to pierce with something sharp |
| Resistance to fire is high                                                 | A house on a frame will last less than a brick or wooden one                  |
| No interior trim needed, which reduces costs                             | There is little room for imagination - they usually take standard designs    |
| Remodeling and improvement of such a house can be done easily             | The walls do not "breathe", so you need to do good ventilation               |
| Communications can be hidden inside the walls, which saves space           |                                                                                |

The comparison of the characteristics of different types of materials is presented in Table 6.

### Table 6. Comparison of the characteristics of different types of materials.

| Material                     | Advantages                      | Disadvantages                                                        | Cost of materials and works $ / M2 |
|------------------------------|---------------------------------|---------------------------------------------------------------------|------------------------------------|
| Brick (thickness - 380 mm.)  | Reliability; durability;        | The need for insulation; labor input; heavy walls; need a powerful   | 75                                 |
|                              | environmental friendliness      | foundation                                                          |                                    |
| Ceramoblock (thickness - 380 | Reliability; durability;        | Fragility of the material; difficult to find a specialist            | 82                                 |
| mm.)                         | environmental friendliness      |                                                                     |                                    |
| Aerated concrete (thickness  | Speed of construction;         | A solid foundation is needed; Low bending strength                   | 60                                 |
| - 380 mm.)                   | durability; reliability;        |                                                                     |                                    |
|                              | environmental friendliness      |                                                                     |                                    |
| The rounded bar (diameter -  | Environmental friendliness;     | Shrinkage of walls; great dependence on the quality of the material  | 44                                 |
| 200 mm.)                     | speed of construction           | and specialists.                                                     |                                    |
3. Results and discussions
The building materials market offers a wide selection of different options for walling your home. There are several types of brick alone: silicate, clinker, ceramic, chamotte. And wood has been one of the most popular and sought-after building materials for many years. The cost of such raw materials depends on the type of wood (pine, oak, birch, cedar), the type of material (logs, boards, timber). Very popular and more economical option are various types of blocks: foam blocks, ceramic blocks, thermal blocks, lightweight concrete blocks, etc. In Europe, for example, they often build houses using the wire-frame method, which is very fast and inexpensive. About 70% of Europe's private housing stock is occupied by the frame technology of building construction. Builders also note the cost-effectiveness and energy efficiency of SIP panels.

4. Conclusion
Thus, when choosing materials for building a house, you need to measure your capabilities with a number of conditions and factors:

- functional load and purpose (summer house, housing for temporary or permanent residence);
- the climate of the area where the construction of the house is planned;
- project scope and number of storeys;
- the type of future exterior decoration of the facades;
- the presence and possibility of delivery of building materials to the facility;
- own budget.

It should also be borne in mind that relatively lightweight wooden structures and frame-panel structures can be installed on a “lightweight” foundation. But a brick or concrete house requires a deep, powerful, reliable foundation. Accordingly, the construction time will increase, and the cost of such a house will be more expensive.

In addition, the heat capacity of the material plays not the last violin. So, brick, concrete, stone have a cumulative opportunity. In other words, they accumulate heat for a long time, and then slowly and gradually give it away. Due to this property, the temperature inside the house remains constant. Good thermal insulation makes it possible to maintain a comfortable microclimate throughout the year, keeping warm in the winter and leaving the air cool in the summer heat.

Timber and logs have high breathability. You can often hear the wording that wooden houses “breathe”. This property of the tree cannot completely replace ventilation, but it still makes the microclimate healthier.
If you touch on the issue of fire safety, then stone and concrete buildings, of course, are beyond competition. But today the tree is treated with special impregnations and compounds that are able to prevent the occurrence of fires for some time.

Of course, the reliability and durability of the construction will largely depend on the professionalism of the construction team, knowledge and skills to correctly apply the practice of construction technologies, compliance with all rules and safety precautions. However, the correctness and appropriateness of the choice of materials also play a very important role in the level of quality and durability of the future home.

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