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OPTIMAL COMPOSITIONS FOR LOCAL CELLULAR CONCRETE RAW MATERIALS

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Annotation
This article is devoted to the issues of raw materials and the optimal composition of cellular concretes such as foam concrete and aerated concrete. In addition, information is provided on the strength, thermal conductivity, porosity, hardening conditions, bearing capacity, frost resistance, water absorption, fire resistance, environmental friendliness and durability of the material.

Keywords: improving the energy efficiency of buildings and structures, energy resources, thermal insulation, energy efficiency in the design of buildings, increasing the thermal insulation of wall structures.

Cellular concretes are artificial stone materials consisting of a hardened binder with air cells (pores) evenly distributed in it. According to the production method, cellular concretes are divided into foam concrete, aerated concrete and foam gas concrete. According to the type of binder, cellular concretes are divided into the following types:
- on cement (foam concrete and aerated concrete);
– on lime binder (foam silicate and gas silicate);
– on gypsum binder (foam gypsum and gas gypsum).
In addition, when producing cellular concrete, gypsum-cement-pozzolanic binder and mixed binder consisting of Portland cement and lime can be used[1]. (Table 1)

Table 1 Characteristics and requirements for materials

Material	Parameter	Requirement for regulatory documentation	Name of normative documentation
Cement.(CEM I 42.5 N.B)	Setting time start end NG False Grip C3A C3S	>60 min - 29% Not <8% -	GOST 31108-2016 8
Ground quicklime (grade II)	CaO+MgO Extinguishing temperature Extinguishing time Sieve passage 0.09	>80% >67ºC 6-13 min <5%	GOST 9179-77

	Burnout	-	
Lump lime (grade II)	CaO+MgO Temperature extinguishing Extinguishing time	>80% >67ºC 6-13 min	GOST 9179-77
Quartz sand (Class II, fine, very fine)	SiO2 Size modulus Humidity PGI	>85% 1,0-2,0 - <5%	GOST 8736-2014
Gypsum ground natural	Ca2SO4 Residue on sieve 0.2 Humidity	64-76% - -	GOST 23789-79

A porous structure in the production of foam concrete is created by mixing solutions with pre-prepared foam or by introducing a foaming agent directly into the solution, which contributes to the involvement of air bubbles inside the solution during its intensive movement with or without vibration treatment. To obtain stable foam in industry, the following main types of foam concentrates are used[2,3]:

– glue rosin;

- resinous saponin;

– aluminosulfonaphthene;

-KISK, consisting of rosin, lime, casein glue and PRS.

Cellular concrete is represented by a complex multi-component system with a large number of influencing incoming and outgoing parameters. almost all properties are functionally dependent[4].

The main operational characteristics of the developed compositions:

Dimensions - the dimensions of blocks made of cellular concrete (gas and foam concrete) differ markedly. Depending on the purpose, their dimensions may be as follows:

- smooth base block: width - 200–500 mm, height - 200 mm, length - 600 mm;
- blocks for partitions: width - 75–150 mm with the same length and height;
- blocks for jumpers: width 250-400 mm, with a height of 200 mm and a length of 500 mm[5].

In addition, various blocks of complex shape are produced.

It should be noted that the highest requirements are imposed on the geometric dimensions of heat-insulating blocks: deviations of no more than 1.5 mm are allowed. This is due to the method of laying - on a special adhesive composition to prevent the appearance of cold bridges.It is not difficult to make blocks of a different size from standard modules: cellular concrete is just as obedient in processing as wood and is perfectly connected with ordinary nails[6,7].

Properties of materials: Density - the most important property of cellular concrete (including blocks and slabs) is thermal insulation, it depends on the density and degree of porosity. The nature of the binder and hardening conditions practically do not affect this factor. Depending on the number and volume of closed pores, the thermal conductivity of cellular concrete blocks will increase or decrease. The strength and thermal conductivity of the material turn out to be dependent on the degree of porosity. (table 2)[8,9].

Table 2 Strength, and thermal conductivity of the material depending on the degree of porosity

Porosity, %	Density, kg/cu.m.	Compressive strength, MPa	Thermal conductivity, W/(m.K)
50	1100–1200	10–15	0,33–0,40
60	900–1100	5–12	0,24–0,30
70	700–800	2,5–5	0,17–0,22
80	400–600	1,2–4	0,10–0,14
90	200–300	0,7–1,2	0,06–0,08
95	200	0,4–0,7	0,06

The density of cellular materials is determined in a dry state by compressing a cube with an edge of 20 cm, aged for 28 days. It is marked with the letter D, the figures given indicate the density of the material in kg / m3. Cellular concretes include the following grades: D 200, D 250, D 300, D 350, D 400, D 500, D 600, D 700, D 800, D 900, D 1000, D 1100[10,11].

Strength. The class of a given material or its strength determines the resistance of a substance to compression. The sample for research is the same concrete cube after hardening. Foam concrete classes: B 0.35; At 0.5; At 0.75; IN 1; At 1.5; IN 2; At 2.5; At 3.5; AT 5; At 7.5; AT 10 O'CLOCK; At 12.5; B 15. The coefficient indicates the maximum pressure that the material can withstand without breaking. So, for B 0.35 this pressure is 0.5 MPa. Hardening conditions. The strength and, accordingly, the strength class are significantly affected by the nature of the binder and the hardening conditions. Thus, autoclaved concrete exceeds in strength the same material hardened in natural conditions by almost 6–8 times. An equally important factor is the amount of mixing water. The excess volume does not bind, but forms cavities and interlayers, which, of course, intensively reduces the index. Therefore, an obligatory step in the manufacture of the material is the vibrational effect both during the preparation of the solution and during the swelling period.

The bearing capacity of a material is determined by its density. Thus, heat-insulating materials based on cellular concrete cannot be used in the construction of load-bearing walls, supports or ceilings of any plan, while a structural option with a density of 1100 kg / m3.used for the construction of both walls and panels.

Frost resistance significantly affects the durability of materials, so the number of freeze and thaw cycles when saturated with water is a very important indicator. According to this parameter, the cellular material is inferior to ordinary concrete, since the pores, nevertheless, absorb moisture to a greater extent. To reduce absorption, mixtures are produced with the maximum number of closed pores. The frost resistance classes are as follows: F15, F25, F35, F50, F75. The figure means the number of cycles that the material transfers without destruction. Considering that cellular concrete is mainly used for thermal insulation from the outside, the need for a protective or decorative layer is obvious[12,13].

The amount of water absorption. The amount of water absorption depends on the type of binder. Thus, cellular concrete based on Portland cement absorbs less water than lime or gypsum based. If the first option is allowed to be used in rooms with humidity up to 50%, then the gypsum material requires protection in any case.

The fire resistance of cellular concrete is higher than usual, which, nevertheless, does not allow the use of materials in conditions where strength is required at a constant high temperature. The heat resistance or heat resistance of foam concrete is low: the material begins to break down at temperatures above 400 C. However, a short heating of a product made of cellular concrete is tolerated quite satisfactorily. So, when heating the class block. At 0.35, a material deflection of 24 mm with a total thickness of 400 mm was observed only at 151 minutes of exposure[14,15]. Deflection of 18 mm - at 61 minutes. These are sufficient indicators to consider the material fire resistant.Environmental friendliness. Environmental friendliness, that is, the assessment of the naturalness of raw materials, the energy intensity of the process, the possibility of natural processing, etc., depends on the manufacturing method, but in general it far exceeds not only reinforced concrete, but also clay and silicate bricks. According to the Ministry of Health, foam concrete has an indicator of 2.00. For comparison, the wood indicator is 1.0, and the environmental friendliness of expanded clay concrete is 20.0. The material is completely harmless to humans and the environment[16].

Conclusion

The question of the durability of foam concrete remains open, since it has been in operation not so long ago. The service life of a building made of aerated concrete is about 100 years, subject to major repairs after 60 years. However, it is no secret that the durability of the material is strongly influenced by conditions. So, too high humidity will cause destruction much earlier. The characteristics of cellular concrete, blocks of them will allow you to choose the right material for each construction site and for any operating conditions. At large facilities, the material most often serves as a heat insulator, but in low-rise construction it is indispensable due to its lightness [17].

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