COMPOSITIONAL MODIFICATION OF LIME AND ALUMINUM POWDER FOAM CONCRETE: THE ROLE OF BASALT FIBERS

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Annotation: *Currently, a number of scientific studies are being conducted on foam concrete with the addition of aluminum powder and basalt powder or fibers. This article partially covers the technology and properties of this particular material.*

Annotatsiya: *Hozirgi kunda alyuminiy pudrasi va bazalt kukuni yoki tolalari qo‘shilgan ko‘pikli beton ustida bir qancha ilmiy izlanishlar olib borilmoqda. Ushbu maqolada aynan shu materialning texnologiyasi va xususiyatlari qisman yoritiladi.*

Аннотация: *В настоящее время проводится ряд научных исследований пенобетона с добавлением алюминиевой пудры и базальтового порошка или волокон. В данной статье частично освещаются технология и свойства данного материала.*

Keywords: *aluminum powder, basalt powder, environmental safety, gas emission, density, strength, thermal conductivity, crack resistance*.

Kalit so‘zlar: *alyuminiy pudrasi, bazalt kukuni, ekologik xavfsizligi, gaz chiqishi, zichlik, mustahkamlik, issiqlik o‘tkazuvchanligi, yorilishga qarshilik***.**

Ключевые слова: *алюминиевая пудра, базальтовый порошок, экологическая безопасность, выделение газа, плотность, прочность, теплопроводность, трещиностойкость.*

Modern construction materials are rapidly evolving, among which foam concrete holds a special place. Its lightness, excellent heat retention, environmental safety, and economic efficiency are making foam concrete a popular and widely used building material. Cement, sand, lime, and special additives are incorporated into foam concrete. Currently, several scientific studies are being conducted on foam concrete with the addition of aluminum powder and basalt powder or fibers. This article partially covers the technology and properties of this particular material.

First, let's examine why special additives are included.

When **lime** (Ca (OH) 2) is added to concrete, it aids in the hydration process of cement, that is, it slightly accelerates the hardening process. This increases the initial strength of concrete. Since lime is a cheaper material than cement, adding a certain amount of it reduces production costs and brings economic benefits.

Aluminum powder is the main gas-forming additive in foam concrete. It reacts with lime and water to release hydrogen gas, resulting in the formation of small bubbles inside the concrete. When lime and aluminum powder are used together in concrete, they create an

alkaline environment in the concrete mass, stabilizing the reaction with aluminum powder. This ensures even distribution of foam and improves the quality of the blocks.

The use of basalt powder or fiber in foam concrete has rapidly gained popularity in construction materials, sparking scientific interest and prompting numerous research studies. **Basalt powder** or **fiber** improves the mechanical properties of concrete and increases its resistance to cracking. The benefits of adding basalt fiber to foam concrete are listed below.

1. **Increases strength**
   - Fibers perform the role of micro-reinforcement within concrete.
   - Compressive strength increases by up to 15-20%, while flexural and tensile strength increase by up to 30-40%.
2. **Cracking resistance**
   - Ordinary foamed concrete develops many micro-cracks during construction or after drying.
   - Basalt fiber "holds" these cracks and prevents their expansion.
3. **Frost resistance**
   - Due to fibers, the porous structure of concrete becomes stable, resulting in reduced water penetration.
   - As a result, resistance to freeze-thaw cycles increases (F50 → F75/F100).
4. **Hot resistance**
   - Basalt fiber maintains its shape up to 600-700°C.
   - As a result, concrete experiences less deformation even when exposed to high temperatures.
5. **Lightness is retained**
   - Basalt fiber is added in very small quantities (usually 0.5-1% by weight), therefore the density of foam concrete remains practically unchanged (staying within the D400-D800 range).

When conducting scientific research on building materials, it is particularly important to emphasize that the manufacturing technology has a significant impact on the properties of the material. Below, we will examine the process of preparing foam concrete with the addition of lime, aluminum powder, and basalt fiber:

1. **Preparation of a dry mixture**

• first, cement, sand, lime, and basalt powder are mixed according to the norm.

• If basalt fiber is added, it should be spread evenly beforehand.

2. **Preparation of aluminum powder**

• Aluminum powder is added in very small quantities (usually 0.05-0.1%).

• It is recommended to prepare it as a smooth suspension with water beforehand, as it may not spread evenly in a dry state.

3. **Mixing**

• Water is added to the dry mixture.

• Then aluminum suspension is added and quickly stirred.

• The aluminum + lime reaction begins instantly:

$2Al+3Ca(OH)2+6H2O \rightarrow 3CaO \cdot Al2O3 \cdot 6H2O+3H2\uparrow 2Al + 3Ca(OH)\_2 + 6H\_2O \rightarrow 3CaO \cdot Al\_2O\_3 \cdot 6H\_2O + 3H\_2 \uparrow 2Al+3Ca(OH)2+6H2O \rightarrow 3CaO \cdot Al2O3 \cdot 6H2O+3H2\uparrow$

(Hydrogen gas is released and forms small bubbles inside the concrete).

4. **Molding**

•The prepared mixture is poured into molds.

•As a result of gas release, the mass rises and its volume increases; therefore, the mold is filled only to 70% capacity to allow for expansion.

5. **Drying**

• Initially, it hardens under natural conditions for 1-2 days. If the mold is placed in a cellophane bag during this time, the concrete's expansion accelerates.

• Subsequently, the blocks are removed from the mold and continue to harden under natural conditions for 28 days or are accelerated through steam treatment in an autoclave.

When using aluminum powder in foam concrete, it is essential to strictly adhere to safety regulations, as it exists in the form of fine dust and can pose an explosion hazard in the air. Additionally, specific ratios (cement-sand-lime-basalt-aluminum powder) are determined based on the production technology and the required grade of the concrete.

Table 1.

Properties of foam concrete with and without basalt fiber addition

Indicators	**Simple foam concrete (Al + lime)**	**Basalt-fiber foam concrete**
Density (kg/m³)	300–800	310–820 (practically unchanged)
Compressive resistance (MPa)	1–5	5–8 (20–50% high)
Bending strength (MPa)	0,5–1,0	1,0–1,5 (twice as high)
Thermal conductivity λ (W/m·K)	0,10–0,25	0,11–0,26 (almost nearly)
Frost resistance (F, cycle)	F25–F50	F50–F100 (twice as high)
Water absorption (%)	10–15	8–12 (Fibers shorten the path of water)
Flammability	Won't burn (A1 class)	Won't burn (A1 class)
Crack resistance	Low	High (microcracks are trapped)
Heat resistance (°C)	to 200–300 °C	To 600–700 °C

As evident from the table, ordinary foam concrete is lightweight and has good heat retention properties, but its strength is relatively low. Foam concrete with the addition of basalt fiber maintains its lightness and thermal characteristics, while significantly increasing its strength, frost resistance, and heat resistance.

In conclusion, foam concrete with the addition of basalt fiber is more suitable for load-bearing wall blocks, industrial structures, and long-term construction projects.

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