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**Testing methods for bioconcrete products with organic filler**

*The paper presents wall elements made of bioconcrete, in which agricultural waste is used as a filler. The methodology of experimental studies of bioconcrete elements and the main parameters of the initial materials are presented.*

The main task in the development of the construction materials industry is to widely use local raw materials and develop the production of efficient materials (Fig. 1), which reduce the weight of structures and reduce construction costs. Thermal insulation materials are of particular importance.

In the economics of modern regional construction, lightweight aggregates, especially those based on local raw materials, play an important role in the production of thermal insulation materials [1-3].

Large volumes of capital construction in the regions are made possible by increasing the level of industrialization and mechanization of construction.

The main direction of construction industrialization is the construction of prefabricated universal frame-panel buildings with various types of thermal insulation.

In most regions, they are particularly scarce. Their shortage is one of the reasons for the poor development of prefabricated construction.

**a)** **b)**

Fig. 1. Types of bioconcrete blocks: a) symmetrical; b) asymmetrical

Organic raw materials used as aggregates for lightweight concrete have their own characteristics that distinguish them from mineral aggregates. The properties of lightweight concrete were studied using different types of mineral and organic binders. The research was conducted on cements (quick-setting, Portland, slag-Portland), caustic magnesite powder, gypsum and bituminous binders. Petrolatum and Kukersol shale varnish were used to make thermal insulation fills.

Six twin specimens were prepared for each type of test. The study of the properties of concrete with different types of binders was carried out on cubes measuring 10x10x10 cm; prisms 10x10x30 cm and slabs 100x50x103, 100x50x8, 80x50x8, 80x50x6 cm.

For the experimental work, corn cob stalks in the form of “crushed stone” were used as aggregate.

Mixing of the crushed corn cob cores with mineral binders was carried out in a laboratory stirrer of forced action for 4-5 minutes.

The samples were compacted on a hydraulic press under a pressure of 0.03-0.05 MPa. Hardening and drying of the samples was carried out in artificial and natural conditions. Under natural conditions, the samples were cured on racks in a room with an air temperature of 18-20° and a relative humidity of 60-65%. The specimens were cured in humid conditions on racks above water in a bath with a hydraulic gate at a relative humidity close to 100%.

Samples on gypsum binders were dried in an oven at a temperature of 50-60°C.

Bulk weight, compressive strength, water absorption, and hygroscopicity were determined on the cube samples. Compression tests were performed on a 5-ton press of the P-5 type, and bending tests were performed on a 6-ton hydraulic press.

The hygroscopicity was determined daily for 60 days at t = 15-20° and relative humidity in the exciter equal 100%, 90%, 80%, 70%, 60%, 50%, 45%, which was created by different concentrations of sulfuric acid solution, which was determined by an areometer in accordance with Table 1.

The decay resistance of the bituminous binder samples was determined directly by testing samples that were placed in the ground to a depth of 50 cm and kept there for a year.

The thermal characteristics of various concrete and backfills were determined using the regular mode method.

As a rule, three samples were tested for each composition.

This method of determining the thermal coefficients of building materials under non-stationary thermal conditions is based on the use of its regularities, which are generally described by the Fourier differential equation:

$$dt/dz=a(d2t/dx2+ d2t/dy2+ d2t/dz2) \qquad (1)$$

where $a=\lambda/c\gamma$ - thermal conductivity coefficient of the material. Observations have established that there are two stages in the process of heating or cooling any body placed in an environment with a constant temperature that differs from the body's temperature at the initial time.

In the first stage, which usually lasts for a short time, the temperatures of individual points on the body fluctuate unevenly, in waves that gradually decay.

As the temperature fluctuations level off, the second stage of the process, called regular, occurs, characterized by a uniform change in temperature over time.

If the data of measurements of changes in temperature differences at any point of the body during its heating or cooling and the ambient temperature $\upsilon=\tau t-\tau$ are plotted on a semi-logarithmic grid, where the abscissa axis is the time Z and the ordinate axis is the natural logarithm of the temperature difference $\lg\upsilon$.

The wavy part of the curve represents the first stage of the process, and the straight part represents the second stage. The angle of inclination of the straight section to the horizon $\beta$ characterizes the cooling rate of the body. The tangent of the angle of inclination m=tgβ (3 is related by a functional relationship to the value of the thermal conductivity coefficient a.

The direct test consisted in measuring the cooling rate of a material sample placed in a tightly closed vessel called an acalorimeter, which was immersed in a liquid medium with a constant temperature (water-ice bath) lower than the initial temperature of the device. The thermal conductivity coefficient (a) was calculated based on the cooling rate and the device constant obtained from experience.

*Table 1.*

Concentration of solutions

| relative air humidity in the exciter, % | sulfuric acid concentration, $H_2SO_4$, % | specific weight of the solution |
|---|---|---|
| 100 | 0 | 1,0 |
| 90 | 17,66 | 1,125 |
| 80 | 26,30 | 1,192 |
| 70 | 32,80 | 1,245 |
| 60 | 38,00 | 1,360 |
| 50 | 43,00 | 1,425 |
| 45 | 45,30 | 1,455 |

The thermal conductivity coefficient (λ) was calculated from the obtained value of the thermal conductivity coefficient and the tabulated value of the specific heat capacity of the material according to the formula:

$$\lambda = a \cdot c \cdot \gamma 0 \quad (2)$$

The X-ray diffraction and gravimetric analyses were performed in the problematic soil silicates laboratory.

X-ray structural analysis of neoplasms in lightweight concrete on construction gypsum from corn cob rods was performed by ionization registration of X-ray intensity using the URS-50 IM unit. The survey was performed on CuKα radiation. Kβ radiation was filtered by a manganese or nickel filter. Interplanar distances were calculated using the Wolfe-Bragg formula. The interpretation was performed by comparing X-ray diffraction patterns for pure gypsum stone mixed with water and gypsum stone mixed with corn cob extract, as well as for samples of both types that had been previously aged for one hour at typical temperatures of 120 and 180°C.

The preparations were prepared as follows: the studied mixtures were subjected to thorough grinding until they passed through sieve No. 0053. 0.5 g of this mixture was mixed with Ramsay's putty and placed in a special cuvette for taking polycrystalline samples, which was fixed on an URS-50 slide. The speed of movement of the counter and the sample was 2° per minute.

Thermographic studies of neoplasms in the gypsum stone of concrete samples on corn cob rods were performed on an automatic photo-registration pyrometer FPK-55 using simple and differential recording according to the method.

The heating rate was 10-12° per minute.

Platinum-platinum-rhodium thermocouple.

Gravimetric analysis was used in conjunction with thermographic analysis to gain insight into the kinetics of the reactions. The research was performed on a setup consisting of two devices - a damper balance and an AC bridge. The analysis was based on the thermobalance method of determining the change in mass of a substance. The setup uses the principle of a compensating chain. The gravimetric analysis made it possible to determine the temperature range for the removal of chemically unbound and chemically bound water, as well as the intensity of the processes.

Petrographic analysis was performed by viewing grinds under a MIN-8 microscope (magnification up to 500) and immersion preparations of lightweight concrete on construction gypsum and corn cob rods.

## References


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