ISSN: 2775-5118 VOL.4 NO.3 (2025) I.F. 9.1

PHYSICAL AND MECHANICAL PROPERTIES OF NEW COMPOSITION THERMAL INSULATING MATERIALS RESEARCH

Xashim Mamatkarimovich Dosmatov
(Candidate of chemical sciences, associate professor, Professor of the Academy of the Ministry of Emergency Situations of the Republic of Uzbekistan)
Anzirat Djumabaevna Dosmatova
(Candidate of chemical sciences, associate professor, Head of the Department of Pharmaceutical Education and Research Institute)
Yashnar Ibrahimovich Gulyamov
(Independent researcher at the Academy of the Ministry of Emergency Situations of the Republic of Uzbekistan)
Aminjon Roziboevich Shukurov
(Researcher of the Academy of the Ministry of Emergency Situations of the Republic of Uzbekistan)

Abstract. This article analyzes the results of research on the physical and mechanical properties of new composite thermal insulation building materials . The characteristics of the components necessary for the preparation of brick specimens based on industrial waste were studied, raw materials were selected and optimal compositions were developed. As a result of research on the physical and mechanical properties of brick specimens prepared in an optimal composition based on industrial waste , the bending and compression strength of the specimens with the addition of 7% and 9% asbestos-cement waste in the composition of the brick specimens was increased. The article presents the results of experiments on determining the physical and mechanical properties of brick specimens prepared on the basis of asbestos-cement waste, microsilica, and cement.

Keywords: thermal insulation materials, flexural strength, compressive strength, asbestos-cement waste, microsilica, cement grade, temperature, brick specimens, industrial waste, concrete, dispersed strength, efficiency, concrete matrix, deformation.

Introduction.

Nowadays, the construction of energy-efficient housing and the use of environmentally friendly materials in construction are one of the most important issues in the world. In our republic, the use of local, energy-efficient, fire-resistant and heat-insulating building materials in housing construction is considered to be advantageous in all respects and is developing. The effective use of fire-resistant and heat-insulating wall materials in the construction industry prevents possible emergencies in the future and ensures minimal losses. As a result of the development of science and advanced technologies, modern types of fire-resistant and heat-insulating wall materials are currently being produced. The development of low-rise and individual construction , as one of the main directions of work on increasing the housing stock, requires the development and organization of the production of effective building materials that combine high technical and economic indicators.

The most commonly used in construction are simple and multi-hole masonry bricks, which are mainly used in the external and internal walls of buildings, in the construction of brick blocks and panels. It is desirable that masonry thermal insulation materials be frost-resistant, strong in bending and compression. For this purpose, the physical and mechanical properties of the newly obtained composite thermal insulation materials were studied [1-2].

Methods of research.

The bending and compression strength of the new composition of thermal insulation materials was tested on a MIG.1000.06RU testing machine. Based on the new composition, brick specimens were prepared with the addition of asbestos-cement waste in the amount of 5%, 7%, 9%, 11% and 13% [1, 3-5].

Asbestos-cement waste creates dispersed reinforcement in the brick structure and increases its strength.

The effectiveness of the dispersed strength of concrete depends on the ratio of the strength and deformation characteristics of the interpore walls of the concrete matrix and the reinforcing fibers (fibra). The strength of concrete can be made by adding different fibers to its composition [5-10].

Table 1.**Results of bending and compressive strength testing of brick specimens with asbestos-cement waste**

Cement stamp	ACCH quantity	The average volumetric mass of the sample, g/cm 3			Bending strength kN	Compressive strength, kN			Difference in compressive strength , ,
		7 days	14 days	28 days	7 days	7 days	14 days	28 days	
PC-400	0 %	683	670	640	15	6.4	7.0	9.0	0
PC-400	5%	673	595	590	15	6.7	7.1	9.3	3.3%
PC-400	7%	710	680	653	20	7.6	8.2	12.5	38.8%
PC-400	9%	640	625	595	16	6.8	7.5	10.2	13.3%
PC-400	11%	750	745	658	15	6.4	6.8	10.0	11.1%
PC-400	13%	778	710	640	17	6.1	6.5	9.5	5.5%

A new composition of a brick mixture was developed in the laboratory from wet asbestos-cement waste and microsilica waste. In particular, in this composition, the moisture content of wet asbestos-cement waste is 30-35%.

This amount is sufficient for the hydration process of the cementitious binder with water in the mixture to occur.

1. ATsCh (at 30% humidity)-80%+white PTs 500 D0-20%;
2. ATsCh (at 30% humidity)-80%+PTs 400 D20-20%;
3. ATsCh (at 33% humidity)-70%+MK-10%+ PTs 400 D20-20%;
4. ATsCh (at 35% humidity)-60%+MK-20%+ PTs 400 D20-20%;

Based on the composition, brick specimens were prepared at a pressure of 25-28 MPa in a hydraulic press with a pressure of 600 tons , and the properties of the specimens for bending and compressive strength were determined.

Table 2**. Strength results of brick specimens**

Cement stamp	Additional amount,%	The average mass of a brick of size 250x120x65 mm, g		Bending strength, MPa	Compressive strength , MPa
		3 days	28 days	28 days	28 days
PC-400 D20	ACCH, 80	1652	1248	0. 69 4	2.041
White PC-500 D0	ACCH, 80	1710	1260	0.776	2.624
PC-400 D20	АСЧ 60+МК10	1825	1320	0.984	3.022
PC-400 D20	АСЧ 60+МК20	2065	1342	0.512	1.833

Determination of the brick grade by testing the compressive strength of various building bricks is shown in Table 3.

Table 3. **Table for determining the grade of brick by compressive strength limit**

Brick brand	Brick strength limit, MPa		
	Compressive strength of all types of bricks	Bending strength of hollow brick	
		In plastic molding	In wet-dry pressing
300	30.0	4.4	3.4
250	25.0	3.9	2.9
200	20.0	3.4	2.5
175	17.5	3.1	2.3
150	15.0	2.8	2.1
125	12.5	2.5	1.9
100	10.0	2.2	1.6
75	7.5	1.8	1.4

Results.

Specimens were prepared by molding and pressing a mixture of asbestos cement waste, binder and water. The bending strength of the specimens was 0.694 MPa, and the compressive strength was 2.041 MPa. According to the test results, it was found that the average brand of the sample bricks has 20 indicators [1, 3-6].

ISSN: 2775-5118 VOL.4 NO.3 (2025) I.F. 9.1

Table 4.**Sample strength test result**

Sample t/r	**Thickness a ₀ , mm**	**Now b ₀ , mm**	**Cut surface S , mm ²**	**Diameter d ₀ , mm**	**Length l ₀ , mm**	**Maximum stress F max, kN**	**Compressive strength limit Rc к , MPa**	**Modulus of elasticity in compression Ec**
The thief show.	65 .000	120,000	14400.00 0	13.0 0	120.0	90,657	3.022	16,918

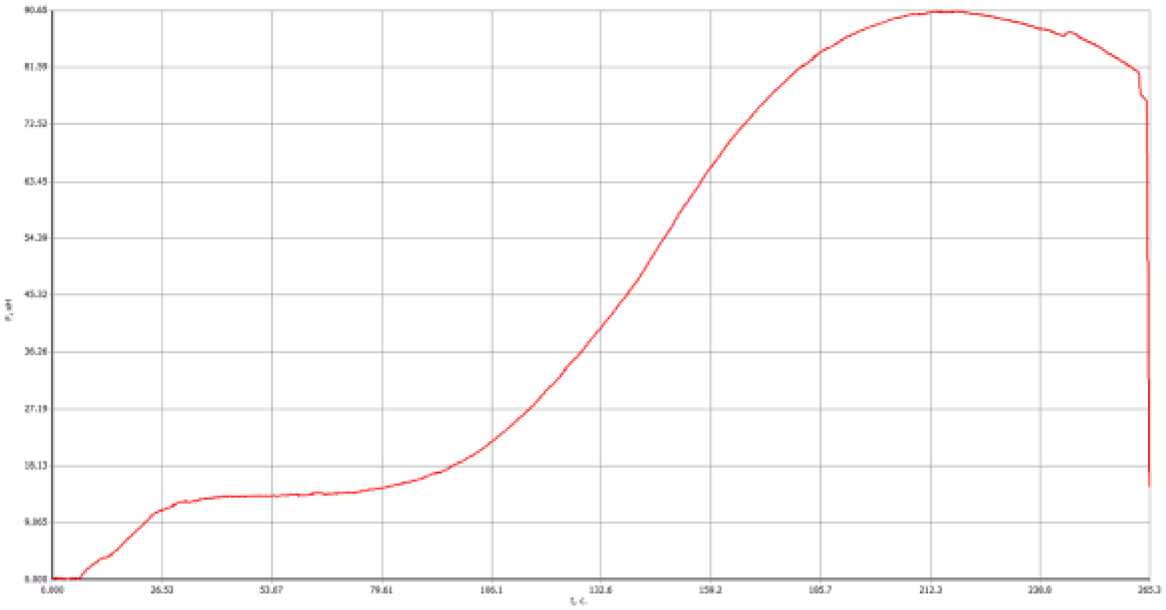

Fig 1. Test diagram of the compressive strength of a sample as a function of force F (kN) versus time t (seconds)

Conclusion. The characteristics of the necessary components for the production of building bricks based on industrial waste were studied, raw materials were selected and their optimal composition was developed. Brick specimens prepared with optimal composition based on industrial waste were analyzed by differential-thermogravimetric method. As a result of physical and mechanical properties studies, the bending strength of the sample with 7% and 9% asbestos cement waste in the brick specimens increased by 33%, and the compressive strength increased by 21% .

Deterioration of building structures occurs mainly under the influence of humid temperatures. This is due to the fact that water expands on average up to 9% when it freezes. The ability of concrete to maintain its properties or change them within a certain range under the influence of alternating freezing and thawing is called frost resistance. Frost resistance is measured in cycles of one freezing and one thawing; the duration of the cycle should not exceed 24 hours.

Determination of frost resistance properties of aerated concrete: according to GOST 10060-2012. "Methods for determination of freezing resistance" The freezing resistance of aerated concrete specimens of average density was determined after the specified time .

Frost resistance is the property of a water-saturated material not to deteriorate and not to lose strength during repeated freezing and thawing. The frost resistance of materials is tested by freezing water-saturated specimens in cooling chambers at a temperature of –15–17 ^{0}C and then thawing them in water at a temperature of about 20 ^{0}C. If, after a given number of freezing and thawing stages, the sample does not lose more than 5% of its mass as a result of crushing and stratification, and its strength decreases by more than 25%, the material is considered frost-resistant. If the specimens do not have any deformations or cracks after freezing, then the degree of frost resistance is determined by determining the frost resistance coefficient:

$$K_F = \frac{R_F}{R_{муй}}, (2.3)$$

where R_F is the compressive strength limit of the material after testing for frost resistance, MPa;

R_{tuy}, - compressive strength limit of water-saturated material, MPa.

For frost-resistant materials, R_F should not be less than 0.75. Depending on their ability to withstand successive freezing and thawing stages (frost resistance coefficient), materials are divided into grades F 10, 15, 25, 35, 50, 100, 150, 200 and above.

The criteria that determine the frost resistance of aerated concrete are their optimal structure, the amount of water retained in the pores of the concrete, the form of water bonding with the material, and its freezing temperature. Changing the pore structure, that is, changing it by giving the material hydrophobic properties, can affect the frost resistance of concrete.

In addition to relatively large air-filled voids, aerated concrete contains a large number of small voids such as capillary, contraction, etc. In addition, hydrothermal treatment of concrete in autoclaves also contributes to the formation of voids that differ from those of concrete hardened under natural conditions.

During steam treatment, significant temperature gradients cause stresses in the products, which lead to an increase in the porosity (intercellular walls) of the aerated concrete matrix, a change in its nature, and the formation of microcracks. Changes in the relative humidity of the surrounding air, along with temperature changes, lead to a fragmentation of the cement stone structure and the formation of cracks, which in turn increases the number of various pores and, as a result, increases the water absorption of cellular concrete.

There are different opinions about the influence of a certain group of pores on the resistance of aerated concrete to cyclic freezing and thawing. Therefore, studies have been conducted to determine the influence of the structure of aerated concrete on its frost resistance. This method is used not only for heavy concrete, but also for determining the frost resistance of porous concrete, road and hydraulic concrete. The frost resistance of concrete is determined by the number of cycles. That is, after the specimens have passed the freezing and thawing cycle, their compressive strength should not decrease by more than 15%, and their weight should not decrease by more than 5%, in addition to the strength.

In the preparation of experimental specimens, based on the requirements of state standard 25485-2019, an aerated concrete mixture was prepared from the components measured in the laboratory and placed in molds. It should be noted that the lime component was not added to the selected composition, this is due to the fact that OTKMK Jizzakh cement PC400 D20 was used for the composition, and limestone was used as an additive to the cement. The following optimal composition for 0.017 m^3 of aerated concrete, which was considered necessary for the preparation of specimens based on the selected composition, is given in Table 2.15.

Table 5.**Optimal composition for selected components for the preparation of experimental specimens**

Component	**1m^3, kg**	**0.017m^3, kg**
Cement	280	4.76
Sand	240	4.08
Caustic soda	1.4	0.0238
Aluminum powder	0.5	0.0085
Water	260	4.42 l
Sodium sulfate	5.6	0.0952
Technician soda	0.1	0.0017

The freezing test of the specimens started 28 days after their preparation. In the study of determining the freezing resistance of aerated concrete specimens, 12 out of 21 specimens with a size of 100x100x100 mm were the main specimens, and these main specimens were used for freezing and thawing processes. 6 control specimens - the ratio of the control sample is taken during the cycle calculation of the main specimens, the control sample is saturated with water during the compression test. For fixed and intermediate cycles and 3 specimens were used to determine mass loss.

The main specimens are inspected before testing, saturated in water for 96 hours, the water temperature should be 15-20 ^{0}C , and the water layer above the specimens should not exceed 20 cm.

Freezing tests were performed in a freezing chamber under the following basic conditions:

specimens at a temperature of 15-20 ^{0}C. If the temperature of the specimens is higher than -15 ^{0}C when installing the equipment, the time of freezing is calculated after the temperature drops to -15 $^{0\,C}$;

specimens are installed in the freezing chamber at a distance of 2 cm from each other .

The first test cycle consisted of 4 hours of freezing and 4 hours of thawing in a water bath at a water temperature of 15-20 ^{0}C. The control specimens were stored in a normal environment, i.e., with a humidity of 20±2%; at a temperature of 20±20 C, and were measured and tested simultaneously with the main specimens, which were saturated with water. The tests were stopped if the compressive strength of the specimens decreased by more than 15% compared to the control specimens .

The main and control specimens were soaked in water for 8 hours. After this period , the control specimens were stored in normal conditions in chambers with a temperature of 15-20 ^{0}C and a humidity of 95±2%. The main specimens were frozen in a freezing chamber at -15-20 0 ^{C} for 4 hours and thawed in a chamber with a temperature of 20 ^{0}C and a humidity of 95±2%.

21 specimens measuring 100x100x100 mm were prepared from the molded aerated concrete block. Of the 21 specimens, 12 were prepared for the main ones, 6 for the control ones, i.e. for the specified and intermediate cycles, and 3 specimens were prepared to determine the mass loss. The aerated concrete specimens were frozen and thawed twice a day in the department's laboratory using a computerized Arktiko LAF 700 freezing chamber, a water-filled bath, and electronic scales were used to measure their mass.

References

1. GOST 310.4-92 Cements. Methods for determining the ultimate bending and compressive strength.

2. GOST 8462-85 Wall materials. Methods for determining the ultimate bending and compressive strength.
3. Zhukov A.D. Technology of thermal insulation materials. Part I. Thermal insulation materials. Production of thermal insulation materials, study guide. Moscow: Moscow State University of Civil Engineering 2011. Page 431.
4. Elistratkin M.Yu. Cellular concrete based on VNV using KMA waste [Text]: abstract of dis. candidate of technical sciences // M.Yu. Elistratkin. Belgorod, 2004. Page 22.
5. Zheleva N.V. Disposal of asbestos-cement industry waste // Collection of abstracts of the third scientific conference of graduate students of IGASU. Ivanovo, 2003.
6. Zheleva N.V., Guyumdzhyan P.P. Industrial waste - valuable raw material for the production of building materials // Problems of ecogeoinformation systems. Issue 1. - Ivanovo, 2000.
7. Abdusamatov K.B., Tilavov E. Mirzaev J. Bino and of the facilities local materials based on under construction from aerated concrete of use energy efficiency // " Modern research, innovation , technology and of technologies current problems and development on the subject of " trends " . republic scientific and technical conference materials . JizPI. -2018 , p . 285-287 .

8. Dolotova R.G. Non-autoclaved cellular concretes using natural and technogenic low-silica raw materials [Text]: Abstract of Cand. Tech. Sciences. – Tomsk, 2006.-P16.

9. Orientlikher L.P., Soboleva G.N. Construction materials based on wet waste from the production of asbestos-cement products. Construction materials, equipment, technologies of the XXI century, No. 7, 2000.

10. Samigov N.A. Thermal insulation construction materials: status and development. Reports of the Interuniversity Scientific and Technical Conference with the participation of foreign scientists. Tashkent-Samarkand. 2007. Collection of works. - T.: 2008. - 212 p.

11. Dusmatov HM, KRBerdiev, QXYakubov, A.Sirojitdinov. Study Of Structural Properties And Flame Of Wollastanite, Dolomite, Vermiculite Minerals // The American Journal of Applied sciences. Volume 03, Issue 01, January 2021. P. 30-37.

12.B.T.Ibragimov, Dusmatov HM, B. Akramkhodjaev . Research of Thermal and Mechanical Influence on Ferro-Concrete Designs with Damping Inserts // International Journal of Advanced Research in Science, Engineering and Technology. Vol.4, Issue 12, September 2019. P.4595-4598.