Some structural aspects of heat resistant plates from brick fight

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Abstract. The article describes some aspects of analyzing structures of heat-resistant reinforced concrete slabs designed to cover the surface of brick ovens. Fragments of crushed stone from bricks were obtained as the main filler in manufacturing heat-resistant facing slabs. The plate is reinforced for strength, and its protective zone is offset to the neutral axis to protect the armature from temperature. Contains analytical data on scientific research over the years, problems, conclusions about the need for research, the results of experimental tests, and the results of studies of porosity and structural aspects of the developed design of heat-resistant plates. This heat-resistant reinforced concrete slab has passed natural tests in brick kilns of brick factories in the Namangan and Andijan regions of the Republic of Uzbekistan. Conclusions are made about the application of the obtained research results in production.

1 Introduction

To date, certain tasks have been set in the construction field for introducing energy and resource-saving technologies, and a wide range of measures are being taken in this direction. One of the most important objects in implementing these tasks is the development of building structures that ensure the quality and efficiency of brick factories.

We know that the internal temperature in a brick kiln is around 1000 ° C. Until recently, expensive kaolin heat-retaining plates were used to cover brick kilns. At the same time, it was found that the cost of such heat-resistant plates affects the cost of manufactured products and several shortcomings in the application process. In addition, the cover constructions made of this heat-resistant material allow using it for a maximum of 6-8 months. Therefore, scientific research in this area and developing and experimentally researching low-temperature heat-resistant coatings based on local industrial waste for brick kilns. Due to the lack of such heat-resistant slab constructions, it can be seen in many brick factories that the quality of the produced bricks is still insufficient.

Scientists worldwide have researched the thermal conductivity of reinforced concrete structures and their materials and achieved certain results [1-7, 10-18]. However, in these studies, the flammability of existing buildings and structures, as well as reinforced concrete structures, and the stress-strain conditions in structures in the event of a fire are studied in depth. The effects of high temperatures (600-1000 ° C) over a long period of 10-12 hours have been poorly studied, and insufficient research has been conducted on creating heat-

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resistant structures. In particular, research on the production technology of heat-resistant ceramic reinforced concrete structures based on industrial waste is not sufficiently developed.

2 Methods

To study the thermal and technical quality of the developed reinforced concrete slab, the porosity of the reinforced concrete slab construction material was studied. Infrared Fourier spectrometry (SHIMADZU, Japan, 2017) was used [4, 10]. The internal structures of the prepared samples were studied and analyzed. The number of waveforms on the scale of the spectral range was 4000 ÷ 40 mm-1, the resolution was 4 mm-1, the sensitivity to the signal/noise was 60: 1, and the imaging speed was 20 spectra per second.

Symbolic porometry was used to study the porosity of hot concrete, using Thermo Scientific's Pascal 240 EVO series symbolic porosimeter and three types of compositions. All samples were placed on a CD3-type dilatometer, and the air was removed from the pores and filled with mercury using a vacuum device. The dilatometer Pascal 240 EVO was placed in the autoclave, and the mercury intrusion was 200 MPa. With the help of special software, the total porosity (%), and specific and relative pores (mm^3 / g) were determined.

Results and discussion

The new hot-rolled reinforced concrete slabs are made based on industrial wastes and suitable for construction brick kilns and kilns. In manufacturing the proposed hot-rolled reinforced concrete slab, brick fragments from the building are used as coarse aggregate. In recent years, research conducted at brick factories in Namangan and Andijan regions has shown that the production of new hot-rolled reinforced concrete slabs is influenced by the high temperature in the brick kilns. The heat-resistant slab has been tested for five years at brick factories in Namangan and Andijan regions. The proposed reinforced concrete slabs differ from the existing load-bearing slabs and roofing slabs in the following ways: they are made of brick fragments as aggregates; the working armature is moved a certain distance from the elongation zone due to the calculation due to the high temperature in the elongation zone (around 1000°C); There are additional fillers that provide the strength of hot-rolled reinforced concrete slabs.

The brick fragments attached to the reinforced concrete slab define the macrostructure of the concrete slab. The strength and character of the fractures, their large or small size, shape, and granulometric composition are also important. At the same time, sand determines the mesostructure of the reinforced concrete slab material and the water-cement ratio due to its bond with cement, and the slab structure also plays an important role in forming macrostructure in concrete.

The robustness of the samples was determined in compliance with the requirements of international standards [8, 9] approved by the Commonwealth of Independent States. So $R = \alpha \frac{F}{A} K_W$ the average strength of the concrete cube according to the formula was (R) 11.09-15.44 (MPa).

Porosity plays an important role in the heat retention of reinforced concrete slab construction because the degree of heat retention is ensured due to porosity. Therefore, porosity is one of the most important characteristics of reinforced concrete slabs. Porosity is defined based on the spatial parameters of porosity, the fact that they are part of the total volume, their occupancy, and location due to differences in size and the range of sizes. Also, the size of micro-pores (less than 2 nm) in the cement stone of reinforced concrete, mesopores (2-50 nm), and macro-pores (greater than 50 nm) by the international organization IUPAK (International Union of Pure and Applied Chemistry) and according to the classification of MM Dubinin) is known to be defined by certain divisions. Based on this, 3 different samples (I, II, III) were prepared for the experimental study of porosity-permeability-heat resistance, and the porosity in their structures was studied in several compositions. The indicators of the structural porosity of the prepared samples can be seen in Table 1:

Table 1. Characterization of structural porosity of samples

№	Indicators	Unit of measurement	Quantity		
1	2	3	I	II	III
1	Total porosity volume	mm^3/g	88.38	158.15	154.75
2	The total surface area of pores	mm^2/g	1.376	11.906	3.077
3	The average diameter of pores	μm	0.2569	0.0531	0.2012
4	The diameter between pores	μm	1.5094	0.1107	0.5941
5	The modal diameter of cavity	μm	0.0098	0.0089	0.0091
6	The general porosity of sample	%	19.391	30.212	29.444

I, II, III - the total porosity of the samples was determined, and a comparison histogram was developed (Fig. 1):

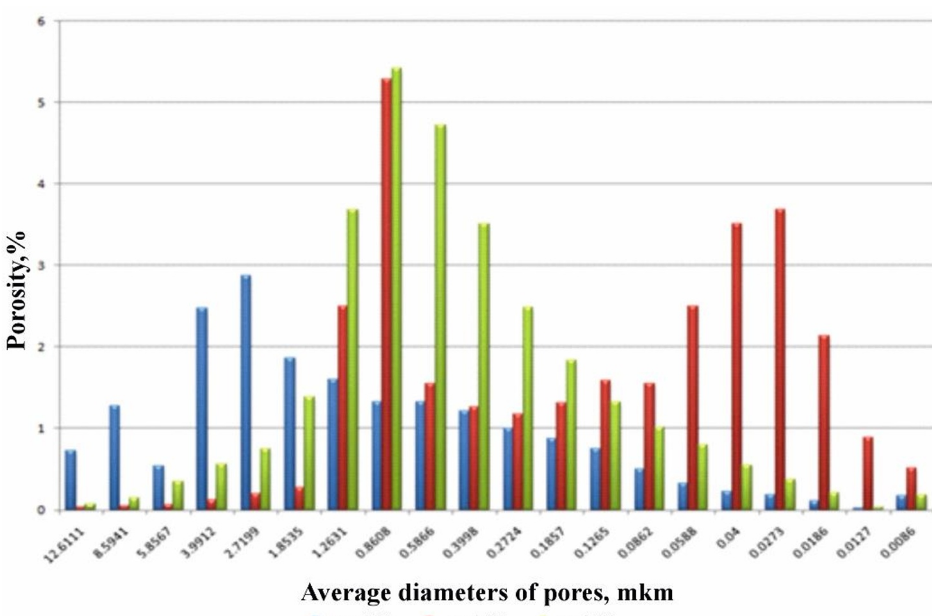

Fig. 1. Histogram comparing total porosity by size: total porosity of first sample was 19.391%, the second sample was 30.212%, and the third sample was 29.444%

The analysis of the above data shows that the total porosity of the first component is 19.391%, and the contribution of the largest pores is M.M. Based on Dubinin's and [5-7] classifications, it was shown to be in the range of 15–1.26 μm, and that these porosities affect the physical and mechanical properties (strength, cold resistance, and permeability) of concrete.

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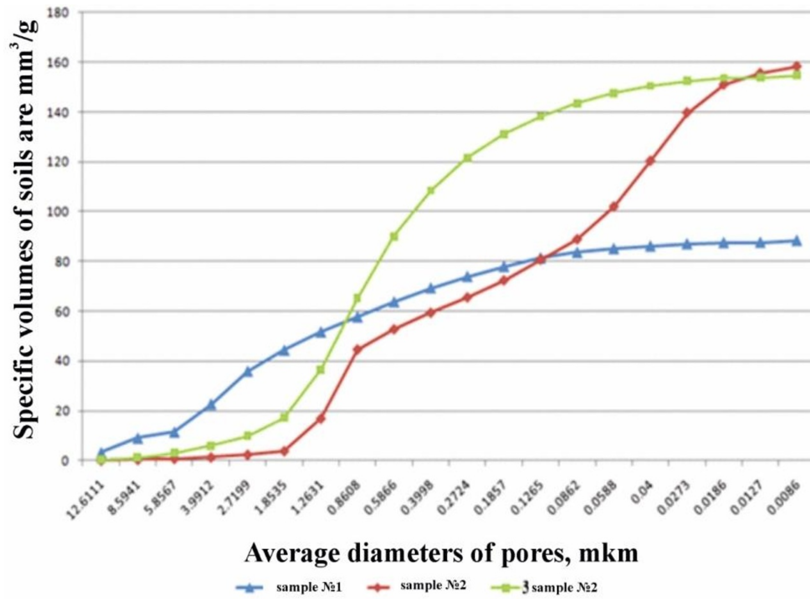

Fig. 2. Graph of comparison of specific volumes of pores of samples

In the second composition, the main set of pores was found to be in the range of 1.26-0.18 μm and 0.0588-0.0186 μm. The total porosity of the content was 30.12%.

The total porosity of the third component studied was 29.444%. The main pores were found to be in the 1.26-0.0862 μm size range. Based on the research results, a comparison chart was developed for the relative size of the pores of the samples (Fig. 2).

When the specific volumes of samples 2 and 3 were 158.15 and 154.75, it was observed that the specific volume of sample 1 was twice less (Fig. 3).

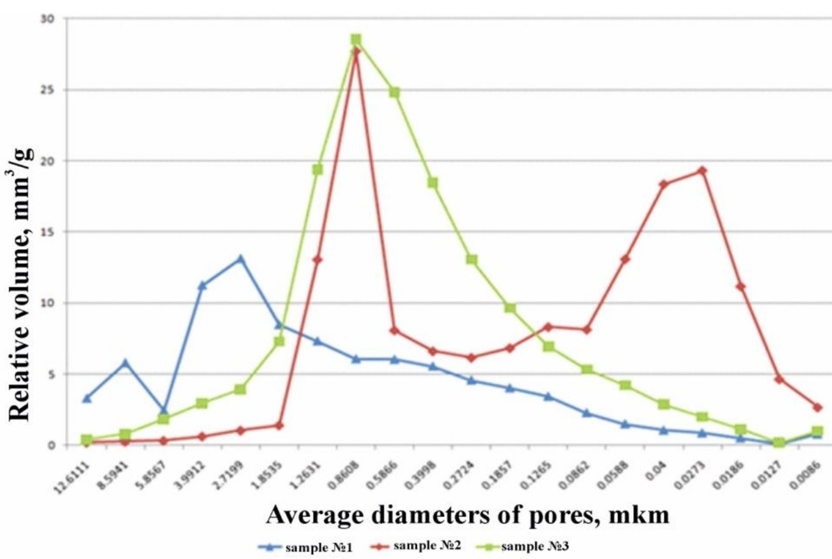

Fig. 3. Graph comparing relative sizes of pores of samples

A comparison of the samples' specific and relative porosity volumes showed that, based on the theory of heat retention of pores, it was determined that using the second and third components as heat-resistant reinforced concrete structures was expedient.

Based on the results of the study, it was found that the total porosity of the heat-resistant structure is in the range of 20-30%. It was noted that it is possible to prepare a heat-resistant structure of these parameters to meet their regulatory requirements [10].

In the study, M.M. Dubinii and based on the classifications [5-7], the hazardous and non-hazardous porosities of the studied compounds were studied (Fig. 4). It was found that the best content in terms of safe porosity is the second content. The highest risk porosity index corresponds to the third content.

Subsequent studies have been devoted to microscopic analysis to study the composition of heat-resistant concrete and the new composition in its structure. This, in turn, helped to obtain information about the new composition. The research was conducted using the existing SHIMADZU instrument in the Center for High Technologies laboratory in Tashkent. As an example, 3 (I, II, III) components were used: 1). Sample made of bricks from Shohidon brick factory (Namangan region); 2). Sample made of bricks from Khanabad brick factory (Andijan region); 3). Laboratory-prepared sample (NamECI).

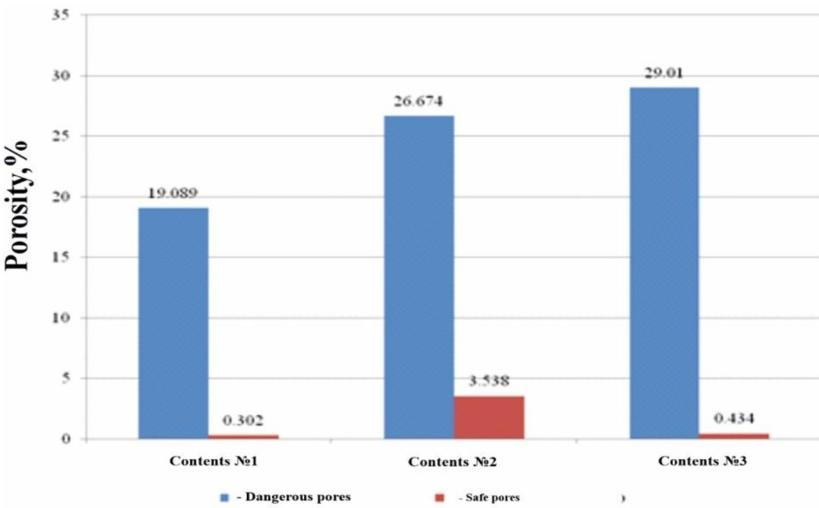

Fig. 4. Dangerous and unsafe porosity of ingredients under study

The results of the chemical composition of the samples are given in Table 2:

Table 2. Chemical composition of samples

№	Element			Weight,%			Sigma, weight,%		
	I	II	III	I	II	III	I	II	III
1	O	O	O	41.1	41	47.9	0.9	0.8	1.0
2	Ca	Ca	Ca	30.6	35.7	19.9	0.6	0.6	0.5
3	Si	Si	Si	9.2	6.8	15.6	0.3	0.2	0.4
4	C	Al	C	6.4	5.4	9.4	0.7	0.2	1.6
5	Fe	C	Al	6.2	5.4	2.8	0.5	0.6	0.2
6	Al	S	Fe	4.8	2.6	1.6	0.2	0.2	0.3
7	S	Fe	S	0.9	2.1	1.4	0.1	0.4	0.1
8	Mg	Mg	K	0.9	1.0	0.5	0,1	0.1	0.1
9			Mg			0.8			0.1

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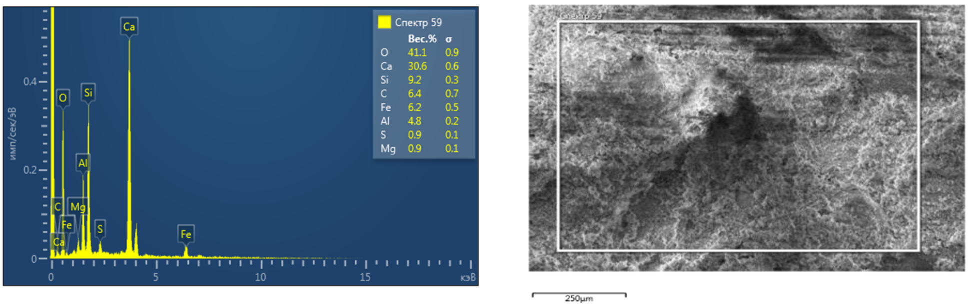
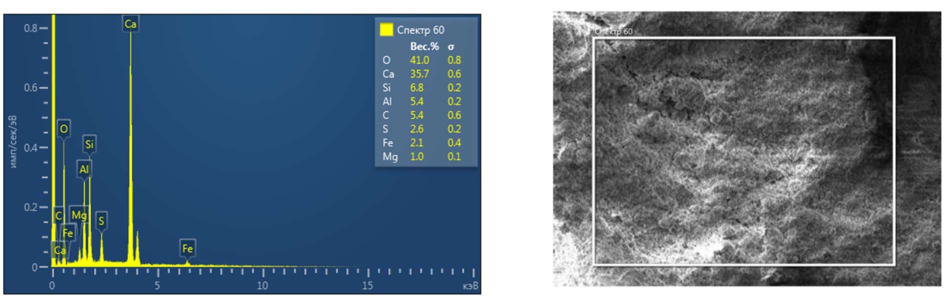
I-sample. Results obtained at 250 μm according to the sample made of bricks from Shohidon brick factory:



a *b*

Fig. 5. Results of X-ray phase and microstructural analysis (Shohidon brick factory brick): a) results of X-ray phase analysis; b) Microstructure of sample of heat-resistant ceramic, concrete slab: cement, quartz sand, ash powder, crushed brick[19].

II-Sample. Results obtained at 250 μm according to the sample made of bricks from Khanabad brick factory:



a *b*

Fig. 6. Results of X-ray phase and microstructural analysis (Khanabad brick factory brick): a) results of X-ray phase analysis; b) microstructure of heat-resistant ceramic, concrete slab sample: cement, quartz sand, ash powder, crushed brick [20].

Sample III: Results obtained at 250 μm according to the sample (NamECI) prepared in the laboratory "Building materials" of Namangan Engineering-Construction Institute:

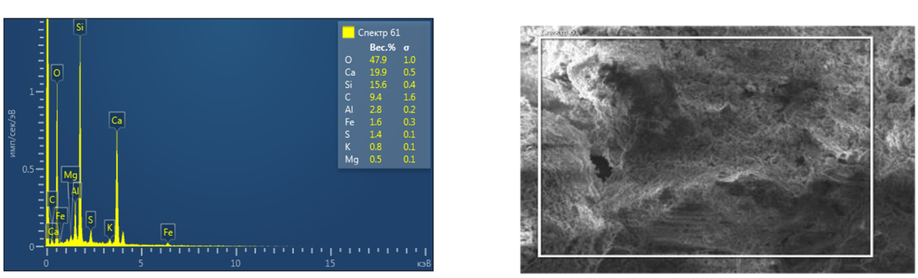


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Fig. 7. Results of X-ray phase and microstructural analysis (NamECI laboratory): a) results of X-ray phase analysis; b) Microstructure of the sample of heat-resistant ceramic, concrete slab: cement, quartz sand, ash powder, crushed brick.

In general, it was recommended that the selected composition for the proposed heat-resistant reinforced concrete slab for brick kilns should also be used to cover the walls of heating aggregates.

4 Conclusions

As a result of the tests, the following conclusions were drawn from the samples:

1. the study's results determined that the total porosity of the heat-resistant structure can be obtained in the range of 20-30%.
2. Based on the comparison of the relative and relative porosity volumes and based on the theory of thermal retention of pores, it was determined that the second and third components could be obtained as heat-resistant reinforced concrete structures.
3. The highest rate of hazardous porosity was observed and determined in the third component.
4. Regarding the contribution of safe pores, the best content was found to be the second.
5. As a final general recommendation, it was determined that the most suitable composition for use in heat-resistant structures is the second composition.

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