

# Investigation of physical and mechanical properties of non-autoclaved aerated concrete from prescription and technological factors

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**Abstract.** With the development of science and technology in the field of building materials science, with the advent of new chemical modifiers and mineral fillers, new composite building materials (KSM) will be obtained. The development of the theory of composite materials makes it possible to obtain building materials with predictable physical, mechanical, and technological properties that meet specific requirements and improve the technology while reducing the energy consumption of the production of products.

## 1 Introduction

The polystructural theory of composite building materials considers multicomponent systems whose structure has clear phase boundaries. From the point of view of the polystructural theory, considering a multicomponent system consisting of various structural levels, namely micro- meso-macro, allowed us to formulate the methodological concept "structure within structure" fundamental to the polystructural theory, including the signs of the structure of each level and the relationship between them.

This theory has become the basis of our research methodology in the field of cellular concrete, which in turn can be represented by the structure of the pore space and the structure of the interstitial partitions. Obtaining a high-quality cellular structure depends on the pores of the correct spherical shape, evenly distributed in the concrete mass. The quality of the cellular structure depends on the kinetics of gas release and the plastic-viscous characteristics of the expanded cellular concrete mass. To regulate the processes of swelling of the aerated concrete mass, which should increase slowly at the beginning of the gas release process and quickly at the end, various technological and prescription techniques are used, such as the introduction of superplasticizers, mineral fillers with high SiO<sub>2</sub> content, regulation of W/S and the temperature of the mixing water.

This article examines studies on the structure formation of a multicomponent cement system for non-autoclaved aerated concrete using various chemical additives of water-reducing action and active mineral fillers, such as fly ash and silica [1-6, 8].

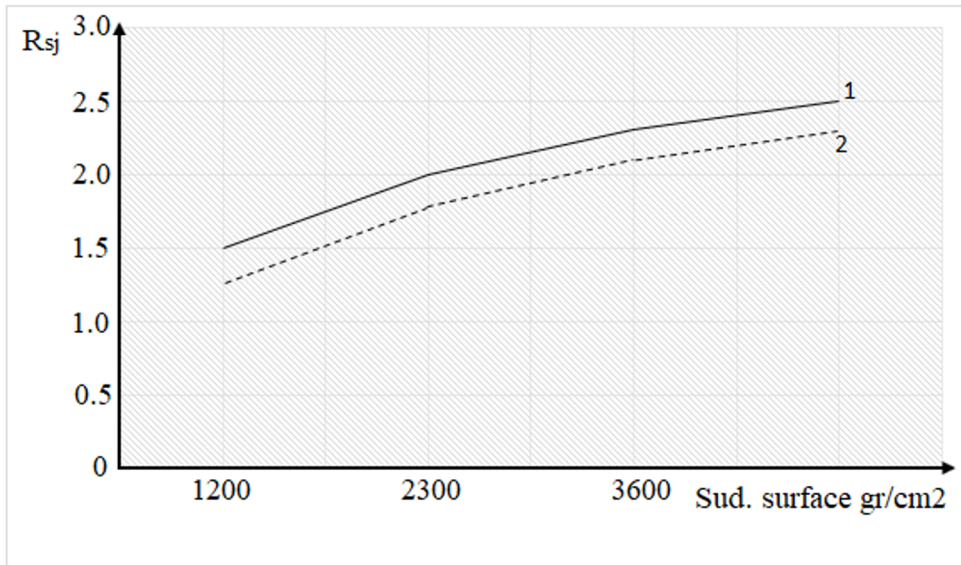
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## 2 Results

The increase in the strength of binders when micro-fillers are introduced into their composition, in addition to hydraulic activity, is also explained by the formation of crystallization centers in the contact zone of cement by the smallest grains of the micro-filler.

Graph 1 shows the results of a study of the effect of the specific surface of the ground sands of the Kuylyuksky and Chinazsky quarries on the strength of non-autoclaved aerated concrete.

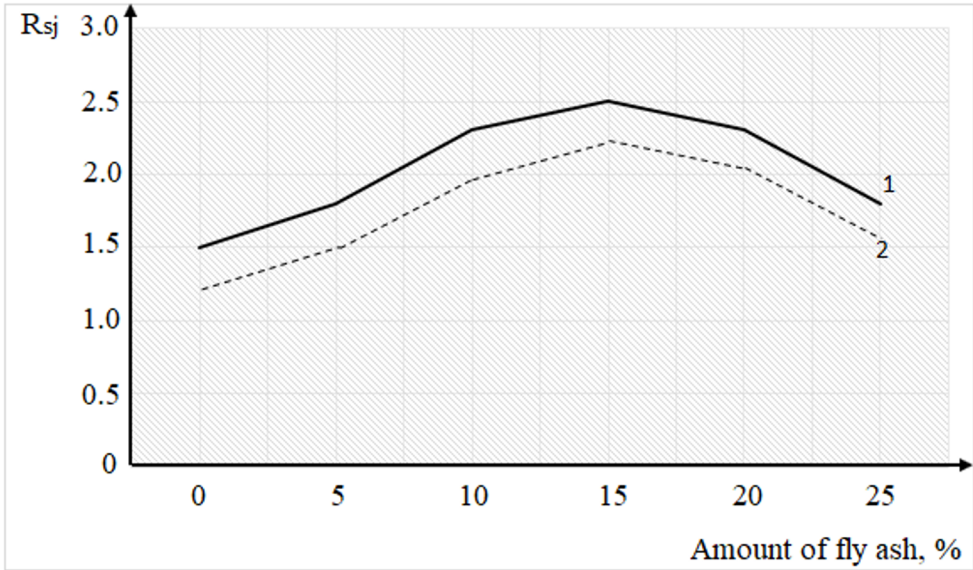


**Fig. 1.** Influence of strength of non-autoclaved aerated concrete on the specific surface of river sands crushed in a ball mill: 1 is Kuylyuksky; 2 is Chinazsky quarries.

Based on the analysis of the obtained dependences, the optimal specific surface area of the two types of sands is  $Sud = 2700 \text{ cm}^2 / \text{g}$ , a further increase in the specific surface area is considered inappropriate.

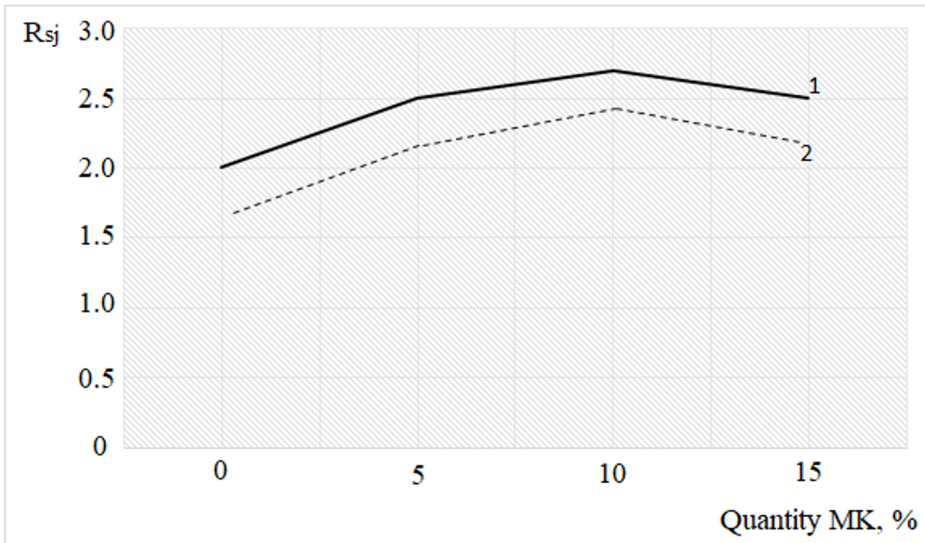
The slight difference in the results obtained is explained by the  $\text{SiO}_2$  content in both samples is almost the same and amounts to 30 and 37%, respectively.

At the next research stage, Fig. 2, we studied the effect of the active mineral fly ash filler of the Novo-Angren thermal power plant with a specific surface area of  $4800 \text{ cm}^2/\text{g}$  and a content of 47% active  $\text{SiO}_2$ .



**Fig. 2.** Influence of strength of non-autoclaved aerated concrete on content of fly ash with specific surface area of  $4800 \text{ cm}^2 / \text{g}$ : 1 is Kuylyuksky; 2 is Chinazsky quarries.

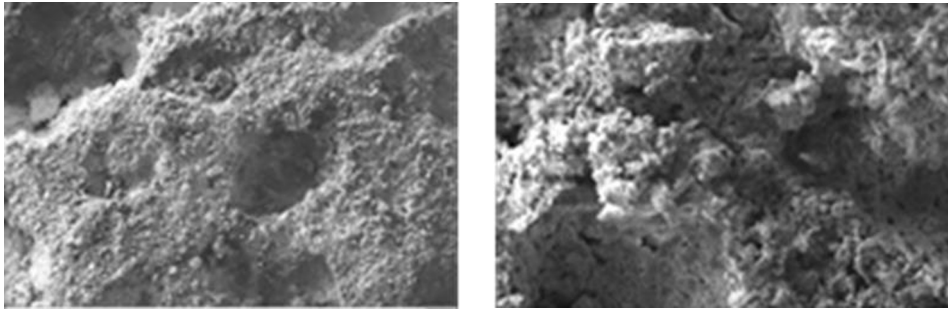
As can be seen in Figure 2, the strength of non-autoclaved aerated concrete increases to 15%, then apparently, due to an increase in the  $V / T$  ratio, the strength begins to decrease. Investigating the activity of fillers by the content of active  $\text{SiO}_2$ , microsilica is in the first place. In this regard, we decided to study its effect on the strength properties of non-autoclaved aerated concrete Fig. 3.



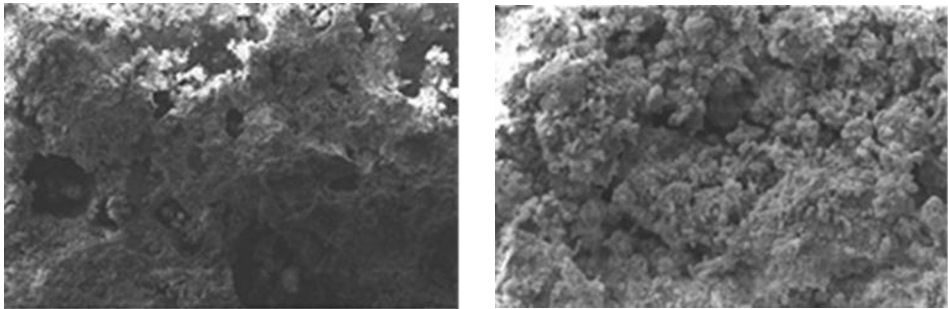
**Fig. 3.** Influence of strength of non-autoclaved aerated concrete from silica with specific surface area of  $5300 \text{ cm}^2 / \text{g}$ : 1 is Kuylyuksky; 2 is Chinazsky quarries.

The data obtained are well explained by microphotographs of an additive-free cement stone filled with fly ash and silica.

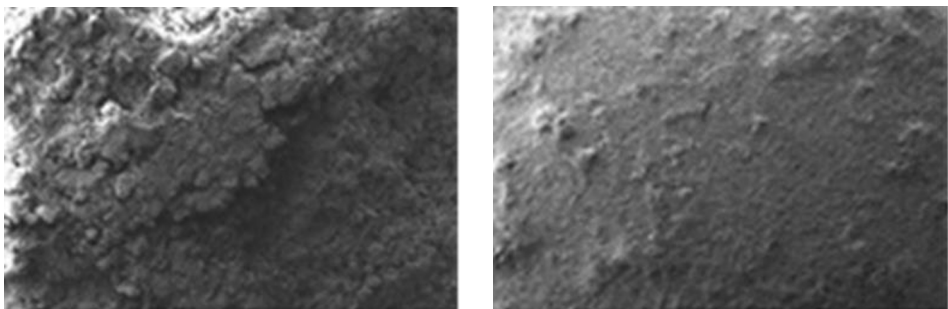
Micrographs of the fracture surface of the non-additive cement stone are shown in Fig. 4. As can be seen from Fig. 4; the additive-free cement stone consists of calcium hydrosilicates, sulfohydroaluminates and calcium hydrosilicates. There are neoplasms in the pores, but no complete overgrowth of the pores is observed.



**Fig. 4.** Micrographs of fracture surface of non-additive cement stone obtained at age of 28 days



**Fig. 5.** Micrographs of fracture surface of cement stone with fly ash + sp obtained at age of 28 days



**Fig. 6.** Micrographs of fracture surface of composite (MK+ fly ash + SP) cement stone obtained at age of 28 days

Figure 4-6 shows that in the samples of the composite binder at the age of 28 days with the addition of MK, an increased homogeneity of the monolith with a pronounced dispersed phase is observed. The next feature is the high density of the cement stone structure with no visible defects. [7, 9-12]

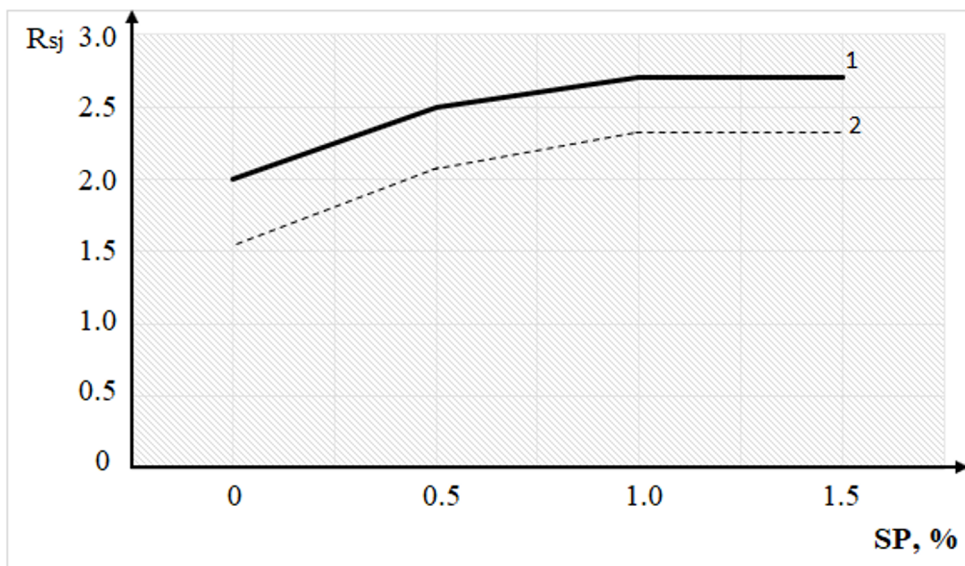
During structure formation, an increasing ability to the sealing properties of finely

dispersed silica is seen. In Fig. 2-3, the edges consisting of the phases of neoplasms clearly appear along the contact zone. The pore structure of cement stone with a predominance of micropores.

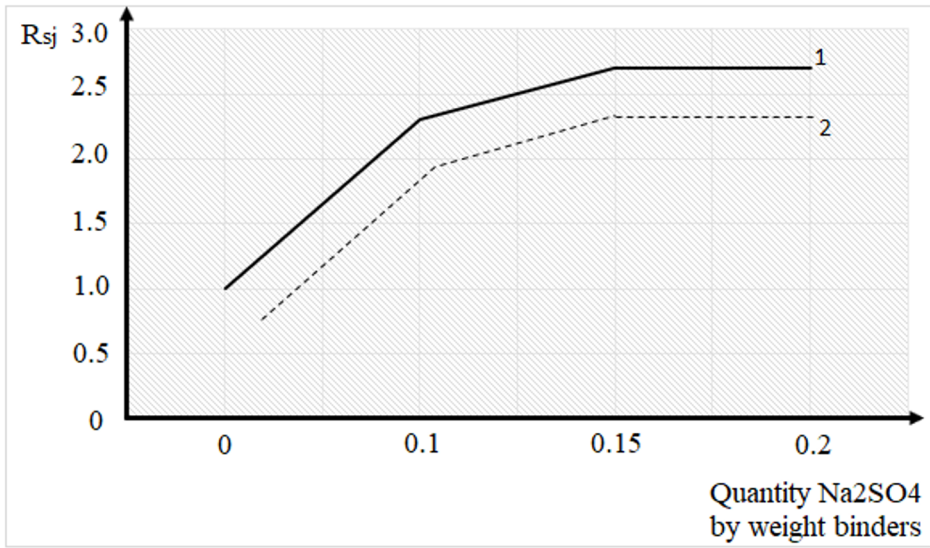
The introduction of a complex additive fly ash+MK+Polyplast undoubtedly contributes its peculiarity to the process of structure formation of cement stone.

Based on the above-mentioned features of structure formation, due to the mechanism of action of the polyplast additive in combination with the addition of MK + fly ash, the strength of the cement stone increases due to the pozzolan-active effect of the hardening system.

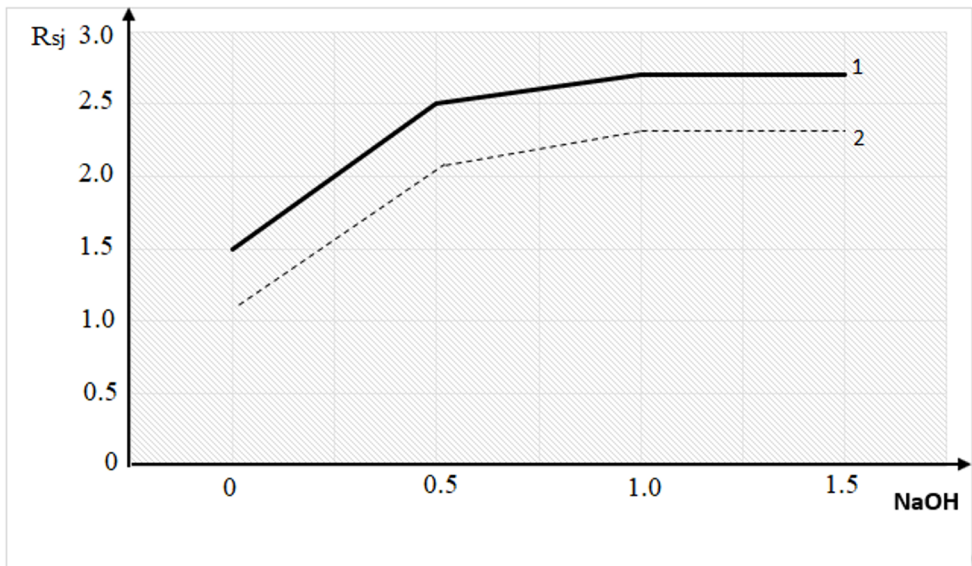
At the stage of forming the structure of the composite binder, technological factors play a significant role in the strength of non-autoclaved aerated concrete. Fig. 7-10 shows the dependences of the influence of the joint venture affecting the water-reducing properties of the cement composition, the content of sodium sulfate affecting the period of structure formation of the aerated concrete mixture, the amount of alkali and the amount of aluminum powder affecting the processes of gas formation.



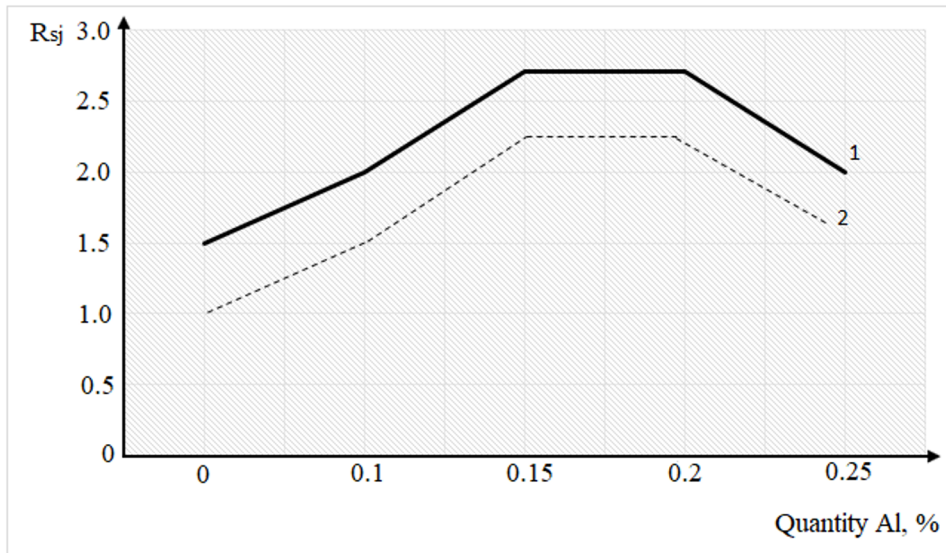
**Fig. 7.** Influence of strength of non-autoclaved aerated concrete on content of joint venture: 1 is Kuylyuksky; 2 is Chinazsky quarries.



**Fig. 8.** Influence of strength of non-autoclaved aerated concrete on content of sodium sulfate: 1 is Kuylyuksky; 2 is Chinazsky quarries.



**Fig. 9.** Influence of strength of non-autoclaved aerated concrete from alkali: 1 is Kuylyuksky; 2 is chinazsky quarries.



**Fig. 10.** Influence of strength of non-autoclaved aerated concrete from aluminum powder: 1 is Kuylyuksky; 2 is Chinazsky quarries

## 4 Conclusions

Non-autoclave aerated concrete of the D 600 grade with increased strength properties was obtained due to the introduction of actin mineral fillers with a high SiO<sub>2</sub> content and an optimally selected composition of the composite binder. It was found that the formation of low-base calcium hydrosilicates of the C-S-H(I) type during the interaction of MK and fly ash with calcium hydroxide is visible at all hardening periods. The degree of influence of MC on the change in the phase composition of hydrates and the kinetics of structure formation correlates with the hydraulic activity and dispersion of neoplasms and also agrees with the values with an increase in the strength of cement stone.

## References

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