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Optimal concentration of post-alcohol bard and microsilica in cement-sand mixtures determination

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ABSTRACT

The article presents part of the results of the study of the components of foam concrete made by the two-stage foam injection method, in particular, the influence of microsilica and post-alcohol bard on the setting time and strength of cement. The paper shows the methodology for determining the compressive and flexural strength, selection of the composition of components, analysis, and evaluation of setting times, and strength characteristics of the compared samples. During the study, laboratory experiments were performed to better understand how these additives affect the behavior of cement mixtures. The studies carried out allow us to determine the influence of the modified additive components on the properties of foamed concrete during the production process. The setting time analysis presented in the study revealed that increasing the concentration of the additive significantly reduced the setting time performance of cement. With increasing the content of microsilica and post-alcohol bard at 10% and 30% of the cement weight, the setting initiation and completion times are significantly reduced. To evaluate the change in strength, samples were made and tested in compression and flexure at ages of 3, 7, 14, 21, and 28 days of normal moisture curing. According to the results, it was found that the additive, by accelerating the curing, promotes strength improvement both at an early age and at the design age (28 days). The experimental results showed that the flexural and compressive strength of the material increased as the concentration of the additive increased. The maximum increase in flexural and compressive strength was recorded at additive concentrations of 10% and 30%. This indicates the important role of additives in the strengthening of materials and their potential application in construction. The additive showed an optimum positive effect, therefore, the use of this percentage of additive is the most effective for increasing the compressive and flexural strength of concrete.

Keywords: foam concrete, modified additive, microsilica, post-alcohol bard, setting time, strength characteristics.

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Introduction

The production of construction materials plays a key role in the economy and provides raw materials for the construction industry, which has a high contribution to the total output. In this area, not only the creation of new building materials is actively researched, but also the search for ways to improve the environmental aspects of production, including the utilization of man-made waste and its recycling in building composites.

In modern construction, ensuring the high strength and durability of materials plays a fundamental role. In this context, cement and its compositions, such as foamed concrete, represent some of the most important building materials that are widely used in various industries. Foamed concrete, due to its lightness, thermal insulation properties and resistance to collapse, is a popular choice for creating a variety of building structures and products. However, its properties and characteristics can be significantly improved with the use of various additives [[1], [2], [3], [4], [5]].

Cellular materials, including foamed concrete, occupy a special place in modern construction due to their outstanding thermal insulation properties and suitability for low-lying buildings. This is particularly important from an environmental and resource efficiency perspective, as improved thermal insulation helps to reduce the consumption of fuel, energy, and natural materials. However, the foam concrete production process includes a worrying problem - the short-lived nature of the foam. This means that there is a need to develop ways to extend the life of foam concrete, and one such method is foam stabilization. There are many methods of foam stabilization, but one of the most promising approaches is the use of special additives. These additives help to increase the stability of the foam and ensure a longer service life [[6], [7], [8]].

It is important to note that the variety of such stabilizing additives and their application methods allow finding the best solutions to strengthen the foam, which ultimately improves the quality and reliability of foam concrete structures. The rapid development of this area of research provides the construction industry with innovative solutions that help to reduce environmental impact and improve energy efficiency [[9], [10], [11], [12], [13]].

An important task is the research and optimization of compositions of construction composites using secondary materials, such as technogenic wastes and products of their processing. This makes it possible to create more environmentally sustainable and efficient building materials, contributing to resource-saving and reducing the impact on nature. This approach promotes the development of innovative solutions in the construction industry and strengthens its position in the field of sustainable development. Research into construction composites and their formulations continues to evolve, introducing new technologies and approaches to improve the quality and environmental performance of building materials. This ensures not only economic growth but also contributes to the environmental sustainability of the industry [[14], [15], [16]].

In recent years, many researchers have obtained and published data showing that the combination of fine aggregate and superplasticizer provides a synergistic effect in concrete, allowing to obtain the best strength results [17]. Today, both builders and researchers are very interested in the use of ferroalloys production waste - microsilica in concrete. The positive effect of microsilica as a fine active mineral additive and the necessity of its use in concrete in combination with superplasticizer was described in publications about 40 years ago [[18], [19], [20]].

The main objective of this work is to methodically analyze the effect of microsilica and post-alcohol bard on the setting time and strength of foam concrete. For this purpose, a study was carried out, which included measuring the compressive and flexural strength of foam concrete samples with different concentrations of these additives. The results of these studies are presented in tables and graphs, which allow us to compare the strength characteristics of different samples and analyze their dependence on the concentration of additives.

Experimental technique

Cement. Cement provided by Kokshe Cement LLP - CEM I 42.5 N was used for this study. This cement, known for its high quality characteristic, represents the main component in the process of foamed concrete production. It was used as a base material for all the compositions subjected to the study.

Components of the modified additive:

Microsilica: To investigate the effect of microsilica on the properties of foamed concrete, amounts of 10%, 20%, and 30% were used. These different percentages of microsilica allowed the evaluation of its effect on the performance of foamed concrete.

Post-alcohol bard: To study the effect of post-alcohol bard on the properties of foamed concrete, quantities of 2.5%, 5.0%, 7.5%, and 10% were used. The variety of bard content allowed the evaluation of different levels of effect on the final material characteristics.

As part of the modified additive study, component tests are performed in two phases, which represent key steps in determining effectiveness and functionality.

In the first stage, the setting time of cement dough using the modified additive is evaluated. Setting time reflects the speed and nature of the cement mixture curing process. It is an important parameter that determines the possibility of concrete application in specific conditions and production processes. The study of the setting time of cement batter in the first stage is an important step in evaluating the effectiveness and functionality of the modified additive. The obtained results will serve as a basis for further optimization of the additive composition and ensuring the required time characteristics in the production of foam concrete.

The second stage involves the evaluation of the strength characteristics of concrete containing the modified additive. The tests are aimed at determining the mechanical properties of concrete such as compressive and flexural strength. These parameters are key to assessing the quality and reliability of concrete structures. A comprehensive study of the components of the modified additive on cement setting time and strength properties provides a complete picture of the effect of the additive on foam concrete mixtures. These steps provide the necessary information to optimize the additive composition, reference curing processes and achieve the required mechanical properties of concrete.

The research involves the following sequence of activities (Figure 1):

1. Sampling of different types of samples with different percentages.

2. Preparation of samples for testing.

3. Determination of setting time using the methodology provided in GOST 310.3-76.

4. Preparation of sample beams of standard size (40x40x160 mm) in an amount of not less than 6 pieces for each of the compared types.

5. Tests on the strength of sample beams according to the methodology established in GOST 10180, including tests in bending and compression, in order to assess the mechanical properties of the material.

6. Analysis of test results.

A comparison of the results of laboratory tests was carried out for the compositions:

Type 1: Reference sample without additive, standard composition according to GOST 30744-2001;

Type 2: Sample with additive (10% of microsilica);

Type 3: Sample with additive (20% microsilica);

Type 4: Sample with additive (30% microsilica);

Type 5: Sample with additive (2.5% post-alcohol bard);

Type 6: Sample with additive (5% post-alcohol bard);

Type 7: Sample with additive (7.5% post-alcohol bard);

Type 8: Sample with additive (10% post-alcohol bard).

Phase 1: Evaluation of the setting time of cement dough

In the first phase of the study, the components of the modified additive including post-alcohol bard and microsilica in different percentages were tested in order to evaluate and establish the setting time of the cement dough. The tests were carried out by preparing cement tests with different proportions of post-alcohol bard and microsilica as part of the modified additive. Then, the time required for the initiation and completion of the setting process of the cement mixture was measured. For this purpose, standardized methods and equipment were used to ensure the accuracy and reliability of the data obtained.

The aim of this study is to carry out a comparative evaluation of the effect of the modified additive on the setting time of cement dough.

The results of the tests made it possible to determine the effect of different proportions of post-alcohol bard and microsilica on the setting time of cement dough. The optimum ratios of the additive components were identified which provided the desired setting rate of the cement mixture within the required parameters for the production of foamed concrete. Table 1 with the technological composition of samples for the production of foam concrete with different proportions of components (cement, water, microsilica, and post-alcohol bard) is given below.

Phase 2: Evaluation of strength properties

In the second phase of the study, the components of the modified additive including post-alcohol bard and microsilica in different percentages were tested to evaluate their effect on the flexural and compressive strength properties of the cement dough. The data obtained were analyzed and comparatively evaluated to determine the effect of different percentages of additive components on the strength characteristics of cement dough.

Table 1 – Technological composition of samples

Sample	Cement, g	Water, g	Microsilica, g	Post-alcohol bard, g
Type 1	350	98.0	-	-
Type 2	245	98.0	35 (10 %)	-
Type 3	280	98.0	70 (20 %)	-
Type 4	315	98.0	105 (30 %)	-
Type 5	350	88.82	-	8.75 (2.5 %)
Type 6	350	79.63	-	17.50 (5.0 %)
Type 7	350	70.44	-	26.25 (7.5 %)
Type 8	350	61.25	-	35.0 (10.0 %)

Table 2 – Technological composition of samples

Sample	Cement, g	Sand, g	Water, g	Microsilica, g	Post-alcohol bard, g
Type 1	450	1350	180.0	-	-
Type 2	324	1350	180.0	45 (10 %)	-
Type 3	360	1350	180.0	90 (20 %)	-
Type 4	405	1350	180.0	126 (30 %)	-
Type 5	450	1350	88.82	-	168.18 (2.5 %)
Type 6	450	1350	79.63	-	156.37 (5.0 %)
Type 7	450	1350	70.44	-	144.56 (7.5 %)
Type 8	450	1350	61.25	-	132.75 (10.0 %)

a) b) c)

Figure 1 - Testing of samples: a) setting time of cement dough, Vika device; b) preparation of standard-sized beam samples; c) strength testing of samples, Press Automatic Pilot

Evaluation of the strength characteristics of cement dough in bending and compression allows us to optimize the composition of the additive and achieve the required strength for the production of foam concrete. This contributes to improving the quality and reliability of structures and ensures compliance with the requirements of building codes and standards. Table 2 shows the technological compositions of the compared types of samples for strength characteristics.

Results and Discussion

Setting times. Important data on the setting times of different cement compositions have been obtained in the course of the studies carried out. Setting time, i.e. the time required to initiate and complete the setting process of cement mixture, is an important parameter affecting the nature and applicability of foam concrete structures.

This study presents an analysis of the results of setting time measurements of different compositions including different percentages of microsilica (types 2, 3, and 4) and post-alcohol bard (types 5, 6, 7, and 8). These data are important to understand the effect of this additive on the rate and character of the setting of the cement mixture. Two main peaks can be identified in the setting time diagram (Figure 2). The first peak corresponds to the Start of the setting and the second peak corresponds to the end of the setting. The placement of the types of the compared compositions on the diagram is in ascending order, counting from bottom to top. Here the red color indicates Type 1, which represents the reference sample without additive and serves as a base for comparison. The analysis of the setting time diagram will allow a more detailed study of the effect of the addition of components on the rate and duration of the setting of foam concrete in comparison with the reference sample.

Figure 2 visually demonstrates a comparison of setting times between different types of compositions. It contains information on the Start and end of setting time for each type:

Type 1: Reference sample without additive, with the following values:

- Start of setting time: 2 hours 50 minutes.
- End of setting time: 6 hours 33 minutes.

Type 2 (10% microsilica), which shows shorter setting times compared to Type 1:

- Start of setting time: 1 hour 45 minutes.
- End of setting time: 5 hours 05 minutes.

Type 3 (20% microsilica), which also has shorter setting times:

- Start of setting time: 1 hour 20 minutes.
- End of setting time: 4 hours 30 minutes.

Type 4 (30% microsilica), which exhibits even shorter setting times:

- Start of setting time: 1 hour 15 minutes.
- End of setting time: 4 hours 05 minutes.

Analyzing the data from Figure 2, the following observations can be made:

1. The addition of microsilica significantly accelerates the setting process of the cement mixture. The setting time decreases with increasing microsilica content.
2. The initial setting time decreases more markedly than the setting completion time, indicating an earlier onset of the curing process.
3. These results have important practical implications, as they allow more precise reference and optimization of processes in production using microsilica as an additive.

These data allow a comparison of the setting times of compositions with different additive proportions. They indicate an acceleration of the setting process with the addition of microsilica in proportions ranging from 10% to 30% of the cement weight. As the proportion of additives increases, a decrease in the time required to initiate and complete setting is observed. This information is an important aspect in the design and reference of the foam concrete production process. It allows a more accurate determination of the optimum proportions of components to achieve the required setting time according to specific needs and conditions.

This study presents results that allow analyzing the setting times of different compositions with different proportions of additive, in this case microsilica. The addition of microsilica has a noticeable effect on the setting time of cement mixtures. As the percentage of microsilica increases, the time required to initiate and complete setting decreases. The initial setting time decreases more significantly than the setting completion time, indicating an earlier start of the curing process when microsilica is present in the formulation. This information is of great practical importance in the design and reference of the foam concrete production process. It makes it possible to accurately determine the optimum proportions of components to achieve the required setting time for specific needs and conditions. This helps to improve reference over the production of foamed concrete structures and to ensure that they meet the requirements and quality.

Figure 3 visually demonstrates a comparison of setting times between different types of compositions. It contains information on the Start and end of setting time for each type:

Type 1: Reference sample without additive, with the following values:

- Start of setting time: 2 hours 50 minutes.
- End of setting time: 6 hours 33 minutes.

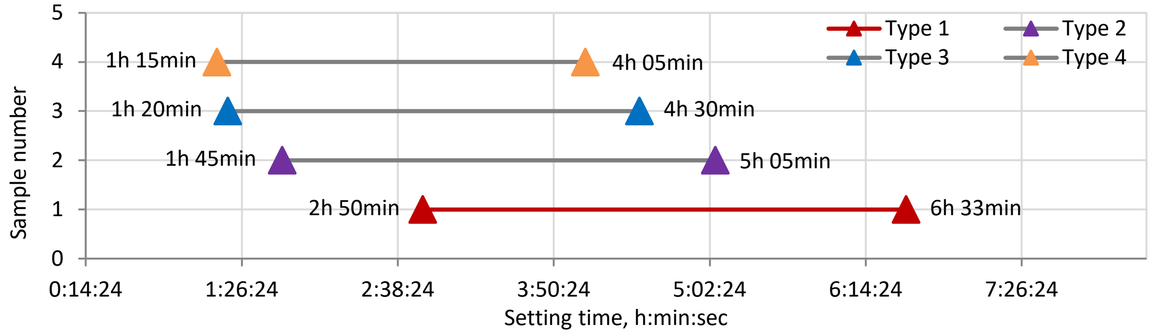

Figure 2 - Effect of additive (microsilica) on setting time

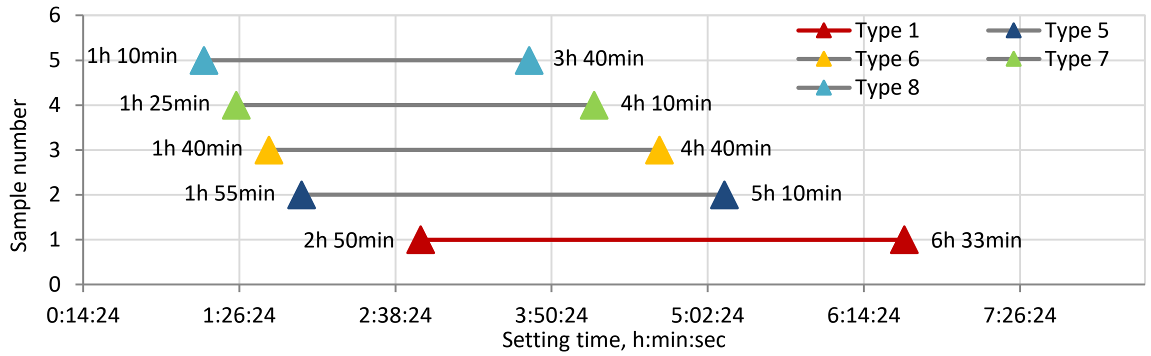

Figure 3 - Effect of additive (post-alcohol bard) on setting time

Type 5 (2.5% post-alcohol bard), which shows shorter setting times compared to Type 1:

- Start of setting time: 1 hour 55 minutes.
- End of setting time: 5 hours 10 minutes.

Type 6 (5.0% post-alcohol bard), which also has shorter setting times:

- Start of setting time: 1 hour 40 minutes.
- End of setting time: 4 hours 40 minutes.

Type 7 (7.5% post-alcohol bard), which exhibits even shorter setting times:

- Start of setting time: 1 hour 25 minutes.
- End of setting time: 4 hours 10 minutes.

Type 8 (10% post-alcohol bard), which also exhibits shorter setting times:

- Start of setting time: 1 hour 10 minutes.
- End of setting time: 3 hours 40 minutes.

Analyzing the data from Figure 3, the following observations can be made:

1. The addition of post-alcohol bard has a significant effect on the setting time of cement mixtures. As the percentage of bard content increases (from 2.5% to 10% of cement weight), the time required to initiate and complete the setting decreases.

2. The initial setting time decreases more significantly than the setting completion time, indicating an earlier onset of the curing process when post-alcohol bard is present in the mix.

3. The obtained data have an important practical significance for designing and reference foam concrete production. They make it possible to determine the optimum proportions of components to achieve the required setting time corresponding to specific needs and conditions.

These data allow the setting times of different compositions with different proportions of additives to be compared. It can be seen that setting times decrease with the addition of increasing amounts of additives. The lower setting time values for sample types 5 through 8, where 2.5% to 10% additive is added, indicate a faster setting process compared to the reference sample type 1. These results help to understand how additives affect the setting time characteristics of foam concrete and can be used to optimize the production process and quality reference. The comparative results of the samples are presented in Table 3.

Table 3 - Comparative results of samples

№	Type	Additive, %	Start of setting time, h-min	End of setting time, h-min
1	Type 1 reference sample	-	2-50	6-33
2	Type 2	microsilica-10	1-45	5-05
3	Type 3	microsilica -20	1-20	4-30
4	Type 4	microsilica -30	1-15	4-05
5	Type 5	post-alcohol bard-2.5	1-55	5-10
6	Type 6	post-alcohol bard-5.0	1-40	4-40
7	Type 7	post-alcohol bard-7.5	1-25	4-10
8	Type 8	post-alcohol bard-10.0	1-10	3-40

Comparative analysis of setting time yields the following key observations:

1. Effect of microsilica addition (Type 2, Type 3, Type 4): It can be seen that as the percentage of microsilica in the composition increases (Type 2 to Type 4), the onset of setting is accelerated and the setting time (second peak) decreases. This indicates that microsilica significantly accelerates the setting process of cement.

2. Effect of post-alcohol bard addition (Type 5, Type 6, Type 7, Type 8): A similar effect is observed with the addition of post-alcohol bard. The higher the percentage of bard (Type 5 to Type 8), the faster the setting starts and the shorter the setting time. This also indicates the ability of post-alcohol bard to accelerate the cement hardening process.

As can be seen from the results, the maximum effect of the additive in the mortar-cement mixture is achieved at a concentration of 10 and 30% relative to the weight of cement at w/c ratio=0.28. The setting time of mortar mixtures significantly depends on the concentration of the additive in them. The additive allows to reduce the setting time by 30% compared to the reference sample. At the same time, the interval between the Start and the end of the setting time is reduced by 40%. Consequently, this additive can be used as a setting time referenceler. Compositions of Types 2-4, containing microsilica in different proportions, are positioned above the reference sample (Type 1), which may indicate faster setting in the presence of this additive. Samples of Types 5-8, which include post-alcohol bard, are even higher and may indicate an even more accelerated setting process.

Strength characteristics. This study examined the strength characteristics of materials, including compressive and flexural strength. These parameters are key indicators that determine how reliably and durably materials can perform their functions. The strength properties were determined on samples made from a cement-sand mixture consisting of cement, sand, additive (for samples of types 2, 3, 4, 5, 6, 7, and 8), and water, curing under normal conditions. The analysis of the results allows us to evaluate how the additive components affect the strength properties of the material. The data obtained represent comparative results between different types of compositions and different additive proportions. The strength values of the sample are shown (at 7, 14, and 28 days) in Figures 4-7.

The results of the bending and compressive strength studies of the sample carried out at the age of 28 days allow us to make a comparative analysis of the different types of compositions and their influence on the strength characteristics of the material.

Type 1, which is a reference sample without additive, has a flexural strength of R = 55.29 kgf/cm² and a compressive strength of R = 420.78 kgf/cm². This sample served as a benchmark for comparison with other types of compositions. The increase in strength was 0%.

Type 2 containing 10% additive shows a significant increase in flexural and compressive strength of 24.63% and 21.39%, respectively, compared to the reference sample. The test results of Type 2 are R = 65.01 kgf/cm² and R = 510.81 kgf/cm².

Type 3 containing 20% additive shows an increase in flexural and compressive strength of 30.49% and 27.01% respectively compared to the reference sample. The test results of type 3 are R= 69.15 kgf/cm² and R = 534.45 kgf/cm².

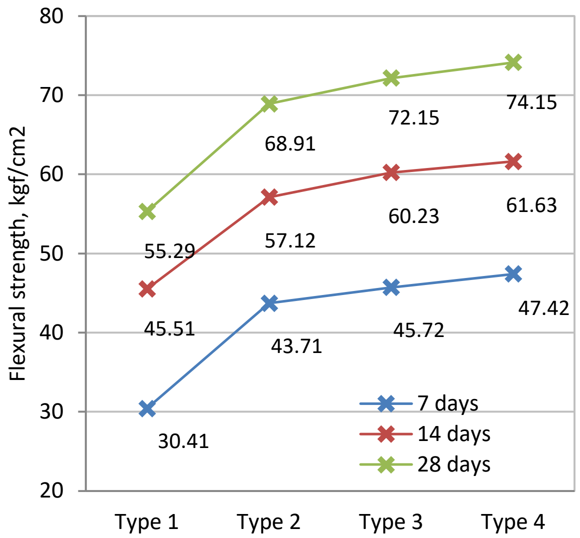

Figure 4 - Flexural strength (microsilica)

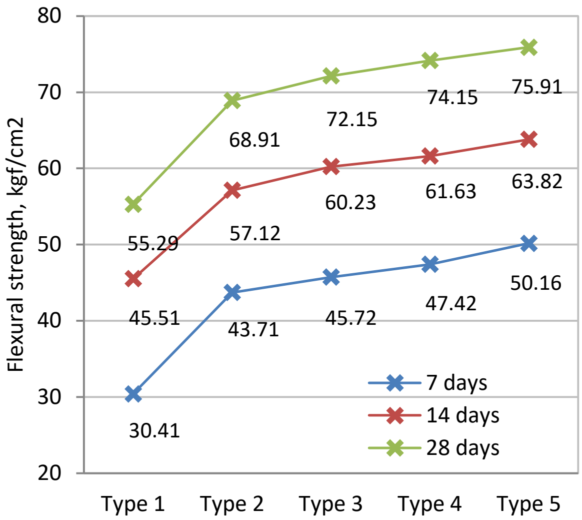

Figure 5 - Flexural strength (post-alcohol bard)

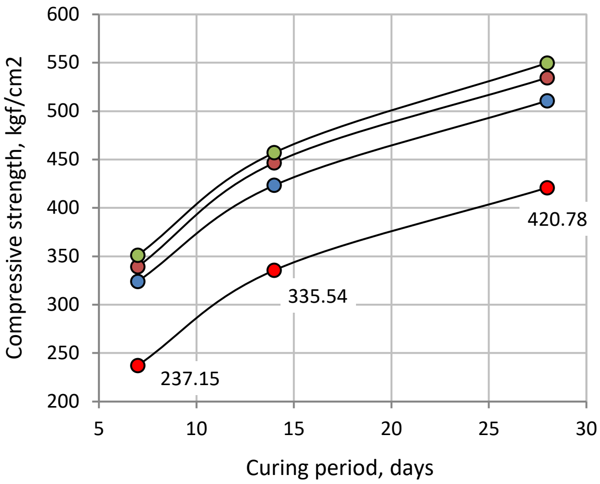

Figure 6 - Compressive strength (microsilica)

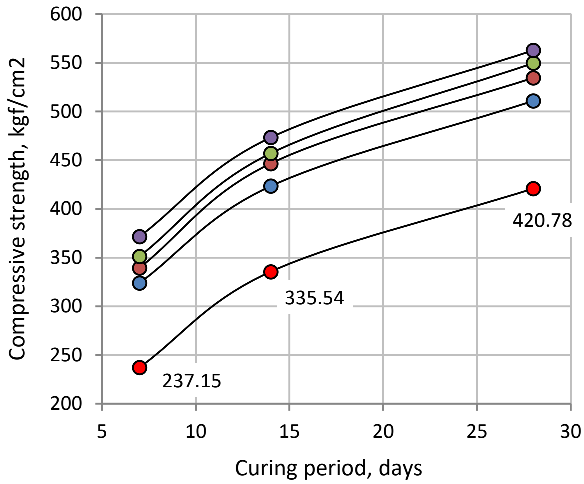

Figure 7 - Compressive strength (post-alcohol bard)

Type 4, maximum increase in flexural and compressive strength by 37.29 and 33.79% was recorded in the sample with 30% additive compared to the reference sample. The test results of type 4 are R= 71.15 kgf/cm² and R = 549.85 kgf/cm².

Type 5, with the addition of 2.5% additive increases the flexural strength by 34.11 and 30.67% compared to the reference sample. Test results for type 5: R= 68.91 kgf/cm² and R=510.81 kgf/cm².

Type 6, when 5.0% additive is added, the flexural strength increases by 34.11 and 30.67% compared to the reference sample. The test results of type 4 are R= 72.15 kgf/cm² and R=534.45 kgf/cm².

Type 7, when 7.5% additive is added, the flexural strength increases by 34.11 and 30.67% compared to the reference sample. The test results of type 4 are R= 74.15 kgf/cm² and R=549.85 kgf/cm².

Type 8. The maximum increase in flexural and compressive strength by 37.29 and 33.79% was recorded for the sample with 10% additive. The test results for type 5 are R= 75.90 kgf/cm² and R=562.98 kgf/cm².

From the analysis of the results, it can be seen that the additive has a significant effect on the strength characteristics of the material. Increasing the concentration of additives leads to a stronger increase in flexural and compressive strength. An important aspect of the curing process is the effect of the additive, which promotes the formation of a strong framework in the material structure. This framework further strengthens the compositions and results in maximizing the strength

Table 4 - Comparative results of samples

Type	Flexural strength, kgf/cm^2			Compressive strength, kgf/cm^2		
	7 days	14 days	28 days	7 days	14 days	28 days
Type 1	30.41	45.51	55.29	237.15	335.54	420.78
Type 2	43.71	55.02	65.01	324.16	423.45	510.81
Type 3	45.72	57.23	69.15	339.35	446.59	534.45
Type 4	47.42	59.63	71.15	351.27	457.19	549.85
Type 5	43.71	57.12	68.91	324.16	423.45	510.81
Type 6	45.72	60.23	72.15	339.35	446.59	534.45
Type 7	47.42	61.63	74.15	351.27	457.19	549.85
Type 8	50.16	63.82	75.90	371.76	473.51	562.98

performance. For a more detailed analysis of the effect of different compositions on strength properties, the results of the studies are shown in Table 4.

The comparative analysis of the test results of the samples allows us to conclude about the influence of the additive concentration on the bending and compressive strength. It was found that increasing the concentration of the additive significantly increases the strength of the material both in bending and in compression. This confirms the important role of additives in strengthening the material. The amount of the introduced additive was set based on the greatest effect of accelerating curing, as well as to obtain the maximum strength gain compared to the analog without additives. The maximum strength gain is achieved at concentrations of 10% and 30% relative to the weight of cement. These formulations have strengths significantly higher than the reference sample (Type 1) and can be considered as optimum for achieving maximum strength. Flexural and compressive strength values show approximately the same increase for most types of compositions, indicating the balanced nature of the effect of the additive. The addition of post-alcohol bard at concentrations of 2.5%, 5%, 7.5%, and 10% also increases strength, although to varying degrees. This provides a choice in developing compositions according to specific needs. Compared to the reference sample (Type 1), all types of compositions show a significant improvement in strength performance.

Conclusion

The results of the conducted research are important to consider in the context of actual problems related to the production of foam concrete and the improvement of its characteristics. The conducted experiments allowed us to reveal a significant influence of additives, such as microsilica and post-alcohol bard, on the setting time and strength characteristics of foam concrete. The results allowed us to draw the following conclusions:

1. The greatest effect was observed when microsilica was used at concentrations of 10% and 30% of cement weight. This resulted in a marked increase in flexural and compressive strengths, as well as a reduction in setting time. Hence, microsilica can be considered as an effective agent for improving the quality of foamed concrete and regulating the setting time.

2. Post-alcohol bard has also shown to be an effective additive for increasing strength and shortening setting time. It should be noted, however, that different additive concentrations can lead to different results, and not always more additive means better performance.

In summary, these results of the study can be used to optimize the production process of foamed concrete, increase its strength and stability, and reduce setting time, which contributes to better performance and more efficient use in construction.

Conflict of interest. The corresponding author declares that there is no conflict of interest.

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ТҮЙІНДЕМЕ

Мақалада екі сатылы көбікті енгізу әдісімен дайындалған көбік бетон компоненттерін зерттеу нәтижелерінің бір бөлігі, атап айтқанда, микрокремнезем мен спирттін кейінгі барданың цементтің қатаю уақытына және беріктігіне әсері көрсетілген. Жұмыста қысу және иілу кезіндегі беріктікті анықтау әдістемесі, компоненттердің құрамын іріктеу, салыстырылатын үлгілердің қатаю уақыттарын және беріктік сипаттамаларын талдау және бағалау көрсетілген. Зерттеу барысында осы қоспалардың цемент қоспаларының әрекетіне қалай әсер ететінін тереңірек түсіну үшін зертханалық тәжірибелер жасалды. Жүргізілген зерттеулер модификацияланған қоспалар компоненттерінің көбікті бетондардың қасиеттеріне әсерін оларды өндіру процесінде анықтауға мүмкіндік береді. Зерттеуде ұсынылған қатаю уақыттарын талдау қоспаның концентрациясының ұлғаюы цементтің қатаюының уақытша көрсеткіштерін айтарлықтай қысқартатынын анықтады. Цемент салмағымен салыстырғанда микрокремнезем және спирттік кейінгі барда мөлшерлерінің 10% және 30% артылғанда, қатаюдың басталу және аяқталу уақыты айтарлықтай қысқарады. Беріктіктің өзгеруін бағалау үшін үлгілер дайындалып, 3, 7, 14, 21 және 28 күн мерзімде қалыпты ылғалдылықта қатайған бетон қысу және иілуге сыналды. Зерттеу нәтижелері бойынша қоспа қатайтуды жеделдете отырып ерте мерзімде де, есептелген (28 тәулік) мерзімде де беріктікті арттыруға көмектесетіні анықталды. Тәжірибе нәтижелері қоспаның концентрациясы жоғарылаған сайын материалдың иілу және қысу беріктігінің жоғарылайтынын көрсетті. Иілу және қысу беріктігінің максималды өсуі 10% және 30% қоспа қосу кезінде болды. Бұл материалдарды нығайтудағы қоспалардың маңызды рөлін және оларды құрылыста қолдану мүмкіндігін көрсетеді. Қоспа оңтайлы оң әсер етті, сондықтан қоспаның осы мөлшерін пайдалану бетонның қысу және иілу беріктігін арттыруда ең тиімді болып табылады.

Түйін сөздер: көбік бетон, модификацияланған қоспа, микрокремнезем, спирттен кейінгі барда, ұстасу мерзімдері, беріктік сипаттамалар.

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Определение оптимальной концентрации послеспиртовой барды и микрокремнезема в составе цементно-песчаной смеси

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АННОТАЦИЯ

В статье представлена часть результатов исследования компонентов пенобетона, изготовленного методом двухстадийного введения пены, в частности влияние микрокремнезема и послеспиртовой барды на сроки схватывания и прочность цемента. В работе показана методика определения прочности при сжатии и изгибе, подбор состава компонентов, анализ и оценка сроков схватывания и прочностных характеристик сравниваемых образцов. В ходе исследования были выполнены лабораторные эксперименты, чтобы более глубоко понять, как эти добавки влияют на поведение цементных смесей. Проведенные исследования позволяют определить влияние компонентов модифицированной добавки на свойства пенобетонов в процессе их производства. Анализ сроков схватывания, представленный в исследовании, выявил, что увеличение концентрации добавки значительно сокращает временные показатели схватывания цемента. С увеличением содержания микрокремнезема и послеспиртовой барды на 10% и 30% от массы цемента, время начала и завершения схватывания существенно сокращается. Для оценки изменения прочности были изготовлены образцы и испытаны на сжатие и изгиб в возрасте 3, 7, 14, 21 и 28 суток нормального влажностного твердения. По результатам исследований установлено, что добавка, ускоряя твердение, способствует повышению прочности, как в раннем возрасте, так и в расчетном возрасте (28 суток). Результаты эксперимента показали, что прочность материала при изгибе и сжатии увеличивается по мере увеличения концентрации добавки. Максимальное увеличение прочности при изгибе и сжатии зафиксировано при добавке в размере 10% и 30%. Это указывает на важную роль добавок в укреплении материалов и их потенциальное применение в строительстве. Добавка показала оптимальный положительный эффект, поэтому использование данного процентного содержания добавки является наиболее эффективным для повышения прочности бетона на сжатие и изгиб.

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Ключевые слова: пенобетон, модифицированная добавка, микрокремнезем, послеспиртовая барда, сроки схватывания, прочностные характеристики.

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References

[1] Svatovskaya LB, Sychova AM, Soloviova VYa, Maslennikova LL, Sychov MM. Obtaining Foam Concrete Applying Stabilized Foam. Indian Journal of Science and Technology. 2016; 9(42):104304. https://doi.org/10.17485/ijst/2016/v9i42/104304

[2] Rybakov V, Seliverstov A, Petrov D, Smirnov A, Volkova A. Strength characteristics of foam concrete samples with various additives. MATEC Web Conf. 2018, 245. https://doi.org/10.1051/matecconf/201824503015

[3] Falliano D, Domenico DD, Ricciardi G, and Gugliandolo E. Experimental investigation on the compressive strength of foamed concrete: effect of curing conditions, cement type, foaming agent and dry density. Construction and Building Materials. 2018; 165:735-749. https://doi.org/10.1016/j.conbuildmat.2017.12.241

[4] Uspanova AS, Khadzhiev MR, Ismailova ZH, Basnukaev ISh. Analysis of the effect of methods of introduction of organomineral additive into mortars on fine sands. Construction Materials and Products. 2021; 4(4):32-40. https://doi.org/10.34031/2618-7183-2021-4-4-32-40

[5] Marceau S, Lespinasse F, Bellanger J, Mallet C. Microstructure and mechanical properties of polymer-modified mortars, European Journal of Environmental and Civil Engineering. 2012; 16:571-581. https://doi.org/10.1080/19648189.2012.675148

[6] Qingyu C, Wei S, Liping G, Guorong Z. Polymer-modified concrete with improved flexural toughness and mechanism analysis, Journal of Wuhan University of Technology-Materials Science Edition. 2012; 27:597-601. https://10.1007/s11595-012-0512-5

[7] Tarakanov OV, Belyakova EA, Yurova VS. Complex organomineral additives with hardening accelerator. Solid State Phenomena. 2018; 284:929-935. https://10.4028/www.scientifi c.net/SSP.284.929

[8] Al-Khazraji AA. Use of plasticizers in cement concrete. Journal of Advanced Research in Dynamical and Control Systems. 2020; 12(3):599-607. https://10.5373/JARDCS/V12I3/20201229

[9] Garzón-Agudelo PA, Palacios-Alvarado W, Medina-Delgado B. Impact of plasticizers on the physical and structural properties of concrete used in constructions. Journal of Physics: Conference Series. 2021; 2046(1):012069. https://10.1088/1742-6596/2046/1/012069

[10] Rybakov V, Seliverstov A, Petrov D, Smirnov A, Volkova A. Strength characteristics of foam concrete samples with various additives. MATEC Web Conf. 2018, 245. https://doi.org/10.1051/matecconf/201824503015

[11] Gencel O, Nodehi M, Hekimoğlu G, Ustaoğlu A, Sarı A, Kaplan G, Bayraktar OY, Sutcu M, Ozbakkaloglu T. Foam Concrete Produced with Recycled Concrete Powder and Phase Change Materials. Sustainability. 2022; 14(12):7458. https://doi.org/10.3390/su14127458

[12] Fu Y, Wang X, Wang L, Li Y. Foam Concrete: A State-of-the-Art and State-of-the-Practice Review. Advances in Materials Science and Engineering. 2020; 2020:1-25. https://doi.org/10.1155/2020/6153602

[13] Gołaszewski J, Klemczak B, Smolana A, Gołaszewska M, Cygan G, Mankel C, Peralta I, Röser F, Koenders EAB. Effect of Foaming Agent, Binder and Density on the Compressive Strength and Thermal Conductivity of Ultra-Light Foam Concrete. Buildings. 2022; 12(8):1176. https://doi.org/10.3390/buildings12081176

[14] Zhongwei Liu, Kang Zhao, Chi Hu, Yufei Tang. Effect of Water-Cement Ratio on Pore Structure and Strength of Foam Concrete. Advances in Materials Science and Engineering. 2016; 2016:9. https://doi.org/10.1155/2016/9520294

[15] Tian Y, Shuaifeng S, Shuguang H. Mechanical and dynamic properties of high strength concrete modified with lightweight aggregates presaturated polymer emulsion. Construction and Building Materials. 2015; 93(1):1151-1156. https://doi.org/10.1016/j.conbuildmat.2015.05.015

[16] Altynbekova A, Lukpanov R, Dyussembinov D, Askerbekova A, Tkach E. Effect of a complex modified additive on the setting time of the cement mixture. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2022; 325(2):29-38. https://doi.org/10.31643/2023/6445.15

[17] Altynbekova AD, Lukpanov RE, Yenkebayev SB, Dyussembinov DS, Yerzhanova NK. Udoboukladyvayemyy beton bystrogo tverdeniya dlya proizvodstva buronabivnykh svay [Fast-hardening workable concrete for the production of bored]. Stroitelstvo i rekonstruktsiya = Building and Reconstruction. 2022; 2:99-111. (In Russ.). https://doi.org/10.33979/2073-7416-2022-100-2-99-111

[18] Altynbekova AD, Lukpanov RE, Dyussembinov DS, Askerbekova AM, & Gunasekaran M. Effect of a complex modified additive based on post-alcohol bard on the strength behavior of concrete. Kompleksnoe Ispolzovanie Mineralnogo Syra= Complex use of mineral resources. 2023; 327(4):5-14. https://doi.org/10.31643/2023/6445.34

[19] Lukpanov RE, Dyussembinov DS, Altynbekova AD, Zhantlesova ZB. Research of Foam Concrete Components by Two-Stage Injection Method. 2022, 36-42. In: Klyuev SV, Vatin NI, Sabitov LS. (eds) Industrial and Civil Construction 2022. ISCICC 2022. Lecture Notes in Civil Engineering. 2024; 436. Springer, Cham. https://doi.org/10.1007/978-3-031-44432-6_5

[20] Lukpanov RE, Dyussembinov DS, Altynbekova AD, Yenkebayev SB. Research on the Effect of Post-alcohol Bard on the Properties of the Cement-Sand Mixture. 2022, 107-113. In: Klyuev SV, Vatin NI, Sabitov LS. (eds) Industrial and Civil Construction 2022. ISCICC 2022. Lecture Notes in Civil Engineering. 2024; 436. Springer, Cham. https://doi.org/10.1007/978-3-031-44432-6_14