https://www.sworldjournal.com/index.php/swj/article/view/swj29-01-020
DOI: 10.30888/2663-5712.2025-29-01-020

УДК 666.948 : 666.972.112

INFLUENCE OF MICELLAR CATALYSIS ON THE STRENGTH OF ALKALINE REACTIVE POWDER CONCRET

ВПЛИВ МІЦЕЛЯРНОГО КАТАЛІЗУ НА МІЦНІСТЬ ЛУЖНОГО РЕАКЦІЙНОГО ПОРОШКОВОГО БЕТОНУ

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Abstract. *It has been shown that under certain conditions, an increase in the rate of hydration of the binder helps to increase the compressive strength of concrete. This is especially true for reactive powdered concretes. Taking into account the specific effect of surfactants that form micelles, research is aimed at further improvement and development of concrete production technology based on the granular slag domain and alkaline component, using the above-mentioned surfactants.*

The effect of surfactants capable of forming micelles on the rate of formation and the final value of compressive strength of alkaline reactive powdered concrete has been studied. A feature of the research was the study of the simultaneous effect of surfactants that form micelles and the reaction of powder to changes in the strength of concrete. It has been established that these micellar solutions and reaction powders: blast furnace slowly cooled blast furnace slag and rocks containing iron carbonates change the nature of strength formation of alkaline reactive powdered concretes.

Key words*: concrete, micellar catalysis, surfactants, strength*

Introduction

Every year the volume of construction with the use of monolithic concrete increases, to which many requirements are put forward, the first of which is a high speed of strength formation, as well as, depending on the type and operating conditions, a high tensile strength. The main type of binders used in the technology of monolithic construction is Portland cement. A WORTHY competitor to Portland cement are cinder alkaline binders.

Analysis of recent research and publications

Modern scientific achievements in the field of concrete science are based on the use of superplasticized Portland cements and mixtures of Portland cements with a variety of reactive powders. Microsilica, metakaolin, TPP removal ash, rocks and others are used as such powders. As a result of the use of reactive powders and super- or hyperplasticizers, it was possible to obtain concretes with a compressive strength of

100 to 200 MPa and a tensile strength of 25–50 MPa [1, 2]. It should be noted that such concretes have been developed and researched when using Portland cement as the main binder.

At the same time, there is a large group of binders that do not contain minerals similar to those of Portland cement. The basis of such binders is finely ground granular blast furnace slag, which is mixed with an aqueous solution of the alkaline component (slag mud concrete) [3]. It is recommended [4] to introduce reactive powders into the composition of such concretes, in particular those containing ions of transitional chemical elements.

These concretes have a different nature and hydration mechanism than Portland cements, and the strength of such concretes reaches 100 MPa at a hardening rate that exceeds the hardening rate of Portland cements. However, the current state of construction development requires further improvement of the properties of traditional binders, including those based on blast furnace granular slag and alkaline component by modifying their structure.

Thus, taking into account the specific effect of micelles of surfactants, research aimed at further improvement and development of concrete technology based on blast furnace granulated slag and alkaline component should be considered relevant.

It has been established that an increase in the strength of concrete occurs with the simultaneous introduction of surfactants into its composition, which form micelles [5]. As for cinder alkaline concretes, the introduction of traditional mineral additives into their composition does not lead to a change in the rate of formation of concrete strength [6], which is a problem point for these concretes.

Purpose and objectives of research

The purpose of the work is to determine the effect of micel-forming surfactants (MPAs) on the rate of strength formation and its value of cinder alkali reaction powdered concrete

To achieve this goal, the following tasks were set:

- to determine the effect of surfactants that form micelles on the compressive strength of alkaline reaction powdered concrete;

- to determine the effect of surfactants that form micelles on the rate of strength formation during compression of alkaline reaction powdered concrete.

Main research materials

For the manufacture of concrete, ground blast furnace granular slag and slowly cooled blast furnace slag of PJSC "Mitalsteel. Kryvyi Rih" (Ukraine), as a fine aggregate – rocks of an iron ore deposit (Kryvyi Rih, Ukraine), which have a particle size from 0.001 to 0.63 mm. Sodium oleate (Simagchem Corp., China), as an alkaline component – liquid glass with a silicate modulus of 2.8, density of 1340 kg/m3 (Novokhim Company LLC, Kharkiv, Ukraine).

Sodium oleate was dissolved in water to a concentration of 0.0001%, liquid glass was diluted with water to a density of 1200 kg/m3. An aqueous solution of sodium oleate in the amount calculated according to the experiment plan was added to the liquid glass solution. Production and testing of concrete samples was carried out according to standard methods.

In the process of the experiments performed, it was found that the introduction of MPAs into the system under study (reaction powdered concrete) in a certain amount leads to a sharp increase in the strength of the resulting concrete (Fig. 1).

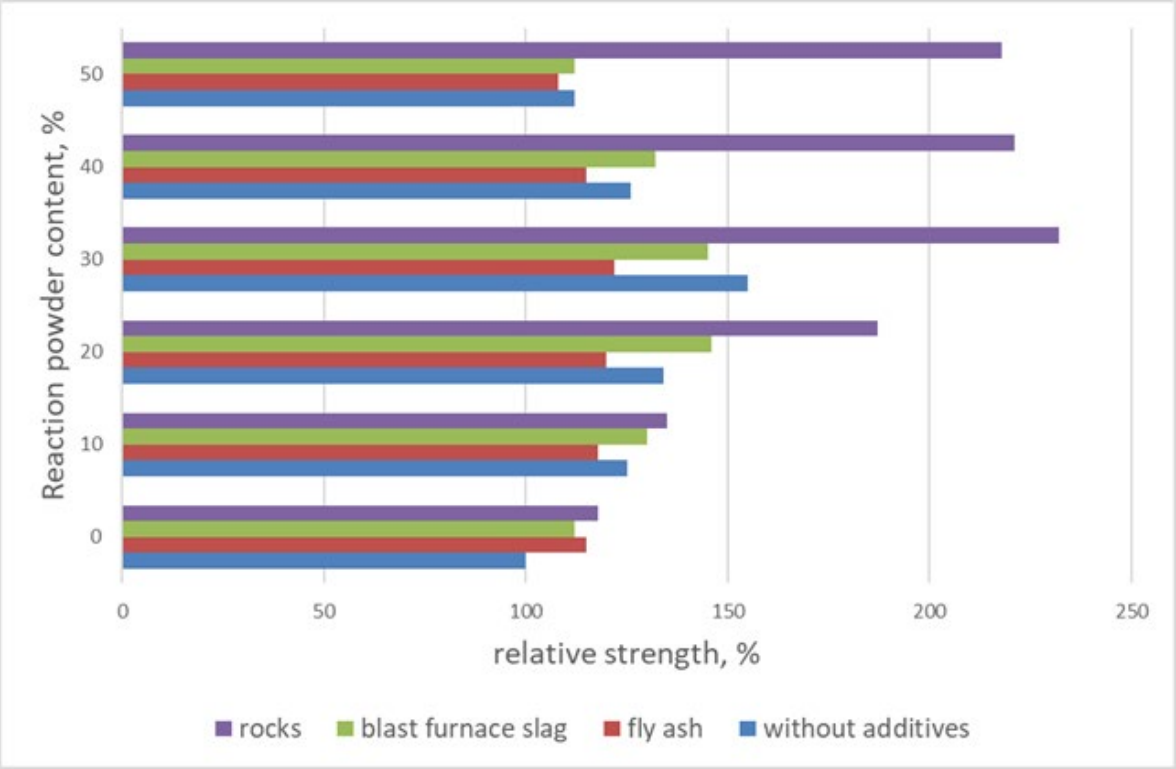

Figure – 1. Strength of alkaline reaction concrete

The total dependence of the compressive strength of alkaline reaction concrete on the consumption of reaction powder and MPA is shown in Fig. 2.

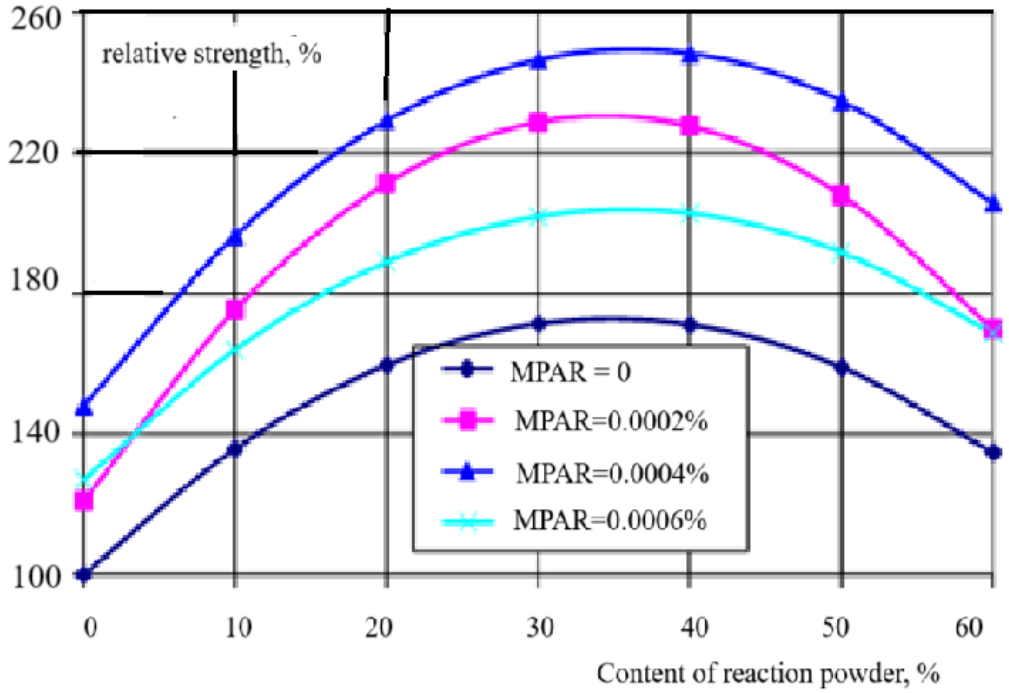

Figure – 2 Total Compressive Strength Dependence of Alkaline Reaction Concrete

The kinetics of changing the strength of the tested concrete depending on the content of reaction powder and MPA in its composition was determined by establishing and comparing the strength of concrete (Fig. 3).

The results of the experiments showed that the addition of mice-forming surfactants (MPAs) to alkaline reaction powdered concrete leads to an increase in the strength of the concrete mixture. The content of MPAs in alkaline reaction concrete, which provides maximum strength at pressure, is 0.0004%, and reaction powder is 30–40%. The rate of change in the strength of concrete over time increases with the introduction of MPAs and depends on the type of reaction powder.

Obviously, the use of MPAs leads to an increase in the effectiveness of reaction powders. At the same time, the most effective use of iron ore beneficiation waste.

The advantages of the results of the conducted research are the determined possibility of a significant (more than 200%) increase in the strength of powdered concrete based on blast furnace granular slag and alkaline component.

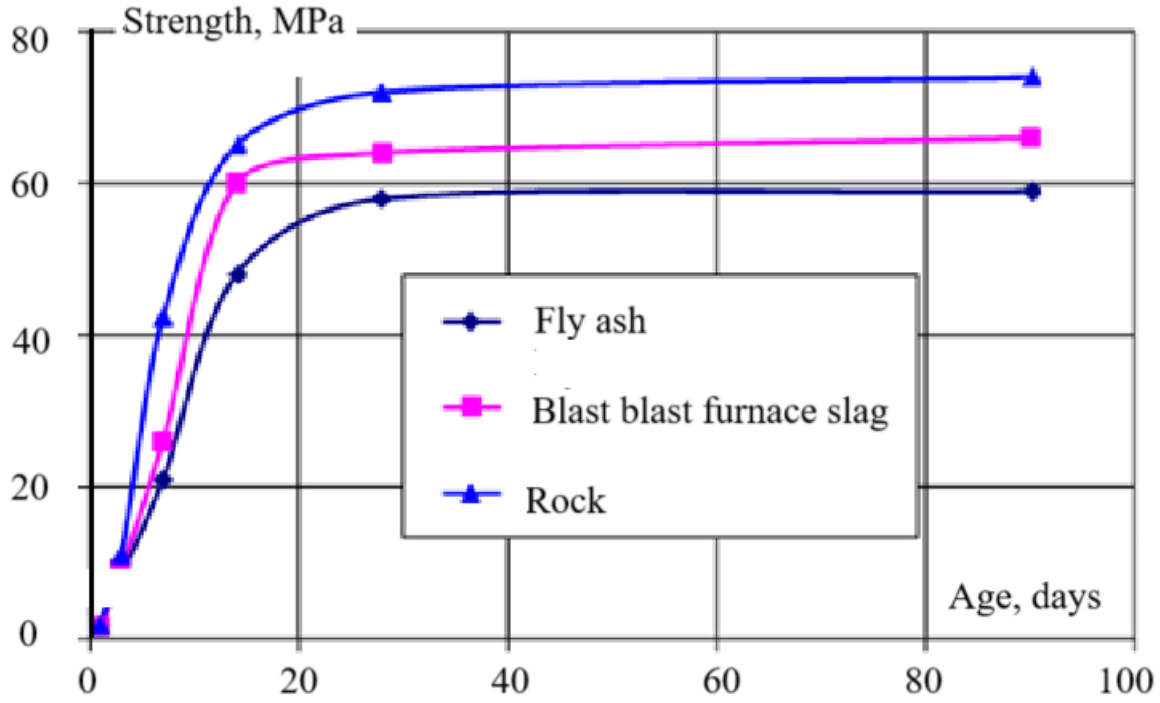

Figure – 3. Change in concrete strength over time (MPAR consumption – 0.0004%)

However, there are certain limitations in the application of the results of this study. Thus, it is necessary to control the hardening time of concrete, which, when using certain types of alkaline component, can be quite small. In the future, in order to expand the field of application of the studied concretes, it is advisable to study the effect of micellar catalysis on deforming properties.

Conclusions

The influence of the type and amount of reaction powders and surfactants that form micelles was considered.

It has been established that the introduction of micelle-forming surfactants into the composition of alkaline reaction powdered concrete leads to an increase in concrete strength by 100–150%. An increase in the amount of a certain reaction powder: blast furnace slowly cooled blast furnace slag and rocks containing iron carbonates leads to an increase in compressive strength by 48% of the strength of concrete of a similar composition obtained without the use of reaction powder.

It has been determined that the simultaneous introduction of MPAs and a certain reaction powder into alkaline reaction powdered concrete: blast furnace slowly cooled

blast furnace slag and rocks containing iron carbonates leads to an increase in concrete strength, which is 230 % of the strength of concrete of a similar composition obtained without the use of reaction powder.

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Анотація. *Показано, що при певних умовах збільшення швидкості гідратації в'яжучого сприяє підвищенню міцності бетону при стисненні. Особливо це стосується реакційно-здатних порошкових бетонів. З огляду на специфічну дію поверхнево-активних речовин, що утворюють міцели, дослідження, спрямовані на подальше вдосконалення та розробку технології виготовлення бетону на основі домену гранульованого шлаку та лужного компонента, з використанням вищезазначених поверхнево-активних речовин.*

Вивчено вплив поверхнево-активних речовин, здатних утворювати міцели, на швидкість утворення та кінцеве значення міцності на стиск лужних реактивних порошкових бетонів. Особливістю досліджень стало вивчення одночасного впливу поверхнево-активних речовин, що утворюють міцели, і реакції порошку на зміну міцності бетону. Встановлено, що зазначені міцелярні розчини та реакційні порошки: доменний повільно охолоджений доменний шлак та гірські породи, що містять карбонати заліза змінюють характер формування міцності лужних реактивних порошкових бетонів.

Ключеві слова: *бетон, міцелярний каталіз, поверхнево-активні речовини, міцність*

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