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THE MODIFIED COMPOSITE SLAG-CEMENT BINDER

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ABSTRACT

The work is devoted to the designing of composite binders with the application of clinker, blast-furnace granulated slags and admixtures (CSCB), and the subsequent producing of efficient fine-grained paving flag concretes on its base. Due to the complexity of the binders' formulas it will be possible not only to reduce the amount of clinker in the mixture, but to regulate the structure formation processes efficiently, providing the high quality of the produced concretes and products on their base. The article analyzes the influence of mineral admixture on structure formation processes and structural optimization of cement stone. There are obtained functions of the ultimate compression strength of a composite binder with mineral admixture and without it. Within this work there was carried out the research of the influence of the amount of blast-furnace granulated slag and admixture at producing CSCB on the activity of binders. There are developed the formulas of composite binders on the base of blast-furnace granulated slags, which allows reducing the consumption of clinker to 70% while providing the activity of binder within the range, required for producing paving flags.

Keywords: composite binders, blast-furnace granulated slag, mineral admixture, structural optimization, paving flag.

INTRODUCTION

At present, for arranging yards, children's playgrounds, pedestrian areas and especially suburban lots the ornamental-concrete paving materials are used with increasing frequency. The great variety of shapes and wide range of colours make the paving flags very popular. The paving flags make either urban streets or suburban lots look modern and neat; one of the determining factors of replacing asphalt with paving flags is also ecology [1-3].

At the same time the modern approach to building implies the creation of efficient low-cost building materials. The main direction in solving this problem is the obtaining of composite binders, at the production of which the fuel and clinker consumption is reduced substantially in comparison with plain cements. By now there has been gained solid experience in producing binders with active mineral admixtures [4-16]. One of the most effective materials for cement saving is the fine-ground blast-furnace granulated slag. This material is thoroughly studied as an active mineral admixture for cements; besides, slag is the main ingredient for obtaining slag-lime binders and products on their base [17]. But applying it, the ecological problem is solved at the same time.

The working hypothesis of this research was the possibility of obtaining a composite slag-cement binder (CSCB) by using clinker, blast-furnace granulated slags and admixtures, which then could allow producing on its base the effective fine grained concretes for vibrocompressed paving flags.

METHODOLOGY

The research of the synthesized composite binders' material composition was done by X-ray phase analysis. The physical and mechanical characteristics of the synthesized materials were researched by conventional methods according to the state standards.

In this work there was carried out the research of influence of blast-furnace granulated slag and admixture amount at the CSCB production on the activity of binders, which were obtained by means of intergrinding clinker, gypsum, admixture and slag. The specific surface amounted to 500 550 m^2/kg. The composition of the binder altered depending on the slag content (10 70 %).

The main part

It is known, that the most important characteristics of a binder is its specific surface area. The finer is the grinding of a binder, the quicker the solid crystalline part grows. But it is not enough just to increase the binders' specific surface, and not to give attention to their granulometric composition.

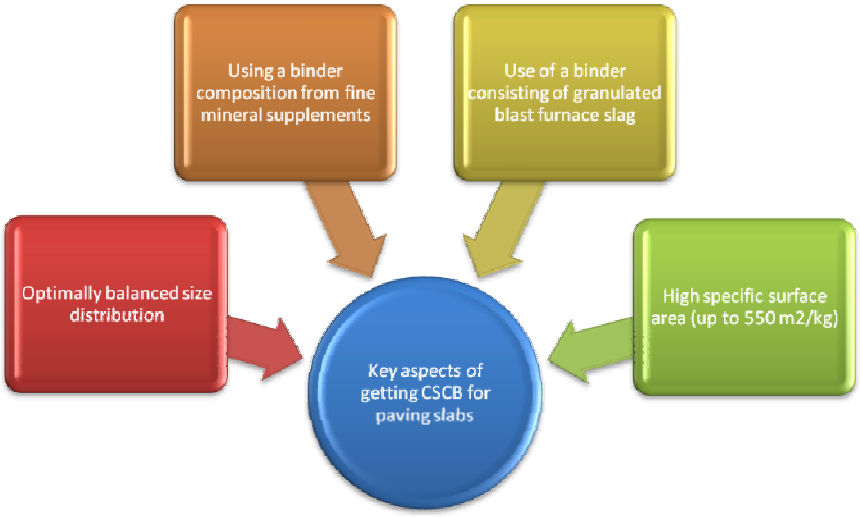

Figure-1. The basic regularities of producing composite binder for paving flags.

By introducing various fillers we can determine the most optimal granulometric composition of binders to provide the maximum density of concretes on their base [8-10]. So, to improve the quality of composite binders there were formulated the basic regularities of their production (Figure-1).

The obtained regularities of ultimate compression strength of the composite binder with mineral admixture and without it, indicate that at introducing admixture 0,5 % of clinker mass the increase of density amounts to " CSCB 10% slag - CSCB 20% slag - CSCB 50% slag" 12,5% - 5% - 9,5%; which is due to the effect of Tricosal-181 mineral admixture (Figure-2).

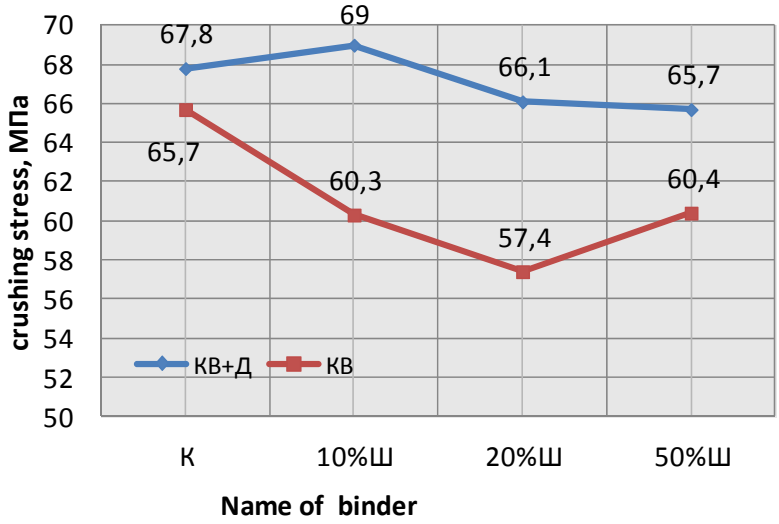

Figure-2. Alteration of binders' activity at the introduction of Tricosal 181 admixture, Д-admixture- 0, 5% of the overall components consumption.

Due to high dispersity and peculiarities of mineral composition, after the formation at the initial hydration process the admixture particles adsorb the considerable amount of water, thereby the water-binder ratio is reduced, which results in activation of structure formation processes and synthesis of finer calcium silicate hydrates crystals, which is sure to influence the optimization of cement stone microstructure in comparison with test samples. At that, its particles, being inoculums, carriers and crystallization centers of the slag, catalyze the hydration and binder hardening processes.

Besides, gain in strength is explained by the determined optimal granulometric composition of the binder, high-density packaging of its particles, and the raise of activity of CSCB components due to fine grinding, promoting the more complete execution of hydration processes. This is also confirmed by the X-ray phase analysis (Figure-3).

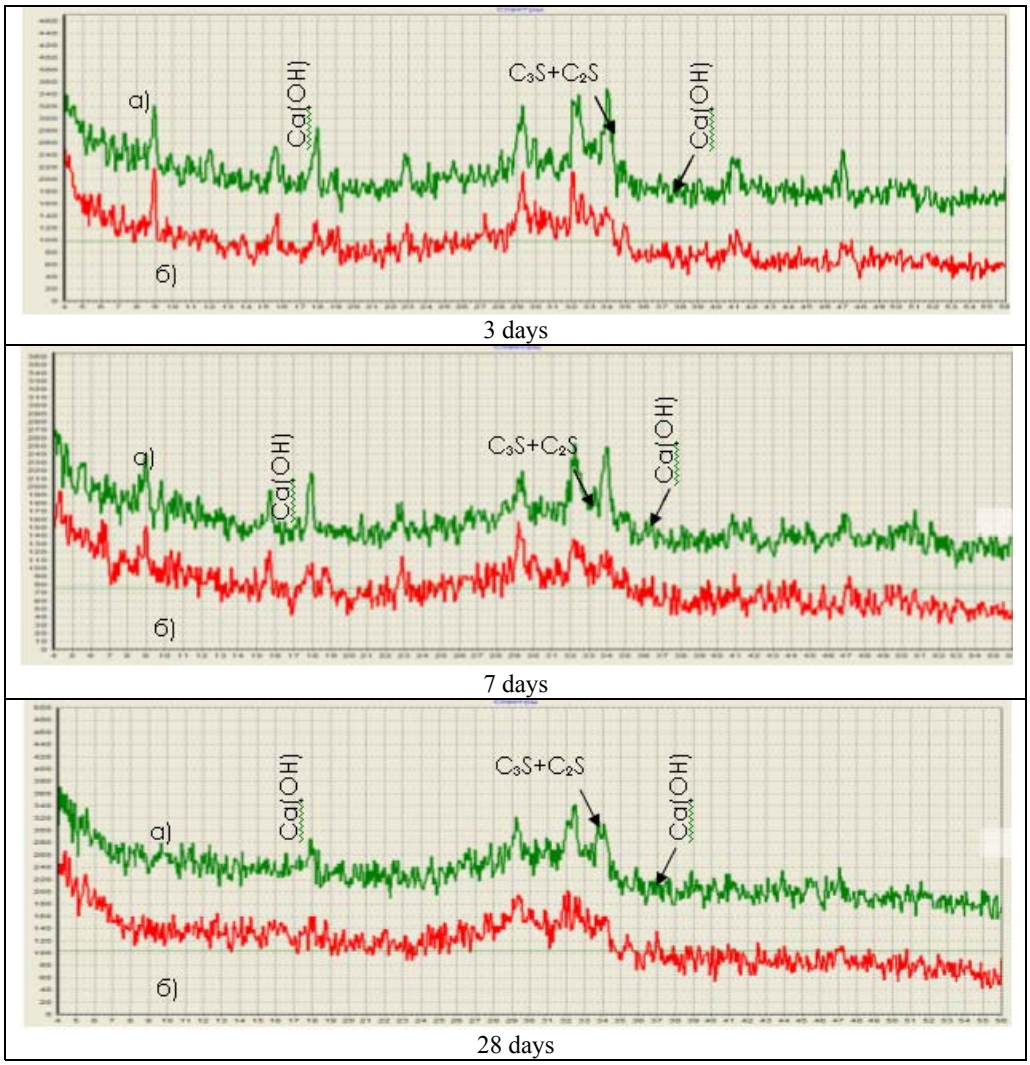

Figure-3. X-ray patterns of cement stone of the composite slag-cement binder: а) CSCB50; б) CSCB30.

The amount of Portlandite formed in CSCB at the ending period of hardening reduces for both binders, which is conditioned by pozzolanic reaction between Ca $(OH)_2$ and active slag particles in the binder. After the complete fixing of free CaO, the formation of hydrosilicates of CSH (B) row begins, which provides extra compaction of the composite.

For the subsequent production of binders the optimal concentration of Tricosal 181 admixture was determined (Figure-4).

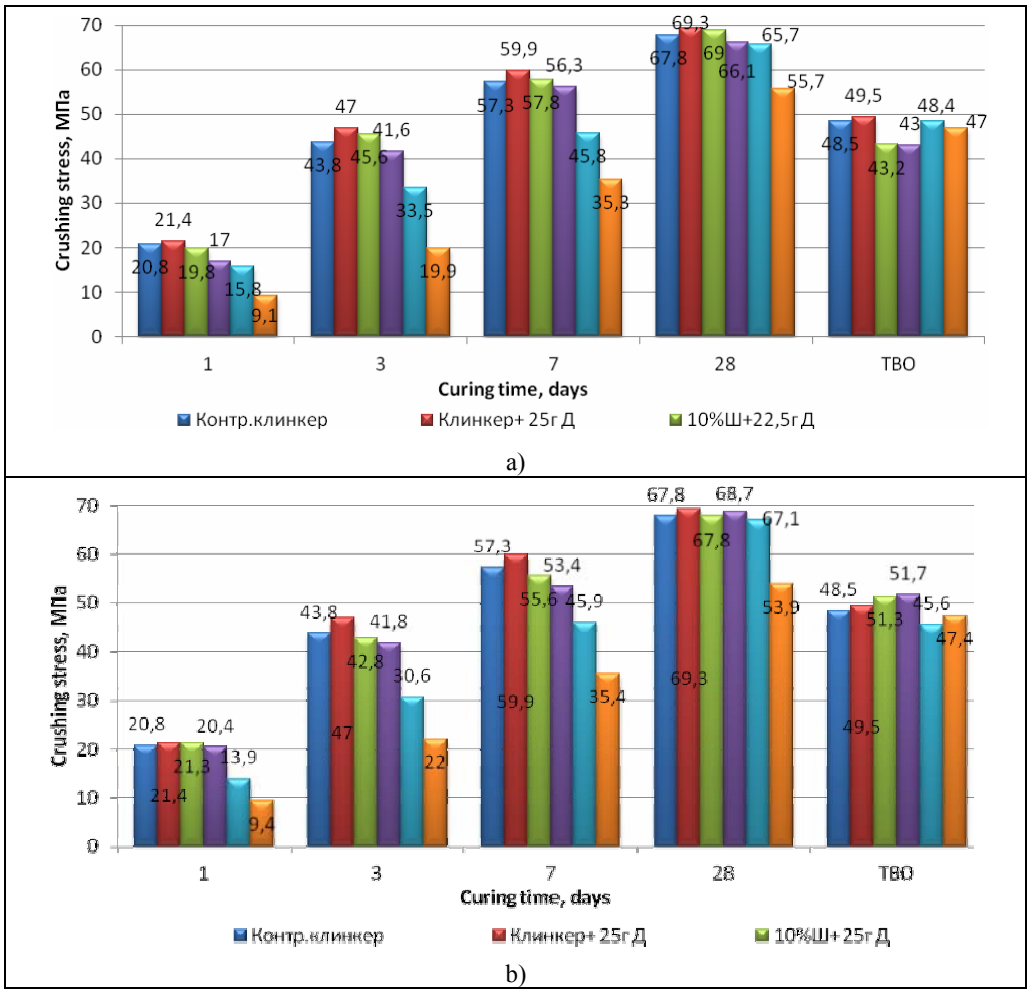

Figure-4. The strength development of binders depending on TRICOSAL 181 admixture content: a) 0, 5% of clinker amount; b) 0, 5% of the overall components amount, (Ш-slag, Д-admixture).

In the early period the slag slows down the hydration process and by 28 days the strength characteristics of all binders except CSCB with 70% of slag are equal to the strength of clinker, and sometimes even exceed it. The introduction of slag in the amount of 10 and 20 % allows obtaining a binder of the same strength as the strength of the initial clinker at Sуд = 550 m^2/kg both in early, and in late stages of hardening. At the slag content 50 % the strength achieves the values of the clinker only at the age of 28 days.

At carrying out thermal vacuum treatment the strength characteristics of fine ground composite binders with introducing 50% of slag as a filler are virtually the same as the strength of the initial clinker, and introducing less than 20% of slag allows even exceeding the strength of clinker and clinker with TRICOSAL 181 admixture.

CONCLUSIONS

Thus, there have been developed the principles of improving the efficiency of fine-grained paving flag concretes, consisting in the application of fine ground composite binder on the base of blast-furnace granulated slags, obtained by intergrinding all the components, which provide the directional effect on the concrete structure formation, compacting and strengthening it due to optimal granulometric composition and high activity of slag components.

The mineral composition, activity and physical and mechanical characteristics of blast-furnace granulated slags are determined, which will allow using them more efficiently in obtaining fine grained concretes for producing vibrocompressed paving flags, based on composite binders, and in the formulas of these binders.

The formulas of composite binders based on blast-furnace granulated slags are developed, which allows reducing the consumption of clinker to 70% while providing the activity of binder within the range, required for producing paving flags.

The optimal proportionings of mineral admixture, gypsum and fine ground slag for producing composite slag-cement binders are determined.

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