binders developed in the period of the 60–70s of the last century turned out to be possible only with their heat and moisture treatment used in a factory.

In modern realities, when the volumes of monolithic construction increase, the use of classic slag-alkali binders is rather limited. Therefore, modern research in the field of alternative clinkerless binders and, in particular, slag-alkali binders are associated with the possibility of obtaining high-strength composites based on them, hardening in normal temperature and humidity conditions, without heat treatment.

Two factors are the basis for obtaining a new generation of slag alkaline binders. Firstly, this is the use of binders of micro- and nanodispersed fillers with hydraulic activity. Secondly, it is the mechanochemical activation of binders during grinding.

The well-known developments of slag-alkali binders of the modern period [1–21] showed wide possibilities in comparison with clinker cement for controlling the composition, structure and properties of artificial stone building composites based on them. This is ensured by the introduction of mineral fillers and modifiers in the composition of these binders. The general and particular patterns of the influence of the material and particle size distribution, dispersion and surface potential of certain types of slag, mineral additives and alkaline additives on the structure formation and properties of paste and stone based on slag-alkali binders [1–14] were studied. Various works studied the effect on structure formation, hardening and the complex of properties of binding fly ash additives [15], waste sand [16], ground silica sand and micro-silica [17–18], zeolite-containing carbonate-silicon [19] and aluminum silicate [20] mineral additives. As a result, it was proved that it is the use of hydraulically active micro- and nanodispersed mineral modifiers that allows one to obtain binders that achieve strength up to 50 MPa without heat treatment.

However, the most effective ways of adding these modifiers (with joint or separate grinding), their optimal dosages, and also the rational dispersion of slag-alkali binders have not been clearly defined.

The results of experimental studies discussed in this article are correlated with modern approaches to obtaining highly effective clinkerless binders belonging to the class of slag alkaline. At the preliminary stage of research, the authors optimized, according to the criterion of strength, the composition of a new variety of cinder-alkaline binders based on granulated blast-furnace slag, silica fume, quicklime, two-water gypsum and powdery C-3 superplasticizer. Distinctive features of clinkerless slag-silica binder (CSSB) are:

1) obtaining by co-grinding all components in the presence of superplasticizer,

2) a high dosage of silica fume (20 %),

3) a high specific surface area of 900 m^2/kg.

The scientific approach to substantiating the composition and method of obtaining this binder is based on the implementation of the “top-down” nanotechnological principle [21]. It is believed that it is the joint grinding of all components that will provide a change in the energy state of the structure and, accordingly, the physical and/or physicochemical activity of surface and internal volumes of solid particles as they are being ground. In this case, the introduction of a superplasticizer as a surface-active substance during grinding will contribute to amorphization of the surface of binder particles, their saturation with structural defects of the nanoscale range. The achieved high specific surface area of the binder will determine the predominance of nano- and micro-sized particles in its composition. As a result, it is supposed to increase the rate of structure formation and hardening of the binder precisely due to nanotechnological activation of its components at the manufacturing stage, using the hydraulic potential of nano- and micro-sized particles at the hardening stage.

The aim of the work was to assess the applicability of clinkerless slag-silica binder (CSSB) as a hydraulic binder of normal hardening based on comprehensive studies of phase composition, structuration process and hardening. The objectives of the study included:

– assessment of the particle size distribution of the initial components and the CSSB obtained to evaluate the content of nano-and micro-sized particles in their composition;

– studying changes in phase composition of CSSB during hydration and structuration processes;

– assessment of flocculation and hardening kinetics of CSSB

2. Materials and Methods[1]

The following raw materials were used to obtain clinkerless slag-silica binder:

– granulated blast-furnace slag from LLP “Arcelor Mittal” plant (Temirtau, Kazakhstan) with a lime factor of 0.75;

[1] The studies were conducted in the laboratory of the Collective Use Center Named After Professor Yu. M. Borisov (Voronezh State Technical University, Russia)