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Effiency of Low Water Demanding Cements and Their Prospects

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Abstract: The industries in Uzbekistan is developing with great factors, so that their diversity is increasing, and new modern technological methods are being introduced, as well as innovative technological systems are being put into operation. Therefore, solving problems related to production based on high-quality, cheap local raw materials and industrial waste has been one of the main tasks. One of the important areas of increasing the efficiency of social production in the current conditions of rapid development is economising. Economical use of all local resources and industrial waste, use of existing capacity and energy-efficient modern equipment, ensuring the implementation of measures such as localization of production depend to a large extent on economy. Especially, cement can be example of that. One of the most important tasks of the cement production industry is to produce high-quality, low-cost binders using local raw materials widely, to improve the quality of the development of the production of various materials, products and structures based on them, and to reduce the cost of construction, while at the same time stable production and It is important to increase the technical and economic indicators of the production of ecologically clean, local raw materials, effective materials from secondary waste, to improve the durability of the produced materials, and to be used in the construction industry in the territory of the republic.

Keywords: low water requiring cement, plasticizer, rheological properties, strength.

Introduction. Doctor of Chemical Sciences Bikbau M.Y. From the article “Nanocements - the future of the world cement industry and concrete technology” [1] - "the phenomenon It is impossible to understand and explain the radical increase in the structural and technical properties of modified portland cement on the basis of the accumulated knowledge on the physical chemistry of cements, until we experimentally prove the change of portland cement in a certain process, mechanochemical in the presence of a modifier activation turns into a dispersed composition in the form of Portland cement grains covered with a shell of structured modifier. And we called it nanocement."

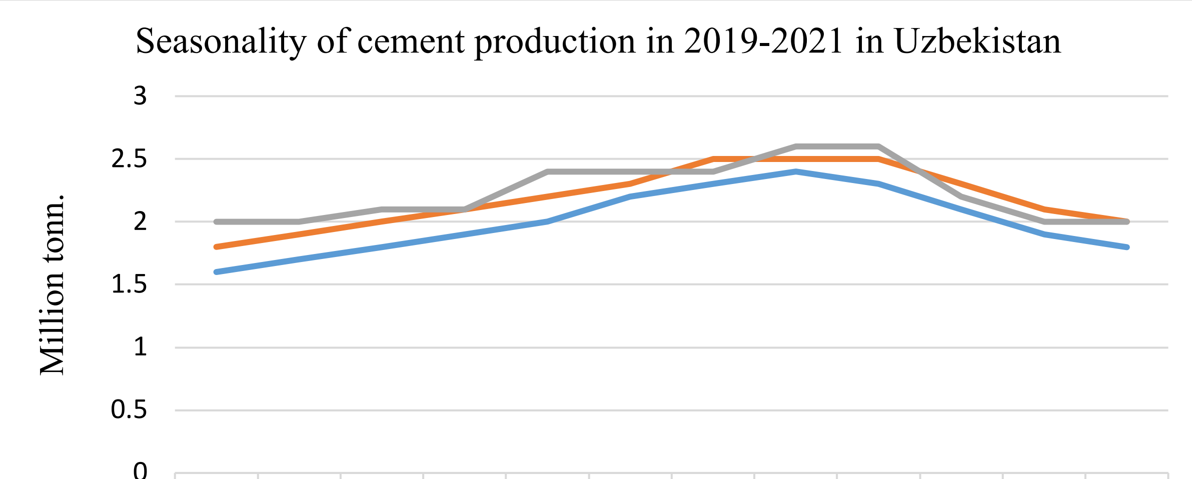
Significantly, Bikbau did not find such nanoparticles in the small quartz particles; nanoparticles of modified polymer (superplasticizer) are not settled in silica, and at the same time, the author believes that only silica (quartz) or aluminosilicate (slag) can be the second effective component of low water requiring cement (LWDC). Thus, Bickbau excludes the possibility of nanoencapsulation of the second component of LWDC - the mineral substance. M.S. Garkavi, A.V. Artamonov, E.V. Kolodejnaya et al. [2,3,4] suggested the use of centrifugal impact mills (type MTs-0.36) for the production of LWFC-100 and LWDC -50 (mineralogical additive - quartzite) of various materials, because they provide high speed provides. A characteristic feature of centrifugal impact mills is high energy intensity (more than 10 kW/kg), which predetermines the process of mechanochemical activation in them. The authors achieved positive results in terms of strength for LWDC -100 - 73.2 MPa, for LWDC -50 - 41.8 MPa, but the specific specific surface area is low, which is - (350-370 m2/kg) low specific surface area of binders clearly limits its possibilities.

Bisultanov R.G., Murtazoev S.Y., Salamanova M.Sh. [5] suggested the use of active silica additives (volcanic ash, quartz powder, etc.) to obtain highly active LWDC. The best strength (74.5 MPa) was obtained for LWDC-70 using volcanic ash, which allows to save up to 20% of Portland cement in binders of equal strength. The positive effect of volcanic ash on the strength of LWDC is partially explained by the presence of amorphous glass (50-80%), silicates and aluminosilicates, as well as their hydrates in the crystalline state, which contribute to self-solidification. The obtained results justify the production of LWDC for high-quality concretes with pressure resistance classes from B60 to B100, as well as the fact that heat and moisture treatment is not necessary and allows to achieve high strength in 18-24 hours.

Analysing above the literatures, I can say that the authors talked about increasing the strength of cement by mechanoactivation of cement raw materials, saving the expensive clinker raw materials replasing it with introducing industrial waste and mineral raw materials 30 to 50 %, and thereby reducing its cost.

Method and materials. LWDC absorbs a certain amount of water to form a normal density, which gives it a certain consistency. In the climatic conditions of Uzbekistan, the introduction of microsilica increases the water demand of LWDC, which even reaches 30%, but the water demand can be reduced to 20% by adding a superplasticizer from 0.6 to 0.8%. microsilica, due to its high dispersion, absorbs more water than the original cement. The average particle size of microsilica is about 1 μm, which is about 6 μm smaller than the average particle size of cement.

For example, if we pay attention to Figure 1, it shows the amount of cement produced in Uzbekistan in 2019 and 2021 in million tons, and it can be observed that the volume of cement production decreased during these periods. From this it can be said that as the number of constructions increases, the consumption of cement also increases, but the increase in price has a negative effect on this and has caused a great loss to the cement industry.



	jan.	feb.	mar.	apr.	may	jun.	jul.	aug.	sep.	oct.	nov.	dec.
2021	1.6	1.7	1.8	1.9	2	2.2	2.3	2.4	2.3	2.1	1.9	1.8
2022	1.8	1.9	2	2.1	2.2	2.3	2.5	2.5	2.5	2.3	2.1	2
2023	2	2	2.1	2.1	2.4	2.4	2.4	2.6	2.6	2.2	2	2

Figure 1. Seasonality of cement production in Uzbekistan in 2021-2023.

If we pay attention to Figure 2, it shows the demand for the production of cement products in Uzbekistan in 2019 and 2023 in million tons, observing the increase in the demand for cement production in these periods.

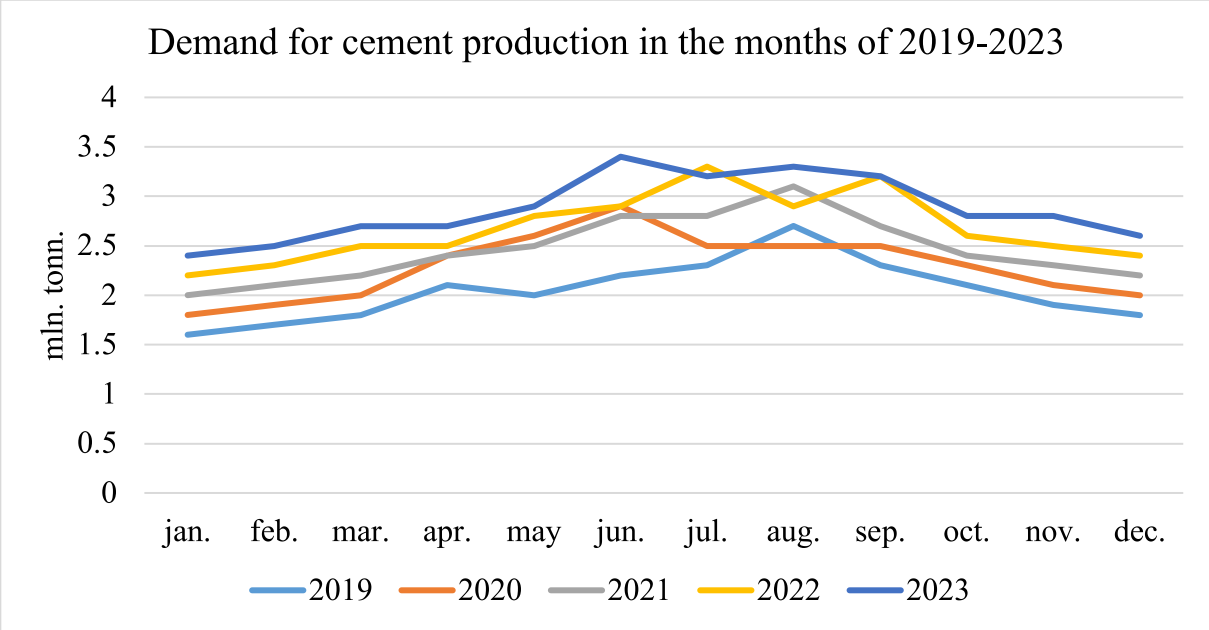


Figure 2. Demand for cement production in Uzbekistan in 2019-2023.

LWDC absorbs a certain amount of water to form a normal density, which gives it a certain consistency. The inclusion of microsilica increases the water demand of low-water cement, which can even reach 30%, but the water demand can be reduced to 20% by adding up to 0.8% superplasticizer. microsilica, due to its high dispersion, absorbs more water than the original cement. The average particle size of microsilica is about 1 µm, which is about 6 µm smaller than the average particle size of cement.

In order to most fully evaluate the behavior and flow of LWDCs mixed with water as a plasticized binder, it is essential to evaluate rheological properties such as viscosity and shear stress. As a rule, the main effect on these properties is carried out by the cement paste, because LWDC is a dispersed system, which has a highly developed interface between the solid and liquid phases, which determines the magnitude of the intermolecular forces of cohesion and the coherence of the system. The presence of various chemical and mineral additives, as well as the water-cement ratio, are important. [6,7]. According to many authors [8,9,10], based on the rheological properties of raw cement production mud, cement paste and other aqueous mineral suspensions, they can be classified as plastic viscous systems with a coagulation structure. The behavior of such systems is described by Bingham's equation [11,12]:

$$\tau = \tau_0 + \eta_{pl} \cdot \gamma'$$

where τ - tangential shear stress, Pa; τ_0 is the ultimate shear stress. Pa; η_{pl} - plastic viscosity, Pa·s; γ' is the rate of shear strain, c^{-1}.

Rheological characteristics of cement pastes and other mineral suspensions, as a rule, are measured using a coaxial cylinder rotary viscometer. The relationship between shear rate gradient and shear stress is considered after the cement paste has reached stability at different rotating rotor speeds. The ultimate dynamic shear stress t0 and plastic viscosity ηpl are determined from the rheological curve as a segment along the shear stress axis and from the tilt angle of the falling hysteresis loop, respectively.

A number of works [13,14,15] state that there is a general tendency to decrease the hysteresis area, the magnitude of the ultimate shear stress, and the plastic viscosity with an increase in the plasticizer concentration in aqueous mineral dispersions. In this case, as the amount of additives in the dispersion increases, the ultimate shear stress practically disappears and the viscosity takes a constant low value.

Similar data were obtained by introducing effective plasticizing additives, both nonionic and polyelectrolyte, into aqueous mineral dispersions. As the concentration of plasticizer additives increases, the system transitions from Bingham nature to Newtonian flow and then to Dilatant flow. This is explained by the emergence of limited conditions and the dominance of repulsive forces over gravitational forces.

Research results and discussions. The rheological properties of cement compositions are greatly influenced by the molecular weight of plasticizers. According to the research conducted by Falikman V.R., Bulgakova et al. [16], the mobility of the concrete mixture depends on the molecular weight of polymethylene polynaphthalene sulfonates: when the amount of water is constant, longer retention of mobility over time is characteristic of polymers, while oligomers can slightly accelerate the hardening process. The authors studied the effect of surfactant concentration, type and number of polar groups, hydrophobic radical length and other parameters of surfactants on the rheological properties of dispersed structures. In this case, changes in the properties of KSTTs systems are associated with the presence of reactive groups and hydrophobic radicals in the surfactant molecule. In this case, the most favorable state of the structure in terms of energy appears. According to Bingham's theory and other solid dispersion systems, there is a general equation that describes the behavior:

$$P - P_T = k \cdot \gamma^n$$

here P- shear stress, Pa; P_T – yield strength, Pa; k and n are constants describing the given liquid-like structure. When $n=1$ is Bingham's equation, $n>1$ is plastic dilatant equation and $n<1$ is pseudoplastic solid equation.

The rheological properties of mineral dispersion systems depend more on the presence and quality of interparticle media. Through these layers, depending on the distance between the particles caused by van der Waals and hydrogen bonds, the attractive forces between them act. Layers of the environment, which act as lubricants at the contact points, ensure the mobility of individual structural elements. Thus, it is possible to regulate the mechanical properties of the coagulation structure of the material by increasing or decreasing the thickness of the media layers at the contact points of the particles, or by changing their hydrodynamic properties with the help of plasticizing additives. The width of the particle surface increases with the development of electric double layers, their diffuse part, which is provided by the replacement of all cations on the particle surface with singly charged alkali metal cations. In this case, the fluidity of the systems increases. However, the rheological properties of KSTTs pastes in concrete mixtures should be used with some caution. Thus, SP can both decrease and increase this property of the fresh concrete mix, depending on the ratio between the components, by reducing both the ultimate tensile stress and the plastic viscosity of the paste.

Summary. New generation binders (LWDC) have been shown to be a combination of cement clinker, various siliceous mineral substances (construction sand, microsilica, residual ash, etc.) and a number of water-soluble organic compounds. The second is a microcapsule shell around the hydration-active particles of clinker minerals and other amorphous siliceous substances, temporarily preventing their chemical interaction with the dispersion medium (water, that is, they slow down the process of wetting the highly developed binding surface of the powder. As a result, the dough based on low water-demanding cement the amount of mixing water required to obtain normal consistency is reduced. The maximum convergence of the dispersed phase part in a unit volume creates special conditions for the occurrence of chemical and physicochemical processes [17]. Under such conditions, due to the dense packing of the dispersed phase particles, the distance between the particles is minimal, free space filled with ultra-fine particles of mineral additives, ultra-fine silica particles interact with the hydrolysis product of the alitic phase - Ca(OH)2, which leads to the formation of a dense structure and the synthesis of calcium additives of low base hydrosilicates. Thus, the formation of a phase from traditional portland cements , the developed modified LWDC characterized by structure formation, hardening kinetics and high density and sulfate resistance can be the basis for creating a whole set of building materials with specified properties.

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