

The role of superplasticizers in improving the quality and properties of construction materials

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Аннотация

Ушбу мақолада юқори мустаҳкамликка эга бўлган боғловчи моддалар олишнинг муаммоларини бартараф қилиш яъни цементнинг муҳим экологик нуқсон ва камчиликлари, уларни ишлаб чиқаришда кўп энергия талаб қилиниши, CO₂ ва чангнинг катта чиқиндилари ажралиб чиқиши, экологияга зарарлари ва буларни олдини олиш бўйича қилинган ишлар ёритилган.

Калит сўзлар: боғловчи моддалар, клинкер, цемент, суперпластификатор, механик фаоллаштириш, модификация.

Аннотация: В данной статье освещены работы по устранению проблем получения высокопрочных вяжущих, т.е. важных экологических дефектов и недостатков цементов, необходимости использования большого количества энергии при их производстве, выделения больших выбросов CO₂ и пыли, нанесения ущерба окружающей среды и их предотвращению.

Ключевые слова: вяжущие вещества, клинкер, цемент, суперпластификатор, механоактивация, модификация.

Annotation: The article covers work to eliminate the problems of obtaining high-strength binders, i.e., important environmental defects and disadvantages of cements, the need to use large amounts of energy in their production, the release of large CO₂ and dust emissions, environmental damage and their prevention.

Keywords: binders, clinker, cement, superplasticizer, mechanical activation, modification.

At present, the application of modern local materials and technologies plays an important role in construction and housing-utility complexes. This is especially related to the creation of import-substituting materials and technologies. The most important direction in the building materials industry is the production of mineral binders and various materials based on them. Due to the increase in the volume of construction, the demand for cement in the Republic of Uzbekistan is growing. Saving resources and energy, using innovative technologies and solving environmental problems in the production of hydraulic binder cement are the requirements of today and the future. At the same time, one of the main tasks is to develop new compositions of binders using various local raw materials and industrial waste. The decision of the President of the Republic of Uzbekistan PD-4335 "On additional measures for the rapid development of the construction materials industry" sets the target parameters for the production of construction materials in 2019-2025 and envisages the amount of cement produced, including the production of building materials based on high-quality and energy-efficient technologies

At present, the most important research priority is the development of nanotechnology and innovative methods in the production of cement and binders. High-grade binders are effective binders based on Portland cement clinker, which have the lowest water demand among existing mineral

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binders. The normal density of high-grade binders is 16-20%, and that of ordinary Portland cement is 24-30%.

High-grade binders are composite hydraulic binders obtained by grinding Portland cement clinker or ordinary Portland cement with mineral powder fillers (quartz sand, slag, limestone, industrial waste or other natural raw materials) and dry organic modifier, e.g., plasticizers of various nature.

One of the ways to improve the quality of reinforced concrete products and structures, speed up the production of concrete works and save cement is the use of chemical additives. Here, the use of highly effective superplasticizers allows to significantly reduce the material, energy and labor costs of production, save 25% of cement, obtain high-strength concrete in ordinary cements by reducing the water-cement ratio, and increase the quality and durability of structures.

The increase in strength of concrete prepared on the basis of traditional technology using superplasticizers and concrete based on high-quality binders is significantly different from each other. After a certain time from the time of preparation of the KTSB-based concrete mixture, its mobility is sharply lost, which leads to an intensive increase in the hardening of concrete (after 6 ... 8 hours). Under normal conditions, the strength of concrete based on high-quality binders is 15...25 MPa after 16 hours, and 20...60 MPa after 1 day, or it allows to significantly reduce the time of wet heat treatment. Researchers explain this by the fact that cement particles are "preserved" by a dense molecular shell of superplasticizer, which prevents moisture from the environment from penetrating into the cement particles. During the production of high-quality binders, superplasticizer molecules are not simply "mechanically" attached to cement particles, but form a "shell" on their surface layer up to 1...2 microns. As a result, the active zones of cement particles become hydrophobic.

Mineral additives included in mechanically activated cements should be characterized by a high amount of silicon and its compounds and low moisture content. It should be noted that in order to reduce the cost of high-quality binders, a third component is often added - a mineral soft filler with inert or pozzolan activity of natural and anthropogenic origin. The use of anthropogenic raw materials in the production of Portland cement should not only prevail over the use of natural raw materials in the production technology of Portland cement clinker, and even completely replace them, and in the second stage, they should be the second main component in the production of mixed cement. By using the complex additive, it was possible to obtain fast-hardening concrete by replacing cement with sour fly ash of thermal power plants by up to 30%. When using a complex admixture, 40% replacement of cement with fly ash was achieved without reducing the strength of concrete compared to the strength of concrete without admixture. According to the information provided by the researchers, reasonable areas of use are identified as a result of pilot-production tests of effective concrete prepared using high-quality binders and fine-grained multi-component cements.

Production of high-strength concrete (500-800 grade) or low-strength concrete with a cement saving of up to 80% from a binder based on M400 Portland cement and granulated blast furnace slag, as well as the use of finely dispersed high-grade binders based on construction sand allows to save up to 50% of Portland cement for 1 m³ of 200-300 grade concrete. The use of high-quality binders - finely divided multi-component cements provides a saving of 40-70% of cement, taking into account the consumption of cement in the production of building materials.

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At the same time, concretes made from high-quality binders obtained using slag are characterized by increased sulfate resistance, frost resistance and a number of other positive properties. This allows to significantly save cement. The use of electric steel melting slag in making high-grade binders leads to an average reduction of 30% in water demand of the binder. These factors allow to obtain high-grade binders with a strength of 57.4 MPa with 50% electric steel melting slag in 28 days. An increase in the amount of electric steel melting slag in high-grade binders inevitably leads to a sharp reduction in the setting time of the cement paste and a decrease in the initial strength. Mineral additives are classified as active and inert according to the nature of their influence on the hardening process of cement. Active additives are artificial silicate materials with hydraulic properties in volcanic or sedimentary rocks, including Ca(OH)_2 .

As a result of research conducted by researchers, using limestone powder, volcanic ash, thermal power plant ash and quartz powder to obtain high-quality binders from active mineral additives of different origins, it is possible to obtain high-quality concretes from strength class V60 to V100, while preparing concretes with the same performance reduces the water requirement of the mixture and concrete by 25-30%. In addition, the high rate of increase in the strength of concrete based on high-quality binders led to the conclusion that the strength of the products can be removed from the mold in 18-24 hours. It was found that grinding cement with a plasticizer accelerates the process. This indicates that, in addition to the plasticizing effect, during grinding, the effect of the additive to penetrate into the cracks of the material being crushed is explained by the effect of pushing as a quoin. In addition, it can be seen that the kinetics of crushing granite in obtaining high-grade binders is the same as that of previously studied anthropogenic raw materials. It has been found that the use of complex binders and the arrangement of filler grains at a high density significantly increase the strength properties. An optimal choice of filler, using anthropogenic sands in mechanically activated compositions allows to obtain fiber concrete with a compressive strength of 160.2 MPa and a bending strength of 31.2 MPa. As a result of the work carried out, effective multi-functional modifying additives on the basis of high-grade concrete were obtained for monolithic concrete mixtures, which ensures acceleration of hardening by 120...150%, the strength of hardened concrete under normal conditions was more than 30 and 50 MPa on the 1st and 3rd day, respectively.

At a temperature of 10 ± 2 °C, the increase in strength with the addition of the additive was 200 ... 250% (more than 20 and 40 MPa in 1st and 3rd days) and at a temperature of 2 ± 2 °C more than 300% (more than 2 and 15 MPa). At the time of 28 days, the use of the developed additive ensures the production of concrete of grade V60. Concrete mixtures using high-quality binder additives up to 15% in the cement mass are characterized by a high mobility class P5 and belong to the class of self-compacting concrete mixtures. At the same time, the mechanism of action of the additive consists in the rapid formation of a crystal hydrate structure with a low demand for water and an increase in the level of hydration of the main highly active cement. As a complex modifier of cement, during grinding, it is recommended to use a superplasticizer based on polycarboxylates and a grinding process intensifier. The advantages of high-quality binders include the versatility of compositions.

At the same time, high-grade binders, especially ultra-fine cements, can lead to insufficient hydration of the concrete clinker foundation, which affects the strength of concrete products. The strength of ultra-fine cement samples after three years reaches 420 kg/cm², while that of ordinary cement is only 175 kg/cm². Modern studies have shown that it is enough to increase the specific surface

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area of binders by 5000-6000 cm²/, because the strength of one-day concrete doubles, but at the same time, cracks may appear in the panels. Another serious obstacle to the complete transition to the use of high-quality fasteners is the versatility of their composition, which can inevitably lead to compatibility problems. The requirement to solve these problems leads to the achievement of our purpose.

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