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IMPROVEMENT OF CEMENT STONE PROPERTIES BY ADMINISTRATION OF ROUGH-DISPERSED MINERAL FILLERS AND PLASTIC ADDITIVE.

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Abstract: *the dependence of the autogenesis of Portland cement particles on the type, dispersion and content of fillers is substantiated. The optimum dispersion of the fillers is established. The relationship between the value of the ultimate shear resistance of cement powder and the strength of cement stone is revealed.*

Key Words: *cement, concrete, structure formation, plastic strength, additive, mineral filler, cement stone, concrete mix.*

1. INTRODUCTION:

Cement stone from ordinary, pozzolanic and slag Portland cement even after prolonged hardening contains a certain amount of non-hydrated clinker particles. In addition, pozzolanic and slag cements have a slower hardening and can have significantly lower strength compared to ordinary Portland cement. A relative decrease in strength may be greater than the amount of active mineral supplement introduced. [1,2].

These features of the structure formation of cement stone indicate underutilization of the activity of the binder and the presence of internal reserves to improve the properties of cement and its economy by introducing fillers. Although the proposed and widely used in cement production active mineral additives are aimed at solving this problem, however, as noted above, they do not provide the desired effect, which is probably due to the grinding of mineral additives to or a large fineness of grinding cement clinker.

This assumption is well explained from the standpoint of autohesion of bulk materials. Fine materials are characterized by significant porosity and disordered structure. With a decrease in the particle diameter, the forces of autohesion and internal friction increase and prevent a more complete packing of particles. In this regard, it was shown that the introduction of mineral additives in the form of fillers of a coarser dispersion positively affects the autogenesis of cement particles.

When co-grinding cement clinker with clay, the latter is crushed faster due to lower hardness and the mineral additive is characterized by a significantly greater particle dispersion than cement. Therefore, the powder of pozzelanic cement is characterized by a smaller comparison with ordinary Portland cement by the value of shear resistance (τ).The even smaller value (τ) of Portland cement with fly ash also explains the high dispersion and porosity of the filler. (3).

2. THE OBJECTIVE OF THE RESEARCH IS:

- To justify the possibility of obtaining a concrete mixture with a high content of coarse-grained fillers (slag or electrothermophosphoric slag) and a rational dosage of ACF-3M resin additive. To do this, the following experimental and theoretical studies are carried out.
- In order to justify the rational dispersion and filler content in Portland cement on a device developed at the Institute of Chemical Physics of the Russian Academy of Sciences, the shear resistance of binder powders of various compositions was determined.
- To establish the basic laws of structure formation and identify the features of the mechanism of hydration and hardening of Portland cement with mineral fillers and the addition of ACF-3M:

in studies, the plastic strength of cement pastes is determined on a Hipplerconsistometer.

the structure formation of cement stone and the phase composition of neoplasms are investigated using methods of thermographic, quantitative x-ray phase and electron microscopic analyzes.

- A study of the technological physical, technical and operational properties of cement mixtures and concrete was carried out according to current standard methods.

3. THE SOLUTION TO THE PROBLEM.:

From the moment of mixing, the dispersed filler exerts a peptizing and structure-forming effect in the cement test, thereby accelerating the hydration and hardening of cement stone. This effect of dispersed fillers is explained by the fact that the particles of the filler located between the individual grains of cement, push them apart and increase water access to them. The resulting hydration products are distributed in a large volume, since they are removed from the reaction zone to the surfaces of the filler particles. It was established in MIIT, TashIIT, Odessa ISI, FerPI and other developments that for each type of mineral substance there is its own optimal dispersion of the filler, and that there is no need for joint grinding of the mineral substance and clinker to obtain cement.

On the contrary, the mineral substance should be grinded separately to the optimum dispersion and injected into it when preparing the concrete mixture or when receiving filled cement, separately grinding the cement clinker and the mineral filler, followed by mixing. The enlargement of the particles of mineral cement additives cannot fully ensure the achievement of the goal, since an excessive increase in the filler should lead to the effect of dilution of the binder and a decrease in its activity. Compensation of this factor can be achieved by introducing plasticizing chemical additives into the concrete mixture. [3,4,5,6,7,8,9].

4. THE MAIN CONTENT OF EXPERIMENTAL AND THEORETICAL RESEARCH.:

Given the large reserves, the technical and economic feasibility, as well as the environmental need to use concrete as fillers, the use of slag and electrothermophosphoric slag is justified. For comparison purposes, fly ash was also used. [3]. The experiments established that in the rational dosage range of the ACF-3M additive (0.1-0.2% of cement weight calculated on the basis of dry matter), the water demand of ordinary pozzolone Portland cement is reduced by only 6%, and the greatest strength indicators of cement stone are observed at 0.15 % additives. Therefore, in the future, 0.15% ACF-3M additives were taken in studies.

When gliege and ETF slag are introduced as a filler, the extreme character of shear resistance is observed at a dispersion of ~ 1500 cm2 / g and a filler content of 25% with the same filler content up to 50% (Figs. 1 and 2). Coarse-dispersed fillers have a positive effect on the accommodations of the water demand of cement stone; it has an extreme character with a dispersion of 1000-1500 cm2 / g and a content of 45% of fillers (Fig. 3-4). The extreme strength of cement stone is observed at a dispersion of 1500 cm2 / g and a content of 25% fillers (Fig. 5 and

The introduction of a coarse-grained filler reduces the total surface in contact with water, which in combination with the addition of ACF-3M positively affects the reduction in water demand of cement dough, setting time, the kinetics of structure formation and the strength of cement stone.

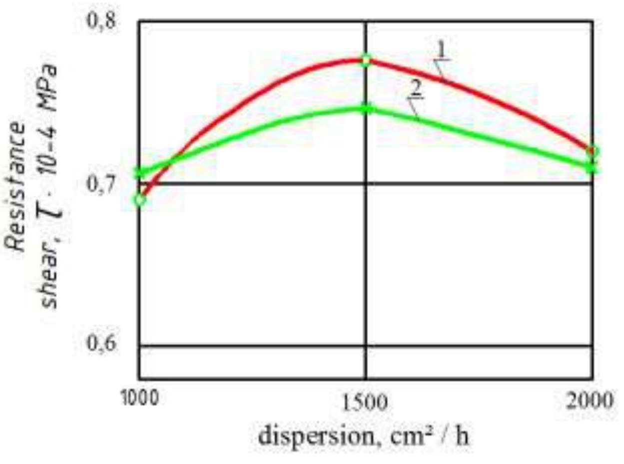

Figure-1 Dependence of the magnitude of the shear resistance of the filler on the dispersion.
1-glezh; 2-slag.

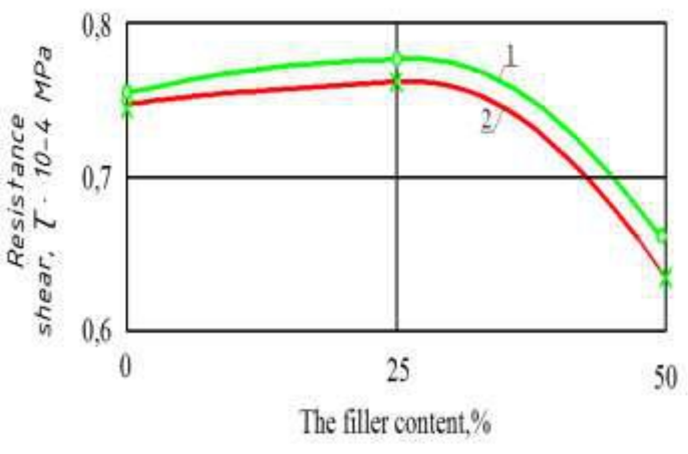

Figure-2 Values of shear resistance of the filler from its content.
1-glizh; 2-slag.

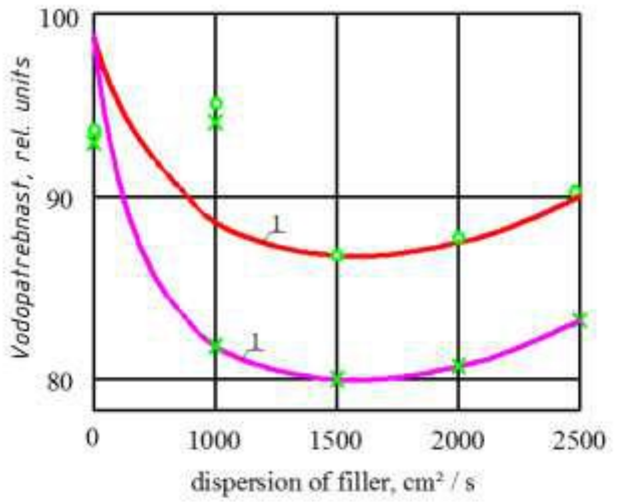

Figure-3 The dependence of the water demand of the cement paste on the dispersion of the filler.
1-glizh; 2-slag.

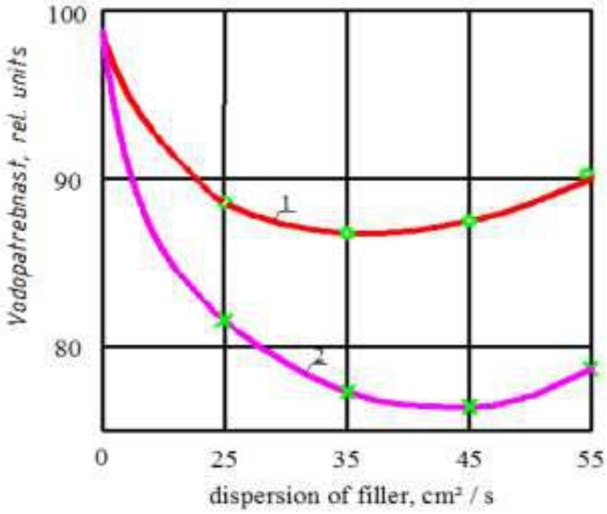

Figure-4 Change in water demand. Cement test on filler content.
1-glizh; 2-slag.

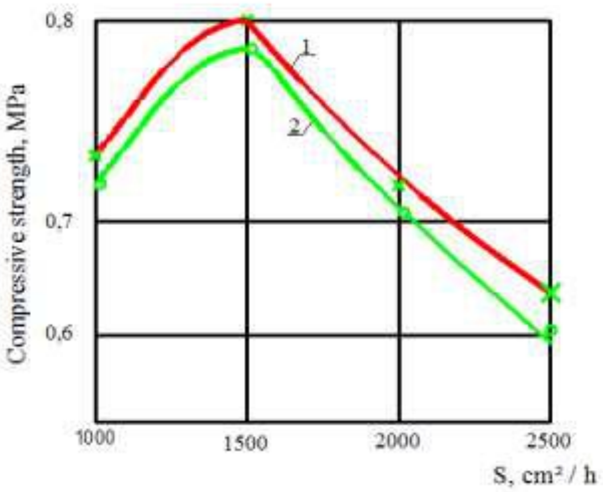

Figure-5 Strength Change cement stone depending on the dispersion of the filler.
1-glizh; 2-slag .

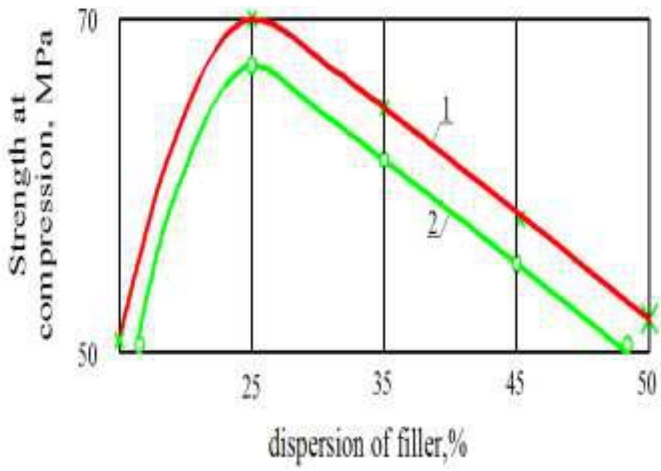

Figure-6 Strength Change cement stone depending on filler content.
1-glizh; 2-slag.

With the joint introduction of 0.15% of the additive and the mineral filler, the greatest degree of reduction in the water demand of the cement paste is 12 and 20% when the dispersion of the clay and slag ETF is 1000 and 1500 cm2 / g. At the same time, the strength of cement stone hardened in water increases by 35-40%. The strength of samples of cement stone with filler glijez is slightly higher than the strength of samples with ETF slag, which is explained by the lower activity of the latter.

With a constant dispersion (~ 1500 cm2 / g) of fillers, comparable with the strength of ordinary cement stone indicators are achieved when the content of slag and ETF slag is up to 45%.

The introduction of large filler particles into Portland cement in combination with the intensifying effect of the action of the ACF-3M additive has a positive effect on the acceleration of the structure formation of cement stone (Fig.

So, the coagulation period of structure formation is reduced from 3 to 1.5-2 hours and the plastic strength indices of cement paste with 0.15% ACF-3M and 25% content of fillers with rational dispersion are 2-3 times higher than ordinary pozzolanic cement. Along with this, the setting and structuring times of the mixed binder are shorter and faster with filler slime than with ETF slag, which is explained by the lower hydraulic activity of the latter.

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The intensification of the structure formation of cement stone with mineral fillers and the addition of ACF-3M favorably affects the increase in strength over time. The strength of the filled cement stone is significantly accelerated in 1 and 3 months. hardening both in water and air - wet conditions and after 3 months. hardening there is a slight increase in strength indicators. (Fig. 9 and 10) The relative increase in strength of Portland cement with iron compared to conventional pozzolanic cement is 1 and 3 months, hardening is 50-75% and 30-40%, respectively, and with ETF-40-70 and 35-40% slag .

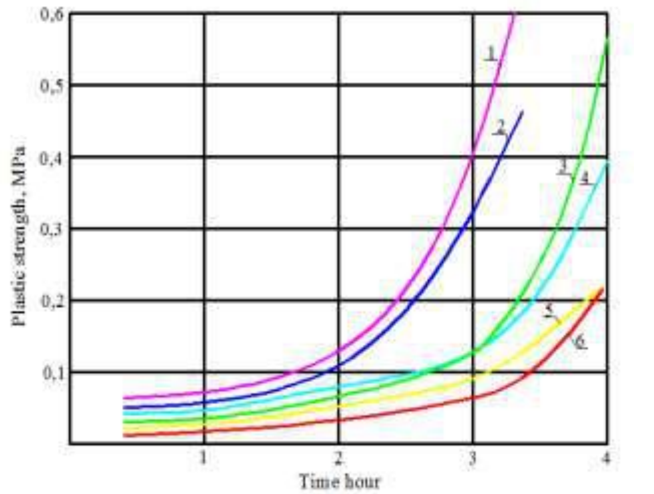

Figure 7. Growth of plastic strength.
cement paste in time depending
on the amount of fillers and the addition of ACF-3M
1-Portland cement with a slice of 25%,
2- also, gliezhem and ACF-3M,
3- also with a slag of 25%,
4- also, with slag and ATsF-3M,
5 pozzolon cement
6- also with ACF-3M

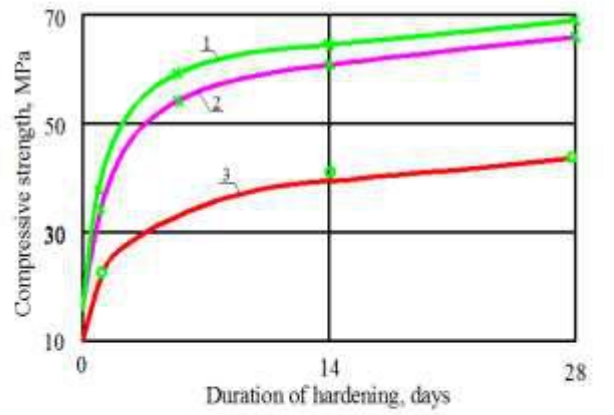

Figure 8. The growth of cement stone strength over time when hardened in water.
1,2- Portland cement with 25% gleizh, slag and ACF-3M, 3-pozzelon cement.

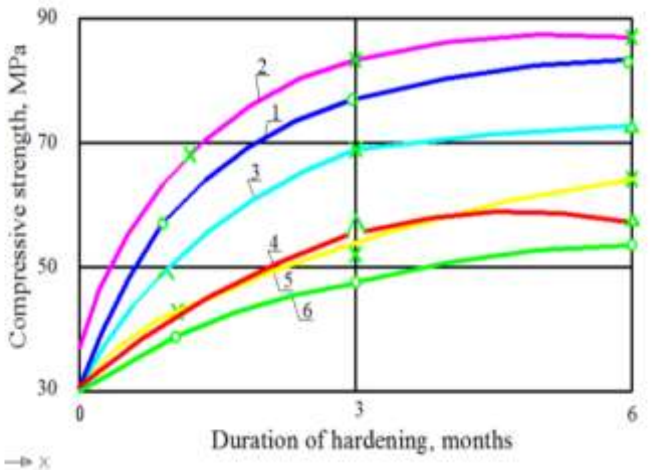

Figure 9. Cement Strength Growth stone in time during hardening in air-wet conditions.
1,3-P / C with a slice of 25% and 45%.,
2,4 - also without ACF-3M,
5 pozzolon cement with ACF-3M,
6 - also without ACF-3M.

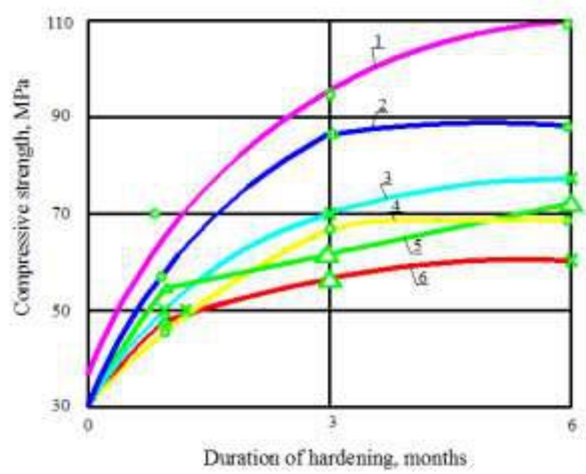

Figure 10. The increase in the strength of cement stone over time when hardening in water .
1,5- Portland cement with 25% and 45% gliezha and ACF-3M, 2,6- also without additives, 3-pozzolon cement with ACF-3M, 4- also without additives

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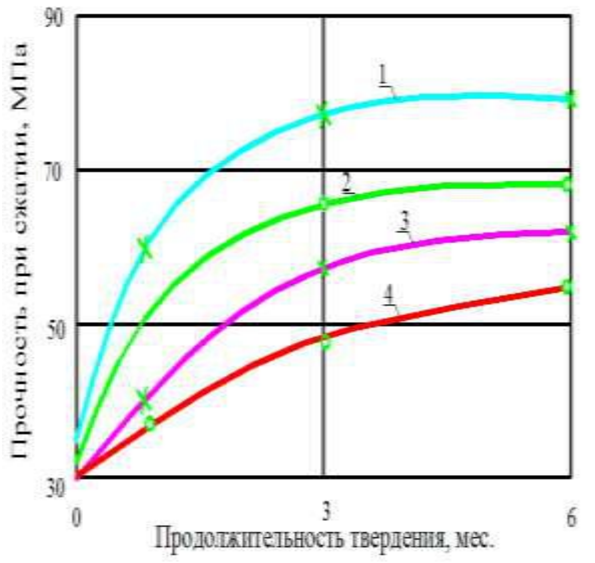


Figure 11. Cement Strength Growth stone in time during hardening in air-wet conditions.
1,3-Portland cement with 25% and 45% slag and ACF-3M. 2,4 - also without the addition of ACF-3M.

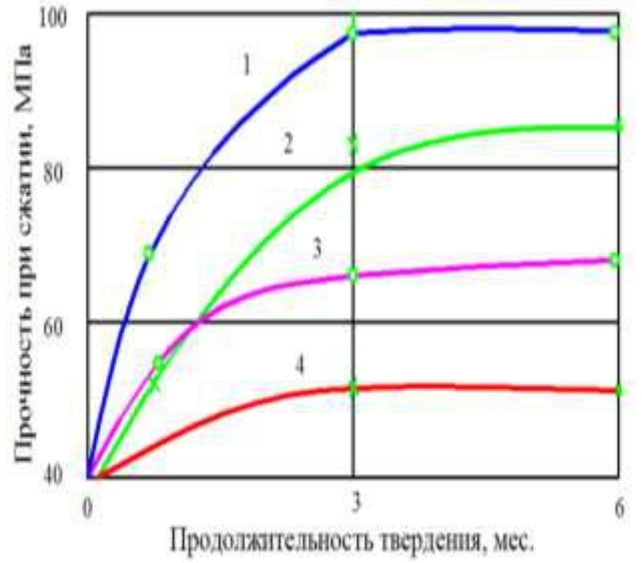


Figure 12. The growth of cement stone strength over time when hardened in water.
1,2- Portland cement with 25% and 45% slag and ACF-3M,
3,4- without the addition of ACF-3M.

With the joint introduction of mineral fillers and ACF-3M additives into Portland cement, the general patterns of the morphology of cement stone - its block aggregate structure - are observed. The use of ACF-3M additive and an increased amount of coarse mineral fillers contributes to the compaction of cement stone, reduces shrinkage, which may result in increased concrete durability.

The introduction of coarse dispersed fillers and ACF-3M additives leads to a more uniform pore size distribution, reduces capillary porosity and increases the number of conditionally closed pores, improves the pore structure of cement stone with fillers and causes a sufficiently high frost resistance of filled concrete, which amounted to 300 cycles.

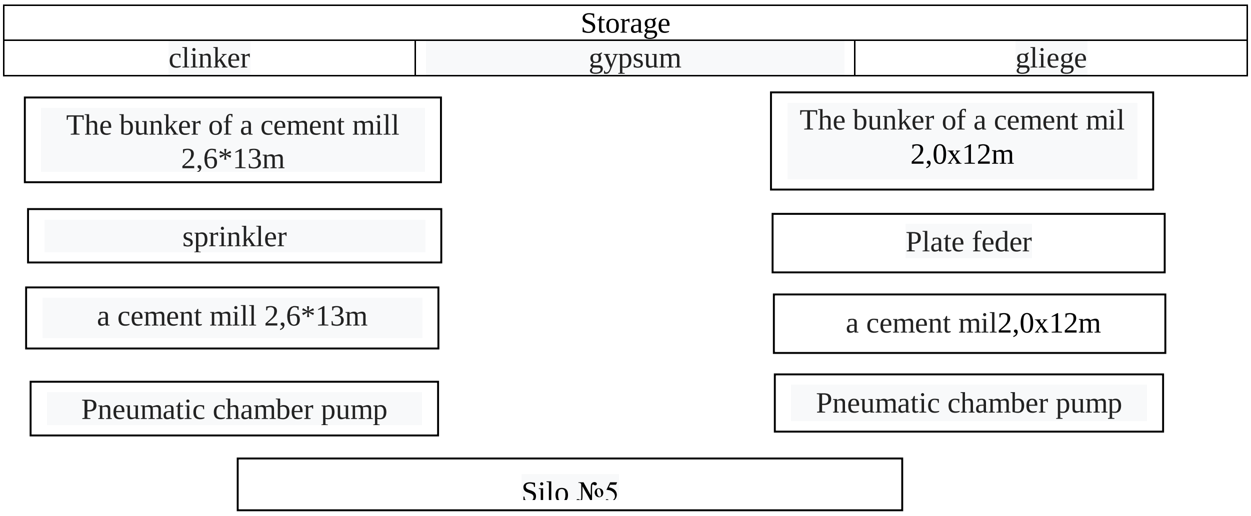
Comparative studies of the influence of fly ash on the properties of cement paste and stone with the addition of ACF-3M have shown that in cement mixtures with the addition of ACF-3M, highly dispersed filler with a porous structural can be used in an amount of not more than 30%.

An intensive factor arising from the multistructure theory is the physicochemical activation of fillers by joint grinding of mineral material with various types of surfactants. Based on this, taking into account economic and environmental factors, it is advisable to use a filler jointly crushed with caprolactic production by-products. So, the use of glizh and ETF slag, modified with 0.1% caprolactam waste and the introduction of 0.15% ACF-3M reduces the normal density of cement paste to 21-22%. Strength indicators are 15-25% higher than cement stone with unmodified filler. It was also shown that despite the shift of the crystallization period of structure formation upward, the plastic strength indices of cement paste with a complex additive are slightly, but higher than without ACF-3M.

The results of experimental studies, the use of coarse dispersed fillers and additives ACF-3M in cement systems allows them to be introduced into production. In production conditions, cement was obtained, similar to putioplan, with a high content of 40-50% of the mineral filler. The filler in the combination of additives ACF-3M was used for concreting the concrete cladding of irrigation canals and for the production of displaced reinforced concrete hollow core slabs.

The traditional technology of cement production using mineral additives and mineral additives allows the search for Portland cement using a mineral filler, which should be half as much as the cement itself. Therefore, we, together with the engineering and technical workers of the Kuvasay cement plant, proposed a separate technology for grinding cement clinker and mineral filler with their subsequent mixing in the stream in the required proportions.
Schematic diagram of the production of Portland cement with mineral filler is presented in scheme-1.

Scheme 1. Technological scheme of obtaining Portland cement with a mineral filler.



In accordance with this technology, pilot batches of portland cement with a mineral slab-slurry of the Kyzylkiy field were produced with a specific surface of ~ 1500 cm2 / kg, with a filler content of 40% -148 t and 50% (of clinker weight, respectively) -72 t. Test properties the resulting batches of cements are shown in table-1.

Table – 1 Physico-mechanical properties of portal cement with mineral filler.

№	Recruitment of indicators	unit of measurement	Filler amount slice% 40 and 50	
1.	Normal density	%	26,5	26,5
2.	Setting time:			
3.	Start	Hour/min	1^{40}	1^{45}
4.	end	Hour/min	3^{00}	3^{10}
5.	Activity (Strength)	MPA	32,6	28,8
6.	Specific surface area	sm^2/g	3090	3040
7.	Bulk density	kg/m^3	1040	1020
8.	Compacted bulk density	kg/m^3	1450	1420

The resulting batches of cement, as can be seen from the table, meet their performance indicators with the requirements of GOST 22266-76 for pozzolanic Portland cement.

Portland cement with a slurry content of 40% was used in the preparation of a concrete mixture with the addition of 0.15% ACF-3M for facing the P-3 canal in the Kushtepa district of the Ferghana region.

The channel is characterized by the following dimensions: depth-1.05 m; width along the bottom -1.0 m, on the top-4 m; slope slope = 1.5; cladding thickness 15 cm.

For channel lining, the concrete mixture M-150 of the following composition (kg / m3) was used: Portland cement with mineral filler glijez (40%) -318 :; sand with MKR = 2.9-770; crushed stone of a fraction of 10-20 mm-1100; additive ACF-3M-0.68; water 182 l; w / c-0.57;

The concrete mixture was digested in a continuous automatic mixing plant SB-75 with a capacity of 30 m3 / h. The concrete mixture was transported over a distance of 47 km by KAMAZ dump trucks with a body capacity of 5 m3.

The technology of concreting the canal lining included the following processes: supply, laying and compaction of the concrete mixture, primary and subsequent care of freshly compacted concrete.

When facing the channel, the supply and laying of concrete mixture was carried out manually with unloading of concrete mixture by dump trucks directly into the channel, the concrete mixture was compacted with a surface vibrator HB-91. In the concrete cladding along the entire perimeter, every 5 m along the length of the channel, seams were cut that were stained 2 times with hot bitumen. Initial maintenance of freshly compacted concrete was carried out by covering the canal lining with a plastic film. Subsequent care was carried out by arranging on the surface of the lining of a wettable coating of sand and systematic abundant moisture until concrete reached 70% of design strength. In the process of concrete work, input and operational types of control were carried out by periodically determining the mobility of the concrete mixture at the place of laying and making sample cubes for their subsequent testing at 7 days of age. The test results showed that the concrete mixture was characterized by workability within 3-4 cm in the draft of a standard cone, and the strength indicators were 72-76% of the design.

5. RESULT:

The results of the work showed the possibility of saving cement consumption by 40% with good quality of the channel lining.

Multi-hollow core slabs at Faiziabad Rural Construction Plant were also made from Portland cement with a mineral filler - gliezh - 40% and the addition of 0.15% ACF-3M. The concrete mixture was prepared from sand with MKF = 2.9 and a degree of contamination of 2.7%, as well as crushed stone fractions of 10-20 mm and the following consumption of components (kg / m3): cement-290; sand-1150; crushed stone -830 and W / C = 0.43; ACF-3M-0.62 additive.

The results of experimental moldings showed that the duration of the manufacture of plates is reduced by 25% and the strength of concrete in samples and products after steaming according to the standard mode was 70-75% of the design. Due to the improvement of the thixotrene properties of the mixture, the surface of the plates was of good quality.

6. CONCLUSION:

Based on the analysis of literature data on the production and use of pozzolanic and Portland cement slag, based on the ideas of the multistructure theory of composite materials, the effectiveness of the use of coarse-dispersed fillers-slag and electrothermophosphoric slag in combination with the addition of non-inogenic type ACF-3M-surfactant for the first time is substantiated in cement systems.

The dependence of the autogenesis of Portland cement particles on the type, dispersion, and filler content is shown. The optimal dispersion of the fillers of glizh and slag (~ 1500 cm2 / g) and the rational limits of their quantitative content were established. (25-50%). The relationship between the maximum shear resistance of cement powder and the strength of cement stone was also revealed.

The extreme nature of the strength of the cement stone from the dispersion, the content of the mineral filler during rational dosing of the ACF-3M additive in the amount of 0.15% of the mass of mixed binder was revealed. When 25% of the clay and slag fillers with a dispersion of 1,500 cm2 / g are added to the cement paste with the addition of ACF-3M, the strength of the cement stone is 40-60% higher, and at 45% of the filling, indicators comparable to the strength of the stone on ordinary cement are provided. On the example of fly ash, it is shown that an increase in dispersion reduces the marginal content of the filler in the concrete mixture with the addition of ACF-3M to 30%.

The research results are introduced into production. According to the developed factory technology of separate grinding of cement clinker and mineral filler, the Kuvasay cement plant produced pilot batches of Portland cement with a slurry content of 40-50%, a dispersion of 1500 cm2 / g, which meets the requirements for pozzolon portland cement. The use of Portland cement with a mineral filler - 40% glizh with ADF-3M admixture for concrete cladding of irrigation canals at the Ferganairstroy trust facilities showed a good canal cladding, as well as the production of prefabricated hollow core slabs due to improved thixotropic properties of the mixture, the surface of the slabs was of good quality.

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