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Influence of softener on rheological characteristics of the nanostructured modifier

NELUBOVA Viktoriya Viktorovna, STROKOVA Valeriya Valerievna, ALTYNNIK Nataliya Igorevna, PODGORNIY Iliya Igorevich

Belgorod State Technological University named after V. G. Shoukhov,

Russia, Belgorod, Kostukova st, 46

[a]vvnelubova@gmail.com, [b]vvstrokova@gmail.com, [c]natalya-altynnik@yandex.ru, [d]mantra500@mail.ru

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Abstract. Article is devoted to studying of influence of additives on rheology of the nanostructured modifier on the basis of silica-containing raw materials. Optimum technological combinations of the plasticizer were defined, which allow to change flow character of a suspension and to give to a material necessary properties. Basic possibility to use additives on a melamine-formaldehyde basis for plasticization of the nanostructured modifiers of silicate structure is proved.

Introduction.

In modern Russia low construction of individual housing develops with high rates. That gives application for a wide range of construction materials among which one of the most effective is the autoclaved gas concrete. By experience of production of autoclave cellular concrete it is shown that the macrostructuring, formed at the first stage of receiving products, directly depends on essential quantity of factors: temperature of mix, dispersion and structure of components, and also from rheological characteristics (mobility) of cellconcrete mix which directly depends on characteristics of input products.

One way of regulation of system mobility is application of the disperse components, which are capable to give necessary viscoplastic properties for mix.

According to the performed earlier researches we have established the possibility of application of nanostructured binder, received by technology of the high-concentrated binding systems (HCBS/VKVS), as a modifying component receiving silicate autoclaved materials [1, 2].

Earlier, the use of the high-concentrated binding systems (HCBS/VKVS) for production of construction materials was complicated that is connected with features of rheological characteristics of the binder. For plastification of the binder the additive of SB-5 developed by scientists of BSTU named after V. G. Shoukhov was offered. However, raw materials for production of this softener are resorcin and furfural. The source of this raw materials is almost exhausted. In this regard there is a need of correction of structure of the complex modifier by introduction of a new plasticizing additive.

Experimental program.

For researches nanostructured binder on the basis of sand of the Korochansky field was used. As a plasticizing additive it is offered to use melamine – formaldehyde plasticizer Melment F10 softener (BASF, Germany). This type of plasticizer differs with its universality and wide usage in suspensions of various structure. The dosage of plasticizer in system gets out on the basis of the optimum concentration recommended by the producer for cement systems. According to recommendations of the producer, concentration of plasticizer Melment F10 should be in limits of 0,2-1,5%. In this regard for experiments the following dosages of an additive were accepted: 0,03; 0,05; 0,1; 0,2; 0,3; 0,4; 0,5%.

For studying influence of additives on a rheology of system suspension with the set concentration of the additive was prepared. Calculation of quantity of additives was made on solid substance. Correct calculation requires determination of initial humidity of suspension. Further suspension with the measured amount of plasticizer arrived to the operator for shooting of rheological characteristics with help of the Rheotest RN4.1 device. After the end of shooting all obtained data were transferred to a graphic view.

For comparison of the fluidity of suspensions Engler's viscometer was used. Testing liquid was poured in a vessel, and then let out through nozzles. Flow time of 200 cm^3 of liquid is fluidity.

Research of mobility of cement suspensions in the presence of superplasticizer was made with help of a mini-cone. By the received results of measurements the diagram of dependence of a mini-cone spreading from a dosage was built and the minimum dosage which shows the maximum plasticizing effect was defined. Optimum dosage was determined graphically by a curve excess in the maximum value of a mini-cone spreading.

Results and discussions.

Apparently from the obtained data, the modifier of initial structure possesses a typical character of flow for these systems (fig. 1).

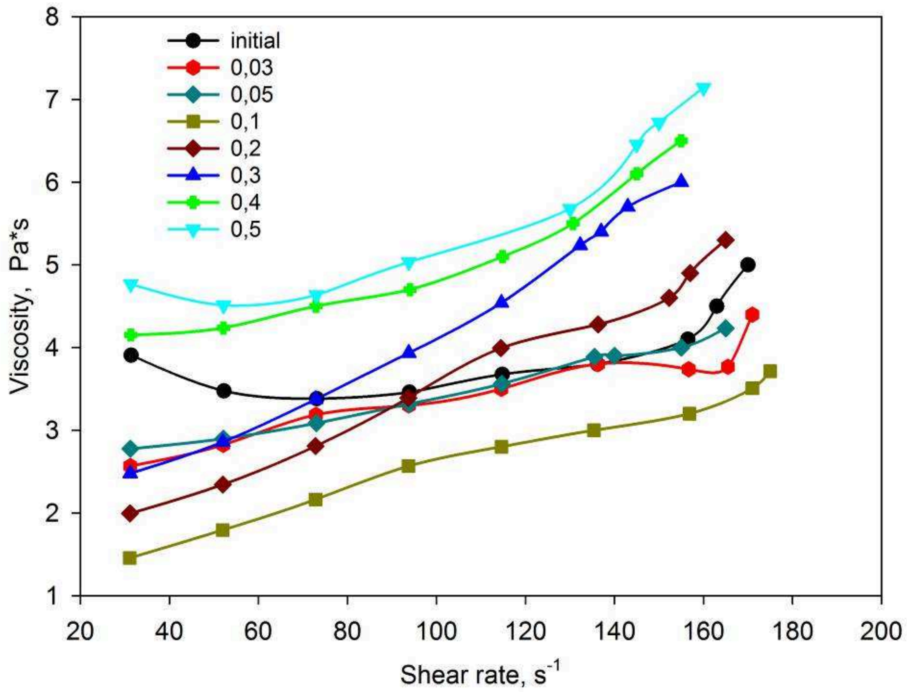

Fig. 1. Reogramma nanostructured softener knitting depending on quantity

At small gradients of shear rate (to 100 s^{-1}) the system shows thixotropic properties: gradual decrease in viscosity is observed. While loading the system with dynamic power (the gradient of shear rate is higher than 150 s^{-1}) its structuring is noted.

Plasticizer introduction in system promotes its fluidifying. At introduction of small dosages (0,03 and 0,05%) character of flow of curves is similar to the initial modifier. Decrease in initial viscosity by 1,5 times in comparison with NM is noted. However, it is obvious this amount of plsticizer isn't enough since value of final viscosity for three structures practically coincides.

The increase in amount of plasticizer (0,2 and 0,3%) leads to essential falling of initial viscosity. However, final viscosity of system is higher by 10 and 25% in comparison with the initial modifier at a dosage of plasticizer 0,2 and 0,3% respectively.

The further increase in plasticizer amount leads to increase of viscosity of the modifier. Thus the system is characterized by classical dilatant type of a current: the increase in viscosity along with increase of a gradient of share rate that is caused by an obvious overexpenditure of an additive in system is observed. That leads to formation of clusters in structure of NM and to modifier jelling.
Optimum rheological properties characterize the composition with the content of plasticizer of 0,1%. In this case decrease of both initial and final viscosity is observed: in 2,5 and 1,8 times respectively in comparison with the modifier of initial structure.
For confirmation of the obtained data, mobility and modifier fluidity depending on the content of softener were also studied (fig. 2).

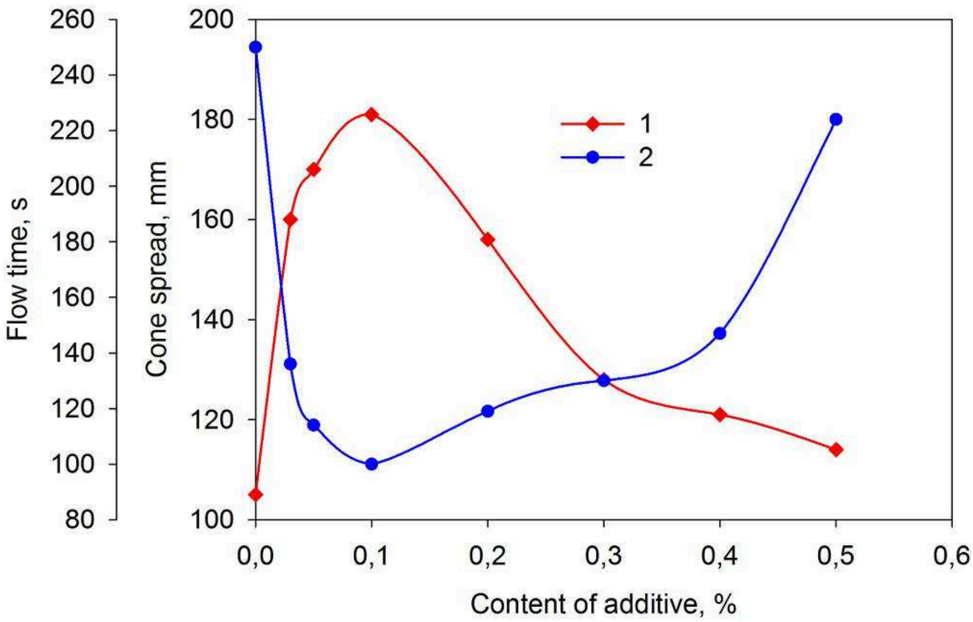

Fig. 2. Dependences of mobility (1) and fluidity (2) the modifier from amount of softener

The provided data shows that the increase in amount of plasticizer to 0,1% leads to increase of mobility of system (a curve 1, fig. 2.) . The further increase in amount of additive in system isn't expedient as leads to decrease in rheological characteristics of the nanostructured modifier. Thus introduction of optimum quantity of an additive (0,1%) promotes increase in fluidity by 2,5 and mobility 1,7 times in comparison with the modifier without plasticizing components.
For confirmation of efficiency of plasticizers on a melamine-formaldehyde basis the granulometric structure and value of the electrokinetic potential (dzeta-potential) of a colloidal component of the modifier depending on the content of plasticizer in system were studied in this work.
Introduction of the plasticizer in structure of the nanostructured modifier changes a potential sign with positive to negative (table. 1) that confirm to its adsorption on a surface of particles of firm phase NM. The increase in concentration of an additive to 0,1% promotes increase in dzeta-potential to the maximum value. It confirms efficiency of this dosage. The further increase is inexpedient since value of dzeta-potential decreases.

Table 1. Value of electrokinetic potential depending on the content of NM

Maintenance NM, %	0	0,03	0,05	0,1	0,2	0,3	0,4	0,5
Electrokinetic potential, mV	34,85	21,49	22,94	27,44	23,19	21,8	19,49	18,8

The analysis of particles size distribution (fig. 3) testifies the shift of the sizes of particles in smaller area in comparison with the initial modifier. Thus introduction of over 0,2% of modifier leads to increase of the size of particles that is caused by aggregation of particles in the clusters, caused by excess of softener.

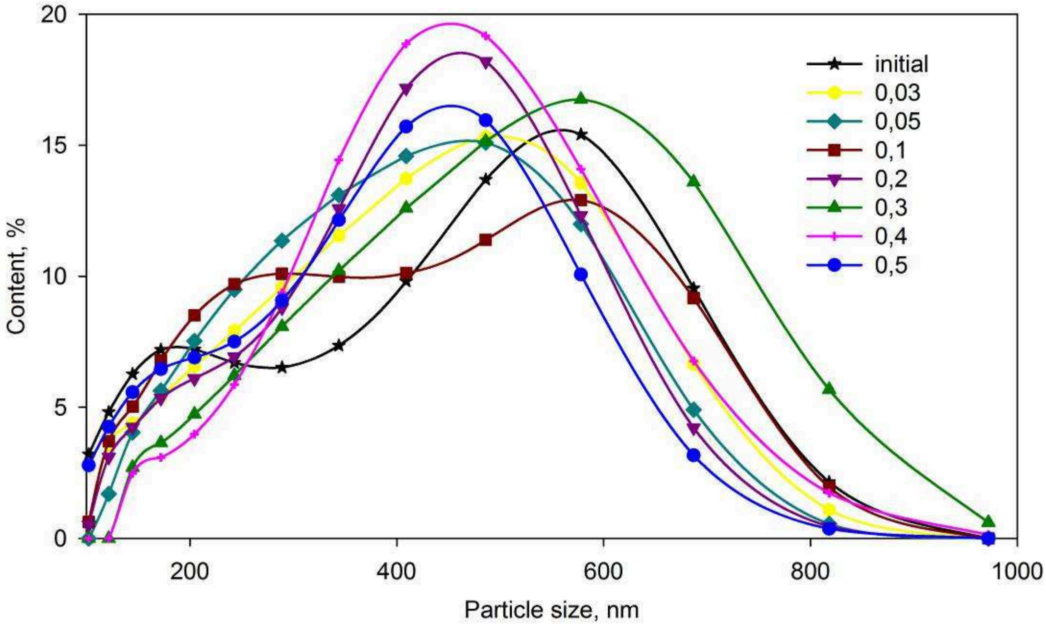

Fig. 3. Distribution of particles of colloidal fraction by the sizes depending on the content of softener

Shift of peaks towards particles of the smaller size for the modifier the content of plasticizer in which makes 0,1% is noted. Thus along with decrease in concentration of particles with sizes of 500-600 nm the increase in concentration for particles with sizes of 200-300 nm by 1,5 times is observed.

Specified facts can be explained by the following. In this case the additive carries out double function: being adsorbed on a surface of particles of a firm phase, it changes a surface charge that leads to decrease in viscosity of system. Thus plasticizer carries out dispersing function, as was noted in the analysis of particles size destribution.

Conclusions

There by, basic possibility to use additives on a melamine-formaldehyde basis (Melment F10) for plasticization of the nanostructured modifiers of silicate structure is established. Thus the optimum amount of an additive in system shouldn't exceed 0,1%. The further increase in content of additive in system isn't expedient as leads to decrease in rheological characteristics of the nanostructured modifier. Introduction of optimum quantity of an additive (0,1%) promotes increase in fluidity by 2,5 and mobility by 1,7 times in comparison with the modifier without plasticizing components. Introduction of the plasticizer into the system promotes its fluidifying.

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