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COMPARATIVE ESTIMATION OF DOMESTIC AND FOREIGN SUPERPLASTICIZERS FOR MANUFACTURE OF HIGH STRENGTH CONCRETE

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ABSTRACT

Estimation of domestic and foreign superplasticizers blocking action on hardening of various cements is carried out. The opportunity to use them for unwarmed and slightly warmed up high strength concrete is established.

Keywords: hardening, durability, cement superplasticizer, technology, concrete.

1. INTRODUCTION

Superplasticity of concrete mixtures, which do not block cement hardening, is a basis for manufacture of unwarmed and slightly warmed up high strength concretes, which for Russia defines the economy of construction in many respects.

Molecular nature and structure of superplasticizer (SP), presence of active functional groups determine their adsorption ability on various relicts of cement particles and rheological activity in water suspension of powders and hydraulic hardening of bindings.

A condition of molecules of domestic and foreign superplasticizers with various functional groups and study of their rheological action on dispersed system of mineral natural technogenic materials considered on more than 200 mineral kinds and their mixtures have allowed to formulate the following universal features of chemical structure of "good" plasticizers molecules.

1. Chemical generality of all plasticizers in superplasticizers is determined by existence of oxygen groups in structure of functional groups in which a negative charge is located or delocated at the expense of ionization of monomeric or oligomeric molecule in alkaline environment. Adsorption of oligomeric ions is carried out owing to nucleo attack of active centres of a surface.
2. Maximal dispersed and plastifying effects in water mineral systems are peculiar only to plasticizers of onion type of oligomeric structure with rather small length of a circuit with 530 monomeric parts with active functional group, mainly SO_3 groups. These are aromatic one, two and multinuclear carbo heterocycled sulphonizing, hydroxylated and carboxylated compounds with developed resonant electronic carbo or heterocycle system.

3. Adsorbing and the best plasticizing alility depends on the sizes of induction effects, i.e. the presence of electronic pulling groups, values of mesomeric effects, i.e degree of charges and connections levelling owing to delocalization and spreading of electrons functional group, influencing the whole molecule of substance. This is experimentally proved for oligomeric molecules and it is a determining factor for search and synthesis of new effective superplasticizer to display high efficiency.
4. To display high efficiency aromatic compounds should be in soluble salty form ionized by water or electrolytes. In this connection, in binding systems, activated by concentrated alkaline hydroxides solutions, hydrolys of superplasticizers is presented, and full dispersing of binding particles take place due to deep superplasticizer ionization.
5. Volumetric alkyl and aryl lateral substitutors creating geometrical difficulties at adsorption worsen plasticizing action as well as two replaced olygomers at the nucleus with substitutors in pair–state (in state 14) for naphthalene.
6. From A and B multinuclear condensed sulphoacide or naphthalene phenil. B acids and B phenols are more effective than their A homologue because of creation of higher density of nucleuses and functional groups location along oligomeric length circuit and thus more extended delocalization of electronic system cycle and creation of high molecular barrier on the surface of firm phase presenting aggregation and particles adhesion.
7. Plasticizing action of linear annelated multinuclear compounds is much higher than angular annelated owing to display of oriented steric effects at adsorption.

It is possible to consider the following as colloid chemical and rheological features:

1) Plasticizers for provision maximal deluent effect unlike existing conception shouldn't promote creation of special coagulated structures both in volume and in surface layers of firm substances at adsorption. They should prevent multilayer water adsorption on particles surface and promote formation of minimal lager dynamically free water, transforming semi dry powders and rigid pastes in watery state.
2) More perspective superplasticizers for dispersed system are such substances which greatly reduce superficial tension on the border "firm phase-liquid" and lower in the least degree superficial tension on border "gas-liquid", opposite to existing thinking, preventing strong air-entraining.
3) Criterion of the best superplasticizer action is creation of highly-aggregate-firm dispersed systems not only in the state of water suspensions but in firm pastes and humidified pressed powders, when at high pressure of pressing the interpartjal distances correspond to close potential minimum, and the system doesn't coagulate.
4) Rheological action of "good" plasticizers on the degree of fluidity limit decrease for mutually combined superplasticizer and mineral powder makes 4-5, for cement fluidity limit decreases in 250-350 times. Water lowering should provide volumetric concentration increase of firnl phase in systems up to 50-70% and more at the same fluidity.

The carried out analyses allowed to approach scientifically to revealing mechanism of superplasticizer action taking into account modern ideas of chemical mineral structure of firm phase.

For cement systems plastified by superplasticizer not only rheological efficiency is necessary but hydrated activity, determining early and the following durability.

The requirements to superplasticizers are considerably extended in technology of unwarmed and slightly warmed up concretes. For these concretes superplasticizers should delute concrete mixtures to provide the best water reduction as well as to serve simultaneously as an accelerator of initial and following concrete hardening. We can call this superplasticizer effective universal additive to unwarmed and slightly warmed up concretes. It is obvious that synthesis of these superplasticizers is a difficult task and at the first stage it is important that the SP won't block the kinetic of early hardening of concrete mixtures with strong water reduction as the following increase of durability of plasticized concrete is provided at the expense of high density and contact in constrained conditions of cement particles.

2. CHARACTERISTICS OF THE USED SP AND CEMENTS

Traditionally used SP C-3 by Novomoscowsky chemical plant was used as a plasticizer of Russian production.

SP C-3, which diluents concrete mixtures is an additive on the basis of naphthalene sulfacid and formaldehyde polycondesation. It is produced by Novomoskowsk plant of organic synthesis according to TC-6-36-020429-625.C-3 is a liquid, with dark brown colour, solution with 30-39% concentration. The product does not change its properties at heating and freezing up to T-40C PH of the environment is 4-6. Recommended dosage in concrete mixtures is from 0 4 to 1%.

Peramin FP (SMF-10) is a highly effective SP. It is a white powder of melamine sulphanate, condensed by formaldehyde (a producer is Peritolp, Sweden) Peramine FP does not contain chlorine ions and is compatible with all other peramine group products, such as dehydraters air involving additives, accelerators, retarders and a big group of other highly effective additives. The main properties of SP SMF (Sweden) are given in Table I.

Table I Main proerties of SP SMR

Properties	Value	Method
Relativedensi at 20C	1.21 dm^3 +$10_2/dm^2$	ISO758
Finn content	35% ±1%	BS-EN-480-8
Equivalent Na_2O	<5%	BS-EN-480-12
Chlorine content	<0 05%	BS-EN-480-10
Phvalue	10 5±1.0	150-4316
Active components	Oligomer on the basis of melamine	
Colour	Transarent	
Point of freezin	0 C	
By-effects of introduction	No	
By-effect of overdosage	Delay in hardening	
Melment □ 10		

For testing they used cements with various additives with gypsum stone received by grinding

Table 3

No.	Kind of cement	T. of hardening	Kind of additive	Durability at MPa			
				1 day	2 days	3 days	28 days
1	Cement on the basis of "Volskcement" clinker	16±0.5	-	8.1	15.0	25.0	51.8
			C-3	-	0.75	19.7	52.6
			SMF-10	7.9	32.5	38.0	60.0
			SMF-30	6.4	30.1	37.5	58.9
			C-3+SMF-10	3.2	26.1	36.8	56.5
		23±0.5	-	9.6	19.0	27.1	56.9
			C-3		8.8	21.4	52.1
			SMF-10	9.9	20.5	39.4	64.9
			SMF-30	7.1	21.2	38.1	61.1
			C-3+SMF-10	8.1	20.0	36.4	62.1
2	Cement on the basis of "Oskolcement" clinker	16±0.5	-	6.4	20.0	24.4	48.7
			C-3	-	-	10.1	47.5
			SMF-10	-	17.6	34.4	59.8
			SMF-30	-	12.5	32.1	54.4
			C-3+SMF-10	-	15.1	33.1	57.2
		23±0.5	-	15.1	18.6	26.0	48.3
			C-3	-	3.2	15.6	45.0
			SMF-10	6.6	19.2	36.1	58.8
			SMF-30	3.1	18.4	34.3	56.1
			C-3+SMF-10	5.2	18.8	35.1	57.2
3	Cement on the basis of "Mordovcement" clinker	16±0.5	-	19.4	26.0	35.0	49.9
			C-3	20.6	29.0	49.0	65.0
			SMF-10	18.5	27.7	48.8	64.2
			SMF-30	15.5	23.3	49.0	61.5
			C-3+SMF-10	17.1	26.3	47.1	63.3
		23±0.5	-	23.4	28.9	39.0	51.3
			C-3	37.6	39.1	44.0	59.2
			SMF-10	30.4	34.1	41.1	60.9
			SMF-30	25.0	32.1	40.9	59.8
			C-3+SMF-10	31.2	34.4	45.5	61.1

Table 4 Structure and physical mechanical characteristics of super heavy high strength concrete

No.	Expenditure of materials m^3 kg.			Kind of SP dosage %	V/C	CS sm / G sec.	Durability MPa/Density kg/m^3		
	Cement	Sand	Granite crushed						
1	620	730	1300		0.38	2-4%	17.6/2520	38.0/2490	74.0/2483
2	560	560	1300	C-3 1%	0.29	2-4%	50.0/2515	70.0/2510	91/0.2500
3	560	560	1300	SMF 1%	0.29	2-4%	55.0/2525	72.0/2550	92.0/2510