

## THE DEVELOPMENT OF CONCEPTION OF NEW GENERATION CONCRETES

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**Summary.** In the article are introduced the main statements of developed technology of new generation concretes with high performance properties. It was shown that the background of the technology is the observance of the principles of the correlation of activated effects on all components of a cementing system. There have been quoted the results of received concretes on activated cementing.

**Key words:** concrete, monolithic constructions, organic mineral complex, technology without heating.

### INTRODUCTION

The 20<sup>th</sup> century will be retained in one's memory by a considerable progress in material sciences. A special place in it takes a concrete remained to be a popular material of construction and in many cases determining the level of civilization development. At the same time a concrete represents itself one of the most complicated artificial materials, having at this the unique properties. The concrete is used in different service conditions and is harmonically combined with the environment and differs by its high architectural constructive expressiveness. To a number of positive qualities of a concrete should be also referred the possibility of usage local raw and man-triggered products of industry, ecologic safety which is undoubtedly will leave it the main constructive material in foreseeable future. However it's known that a cementing concrete together with the absolute advantages has an important deficiency which is a long term of hardening with all following from here negative productive technologic and economic consequences.

The most widespread method of speeding-up concrete hardening is heating of wares realized in plants' conditions by way of steaming in non-ramming chambers and autoclaves at the pressure of steam 0,8...1,2 MPa. At raising of monolithic constructions are used electric curing and thermal active concrete form.

The process of thermal treatment at the modern level of construction has two significant deficiencies. First of all, it's a high share of energy demands in the structure of production costs of steel concrete constructions having in average

0,45 Gcal/m<sup>3</sup> of steel concrete with the rate 154 m<sup>3</sup> of natural gas. The second and the main deficiency of influence of thermal treatment of concrete is the enlargement of structure imperfection, development of micro crack formations with the growth of internal stresses and as the consequence the considerable worsening of service characteristics of constructions.

One of the most upcoming trends of technologic progress in technology of concrete is the creation of conditions for the formation of arranged structure of cementing stone which will allow to increase service qualities of concrete. By this it's rational the deletion of thermal treatment of a concrete in the way it exists in modern economic conditions.

### RESEARCH OBJECT

The more complete development a modern technology of a concrete got at creating new generation concretes with high service properties – High Performance Concrete. Under this term accepted in 1993 by mutual working group ECC/PRC have been united the multicomponent concretes by resistance at compression at the age of 2 days 30-50 MPa, at the age of 28 days – more 60 MPa, freeze resistance F 600 and higher, water resistance W 12 and higher, with regulated data of deformation [Bazhenov Yu.M. 2001]. In real conditions the forecasting term of service of such concretes is more than 200 years. It's possible to get super long term concretes with the service up to 500 years which is confirmed by the investigations of Japanese scientists [Fukushima T. 1999].

The appearance of high qualitative concretes opened a new epoch in the construction. The unique properties of such concretes allowed to realize such construction projects, the realization of which recently cannot be even possible to suppose. To the constructions of such kind belong the tunnel at the English Chanel, 125-stores skyscraper in Chicago with the height of 610 m, the bridge through the gat Akashi in Japan with central bay 1990 m, the bridge through the gat Nordamberland in Canada with the length of 12,9 km the slant legs of which immerge on 35 m into the water.

The prominent example of of conception realization of new generation concretes with high service properties is the construction of sea oil-producing platform in Norway (1995 year) with the height of 472 m out which 370 m are steel concrete part. The depth of the sea in the place of platform installation is more than 300 m and the platform itself is relied on the influence of brisk storm with the maximum wave height 31,5 m. The forecasting term of service of the platform is 70 years.

Such tasks are also vital for Ukraine, especially, at construction of sea platforms, repair of transport and hydrotechnical constructions, concrete spraying and other works. In this connection appeared the necessity of transfer into fundamental new effects on a cementing as to the means of increasement of service characteristics of concretes of special destination.

With the aim to increase the constructive technical characteristics of heavy concretes it has been developed the technology without heating multicomponent concretes for the account of incorporation of raw materials of cementing mixture having the polyfunctional action on the majority carrier – concrete.

The main principal of developed technology is in application of complex of reactive effects on cementing system combining highly active cementing with active micro filler. Such system was named by S.V. Shestoperov an «agelong concrete», which structure is like «Rome» concretes.

On the modern stage of development the technologies of new generation concretes practically 100% of produced concrete abroad contain in its composition the siliceous component incorporated into the mixture in different states. However in order to get arranged cementing matrix of concrete it's necessary to provide the conditions for the most complete chemical interaction of siliceous component with neoformations of a cementing. From the illustrated analysis it follows that without high-intensity activation of a cementing system and in order to get its long term usage and activation of amorphized siliceous micro filler, it's impossible to get HPC. Namely the combination of activation of a cementing and micro filler defines the principle of mutuality of reactive effects on all the components of cementing system.

A priori considered that the activation should be carried out in turbulence mixers or at ultrasound effect on cementing suspensions. However the famous methods of activation turned out to be not effective enough and the increasement of resistance of concrete on 15-30% doesn't match up to a high level of energy demands.

Summarizing accumulated experience of perfectibility of technology of concretes, one may conclude that the optimization of the properties of concrete is possible at increasing binding potential of cement and chemical activity of micro filler together with the development of high plastifying effect in activated cementing dough. It's evident that till that time there was absent combination of high-intensity physical methods of activation with the chemical ones. Usage of such complex of activated effects must lead to the creation of a material with tailor-made properties.

Taking into account all these statements it was developed by us fundamentally new physical chemical method of high-intensity activation of cementing system of a concrete consisting of a cementing and a special organic mineral complex.

In order to perform physical chemical activation of cementing system it was developed a special reactor-activator which represents itself a cylindrical vessel with opposite positioned nozzles [Pshinko O.M., Punagin V.M., Rudenko N.N., Gerasimenko V.O. 2001].

Chemical part of activation is in the incorporation into cementing dough the organic mineral complex (OMC) consisting of mineral micro filler, organic plasticizer and chemical optimicizer of structure formation. The action of OMC is based on the principal of synergism of components.

Physical part of activation is in the influence of cavitating on cementing system. At impinging of meeting of moving streams of activated cementing system are formed two fronts of blast waves. This happens because of compression shock of material medium in which transferred region appears, spreading with near sound rate. The collision of blast waves in liquid medium leads to the formation of pulsed sign-variable field of ultrasound frequency which in liquid medium of drowned jets intensifies the formation of cavitating space which is accompanied by the formation of cumulating jets.

The development of the process of cavitation according to the [Agranat B.A. 1974] leads to the appearance of the pressure in a liquid phase nearly 300 MPa and a local temperature splashing up to 6000 K within 40 mcs. Low temperature plasmic

impulse appearing in a liquid medium transfers it to the highest level of energetic state as the interaction of electrons and ions of plasma between themselves is characterized by Coulomb forces of gravitation and repulsion descending with distance much slower (i.e. much “long-rang”) than the forces of interaction of neutral particles. For the account of electron impact speed up the processes of molecular dissociation. Cavitation effects intensify the chemical interaction between the neoformations of a cementing and the surface of micro filler. In summary, the cavitation causes the triad of activation effects consisting of dispersion of particles of a concrete and dissection of silicate structures, overground activation of particles of micro filler with the formation of non-compensated structural bonds, including the conversion of a liquid phase into the highest level of energetic state.

## RESULTS OF EXPERIMENTAL RESEARCH

Physical chemical activation of cementing system leads to the change of rheological properties of cementing system itself as well as cementing mixture. Using activated cementing system the castability of cementing mixture is increased from 2...4 cm to 16...18 cm at the same W/C. This effect is explained by the following way. In the process of preparation of organic mineral complex by way of barbotage in a separate reservoir long chain complexes of dosage organic plasticizer are attached to the particles of mineral micro filler [Pshinko O.M., Chernik V.I., Rudenko N.M., Kolesnichenko I.I., Krasnuk A.V., Gromova O.V. 2001]. In the process of physical chemical activation the collapse of cavitation bulbs contribute to splintering of long chain complexes of plasticizer. The last one supports super plasticized effect using usual plasticizers. Besides that, incorporated by such way the plasticizer does not influence passivating on hydration of a cementing.

Established high data of physical mechanical properties of a concrete on activated cementing introduced in Table 1 have both physical and chemical nature.

Table 1. Empirical compositions of small seed concrete on activated cementing

Concrete brand	Composition of concrete, kg/m <sup>3</sup>			Resistance of concrete, Mpa		
	concrete	sand	water	OMC	C/W	
400	342	1857	130	64,64	2,63	80,4
	314	1880	132	57,78	2,38	71,2
500	362	1824	134	73,12	2,70	91,3
	300	1890	132	60,60	2,27	82,6
600	359	1829	133	63,54	2,70	97,4
	305	1895	131	54,04	2,33	93,1

The increase of characteristics is observed at exceeding the definite limit value of intensity of activation which as it was established corresponds to the sill of cavitation. The existence of sill of activation had been proved experimentally according to the change of physical mechanical characteristics including the structure of activated cementing system and the effect of activation is much more manifested on general concretes.

It was especially very important to define the factors of repetitive increase of resistance of concretes on activated cementing. As it's known, the cementing stone in concretes of normal hardening is characterized by block rhythmic structure. Physical chemical activation of cementing system provides the formation of crystallhydrates in three planes. At this the quantity of contacts on the unit of volume increases on 1...2 orders. This important statement is explained by the following.

As it's known, the cementing stone in concretes of normal hardening is characterized by block rhythmic structure [Rudenko N.N., 1999]. In this case crystallhydrates contact as per the scheme "plane to plane". At the implication of load the destruction on the material goes on between plane connections which are the cause of resistance decrease.

In activated cementing system together with negatively charged structure forming ions create also positively charged ones. In this case the contacts between the crystallhydrates develop as per the scheme "border to plane". The destruction of such connections is extremely difficult as with the square enlargement of implification of load the number of connections involved into work extremely increases. By 24h. is observed a well crystallized structure of a cementing stone consisting of cross formed engaged fibrous hydrosilicates, i.e. is formed selfly closed structure of a cementing matrix of a concrete. Hydroaluminates of hexagonal and octahedral form are in close contact with crystals of hydrosilicates. At this the volume of open pores is not considerable [Shpynova L.G. 1981].

Table 2. Norigid characteristics of samples of concrete

Code of prism	R <sub>cube</sub> , MPa	R <sub>np</sub> , MPa	E <sub>0</sub> , MPa	Limit deformations, 10 <sup>-3</sup>		Borders of micro crack formation	
				ε <sub>1</sub>	ε <sub>2</sub>	low	upper
H-4-3	41,4	33,3	43200	1,14	0,357	0,62	0,83
H-4-4	42,2	34,8	42700	1,24	0,386	0,63	0,86
H-5-7	50,6	42,7	49500	1,46	0,437	0,68	0,81
H-5-9	56,8	47,5	37000	1,74	0,493	0,71	0,82
H-5-11	54,7	45,2	42800	1,67	0,702	0,702	-
A-5-7	84,2	73,3	64900	1,70	0,391	0,391	0,91
A-5-9	89,7	78,0	65000	1,90	0,475	0,475	0,90
A-6-5	103,4	90,0	67000	2,39	0,573	0,573	0,93
A-6-7	118,7	104,5	67100	2,40	0,552	0,552	-
A-6-8	112,6	98,0	67000	2,40	0,624	0,624	0,91

Established regularities of structure formation of activated cementing systems allowed getting on their ground the concretes HPC. Physical chemical activation promotes the formation of a special structure of a cementing stone and a concrete. It's confirmed by principally excellent character of destruction of concrete under load which is confided in the formation of a vast zone of pre-destruction and blast release of energy

of compressing stresses as contrasted with the formation of a single main crack at destruction of a general concrete.

The peculiarities of the structure of concrete on activated cementing are also the absence of increased deformation at the initial period of load imposition and high borders of micro crack formations (Table 2). It should be noted the change of the ratio of wedge resistance of got concretes upwards.

## CONCLUSION

Thus the summation of the properties of concretes on activated cementing defines the possibility of their usage at construction, repairing and restoring the constructions of a special purpose.

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## РАЗВИТИЕ КОНЦЕПЦИИ БЕТОНОВ НОВОГО ПОКОЛЕНИЯ

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**Аннотация.** В статье изложены основные положения разработанной технологии бетонов нового поколения с высокими эксплуатационными свойствами. Показано, что основой технологии является соблюдение принципа взаимности активационных воздействий на все компоненты цементной системы. Приведены результаты исследований свойств полученных бетонов на активированном связующем.

**Ключевые слова:** бетон, монолитные сооружения, органо – минеральный комплекс, беспрогревная технология.