DOI 10.52209/1609-1825_2022_4_230 UDC 666.974

Ways to Manage the Quality of Nanocrete

[1]***AKIMBEKOVA Samal,** *Master, Senior Lecturer, sammi_ok@mail.ru,*
[1]***ORAZOVA Dinara,** *PhD, Associate Professor, dinarzhan_84@mail.ru,*
[1]***DYUSSENOVA Zhenisgul,** *Master, Senior Lecturer, zhenisgul1@mail.ru,*
[1]***YAKUBOVSKAYA Galina,** *Master, Senior Lecturer, Galina_pvl7676@mail.ru,*
[1]***OSPANOVA Zhulduz,** *Master, Senior Lecturer, zhulduz-ospan@mail.ru,*
[1]*NCJSC «Toraighyrov University», Kazakhstan, Pavlodar, Lomov Street, 64,*
**corresponding author.*

Abstract. *The article presents an integrated approach to the design of the concrete composition, which contains a combination of various types of modification of the concrete mixture by introducing a hyperplasticizer based on polycarboxylate ether, as well as reinforcing fibers (anisotropic additive), activation of aggregates, binders and mixing water. It is shown how the reinforcement of concrete cement stone with fibers reduces the formation of shrinkage cracks and increases its frost resistance, and polycarboxylate nanoparticles significantly reduce the amount of water used and the hardening time of the material, making the steam treatment stage optional. The article presents the mechanism of action of the hyperplasticizer, the results of testing of samples-beams and samples-cubes at the age of 28 days. As a result of the action, polycarboxylate particles are adsorbed on the surface of cement grains, mutually repel and drive the cement mortar. With the help of this approach, a condition is created for the formation of a cement stone nanostructure of various functional actions with the help of nanoparticles already at the initial stage of mixing.*

Keywords: *concrete, nanotechnology, durability, concrete mix, structure, superplasticizer, fiber, concrete composition, hyperplasticizer, cement stone.*

Introduction

Currently, nanotechnology in the production of concrete allows for local stimulation of chemical reactions at the molecular level, changing the properties of traditional structural materials by modifying them with nanostructures, increasing strength, water and corrosion resistance.

One of the most important in the technology of nanobetons is the directed use of the process of self-formation of cement stone (in cement concretes), launched by nanoparticles specially introduced into the composition of concrete-nanoinitiators, either containing some compounds that initiate a special growth of cement stone, or possessing stable anisotropy of electrophysical properties, also causing the directed development of cement stone during concrete maturation. Nanocrete has these or other advantages due to its special structure set at the nanoscale [1].

The structure and properties of concrete are primarily determined by the quality of the cement stone. Which, accordingly, leads to the need to form a cement stone structure that will have a high density, low water permeability, high strength, frost resistance and corrosion resistance [2].

Research methods

To improve these properties, an integrated approach to the design of the concrete composition is required, which will contain a combination of various types of modification of the concrete mixture by introducing a hyperplasticizer based on polycarboxylate ether, as well as reinforcing fibers (anisotropic additive), activation of aggregates, binders and mixing water.

One of the ways to improve the properties of concrete is dispersed reinforcement with fibers (fiber) of various origins, such as polypropylene, steel, glass, basalt, synthetic, carbon and others. Reinforcement of concrete cement stone with fibers reduces the formation of shrinkage cracks and increases its frost resistance [3, 4].

The polycarboxylate ether-based hyperplasticizer is superior to traditional superplasticizers in reducing the amount of water, preserving workability, shrinkage, not to mention other parameters. With the help of the new technology, it is possible to create polymers for different types of cement, but this also means that each polymer structure behaves differently in different cements [5].

Scientific results

It should also be mentioned about self-compacting concrete, which does not require vibration to consolidate the composition. Its use significantly reduces energy and labor costs. The starting material containing highly dispersed polycarboxylate nanoparticles behaves like a thick liquid with a small cement-water ratio. When hardening, the swelling particles of the plasticizer prevent the formation of voids and cracks [6]. Self-compacting concrete has another important advantage. Conventional plasticized concrete slowly sets in winter, which leads to the need for additional steam treatment of structures. Polycarboxylate nanoparticles significantly reduce the amount of water used and the hardening time of the material, making the steam treatment stage optional [7].

The mechanism of action of the hyperplasticizer is shown in Figure 1.

The mechanism of action of the new superplasticizer is that polycarboxylate particles are adsorbed on the surface of cement grains and give them a negative charge. As a result, the cement grains mutually repel and drive the cement mortar. Only a small part of the cement grain is coated with polymer and the free surface of the cement floccules are sufficient for water access and the hydration reaction. Note that the structure of polymers differ in the length of the main chain, the length of the side chains, the number of side chains and the ionic charge. Therefore, the properties of these polymers can be controlled by changing the molecular structure and directly affecting the properties of cement stone [8].

During the experiment, a control composition and formulations were made with the joint introduction of GP «Muraplast FK 63» with polypropylene fiber.

Figures 2 and 3 show data on the study of the effect of complex administration of the above-mentioned compositions of cement stone at the age of 28 days.

It should be noted that already at the daily age of the samples, an early set of strength, acceleration of hardening of cement stone, light stripping, smooth surface and smooth edges of the samples are noticed.

After analyzing the obtained values, it was found that with the introduction of polypropylene fiber modifiers in a percentage of 0,1% (FcofM0.1) and Muraplast FK 63 – 0,5% (by weight of cement), the bending strength of the beam samples increased by 25,7%, and in a percentage of 0,2% (FcofM0.2) – by 33,3%.

As a result of the analysis of the obtained values, it was found that with the introduction of fiber in a percentage of 0,1% (FcofM0.1) and Muraplast FK 63 – 0,5% (by weight of cement), the compressive strength

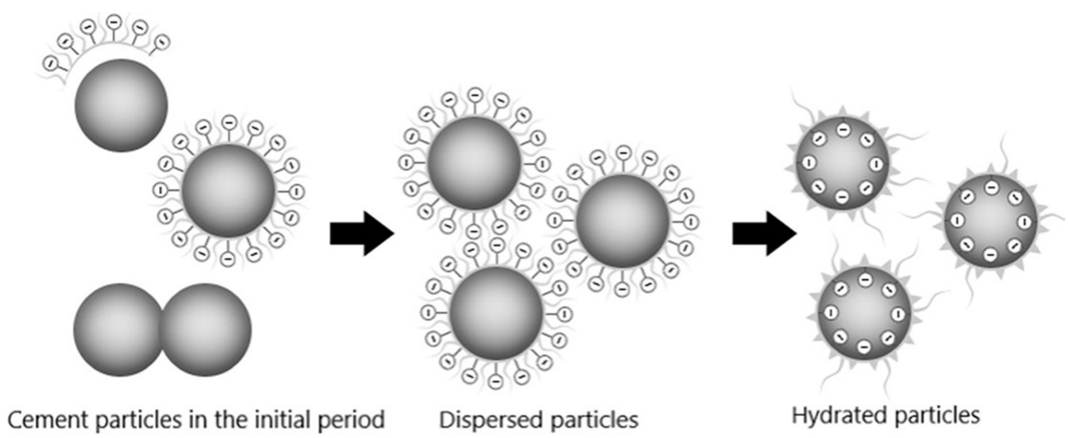

Figure 1 – Mechanism of action of polycarboxylate additive

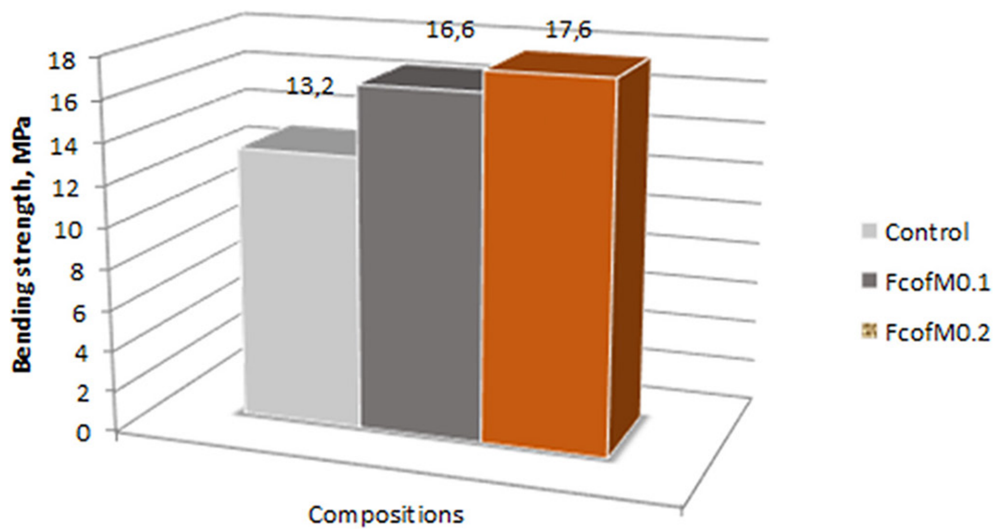

Figure 2 – Test results of beam samples at the age of 28 days

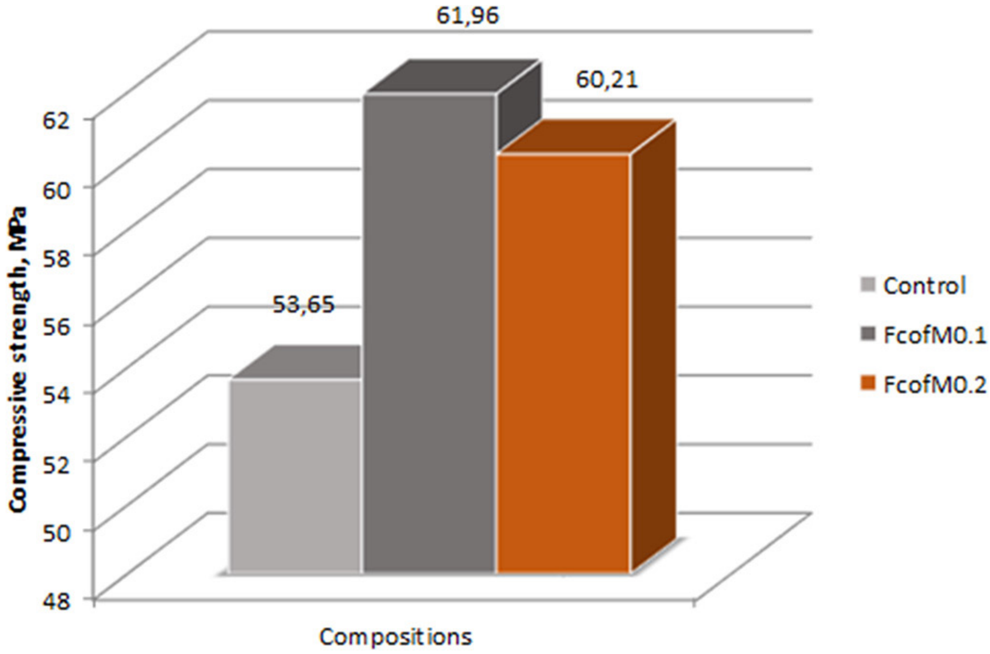

Figure 3 – Test results of cube samples at the age of 28 days

of the cube samples increased by 15,5%, and with a percentage of 0,2% (FcofM0.2) – by 12,2% [9, 10].

Conclusions

Thus, by adding polypropylene reinforcing fiber together with the «Muraplast FK63» modifier to the cement mortar, a condition is created for the formation of a cement stone nanostructure of various functional actions using nanoparticles already at the initial stage of mixing.

At a later stage, when the cement stone has hardened and begins to shrink, polypropylene fiber fibers connect the edges of the cracks, thus reducing the risk of fracture. The use of fiber makes it possible to reduce the water separation of cement stone through effective hydration control, thereby reducing internal loads.

During the experiment, it was noted that polypropylene fiber is resistant to absolutely all chemicals that make up cement stone, to physical damage during mixing, is distributed evenly, without forming clots (when using a coffee grinder) throughout the entire volume of the composition and reinforcing it in all directions, does not lose its durability and appearance. Fiber is also compatible with any additives in cement composition and in concrete.

REFERENCES

1. Bazhenov Yu.M. Modified high-quality concrete / Yu.M. Bazhenov, V.S. Demyanova, V.I. Kalashnikov // Scientific edition. – Moscow: Publishing House of the Association of Construction Universities, 2006. – 368 p.
2. Kastornykh L.I. Additives in concrete and building mortars: an educational reference manual / L.I. Kastornykh. – 2nd ed. – Rostov n/A: Phoenix, 2007. – 221 p.
3. Belov V.V., Smirnov M.A. Innovative solutions in the technology of high-tech concrete [Electronic resource]. – access mode: http://cdokp.tstu.tver.ru/site.services/
4. Bazanov S.M., Toropova M.V. Self-compacting concrete is an effective tool in solving construction problems [Electronic resource]. – access mode: http://www.бетонплюс.рф/samuplbeton.htm/
5. GOST 24211, GOST 30459, TU 5745-013-51552155-2003. Muraplast FK 63. Hyperplasticizer for concrete, reinforced concrete and prestressed reinforced concrete structures. 2003. – 2 p.
6. Additives for concrete [Electronic resource]. – access mode: http://www.nt-stroy.ru/dobavki-dlja-betona.html
7. Bazhenov Yu.M. Technology of concrete. – Moscow: Publishing House of the DIA, 2011 – 491 p.
8. Kudryshova B.Ch., Akimbekova S.T. Managing the relationship between the properties of cement stone and the quality of concrete. Collection of scientific papers of the IV International Conference of schoolchildren, students, postgraduates, young scientists / Resource-efficient systems in management and control: a look into the future. T1. – Tomsk: 2015. pp. 31-35.
9. Sakanov K.T., Akimbekova S.T. Ways of nanobeton quality management. Collection of scientific papers of the IV International Conference of schoolchildren, students, postgraduates, young scientists / Resource-efficient systems in management and control: a look into the future. T1. – Tomsk: 2015. pp. 26-30.
10. Kudyakov A.I., Ushakova A.S., Totay S.T. Quality management of cement stone concrete for pavement. International collection of scientific papers / New technologies in building materials science. – Novosibirsk: 2012. pp. 97-101.

Нанобетонның сапасын басқару жолдары

[1]***АКИМБЕКОВА Самал Тотайкызы,** магистр, аға оқытушы, sammi_ok@mail.ru,*
*[1]**ОРАЗОВА Динара Казбековна,** PhD, қауымдастырылған профессор, dinarzhan_84@mail.ru,*
*[1]**ДҮЙСЕНОВА Жеңісгүл Жағыпарқызы,** магистр, аға оқытушы, zhenisgul1@mail.ru,*
*[1]**ЯКУБОВСКАЯ Галина Ивановна,** магистр, аға оқытушы, Galina_pvl7676@mail.ru,*
*[1]**ОСПАНОВА Жулдуз Джумагалиевна,** магистр, аға оқытушы, zhulduz-ospan@mail.ru,*
[1]«Торайғыров университеті» КеАҚ, Қазақстан, Павлодар, Ломов көшесі, 64,
**автор-корреспондент.*

***Аңдатпа.** Мақалада бетонның құрамын жобалауға кешенді тәсіл ұсынылған, онда поликарбоксилаттар эфиріне негізделген гиперпластификаторды, сондай-ақ күшейтетін талшықтарды (анизотропты қоспа), агрегаттарды, байланыстырғыштарды және суды белсендіруді енгізу арқылы бетон қоспасын түрлендірудің әртүрлі түрлерінің комбинациясы бар. Бетон цемент тасын талшықтармен нығайту шөгу жарықтарын азайтады және оның аязға төзімділігін арттырады, ал поликарбоксилаттың нанобөлшектері пайдаланылған судың мөлшерін және материалдың қатаю уақытын едәуір азайтады, бұл бумен өңдеудің қажетсіз кезеңін жасайды. Мақалада гиперпластификатордың әсер ету механизмі, 28 күндік үлгілер мен текшелерді сынаудың нәтижелері келтірілген. Әсер ету нәтижесінде поликарбоксилат бөлшектері цемент түйірлерінің бетіне адсорбцияланады, өзара итеріліп, цемент ерітіндісін қозғалысқа келтіреді. Осы тәсілдің көмегімен араластырудың бастапқы кезеңінде нанобөлшектерді қолдана отырып, әртүрлі функционалды әрекеттегі цемент тасының наноқұрылымын қалыптастыру үшін жағдай жасалады.*

***Кілт сөздер:** бетон, нанотехнология, беріктік, бетон қоспасы, құрылым, суперпластификатор, талшық, бетонның құрамы, гиперпластификатор, цемент тасы.*

Способы управления качеством нанобетона

[1]***АКИМБЕКОВА Самал Тотайкызы,** магистр, старший преподаватель, sammi_ok@mail.ru,*
*[1]**ОРАЗОВА Динара Казбековна,** PhD, ассоциированный профессор, dinarzhan_84@mail.ru,*
*[1]**ДЮСЕНОВА Женисгуль Жагипаровна,** магистр, старший преподаватель, zhenisgul1@mail.ru,*
*[1]**ЯКУБОВСКАЯ Галина Ивановна,** магистр, старший преподаватель, Galina_pvl7676@mail.ru,*
*[1]**ОСПАНОВА Жулдуз Джумагалиевна,** магистр, старший преподаватель, zhulduz-ospan@mail.ru,*
[1]НАО «Торайгыров университет», Казахстан, Павлодар, ул. Ломова, 64,
**автор-корреспондент.*

***Аннотация.** В статье представлен комплексный подход к проектированию состава бетона, который содержит в себе комбинирование различных видов модифицирования бетонной смеси за счет введения гиперпластификатора на основе эфира поликарбоксилатов, а также армирующих волокон (анизотропная добавка), активацию заполнителей, вяжущих веществ и воды затворения. Показано, как армирование цементного камня бетона волокнами уменьшает образование усадочных трещин и увеличивает его морозостойкость, а наночастицы поликарбоксилата значительно уменьшают количество используемой воды и время твердения материала, делая необязательной стадию парообработки. В статье приводятся механизм действия гиперпластификатора, результаты испытаний образцов-балочек и образцов-кубиков в возрасте 28 суток. В результате действия частицы поликарбоксилатов адсорбируются на поверхности цементных зерен, взаимно отталкиваются и приводят в движение цементный раствор. С помощью данного подхода создается условие для формирования наноструктуры цементного камня различного функционального действия с помощью наночастиц уже на начальном этапе смешивания.*

***Ключевые слова:** бетон, нанотехнология, долговечность, бетонная смесь, структура, суперпластификатор, волокно, состав бетона, гиперпластификатор, цементный камень.*

REFERENCES

1. Bazhenov Yu.M. Modified high-quality concrete / Yu.M. Bazhenov, V.S. Demyanova, V.I. Kalashnikov // Scientific edition. – Moscow: Publishing House of the Association of Construction Universities, 2006. – 368 p.
2. Kastornykh L.I. Additives in concrete and building mortars: an educational reference manual / L.I. Kastornykh. – 2nd ed. – Rostov n/A: Phoenix, 2007. – 221 p.
3. Belov V.V., Smirnov M.A. Innovative solutions in the technology of high-tech concrete [Electronic resource]. – access mode: http://cdokp.tstu.tver.ru/site.services/
4. Bazanov S.M., Toropova M.V. Self-compacting concrete is an effective tool in solving construction problems [Electronic resource]. – access mode: http://www.бетонплюс.рф/samuplbeton.htm/
5. GOST 24211, GOST 30459, TU 5745-013-51552155-2003. Muraplast FK 63. Hyperplasticizer for concrete, reinforced concrete and prestressed reinforced concrete structures. 2003. – 2 p.
6. Additives for concrete [Electronic resource]. – access mode: http://www.nt-stroy.ru/dobavki-dlja-betona.html
7. Bazhenov Yu.M. Technology of concrete. – Moscow: Publishing House of the DIA, 2011 – 491 p.
8. Kudryshova B.Ch., Akimbekova S.T. Managing the relationship between the properties of cement stone and the quality of concrete. Collection of scientific papers of the IV International Conference of schoolchildren, students, postgraduates, young scientists / Resource-efficient systems in management and control: a look into the future. T1. – Tomsk: 2015. pp. 31-35.
9. Sakanov K.T., Akimbekova S.T. Ways of nanobeton quality management. Collection of scientific papers of the IV International Conference of schoolchildren, students, postgraduates, young scientists / Resource-efficient systems in management and control: a look into the future. T1. – Tomsk: 2015. pp. 26-30.
10. Kudyakov A.I., Ushakova A.S., Totay S.T. Quality management of cement stone concrete for pavement. International collection of scientific papers / New technologies in building materials science. – Novosibirsk: 2012. pp. 97-101.