UDC 539.3.691

CRITERIA OF QUALITY AND EFFICIENCY OF ANTIFREEZE ADDITIVES APPLICATION

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Abstract: Reliability of concrete and reinforced concrete structures can only be ensured if the quality of the material used is high. The aim of our work is to determine the criteria for the quality and effectiveness of the antifreeze additives use. Technological measures aimed at improving the quality indicators of concrete monolithic structures with the use of effective antifreeze additives in winter conditions are proposed. It is established that the use of antifreeze additives allows to obtain concrete with high quality indicators.

Keywords: concrete, quality, antifreeze additives, resistibility, standards, measurement capabilities

КРИТЕРИИ КАЧЕСТВА И ЭФФЕКТИВНОСТИ ПРИМЕНЕНИЯ ПРОТИВОМОРОЗНЫХ ДОБАВОК

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Аннотация: Надежность бетонных и железобетонных конструкций может быть обеспечена только в случае высокого качества используемого материала. Целью нашей работы является определение критериев качества и эффективности применения противоморозных добавок. предложены технологические мероприятия, направленные на повышение качественных показателей бетона монолитных конструкций с применением эффективных противоморозных добавок в зимних условиях. Установлено, что использование противоморозных добавок позволяет получить бетон с высокими качественными показателями

Ключевые слова: бетон, качество, противоморозные добавки, прочность,стандарты, метрологическое обеспечение

It is known that at present, concrete is the main building material and will remain for many decades. Loadbearing constructions of the most important structures are erected from monolithic concrete. Obviously, the reliability of concrete and reinforced concrete structures can only be ensured if the quality of the material used is high.

In the technology of concreting monolithic structures in winter there are two main areas. The first should include all the methods associated with providing in hardening concrete in winter conditions with positive temperatures to set them given resistibility. The second is the use of aqueous solutions of antifreeze additives, which ensure the hardening of the concrete of monolithic buildings and structures at negative temperatures. These two areas can complement each other, which allows you to expand the use of different methods in the winter period of work.

The use of antifreeze additives is based on the properties of concrete, hardened with aqueous chemical solutions, to harden at negative temperatures. At negative temperatures, due to these substances, water in concrete is in liquid phase and favorably promotes integrity with cement. Therefore, antifreeze additives are added into the mixing water of concrete in order to reduce the freezing point of aqueous solutions.

At different times, there were antifreeze additives based on various raw materials. Initially, metal salts (potash, calcium chloride, sodium nitrite, etc.) and complex additives based on them, then formates, next an antifreeze complex appeared together with melamine or naphthalene formaldehyde superplasticizer and finally an antifreeze complex together with a polycarboxylate hyperplasticizer. [1].

Recently, complex additives of multifunctional activity have appeared. They consist of two, three or more components of organic and non-organic origin, which provide not only lowering the freezing point of water, but also have plasticizing and accelerating concrete hardening effects. The promising outlook of such additives is obvious, since they make it possible to improve various properties of concrete and concrete mixes. Antifreeze additives allow concreting monolithic structures even at temperatures of -25 ° C and below, providing the process of hydration of cement and, as a result, the hardening of concrete.

The use of elevated concentrations of calcium chloride (CaC12) and sodium chloride (NaC1) in the production of concrete work during the winter period has played a major role in the study and application of antifreeze additives. [2] The revealed deficiencies - corrosion of reinforcement, the appearance of efflorescence much limited the scope of application of chloride salts, which led to an intensive search for new chemical antifreeze additives in winter conditions. M. G. Davidson and I. A. Tokmakova investigated and recommended the use of potash (K2CO3) as an antifreeze additive in an amount up to 20% at negative temperatures reaching - 20 ° C. In the 70s of the last century, such an antifreeze additive as ammonia water (aqueous ammonia solution) was investigated. [3]

In construction practice, complex (mixtures of salts in different proportions) antifreeze additives are more often used, the use of which is more effective than each separately when obtaining specified properties. For example, adding the complex additive CaC12 + Ca (N02) 2 + Ca (NO3) 2 allows for concrete work at -25 ° C, and in combination with the thermos method up to -50 ° C. The amount of additive ranges from 7 to 25% by weight of the mixing water. The presence of nitrite-nitrate mixture - Ca (NO2) 2 + Ca (NO3) 2 - reduces the corrosive effect of calcium chloride on the reinforcement [11].

In 2011, updated regulatory documents were introduced that set the basic requirements for the modifiers of concrete and mortar mixes, which take into account the basic regulations of European standards. The introduction of the main regulations of the European standards into the standards developed in the Republic of Kazakhstan is an important step towards harmonization in the field of ensuring a mutual understanding of test results and the information contained in the standards on the interchangeability of products.

The aim of our work is to determine the quality criteria and the effectiveness of the use of antifreeze additives. Analysis of different works on the issue under study was carried out.

Antifreeze additives recommended by scientists are given in table 1 [1].

Antifreeze additives

Patent №, name	Authors	Composition of the additive	Additive scope
2024457 Complex antifreeze additive	Solomatov V. I., Dobshits L. M., Prudovsky D. M.	sodium nitrite, waste production of ferrosilicon based on SiO2, potash	Up to -15 0C
2187480 Complex additive to mortars and concrete	Payanova N. N., Steklov G. M.	Antacidin + Calcium Chloride	Up to -55 0C
2256626 Antifreeze additive in cements	Khudyakova L. I., Konstantinova K. K., Narkhinova B. L.	magnesium silicate rock (dunite)	At negative temperatures
2256627 Antifreeze additive in cements	Khudyakova L. I., Konstantinova K. K., Narkhinova B. L.	magnesium silicate rock (basalt)	At negative temperatures

2273613 Complex additive	Dorogobid D. N., Ushakov V. V.	superplasticizer C-3, sodium sulfate, technical lignosulfonate, aluminum sulfate, potash	At negative temperatures
2278836 Complex additive for concrete and mortar	Zharikov L. K., Mashchenko K. G.	CC+polyalcohols+NN+ LST	At negative temperatures
2292314 Complex additive for construction mix «Cryoplast sp15-1»	Kovalev A. F., Tsepilova I. A.	superplasticizer C-3+sodium formate+sodium sulfate	Up to -15 0C
2307099 Complex additive for concrete and mortar «Cryoplast P25»	Kovalev A. F., Tsepilova I. A., Gorobets I. I.	superplasticizer +LST+ potash+sodium formate	Up to -25 0C

We have identified the classifications and types of antifreeze additives and superplasticizers used in winter conditions of the Republic of Kazakhstan. The effects of various antifreeze additives on the resistibility characteristics, frost resistance and water resistance of concrete in winter conditions are investigated. The increase in the concrete resistibility with chloride salts, depending on the temperature, is: at -5ºC after 1, 14, 28 and 90 days, the resistibility, respectively, is 35%, 65%, 80%, and 100%; at -10 ° C resistibility is of 25%, 35%, 45%, and 70%; at -15 ° C, resistibility is 15%, 25%, 35%, and 50%.

A calculation method was developed for concreting monolithic structures with antifreeze additives. Examples of calculating the use of antifreeze additives for concreting monolithic structures in winter conditions are given.

The quantitative dependences of the mass loss of concrete with and without addition of additives while keeping in the frost are determined. It is established that the mass loss of samples from concrete with antifrosty additives is less, and the increase in mass is greater than samples from concrete without additives.

After conducting a literature data analysis of the state of the use of modern antifreeze additives issues in the Russian construction industry, we also analyzed the use of effective additives in winter conditions in the construction practice of Kazakhstan.

Benotech PMP-1 is an antifreeze additive for concrete and mortar, consisting of a complex of antifreeze additives with a metal corrosion inhibitor. According to the main effects of the additive, Benotech PMP-1 refers (according to State all-Union Standard 24211) to antifreeze additives that ensure the hardening of concrete and mortar at a negative temperature, prevent freezing of the concrete mix during transportation, laying and compaction at construction sites, as well as hardening accelerators..

Antifreeze additive Benotech PMP-1 is used at ambient air temperature up to minus 25 ° C in conditions of unheated landfill or construction site in the manufacture of precast and monolithic concrete and reinforced concrete structures and products, ready-mixed concrete and in mortars used in non-aggressive media in accordance with SNiP 2.03.11-85. Restrictions on use - in prestressed reinforced concrete structures and joints (channels) of precast-monolithic and precast structures; in reinforced concrete structures located in the range of stray currents or located closer than 100 m from high voltage DC sources.

Provides standardized resistibility development of concrete or mortar at ambient air temperature up to minus 25 ° C. The amount of additive, in % by weight of cement 1-5. It increases the resistibility of concrete in the first day of normal hardening and after TVO by 30% or more. It reduces the water demand of concrete or mortar mixtures to 10% or more while maintaining the desired mobility. It reduces the dissolution and water separation of concrete and mortar mixes. It allows you to partially or completely abandon the heating of inert materials in the winter. It allows reducing the consumption of cement up to 10% in concretes subjected to heat treatment, as well as maintained in conditions of natural hardening. In the recommended dosages it does not reduce the

protective properties of concrete with respect to steel reinforcement and does not form efflorescence. The additive is produced in liquid form, ready to use without additional preparation, which significantly saves time and money in the manufacture of concrete and mortar in the winter season.

Antifreeze additive Hydrotex-PMD is as an antifreeze plasticizing fluid for adding to concrete and mortars, improving their properties.

Winter Supplements POZZOLITH 42 CF. Antifreeze additive to concrete that does not contain chlorine. For ready-mix and prestressed concrete, it accelerates the setting and provides plasticity. Pozzolith 42 CF accelerates the reaction between water and cement at the initial stage. Thus, in concrete in the first days, a higher temperature is formed during hydration. Both of these processes have a positive effect primarily on the acceleration of setting, and subsequently on the resistance to the effects of freezing and thawing cycles.

Pozzolith 42 CF, especially in cold climatic conditions, reduces the water content by: 7 to 8 and contributes to increasing the strength of the initial concrete resisitibility. The additive does not harm the reinforcing structures used in concrete, does not contain chlorine.

It accelerates the setting by reducing the initial and final setting time. It gives early resistance especially in cold weather conditions. For example, using 400 kg / m³ of portland type 1 cement, a compressive resisitibility of 20 MRA at a temperature of + 5 ° C can be achieved in 15 days.

The same concrete with 2% Pozzolith 42 CF gives the same strength for a period of less than 6 days. Accelerates the curing of concrete at high ambient temperatures and thus reduces the construction time. For example, using 400 kg / m³ of portland type 1 cement, a compressive resistibility of 20 MRA at + 20 ° C can be reached in 3 days, and using 2% Pozzolith 42 CF gives the same resistibility in 2 days. Chemical additives for building materials 35 kg, barrels of 100 kg or on tap.

Antifrosty additive "Steinberg" FROST-25 for concrete and mortar, meets the requirements of State all-Union Standard 24211 for "warm" and "cold" concrete and mortars. Provides concrete hardening in conditions of negative temperatures up to minus 25 * C, subject to the following recommendations for use.:- minimum consumption of the additive for the finished product; does not reduce the viability of concrete mixes; it is applied with any plasticizers; does not contain substances that cause corrosion of the reinforcement; during storage, the additive does not freeze and does not precipitate even at very low temperatures (below minus 30 ° C); electric heating is allowed.

Additive "Steinberg" FROST-25 should be added into the concrete or mortar mixture in the form of a ready-to-use product at the same time with all or part of the mixing water or most of it from plasticizing, air-entraining and other types of additives.

Currently, various standards are used to determine the quality and effectiveness of antifreeze additives. For example, State all-Union Standard 24211-2008 “Additives for concrete and mortar. General technical conditions". It applies to non-organic and organic substances and establishes the classification and criteria for technological and technical efficiency of the action of additives in mixtures, concrete and mortars. This standard takes into account the main regulations of the regional standard EN 934-2: 2001 "Additives for concrete, building and injection solutions - Part 2. Additives for concrete - Definitions, requirements, compliance and labeling" (EN 934-2: 2001 " Admixtures for concrete mortars and grout - Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labeling ") in terms of definitions and technical requirements for the main types of chemical additives. [5].

State all-Union Standard 30459-2008 “Additives for concrete and mortar. Definition and Evaluation of Efficiency "establishes requirements for test methods for additives that should be considered when evaluating their effectiveness in mixtures, concrete and mortars in accordance with the performance criteria according to State all-Union Standard 24211 and contains the main regulatory provisions of the European standard EN 934-6: 2002" Additives for concrete, building and injection solutions. Part 6. Sample preparation, control of conformity and confirmation of conformity "(EN 934-6: 2002" Admixtures for concrete, mortars and grout - Part 6: Sampling, conformity control and evaluation of conformity ") in terms of the requirements for the production of samples for testing

individual types of additives, EN 480-1: 1997 "Additives for concrete, building and injection solutions. Test methods. Part 1. Control concrete and control mortar for testing "(EN 480-1: 1997" Admixtures for concrete, mortars and grout - Part 1: Reference concrete and mortar for testing ") in terms of test methods for certain types of additives [6].

To ensure the durability of concrete in reinforced concrete structures used in corrosive environments, and the protective ability of concrete in relation to steel reinforcement when choosing modifying additives, it is necessary to take into account the requirements of State all-Union Standard 31384 “Protection of concrete and reinforced concrete structures from corrosion. General technical requirements. Due to the nature of the composition of the active components, which provides the main effect of the action, the following requirements must be met when choosing antifreeze additives:
– the total number of chemical additives, when used for the preparation of concrete or mortar, should not exceed 5% by weight of cement;
– the maximum permissible chloride content in concrete, expressed as a percentage of chloride ions to the mass of cement, should not exceed the values given in table 1;
– adding chloride salts to the composition of the concrete in the manufacture of the following concrete products and structures is not allowed: with prestressing reinforcement, with non-stressed wire fittings of class B-I with a diameter of 5 mm or less, operated in damp or wet conditions, with autoclave treatment, exposed to electrocorrosion;
– chlorine salts are not allowed to be incorporated into concrete and mortar for injecting channels of prestressed structures, as well as for monolithing seams and joints of precast and precast monolithic reinforced concrete structures;
– in the presence of potentially reactive rocks in aggregates, the introduction of sodium and potassium salts into concrete is not allowed.

We have proposed technological measures aimed at improving the quality indicators of concrete in monolithic structures with the use of effective antifreeze additives in winter conditions. It has been established that the use of antifreeze additives allows to obtain concrete with high quality indicators. [6]

References

1. Antifreeze additive based on sodium salt of glyoxalic acid / N.P. Gorlenko, A.V. Rubanov, S.Yu. Sarkisov, L.V. Maslenitsyna // Bulletin of the Tomsk State University of Architecture and Civil Engineering. - 2015. - № 5. - P. 110–116.
2. Serb - N.N. Serbina, Yu.A. Savina Physics - chemical features of the hardening of cement stone in concrete at low temperature // Concrete with increased additions of chloride salts in winter conditions. - M .: Gosstroyizdat, 1967. - p. 147-153.
3. Kuzmin, ED, Concrete with antifrosty additives.- Kiev: Budivelnik, 1974.- 108 p.
4. Guidance on the use of chemical additives to concrete. M .: stroiizdat, 1975.– 65 p.
5. Interstate standard GOST30459 - 2008. Additives for concrete and mortar. Determination and evaluation of effectiveness
6. Antifreeze additives: criteria for technological and technical efficiency. Ensuring the durability of reinforced concrete structures http://www.concrete-union.ru/articles/additives_for_concrete.php?ELEMENT_ID=8214