Spectrum Journal of Innovation, Reforms and Development
Volume 10, Dec., 2022 | ISSN (E): 2751-1731
Website: www.sjird.journalspark.org

INVESTIGATION OF THE PROPERTIES OF CONCRETE BASED ON NON-FIRING ALKALINE BINDERS

Adxamjon Khamidov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Islombek Akhmedov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Yusupov Shavkat
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Zayniddin Jalalov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Isroiljon Umarov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Sodiqjon Xakimov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Akbarjon Abdunazarov
Namangan Engineering-Construction Institute,
Islom Karimov Avenue, 12, Namangan, Uzbekistan, 160103

Abstract
The article deals with the use of film-forming materials for the care of freshly laid concrete based on non-firing alkaline binders, the results of studies to determine the strength, frost resistance and plastic shrinkage of concrete are presented.

Keywords: Concrete, unfired alkaline binder, fresh concrete care, film-forming materials, strength, frost resistance, plastic shrinkage.

One of the main priority areas of market economic reforms is the expansion of production of high quality export-oriented and import-substituting products. Among these top-priority industries is the building materials industry, which has a strong potential and great importance for the development of the construction complex. It is known that the most priority direction in the building materials industry is the production of mineral binders and various materials based on them.

In the world practice of construction, the demand for cement concrete is increasing as an alternative and effective structural material. According to the International Federation for Structural Concrete (FIB), at present, the annual production of cement in the world is approximately 4 billion tons, and the production of concrete based on it on a global scale is approaching 12.0 billion m3 in year. The first decade of the 21st century was marked by significant advances in the development of new cement concrete technologies.

Portland cement is one of the most popular and at the same time scarce technical products of our time, which has many wonderful properties that have made it the bread of construction.

However, Portland cement, along with undeniable advantages, also has serious disadvantages. These are, first of all, high energy consumption (clinker firing temperature 14500C), relatively low activity (40 ... 60 MPa), lack of interaction with clay and dust particles, the need to use large and small aggregates.

And in this regard, the production of unburned alkaline binders (BSC) from industrial waste is of great interest, the production technology of which is simple and environmentally friendly.

For the manufacture of unburned alkaline binders in Uzbekistan, there are sufficient raw materials in the form of many tonnage waste from the metallurgical, chemical and energy industries.

The main raw materials for the production of non-firing alkaline binders are aluminosilicate slags (electrothermophosphoric, electric steel-smelting), burnt rock (gliezhi), rock (tuffite), active mineral additive (Portland cement or cement clinker), alkaline component (soda sulfate mixture, baking dust, etc.) . It should be noted that in the preparation of concretes based on unfired alkaline binders, it is possible to use fine aggregates containing a large amount of dust and clay particles, while, in concretes based on Portland cement, the presence of these particles is limited by standards.

The main technology for the production of non-calcined alkaline binders is the drying of raw materials, dosage and grinding.

Non-firing alkaline binders have a number of physical-mechanical and technical-operational characteristics that significantly exceed those of many other mineral binders and composites based on them. Low costs of heat and electricity for their production, a wide range of compressive strength of binders (from 20 to 180 MPa) and concrete (from 0.5 to 150 MPa) substantiate their versatility. The highly active non-firing alkaline binder, which is part of the concrete, makes it possible, due to the increased adhesion to aggregates, to obtain a material with a compressive strength of 49-50 MPa. It should also be noted that this type of binder is environmentally friendly, which is very important in conditions of environmental pollution (especially in the production of Portland cement). In this regard, extensive scientific research is being conducted in Uzbekistan to expand the use of these binders in construction.

It is known that the durability of concrete and reinforced concrete structures and structures depends not only on the composition of concrete and the quality of materials used for its preparation, but also on the conditions for the formation of its structure and basic properties (temperature and humidity of the environment at which laying and subsequent curing takes place) .

In Uzbekistan, characterized by a dry and hot climate, the relative air humidity during the day in summer at a temperature of more than 450C is 10%. The surface temperature of freshly laid concrete on sunny days reaches 60-700C. As a result, intensive evaporation of mixing water occurs, the processes of structure formation are accelerated, concrete mixtures quickly lose their plastic properties. Intensive evaporation of mixing water from freshly laid concrete can significantly slow down or even completely stop the process of increasing its strength. In addition, the evaporation of moisture from the freshly laid concrete mix has a negative effect on the formation of the concrete structure, a network of through microchannels is formed in it, reducing its strength, deformation and operational characteristics.

The filtration capacity of freshly laid concrete curing in dry and hot climates is 70% greater than that of concrete curing in "normal" conditions. This indicator also negatively affects the strength and performance capabilities of concrete. In this regard, it is necessary to take care of freshly laid concrete in order to protect it from moisture loss.

In practice, when laying concrete mixtures, various methods of care are used. As you know, one of the effective ways of care is the use of film-forming materials. There are a number of works devoted to the use of film-forming materials for cement concrete [4,5]. However, the issues of using film-forming materials for the care of concrete mixtures based on non-firing alkaline binders have been little studied.

At the Namangan Civil Engineering Institute, at the department "Production of building materials, products and structures", research was carried out on the selection of film-forming materials that form a strong film in an alkaline environment. More than 30 different film-forming compositions have been studied to meet the goals.

According to the research results, the most effective film-forming composition that meets the technical requirements and forms a waterproof film in an alkaline environment and well protects concrete from moisture loss in dry and hot climates was a water-based film-forming material (water-soluble composition-WRC).

In the future, to study the issue of using film-forming materials for the care of freshly laid concrete based on non-firing alkaline binders, studies were carried out using WRC.

Characteristics of the materials used to prepare 1 m^3 of concrete:

The composition of the concrete mix (1:2.21:4.62, W/C=0.56).

Type of binder - non-firing alkaline binder grade 400 - 333 kg.

Large aggregate - crushed granite (fr. 5-20 mm.) - 1539 kg.

Fine aggregate - quartz sand Mcr = 1.64 - 736 kg.

Water - 187 *l*

The film-forming material is a water-soluble composition (WRC).

The design strength of concrete (standard) is 40 MPa.

The materials used comply with the requirements of GOST.

To determine the compressive strength of concrete during solar thermal treatment, samples with dimensions of 150x150x150 mm were prepared.

Forms filled with a concrete mixture based on non-firing alkaline binders were compacted on a vibrating table, and film-forming materials were immediately applied to the surface of the samples with a paint sprayer. The consumption of film-forming materials in this case amounted to 200-250 g/m2. After applying the film-forming materials, one series of samples was placed in a climatic chamber at t = 400C and humidity W = 30% for keeping, the other series was placed in a chamber of normal conditions (t = 200C + 20C, W = 95-98%). The samples were tested after 1, 2, 3, 7, 28 and 90 days of storage in the chambers. The test results are shown in table-1

Table 1. Strength of concrete during solar treatment

Hardening conditions	Compressive strength of concrete, day				
	1	3	7	28	90
Normal conditions	-	-	-	39,8 100	-
climate chamber (using VRK)	15,4 39,49	25,0 64,1	37,0 94,9	41,7 106,9	43,0 110,3
no care	-	-	-	21,0 53,8	-

Note: Above the line, the strength of concrete in MPa, below the line in % (compared to the strength of samples hardened for 28 days under normal conditions).

As can be seen from the table, the strength of concrete samples hardened under the film-forming composition was 15.4 MPa or 39.49% after 1 day of hardening, 25 MPa or 64.1% after 3 days, 37.0 MPa or 94.9% after 7 days. % (compared to the strength of samples hardened for 28 days under normal conditions). An intensive increase in the strength of concrete is a consequence of helio-heat treatment with the prevention of moisture evaporation. Despite the intensive increase in the strength of unfired alkaline binders in the early stages of hardening, their heat release is low (1.5-2.5 times less than that of Portland cement).

The results obtained show an increase in the strength of concrete (based on non-firing alkaline binders), hardened under the film-forming composition due to the complete hydration processes.

To determine the frost resistance of concrete based on unfired alkaline binders, samples of the same composition of the concrete mixture were prepared as indicated above and based on the requirements of GOST 10060. “Concrete. Determination of frost resistance. tests have been carried out.

According to GOST, the concrete grade for frost resistance: an indicator of frost resistance of concrete corresponding to the number of freezing and thawing cycles of samples determined during testing by basic methods, in which the concrete characteristics established by the standard remain within normalized limits and there are no external signs of destruction (cracks, chips, peeling of sample edges). The test results are shown in table 2.

Table 2. Frost resistance and strength of concrete during solar treatment

Hardening conditions	Compressive strength of concrete, MPa				Frost resistance, cycle
	Before test 100 cycle	After testing 100 cycle	Before test 150 cycle	After testing 150 cycle	
Normal conditions	40,5	38,0	41,0	39,0	150
Solar thermal treatment (using VRK)	40,7	36,8	41,7	39,1	150
no care	28,7	21,0	-	-	75

As can be seen from Table 2, during solar thermal treatment using a film-forming composition, the frost resistance of the samples was 150 cycles. This indicator is close to the indicators of concrete samples hardening under normal conditions. For samples hardened without maintenance, frost resistance was only 75 cycles.

One of the most important problems of concreting in a dry hot climate is the all-round limitation and elimination of various physical destructive processes occurring in concrete in the initial period of hardening. A special place among them is occupied by plastic shrinkage, which is one of the main causes of early cracking of concrete.

To measure the plastic shrinkage of freshly molded concrete, a device proposed by E.N. Malinsky was used.

An indirect assessment of film-forming materials from the point of view of the occurrence of plastic shrinkage is proposed to be carried out using the coefficient of caring for a long loaf Kef, determined by the formulas:

$K_{ef} = 1 - \frac{E_i - E_0}{E_{max} - E_0}$ or $K_{ef} = \frac{E_{max} - E_i}{E_{max} - E_0}$

Where E_0 - initial deformations of freshly laid concrete with the exclusion of evaporation, mm/m;

E_{max}-maximum value of plastic shrinkage of concrete hardening without maintenance, mm/m;

E_i- the value of plastic shrinkage of concrete protected from dehydration by the studied film-forming material, mm/m.

As follows from the above formulas, the film-forming material will have the highest concrete (K_{ef} =1)care efficiency, when applying which E_1=E_0, and the worst - when E_i=E_{max} (K_{ef}=0).

To determine the plastic shrinkage of freshly laid concrete based on unfired alkaline binders, hardened under a film-forming coating, samples of the same composition of the concrete mix were prepared as indicated above.

Plastic shrinkage of heavy concrete of the above composition and moisture loss in% of mixing water are shown in figure-1

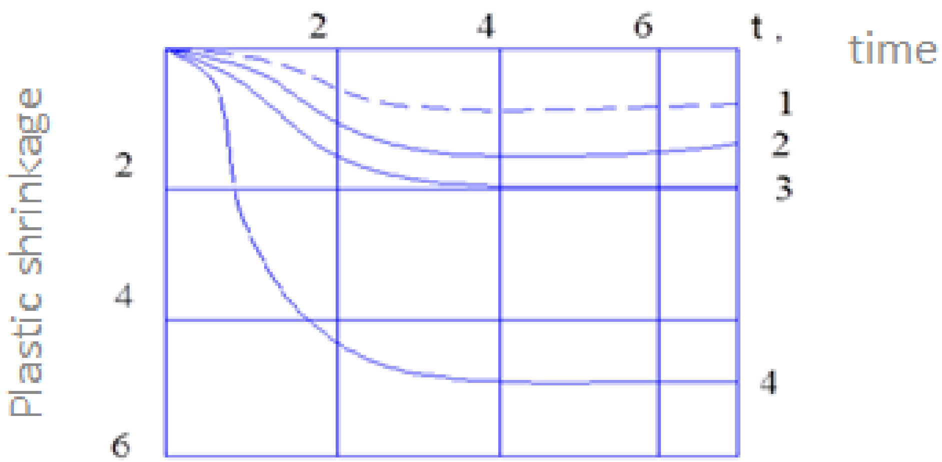

figure-1. The dependence of plastic shrinkage on the type of care

1.covering concrete with a layer of moistened sand

2.sample aged under VRK;
3.sample aged under polyethylene film (h=200mcr)
4. Uncoated sample
It can be seen from the given data that the K_{ef}^{2} values of the concrete care when using the water-soluble composition and the K_{ef}^{3} v -polyethylene film were 0.90 and 0.81, respectively. As can be seen from Figure 1, the plastic shrinkage of concrete hardened under a water-soluble film-forming composition is insignificant and close to that of concrete hardening under a layer of moistened sand.

Conclusions

Based on the results of the studies, it can be concluded that when applied to a freshly laid concrete surface, film-forming compositions and heliothermal treatment (comparable to dry and hot climate conditions), moisture loss is prevented and the "soft" hardening mode provides high strength and frost resistance, as well as from the standpoint reduction of plastic shrinkage, the use of the studied composition for the care of freshly laid concrete based on unfired alkaline binders is very effective.

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