Heat Treated Tuffite - As Hydraulic Additive for Portland Cement

O K. Kabulova	Nukus State Pedagogical Institute, Karakalpak State University
G.Zh. Orazimbetova	Nukus State Pedagogical Institute, Karakalpak State University
A.R. Dzhumamuratova	Nukus State Pedagogical Institute, Karakalpak State University

ABSTRACT

The article examines the suitability of burnt tuffite mineral as a hydraulic additive in Portland cement and, as a result, the durability of Portland cement under sulfate and sulfate-magnesium corrosion resistance.

Keywords: burnt tuffite, hydraulic additive, sulfate resistant, corrosion resistant.

Introduction: A significant part of buildings and structures erected from concrete and reinforced concrete is exposed to aggressive environments during operation, causing damage and even failure of building structures, if measures to prevent corrosion of the structural material are not taken or taken during the construction of the structure.This is especially true for industrial facilities, where the external environment, liquid and gaseous, in contact with building structures, is polluted by products and production waste.

The widespread use in practice of the achievements of science and technology makes it possible to reduce the damage from corrosion. In this regard, there is an acute issue of increasing the durability of building products and structures, i.e. maintaining the quality of building structures required for normal operation for a long time is one of the most urgent problems of construction at the present stage.

It is equally important to solve the problem of ensuring the necessary durability of structures operating in the dry and hot climate of Uzbekistan and in aggressive environments that cause damage and destruction of the material of structures and reduce their reliability. In this regard, two tasks are set before scientists: the first is to rationally use and protect the available resources in order to achieve a long-term service of the building and structure; the second is to find opportunities to save cement and increase the durability of concrete products [1, 2].

Object and methods of research: Our research was mainly devoted to the search for an effective hydraulic additive that ensures the stability of Portland cement under conditions of sulfate and sulfate-magnesia corrosion, which is most common in our country when exposed to aggressive waters.The setting times were normal for the three cements, they passed the

test for uniformity of change in volume by boiling in water vapor and in cold water.

To study the mechanical strength, cements were made from a cement mortar 1:3, prisms 1x1x3 cm and cubes 1.41x1.41x1.41 cm with a face area of 2 cm2. Pressing pressure 40 MPa, storage of samples in water.

Results and their discussions: The results of testing the strength of Portland cement in small samples are given in table 1.

Table 1

Strength of Portland cement, MPa

Type of cement	Compressive strength, MPa					Bending strength, MPa				
	Curing time					Curing time				
	day			months		day			months	
	3	7	28	3	6	3	7	28	3	6
Alitovy	21	23	32	34	35	4,9	5,1	5,1	6,0	6,2
Usual	17	21	30	34	35	4,2	4,3	5,0	6,0	6,1
Usual	11	15	23	30	35	3,0	4,2	4,5	5,1	5,9
Strength of Portland cement with 20% tuffite, MPa										
Alitovy	14	22	28	31	35	3,8	4,4	5,5	6,8	6,7
Usual	14	19	26	29	32	3,7	3,8	4,7	6,3	6,6
Usual	12	17	24	30	21	3,0	3,5	4,7	6,3	6,7
Strength of Portland cement with 30% tuffite, MPa										
Alitovy	14	15	26	32	33	2,5	4,2	5,1	7,1	7,3
Usual	10	14	22	30	30	2,1	3,5	4,8	7,0	7,3
Usual	10	13	21	26	27	3,0	3,0	4,9	6,6	6,6

From the data in Table 1, we can conclude that the strength of cements increases with an increase in the content of alite in them and a decrease in the content of belite. In the first stages of hardening, cements with a high content of alite differ sharply in strength from belite Portland cements (with a belite content of 20% and 25%), and in longer periods, the strengths of all cements approach each other. With regard to the content of C3A and C4AF, cements with the same 10% amount of both minerals show the best results.

Based on the data given in Table 1, it can be concluded that alite cement (No. 1) gives the best strength with additives, ordinary cements (No. 2 and No. 3) are closest to it in strength. By 28 days, the strength of pozzolanic cements approaches the strength of pure Portland cements, but this decrease is much less than the percentage of the introduced additive. The long-term strength of cements with 30% tuffite exceeds the strength with 20% tuffite.

The study of sulfate resistance was carried out by the method of changing the mechanical strength when the samples are immersed in aggressive solutions. For this, 1x1x3 cm prisms were made from a solution with sand 1:3, as more sensitive to the destructive action of aggressors than cubes, due to the smaller cross section. Sand was taken to test the mechanical strength, passed through a sieve of 144 holes/cm2 and remained on a sieve of 256 holes/cm2. The samples were prepared from pure cements, from cements with 20 and 30% tuffite, fired at 600°C. The samples were pressed under a pressure of 400 kg/cm2 and, after fabrication, were stored for 28 days in a humid environment, after which they were immersed in salt solutions and water.

Table 2

Durability of Portland cements during storage in aggressive solutions

No. of cement	Bending strength, MPa
	Curing time

	3 days	7 days	28 days	3 months	6 months	1 year
Вода						
1	4,2	4,8	6,3	6,2	6,1	5,8
2	4,4	5,2	5,9	6,0	6,2	6,3
3	2,8	4,8	5,4	5,9	5,9	6,0
5% Na_2SO_4						
1	4,3	4,9	6,3	5,8	4,8	4,2
2	4,4	5,2	5,9	5,8	4,3	3,8
3	2,8	4,4	4,8	4,6	4,0	3,6
3% $MgSO_4$						
1	4,2	4,8	6,3	5,0	4,4	3,5
2	4,4	5,2	5,9	4,9	4,0	3,1
3	2,1	4,4	5,0	4,5	4,0	3,4

Storage was carried out in desiccators, the amount of solution per sample was taken in 100 ml, solutions were changed every 2 months. The following were used as aggressive solutions: 5% Na2SO4 solution, 3% MgSO4 solution and tap water. The results of testing the strength of Portland cement during storage in aggressive solutions are given in table 2.

Table 3

Portland cement stability factor during storage in aggressive solutions

No. of cement	3 days	7 days	28 days	3 months	6 months	1 year
5% Na_2SO_4						
1	1,02	1,02	1,0	0,90	0,79	0,70
2	1,0	1,0	1,0	0,95	0,70	0,61
3	1,0	0,92	0,82	0,78	0,69	0,60
3% $MgSO_4$						
1	1,0	1,0	1,0	0,80	0,72	0,61
2	1,0	1,0	1,0	0,81	0,65	0,50
3	0,75	0,92	0,98	0,76	0,68	0,57

Table 4

Strength of cements with 20% tuffite during storage in aggressive solutions

№ цемента	Bending strength, MPa					
	Curing time					
	3 days	7 days	28 days	3 months	6 months	1 year
Вода						
1	3,8	4,7	5,7	5,9	6,8	7,0
2	3,5	4,5	5,5	6,3	6,6	6,9
3	2,2	3,3	5,2	5,9	6,1	6,7
5% Na_2SO_4						
1	3,8	4,8	5,6	5,8	6,7	6,0
2	3,6	4,5	5,5	6,2	6,5	5,9
3	2,5	3,3	5,3	5,7	5,9	6,1
3% $MgSO_4$						
1	3,8	4,7	5,3	4,7	5,2	4,9
2	3,6	4,5	5,4	5,0	4,9	4,7

3	3,1	3,9	4,4	4,7	4,3	4,6

Based on the data given in tables 1-4, the following conclusions can be drawn: the introduction of hydraulic additives into Portland cements increases their sulfate resistance, especially in cases where cements have a high content of C3A. Cements with 30% tuffite give better strength than those with 20% tuffite.

Conclusion: The possibility of replacing 20-30% of the mass fraction of clinker with the specified additive was shown and confirmed with an increase in the strength characteristics of the binder in all periods of hardening (from 1 day to 2 years), and at 28 days of age - by 4-5 MPa, while improving kinetics of strength growth after heat and moisture treatment, increasing the sulfate resistance of cements and their frost resistance.

The developed compositions of mixed cements with the addition of heat-treated tuffite to the composition of Portland cement, which make it possible to reduce the mass fraction of clinker by 20-30% without reducing the strength characteristics of the mixed cement.

Literature

1. Atakuziev T.A., Uteniyazova G.K. Iskenderov A.M. Wastes of the Kungrad soda plant and their use in the production of binders / Proceedings of the scientific and practical conference "Actual problems of protecting the population in emergency situations." – Tashkent, 2000. S. 51-54.
2. Atakuziev T.A., Uteniyazova G.K., Iskenderov A.M., Shamadinova N.E. Cements and concretes of increased corrosion resistance against solutions of sodium and magnesium sulfates / Materials of the VI All-Russian Scientific Conference. Ceramics and composite materials. – Syktyvkar, 2007. P.33