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Gypsumcementpozzolana Composites with Application Volcanic Ash

Valeria Kretova[a,] *, Tolya Hezhev[b], Timur Mataev[b], Khasanbi Hezhev[c], Amelin Vasily[a]

[a]*South-West State University, 50 let Oktyabrya St., 94, 305040, Kursk, Russia.*
[b]*Kabardino-Balkarian State University, Chernyshevsky St., 173, 360004, Nalchik, Russia*
[c]*Architectural studio M4, Moiseenko St. 22, 196197, St. Petersburg, Russia.*

Abstract

It is established, that the development of new effective gypsumconcrete composites on the basis of technogenic raw material and local materials is urgent task. For eliminating the deficiencies in the gypsum materials and articles is proposed the application of pumice as the filler and the active mineral additive. The influence of the additives of portland cement on the properties of hemihydrate gypsum is at shown on table. Further are given the results of studies of the properties of composite in the dependence on the relationship of the components of gypsum, ashes and portland cement, and also grain composition of pumice. It is revealed, that the application of pumice together with the portland cement in the gypsumconcrete composites makes it possible to reduce the expenditure of gypsum to 50% without considerable reduction in the strength characteristics. In this case the developed gypsum concrete composites have the increased water resistance. It is established that the influence of the granulometric composition of ashes on the strength properties of composite is ambiguous, in the compositions with the high content of ashes the use of larger fractions is expedient, and with the content it is less than 50% ashes in the composite - small fractions.

Consideration of gypsumcementpozzolana composites using gypsum, Portland cement and volcanic ash. The results of studies of the composition and physico-mechanical properties of the composites gypsumcementpozzolana, the influence of the grain size of volcanic ash on their properties.

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* Corresponding author. Tel.: +7-903-876-09-93; fax: +7(4712)50-48-00
E-mail address: 325573@mail.ru

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1. Introduction

Reducing the cost of construction products is the main task of construction. Therefore, it is urgent to develop new effective composites based on man-made materials and local materials the advantages which is the low cost and improved physical and mechanical properties.

Developments in the field of gypsum binders, materials and products, as well as the environmental and technical and economic aspects of their production and use indicate that there are all necessary conditions for extending the scope of their application in new construction as well as renovation and refurbishing existing buildings and structures. Along with a number of positive technical properties of gypsum binders and products have the following disadvantages: a large fragility, low water resistance, low frost resistance, high creep when wet.

Overcoming many of the disadvantages of gypsum binders and products possibly when in the creation of composites using effective fillers. For gypsum concrete as aggregate and active mineral supplements can be effectively used materials natural and technogenic origin [1]. One of these materials is volcanic ash of Kabardino-Balkaria, previously insufficiently investigated for use in gypsum concrete composites [2].

As the binder used for research was used:

- Gypsum binder Ust-Dzhegutinskyi gypsum combine brand G-5 BII GOST 125-79 with GOST 23789-79 specifications: normal density (thickly) - 50%; setting time: the beginning - 12 minutes, the end - 17 minutes; the compressive strength and bending respectively - 5.3 MPa and 2.6 MPa;
- Portland PTS500-UP manufactured by JSC "Belgorod cement".

As the filler and active mineral additives used volcanic ash Zayukovskoe deposit with a maximum grain size of 5 mm. Granulometric composition of the volcanic ash is given in (Tab. 1).

Table 1. Granulometric composition of the volcanic ash

Material name	Private residues on the sieves, [%]					Has passed through a sieve 0.14
	2.5	1.25	0.63	0.315	0.14	
1	2	3	4	5	6	7
Ash	9.3	9.2	19.0	18.7	15.4	28.4

Preparation of the mixture was carried out in a forced action mixer, wherein after water supply consistently charged with a mixture of gypsum and Portland cement, whereupon filler or pre-mixed dry mixture of gypsum, aggregates and Portland cement, whereupon stirring was carried out before obtain homogeneous mixture of gypsumconcrete. Samples size 4h4h16 cm was be formed casting method and and was natural drying carried out in air-dry conditions. Testing of samples was carried out in accordance with GOST 23789-79.

At the beginning was conducted , we studied the effect of additives on the properties of Portland cement plaster of paris (semi aquatic gipsum) (Tab. 2).

Table 2. Effect of additives Portland cement on the properties of the semi aquatic plaster gypsum

Consumption of cement [%] by weight of the gypsum	Water / binder	Flexural strength [MPa] aged		Compressive strength [MPa] aged	
		[2 h]	[28 days]	[2 h]	[28 days]
1	2	3	4	5	6
–	0.5	2.6	4.5	5.3	10.5
10	0.52	3.9	5.8	7.8	12.8

20	0.52	4.0	7	8.3	15.7
30	0.53	3.4	6.1	7.8	13.1

Table 2 shows that a substantial increase in flexural strength and compressive strength of the samples takes place with the addition of Portland cement up to a 20% by weight of gypsum, further increase the cement additive leads to a decrease in strength of the composite.

Further research has focused on determining the ratio of the components of gypsum, ash and portland cement, which would provide a decrease in the specific consumption of the binder. In addition,was researched the influence of the grain composition filler on the properties of the composite gypsumcementpozzolana composite.

(Tab.3) shows the results of studies using composites of volcanic ash with a maximum grain size of 5 mm.

Table 3. Physical and mechanical properties of the composite gypsumcementpozzolana composite.

№ composition	Ratio gipsum / ash by mass	Cement consumption in [%] by weight gypsum	Properties of composites				
			mean density at 28 days, [kg/m3]	flexural strength [MPa] at the age		compressive strength [MPa] aged	
				[2 h]	[28 days]	[2 h]	[28 days]
1	2	3	4	5	6	7	8
1	1:1	–	1183	2.1	3.8	4.6	7.0
2	1:1	10	1174	2.2	3.9	5.2	7.7
3	1:1	20	1195	2.3	4.0	5.4	7.6
4	1:1	30	1182	1.8	3.8	4.2	7.2
5	1:2	–	1090	1.3	2.4	2.4	5.6
6	1:2	10	1076	1.6	2.7	3.3	5.9
7	1:2	20	1122	1.4	2.7	2.8	5.8
8	1:2	30	1168	0.9	2.7	1.4	4.9

From the test results, it follows that occured a significant increase in bending strength and compressive strength of the samples when replacing 10-20% gypsum by portland cement same average density. It should be noted that the replacement of 50% of gypsum by ash in composition №1 flexural strength and compressive strength of the composite remain quite high. This is due to the fact that the semi aquatic plaster gypsum is the causative agent of latent hydraulic activity of volcanic ash. Moreover, additive Portland cement prior to 10-20% by weight of gypsum, increases the coefficient of softening from 0.45 to 0.7 for the ratio of gypsum: ash to 1: 1 and 0.4 to 0.6 for the composition with ratio of gypsum / ash equal to 1: 2. This allows you to rank the proposed gypsum concrete composites to the materials increased water resistance.

The results of studies of composites with using volcanic ash with a maximum grain size of 1.25 mm are shown in (Tab. 4)

Table 4. Physical and mechanical properties of the composite gypsumcementpozzolana composite.

№ composition	Ratio gipsum / ash by mass	Cement consumption in [%] by weight gypsum	Properties of composites				
			mean density at 28 days, [kg/m3]	mean density at 28 days, [kg/m3]		mean density at 28 days, [kg/m3]	
				[2 h]	[28 days]	[2 h]	[28 days]
1	2	3	4	5	6	7	8
1	1:1	–	1090	2.3	4.3	5.4	7.5
2	1:1	10	1086	2.4	3.8	5.4	8.5
3	1:1	20	1120	2.1	3.7	4.8	7.9

4	1:1	30	1150	1.5	3.4	3.3	6.9
5	1:2	–	1130	1.3	2.9	2.5	5.9
6	1:2	10	1180	1.3	2.7	3.0	6.2
7	1:2	20	1140	1.2	2.6	2.9	6.0
8	1:2	30	1160	1.1	2.3	2.1	4.6

From Table. 4 obviously that the addition prior to 10-20% Portland cement has a positive influence on the compressive strength only for composition: gipsum / ash ratio of 1: 1. In other combinations of Portland cement additive has no appreciable effect on the strength properties of the composite.

Table 5. Results of studies using composites of volcanic ash with a maximum grain size of 0.14 mm

№ composition	Ratio gipsum / ash by mass	Cement consumption in [%] by weight gypsum	Properties of composites				
			mean density at 28 days, [kg/m3]	mean density at 28 days, [kg/m3]		mean density at 28 days, [kg/m3]	
				[2 h]	[28 days]	[2 h]	[28 days]
1	2	3	4	5	6	7	8
1	1:1	–	1195	1.6	2.5	2.6	5.8
2	1:1	10	1179	1.7	2.8	3.8	6.9
3	1:1	20	1195	1.5	2.9	3.7	7.8
4	1:1	30	1220	1.4	3.2	3.6	6.7
5	1:2	–	1090	0.8	1.5	1.5	2.5
6	1:2	10	1120	1.0	1.8	2.1	3.4
7	1:2	20	1080	0.9	1.9	1.9	4.2
8	1:2	30	1140	0.8	1.8	1.4	4.1

From the test results, it follows that the use of volcanic ash with a maximum grain size of 0.14 mm composites without portland cement results in a marked reduction of the compressive strength and flexural strength as compared to composites with using larger fractions. However, it should be noted that the replacement of gypsum on cement prior to 20-30% provides a higher increase in strength of the samples compared to composites using volcanic ash with larger particles, especially on the 28 day curing that provides interaction hydration products of Portland cement with dust-like fractions of volcanic ash

2. Summary

Thus, the use of ash in conjunction with Portland cement composites in gypsumconcrete composites allows to reduce the consumption of gypsum up to 50% without a significant reduction in strength properties. At the same time developed gypsumconcrete composites have improved water resistance. Effect of particle size distribution of the ashes on the strength properties of the composite is ambiguous, in compositions with a high content of ash it is advisable to use a large fraction, and containing less than 50% ash in composite - small fractions

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