UDC 621.9

Part 3

ASH AND SLAG HANDLING

3.3. Ash and slag properties

3.3.7. Experience and regulatory framework for the use of dry fly ash from Russian TPPs for producing concrete, mortar and dry construction mixes

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ABSTRACT

Here you can find the studies of basic consumer properties of fly ash from domestic and foreign TPPs, as well as the main methods of fly ash application to produce concrete, building mortars and dry building mixes.

The analysis was made concerning the current state of the regulatory framework of the Russian Federation, touching upon subject of the use of TPP's fly ash for production of concrete, building mortars and dry building mixes.

INTRODUCTION

Currently, the issue on energy and resource is the critical issue of Russia. One of the effective ways to solve this problem is involving the industrial wastes into the economic turnover. The most common and less reusable industrial waste are ash and slag waste (hereinafter ASW) from TPP. These materials are the valuable resources of anthropogenic origin, which can be successfully used in different areas of the national economy of Russia.

ASW is the mineral residue resulting from the combustion of natural solid fuel on TPP (coal, oil shale, etc.), consisting of fly ash and furnace clinker. These two materials have different chemical composition and different physical and chemical properties, therefore, the areas of their application are different too. The certain fact is that these materials, with properly organized handling, can be used with high efficiency in industry and agriculture of Russia, thus making a significant contribution to solving the problems of resources and energy conservation.

Today, ProfCement-Vector, CJSC, is the leading provider of shale fly ash (of Narva Power Plants, JSC manufacturer) in Russia and has a wealth of experience in the application of these types of fly ash in the production of construction materials (concrete, mortar, dry building mixes, grouting mortars, etc.) and agriculture. The company's specialists do an ongoing research work aimed at deep studying of the properties of shale ash, research results accumulation and systematization. Such work allows discovering the new features of shale ash and the new areas of its industrial and agricultural application in Russia.

At the same time, the company is deeply involved into the active study of the properties and characteristics of domestic TPP's shale ash. So far, it has currently performed the research work on basic consumer properties of fly ash of some Russian power stations: Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarskaya TPP-1.

The research guidelines of fly ash from these power plants were to study the possibility of using them as mineral additives for the production of concrete, building mortars and dry building mixes.

One of the most promising areas of recycling is the application of dry selected fly ash in the production of construction materials, as this kind of industry has a tremendous materials-output ratio and ensures the involvement of high volume of fly ash into the production cycle.

This paper presents the results of studies of consumer properties of fly ash of some TPPs and shale electrofiltered fly ash "Zolest-bet" of Narva Power Plants (Estonia), and based on the research results the attempt has been made to point out the major ways of application of fly ash for the production of concrete, building mortars and dry building mixes.

This paper also covers the present state of regulatory framework of the Russian Federation, encompassing the issues of TPP fly ash application to produce concrete, building mortars and building mixes.

1. APPLICATION OF FLY ASH FOR PRODUCTION OF CONCRETE, BUILDING MORTARTS AND BUILDING MIXES

1.1 The study of consumer properties of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarskaya TPP-1 and electro-filtered shale fly ash "Zolest-bet"

In this paper we have studied the fly ash to determine the following:

- chemical composition;
- physical and mechanical properties;
- effective specific activity of natural radionuclides;
- water demand and hydration activity;
- soundness of Portland cement compositions with fly ash;
- the impact of fly ash on properties of concrete, building mortars and building mixes.

The chemical composition of fly ash was determined according to GOST 8269.1-97 «Macadam and gravel from compact rocks and industrial waste products for construction works. Methods of chemical analysis". Contents CaOfr (free calcium oxide) was determined according to GOST 23227-78 «Lignite, hardcoal, antracite, oil shale, and peat. Method for free calcium oxide determination in ash». Loss on ignition of fly ash was determined according to GOST 11022-95 «Solid mineral fuel. Methods for ash content determination».

Chemical composition (oxide composition) of fly ash is shown in Table 1.

Among the study defined physical and mechanical properties of fly ash are the following:

- appearance;
- bulk density in natural state;
- true density of ash grains;
- sieve residue 008 and 004;
- specific surface area according to Blaine.

Bulk and true density was determined according to GOST 8735-88 «Sand for construction works. Test methods». Sieve residue 008 and 004 was determined according to GOST 310.2-76 «Cements. Grinding fineness test methods». The specific surface area was determined according to the Blaine's instrument.

Basic physical and mechanical properties of fly ash are shown in Table 2.

Table 1. **Chemical composition of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarsk TPP-1 and electro-filtered shale fly ash «Zolest-bet»**

Name of the item	Content, % wt			
	ash «Zolest-bet"	ash from Reftinskaya SDPP	ash from Gusinoozerskaya SDPP	ash from Krasnoyarkaya TPP-1
SiO_2	27,8	57.7	52.1	68.8
CaO	36,6	2.39	4.7	15.2
CaOfr	10.0	<0.1	0.5	3,0
MgO	4,29	0.88	1.48	3,82
Fe_2O_3	4,19	5.56	6.12	3,57
Al_2O_3	7,02	26.4	25.9	6.22
SO_3	10.3	0.23	1.1	0.93
K_2O	4,26	0.47	1.34	0.45
Na_2O	0.087	0.34	0.75	0.18
Percentage of other impurities	4.87	1.32	2.18	<0.1
Chlorides	<0.1	<0.1	<0.1	<0.01

Table 2. **Physical and mechanical properties of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarskaya TPP-1 and electro-filtered shale fly ash «Zolest-bet»**

Name of the item	Unit	ash «Zolest-bet"	ash from Reftinskaya SDPP	ash from Gusinoozerskaya SDPP	ash from Krasnoyarkaya TPP-1
Appearance	-	Grayish powder with a yellowish tinge	Dark grey powder	Stone-color powder	Stone-color powder
Bulk density in natural state	kg/m^3	1100+/-50	790+/-50	1000+/-50	1170+/-50
True grain specific gravity	kg/m^3	2850+/-50	1930+/-50	2410+/-50	2650+/-50
Sieve residue 008	%	0.82	34.3	8,7	8,0
Sieve residue 004	%	0.63	11.4	1.7	19.85
Specific surface area	m^2/kg	300-350	260	600	260

All the fly ash subjects used during the trial according to the GOST 30108-94 «Construction materials and products. The determination of the specific effective activity of natural radionuclides" have shown the importance of specific effective activity of natural radionuclides of less than 370 Bq/kg, which corresponds to the first grade and allows the use of these materials for all types of construction works [2].

The determination of soundness of Portland cement composition with fly ash was carried out by the procedure of EN 450-1 «Fly ash for concrete. Part 1. Definition, requirements and conformity criteria", as well as in accordance with the requirements of GOST 310.3-76 «Cements. Methods for determination of normal consistency, setting time and soundness" and GOST 30744-2001 «Cements. Test methods using heterogeneous sand». During the trial the fly ash content in Portland cement compositions was selected based on the evaluation of the chemical composition of each fly ash. Test results on compositions soundness are shown in Table 3.

The determination of water demand of Portland cement and fly ash compositions was carried by the method of EN 450-1 «Fly ash for concrete. Part 1. Definition, requirements and conformity criteria». The determination of results of water demand of compositions is shown in Table 4.

Table 3. **Soundness of Portland cement and fly ash composition: of Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarsk TPP-1 and electro-filtered shale fly ash «Zolest-bet»**

Composition type	Composition soundness	
	Pat assessment acc. to GOST 310.3-76	Sample expansion GOST 30744-2001
Reference formulation Cement-100 %	pats have passed the testing	0 mm
Composition type	Composition soundness	
	Pat assessment acc. to GOST 310.3-76	Sample expansion GOST 30744-2001
Cement-80 % wt + fly ash «Zolest-bet»-20 % wt	pats have passed the testing	3.0 mm
Cement-70 % wt + fly ash from Reftinskaya SDPP-30 % wt	pats have passed the testing	0.0 mm
Cement-70 % wt + fly ash from Gusinoozerskaya SDPP -30 % wt	pats have passed the testing	0.2 mm
Cement-70 % wt + fly ash from Krasnoyarskaya TPP-1-30 % wt	pats have passed the testing	1.0 mm

Table 4. **Water requirement of Portland cement and fly ash compositions: of Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarsk TPP-1 and electro-filtered shale fly ash «Zolest-bet»**

Composition type	Water requirement of compositions, %
Reference formulation Cement-100 %	100
Cement-70 % wt + fly ash «Zolest-bet»-30 % wt	93
Cement-70 % wt + fly ash from Reftinskaya SDPP – 30 % wt	102
Cement-70 % wt + fly ash from Gusinoozerskaya SDPP – 30 % wt	95
Cement-70 % wt + fly ash from Krasnoyarskaya TPP-1 -30 % wt	97

Determination of fly ash activity was carried using the EN 450-1 method «Fly ash for concrete. Part 1. Definition, requirements and conformity criteria». The root of the method is to compare the compressive and the bending strength of building mortars at the age of 28 days, produced from Portland cement of a strength of 42.5 (reference formulation) with a compressive and bending strength of building mortars prepared from Portland cement in an amount of 80%, and fly ash in an amount of 20% of binder wt. [3]. Results of fly ash activity determination are shown in Table 5.

As part of this work the investigation of the influence of fly ash on the properties of concrete mixes and concrete was carried out. The content of this study was to choose the composition of the concrete mixtures having the same plastic nature, produced using Portland cement (reference formulation) and Portland cement and fly ash compositions, and then to compare the characteristics of the produced concrete mixtures and the hardened concrete. The results of the study are presented in Table 6.

Table 5. **Activity of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarsk TPP-1 and electro-filtered shale fly ash «Zolest-bet»**

Mixture composition				Strength at the age of 28 days, %	
Binder, % wt	W/C	W/B	Water	flexing	compressing
Cement 42.5-100 %	0.5	-	225	100	100
Cement-80 % + fly ash «Zolest-bet"-20 %	0.625	0.5	225	102	103
Cement-80 %+ fly ash from Reftinskaya SDPP-20 %	0.625	0.5	225	108	89
Cement-80 %+ fly ash from Gusinoozerskaya SDPP-20 %	0.625	0.5	225	87	101
Cement-80 %+ fly ash from Krasnoyarskaya TPP-1 -20 %	0.625	0.5	225	84	75

(W/C-water-cement ratio; W/B-water/binder ratio)

Table 6. **Assessing the impact of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarsk TPP-1 and electro-filtered shale fly ash «Zolest-bet" for the properties of concrete mixes and concrete**

Concrete composition						Characteristics of the concrete mix		Compressive strength, MPa (normal curing conditions)
Cement, kg (grade 32.5)	Additive, kg	Sand, kg	Chip stone, fr. 5-20 mm, kg	W/C (W/B)	Water	Density, kg/m^3	Slump of cone, cm	
345	«Zika 2190»-1.73	824	1015	0.54	186	2415	18.0 in 1 hour - 16.0	1 day-7.4 (100 %) 7 days - 24.0 (100 %) 28 days-35.0 (100 %)
280	fly ash «Zolest-bet"-65+ «Zika 2190»-1.73	824	1015	0.60 (0.49)	169	2430	21.0 in 1 hour - 19.0	1 day-4.0 (54 %) 7 days-25.2 (105 %) 28 days-42.0 (120%)
280	fly ash from Gusinoozerskaya SDPP-65+ «Zika 2190»-1.73	824	1015	0.62 (0.50)	174	2410	19.5 in 1 hour - 17.0	1 day-4.2 (57 %) 7 days- 22.4 (93 %) 28 days-36.0 (103 %)
280	fly ash From Reftinskaya SDPP-65+ «Zika 2190»-1.73	824	1015	0.66 (0.54)	186	2390	19.0 in 1 hour - 17.0	1 day-5.2 (70 %) 7 days- 18.1 (78 %) 28 days-29.3 (84 %)
280	fly ash from Krasnoyarkaya TPP-1 - 65+ «Zika 2190»-1.73	824	1015	0.64 (0.52)	180	2415	19.0 in 1 hour - 16.0	1 day-5.5 (74 %) 7 days- 16.8 (70 %) 28 days-28.0 (80 %)

Since the electro-filtered shale fly ash «Zolest-bet" contains a considerable amount of components that can affect the linear expansion of cement paste (CaOfr, SO3), then the tests have been also conducted for this fly ash, to determine its impact on the linear expansion of cement paste during its hardening. The test was conducted in accordance with the requirements of GOST 30459-2008 «Additives for concrete and building mortars. Identification and assessment of the effectiveness", test results are given in Table 7.

There was held an additional research concerning the fly ash from Krasnoyarskaya TPP-1, aimed at determination of the influence of fly ash on the properties of mortar mix and hardened mortar, made of the dry building mix, being the finishing adhesive.

The composition of the adhesive was developed during the study using Portland cement (reference formulation) as a binder, and the composition of the finishing adhesive using Portland cement and fly ash from Krasnoyarskaya TPP-1 as a binder. Then, a comparison of technical performance data of adhesives of these compositions was carried out. The results of the study are presented in Tables 8 and 9.

Table 7. **Influence of electro-filtered shale fly ash "Zolest-bet" on the linear expansion of cement paste during its hardening**

Mixture composition			Linear expansion of cement paste, %		
Binder, % wt	W/C	W/B	3 days	7 days	28 days
Cement 42.5 + 30 % fly ash «Zolest-bet»	0.328	0.252	0.12	0.34	0.65
Cement 42.5 + 40 % fly ash «Zolest-bet»	0.334	0.239	0.23	1.0	1.6

Table **8. Composition of finishing adhesives**

No.	Material name	Composition 1		Composition 2	
		Weight, %	Weight, g	Weight, %	Weight, g
1	PC 42.5 H («Cesla»)	35.0	35.00	28.0	28.00
2	Ash	-	-	7.0	7.00 (25 % of cement weight)
3	Sand 0-5 mm	64.7	64.69	64.7	64.69
4	Cellulose ester	0.25	0.25	0.25	0.25
5	Starch ester	0.06	0.06	0.06	0.06
TOTAL		100.00	100.00	100.00	100.00

Table 9. **Testing results of finishing adhesives**

Names of adhesive composition parameters	Requirements for adhesive composition parameters	Composition 1	Composition 2
Quantity of water, %	not rated	23.0	23.0
Slipping down, mm	not rated	0.50	0.50
Open time, min	not rated	15	15
Flexural strength during the day 28, MPa	not rated	4.80 (100 %)	3.55 (74 %)
Ultimate compressive strength during the day 28, MPa	not less than 5	14.62 (100 %)	9,70 (66 %)
Tensile bond strength under normal storage conditions on the 7th day, MPa	not rated	0.694 (100 %)	0.670 (97 %)
Tensile bond strength to the surface under normal storage conditions on the 28th day, MPa	not less than 0.5	0.721 (100 %)	0.801 (111 %)

1.2 Discussion of the results of studies of consumer properties of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP, Krasnoyarskaya TPP-1 and electro-filtered shale fly ash «Zolest -bet»

In the analysis of the test results presented in Tables 1-5 the following can be noted:

- the chemical composition of fly ash from Reftinskaya SDPP, Gusinoozerskaya SDPP is acidic (high-silica) with high SiO2 content, and fly ash from Krasnoyarskaya TPP-1 and shale electro-filtered fly ash «Zolest-bet" are basic (high-calc) with high CaO content, however it is noteworthy that fly ash from Krasnoyarskaya TPP-1 also contains SiO2 in an amount comparable to the content of acidic fly ash [4];
- in terms of specific surface area and sieve residue 008, fly ash from Reftinskaya SDPP and Krasnoyarskaya TPP-1 according to GOST 25818-91 «Fly ash from thermal power plants for concrete. Specifications" refer to grades I-III, and fly ash from Gusinoozerskaya TPP and electro-filtered shale fly ash «Zolest -bet" refers to grades I-IV [4];
- as for the specific effective activity of natural radionuclides, all the studied fly ash, in accordance with GOST 30108-94, is classified as grade I fly ash, which allows using it in the production of all kinds of construction materials [2];
- in terms of soundness of Portland cement compositions and fly ash, all the studied fly ash meets the requirements of EN 450-1 and causes minor or moderate expansion of the cement paste that cannot lead to the its strength reduction;
- as for the activity (impact on the compressive strength of Portland cement compositions and ash) all the studied fly ash can be divided into high-active: electro-filtered shale fly ash «Zolest-bet", fly ash from Gusinoozerskaya TPP and low-active: fly ash from Reftinskaya SDPP and Krasnoyarskaya TPP-1;
- as for the impact on flexural strength of Portland cement compositions with fly ash, the best result was shown by the fly ash from Reftinskaya SDPP (108 % of the strength of the reference formulation), and the worst result was shown by the fly ash from Krasnoyarskaya TPP-1 (84 % of the reference formulation strength);
- the influence on the water demand of the compositions of Portland cement with fly ash can be divided into ones reducing the water demand: electro-filtered shale fly ash "Zolest-bet" (93% of water demand of reference formulation), fly ash from Gusinoozerskaya TPP (95% of water demand of reference formulation), fly ash from Krasnoyarskaya TPP-1 (97% of water demand of reference formulation) and the ones increasing the water demand: fly ash from Reftinskaya SDPP (102% of water demand of reference formulation);
- activity and performance of fly ash is the higher, the higher is the value of its specific surface area.

During the analysis of test results presented in Table 6, it is noteworthy that:

- with respect to the impact on the properties of concrete mixes (plasticity, rheology) the most effective were the following: electro-filtered shale fly ash «Zolest-bet", fly ash from Gusinoozerskaya SDPP, fly ash from Krasnoyarskaya TPP-1, as they helped to reduce the water demand, viscosity and increase the plasticity of concrete mixtures;
- with respect to the impact on concrete strength, the most effective were the following: electro-filtered shale fly ash «Zolest-bet", fly ash from Gusinoozerskaya SDPP, as well as the application of this ash in concrete composition, has led to an increase in its ultimate strength;
- when assessing the impact of fly ash to the preservation of the primary plasticity of concrete mix, it was established that all the fly ash under review have no great impact on this value.

During the analysis of test results presented in Table 7, one can mention the following:

- electro-filtered shale fly ash «Zolest-bet" being used in an amount of 30 % and 40 % of cement weight, causes significant linear expansion of the cement paste during its hydration;
- the importance of linear expansion of the cement stone, caused by shale ash, is such that allows to consider this ash an expanding additive for concrete and building mortars that meets the requirements of GOST 24211-2008 «Additives for concrete and building mortars. General specifications».

In the analysis of test results presented in Table 8-9 it is worth mentioning the following:

- the use of fly ash from Krasnoyarskaya TPP-1 as a part of the finishing adhesive leads to deterioration of performance characteristics of adhesive strength under its compression and bending, but at the same time it improves the basic characteristic of the adhesive - the tensile strength of surface adhesion;

- the use of fly ash from Krasnoyarskaya TPP-1 as a part of the finishing adhesive causes no deterioration of the final consumer properties;
- provided that the cost of fly ash from Krasnoyarskaya TPP-1 was significantly lower than the cost of Portland cement, it can be argued that the application of fly ash from Krasnoyarskaya TPP-1 as part of the finishing adhesive will significantly reduce its net cost.

1.3 General conclusions on the section

1. The fly ashes under review are the active mineral additives with certain consumer properties.
2. Fly ash can be effectively used in the manufacture of concrete, building mortars and dry building mixes in order to reduce the net cost of final products or to modify the properties of the final products.
3. In order to reduce the cost of production of fly ash, it is advisable to use for production the following construction materials:

- ready mix concrete and building mortars of general purpose and medium strength;
- porous and foam concrete;
- dry building mortars of general purpose (adhesives, plasters, assembly mixtures, etc.);
- prefabricated reinforced concrete manufactured using the heat treatment.

4. In order to modify the properties of the product, it is advisable to use the fly ash for the production of the following construction materials:

- concretes and building mortars with low heat release (massive structures) [1];
- concretes and building mortars, operated in chemically aggressive environments (sea water, acid solution, etc.) [1];
- nonshrinking and tensible concrete and construction solutions;
- highly mobile and self-compacting concretes and building mortars [1];
- dry mixes of special purpose (repair, chemical resistant, waterproofing, etc.).

5. The application of fly ash in order to reduce the production cost is possible under the following conditions:

- stability of fly ash properties and well-handled quality monitoring system;
- availability of fly ash on the construction materials market during the whole period of yearlong construction cycle;
- use of fly ash in the regions neighboring the places of its production;
- fly ash cost shall not exceed 50 % of the cost of cement grade 42.5.

6. To apply the fly ash for the purpose of modification of products properties the following conditions must be met:

- stability of fly ash properties and well-handled quality monitoring system;
- availability of fly ash for construction materials during the whole period of yearlong construction cycle;
- presence of special properties of fly ash (e.g. the effect of shale fly ash expansion);
- competitive price;
- availability of special tasks (unique construction projects) to decide on fly ash application equipment.

2. THE RF REGULATORY FRAMEWORK GOVERNING THE USE OF FLY ASH FOR PRODUCTION OF CONCRETE, BUILDING MORTARS AND DRY CONSTRUCTION MIXES

2.1 Condition of the RF state regulatory framework governing the use of fly ash to produce concrete, building mortars and building mixes

Currently, there is a number of normative documents regulating the application of fly ash for the production of concrete, building mortars and dry building mixes in the Russian Federation.

7. GOST 25818-91 «Fly ash from thermal power plants for concrete. Specifications" is the main regulatory document establishing the quality requirements for fly ash from TPP for the production of various types of concrete. This standard specifies the general methods of fly ash quality control and the major demands are presented regarding the quality monitoring system when shipping the fly ash to the consumers. GOST 25818-91 effective from 1991, is obsolete and has several disadvantages by now:

- the standard applies only to the fly ash produced by thermal power plants as a result of combustion of coal and lignite, and does not include fly ash, which is the mineral residue from burning other fuels (oil shale, biomass, etc.) [4];
- the standard places demands on the chemical composition, particle size, surface area and soundness of fly ash, but leaves out of consideration an assessment of important consumer characteristics such as activity, water demand, which are reflected in the European standard for fly ash from TPP - EN 450-1 [1,4];
- the technique of cement and ash mixture soundness determination is not quite correct, as it implies the testing of mixtures with calcium content fly ash exclusively in an amount of 50 % wt, and in case the fly ash with CaO_{fr} and MgO is beyond the requirements of the present standard, it is expected to hold trials using autoclave, despite the fact that the autoclaving conditions apply only to the certain types of concrete, and these conditions do not correspond to the real conditions of curing of the main types of concrete, and thus these test conditions do not reflect the real behavioral pattern of fly ash mixed with Portland cement at hydration [4].

8. GOST 24211-2008 «Additives for concrete and building mortars. General technical conditions" establishes the requirements for additives for concrete and building mortars. This standard specifies the use of mineral additives, which may include TPP fly ash. According to this standard the acidic fly ash can be classified as active mineral additives with pozzolanic

properties and calcium ash as the active mineral additives possessing both pozzolanic and binding properties [5]. GOST 24211-2008 establishes only mineral additives criteria on the effects of their use in concrete and building mortars, and does not place requirements to the quality of additives (chemical composition, mechanical properties, etc.). Therefore, GOST 24211-2008 permits the use of fly ash as mineral additives according to the relevant manufacturer's specifications.

9. GOST 26633-2012 «Heavy and fine-grained concrete. Specifications" places demands on the quality of heavy and fine-grained concrete, as well as the demands on materials for their preparation. This standard permits the use of fly ash corresponding to the GOST 25818-91as fine filler and allows the application of additives in accordance with GOST 24211-2008, which includes the TPP fly ash [6].
10. GOST 28013-98 «Building mortars. General specifications», GOST 25820-2000 «Light concretes. Specifications», GOST 31359-2007 «Autoclave curing cellular concrete. Specifications», GOST 31357-2007 «Dry building mixes with cement binder». General specifications" do not specify the use of fly ash from thermal power plants, however, they allow the use of additives in accordance with GOST 24211-2008, which include the TPP fly ash [7,8,9,10].

2.2 Summary

While analyzing the regulatory framework of the Russian Federation, which regulates the use of fly ash for the production of concrete, building mortars and dry building mixes, one can draw the following conclusions:

- basic standard for TPP fly ash - GOST 25818-91 - is obsolete and requires the revision of some items;
- GOST 24211-2008 allows the use of fly ash for the production of concrete, building mortars as mineral additives, manufactured according to the relevant manufacturers' specifications;
- RF regulatory documents governing the production of concrete, building mortars and dry building mixes allow the use of TPP fly ash as mineral additives.

CONCLUSION

The analysis of fly ash research results suggests that these materials are highly valuable products, which are, if handled right, can be effectively used in the production of concrete, building mortars and dry building mixes to reduce the net cost of construction materials, as well as for modification of their properties.

Regulatory framework of the Russian Federation in the field of production of construction materials allows the legitimate use of TPP fly ash as mineral additives for concrete, building mortars and building mixes, but needs to be improved.

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A.V. Ukhanov. Experience and regulatory framework for the use of dry fly ash from Russian TPPs for producing concrete, mortar and dry construction mixes // Proceedings of the V Conference "Ashes from TPPs: removal, transport, processing, storage", Moscow, April 24–25, 2014 — M.: MPEI Printing House, 2014. P. 146 – 152.