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THE INTEGRATED BINDER WITH THE USE OF ASH OF THE BELARUSIAN STATE DISTRICT POWER STATION OF THE URBAN VILLAGE OREKHOVSK

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The article considers the effectiveness of the application of ash from the Belorusian state district power station of the urban village Orekhovsk in the integrated binder based on Portland cement. The results of the determination of the activity of the integrated binder according to the procedure of EN 450-1 are given. The dosage of ash in an amount of 10–20% of the mass of the binder is established, which increases the activity of the integrated binder.

Plans for the development of energy are associated with the increase by 2020 of the share of own energy resources (including: peat, firewood, biomass) in the balance of boiler-furnace fuel to 32 ... 34% [1]. Without the use of modern processing technologies, the increase in ash-waste streams will lead to an increase in the areas of slag-hills, which will cause irreparable damage to the environment.

The Belorusian state district power station of the urban village Orekhovsk in the Vitebsk region works on local fuels. This station is equipped with a boiler plant, which operates on milling peat and wood chips. In the furnaces the fuel is burned in a fluidized bed of quartz sand. The average burning temperature does not exceed 800°C.

Chemical composition of the ash and slag mixture is formed (mass %) according to Interstate Standard 10538-87 "Solid fuel. Methods for determining the chemical composition of ash" [2] is presented in Table 1.

Table 1. – Chemical composition of the ash and slag mixture of the Belorusian state district power station (mass %)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	loi
87.62	4.39	1.08	3.08	0.55	0.61	1.79	0.24	0.19	<0.10	0.07

According to the chemical composition, the ash and slag mixture consists mainly of silicon and aluminum oxides (92%). According to the modulus of basicity (M_O <1), the ash and slag mixture is acidic [3], the content of calcium oxide and magnesium oxide is 3.63%.

The use of ash-and-slag wastes of dry sampling in the production of building materials is one of the most promising areas of utilization.

In the article [4] rational areas of application of low-calcium ash-and-slag wastes of TPP are generalized. The effectiveness of application of autoclaved hardening in the production of binders, as a hydraulic additive to cements, as well as aggregate in heavy and cellular concrete were noted.

Acid ash has pozzolanic activity, that is, the ability to bind at normal temperatures calcium hydroxide, forming insoluble compounds. In the technology of autoclaved cellular concrete, acid ash interacts with CaO of lime, forming mainly calcium hydrosilicates. This allows to achieve better physical and mechanical characteristics of ash cellular concrete in comparison with sand cellular concrete, in particular, reduction in density and higher strength and frost resistance.

The research carried out by E.A. Stroitelova [5], have confirmed the high efficiency of the use of acid fly ash to replace part of the fine aggregate in fine-grained concrete in order to increase strength parameters. A decrease in the capillary porosity of cement stone due to improved particle size distribution and pore colmatation with additional calcium hydrosilicates formed during the interaction of fly ash with Portland cement hydration products is established.

In the work of A.V. Ukhanov [6] it is shown that the dump ash-slag mixture can be used as a mineral additive for the production of concretes, mortars and dry construction mixtures. It is shown that fly ash can both reduce and increase the water demand, the viscosity and plasticity of concrete mixes, can lead to an increase in the strength of concrete, and also can cause significant linear expansion of the cement stone when it is hydrated. In this case, the chemical composition of the ash plays a decisive role.

To determine the possibility of effective use of the ash and slag mixture of the Belarusian state district power station in concrete mixtures and concretes, a set of studies is planned. The first step was to determine the activity of the integrated binder, in which a fraction of the ash-slag mixture passed through a No. 008 sieve was used as a mineral additive, i.e. fly ash (further ash) with the following characteristics: bulk density 960 kg/m^3; the true density is 2100 kg/m^3.

The determination of the activity of integrated binder was carried out according to the procedure EN 450-1 "Volatile fly ash for concrete. Part 1. Definition, requirements and criteria of conformity" [7]. The essence of the technique is to compare the compressive strength and flexural strength of mortars at the age of 3, 7 and 28 days, made of Portland cement of the hardness class 42.5 (control composition) with the compressive strength and flexural strength of mortars made from Portland cement in an amount of 90%, 80% and 70% and ash in the amount of 10%, 20% and 30% of the binder by weight. For testing, samples were made with 4x4x16 cm bricks that were hardened in normal-humid conditions for 1 day, then placed in a container with water, the temperature of which was 20°C, and stored there until the desired age. The ultimate strength of the bending samples was determined on a MII-100 machine, and then each of the halves obtained was tested for compression using two metal plates, the area of which was 25 cm^2. The results of determining the activity of complex binder are presented in Table 2.

Table 2. – The activity of the integrated binder

Composition number	Mixture composition				Strength at the age of 3 days, %		Strength at the age of 3 days, %		Strength at the age of 3 days, %	
№	Binder, mass %	W/C	W/B	Water	flexural strength	compr. strength	flexural strength	compr. strength	flexural strength	compr. strength
1	Control composition Cement 42.5 - 100%	0,5	0,5	225	100	100	100	100	100	100
2	Cement - 90% by mass + ash and slag mixture 10%	0,56	0,5	225	87	94	96	106	108	114
3	Cement - 80% by mass + ash and slag mixture 20%	0,625	0,5	225	66	82	74	99	84	108
4	Cement - 70% by mass + ash and slag mixture 30%	0,714	0,5	225	54	56	60	69	77	81

The activity of the integrated binder in the early periods of hardening (at the age of 3 and 7 days) decreases. Compression strength at the age of 3 days decreased by 6%, 18%, 44% with the amount of ash in the integrated binder, respectively 10%, 20%, 30%. The compressive strength at the age of 7 days for composition No. 2 exceeds the strength of the control sample by 6%. At an ash content of 20%, 30%, the activity of the integrated binder at the age of 7 days is below the control value. At the age of 28 days, the compressive strength exceeds the strength of the control sample by 14% and 8%, respectively, with an ash content of 10% and 20% in the integrated binder composition. At an ash content of 30%, the binder's activity is significantly reduced and at the age of 28 days it is 80% of the strength of the control sample.

The tests showed that the addition of ash in the composite cement based on Portland cement leads to a decrease in activity at the age of up to 7 days. In the subsequent periods of hardening, there is an intensive set of strength of the samples and by 28 days the strength exceeds the control values. At an ash content of 30%, a significant decrease in the activity of the integrated binder is observed. This dosage of ash is not recommended. Thus, an effective composition of the integrated binder is a composition with the replacement of Portland cement with ash in an amount of 10-20%.

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