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Concrete Based on Fuel Ash and Slag

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Abstract: *The article talks about the use of fuel ash (Termez) and their waste in concrete to obtain an economical strength for the construction of concrete up to 35 MPa.*

Keywords: *Econony concrete, mixing, active mineral additives, strength, bending, compression, penetration, contact, binder, cement, expanded clay, stress, filler, adhesion.*

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Introduction:

Waste from the fuel and energy industry includes waste products from the enrichment and combustion of solid fuels. This group includes the source of waste generation, fuel type, granularity, chemical and mineral composition, multiplication rate, and x. k. differs in descriptions.

Concrete with ash dust- the effectiveness of the introduction of dry powdered ashes as active mineral additives in the preparation of concrete and building mixes, as well as microfillers, has been proven in practice.

The all-concrete mix has properties such as high binding, low stratification, and convenient placement. Such concretes are typically characterized by high strength, density, water impermeability, cold resistance, and resistance to certain abrasions.

The use of sour ashes as an active additive is effective because their putty-like activity is manifested when they interact with cementitious binders. The optimum consumption of ash is 150 kg / m^3 for evaporating concrete and 100 kg / m^3 for curing in a standard environment. According to the recommendations of the normative documents, for heavy concrete of class C7,5-C30, cement consumption is saved by 40-80 kg as a result of applying an average of 150 kg of ash powder per 1 m^3 of concrete mix. In heat-hardened concrete, the use of ashes can save up to 25% of cement.

Materials

High results are being achieved in the application of ash dust to the concrete of waterworks. Currently, a technology has been developed to replace 20-30% Portland cement with ash dust in concrete for roads and waterworks.

Recently, ash dust has been widely used in the production of prefabricated reinforced concrete structures. Concrete with dry ash class C7.5-C40 is added to 20-30% of the cement mass.

The main characteristic of the use of ash as an active mineral additive is its hydraulic activity. Their positive description of the formation of the concrete structure is characterized by the "effect of fine powder", in which the dust particles precipitate the hydration products and accelerate the hardening process of cement.

Ashes are divided into the following types of application: for I-reinforced concrete structures; II for concrete structures; III-for constructions of water structures. Class of ashes: A-heavy; B is allocated for lightweight concrete types. The specific surface area of Class A ash should not be less than 2800 cm^2 / g, and that of Class B ash should not be less than 1500-4000 cm^2 / g.

Pic.1. General view of fuel slag

Methods

When choosing the composition of concrete with ash admixture, it is necessary to choose the ratio of components in such a way as to achieve the required properties of the concrete mix and concrete by minimizing the consumption of cement. In the concrete mix, ash not only acts as an active mineral additive, but also as a microfiller, which improves the granular composition of the sand and actively influences the formation of the concrete structure [1].

The effect of ashes on the strength of concrete depends on their properties and dispersion, the amount and chemical-mineral composition of cement, the age of the concrete and the conditions of its setting. To assess the impact of ashes on concrete strength, the concept of “cementation efficiency” was introduced and is characterized by the ktss coefficient. When predicting the strength of concrete, it is recommended to determine the cement-water ratio using the following formula.

$C / W = (C + D_a) / W$

where C- cement consumption, kg / m3; S-water consumption, l / m^3; D_a-ash consumption, kg / m^3.

$D_a = (C\times M_k) / (100-M_k)$

where M_k is the mass of ash in the mixed binder.

The dispersion of the ashes has a very significant effect on the strength of concrete relative to cement. This is the result of the plasticizing effect of the fine particles of ash. Even low-active ash can save 20-30% of cement consumption without changing the strength of the concrete when the relative surface area seems to be 4000-5000 cm^2 / g. There are given consumption of materials for concrete mix(table 1.)

Table 1. Proportions of concrete mixtures [kg/m3]

Material denomination	I	II	III	IV
CEM I 22.5	260	250		
CEM I 32.5	-	-	270	240
ash	40	50	30	60
natural sand 0,16-2,5	255	255	255	255
natural sand 2,5-5	340	340	340	340
CA 5-10	400	300	600	400
CA 10-20	400	600	300	400
CA 20-40	400	300	300	400
water	180	180	180	180

Results

The chemical-mineral composition of clinker is of special importance for achieving high strength of gray concrete. The rapid increase in the initial strength of concrete is facilitated by alkalis in clinker, which accelerate the chemical reaction of ash and cement.

Replacing a portion of the cement with ash reduces the volumetric subsidence deformation of the concrete. In this case, the ash absorbs dissolved alkalis from the cement, resulting in the formation of resistant and insoluble aluminosilicates. It also increases the alkalinity of gray cement concretes (like other active mineral additives)[2,3].

Ash-concretes can be obtained in a wide range of properties; compressive strength 0.5-40 MPa; from very light (ρ_m<1000 kg / m^3) to heavy (ρ_m = 1800-2200 kg / m^3) in terms of average density. They are obtained on the basis of Portland cement, as well as on the basis of clinker-free binders, which are hardened under normal conditions and autoclaved. Dense of ash-concretes is characterized by high strength to bending and deformation properties (boundary compression and slip).

The table 2. shows results of compressive and tensile strength test

Concrete property / Sign of mixture	I	II	III	IV
compr. strength 28d fcm [MPa]	25.1	24,5	30,0	31,2
tensile strength 28d fctm [MPa]	3,45	3,9	3,2	3,0
compr. strength 90d fcm [MPa]	36,9	39,0	37,1	37,1
tensile strength 90d fctm [MPa]	4.1	4,0	4,4	4,89
water	180	180	180	180
W/C	0,52	0,51	0,49	0,4

Discussion:

The bending and tensile strength of concrete at 28 days was 4,45 MPa for normal content and 3.9 MPa for ashconcrete. The increase in strength is 25% compared to normal content [4, 5].

From the above, it can be concluded that ash binds the bonds between cement and fillers to form additional strong carcasses in the structure. That is, heavy concrete reinforced with ash has the following advantages:

- reduction of volumetric penetration deformation during hardening of concrete, its strength, cracking, etc. increase in properties is achieved;
- opportunities for efficient use of fuelash industry waste will be expanded;

- saves on materials, including structural fittings;
- high-tech production, ie in the manufacture of products and structures, dispersed reinforcement of concrete is carried out directly on concrete screeds [6].

Conclusion:

Based on the conducted experiments and the obtained results, it can be noted that by dispersive connect with ash it is possible to obtain fine-grained heavy concrete with high strength and other performance requirements. Such concretes can be used effectively in thin-shell space constructions, engineering structures exposed to aggressive environments, and energy-efficient residential and public buildings.

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