EFFICIENT USE OF INDUSTRIAL WASTE IN THE PRODUCTION OF CONCRETE FILLER

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ABSTRACT

This article provides information on the effective use of industrial waste, in particular, waste from the ferrous metallurgy industry, in the production of concrete aggregates.

Keywords: industrial waste, metallurgical slag, slag gravel, slag fillers, ash fillers, granulated fuel slag.

INTRODUCTION

After the independence of our country, special attention was paid to the production of construction and construction materials, as in all fields, and a number of decisions and decrees were adopted on the development of the field. Especially this has little effect on the reforms carried out in the field in the following decades.

Decree No. PQ-4198 of the President of the Republic of Uzbekistan dated February 20, 2019 on measures for the fundamental improvement and comprehensive development of the construction materials industry, Decree No. PF-60 dated January 28, 2022 on the development strategy of Uzbekistan for 2022-2026 among them.

The rational use of secondary resources in the production of construction materials and products determines the following economic efficiency: saves raw resources and increases them, eliminates the shortage of natural raw materials, reduces land occupation, including fertile land, there is no need to build warehouses, technical and economic indicators of industries increases, creates an opportunity to intensify the material production technology, sharply reduces the cost of solving the environmental problem.

Metallurgical slag is a significant resource in the construction industry as a filler for concrete. Slag fillers are heavy in bulk density ($\rho m > 1000$ kg/m^3) and light ($\rho m \leq 1000$ kg/m^3), divided into small (<5 mm) and large (>5 mm) types according to grain size.

Light fillers with slag (GOST 9757-90). Granulated slag is widely used as a fine filler for concrete. In terms of grain size, it corresponds to large-grained sand. The bulk density of granulated slag depends on the slag solution and granulation technology and is 600 - 1200 kg/m^3. The grains formed by rapid cooling of the slag solution with water turn into porous glassy crystals.

Slag pumice is one of the effective types of artificial pore fillers. The structure of slag pumice depends on the composition and properties of the foaming solution. Slag pumice is obtained by rapid cooling of high-temperature (1200 - 1250 °C) slag solution using water, air pressure and steam. It mainly uses splash-trenches, pond cooling, water spraying and hydroscreen methods.

Slag pumice is made in fractions of 5 - 10, 10 - 20 and 20 - 40 mm as a large filler, and in fractions of 0.16 - 1.25 and 1.25 - 5 mm as a fine filler. According to the pile density, slag pumice gravel is divided into grades 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, sand 600, 700, 800, 900 and 1000. The size of pores in slag pumice grains should be 0.04 - 4.5 mm, porosity should be 50 - 78%, water absorption should be 10 - 55%, and cold resistance should not be less than 15 cycles. Slag pumice is used as a cheap and effective filler for constructional and heat-retaining lightweight concretes of medium density and strength.

Ash fillers (OzRSt 690-96). The properties of ash and slag depend on the type of fuel and the burning method. The optimal porous structure is formed when anthracite and hard coal slags are burned in a granular form, and black coal slags in a fine powder form.

According to the grain structure, slag is a mechanical mixture, and can be used as a coarse and fine aggregate, the grain size of which is mainly 0.16 - 30 mm.

All fuel slags can be divided into basic, sour and neutral classes. Limestone slag is mostly sour. Coal and shale containing up to 40% CaO and a high amount of iron oxide belong to the main class of slags.

The bulk density of fuel slag is 600 - 1000 kg/m^3, the average density of grains is 1500 - 2000 kg/m^3. Average density of slag is 40 - 60%, cold resistance is 50 cycles and above. Unlike gravel obtained from natural rocks, slag gravel does not contain flat and spear-shaped (sharp-pointed) grains, as well as clay and harmful impurities.

The bulk density of the ash used in the sand bed (fine filler) for the preparation of structural heat-preserving light concretes of the class B2.5 - B7.5 should not exceed 1100 kg/m^3, and the amount of 0.16 mm grains should not exceed 90% of the total mass. Also, the properties of concrete depend to a certain extent on the moisture content of ash and the amount of sulfurous and alkaline compounds in it. That is, the amount of SO3 should not be more than 3%, and the moisture content should not be more than 35% (by mass).

By adding fly ash to concrete as an admixture, it is possible to replace part of the sand and reduce cement consumption. The amount of ash added to concrete is usually 150 - 250 kg/m^3 and more. When 70 - 90 kg/m^3 of ash with a dispersion of 3000 - 4500 cm2/g is added to the concrete composition, the water requirement of concrete does not change. When the amount of ash is 300 kg/m^3 and more, the water requirement of concrete increases by 5-6% for every 50 kg of ash. Ashes are effectively used as a fine filler in the production of cement concrete. To create a dense structure of concrete, the amount of small fractions (less than 0.16 mm) should be 40-50% by mass.

Addition of 180 - 200 kg/m^3 of ash to the composition of kerazit concrete improves the technological properties of the light concrete mixture, ensures the formation of a dense and durable structure. The amount of ash can be taken up to 300 - 450 kg/m^3 for heat-preserving expanded clay concrete.

It is known from the production experience that it is economical to use fly ash mixtures as the main filler for concrete. Because the slag mixture improves the grain structure of sand and gravel, and dusty ash acts as an active micro-filler, improves the bonding and other properties of the mixture, and increases the efficiency of the cement utilization coefficient. This expands the field of use of waste ash. Granulated fuel slag (OzRSt 693-96). The composition of granulated slag resulting from coal burning is characterized by the presence of iron residue compounds. Black coal slag consists of a high amount of alumina or calcium oxide, and a small amount of iron oxide. Shale cinders are high in calcium. Granulated highly sour slags with basicity modulus Mo=0.05 - 0.07 are characteristic for most thermal power plants. Acidic glass-forming oxides (SiO^2+$Al2O^3$) make up 70-85% of such slags. The hydraulic activity of granulated fuel slag is determined by the amount of lime absorbed into the composition.

The physico-mechanical properties and structure of fuel slag depend on the type of raw material being burned and the method of slag separation. Within the total mass of slag, dense and porous grains can be distinguished. The average density of such grains can vary from 2.6 g/cm^3 to 1.5 g/cm^3. Their real density is 2.3 - 2.7 g/cm^3, and the bulk density is 1100 - 1700 kg/m^3. An important aspect of granulated fuel slag is that when slag is used as a filler for concrete, it is characterized by the high strength of the grains, high macro- and microporosity, the absence of clay and other harmful particles, etc.

The mechanical properties of these slags make it possible to obtain concrete of class B40 from them. The cold resistance of slag is relatively high, and it is possible to prepare various constructions for water structures from them. Also, such slag reliably protects concrete reinforcement from harmful effects. Granulated fuel slag has a significant effect on the rheological and technical properties of the concrete mixture. In particular, the convenient placement of the concrete mixture will be improved, it will be possible to transport the liquid concrete mixture with concrete pumps, etc. Concretes based on such slag differ from concretes based on natural fillers according to their structure and properties. Deterioration of concrete made of granulated slag occurs both on cement stone (mixture) and on slag. Such a violation of the structure indicates the homogeneity of the composition and the solid connection of the filler with the mixture.

Replacing natural rock fillers with granulated fuel slag leads to a decrease in cement consumption (due to the quality of the granulation). At present, there is enough experience in using granulated fuel slag as a filler (as well as a micro-filler) for concrete.

In conclusion, it can be said that as a result of the use of waste from industrial enterprises, in particular, metallurgical slag in the production of concrete fillers, the cost of produced filler and concrete will decrease, the costs of waste transportation and disposal will be reduced, environmental and ecological cleanliness will be achieved, and the economic growth of the enterprise will be ensured.

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