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COMPLEX-MODIFIED CONCRETES WITH MICRO FILLERS BASED ON METALLURGICAL INDUSTRY WASTE

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ABSTRACT

The micro-filler researched in the article was gotten by crushing concrete and reinforced concrete waste and sieving gotten particles. Researched crushed particle size was smaller than 0.125 mm. Main micro-filler characteristics were determined. After doing research according to the special research method and according to the gotten results it can be stated that additive (micro-filler) made from crushed concrete waste is active. It was determined that when using concrete waste for concrete mixture mixing a higher amount of water is needed since part of the water is absorbed by used waste filler moistening. Big amount of this excess water is probably absorbed by smaller mixture particles gotten during the crushing process.

Independent from demolition building type and processing method, building demolition main stages are the same: first waste preparation, crushing, sorting, metal, which armoured reinforced concrete constructions, separation, first sieving, granulation, metal separation, sieving . For building demolition usually excavators, hydraulic crushing scissors, metal separation aggregates are used. After

demolition work, waste is processed using special granulation and sorting equipment. In these processes crushers, granulators, magnetic separators, sieves and air separators, which separate thermos-isolation, wallpaper and other impurities from concrete pieces, are used. Other materials such as armature, timber, roofing and other materials should be removed from concrete rubble from building demolition waste during production, so that they couldn't contaminate gotten filler. It would also be useful and rational, if wall concrete constructions would be separated from columns, ceiling. After thoroughly completing all rubble production stages we get various fraction bigger, smaller and micro-fillers . Micro-fillers are fillers of which majority pour out through 0.063 mm pore sieve and which can be placed in building materials to give them certain properties .

Micro-fillers according to specific surface area are classified to different size micro-fillers. To do so is appropriate due to the fact that in various material mixtures they play different roles. Bigger micro-fillers, which particles are bigger than cement, can be useful in concrete and mortar, when big and or normal size sand is used, which have smallest fractions. These kinds of micro-fillers improve mixture filler granular-metric composition, lower their voids, allow saving binding materials, in concrete allow lowering W/C ratio, slightly rises concrete mixture mobility. Therefore, when there is the same mixture mobility, it is possible to get stronger concrete.

Average size micro-fillers, which particles are of cement size, are used when it is needed to rise cement paste amount in a mixture. Then the requirement for water rises and hardened cement stone strength lowers. These micro-fillers are used when producing smaller strength concrete with higher class binding materials, then this size micro-filler usage is rational. In mixtures the volume of binding materials paste increases, mixture mobility increases, products thicken better.

Especially smaller micro-filler particles are at least several times smaller than cement. These kinds of micro-filler particles fit between cement grains and because of this cement granular-metric composition improves. These micro-fillers are used for producing very strong concrete, plastics and putty. Very small micro-filler particles have special properties, due to the fact that their activated surface can better interact with binding material. Concrete strength rises due to the binding materials stone density increase.

Micro-filler surface activity is related to surface accumulated energy, surface layer coarseness and chemical composition. Surface energy is higher the smaller particles and the bigger surface area is. Just produced micro-fillers have higher surface energy, higher adhesion and absorption with other materials; they better encrust with macro-molecular film of water, and then micro-filler resistance to outer normal and shear tensions lowers. To moisten sharp-edged particle surface it requires more water and the mixture gotten is not as mobile. When micro-filler particles are round their surface area is smaller, surface energy is smaller as well. Such particles more compactly arrange in mixture, thicken easier, less water is needed to use for mixture moistening. Micro-filler particles bigger than 0.063 mm have relatively small surface area, way lower surface energy, due to which these particles are assigned to the inert fillers. Main micro-filler characteristics, their activeness, and other properties that show how mixtures with such micro-fillers mixing requires higher water amount were determined. Also, such micro-filler usage recommendations are presented.

Conclusions

Carried out research showed that micro-filler gotten from crushed concrete waste changes the requirement of water for getting normal paste. When putting in bigger micro-filler amounts into cement normal thickness paste was gotten with bigger water amount, due to this when mixing mixtures which have micro-fillers from crushed concrete waste overall water requirement in mixture should grow because of micro-filler influence too. Even though carried out research showed that the additive is active, however, by changing part of cement with micro-filler from concrete waste lower amount of heat emission speed and its amount in mixture is obtained. It is believed that due to the inactive ion emission from micro-filler not

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only cement hardening will get slower but also hardened sample mechanical strength will also lower.

After carrying out research it was determined that used filler from crushed concrete waste has to be sieved and separated from very small particles, which size is smaller than 0.125 mm, since microparticles that appear between bigger (4/16) and smaller (0,125/4) fractions in mixture change hardened concrete structure, raise distance between fillers. Due to this even a small amount of them considerably changes gotten sample physical and mechanical characteristics (compression strength lowers 38–42 %, bending strength 15 %).

Nowadays, a very significant environmental problem is the increase in the scale of industrial and municipal solid waste generation. The calculations made by international experts show that the global generation of waste per capita per day is 0.74 kg. In Russia, this value is 1.24 kg .

In technologies for the processing of technogenic polymeric materials (TPM), one of the energy-intensive stages is the grinding process. When developing energy-efficient equipment for TPM processing, special attention should be paid to their specific physical and mechanical characteristics, such as: low bulk density, elasticity, plasticity, tensile strength (tensile, compression), initial state of materials (shape, dimensions, density, etc.), melting point, the presence of foreign inclusions, etc.

As a result of the analysis of worldwide patent-protected designs of devices for grinding technogenic polymeric materials, the main directions of constructive and technological improvement of equipment were determined. It was established that there is the possibility of grinding TPM with different physical and mechanical characteristics . There are various technologies for organization of a step-by-step grinding process using the combined effect of working bodies on the processed material. As a result, the implementation of internal and external recycling of material flows is carried out. In particular, this is achieved by combining of technological operations (for example, grinding and mixing). Increasing efficiency is confirmed by the possibility of introducing additional components (additives) of raw materials into the aggregate. One of such effective technological steps is preliminary deformation and compaction of the waste, improvement of the conditions for the capture and injection of material into the grinding chamber. As a result, there is reduction of repair complexity by equipping devices with removable elements as well as increasing the operational reliability of the units due to their equipping with devices for the removal of non-crushable materials.

One of the promising directions of constructive and technological improvement of grinding equipment aimed at reducing the energy intensity of the grinding process is the use of working bodies with a developed working surface. Multifunctional technological units with needle-milling working bodies have been developed that provide a selective complex effect on processed materials. In this case, a high-speed impact on the material of the rod elements is carried out, which implement the energy-efficient destruction of technogenic raw materials .

The design of the working bodies makes it possible to obtain various types of products from technogenic polymeric materials: lamellar or spiral fiber fillers, powder or polydisperse mixtures, and others .

Along with other man-made materials, basalt fibrous wastes have their own specific physical and mechanical characteristics. In the process of processing, the material is subjected to various types of mechanical action (defibration, grinding, granulation, etc.). There are technological possibilities for obtaining fibers of various lengths. The results of the analysis of patent-protected structures and methods for processing technogenic fibrous materials (TFM) indicate various directions for their improvement. In work , processing of textile waste into fibrous mass for subsequent use in the production of cotton wool, non-woven materials was carried out. The authors dealt obtaining a loosened and defibrated mass of fibrous material being crushed. Researchers done grinding and homogenization of fibrous materials of medium and low strength. In work , ensuring the recycling of waste from mineral wool production with the creation of granular material with high heat-shielding characteristics, low content of solid non-fibrous inclusions was carried out. Authors dealt granulation of various powdery and fibrous materials. The researchers done improvement of the processing of fibrous material in terms of reducing the energy required for the formation of fibrous mass and the formation of fibers, as well as improving the properties of fibers . In this article, return of production wastes (pieces of mineral wool, its dust, fragments of slag crusts from gutters, spunbond devices, mixture of "beads" with mineral wool, fire-liquid drops) of fibrous heaters into the production of the primary product. Scholars dealt processing of production waste in the primary technological process.

Obtaining porous components of composite mixtures is also possible during mechanothermal processing of organic man-made waste. Analyzing patent-protected methods of waste processing and devices for their implementation, it can concluded on the directions for their further improvement, which is as follows. Lukmanova et al. investigated the possibility of processing wood-fiber materials into finely dispersed coal with a content of 95% carbon. Mukhametrakhimov et al. increased in the efficiency of the pyrolysis plant due to the economical consumption of the coolant. Volodchenko et al. obtained high-quality final products during the processing of organic waste. Stroganov et al. pre-dryed of waste before their pyrolysis processing, as well as pre-heated of the feedstock. Tumuluru er al preliminary grinded the waste and combined exposured to electromagnetic (microwave) and thermal fields. Zhou et al. dealt reduction of temperature and time of exposure to the processed material.

The solid end product, carbon black (CB), obtained by the method of thermomechanical processing of organic and man-made waste, is a specific material. Such physical and mechanical characteristics as: polydispersity, caking, dusting, etc. do not allow the material to be used for its intended purpose without additional processing. One of the methods for solving the above problematic problem is its compaction in various ways using special devices. Structural and technological improvement of patented structures is as follows. De Vietro et al. supplied of a flow of nuclei to the fluidized bed to accelerate the growth of granules. Han et al. sprayed the binder directly into the fluidized bed. Pfeiffer et al. supplied a colloidal solution of 30% silicon dioxide to the granulator plate to reduce the time of granule formation. Liang et al. installated of slot nozzles in the bottom of the apparatus to ensure optimal movement of material particles. Sarkar et al. changed the shape of the granulation chamber to ensure an increase in the strength of the granules. Sousa Rollemberg et al. combinated various devices in one device to increase the efficiency of the process.

Thus, the conducted research in the field of patenting methods and technical means for non-waste processing of technogenic organic and mineral waste reveals the scale of the directions for technological improvement of resource-energy-saving equipment and technologies.

The use of recycled technogenic polymeric materials, carbon black, as well as waste from mineral wool production is of interest in the production of building materials. An effective technique for their use is the inclusion in the composition of the raw mixture. Technological improvement is based on the method of administration.

With regard to carbon black, the following options for its use should be distinguished such composition of the fiber-reinforced concrete mixture, including cement, filler, steel wire and a complex additive consisting of a plasticizing additive and technical carbon black. Correal et al. developed composition for soil stabilization in road construction, containing gypsum, cement, lime and a mineral additive, blast-furnace slag, basalt fibers, and technical carbon black as a mineral additive. Awad et al. proposed a method for obtaining a composition containing carbon black for connecting building structures. Chen et al. developed a method for the production of two-component mastic for sealing and repairing buildings, etc. Mastic includes the main and hardening pastes in the ratio 2:1, the hardening paste includes incl. carbon black. Salayong et al. proposed a method for producing a vulcanizable rubber compound based on synthetic isoprene rubber containing carbon black in its composition.

Modern world-class research confirms the importance of waste management and recycling in the construction industry. Azevedo et al. studied effect of the addition and processing of glass polishing waste on the durability of geopolymeric mortars. Zanelato et al. evaluated of roughcast on the adhesion mechanisms of mortars on ceramic substrates. Martins et al. studied durability of a cement slurry subjected to an accelerated carbonation test. Article related circular economy and durability in geopolymers ceramics pieces obtained from glass polishing waste. Mendes et al. applicated of eco-friendly alternative activators in alkali-activated materials.

The results of the analysis of patent-protected compositions and methods for obtaining mixtures using waste from mineral wool production showed the following possible options for their application:

Use of "beadlets" or its mixture with quartz sand as a fine aggregate of fraction 0.15–5 mm in the production of enclosing structures from lightweight concrete ;

Use as an active mineral additive of a finely ground "beadlets" with a specific surface of 150–200 m^2/kg in the production of enclosing structures from lightweight concrete ;

Use of waste from the production of mineral wool as a desiccant for preparing a mixture containing drill cuttings and waste drilling water for the construction of infield sites, roads, embankment of the bases of well sites, as well as bases for waste landfills ;

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