Production Wastes of Heavy Concrete: Technological Solution of Recycling Problem

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Abstract. The research in the field of waste treatment technologies especially heavy concrete. A valuable component of especially heavy concrete waste is iron ore of granules. The article suggests the extraction of material using the technology of dry magnetic enrichment of the ore. Research conducted aimed at finding the optimal method of processing and recycling of heavy-weight concrete wastes. The resulting secondary material was studied. The preservation of relatively high strength and guarantee characteristics is revealed, which allows reusing it in the production of heavy concrete without loss of quality, as an additive to the initial mixture. To implement the project on an industrial scale, calculations to select devices and constitute a process flow scheme. The issue of recycling of accumulated and newly formed wastes of production of especially heavy concrete is being solved, as well as reduction of payments for placing them in landfills.

1. Introduction
The problem of storage of waste generated during the production, especially heavy concrete and the inability to use that waste as secondary raw materials, leads to the search for technological solutions in modern production. Components of the waste - fillers of particularly heavy concrete, such as scale, iron ore, magnetite and other materials with ferromagnetic properties. Long-term storage causing irreparable damage and lead to the emergence of environmental problems in the regional scale.

However, contaminants when proper technological processing may be used in the production of secondary raw materials. To waste products of particularly heavy concrete include aggregates of concrete on the walls in mixers and tanks, contaminated with extraneous components of the concrete mixture or the remains of overdue concrete, the volume of which can reach up to 100 kg per 1 m³.

Available scientific and practical developments, for example, the recycling process proposed by the Czech company BIBIKO, at the final stage does not allow to receive from the "washed" wastes of especially heavy concrete secondary raw materials with approximate characteristics to the original initial raw materials. Also, waste remains as components of the metal-containing part of especially heavy concrete, for example, iron ore. In the existing schemes of processing of concrete, their separate extraction is not envisaged. At the same time, the value of iron ore is determined by its chemical composition and the possibility of use in the metallurgical industry.

In connection with the above material, a technological decision is proposed for extracting components from the metal-containing part of particularly heavy concrete on the basis of the technology of dry magnetic ore dressing. The technological process must comply with modern ecological and technical requirements, and be economically viable.
2. Experimental part

The basis of the laboratory studies is the principle of searching for a technological solution for the isolation of valuable components from the solid phase when utilizing wastes of particularly heavy concrete. By authors as the main stage of the technological scheme declared magnetic separation, and as the target product - iron ore. In order to effectively carry out the separation, it is necessary to prepare "secondary raw materials", i.e. carry out preliminary crushing and classification by homogeneous fraction.

The technological solution (scheme) includes the following four stages: crushing, grinding, classification, magnetic separation. The use of the crushing method at the first stage makes it possible to ensure the uniformity of the distribution of the granulometric composition during grading (second stage). To grind the crushed material to a fraction of less than 10 mm, a ball mill is proposed in the technological solution. In this case, mechanical cleaning is carried out in the drum of the mill with the interaction of the steel balls with the surface of the granules. The quality of the material at the "exit" of the second stage directly depends on the cleaning of the aggregate granules from the cement stone. The third stage involves the classification of crushed and shredded material with the use of screens. There are 3 fractions: 1 - sand and dust particles (<0.16 mm), 2 - the bulk of recycled concrete (from 0.16 mm to 10 mm) and 3 - non-sifted material (> 10 mm). Not sifted material is recycled to a ball mill. At the magnetic separation stage, to extract valuable components, the proposed technological solution is iron ore, separators with a strong magnetic field were used, since the fine fraction pellets have an underestimated magnetic susceptibility. At this stage, it is advisable to use drum separators (iron separators). The presence of magnets provides a permanent magnetic field that does not require significant energy consumption, and determines the efficiency, durability of the process as a whole, and joint use with the conveyor allows optimizing the entire area of the apparatus and increasing productivity.

The processed material enters the conveyor belt and is loaded into the roll crusher, where it is crushed to a fraction of less than 10 mm. Further it under the action of gravitation enters the ball mill, which is filled with grinding steel balls with a diameter of 25 mm. When the drum rotates, the steel balls and the grinding material move along the inertial trajectory, and then fall along the parabola [1]. Grinding of the processed material occurs as a result of shock contact and abrasion when moving grinding bodies and material particles. Moving spiral blades located along the mill cylinder provide continuity of operation due to simultaneous loading and unloading of material from the drum.

Sifted material arriving through the shutter located at the end of the device comes along the conveyor belt on the vibrating screen. The first level of the working surface is a horizontal perforated grille with round holes and a perforation diameter of 10 mm. Vibrational action with an amplitude of oscillations of 4-8 mm and a vibration frequency of 750 oscillations / min makes it possible to divide the processed material into fractions. Ground material with a size of less than 10 mm is sieved through a horizontal perforated grate and enters the second working surface - a horizontal perforated grating with a perforation diameter of 0.16 mm. The fraction from 0.16 to 10 mm is discharged from the vibrating screen onto the conveyor belt. Sand and dust particles with a size of less than 0.16 mm are screened and fall into sifting, and the remaining material with a particle size of more than 10 mm is to be re-grounded. The sifted material "moves" along the conveyor belt and at the moment of contact of the material with the drum of the iron separator, its separation takes place. Under the influence of a powerful magnetic field, ferromagnetic particles are attracted to the surface of the drum and retained until the conveyor belt leaves the drum surface, as a result of which the magnetic field disappears and ferromagnetic particles enter a separate bin [2]. The non-magnetic part is screened into a crushed stone hopper.

The presented technological design for the processing of wastes of especially heavy concrete allows improving the organization of the technological process, reducing the negative load on the environment, providing energy and resource saving in accordance with modern requirements of environmental safety at the industrial enterprise.

The technological scheme of processing particularly heavy concrete is shown in Figure 1.
Figure 1. The technological scheme of processing particularly heavy concrete.

Table 1. Legend of equipment and streams in Figure 1.

| Equipment                  | Streams                                      |
|----------------------------|----------------------------------------------|
| A  Conveyor belt           | 1    Concrete waste is unprocessed           |
| B  Crusher corrugated      | 2    Crushed concrete                        |
| C  In-mill ball            | 3    Pounded concrete                        |
| D  Vibrating screen        | 4    Recycled concrete fraction 0.16-8 mm    |
| E  Iron separator          | 5    Returned material                       |
| F  Hopper loading / unloading | 6  Sand mixture fraction 0.16-8              |
|                             | 7    Iron ore fraction 0.16-8                |
|                             | 8    Dust fraction <0.16                     |
|                             | 9    Metal dust fraction <0.16               |

From an economic point of view, the processing recycling especially heavy concrete and the further use of its components from metal-containing part as secondary raw materials will increase the profitability of production. Reducing the areas of storage and burial of heavy-concrete waste may will lead to a corresponding decrease in payments for placing them in landfills. The introduction of improved technological solutions into production will reduce environmental by obtaining renewed secondary raw materials without additional energy and mining from the mineral resources, rational use of natural resources.

3. References
[1] Sapozhnikov M Ya 1971 Mechanical equipment of enterprises of construction materials, products and structures Higher School Moscow 382
[2] Karmazin V V, Karmazin V I 2005 Magnetic, electrical and special methods of mineral processing The Mountain Book Moscow 669