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Fine-Grained Concrete

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Abstract: In this work, a literature review on the strength characteristics of fine-grained concrete using two aggregates, screening of marble and quartz sand is carried out. The mutual influence of the sand among themselves and their influence on the properties of concrete are analyzed.

Keywords: fine-grained concrete, evacuation, vibration evacuation, vibration compaction, screenings of marble quarries, sand.

Formulation of the problem. Natural reserves of fine aggregate are being depleted. Therefore, the problem arises of using alternative sources of such aggregate for the preparation of concretes and mortars. In our opinion, the most suitable and promising is the use of fine-grained waste obtained in the production of crushed stone from dense rocks (granite, marble, basalt, etc.).

Concretes based on fine aggregates (fine-grained concretes) are characterized by a very high water demand, therefore, when molding products, they should be subjected to evacuation in order to remove excess water and entrained mixing air and, accordingly, increase the physical and mechanical properties of such concretes.

Analysis of publications. At present, the extraction of marble and the production of marble products are developing in Uzbekistan. According to the JSC "Uzstroyaterialy", Uzbekistan ranks second in the CIS after Russia in terms of reserves of natural stones. The famous gazgan marble deposit, especially white in color, enjoys worldwide popularity. The main deposits, which are located in the Samarkand and Kashkadarya regions [1].

Obviously, the solution to the problem of the integrated use of raw materials and waste disposal during the extraction and processing of stone should begin, first of all, with ensuring the fullest possible extraction of block raw materials from already developed deposits in order to minimize its loss in the depths. At the same time, it is of great importance to preserve all the properties of the stone and its

quality. Further, it is necessary to ensure a minimum of losses during the subsequent processing of blocks, which is equivalent to achieving the maximum possible yield of finished products from stone. At the same time, an integrated approach to the processes of mining and processing of stone is very important, the use of all the components available in the mined and processed rock mass, the all-round reduction of the amount of extracted raw materials going to dumps, the development of low-waste and waste-free industries. Research on the evacuation of fine-grained concrete mixtures gave significant positive results in compressive and flexural strength. Particularly noteworthy is the use of such concrete in the production of volumetric elements and various purposes of flat slabs and panels with immediate demoulding, in the production of high-density concrete products (pipes, road slabs, etc.), as well as in the construction of monolithic structures [3; five].

The experience of using fine-grained concrete has proven a sufficiently high economic efficiency in comparison with conventional heavy concrete. Fine-grained concrete mix fits well into the formwork or forms with various methods of compaction, the products have a good presentation, are characterized by high dimensional accuracy [2]. Despite the fact that the consumption of cement in concrete in the absence of coarse aggregate increases, a number of positive results were obtained: a higher ratio of flexural strength to compressive strength, increased prismatic strength, good durability, low water resistance, sufficient crack resistance [6].

It has been convincingly proven that vibration vacuuming is one of the most effective methods of compacting fine-grained concrete, which allows you to prepare mixtures of the required consistency for satisfactory placement in molds during vibration shaping. Then, in the process of evacuation, it is possible to remove excess mixing water. It has been found that the use of vibration vacuum is more effective for fine-grained mixtures than for coarse-grained ones [8].

Main material. The grain composition of the waste obtained during the production at the open pit "GAZALKENT GRANIT INVEST" has been investigated. For comparison, the grain size composition of local quartz sand was also determined (Fig. 1).

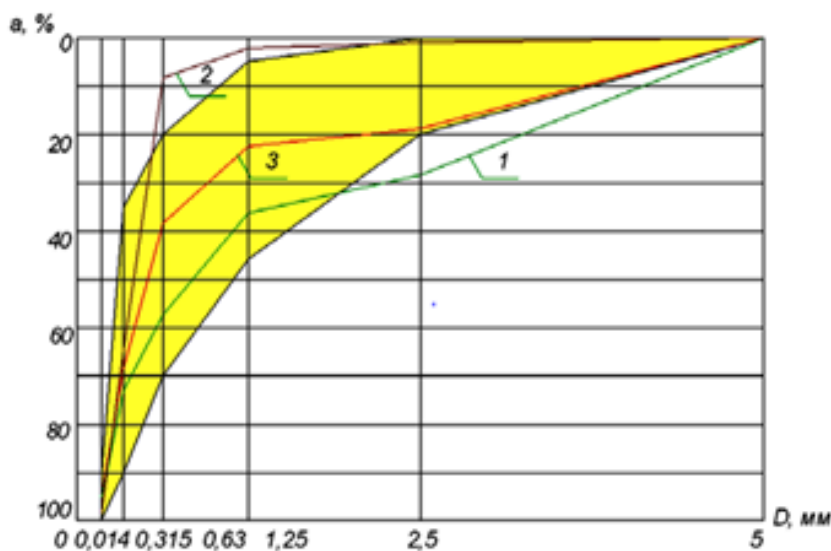


Figure: 1. Grain composition of aggregates:

- 1 - marble quarry screenings;
- 2 - sand;
- 3 - mixtures of sand and screenings of a marble quarry.

Both the screenings of the marble quarry and the grain size composition do not fit into the area of standard sands. In this case, the curve characterizing the grain size composition of the sand is above the standard curve characterizing the permissible fine sands. And the curve characterizing the grain size composition of the screenings is below the standard curve characterizing coarse sands. The sand size modulus was $M_{cr} = 1.9$, and the screenings - $M_{cr} = 2.9$. Such research results served as the basis for obtaining, on the basis of screenings of a marble quarry and sand, a fine aggregate of rational grain composition. As a result of the studies performed, it was found that such a mixture is characterized by a ratio between screening and sand as 1: 0.5 (O: P), i.e., 33% (one third) of sand must be

added to the screening. The resulting aggregate mixture by grain size composition fits well into the area of a standard fine aggregate (Fig. 1).

In studies, when determining the strength characteristics of fine-grained concretes, Portland cement M400 (according to the passport) was used, which has an actual activity at the time of its application for the preparation of concrete mixtures $R_p = 388 \text{ kgf / cm}^2$ (38.8 MPa). The mobility of the fine-grained concrete mixture was characterized by the cone spreading on the shaking table 120 ... 122 mm. Samples were molded $7 \times 7 \times 7 \text{ cm}$ by vibration method, all molded samples were hardened under normal conditions for 28 days. The data obtained indicate that both for compositions 1: 3 (cement: aggregate) and for compositions 1: 4, cube samples on screenings and on a mixture of screenings and sand showed strength 2 times higher than for samples on sand. It should be especially noted that the samples on the screenings consistently show the highest strength in comparison with other compositions. Specimens on a mixture of screenings and sand have a slightly lower strength. Vacuuming must be applied at a qualitatively new level. The following was taken into account.

Vacuuming as an additional operation will always pay for itself and will give a significant effect if, along with the positive properties of vacuum concrete (increasing density, strength, frost resistance, water resistance, reducing shrinkage deformations and water absorption, etc.), it is rational to use some specific features of vacuum concrete and technical capabilities of the technology, such as:

- high structural strength of freshly compacted vacuum concrete (up to 0.2 ... 0.5 MPa) and the possibility of immediate stripping, removal of inserts, etc. ;
- the ability to remove from the mold, transport and stack freshly formed products using vacuum shields (using the vacuum suction effect); - intensive hardening of vacuum concrete in the initial period.

These possibilities of vacuum processing can be rationally used if appropriate equipment and modern technology are used [8].

In further studies, in order to reduce the influence of scale factors, we form by vibration vacuum and for comparison by the vibration method of samples $15 \times 15 \times 7 \text{ cm}$ from fine-grained concrete mixtures of 1: 3 (cement: aggregate) and 1: 4 compositions.

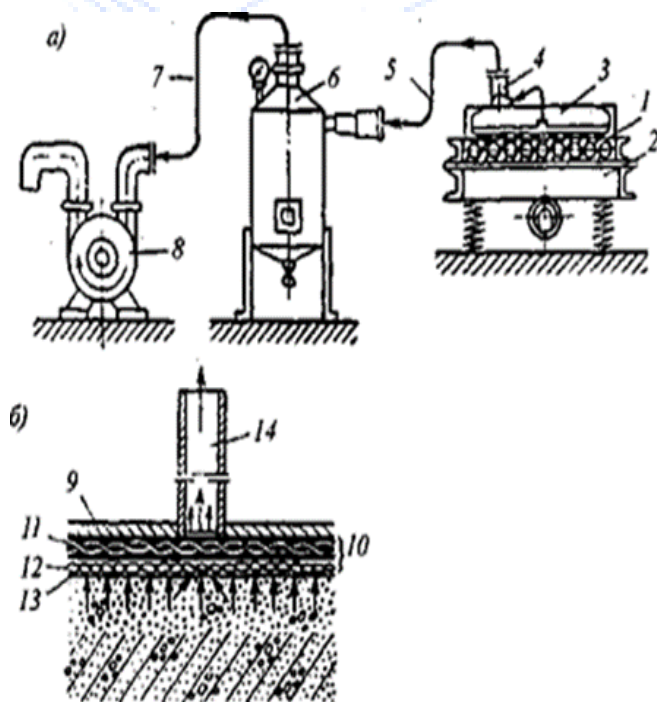


Figure 2. Diagram of the installation for vibration vacuuming of concrete:

a - general diagram; b - a diagram of a vacuum cavity device; 1 - molded product; 2 - vibrating platform; 3 - vacuum shield; 4 - prefabricated collector; 5-suction hoses; b - catchment; 7-suction pipe; 8-vacuum pump; 9-cover of the vacuum chamber; 10 vacuum cavity; 11 coarse wire mesh; 12-thin mesh; 13 - filter cloth; 14 - fitting for connecting to a vacuum network.

The mobility of concrete mixtures should be characterized by a normal cone settlement of $OK = 3 \dots 4 \text{ cm}$. Before evacuation, the samples should be vibrated for 20 s, and the duration of the evacuation should be 6 minutes (Fig. 2). The duration of vibration compaction when molding samples by vibration method is 30 s.

Vibro-vacuum treatment of all types of concrete mixes can significantly increase the strength of concrete, especially for concrete on screenings. With a concrete composition of 1: 3, the strength should increase to 42 MPa, and with a 1: 4 composition, up to 35.6 MPa. Considering that the activity of cement is 38.8 MPa, then, in our opinion, these are significant indicators of strength for fine-grained concrete (with moderate cement consumption) [8].

An essential indicator of compaction of fine-grained mixtures by vibration vacuum is the amount of excess mixing water removed under the action of vacuum. As expected, the greatest amount of extracted water will be obtained during vacuum processing of fine-grained mixtures on sand, despite the fact that such sands are characterized by lower water demand in comparison with the screenings of marble quarries.

When vibro-evacuating concrete mixtures on sand, up to 90 ... 95 l / m³ of mixing water should be removed, and only 60 ... 80 l / m³ from concrete on screenings. This should once again confirm the very high water-holding capacity of screenings as aggregates for concrete and the advisability of compacting such concretes by vibration vacuum. Thus, with a high water-holding capacity, concretes on screenings have a significantly greater strength in comparison with concretes on sand [8].

Conclusions. Screenings of marble quarries in terms of size and grain size are coarse-grained sands. But their water demand is much greater than the water demand of sand.

In the future, it is planned to conduct an experiment on the compressive strength of vibro-compacted concrete. Vibro-vacuumization of concrete mixtures laid in a mold should increase the strength of all types of concretes under study by 60 ... 100%. This opens up wide opportunities for the use of vibration-evacuated fine-grained concrete in construction.

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