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Small-Cracked Concretes Based On Aral Sand Using Secondary Crushed Crushed Concrete

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Annotation. The article shows that for regions experiencing a shortage of large aggregates, it is possible to use low-gravel concrete with an increased sand content. Compounds with sand content, characteristic of low-gravel concretes with the lowest structural viscosity, were isolated. For these compositions, with the same compaction time using vibration, the requirements for the workability of low-gravel concrete can be reduced several times. This is due to the fact that the ability of crushed stone concrete mix to liquefy during vibration compaction is higher. Consequently, concrete mixtures fill the formwork better in a shorter time, i.e., they have increased forming ability, which allows for the use of harder concrete mixtures with reduced cement and water consumption. The study of the flow process of low-gravel concrete mixtures through a calibrated opening during vibration showed that the flow time of uniformly moving (with the same settlement of the standard cone) mixtures is reduced several times. The use of more rigid low-gravel concrete mixtures leads not only to a decrease in water and cement, but also to an increase in crack resistance, frost resistance, strength, and water resistance. Thus, it has been established that using low-gravel mixtures instead of conventional concrete mixtures contributes to increased efficiency, as it leads to a decrease in material and energy resources.
Keywords: small-gravel concretes, structure, formability, viscosity, sand content in the aggregate mixture, fine aggregate, coarse aggregate, flowability.

It has been established that the use of low-gravel concrete (LCR) is advisable in many regions experiencing a shortage of coarse aggregate [1]. However, the widespread use of low-gravel concretes is being held back mainly due to increased cement consumption [2, 3].

Low-gravel concretes include concretes with a gravel consumption of less than 1200 kg/m3 and an increased consumption of fine aggregate [4, 5]. However, this leads to increased water and cement consumption.

These compositions are more mobile and, consequently, when using uniformly moving concrete mixtures that must be compacted at the same time, they have reduced W/C with reduced cement consumption.

To verify this assertion, Portland cement CEM I SS 42.5 N from the Voskresensk plant, containing less than 5% C_3A, superplasticizer C-3, and quartz sand with a water demand of 7%, density of 2.65 g/cm3, and a particle size modulus of Mkr = 0.67 were used. Granite gravel with a fraction of 5...20 mm was used as a coarse aggregate.

The structural viscosity was determined by vibration on a 6 l device with a calibrated hole (switch). When the concrete mixture structure was completely destroyed, the shiber was opened and the mixture flowed out through a hole, the flow time of which was measured in seconds [6, 7]. The structural viscosity was calculated using the formula:

$$P = 0.0121 \cdot p \cdot T, \text{ Pa} \cdot \text{s}$$

where: r - density of the concrete mixture in g/cm3;

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T - flow time, sec.
The strength was determined on the cube samples after 28 days of hardening.
Below is a table characterizing the composition and properties of concrete mixtures and concretes.

Table 1

Characteristics of concrete mixtures and concretes (compiled by the authors)

	R=W/(W+W)	Cement, kg/m3	Sand, kg/m3	Gravel, kg/m3	Water, kg/m3	Time *Tist*, sec	*p* kg/m3	R, MPa
1.	0.32	270.	579.	1230.	184.	20.	23.55	23.
2.	0.39	284.	714.	1124.	199.	12.	23.45	22.
3.	0.5	319	876.	876.	223.	3.	2270	21.
4.	0.6	335.	1029.	686.	235.	3.	2208.	20.5
5.	0.7	364.	1153.	494.	254.	3.	21.55	20.5
6.	0.8	390.	1262.	316.	273.	4.	21.45	19.
7.	1.0	440.	1446.	-	308.	9.	2042.	18.7

Note: in compositions 1-7 the cone sediment (SC) was about 7 cm

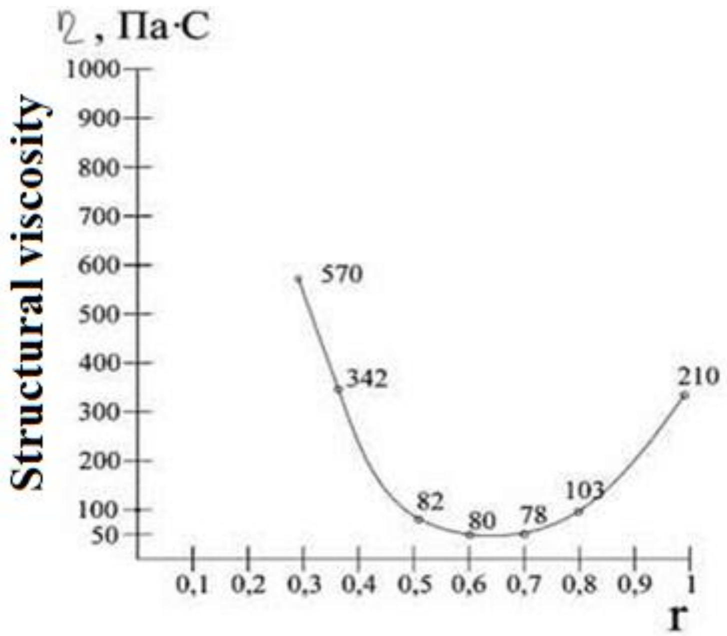

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Figure 1. Dependence of the structural viscosity of the concrete mix on the sand content in the mixture of aggregates (developed by the authors)

Figure 1 shows the dependence of the viscosity structure on the sand content in the concrete mixture. The graph has two branches: the left branch corresponds to compositions with a sand content in the aggregate mixture from 0.32 to 0.5. This zone is characteristic of concrete with high gravel consumption. The right branch corresponds to the sand fraction of 0.8-1, characteristic of solution mixtures. The 0.6-0.8 zone corresponds to low-gravel concrete mixtures.

The behavior of concrete mixtures under vibration and completely destroyed structure is influenced by the following factors: the presence of not only coarse aggregate, but mainly the displacement of the grains of the solution component [8], which is reflected in the flow time through the calibrated opening. In the third zone, a decrease in the cement paste coating thickness of sand grains prevails, which also causes an increase in leakage time.

Thus, compositions with a sand content characteristic of low-gravel concretes, having the lowest structural viscosity, with a sand content in the aggregate mixture of 0.6-0.8, were identified.

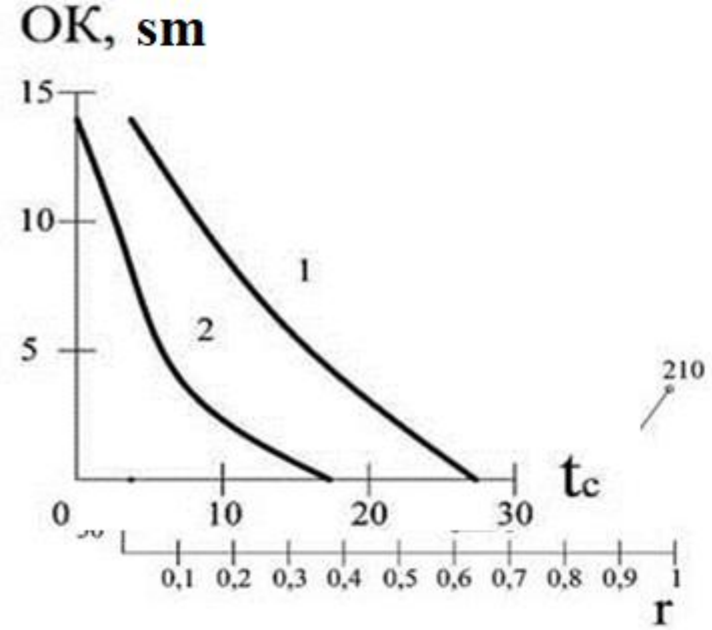

Figure 2. Relationship between forming (t) and mobility of ordinary (1) and low-gravel concrete mixture (2) (developed by the authors)

Increased formability is characteristic of MSS. This indicates that for the established compaction time, for example, under production conditions, MSHBs will be more rigid, and consequently, with a lower content of both water and cement. Figure 2 shows the difference in the workability of concrete mixtures with different workability. For example, for a conical concrete mixture with a sedimentation of 7 cm and a viscosity of 570 Pa•s (composition 1, table. 1) corresponds to a low-gravel concrete mixture with a cone sediment of 1-2 cm. From this, it follows that with the same mixture compaction time, the requirements for the workability of low-gravel concrete mixtures can be reduced by 4-5 times. The use of more rigid MShB mixtures leads to a decrease in water and cement, an increase in crack resistance, frost resistance, and concrete

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strength. The most rational area for implementing the research results in industrial and civil construction in areas lacking large aggregates. The conducted work expanded the existing understanding of the rational use of low-gravel concrete with reduced cement consumption, ensuring high operational characteristics.

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