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QUALITY INVESTIGATION OF SAND FOR THE PRODUCTION OF AGGREGATES ON THE VINOGRADI LOCALITY (DELIBLATSKA PEŠČARA)[**]

Abstract

This paper represents a study which was made to evaluate and interpret the variations in the quality of sand as a potential raw materials for the production of adregate on the Vinogradi locality (Deliblatska peščara). Since deposits of sand constitute a valuable resource for a region, it is desirable that extent and quality variations of these deposits are known. It was hoped that an evaluation of certain properties of sand would assist in determining the value of the Vinogradi locality (Deliblatska peščara) as an undeveloped aggregate source indicating the relative quality of sand from alternate sites of the Deliblatska peščara.

Keywords: aggregate, quality investigation, sand, Deliblatska peščara, production of agregates

1 INTRODUCTION

The largest European continental sandy terrain is located in the south-east part of the Pannonia Plain, i.e. Banat, covering the area of nearly 35,000 ha (Figure 1). It is of elliptical shape and extends from the south-east to the north-west. It was formed during the Ice Age from the vast layers of silica-carbon sand. In the Modern Age, the east wind called "košava" formed a clear dune relief, rising between 70 and 200 meters above sea level. The Vinogradi locality is spatially located on the territory of the municipality of Alibunar (Figure 2).

The Aeolian paragenetic complex is the youngest layer that completely forms the morphological unit of Deliblatska peščara. It can be divided into two stratigraphic units: the older one, created during the younger Pleistocene (ris and virm), deposited in the conditions of cold and dry periglacial climate, which is confirmed by the fossil remains of terrestrial gastropod fauna, and the younger one Holocene age. The Pleistocene Aeolian sand lies beneath a thin layer of "living sands" or "branches" deposited in the Holocene (Davidović et al., 2003).

Samples submitted for partial tests, in addition to the existing field markings that contain the place (locality) of geological research, the mark of exploration work and testing interval, have also received the laboratory markings of analyzes (Table 1). The weight of individual samples was about 20 kg. Table 2 shows the laboratory markings of composite tests and method of their formation (four individual tests in the manner required by the customer).

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2 EXPERIMENTAL

Testing the quality of natural aggregate (sand) of the Vinogradi locality, Banatski Karlovac was performed in accordance with Article 202 of the Rulebook on classification and categorization of reserves of solid mineral raw materials and keeping records on them (Official Gazette of SFRY, No. 53/79), i.e., in accordance with the standards prescribing the quality of mineral raw materials for a given application:

SRPS B.B2.009: 1982 (withdrawn) - Natural aggregate and stone for the production of concrete aggregates. Technical conditions.

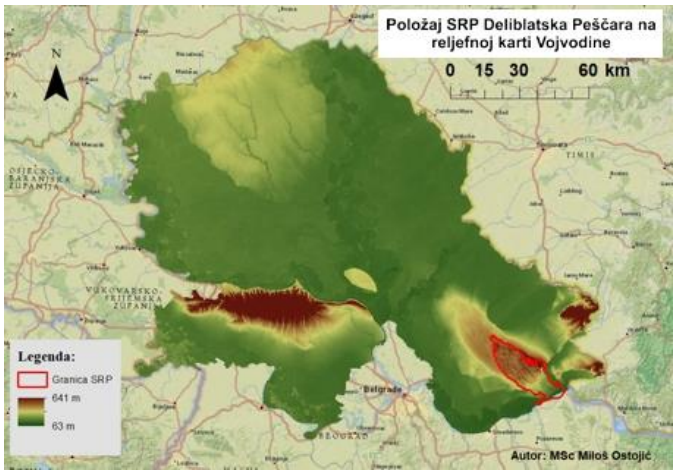

Figure 1 *Position of the Deliblatska peščara on the relief map of Vojvodina (by https:// geografijazasve, 04.04.2020)*

Figure 2 *Sand on the Vinogradi locality (territory of the municipality of Alibunar); by https:// geografijazasve, 04.04.2020*

- SRPS B.B2.009: 1982 (withdrawn) - Natural aggregate and stone for the production of concrete aggregates. Technical conditions.

Table 1 *General data on individual samples on the Vinogradi locality*

Serial number	Well mark	Field rehearsal mark	Trial interval (m)	Sample length (m)
1.	К-1	Р-1/19	2.00-7.00	5.00
2.		Р-2/19	7.00-12.00	5.00
3.	БК-2	Р-3/19	1.00-6.00	5.00
4.		Р-4/19	6.00-12.00	5.00
5.	БК-3	Р-5/19	2.00-7.00	5.00
6.		Р-6/19	7.00-12.00	5.00
7.	БК-4	Р-7/19	3.00-8.00	5.00
8.		Р-8/19	8.00-13.00	5.00

Table 2 *General data on composite sampless on the Vinogradi locality*

Serial number	Well mark	Field rehearsal mark	Trial interval (m)	Composite (m)
1.	К-1/19	Р-1/19	2.00-7.00	20.00
		Р-3/19	1.00-6.00	
		Р-5/19	2.00-7.00	
		Р-7/19	3.00-8.00	
2.	К-2/19	Р-4/19	6.00-12.00	20.00
		Р-2/19	7.00-12.00	
		Р-6/19	7.00-12.00	
		Р-8/19	8.00-13.00	

- SRPS B.B3.100: 1982 (withdrawn) - Fractionated stone aggregate for concrete and asphalt. Technical conditions.
- SRPS B.B2.010: 1986 (withdrawn) - Fractionated stone aggregate (granulate) for concrete. Technical conditions.
- Rule book on technical requirements for fractional aggregate for concrete and asphalt ("Official Gazette of RS", No. 78/2020).

The methods used in the scope of testing partial and complete sample analyzes are presented by the following standards (Table 3 and Table 4).

3 RESULTS AND DISCUSSION

Individual samples were tested by the methods: Granulometric composition, Content of fine particles, Content of clay lumps, Bulk density in loose and compacted state and Bulk density (Table 3). The test results are shown in Table 3, Table 4, Figure 3 and Figure 4.

Table 3 *Test results of individual samples*

	Bulk density in loose state γr [kg//m^3]	**Bulk density in compacted state γz [kg/m^3]**	**Bulk density γρ [kg/m^3] (pycnometric method)**	**Water absorption < 4 mm [%]**
standard deviation	48.85	62.25	41.06	1.80
coefficient of variation	0.05	0.05	0.01	0.34
coefficient of variation [%]	5.47	4.98	1.46	33.60
Minimum	824	1192	2780	3.39
Maximum	988	1390	2880	7.86
Range	164	198	100	2
Mean	894	1251	2815	5.35
Median	884	1237	2800	4.87
Varianse	2385.93	3875.27	1685.71	3.23

The analysis of the results led tests to the following conclusions:

- Granulometric tests determined that the tested sand was the following granulometric composition:
- Grains up to 0.125 mm in size: the average value of the passage is 92.9%, that is, grains smaller than 2 mm and larger than 0.125 mm in sample are of medium content of 7.1%.
- The calculated grain modulus the mean value of 0.059.
- Content of particles smaller than 0.063 mm (also tested by the wet seeding) is in the range from 27.4 to 57.6%. The mean value of pass is 44.4%.
- Content of light particles ranges from 5.1% to 34.2%. The mean value pass is 14.2%.

Table 4 *Methods used in the scope of testing of complete sample analyzes and presents of the results*

Ordinal No.	Characteristic		Test method	Results (Mean)	Technical requirements
1.	Mineralogical-petrographic composition		Annex III-Z	**Fine grains quartz sand**	1)
2.	Ingredients that prevent hydration of cement		Annex III-Z	**not contain**	Must not contain
3.	Bulk density $\gamma\rho$ [kg/m^3] (pycnometric method)		SRPS ISO 7033	**2815**	2000-3000 kg/m^3
4.	Water absorption		SRPS ISO 7033	**5,35**	Max 1.5%
5.	Resistance to frost		Annex III-O	**2.5**	Loss max 12%
6.	Total sulfur as SO_3		Annex III-NJ	**0.002**	Max 1.0%
7.	Chloride content		Annex III-NJ	**≤0.001**	Max 0.10% Max 0.02% 2)
8.	Content of organic matter		Annex III-M	**Color lighter than standard**	Color lighter than standard
9.	Grain shape		Annex III-S	**0**	Min 0.18
10.	**Grain-size distribution, passage through a sieve, %**	2.00 mm	Annex III-I	**100**	1)
		1.00 mm		**99.9**	
		0.5 mm		**99.7**	
		0.25 mm		**99.3**	
		0.125 mm		**92.9**	
11.	Content of fine particles [%]	0,09 mm	Annex III-K	**44.4**	1)
		0.063 mm		**14.2**	
12.	Content of clay lumps [%]		Annex III-E	**0**	1)
13.	Grain moduls			**0,20**	1)
14.	Content of crumbly grains [%]		Annex III-LJ	**0**	1)
15.	Content of light particles [%]		Annex III-J	**14.17**	1)
16.	Grain surface coverage [%]		Annex III-Z	**0**	1)
17.	Resistance to crushing and wear [%]		Annex III-P	**5.0**	Max 35%
18	Bulk density in loose and compacted state [kg / m^3]		SRPS ISO 6782	**893** **1251**	**1)**

1) Technical requirements are not determined, but the test results are stated in the Test Report

2) If the aggregate is used for the production of prestressed concrete

Figure 3 *Microscopic appearance of fraction 0.250 / 0.125 mm, binocular magnification 40X*

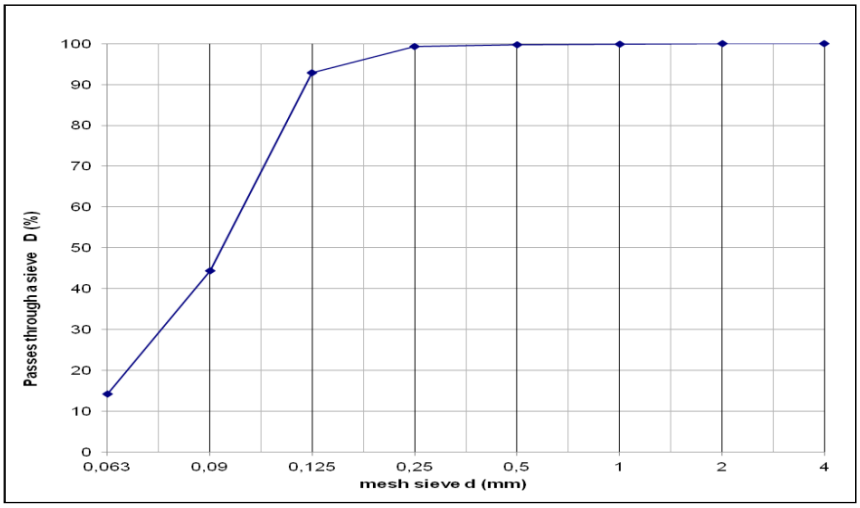

Figure 4 *Grain-size distribution of raw material*

4 CONCLUSION

The analysis of the results of raw material quality testing was performed on the basis of the above results of testing and in accordance with the requirements quality for stone aggregate of the Rule book on technical requirements for fractional aggregate for concrete and asphalt ("Official Gazette of RS", No. 78/2020).

In accordance with the requirements quality for stone aggregate of the Rule book on technical requirements for fractional aggregate for concrete and asphalt ("Official Gazette of RS", No. 78/2020), the raw material is not satisfactory, but, the fine-grained quartz sand from the Vinogradi locality, can be used for the production of lower bearing mechanically stabilized (tampon) layers of pavement structures according to the technical specification of JP PUTEVI SRBIJE of 29/12/2009 for the lower base layer: a layer of unbound stone material - sand.

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