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Influence of raw concrete material quality on selected properties of recycled concrete aggregates

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Abstract

Recycling of construction waste is an enterprise that is extremely important as well as difficult to accomplish in terms of environmental protection. One of the possible ways of the application of the construction waste, from demolition of concrete constructions, is its re-use as recycled concrete aggregates (RCAs) in production of constructive concretes.
The paper attempts to assess the influence of raw concrete material quality on selected properties of RCAs. Volumetric density, bulk density, voids, crushing strength, water absorption, mineral dust content for RCA, obtained from crushed primary concrete having different compressive strength, were examined. RCA was obtained by crushing laboratory concrete having a wide range of water/cement (w/c) ratio (from 0.35 to 0.7); it allowed to obtain the concrete having compressive strength from 30 to 60 MPa. The research also included recycled concrete with the secondary aggregate having optimal granulation (selected empirically and with the assumption of the lowest voids of the aggregate composition).

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Keywords: concrete; recycled aggregates (RCAs).

1. Introduction

The proper segregation of construction debris allows to select the properly fragmented waste, that can be used directly as the aggregate for a new concrete or as the secondary aggregate for various kinds of sand beds. The quality of the construction waste has the great influence on the properties of the obtained RCA. It is very important

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to know the composition, type and properties of materials that can be contained in the construction waste. The construction waste composition is quite diverse and with a significant prevalence of concrete and brick materials.

The unwanted substances in RCA include: mortar, ceramics, wood, soil, plastics, glass [1]. Even if the content of such contaminants is a few percent (e.g. a fraction of percent in the case of paints based on vinyl acetate), the contaminants can cause a significant decrease in concrete compressive strength [2]. Nowadays, the contaminant content in RCA is reduced by application of various segregation techniques depending on material fraction and type. Properly performed segregation, along with the proper crushing of the construction debris, decides about the possibility of the aggregate application in concrete production. The proper segregation allows to select the properly fragmented waste, that can be used directly as the aggregate for a new concrete or as the secondary aggregate for various kinds of sand beds.

The sterling construction concrete can be obtained using the secondary aggregate derived from concretes having higher classes and containing relatively great amount of cement [3,4,5]. The concrete mixture can be made using RCA only or combination of RCA with the natural aggregate in particular fractions [6,7], or with other additives [8,9]. The concrete potential is used to establish the composition of concrete with RCA; the potential is measured based on concrete mechanical properties, e.g. crushing strength [6,10,11].

2. Purpose, scope and course of own research

The paper attempts to assess the influence of raw concrete material quality on selected properties of RCA derived from the raw concrete material. The research on the influence of RCA granulation on the final properties of the recycled concrete was also carried out.

2.1. Preparation of raw concrete material for RCA obtaining

In the first stage of the work five types of normal concrete (NACI, NACII, NACIII, NACIV and NACV), based on natural aggregates and having different composition and w/c ratio, were prepared under laboratory conditions. These concretes were used as the raw material having different strength properties to obtain RCA. They also served as the reference material for concretes based on secondary aggregates. The following assumption were made during concrete preparation:

- maintaining sand content at the level of 30% in each concrete,
- obtaining dense-malleable consistence of mixtures – F2 having distribution of 35 – 41 cm,
- differentiation in concrete strength by presupposing various w/c ratios from 0.35 to 0.70.

The aggregate composition of aggregate mixtures was within the region delimited by standard curves in accordance with PN-EN 12620 for fractions of 0 - 16 mm with mesh fraction. The composition of the primary concrete mixtures is presented in Table 1.

Table 1. Composition of primary concrete mixtures.

		Component content in concrete mixture [kg/m^3]				Mixture properties	
Concrete labelling	w/c ratio	Cement [dm^3]	Water [dm^3]	Sand [dm^3]	Coarse aggregate [dm^3]	Paste volume [dm^3]	Consistency [cm]
NACI	0.35	454	160	554	1292	512	40.5
NACII	0.45	378	170	580	1296	511	41.0
NACIII	0.50	328	164	582	1360	487	37.5
NACIV	0.60	252	149	611	1427	462	39.2
NACV	0.70	225	158	612	1428	461	38.0

The samples were crushed and stored under airy-dry conditions immediately after the examination. In order to