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The Replacement of the Parts of the Aggregate in Concrete with Chalcedonite Powder

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Abstract

In recent years, many researches have been conducted concerning the influence of chemical admixtures and mineral additions on the properties of concrete mixture and the parameters of hardened concrete. The current state of knowledge is not sufficient for effective use of concrete mixtures with the addition of chalcedonite powder. The development of concrete mixture, in which a part of the aggregate is replaced with chalcedonite powder can become an alternative to concrete as it creates the possibility of management of waste located near the chalcedonite aggregate mines. Chalcedonite powder has the same properties as the aggregate it is created from. That means it is not dangerous but has a negative impact on the natural environment. Obtaining chalcedonite powder is not expensive and will not only lower the costs of concrete mixture production but also have a positive impact on the environment.

The article discusses the results of the laboratory tests on the influence of chalcedonite powder on the physico-mechanical properties of concrete. The meal replaced the aggregates in the amount of 5%, 10%, 15% by their mass. The amount of cement was unchanged. The research concerned the rheological properties of concrete mixtures, i.e. consistency, density, degree of aeration and the parameters of hardened concrete, e.g. compressive strength, capillarity and water absorbability. The addition of meal leads to the decrease in compressive strength. The decrease is related to the amount of the chalcedonite powder in the concrete mixture. Improvement was noticed in water absorbability and capillarity.

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1. Introduction

The addition to concrete mixtures used in the laboratory tests is chalconite powder with a diameter less than 0,1µm. It is a waste product obtained from chalconite crushed stone aggregate mines. Chalcedonite powder is composed mainly of silica and contains small amounts of other elements, such as quartz, opal, iron hydroxides, pyrite, manganese compounds and clay minerals. The material used in the research is the final product stored in aggregate mines.

According to the data published in scientific literature, chalcedonite addition modifies the properties of cement paste. The extend of these modification depends on the addition, especially on its type, amount and properties as well as the properties of cement and the presence of other components of cement composite.

The planned research will study the influence of chalcedonite meal on the physico-mechanical properties of hardened concrete, i.e. the change in compressive strength, water absorbability and capillarity[2,3,4,6,7,8].

2. Personal research □

Concrete mixtures were made of Portland cement CEM I 42,5R at a constant ratio w/c=0.4. Chalcedonite powder was added in various proportions of 5%, 10% and 15% of the aggregate mass in the concrete mixture. The meal was examined with diffractogram. It consists mainly of quartz. The research analysis also confirmed the presence of the sample of silica in the form of moganite. This form of silica is difficult to detect but is often found along with chalcedony.

Particle size of chalcedonite meal was measured by laser diffractometer.

$$\begin{matrix}
 x_{10} = 0,28 \mu\text{m} & x_{50} = 3,87 \mu\text{m} & x_{90} = 25,53 \mu\text{m} & \text{SMD} = 0,90 \mu\text{m} & \text{VMD} = 9,50 \mu\text{m} \\
 x_{16} = 0,44 \mu\text{m} & x_{84} = 22,38 \mu\text{m} & x_{99} = 34,99 \mu\text{m} & S_{\text{m}} = 6,64 \text{ m}^2/\text{cm}^3 & S_{\text{m}} = 66392,20 \text{ cm}^2/\text{g}
 \end{matrix}$$

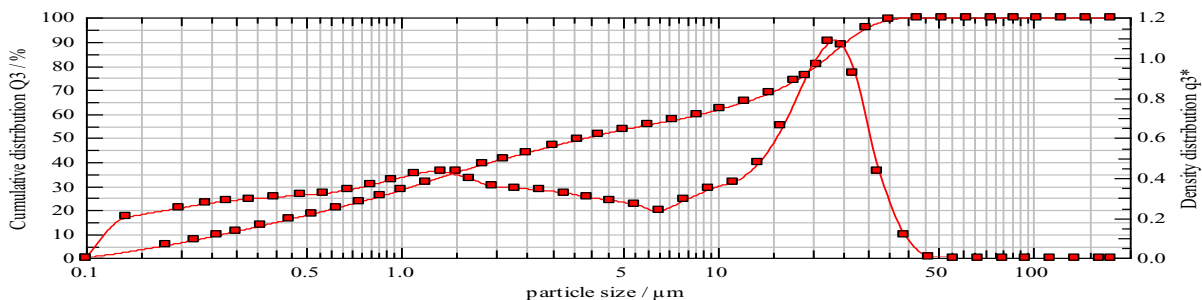


Fig. 1. Particle size of chalcedonite powder.

Planned laboratory tests consisted of the creation of four series of concrete with the composition presented in the Table 1.

Table 1. Composition of concrete mixtures

Components of concrete [kg/m3]	Reference concrete (SW)	Concrete with the addition of 5% of powder (5%)	Concrete with the addition of 10% of powder (10%)	Concrete with the addition of 15% of powder (15%)
cement	400	400	400	400
water	160	168	176	184
sand	598	579	560	541
dolomite 4/8	453	444	435	426
dolomite 8/16	691	682	673	666
chalcedonite powder	----	86	171	248
plastisizing admixture	1,02	1,07	1,14	1,2
air entrainer	9,4	11,17	11,19	11,21

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