EXPERIMENTAL DETERMINATION OF RECYCLED AGGREGATES CONCRETE CARBONATION

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Abstract

The construction industry is one of the main sources of pollution, starting with the extraction of raw materials and the demolition of existing buildings, providing huge amounts of CDW (construction and demolition waste). Concretes with recycled aggregate have higher porosity than those achieved with natural aggregates, (20-30% higher) which can influence the carbonation depth. A typical C16 / 20 concrete class has been studied with natural aggregates, replacing the various granulometric fractions with recycled aggregates. The 100x100x100mm cube specimens were stored for 28 days in water, tested (physico-mechanical characteristics) and subjected to accelerated carbonation experiments. After being stored for 60 days under accelerated carbonation conditions, the specimens were cleaved to determine the carbonation depth after phenolphthalein testing of the faces in the splitting zone, measuring the minimum and maximum carbon dioxide penetration values. Correlation was made between the compressive strengths obtained for the studied specimens and the carbonation depth after the accelerated carbonation experiments in a protected environment - 50% carbon dioxide concentration, temperature 25 ° C and humidity 75-80%.

Introduction

In addition to its major benefits to civilization, the construction sector also has some negative contributions to the environment: it has an important contribution to global warming through CO2-emitting processes and leads to the depletion of natural resources by over-exploiting them. At the same time, the uncontrolled disposal of waste resulting from construction and demolition processes also has a negative impact on the environment.

Eurostat estimates that in 2014 the total waste generated by economic and domestic waste for the 28 Member States at that time was 2598 million tones, being the highest value since 2004 and CDW representing 33.5% [1].

Reuse, recycling and waste reduction are considered to be the only ways to recover waste generated, but there is room for improvement in this direction [2].

Recycling is defined as the process that changes materials into new products for preventing the waste of potentially useful materials, reducing the consumption of fresh raw materials, the energy usage and the air and water pollution. Many of the large, existing buildings which don't have any historical importance, such as industrial type, office buildings or apartments, have a reinforced concrete structure, and in many cases the demolition is the economical option for them [3]. The resulted concrete is mainly used as coarse aggregate and filler in road construction industry. Another option, but not so often choose, for the concrete resulted from the demolition process is to be used as aggregates into a new concrete [4]. Using the RCA in construction field has begun immediately after the second world war, when the concrete resulted from damaged roads, started to be used as support layer for new roads [5].

Results and discussions

An experimental study on the durability of recycled concrete was carried out, focusing on the probability that the RCA used in new concrete would influence the degree of carbonation over time.

The RCA used into the experimental program was obtained after an industrial building demolition, with a reinforced concrete structure as it can be seen in figure 1. The building was demolished using the top- down method, in a mechanical way, with excavators.

Figure 1. RCA after initial crushing

Recycled aggregate concretes are concretes with a higher porosity than those achieved with natural aggregates, with 20-30% which can influence the carbonation depth. It has been proposed, the usual concrete class C16 / 20 made with natural aggregate, replacing it on the different granulometric fractions, with the recycled aggregate.

Concrete Class	**Mixture**				**Water/cement**
	CEM I 42,5R [kg/m^3]	**Mixture water** [kg/m^3]	**Admixture** [kg/m^3]	**Aggregate** [kg/m^3]	
C16/20	292	205	1,46	1694	0,7

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Correlation was made between the compressive strengths obtained for the studied specimens and the carbonation depth after the accelerated carbonation experiments in a protected environment - 50% carbon dioxide concentration, temperature 25 ° C and relative humidity 75-80%.

Figure1.Experimental setup

Figure 2. Testo 350XL analyzer

The three parameters - carbon dioxide concentration, relative humidity and temperature - were measured with the Testo 350XL analyzer, shown in Figure 2.

After being stored for 60 days under accelerated carbonation conditions, the specimens were cleaved to determine the carbonation depth after phenolphthalein testing of the faces in the splitting zone, drawing the carbonated surface and measuring the minimum and maximum carbon dioxide penetration values (Figure 3).

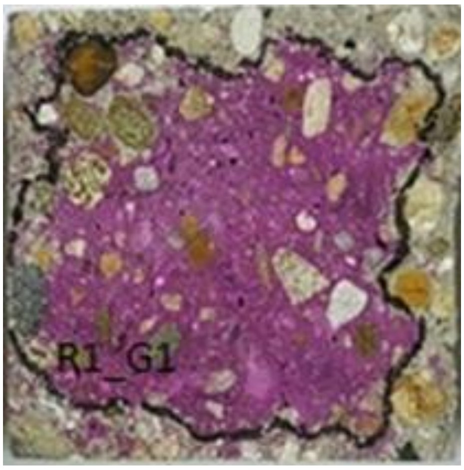

Figure 3. Phenolphthalein test - Carbonated surface

In the calculation of the average depth of theoretical carbonation, the developed C.Bob formula presented below [6] was used:

$$\bar{x}_{teoretic} = \frac{150 \cdot c \cdot k \cdot d}{f_c} \cdot \sqrt{t}$$

where:

$\bar{x}$ - average carbonation depth [mm]

f_c - concrete compression strength [MPa]

t - time [years]

c,k,d – coeficients

Samples	Compression strength- fc [Mpa]	c	k	d	Time [years]	x theoretic [mm]	x-min experim ental [mm]	x-max experi mental [mm]
M1 (100% natural) NAT: 0,0-16,0 mm	29	1	0,7	2,7	0,164	3,96	4,0	11,0
R1 (100% RCA) RCA: 0,0-16,0 mm	32,0	1	0,7	2,7	0,164	3,59	4,0	13,0
R2 (natural+RCA) NAT: 0,5-16,0 mm RCA: 0,0-0,5 mm	23,0	1	0,7	2,7	0,164	5,00	9,0	15,0

Conclusions

Experimental determinations have highlighted carbonation depth values for concretes with recycled aggregates higher than the theoretical values calculated using compression resistances.

For concretes with recycled aggregates, for higher strengths of tested concrete, the carbonation depth measured was lower.

Following the studies under accelerated carbonation conditions, a coefficient will be proposed in the carbonation depth calculation formula, which correlates with the concentration at which the concrete is exposed.

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