CERIS : Civil Engineering Research and Innovation for Sustainability

WP10B – Forced and Accelerated Sequestration of CO_2 by C&DW to Incorporate as Aggregates in Mortars and Concretes

Summary

The construction sector is responsible for a great environment impact, generating almost one third of the total amount of wastes produced over the world. The cement industry that is encompassed in this sector, emits about 650 to 800 kg of CO_2 by each tonne of cement produced, being one of the most polluting industries in terms of CO_2 emissions. The high concentration of this gas in the atmosphere, together with other greenhouse gases, is responsible for a greater reflection of the radiation emitted by the earth's surface, which results in an increment of the planet average temperature and has great consequences for the ecosystems, namely the increase in water level due to the thawing of glaciers.

In the cement industry, a large part of CO_2 emissions is obtained during the clinker production. As well-known clinker is cements' major component, being hard to eliminate the emissions produced. It is necessary to find alternative solutions to reduce the emissions of this gas or, alternatively, to capture them before they are sent to the atmosphere, thus reducing its environmental impact. The capture of part of the CO_2 emitted by the cement companies is the main objective of the W10B project.

The project aims to capture CO_2 through construction and demolition wastes (Figure 1). This uptake is achieved by the aggregates that can present some carbonation potential, as is the case with cementitious materials including concrete and cement-based mortars. It is also intended to evaluate the CO_2 sequestration capacity through physical fixation, namely in porous materials, such as red ceramics or others. Several parameters of forced carbonation will be investigated, such as the concentration, temperature and relative humidity, so that their combination allows achieving optimal carbonation. The parameters for optimal carbonation should take also into account the conditions that can be implemented in factory by the cement industries.

The capture of CO_2 by these wastes permits not only the reduction of gases emitted to the atmosphere, but it can also allow to improve the characteristics of the wastes, potentiating other types of new applications. The possible carbonation of CDW may allow to improve their characteristics, since their porosity tends to be reduced. The reduction of wastes' porosity results in a more compact microstructure which will improve the mechanical resistance of the aggregates and reduce their water absorption. In this context, the project aims to assess the global behaviour of mortars and concretes with the incorporation of the carbonated wastes, contributing to a circular economy. The assessment is performed by comparison with reference non-carbonated waste aggregates of the same source, as well as with natural aggregates. These comparisons allow to assess the possible benefits of carbonation. The incorporation of CDW as aggregates instead of natural aggregates allows to further increase the sustainability of these new materials, reducing the volume of natural resources extracted from nature. Analysis of the life cycle of new materials is also one of the objectives of the project.

Figure 1. CDW illustration.

The WP10B project is part of a set of projects from the c5Lab collaborative laboratory. It has a multidisciplinary and varied work team that includes several members of CERIS - IST (Professor Jorge de Brito, Professor José Bogas, Professor José Silvestre, Professor Rita Nogueira), LNEC (Doctor Rosário Veiga, Doctor António Santos Silva, Doctor Rita Santos), NOVA (Professor Paulina Faria), SECIL (Engineer Vitor Vermelhudo), CIMPOR (Engineer Catarina Coelho), University of Aveiro (Professor Ana Velosa) and c5Lab (Doctor Catarina Brazão Farinha, Doctor Cinthia Maia Pederneiras, Engineer Ricardo Gomes and Engineer David Bastos).

Project Reference

c5Lab WP10B

Leading Institution

c5Lab – Sustainable Construction Materials Association (Portugal)

Partners

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal), CIMPOR – Cimentos de Portugal, SGPS, S.A. (Portugal), Secil (Portugal), ATIC – Associação Técnica da Indústria do Cimento (Portugal), LNEC – National Laboratory for Civil Engineering (Portugal), FCT NOVA – NOVA School of Science and Technology (Portugal), UA – University of Aveiro (Portugal)

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Project Website

c5lab.pt/projects.html