

## LowC-Bionic – Organically shaped structures in low carbon concrete produced by 3D printers

### Summary

The LowC-Bionic project is a multidisciplinary project, which aims to develop an advanced cement-based material and an automated three-dimensional (3D) printing equipment for concrete, to create an emerging technology to provide organic shape structures, which are lightweight, through the significant reduction of cement material, but without any impact on performance and mechanical strength.

The following aspects have been studied: (a) the rheology and properties of low carbon, multifunctional and sustainable cement-based colored materials to enable their printing, (b) the topology, through computational processes, for the design of structures with a three-dimensional organic shape inspired by Nature, and (c) the 3D printer. The integration of all these aspects culminated in a low carbon bionic structure prototype, printed in concrete. It was also possible to obtain a structure capable of reacting to the temperature of the environment in which it is inserted, through reversible chromatic changes.

LowC-Bionic was an initiative of a Portuguese company and three research units, holding together the required scientific and technological background, with international recognition, in all relevant areas. More specifically, CMP - Cimentos Maceira e Pataias, a company of the SECIL Group, is a national reference in the production of cementitious materials, cements, mortars and concrete,

CDRsp (IPLeiria) is a reference in the area of additive manufacturing (3D printing), CERENA (IST) is a reference in the area of materials in general and polymers and adjuvants in particular, and CERIS (IST, Nova, UCoimbra) is a reference in structural concrete (broad sense), including formulation, durability, mechanical characterization, structural evaluation, and image processing, applied to structures produced with cement-based materials.

Figures 1 and 2 show examples of printed / extruded cement formulations (on-going development).



Figure 1. Extruded specimens for compression test based on grey cement — CEM I 42,5R.



Figure 2. Extruded bionic shape specimens based on grey cement — CEM I 42,5R.



### Project Reference

LISBOA-01-0247-FEDER-047074

### Leading Institution

SECIL – Companhia Geral de Cal e Cimento S.A. (Portugal)

### Partners

IST – Instituto Superior Técnico (Portugal), IPLeiria – Instituto Politécnico de Leiria (Portugal)

### CERIS Principal Investigator

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### CERIS Research Team

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### Funding

Portugal 2020

### Period

2021-2023

### Total

253 605.82€

### CERIS

126 802.91€

### Project Website

<https://www.secil-group.com/pt/inovacao/inovacao/lowc-bionic>