

3D FIBER Concrete – Direct Digital Manufacturing of High-performance Fiber Reinforced Concrete Structures through Robot Applications

Summary

The 3D Fiber Concrete project consists of technological research and experimental development of additive manufacturing systems for cementitious materials, with the simultaneous incorporation of mechanical reinforcement for the automatic manufacture of high-performance parts and structures for the construction sector (Figure 1).

The main objective of the project is to combine the advantages offered by additive manufacturing technologies, such as freedom of form and fabrication without formwork, with the increase in quality of the structures provided by mechanical reinforcement (namely tensile strength and bending), in an automatic manufacturing system, integrated in a digital ecosystem from the perspective of Industry 4.0. In this way, it is intended to develop solutions that allow the automated production of high performance elements and structures for the construction sector, with free and innovative design and without the use of molding, tending to be of high dimensions and presenting excellent performance, namely for the mechanical properties. To fulfill the main objective of the project, specific objectives were drawn to answer the challenges that will arise, and to take advantage of all the potential for innovation that additive manufacturing with simultaneous and automatic incorporation of mechanical reinforcement can bring to the construction sector. Additionally, the definition of specific objectives underpins the composition of the consortium formed for the execution of the 3D Fiber Concrete project, based on the combination of the strengths of all entities involved. The initial objectives of the project are:

- To develop an innovative extrusion and robot-assisted additive manufacturing systems, with the simultaneous incorporation of mechanical reinforcement in high-performance structures with cement materials, intended for the construction sector.
- To develop and implement case studies for the application of the technology developed, such as silos, vaults, modular bridges or wind towers.
- To develop a digital ecosystem from product customization to assembly, through the manufacturing process and logistical control.



Figure 1. Printing mortar.

To fulfill the objectives, the 3D Fiber Concrete is organized into 7 different activities: 1. *Preliminary Studies* – for in-depth studies on the technologies to be applied in the equipment developed, as well as studies and characterizations of a range of cementitious materials to be used in the case studies; 2. *Development* – CAD development and respective numerical simulation of the case studies to be developed using the equipment; 3. *Construction of Prototypes* – production of the laboratory units of the equipment, as well as its optimization and continuous adjustment throughout the construction process; 4. *Experimental Tests* – tests of the equipment started through the production of the case studies defined in activity 2. This activity is concluded with the presentation of the results through quantitative and qualitative characterizations of the case studies; 5. *Digital Ecosystem* – focus on the creation of a digital ecosystem, from the perspective of Industry 4.0, involving the process developed in this project. An integrated assessment of the developed ecosystem will be carried out, and adjustments may be made based on the results obtained; 6. *Dissemination* – includes the entire process of dissemination and communication of results, technologies and methodologies of the project; 7. *Management* - management and coordination of the project.

Project Reference

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Leading Institution

Mendes INOV (Portugal)

Partners

AGIX – Innovative Engineering (Portugal), Cimpor – Cimentos de Portugal (Portugal), CDRSP – Centre for Rapid and Sustainable Product Development of Politécnico de Leiria (Portugal), IST – Instituto Superior Técnico (Portugal), ISEC – Instituto Superior de Engenharia de Coimbra (Portugal)

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32 454.36€

Project Website

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