

## **PhD SCHOLARSHIP APPLICATION**

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Division / Business Area: Construction / Industrialised Construction

Building / Province: Donostia / Gipuzkoa

## **SCHOLARSHIP DESCRIPTION**

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**Title: Development of structural elements of responsibility through 3D printing of cement-based materials.**

**Brief description:**

The scholarship proposal is aimed at applied research for the development of structural elements of responsibility, produced through 3D printing of cement-based materials. Developing the design assisted by testing criteria in accordance with Appendix D of the Eurocode 0 EN 1990:

2003 and modelling tools for finite elements to:

1. Predict the deflections derived from the contour-crafting printing process.
2. Predict the mechanical behaviour of the printed piece and the structural evolution throughout its service life.
3. Carry out topological optimisation in accordance with the contour conditions.
4. Establish the optimum printing strategy.

**Detailed description:**

The doctorate student will join the ECOIN Business Area in dPro product development in order to carry out his/her Doctoral Thesis in the Topological Optimisation line, devoted to the R&D of optimised products bearing in mind new manufacturing and execution processes.

- Based on new automated manufacturing and execution processes.
- Topologically optimised.
- With innovative materials.

The main purpose of the research is to develop experimental procedures and numeric models to analyse printed concrete structures in the latent state and hardened, and apply optimisation algorithms (structural) to optimise the printing strategy and the printed concrete structures, bearing in mind the influence of the 3D printing technique and strategy in order to develop reliable structural elements produced through 3D printing. In particular, the following tasks are envisaged:

- Report on the properties of the material and characterisation of the anisotropy based on Procedure EN 1990: 2003 Appendix D, Design assisted by testing;
- Design and evaluation of structural elements through the simulation of finite element modelling (FEM) of the real structural performance of the printed concrete product and mechanical and durability testing and adaptation of the models to the printing strategy (speed, layer height, stacking, deformability ...) with interrelation between variables.
- Analysis of the printing geometry in terms of printing capacity (for example, stability during printing) and expected product properties (such as interface resistance). Develop

- a method that bears in mind not only the stress-strain behaviour depending on the printing material time, as well as modelling depending on the material deposition time.
- Development of optimisation algorithms for the global printing strategy, from the material to the final structural product or their validation.

## **REQUIREMENTS**

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### **Degree and specialisation:**

Master's Degree in Industrial Engineering, specialised in Mechanics, Civil Engineering, specialised in Structures, or other with skills that are compatible with the development of this doctoral thesis.

### **Languages:**

Advanced level of English.

Others will also be positively evaluated.

**IT skills:** Knowledge of programming languages (Python, C, Java) and finite element programmes (ANSYS).

**The following will be a plus:** Knowledge of topological optimisation, previous experience in research or professional mechanic of structures, availability to spend periods of time abroad.

**Further information and applications:** <http://bit.ly/2qEdoNv>