



# PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 38th cycle

**PARTENARIATO PNRR Research Field: CONCEPTUAL DESIGN AND OPTIMIZATION OF  
DIGITALLY FABRICATED BIOMIMETIC/BIOMORPHIC CONCRETE STRUCTURES**

**Monthly net income of PhDscholarship (max 36 months)**

**€ 1275.0**

In case of a change of the welfare rates during the three-year period, the amount could be modified.

## Context of the research activity

**Motivation and objectives of the research  
in this field**

**ECS-MUSA: ECOSISTEMA DELL'INNOVAZIONE  
MUSA - MULTILAYERED URBAN SUSTAINABILITY  
ACTION**

CUP D43C22001410007 – Decreto di concessione D.D.  
1055 del 23/06/2022 D.D. 3277 del 30/12/2021

Avviso pubblico per la presentazione di Proposte di  
intervento per la creazione di 12 Ecosistemi  
dell'innovazione sul territorio nazionale da finanziare  
nell'ambito del Piano Nazionale di Ripresa e Resilienza,  
Missione 4 Componente 2 Investimento 1.5 - Creazione e  
rafforzamento di "ecosistemi dell'innovazione",  
costruzione di "leader territoriali di R&S" - finanziato  
dall'Unione europea - NextGenerationEU.

Concrete is the most largely used construction material in  
the world, with about 10 billion tons produced and  
employed every year. The large used volumes and the  
production technologies of its constituents imply a  
significant environmental impact of the material in terms of  
CO2 tons per unit weight/volume. Still, concrete is used to  
make structures: this on one hand implies that the  
environmental sustainability assessment has to be  
performed with reference to the intended application,  
which cannot disregard the structural performance of the



	<p>material and the way it is used in the same structure. Moreover, besides the impact of the material per se, the construction process (including hauling of materials) and the service life stage have to be considered in an overall consistent evaluation. A dedicated importance has to be given to the structural concept as an integral part of the fabrication stage, which, together with the possibility of optimizing the material performance, can lead to the use of advanced technologies, including additive manufacturing, as a key enabler to design and build structural shapes which exploit the in-structure material performance to achieve a significant saving of the material through shapes which could not be otherwise fabricated.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The candidate will tackle the problem of structural optimization as a function of the advanced mechanical performance of cement based materials (e.g. Ultra High Performance Fibre Reinforced Concrete) and of the employed (digital) fabrication technology. The aim is to demonstrate the feasibility of implementing, in the concrete construction industry practice novel structural concepts inspired to biomorphology/biomimesis. This is meant as the possibility of exploiting at their best the superior mechanical performance of advanced cement based materials with the aim of employing the material where structurally needed, in the framework of the overall sustainability of the engineering artefact.</p> <p>The research will also tackle the integration of different components/materials in the structural fabrication process, with dedicated attention to connection devices among different structural parts, also with the aim of a multimaterial digital fabrication process.</p>
<p><b>Educational objectives</b></p>	<p>The candidate will be trained in advanced topics related to the structural design and applications of advanced cement based materials, including durability testing, life-cycle analysis and advanced manufacturing techniques.</p>
<p><b>Job opportunities</b></p>	<p>The topics of the proposed PhD scholarship are crucial in the development of the construction sector. The candidate, once graduated, can spend his skills into a broad portfolio of engineering firms and construction</p>



	companies and the healthy relationships of the research group with industry will surely open broad possibilities.
<b>Composition of the research group</b>	0 Full Professors 4 Associated Professors 3 Assistant Professors 12 PhD Students
<b>Name of the research directors</b>	Liberato Ferrara and Giovanni Muciaccia

Contacts	
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	638.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p><u>Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:</u></p> <ul style="list-style-type: none"> <li>•ETH Zurich</li> <li>•TU Dresden</li> <li>•Centre Scientifique et Technique du Bâtiment - Paris</li> <li>•TUDelft</li> <li>•University of Freiburg</li> <li>•University of Loughborough</li> <li>•Arizona State University</li> <li>•Indian Institute of Technology Madras</li> <li>•Hinfra Ltd</li> <li>•Cemex</li> </ul>



- MX3D
- Buzzi Unicem

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.

Computer availability and desk availability: Each Ph.D. student has his/her own computer for individual use. Each Ph.D. student has his/her own desk, cabinet and locker.