



PhD in ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO / ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING - 39th cycle

**PNRR 118 PNRR Research Field: UNLOCKING THE POTENTIAL: EXPLORING INNOVATIVE
DIGITAL FABRICATION STRATEGIES FOR SUSTAINABLE BUILDING RENOVATION USING
RECYCLED MATERIALS AND A DIGITAL FRAMEWORK.**

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	
<p>Motivation and objectives of the research in this field</p>	<p>The proposal aims to address sustainability challenges in the construction industry by investigating innovative digital fabrication techniques for building retrofit, or new constructions, using recycled materials. The research recognizes the significant environmental impact of construction waste and the decreasing availability of materials. It aims to maximize material reuse and conversion, minimizing the consumption of new materials through the development of cost-effective and efficient retrofit interventions. The proposal emphasizes the concept of Urban Mining and the need for comprehensive digital paths from waste materials to retrofit applications. The objectives include analyzing building demolition waste, exploring digital fabrication technologies, considering retrofit issues, defining technological paths, proposing an automated workflow, or developing a digital methodology for waste material processing. The research could contribute to the development of new retrofit strategies or building components, a reproducible digital fabrication method, and the exploitation of a business model or policy tools for material waste reuse. The expected results encompass optimized retrofit strategies, a unified digital workflow, and the evaluation of regional</p>



	<p>impacts on sustainability.</p> <p>The followings are the PNNR lines interested in the proposal:</p> <ol style="list-style-type: none"> 1. enhance research in order to increase the competitiveness of researchers and companies in the sector (digital transition) (PNRR M1C2); 2. enhancing circularity and reducing environmental impact; ensuring an energy-efficient and regenerative built environment (PNRR M2C1 and M2C3); and 3. transfer of knowledge and advanced skills in education to reduce the skills mismatch between education and labor demand and economic valorization of research (PNRR M4C2).
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The proposal emphasizes the utilization of parametric tools for shape optimization, performance analysis, and installation efficiency. These tools allow for the generation and manipulation of complex geometries, enabling the exploration of innovative design possibilities and the optimization of material utilization. By incorporating parametric tools into the digital workflow, the research aims to enhance the efficiency and effectiveness of the retrofit or new construction process. The methods and techniques for the research could include statistical evaluation using Large Language Models (LLMs) and/or deep-learning tools to evaluate the potential of Neural networks to evaluate and identify paths connecting waste materials with retrofit needs, highlighting existing paths and gaps in fabrication technologies and renovation strategies. Waste material assessment will be conducted through the development of indicators to evaluate the economic feasibility and technical possibilities of reusing waste materials. The capabilities of digital fabrication technologies will be explored, considering various materials such as concrete, metal, textiles, plastic, and wood. Environmental assessments will be conducted using Building Energy Modelling and Life Cycle Assessment (LCA) to evaluate the environmental potential of the proposed paths.</p>



	<p>Additionally, a digital workflow could be developed to process waste materials through digital fabrication for retrofit interventions, leveraging computational modeling tools.</p> <p>A 6 month period abroad within the PhD period is required (to be defined by the end of 2023).</p>
Educational objectives	<p>The main objectives are:</p> <ul style="list-style-type: none"> •the development of performance analysis and digital fabrication expertise in the field of building systems and components; •to acquire knowledge of urban mining, digital workflows, and data analysis techniques; and •to become an independent researcher by acquiring critical thinking and academic writing.
Job opportunities	<p>Sustainable building Consultant, Research and Development Specialist, Environmental Analyst, Sustainable Policy advisor, Academic Carrier.</p>
Composition of the research group	<p>2 Full Professors 1 Associated Professors 3 Assistant Professors 1 PhD Students</p>
Name of the research directors	<p>Dr. Andrea G. Mainini and Prof. Tiziana Poli</p>

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	637.5 €
By number of months	6



National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	To be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Additional support:</p> <p>Budget for the research activity (only for positions supported by scholarship): total amount Euro 5197.60 per student.</p> <p>In detail:</p> <ul style="list-style-type: none"> - 1st year Euro 1732.53 - 2nd year Euro 1732.53 - 3rd year Euro 1732.53 <p>Additional information about the organization and regulations of ABC-PhD programme can be found in the Regulations for the 39th Cycle of ABC-PhD: download is available at link: https://www.dottorato.polimi.it/corsi-di-dottorato/architettura/architettura-ingegneria-delle-costruzioni-e-ambiente-costruito</p> <p>Additional information about ABC department and ABC-PhD programme: available at link: https://www.dabc.polimi.it/</p> <p>Desk availability: The ABC department provides non-permanent desks to be temporarily booked in common PhD rooms.</p> <p>This scholarship is funded by the PNRR national programme under the research line on "Generic PNRR topics" in D.M. 118. This means that the owner of the position will be obliged to submit periodical reports about her /his activity.</p>