CIVIL AND ENVIRONMENTAL ENGINEERING

MUR DM 118 - Rehabilitation and seismic upgrading of architectures with sustainable systems in the wood supply chain

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Dipartimento DISEG Dipartimento DAD
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Context of the research activity	The complex conception of seismic upgrading interventions on existing architectures is the focus of this proposal. A multidisciplinary approach will embrace both closely related themes, such as seismic and energy retrofit techniques in alpine area that favor the sustainable use of wood, and highly innovative research fields hitherto little exploited in this context: AI techniques (Machine and Transfer learning), computational design, metamaterials, bistable energy dissipation and absorption systems for engineered timber. Progetto finanziato nell'ambito del PNRR – DM 118/2023 - CUP E14D23001700006
	The research programme will develop in accordance with the theme set out in the title and will deepen some of the areas and topics listed above, as they are useful for framing the problem referred to in the proposed research. As far as possible, the research will give priority to frontier research and its interdisciplinary developments and will favour the inclusion of the PhD student in active research projects and on-going experimental campaigns in the involved laboratories of DISEG, in particular the laboratory of Dynamics and Seismic, and DAD, for technological aspects. The aim of the research carried out by the PhD student is to advance the state of knowledge through an original and significant scientific contribution. This contribution must always be based on a thorough knowledge of the state of the art and a rigorous elaboration of new theoretical and/or experimental knowledge. In particular, the candidate will address the topic of designing and implementing seismic upgrading interventions on existing architectures, such as traditional architectures in alpine areas, conceived in the perspective of an

Objectives	increasingly ecologically sustainable built environment. The goal is to direct the design of these interventions towards multiple objectives, combining the optimization of the seismic response with minimum energy consumption and reduced life cycle greenhouse gas (GHG) emissions of the upgraded building. In most cases, historic structures, including architectural assets, are not designed to withstand high seismic forces as well as they are not designed to be energy efficient, or at least, not as current standards conceive it. Integrated and carefully designed retrofit interventions, which require multidisciplinary studies and skills, from architecture to seismic engineering and technical physics could satisfy both needs, while respecting and protecting the original asset. The GHG emissions are produced during all phases of a building's construction, including the intervention phase, in which a significant amount of new building material may be added. With this in mind, the choice of materials of the intervention and their subsequent manufacture is highly incisive. In fact, many studies agree that changes in the Architecture, Engineering and Construction (AEC) value chains can contribute profoundly to GHG emission reductions, both in new and existing buildings. Decisions taken today by professionals and firms in the AEC sector impact the lives of generations far into distant futures. This is the reason why the world of research in this sector is moving towards the use of materials that are eco-sustainable, natural, with reduced or zero impact on the ecosystem in which they are inserted, without renouncing high performance (from various points of view) that can be reached through innovative technological treatments. In this research path the use of engineered wood is proposed as the main material for the structural intervention. Modern retrofit strategies follow the Life Cycle Thinking (LCT) philosophy, an approach that provides for the careful evaluation of the building, from the materials production phase to the demolition phase, if foreseen by the life cycle. The engineered wood in all its phases could be carefully evaluated in the context of this research path, from the production stage, to the possible modification of its mechanical/optical properties, the surface treatments, the assembly, until the possible (if envisaged) disposal, in order to optimize the final properties of the retrofitted building. LCT is based on the principle of minimizing energy consumption associated with maintenance, possible change of intended use or, more importantly, possible extreme events such as earthquakes. From this point of view, it is necessary to consider and define sustainable techniques involving principles such as: prefabrication, standardization, production outside the construction site and the adoption of ecologically efficient

Skills and competencies for the development of the activity	Ideal candidates should have a background compatible with the proposed research and the topics listed, but above all they should show an open mind and a strong motivation to address frontier issues. A propensity for theoretical and experimental research is expected, demonstrable for example with involvement in advanced research topics in their thesis work. Knowledge in the field of earthquake engineering, building systems, FE modeling, structural dynamics, structural identification, machine learning, building systems are appreciated, together with some basic research experiences related to the selected Ph.D. topic. Both the curriculum examination and the interview will evaluate the potential of candidates to develop innovative research activity that leads to exceptional scientific results.