POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

THEMATIC Research Field: POPULATION-BASED STRUCTURAL HEALTH MONITORING FOR CIVIL STRUCTURES

Monthly net income of PhDscholarship (max 36 months)
1500.0 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	In recent years, the monitoring of civil structures has acquired strategic relevance, driven by the progressive ageing of infrastructures and by some catastrophic failures that have highlighted the risks linked to deterioration—especially when structures are subjected to usage conditions beyond those originally foreseen at the design stage.Unlike other engineering systems where monitoring is now a well-established industrial practice, civil structures exhibit specific challenges, such as •low or absent standardization, since most structures are designed and realized for a specific need (think, for example, to a bridge crossing a valley) and, for this reason, they are unique •highly unbalanced datasets, with a near-total lack of data collected under damaged conditions—that limit the scalability of monitoring techniques Within this framework, the objective of the research is to develop population-based monitoring approaches capable of exploiting data from families of similar structures to design advanced anomaly detection algorithms for structural damage identification.
Methods and techniques that will be developed and used to carry out the research	The proposed approach is based on the combined use of traditional methods and mathematical-computational tools for data analysis. On one hand, a solid understanding of structural systems, materials, and the underlying physical phenomena provides the foundation for characterizing the

	structural behaviour and interpreting the outputs generated by the monitoring system. On the other hand, the adoption of advanced data analysis techniques significantly enhances the system's ability to detect and characterize damage. Two complementary strategies will be pursued. On one hand, due to the strong unbalance typically found in real-world datasets, statistical process control techniques, that rely solely on data representing the undamaged, or baseline, condition, will be developed. On the other hand, a scaled physical model representative of a specific class of real structures will be designed, built, and instrumented. This model will allow the simulation of various damage scenarios and the implementation of supervised classification approaches. Moreover, the model will be designed to be easily reconfigurable into different similar structures belonging to that class.The research will investigate the potential for transferring the knowledge developed on the scale model to different similar scaled structures and to real-world structures by means of transfer learning methodologies.
Educational objectives	The research is strongly interdisciplinary and the candidate will gain expertise in different aspects related to the structural health monitoring of large civil structures. In detail, the following subjects will be addressed: •Measurements techniques and sensors •Data processing •Dynamic and structural modeling of structures •Data driven SHM techniques, with particular focus on population-based and transfer learning techniques The educational objectives will be reached through a combination of high-level PhD coursed and research activity within the research group.
Job opportunities	Structural health monitoring is a highly active research area, attracting growing interest both in the academia, in the industry and among the infrastructure management companies. During the PhD program, the candidate will have the opportunity to interact with several research groups working on this topic, both through the mandatory research period abroad and by participating to international conferences, where the outcomes of the

	international conferences, where the outcomes of the research work will be presented.Academic institutions—both in Italy and internationally—represent a potential career path following the completion of the PhD, for instance through postdoctoral positions. At the same time, the skills developed during the PhD in the field of Structural Health Monitoring and data analytics will open many employment opportunities also outside the academia. These include infrastructure operators, as well as companies that provide monitoring-related services, which belong to a growing market involving many startups and innovative companies. Furthermore, the PhD in Mechanical Engineering, combined with the technical competencies acquired throughout this research, will equip the candidate with a solid foundation for pursuing career opportunities in mechanical and aerospace industries.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Gabriele Cazzulani, Prof. Marco Belloli

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops, and conferences) for a total amount of €6,114.50.

PhD candidates benefiting from this scholarship are required to spend a research period of at least 3 months abroad, joining high-level research groups in their specific research field, as agreed upon with their Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approximately €750/month – net amount). Additionally, candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3.000 to cover travel expenses.

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities related to teaching support. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.