POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

PNRR 630 Research Field: DYNAMIC DATA-DRIVEN MODELLING FOR RAILWAY BRIDGE STRUCTURAL HEALTH MONITORING

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	Bridges serve as crucial arteries of connectivity, facilitating the flow of people and goods across regions. However, the relentless forces of weather phenomena and the escalating demands of ever-growing traffic have subjected these fundamental structures to accelerated wear and tear, surpassing the conservative estimates made during their initial design. Structural Health Monitoring (SHM) has emerged as a potent solution, harnessing the power of automated modelling techniques. The imperative to transition towards a data-driven approach has been driven by the escalating number of structures, necessitating algorithms that can generalize across diverse types of structures and sensors. The goal of SHM is to forecast a specific measured parameter of the bridge, facilitating the determination of its health status. SHM is, therefore, a key enabling factor for the infrastructure digitalization and increase of transportation safeness and availability, therefore complying with four of the six pillars mentioned in the Regulation (EU) 2021/241, which are: digital transformation, intelligent growth, territorial cohesion and economic resilience.
Methods and techniques that will be developed and used to carry out the research	The practical implementation of SHM methods for bridges passes through 4 main stages. i) measurement and acquisition system definition and installation ii) data acquisition and data storage iii) system modelling and

	iii) system modelling and iv) anomaly detection. The research will focus on stages iii and iv, that is, the system modelling and anomaly detection. In recent years it has been highlighted how data-driven dynamic modelling techniques are particularly suitable for SHM purposes. These approaches look for relations among the measured quantities by observing the data acquired from the bridge. Among the others, ARX, DMDC and SINDyC look particularly promising in the definition and construction of robust models. The second phase will involve instead the leveraging of these data-driven models to identify the onset of anomalies and possible damages from the structures. The candidate is expected to compare the above-mentioned techniques with state-of-the-art solutions for SHM, to justify the adoption of these innovative algorithms in comparison to more traditional approaches, such as the ones based on physical models suitable for structures (i.e. Mechanics of continuous bodies and Finite Elements Methods). The candidate must therefore be familiar with the handling and manipulation of real measurements coming from civil structures, as well as showcasing a strong background in traditional modelling techniques. These two core competencies will merge in an experimental test case, where the candidate will work mainly on a railway bridge on which a monitoring system will be installed according to a project already in place within a MOST partnership, involving a collaboration between the Mechanical Engineering Department and the sponsor company.
Educational objectives	The candidate is expected to develop strong basics in machine and deep learning, data-driven dynamics, numerical methods for engineering, structural health monitoring theory, anomaly detection and statistics.
Job opportunities	At the end of the experience, the candidate will be suitable for job opportunities in infrastructure manager companies, deep-tech startups, software houses leveraging AI solutions, National and International Research Institutes and worldwide renowned engineering Universities.

Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Eng. Claudio Somaschini

Contacts
Phone +39 331 330 5637 Email claudio.somaschini@polimi.it, lorenzo.benedetti@displaid.it For questions about scholarship/support phd-dmec@polimi.it

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	750.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Displaid S.R.L.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	MIT Senseable City Lab
By number of months abroad	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 or participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114, 50. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.