POLITECNICO DI MILANO

PhD in ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO / ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING - 38th cycle

PNRR_351_DOTT_RICERCA Research Field: MITIGATION OF CLIMATE CHANGE EFFECT ON SCOURED BRIDGES USING REMOTE SATELLITE MONITORING INFORMATION

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	The focus of this PhD project is on the use of remote satellite information as decision support tools for maintenance management of bridges under scouring risk. In the perspective of the **ecological transition and sustainable mobility** promoted by the **Mission M2C2** of the **Italian PNRR** (Piano Nazionale di Ripresa e Resilienza), this project will promote a sustainable approach to bridge management through the development of methods to increase their service life through the efficient management of information relevant to their performance. This will limit both waste creation and consumption of non-renewable resources that are associated with reconstruction projects. This objective will be achieved leveraging the potentialities connected with the digitalization of the bridge performance information management. Operation, maintenance, and repair of bridges currently is still largely based on outdated and underperforming methods such as visual inspections. Recent developments in the field of satellite Synthetic Aperture Radar (SAR) can provide the measurement of displacement to sub-centimeter accuracy with a convenient cost/benefit ratio compared to traditional topographic survey techniques. The efficient use of such

	digital technologies can greatly increase the efficiency of bridge maintenance management. In this perspective the outcome of this PhD project will also contribute to the **Mission M1C2 digitalization, innovation and competitiveness** of the sector of bridge management. Not least, the project will foster the development and acquisition of theoretical and applied knowledge in a field scarcely investigated for civil engineering infrastructures thereby supporting the achievement of **Mission M4C2: education, research and technological transfer** of the PNRR. The overarching objective of this research project is to establish how SAR information can be used to manage the maintenance of a network of bridges. More detailed objectives of the project are: 1. to provide a method to extract information scour settlements from satellite radar measurements; 2. to use this information to update a model of the bridge network; 3. to use the model of the network to support decisions relevant to its operation and maintenance. The topic of the project is highly **interdisciplinary** involving topics related to structural, hydraulic, and geomatic engineering for bridge management. The collaboration with the industrial partner (TRE Altamira) will provide an **intersectoral** profile to the research that will facilitate both the technological transfer of the research outcomes and the cross-sectoral training of the PhD student.
Methods and techniques that will be developed and used to carry out the research	The objectives outlined in the previous section will be achieved through the following steps: • development of a probabilistic model of a bridge over a waterway. As an exemplary case one of the bridges monitored by PoliMi in the context of a joint project between PoliMI and Regione Lombardia (dented as ¿RL project¿ in the following) will be used; • a damage detection algorithm based on Bayesian updating of the bridge model based on displacement

	data retrieved from SAR images will be developed; • the algorithm will be validated on bridges monitored by local systems in the context of the RL project; • the algorithm previously developed will be integrated in a Bayesian probabilistic network (BPN) modeling the performance of a bridge network; • the BPN will be used to develop a decision support tool to identify priorities of interventions and support operational and maintenance decisions; • validation of the BPN on the bridges monitored in the context of the RL project. The development of the PhD thesis will be supported by the collaborations with: **1.a leading company i**n the sector of satellite monitoring (**TRE ALTAMIRA**) https://site.tre-altamira.com/; 2.prof. Michael Havbro Faber at Aalborg University, Denmark, a research excellence in the field of probabilistic modelling and bayesian decision analysis. The PhD student will spend a period of 6 months at Aalborg University.
Educational objectives	The Candidate will acquire expertise in remote satellite monitoring, scour detection, bridge and information probabilistic modelling, methods based on bayesian updating and Bayesian Probabilistic Networks (BPN). Besides this, it is expected that the candidate will develop a publication record in recognized international journals and conferences and transversal skills related to communication and project management.
Job opportunities	The candidate will have wide employment possibilities in academia, R&D departments of companies in private or public bodies owning or managing structures and infrastructures (buildings, bridges, pipelines for oil and gas, water, waste-water, etc.). The expertise in the efficient use of remote sensors will make the PhD candidate a first choice for the market related to the Smartcity vision.

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Composition of the research group	1 Full Professors 1 Associated Professors 0 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Maria Pina Limongelli

Contacts
Prof. Maria Pina Limongelli email: *mariagiuseppina.limongelli@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	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)	Aalborg University, Danimarca
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Additional information can be found in the Regulations for the 37th Cycle of ABC-PhD:
download is available at link:
https://beep.metid.polimi.it/web/abcphd/documenti-e-media

Additional information about ABC department and ABC-PhD programme:
available at link:
https://www.dabc.polimi.it/

Additional support for the research activity:
a total amount of 5.197,62 Euros per student, available since the first year, to be spent according to the department rules.

Study period abroad:

a period of 6 months of study and research at *Aalborg University (Danemark)* is mandatory, preferably during the 1st and/or 2nd year.

Internship in a company:
an internship in TRE ALTAMIRA company (preferably in the 1st - 2nd year) is scheduled.

Desk availability:
the ABC department provides non-permanent desks to be temporarily booked in common PhD rooms.