



PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 38th cycle

THEMATIC Research Field: SAFETY ASSESSMENT OF DISPOSAL FACILITIES FOR LOW LEVEL RADIOACTIVE WASTE: TOWARDS DIGITAL TWINS OF THE CONCRETE BARRIERS, INTEGRATING MULTIPHYSICS SIMULATIONS AND SENSOR NETWORKS

Monthly net income of PhDscholarship (max 36 months)

€ 1195.5

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 project, titled "Safety assessment of disposal facilities for low level radioactive waste", concerns the topic "Industry 4.0" and several priorities of the National Strategy (in particular, Smart and sustainable Industry, Energy and environment, 5.4.2). With reference to cementitious materials utilized inside the near-surface, "temporary" disposal facilities (i.e. for the storage up to 300 years), including low and very low activity radioactive wastes (LLW e VLLW according to the IAEA classification), the research will consist of the following activity: (i) specify and simulate the most important chemical-physical processes, which, together with the mechanical loading, may affect the concrete durability and functionalities (such as, for instance, sulfate attack, cracking phenomena etc.), when it is directly in contact with the stabilized wastes or where it serves as a second and third barrier; (ii) correlate such local deterioration processes with the overall response of the structural elements, not only in terms of elastic stiffness and strength, but also considering permeability and leaching tendency; (iii) develop nondestructive experiments, compatible with the limited mobility and inspectability of such structural elements, allowing for an accurate characterization of the wastes in the initial conditions and along time; iv) integrate the multiphysical predictions,



	<p>suitably simplified and reformulated in an adaptive manner through "machine learning" techniques, with a sensor networks for an effective monitoring activity along time, in view of the design of digital twins.</p> <p>In this research a part of experimental assessment is included, at Politecnico di Milano, in the involved industrial company and/or at other qualified institutions.</p>
Methods and techniques that will be developed and used to carry out the research	<p>The core of the project is the development of advanced tools to simulate the most common chemical-physical processes, which, together with the mechanical loading, may affect the durability and functionalities of the cementitious materials utilized for the waste disposal facility. Such tools will be based on a finite element discretization of the involved multi-physical fields (displacement, temperature, chemical species content, etc), enriched by multiscale approaches and homogenization techniques. The expected results will consist of improved predictions at a structural level, suitably simplified and readapted according to machine learning strategies, to allow for long time monitoring, coupling with a sensor network and the design of digital twins.</p> <p>In this research also experimental activities are planned, concerning samples affected by chemical-physical deterioration, subjected to both laboratory and in situ mechanical tests and monitoring activity.</p>
Educational objectives	<p>The project activities involving several subjects at an international level will favour in the candidate the development of a huge expertise for the research and development of computational and experimental methodologies within a multiphysical environment, oriented to the durability of cementitious materials and to the safety of radioactive waste disposal facilities, with a special sensitivity for the chemical-physical deterioration, monitoring activities by sensor networks and the design of digital twins.</p>



Job opportunities	The collaboration with an Italian company, extremely active as a provider of structural and infrastructural services, and with a research center abroad, will put the candidate in contact with the international community oriented both to research and to the development of large facilities, and with the clients to which such products are provided, namely the private and public entities promoting services for the radioactive waste storage.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Prof. Eng. Roberto Fedele

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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	597.76 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>The PhD position is funded by the Italian National Social Security Institution (INPS): the candidate must be an Italian citizen and must satisfy peculiar requirements. Please check carefully such requirements before applying.</p> <p>The candidate will be provided of a desk and a personal pc required for his/her work. He/she will interact with the community of PhD students active in the same Department for fruitful help and exchange at a personal and scientific level. Numerous educational activity are organized at Politecnico di Milano and offered in particular to PhD students, of which only a few are mandatory.</p>



Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.