



PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 39th cycle

**PNRR 118 PNRR Research Field: GREEN TRANSITION BY IMPLEMENTING SUSTAINABLE
TECHNICAL SOLUTIONS IN EARTH EMBANKMENTS**

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	<p>Natural aging of earth embankments built as transportation or hydraulic infrastructure has been accelerated in recent years due to increased animal burrowing activity as well as increasingly severe and frequent climate events. Both contribute to the deterioration of structures due to degradation and erosion mechanisms that are yet poorly understood and controlled. The current practice in earth embankment strengthening consists of environmentally impactful injections of bentonite-cement mixtures, unless a total removal and reconstruction of the damaged portion is required, which has a rather high CO₂ emission cost. The research intends to respond to the need for earth embankment retrofitting by developing circular economy solutions that combine the benefits of using low-impact materials and techniques and converting otherwise unusable industrial wastes.</p> <p>Textile waste is being investigated because, when mixed with soil, textile fibres can improve specific aspects of the soil performance. Tailored fibre-soil mixtures and treatments could be designed to improve mechanical resistance, to contrast internal or surface erosion, and to enhance water retention and conductivity capability.</p> <p>The research adheres to the United Nations Sustainable Development Goals SDG 12 (Responsible consumption and production) and SDG 13 (Climate action) as well as</p>



	<p>the objectives of the Italian National Recovery and Resilience Plan (PNRR - Piano Nazionale di Ripresa e Resilienza), which devoted Mission M2C1.1 on waste management and circular economy and Mission M2C4.2 to climate change effect mitigation on the territory. The research aims to address sustainability challenges in construction and rehabilitation by leveraging waste materials in earth embankment construction and strengthening.</p> <p>By aligning with principles of waste reduction, circular economy, and sustainable construction, this research has the potential to contribute to a greener and more environmentally conscious approach to critical infrastructure maintenance and development.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>To achieve the dual goal of counteracting embankment aging and deterioration using low-impact solutions and valorising textile waste in a circular economy process, the project will establish methods and processes following the phases:</p> <ol style="list-style-type: none"> 1. definition of the tailored fibre-soil mixture, based on laboratory analysis of the influence of textile fibres on mechanical (strength and compressibility) and hydraulic (permeability, water retention and erodibility) properties; 2. definition of a model of the mixture's behaviour and interaction with the earthworks, based on numerical simulation of laboratory tests on a small and medium scale; 3. prediction of real-scale behaviour based on numerical simulation and on-site application in test fields.
<p>Educational objectives</p>	<p>The candidate will gain knowledge of design of non-conventional testing and monitoring, across different scales, as well as analytical and numerical advanced modelling.</p> <p>She/he will maintain contacts with manufacturing industries, allowing for fruitful collaboration in waste material selection and identification of their physical and chemical properties. She/he will establish contacts with public regional agencies in charge of waste management and hydraulic works maintenance and renovation.</p> <p>The candidate will participate in the PhD educational</p>



	program and will improve the educational skills by participating as teaching assistant in BSc and MSc courses of relevance.
Job opportunities	The research advances theoretical, experimental and numerical knowledge towards solutions that will be applicable and effective in practice. As a result, the PhD title will open up numerous opportunities for academic careers as well as professional careers in engineering design, consulting, and management, with a greater awareness of waste material recycling and infrastructure sustainability.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Donatella Sterpi

Contacts	
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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	597.75 €
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)	To be defined
By number of months abroad	6

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

Computer availability and desk availability: Each Ph.D. student has his/her own computer for individual use. Each Ph.D. student has his/her own desk, cabinet and locker.