PhD Program in Civil, Chemical and Environmental Engineering
May 2022 Call, XXXVIII cycle - Starting date: November 1 st 2022

Industrial Projects

The research projects submitted for the admission to the PhD program must be prepared in accordance to one of the projects listed below. Click on the Thematic you are interested in to see details about the project, the company supporting the project and the reference professor to contact.

Development of innovative metallic monolithic reactors for CO2 capture and conversion processes

Devising novel bio-based methods to stabilise problematic soils: application to infrastructure earthworks

Industrial application-driven research towards the Digital European Sky

Innovative methods & models for the seismic vulnerability assessment of existing masonry buildings

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Curriculum in Chemical, Materials and Process Engineering

Project: Development of innovative metallic monolithic reactors for CO2 capture and conversion processes

Keywords: CO_2, e-fuels, CO_2 utilization, chemical reaction engineering, catalysis.

Brief Description:
This PhD project, in collaboration with Nuovo Pignone Tecnologie Srl, aims at the development and characterization of coatings that can be used in the production of innovative reactors for CO_2 capture and catalytic conversion processes. The study will focus on the production of metal monolithic reactors with catalytic surface coating in collaboration with the company, and on the experimental evaluation of their use in the adsorption and catalytic conversion of CO_2. In addition, the understanding of the reaction mechanisms and the chemistry of the surfaces of these coatings will be deepened, in order to develop the engineering of the materials themselves and of the reactors.

Referent: Prof. Gabriella Garbarino, gabriella.garbarino@unige.it

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Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Project: Devising novel bio-based methods to stabilise problematic soils: application to infrastructure earthworks

Keywords: sulphate-rich soils; mechanical behaviour; soil-water retention; bio-stabilisation methods; multi-scale characterisation.

Brief Description:

Earthworks (e.g. embankments, cuttings, dams) play a fundamental role in the functioning of critical infrastructure systems, including water and transport networks. However, the serviceability and safety of earthworks is severely compromised by the weak resistance of soils against the weathering action of water. This is especially problematic for soils with a high sulphate content that can undergo large changes in volume with moisture variations due to their high affinity to water. The issue has been exacerbated by climate change over the past few decades with prolonged droughts followed by increasingly more intense rainfall events. Commonly, geotechnical engineers resort to cement-based stabilisation to enhance the mechanical behaviour of soils and to reduce their sensitivity to water infiltration. However, this stabilisation technique exhibits several drawbacks such as (a) significant environmental impact, considering that the production of one tonne of cement emits about 0.7-1.1 tonne of carbon dioxide and consumes about 5 GJ of primary energy; (b) the need to use specific aggregates that are progressively harder to source, thus leading to depletion of natural resources and degradation of landscapes and (c) vulnerability of cement stabilisation to chemical attacks by sulphates in the ground. It is therefore paramount that we develop alternative soil stabilisation techniques for sulphate-rich soils, with a reduced environmental impact and better hydromechanical performance, compared with those of conventional cement-based stabilisations.

For this purpose, the present doctoral project, between the University of Genoa (Italy) and Envirosoil Remediation Limited (United Kingdom), will devise novel bio-based stabilisation methods to improve the hydromechanical behaviour of problematic sulphate-rich soils. The proposed methods will be based on the bio-polymerisation of soils or on the precipitation of binding agents (e.g. calcium carbonate) triggered by enzymatic activity. The stabilisation methods will aim at reducing the compressibility and the permeability of the soil while improving their shear resistance. The project will implement the proposed stabilisation methods at two different scales: at the representative elemental volume (laboratory testing to be conducted at the University of Genoa) and field implementations, which will be carried out on sites selected by the company Envirosoil (Remediation) Limited. The PhD candidate will work under the joint supervision of Dr Agostino Walter Bruno and Pr Domenico Gallipoli (University of Genoa) and Adrian de Paoli (Envirosoil (Remediation) Limited).

Referent: Prof. Agostino Walter Bruno, agostinowalter.bruno@unige.it

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Curriculum in Fluid Dynamics and Environmental Engineering

Project: Industrial application-driven research towards the Digital European Sky

Keywords: U-Space, Geomatics, geospatial data analysis, drone, photogrammetry, planning, accuracy

Brief Description:
This PhD project, in collaboration with GeoDataLab Srls, aims to develop industrial application-driven research towards the Digital European Sky.
The candidate will be expected to study and keep constantly aligned in terms of exploratory and industrial research directed at the implementation of the so-called 'Digital European Sky', more specifically in the U-Space area. Specific contributions to the research will be provided both in terms of concrete development of services and demonstration platforms in the U-Space sphere aimed at analysing and validating the scenarios proposed in the European sphere, and in terms of integrations with existing software or plug-ins, such as the U.Ph.O. application developed by the Geomatics Laboratory of the DICCA, University of Genoa, in the sphere of 3D photogrammetric survey accuracy. Finally, the candidate will develop specific analyses aimed at answering the open research points already identified in the first exploratory surveys.
The candidate should have a background in Geomatics and Geospatial Technologies, and experience in programming and spatial data analysis. The candidate should show particular attitude to learning new programming languages. Previous study abroad is also welcome.

Referent: Prof. Domenico Sguerso, domenico.sguerso@unige.it

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National PhD program in Defence against natural risks and ecological transition of built environment

(contact lugi.gambarotta@unige.it or roberta.massabo@unige.it to have more info on how to apply to this program)

Project: Innovative methods & models for the seismic vulnerability assessment of existing masonry buildings

Keywords: Masonry building, finite element models, model synthesis, high performance shell element.

Brief Description:
The seismic assessment of masonry buildings in Italy still is a crucial problem due the remarkable existing buildings patrimony. Several approaches for the evaluation of the masonry buildings to seismic actions have been developed in the last decades which may be classified with reference to the scale of description of the mechanical behavior of the masonry panels: FEM 3D solid models, "frame type models" and macro-element models.
It is largely recognized that 3D solid models (based on solid finite elements like tetrahedron etc.), which could be preferred when carrying out detailed analyses or when analysing masonry walls with irregular shapes, on the other side they may be excessively detailed and computationally burdensome to be applied in a professional engineering context.
Synthetic numerical models with reduced degrees of freedom and simplified constitutive descriptions are appealing, although the mechanical synthesis should be well calibrated in order to catch the more remarkable damage and plasticity dissipative mechanisms. To this aim, the present research project is focused to the formulation and extension of a new nonlinear finite element, based on a mixed Hellinger-Reissner high performance shell including plastic and damage inelasticity. This shell element should be characterized by high accuracy with coarse meshes in order to describe the mechanical response of masonry walls with few elements (the optimal goal should be one element for each panel making up the masonry wall). The goal is to achieve synthetic and high performant computational models, which is a fundamental requirement for the development of assessment procedures applied to a large population of sample buildings, whose generation is derived from a limited set of experimental or statistical data, aimed to the territorial vulnerability assessment.

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