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

The research projects submitted for the admission to the PhD program must be prepared in accordance to one of the projects listed in this file, which are organized by curriculum and general thematic. Click on the Thematic you are interested in to see the full list of projects.

Curriculum in Chemical, Materials and Process Engineering

Chemical processes with reduced environmental impact
Plants and bioprocesses
Materials engineering
Sustainability of products

Curriculum in Fluid Dynamics and Environmental Engineering

Environmental Fluid Dynamics and Morphodynamics
Hydrology and water resources management
Biological fluid dynamics
Geomatics

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Structural Engineering and Mechanics
Mechanics of Materials
Geotechnical Engineering

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@unige.it

Curriculum in Chemical, Materials and Process Engineering

Chemical processes with reduced environmental impact

PROJECTS:

Project: Innovative extraction process for the recovery of bioactive molecules from agro-industrial waste
Project: From chemical reactors to geology: CFD modelling of multiphase systems with cohesive solids
Project: CO2 to use: catalytic processes design and investigation
Project: Molten carbonate cells for energy transition
Project: Valorisation of liquid and solid waste from the production of craft beer
Project: Plastic waste management routes to enhance circularity of the bioplastics value chain (CIRCVAL)

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Chemical, Materials and Process Engineering

Plants and bioprocesses

PROJECTS:

Project: Treatment of agro-industrial wastewaters using microalgae
Project: Carbon dioxide capture by cyanobacteria and microalgae using different photobioreactor configurations
Project: Anaerobic digestion of agro-industrial residues with a view to a zero-waste approach

CLICK HERE TO GO BACK

Curriculum in Chemical, Materials and Process Engineering

Materials engineering

PROJECTS:

Project: From chemical engineering to tissue engineering functionalization of small-diameter vascular prostheses with bioactive compounds
Project: Intelligent and active food packaging based on natural derived materials
Project: Micro and nanoencapsulation strategies for the stabilization of active principles
Project: Innovative engineered catalytic materials for green industrial chemistry
Project: Solid Oxide Cells for energy conversion systems

➡ **CLICK HERE TO GO BACK**

Curriculum in Chemical, Materials and Process Engineering

Sustainability of products

PROJECTS:

Project: Medium-low temperature pyrolysis of biomass to produce chemicals and biofuels
Project: Valorisation of liquid and solid waste from the production of craft beer
Project: Plastic waste management routes to enhance circularity of the bioplastics value chain (CIRCVAL)

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@unige.it

Curriculum in Fluid Dynamics and Environmental Engineering

Environmental Fluid Dynamics and Morphodynamics

PROJECTS:

Project: Present and future ocean storm conditions in the Mediterranean Sea, the contribution of sea waves and storm surge
Project: Mixing processes in the coastal zone, from observation to modelling
Project: Calibrated numerical weather prediction models for the green energy sources
Project: Long term morphodynamic evolution and equilibrium configurations of tidal environments
Project: Mitigation of slope erosion under solar photovoltaic (PV) plants

➡ **CLICK HERE TO GO BACK**

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Fluid Dynamics and Environmental Engineering

Hydrology and water resources management

PROJECTS:

Project: Fluid-dynamics aspects and hydrological consequences of precipitation measurement biases
Project: Modeling the performance of nature-based solutions (NBSs) for sustainable urban drainage
Project: AI-based calibrations of numerical weather forecasts for extreme precipitations
Project: The role of vegetation on urban climate and hydrology
Project: Short-duration rainfall event in actual and future climate scenarios
Project: Development of generalized methodologies for the statistical characterization of drought severity/intensity

➡ **CLICK HERE TO GO BACK**

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Fluid Dynamics and Environmental Engineering

Biological fluid dynamics

PROJECTS:

Project: Mathematical modelling of water transport across the corneal endothelium and corneal hydration
Project: Ocular and brain biomechanics and their connection with glaucoma
Project: Virtual surgery of the human nose via computational fluid dynamics

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Fluid Dynamics and Environmental Engineering

Geomatics

PROJECTS:

Project: Ocean color remote sensing for shallow water hydrographic mapping
Project: GNSS for meteorology

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@unige.it

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Structural Engineering and Mechanics

PROJECTS:

Project: Optimized use of phase change materials for energy and seismic retrofitting in existing structures
Project: Computational mesoscale design of highly porous PCM-enhanced cementitious materials with DIODIC properties
Project: Equivalent frame idealization of masonry buildings for the seismic assessment and retrofitting and implementation in the open-source software framework OpenSees
Project: Probabilistic characterization of human-induced loading for vibration serviceability assessment of lightweight structures
Project: Nonstationary dynamic response of structures to thunderstorm outflows
Project: Damage mitigation in sandwich composites for structural applications
Project: Analysis of non-stationary wind loading effects through experimental investigations in a conventional wind tunnel facility
Project: Dynamic integrated monitoring of flexible structures and infrastructures using traditional sensors and Digital Image Techniques

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Mechanics of Materials

PROJECTS:

Project: Mechanical metamaterials for extreme engineering functionalities
Project: Conception, modelization, analysis and optimization of avant-garde architected materials
Project: Peridynamic models for real world Multiphysics
Project: Reusable materials for mechanical energy absorption

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@unige.it

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Geotechnical Engineering

PROJECTS:

Project: Assessing the Resilience of infrastructure Earthworks subjected to extreme rainfall events: an advanced Unsaturated Soil mechanics approach (AREUS)
Project: Recycling concrete to manufacture compressed earth eco-bricks
Project: MATER: Materiali Alternativi in Terra per l'Edilizia Residenziale
Project: PILATUS: PIles under LATeral Loading in Unsaturated Soils

CLICK HERE TO GO BACK

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Curriculum in Chemical, Materials and Process Engineering

Chemical processes with reduced environmental impact

Project: Innovative extraction process for the recovery of bioactive molecules from agro-industrial waste

Keywords: solvent power, green solvent, bioactives, process optimization, food-waste valorization

Brief Description:
Large amounts of food waste are produced each year. These residues require appropriate management to reduce their environmental impact and, at the same time, economic loss. However, these waste are still rich in compounds (e.g., colorants, antioxidants, polyphenols, fatty acids, vitamins, and proteins) that can find potential applications in food, pharmaceutical, and cosmetic industries. Conventional extraction techniques suffer some drawbacks when applied to the exploitation of food residues, including large amounts of polluting solvents, increased time of extraction, possible degradation of the active molecules during extraction, low yields, and reduced extraction selectivity. For these reasons, advanced extraction techniques need to be developed in order to obtain efficient residue exploitation using more sustainable processes, with a reduced use of toxic solvents, reduced extraction time, high selectivity, and the possibility to recover the extract at high purity. In this project of research, the optimization of different extraction techniques such as high pressure and high temperature extraction, ultrasounds assisted extraction, microwave assisted extraction will be developed for the recovery of high added value compounds from waste generated in food industries such as olive-oil industry, wine industry, fresh vegetables and fruits residues etc. Furthermore, the possibility of combined multi-stage extractions, as well as economic and environmental aspects, will be performed in order to provide a complete study about the topic.

Referent: Prof.ssa Patrizia Perego, p.perego@unige.it

➡ CLICK HERE TO GO BACK

Project: From chemical reactors to geology: CFD modelling of multiphase systems with cohesive solids

Keywords: computational fluid dynamics, cohesivity, multiphase systems, fluid-solid momentum exchange, granular materials

Brief Description:
Granular materials are of the utmost importance in diverse sectors of the chemical industry. Due to the natural presence of voidage among particles, the unit operations that handle them always involve one or more fluids as well. Performing reliable and accurate simulations of such multiphase systems has been the aim of researchers for a few decades, and good results have been achieved for the simplest cases. However, the more complex the involved phenomena are, the more gaps can be currently detected in the literature. In this framework, the modelling of such systems with cohesive solids is an aspect that has received little attention, in spite of its ubiquity.
This project aims at proposing and testing various approaches to model systems with cohesive soldis through computational fluid dynamics (CFD) simulations. First, a detailed analysis of the literature will be performed, to identify the existing methodologies and modelling approaches. Then, the simulation activity will follow a multiscale approach, starting from the particle scale and analysing the flow field in great detail, with the final aim of simulating processes on the industrial scale, with the due simplifications and assumptions. The data for the simulations will be selected from the literature or produced *ad hoc*, possibly through collaborations with other research entities and depending on the needs.
Since the involved phenomena can be encountered in various fields, both in the initial literature survey and in the final large-scale applications diverse applications will be taken into account. In particular, geotechnical applications may be well suited to provide useful insights and benefit from a versatile and robust approach to simulate the behaviour of fluid-solid cohesive systems.

Referent: Prof. Renzo Di Felice, renzo.difelice@unige.it

➡ CLICK HERE TO GO BACK

Project: CO_2 to use: catalytic processes design and investigation

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

Brief Description:
CO_2 use is coming as one of the key-challenges for the next future and the development of new technologies and processes is pivotal to achieve sustainable development goals, set out by united Nations, and achieve carbon neutrality by 2050. The PhD project here proposed will be focused on catalysis and chemical reaction engineering in the development of new processes for this application by aiming at the reduction of environmental impact and by possibly outlining new technological solutions and by looking at the process, reaction mechanism of chosen reactions and kinetics. The present project will be addressed by an experimental point of view.

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

➡ CLICK HERE TO GO BACK

Project: Molten carbonate cells for energy transition

Keywords: Carbon dioxide capture, hydrogen, clean energy, fuel cells, electrolysis

Brief Description:
Molten Carbonate Fuel Cells (MCFCs) have traditionally been used for the production of clean energy. However, more recently, MCFCs have also been investigated as carbon capture devices for application in stationary power plants and maritime mobility. Compared to other carbon capture technologies, MCFCs not only allow the treatment of exhaust gases, but simultaneously produce electricity, residual hydrogen and heat. In addition, MCFCs can function reversibly as electrolysers, in a "power to gas" mode that can be useful for the storage of renewable energy. Thanks to this possibility of multiple applications, MCFCs are emerging as a strategic and very promising solution in the scenario of the energy transition, but still require a strong research effort in terms of electro-chemical-physical phenomena understanding as well as technological optimization. The proposed PhD activity will be part of a broader and more ambitious project which envisages the collaboration of qualified European scientific and industrial partners for the development of an effective and competitive MCFC technology. A multiscale approach will be followed pairing simulation activities with experimental tests to set up detailed theoretical models validated through appropriate data. The codes obtained will be used as diagnostic, design, control and investigation tools. The experimental activity will instead be hosted in the new CAPLAB laboratory, located in Genoa and shared between the DICCA department and the Ecospray Technologies company, which collaborates on the project in a scale-up perspective.

Referent: Prof.ssa Barbara Bosio, barbara.bosio@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Valorisation of liquid and solid waste from the production of craft beer

Keywords: exhausted malt, hops, energy, water treatment, circular economy

Brief Description:
The brewing industry constitute an important economic segment of any country, with beer being the fifth most consumed beverage in the world behind tea, carbonates, milk and coffee. The production of craft beer generates a large quantity of residues as water effluents and solid exhausted materials (malts, hops and yeasts). The valorisation of this waste could help in maximising the profits, the production yield and the energy efficiency of the process.
It is estimated that for the production of 1 L of beer, 3–10 L of waste effluent is generated depending on the production and specific water usage. It must also be noted that effluents from individual process steps are variable. For example, bottle washing results in a large wastewater volume, but it contains only a minor part of the total organics discharged from the brewery processes. On the other hand, effluents from fermentation and filtering are high in organics/biochemical oxygen demand (BOD), but generally low in volume, accounting for about 3% of the total wastewater volume but 97% of the BOD.
Also, spent grains, rich in cellulose, hemicellulose and lignin, contribute up to 85% of the waste residue for most brewing facilities and therefore the potential for spent grain as a value-added product is essential to address to ensure an economic and ecologically successful operation.
In this context, the objective of this thesis will be to assess, evaluate and apply the most efficient valorisation techniques for the exhausted solid materials and apply them inside the brewing process, either for water treatment or energy obtainment, constituting an example of a circular economy strategy.

Referents: Prof.ssa Elisabetta Arato, elisabetta.arato@unige.it
& Prof.ssa Cristina Moliner, cristina.moliner@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Plastic waste management routes to enhance circularity of the bioplastics value chain (CIRCVAL)

Keywords: bioplastics; plastic waste management; mechanical recycling; chemical recycling; energy recycling.

Brief description:
The general aim of CIRCVAL is to explore plastic waste management routes to enhance circularity of the bioplastics value chain, particularly foreseeing the eventual inclusion in the actual waste routes, and therefore mixing with plastic commodities. In particular, three routes (i.e., mechanical, chemical and energy recycling) will be studied, for most representative bioplastics (PLA, PHAs), and their combinations with current most present plastic waste, PET.
The specific technological objectives (STO) are:

- STO1: To develop chemical recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO2: To develop mechanical recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO3: To develop thermal recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO4: To develop combinations of mechanical, chemical and thermal recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.

This research could be performed in international collaboration together with the RDT group in Materials Technology and Sustainability of the Department of Chemical Engineering of the University of Valencia, Spain.

Referent: Prof.ssa Elisabetta Arato, elisabetta.arato@unige.it

➡ **CLICK HERE TO GO BACK**

Curriculum in Chemical, Materials and Process Engineering

Plants and bioprocesses

Project: Treatment of agro-industrial wastewaters using microalgae

Keywords: photobioreactors, new plant development, microalgal biomass exploitation, lipid recovery.

Brief Description:
The increasing of urbanization and industrialization leads to the production of large quantities of wastewater around the world. Part of this waste can be exploited for the growth of microalgae, reducing their cultivation costs, and making chemicals recovery and biofuel production more feasible.
Using the mixotrophic metabolism, microalgae are able to absorb and use many of the organic molecules contained in wastewater, reducing its polluting load, leading to the production of additional microalgal biomass and to the purification of the water used.
After the growth, the microalgae biomass can be collected and used for the production of biofuels and for the recovery of chemicals of interest.
Batch and continuous microalgal growth systems are available in the laboratory of the research group. By means of these plants, wastewater (e.g.: olive mill and winery wastewaters, landfill leachate, sewage wastewaters, etc.) will be micro-phytotrophically treated and then analysed.
An *ad hoc* plant for the growth and the collection of microalgae in wastewaters will be studied and tested, reaching the goal to work in a full continuous mode. A pumping system, operating with variable flow rates, will be carefully developed to make the device less energy intensive and to reduce the hydraulic retention time. Downstream of the cultivation system, a plant will be designed for microalgal biomass settling, and the microalgal biomass will be collected using new methodologies, such as electro-coagulation.

Referent: Prof. Alessandro Alberto Casazza, alessandro.casazza@unige.it

→ CLICK HERE TO GO BACK

Project: Carbon dioxide capture by cyanobacteria and microalgae using different photobioreactor configurations

Keywords: Carbon dioxide, capture, cyanobacteria, microalgae, photobioreator,

Brief Description:
As is known, microalgae and cyanobacteria, under autotrophic conditions, are able to grow using carbon dioxide as the only carbon source and solar light as energy source. This ability will be exploited for CO2 capture from atmospheric emissions, to carry out bioenergetic studies of autotrophic metabolism and to test the performance of different types of bench-scale photobioreactors (open ponds, vertical and horizontal tubular photobioreactors, and helicoidal and column photobioreactors). Several photobioreactors will be tested with these configurations, having different volumes and areas of exposure to light radiation. In the CO2 capture tests from emissions will be studied, as the main parameters, the photoperiod (light-dark alternation), the photosynthetic photon flux density, the exposed area/volume ratio, the flowrate of the incoming gaseous stream and the concentration of CO2 in the air. A combined system of growth and non-destructive extraction of the lipid fraction of the Chlorella vulgaris microalga will also be investigated, with the aim of continuously producing biodiesel with no need to replace the exhausted biomass.

Referent: Prof. Attilio Converti, converti@unige.it

CLICK HERE TO GO BACK

Project: Anaerobic digestion of agro-industrial residues with a view to a zero-waste approach

Keywords: Agro-industrial waste, zero-waste approach, anaerobic digestion, biogas, microalgae

Brief Description:
This project concerns the application of anaerobic digestion to recover energy from agro-industrial residues. Olive pomace from olive oil production will first be dried to stabilize it and later diluted in water and treated in a 7-liter bench-scale digestor equipped with an agitation and temperature control system. Two different research topics will concern biogas upgrading in biomethane and digestate reuse. In the first case, the produced biogas will be conveyed to a photobioreactor in which a microalga will be cultivated autotrophically using the biogas CO2 as the only carbon source. As a result, biogas will be converted to biomethane with percentage higher than 90%. The second approach will take advantage of the ability of microalgae to grow under mixotrophic conditions in the presence of organic carbon source such as the contaminants still present in the digestate. In this case, the digestate produced in the first step will be treated in the photobioreactor in fed-batch mode in order to significantly reduce its chemical oxygen demand demand (COD). It is aimed, with the combination of the two approaches, to transform an agro-industrial residue such as olive pomace (or other similar residues) exclusively in biomethane and microalgal biomass to be used as a biofuel and as a raw material for biodiesel production, respectively, thus pursuing the zero-waste goal.

Referent: Prof. Attilio Converti, converti@unige.it

CLICK HERE TO GO BACK

Curriculum in Chemical, Materials and Process Engineering

Materials engineering

Project: From chemical engineering to tissue engineering functionalization of small-diameter vascular prostheses with bioactive compounds

Keywords: tissue engineering, biomaterials, cardiovascular prosthesis, drug delivery, tissue regeneration

Brief Description:
The synthesis of biodegradable small vascular prostheses able to interact with cells and with the surrounding extracellular matrix is still a challenge. The post-implant inflammation represents one of the main drawbacks influencing the success of the implantation after surgery. The functionalization of biomaterials with antioxidants could modulate the local inflammation after the surgical implant while the incorporation of nanoparticles loaded with specific proteins could be essential for the recruitment and the differentiation of the cells during the regeneration phase. Antioxidants represent a heterogeneous family of bioactive compounds that exert a role in modulating the inflammation and in preventing different diseases such as cancer, cardiovascular and degenerative pathologies. Therefore, the aim of this project is the fabrication of electrospun small diameter vascular prostheses functionalized with natural molecules with antioxidant and anti-inflammatory activity, and with nanoparticles loaded with therapeutic proteins. The production protocol will be optimized and the produced scaffolds will be validated with in vitro using a bioreactor and with in vivo models.

Referent: Prof.ssa Patrizia Perego, p.perego@unige.it

➡ **CLICK HERE TO GO BACK**

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Project: Intelligent and active food packaging based on natural derived materials

Keywords: antimicrobial, antioxidant, biopolymers, electrospinning, solvent casting

Brief Description:

The innovation in the concept of food packaging lead to the introduction of innovative food packaging with smart and active functions which offer to deliver safer and high-quality food product. In particular, active packaging refers to the incorporation of active component into the package with the aim of maintaining or extending the product quality and shelf-life. The current interest of the scientific community is aimed at researching new biodegradable materials of natural origin according to a circular economy approach. A valid alternative to plastics can be represented by biodegradable polymers synthesized from bio-derived monomers. Therefore, the objective of the present research project is the development of innovative process for the production of biopolymer based component for food packaging. Furthermore, the incorporation of active ingredients into polymeric matrices will be attempted with the objective of conferring antioxidant and antimicrobial properties to the produced films. The general approach to the research will be the exploitation of natural resources using green processes for the production of innovative materials.

Referent: Prof.ssa Roberta Campardelli, roberta.campardelli@unige.it

➡ CLICK HERE TO GO BACK

Project: Micro and nanoencapsulation strategies for the stabilization of active principles

Keywords: microparticles, nanoparticles, emulsions, process optimization, drug delivery,

Brief Description:

Micro and nanoencapsulation techniques have generated in the recent years a great interest in the pharmaceutical and food sector. They demonstrate several advantages, such as the ability to encapsulate a wide variety of molecules, including vitamins, peptides, proteins, colorants, antioxidants, to control, tune and target drug release and to protect sensible compounds. Innovation in production processes of micro and nanoparticles is guided by the aim of reducing the process environmental impact and improving the overall process yields. Innovative strategies to scale down particles dimensions, control the particles size distribution, increase the encapsulation efficiency and control the release kinetics are objective of this project.

The research project will focus on:

- Selection of proper raw materials;
- Process optimization;
- Interpretation of main phenomena involved;
- Particles characterizations;
- Product validation.

Referent: Prof.ssa Roberta Campardelli, roberta.campardelli@unige.it

➡ CLICK HERE TO GO BACK

Project: Innovative engineered catalytic materials for green industrial chemistry

Keywords: catalysis, green chemistry, renewables, oxygenate compounds

Brief Description:
Industrial chemistry is seeking for new catalysts for the development of "green" processes arising from renewables and by maximizing renewable resources. In this frame, the production of green and bio-hydrogen, chemical commodities or pseudo-commodities is focusing the attention of scientific research by also addressing important challenges from material and reactor point of views. Together with H_2, the production of aldehydes, dienes, solvents, emulsifiers could be foreseen starting from renewables (biomass, bioethanol etc.) or by means of unconventional processes.
The present project has an experimental nature and will focus on the development and design of engineered materials and processes in the frame of green industrial chemistry by focusing on performances assessment, mechanism and kinetic investigations.

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

➡ **CLICK HERE TO GO BACK**

Project: Solid Oxide Cells for energy conversion systems

Keywords: solid oxide cells, electrochemistry, electroceramic materials, energy conversion

Brief Description:
To follow the roadmap dictated by National and European set-plans (50% reduction for CO2 emissions due to power production before 2050 and 32,5% increase in energy efficiency by 2030), is necessary the implementation of new environmentally-sustainable processes capable to integrate and manage the intermittency of renewable resources with the power demand from consumers. Solid Oxide Electrochemical technologies SOCs (fuel cells (SOFCs), electrolyzers (SOECs) are able to produce and store electricity with unparalleled efficiency and are recognized to have a key role in the creation of valuable power to X (X=gas, fuel, power) chains based on the use of renewables.
Recent studies indicated that dual ion conductors for SOCs can be conceived, however, several challenges remain open such as: the assessment of mechanical, thermal, chemical stability of the electrolyte phases, the comprehension of interfacial and superficial interactions and electrodes materials specifically designed for SOCs dual-ion electrolytes.
In this proposal experimental and theoretical approaches will work together for a deep understanding of the complex structure/mechanisms of the behind this technology with a view to addressing the above issues and modelling an innovative reversible SOC highly integrable with renewable resources and down-stream processes.

Referent: Prof. Marco Panizza, marco.panizza@unige.it
& Prof. Antonio Barbucci, barbucci@unige.it

➡ **CLICK HERE TO GO BACK**

Curriculum in Chemical, Materials and Process Engineering

Sustainability of products

Project: Medium-low temperature pyrolysis of biomass to produce chemicals and biofuels

Keywords: Thermal cracking, biomass characterization, exhausted biomass, biofuel production.

Brief Description:
In the last years, considerable efforts have been made to find new solutions for replacing fossil raw materials with renewable sources. The main reason behind these efforts lies in the need to reduce greenhouse gas emissions and in the production of non-fossil origin biofuels and chemical intermediates.
After the recovery of compounds of interest, microalgae and different types of biomasses can be further treated by pyrolysis at medium-low temperature (300-600 °C).
Indeed, the thermal cracking of macromolecules in the biomass can lead to the production of liquid and gaseous products. Depending on the operating conditions or on the kind of biomass used, such products can find application as alternative biofuels.
At the same time, the possibility of obtaining chemical intermediates of interest for the industrial sector will be investigated.
The topics of research will cover the study of different matrices to be tested, the evaluation and optimization of the pyrolysis conditions (temperature, time, etc.), the development of analytical methods for a complete characterization of the liquid, gaseous and solid products.
The possibility of obtaining new products from biomasses and exhausted biomasses fully places this activity in the trend of green chemistry.

Referent: Prof. Alessandro Alberto Casazza, alessandro.casazza@unige.it

➡ **CLICK HERE TO GO BACK**

Ph.D. Program in Civil, Chemical and Environmental Engineering
dottorato.dicca@unige.it
+39 010 3352303
Via Montallegro 1, 16145 Genova
Coordinator: roberta.massabo@.unige.it

Project: Valorisation of liquid and solid waste from the production of craft beer

Keywords: exhausted malt, hops, energy, water treatment, circular economy

Brief Description:

The brewing industry constitute an important economic segment of any country, with beer being the fifth most consumed beverage in the world behind tea, carbonates, milk and coffee. The production of craft beer generates a large quantity of residues as water effluents and solid exhausted materials (malts, hops and yeasts). The valorisation of this waste could help in maximising the profits, the production yield and the energy efficiency of the process.

It is estimated that for the production of 1 L of beer, 3–10 L of waste effluent is generated depending on the production and specific water usage. It must also be noted that effluents from individual process steps are variable. For example, bottle washing results in a large wastewater volume, but it contains only a minor part of the total organics discharged from the brewery processes. On the other hand, effluents from fermentation and filtering are high in organics/biochemical oxygen demand (BOD), but generally low in volume, accounting for about 3% of the total wastewater volume but 97% of the BOD.

Also, spent grains, rich in cellulose, hemicellulose and lignin, contribute up to 85% of the waste residue for most brewing facilities and therefore the potential for spent grain as a value-added product is essential to address to ensure an economic and ecologically successful operation.

In this context, the objective of this thesis will be to assess, evaluate and apply the most efficient valorisation techniques for the exhausted solid materials and apply them inside the brewing process, either for water treatment or energy obtainment, constituting an example of a circular economy strategy.

Referents: Prof.ssa Elisabetta Arato, elisabetta.arato@unige.it
& Prof.ssa Cristina Moliner, cristina.moliner@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Plastic waste management routes to enhance circularity of the bioplastics value chain (CIRCVAL)

Keywords: bioplastics; plastic waste management; mechanical recycling; chemical recycling; energy recycling.

Brief description:
The general aim of CIRCVAL is to explore plastic waste management routes to enhance circularity of the bioplastics value chain, particularly foreseeing the eventual inclusion in the actual waste routes, and therefore mixing with plastic commodities. In particular, three routes (i.e., mechanical, chemical and energy recycling) will be studied, for most representative bioplastics (PLA, PHAs), and their combinations with current most present plastic waste, PET.
The specific technological objectives (STO) are:

- STO1: To develop chemical recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO2: To develop mechanical recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO3: To develop thermal recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.
- STO4: To develop combinations of mechanical, chemical and thermal recycling routes to valorise wastes based on PLA, PHAs and mixtures with PET.

This research could be performed in international collaboration together with the RDT group in Materials Technology and Sustainability of the Department of Chemical Engineering of the University of Valencia, Spain.

Referent: Prof.ssa Elisabetta Arato, elisabetta.arato@unige.it

➡ **CLICK HERE TO GO BACK**

Curriculum in Fluid Dynamics and Environmental Engineering

Environmental Fluid Dynamics and Morphodynamics

Project: Present and future ocean storm conditions in the Mediterranean Sea, the contribution of sea waves and storm surge

Keywords: ocean waves, storm surge, coastal flooding, climate change, sea level

Brief Description:
Historically ocean storms have been identified mainly by the characteristics of sea waves such as wave height, wave period and wave direction. Duration and inter-arrival time are as well two important parameters that are analyzed when dealing with coastline management. In the last decade, anyway, in different part of the world and especially in Mediterranean Sea, ocean storm characteristics begun to change with respect to historical observations. In the present project the contribution of combined occurrence of sea wave storms and storm surge will be analyzed, investigating the eventual presence of clear trends in historical data, and developing coherent projection for the sea waves and storm surge level under the framework of the AR6 climate change projections. An extensive statistical analysis will be then carried out in order to uncover the expected future behavior of this phenomena that in the present days could be thought as a proxy for a daily condition in the next future.

Referent: Prof. Giovanni Besio, giovanni.besio@unige.it

➡ CLICK HERE TO GO BACK

Project: Mixing processes in the coastal zone, from observation to modelling

Keywords: coastal circulation, mixing, drifter, numerical models, dispersion

Brief Description:
The understanding and the knowledge of the main physical processes governing the dispersion mechanism in the coastal region is of fundamental importance for different application such as for the development of forecasts in the case of oil spill or for the supervision of search and rescue activities. Furthermore, the transport of nutrients and/or of fauna and flora in the larval state has significant effects on the biodiversity state of the ocean environment, on the food chain and finally on the fish stock wealth. The project has the main objective of developing knowledge and tools to describe the dispersion and mixing processes in the coastal zone especially in and close to harbor areas. The activity of the project will involve field measurements through drifters, numerically modelling through the implementation of high resolution models to be nested in the Mediterranean Forecast System and the implementation of a dedicated suite for the evaluation of different mixing characteristics based on lagrangian quantities.

Referent: Prof. Giovanni Besio, giovanni.besio@unige.it

➡ CLICK HERE TO GO BACK

Project: Calibrated numerical weather prediction models for the green energy sources

Keywords: Green Energy, Numerical Weather Prediction Models, AI-based calibration, Energy management

Brief Description:
Wind industry at global level has obtained in 2021 its best performance with a year-over-year growth of 53 % thus reaching a global cumulative wind power capacity up to 743 GW. This trend is expected to continue and before 2025 wind industry is expected to exceed 1 TW in global cumulative installations of onshore and offshore wind.
The growing importance of wind industry is accompanied by an increasing contribution of wind power in power systems (the so-called penetration), a fact calling for a new definition of a modern, more complex, concept of flexibility in power systems. Wind is indeed highly intermittent in space and in time and thus very challenging to predict.
In order to efficiently deal with the continuous increase of the wind power production, the issue on the accuracy of wind forecasts becomes of paramount importance. It is in this framework that the project operates by studying, testing and applying state-of-the-art AI-driven methods in concert with high-resolution Numerical Weather Prediction (NWP) models to provide predictions with unprecedented accuracy of all green sources (wind and solar) for the green industry.

Referent: Prof. Andrea Mazzino, andrea.mazzino@unige.it

CLICK HERE TO GO BACK

Project: Long term morphodynamic evolution and equilibrium configurations of tidal environments

Keywords: tides, sediment transport, bedforms, sea level rise, wetlands

Brief Description:
Tides, storms, rising sea level due to climate change and sediment availability are the main features governing the dynamics of tidal environments such as estuaries and lagoons. In particular, concerns about an increasing sea level and the related ability of tidal environments to maintain their intrinsic characteristics have deserved a considerable attention in the last years. One of the issues that this project aims to study is the stability of tidal bedforms and channel bifurcations under different environmental conditions by means of the formulation of proper process-based analytical and numerical models. Ecological implications, such as those related to the growth of halophytic vegetation at the channel boundary and the role of benthic biofilms on bed erosion, will be eventually included.

Referent: Prof.ssa Nicoletta Tambroni, nicoletta.tambroni@unige.it

CLICK HERE TO GO BACK

Project: Mitigation of slope erosion under solar photovoltaic (PV) plants

Keywords: slope erosion, sediment transport mechanics, wall turbulence, numerical fluid dynamics

Brief Description:
Motivation: The installation of large scale solar PV plants leads extended areas to be exposed to weathering and hillslopes to be eroded by water runoff even at modest steepness. Models of the water velocity and the shear stress acting on the hillslope surface are particularly sensitive to the roughness coefficients. Moreover, the erosion process is affected by environmental and climatic factors that are sharpened by the global climatic change. Roughness elements (surface protrusions) suitably arranged along the slope could significantly reduce the susceptibility of solar PV plants' sites to erosion and preserve the habitats. The reduction and the control of the runoff velocity would prevent environmental and economical disasters.
Objectives: The project is aimed at improving our knowledge on the effect of the arrangement, the shape and the size of roughness elements on the runoff properties (velocity, shear stress) in order to support the development of practical solutions to mitigate the soil erosion in solar PV plants.
Methodology: The candidate will use high-performance-computing (HPC) facilities to analyse big data by means of suitably developed parallel computing tools. The modelling is based on the results of micro-scale particle-resolved direct numerical simulations and of meso-scale large-eddy simulations.
International collaboration: A short research period at the Institue for Hydromechanics (IfH), Karlsruhe Institute of Technology (KIT, Germany) will allow the candidate to further improve her/his knowledge of numerical fluid dynamics and parallel computing.
Supporting company: ENEL Greenpower supports the research with field data and expertises.

Referent: Prof. Marco Mazzuoli, marco.mazzuoli@unige.it

➡ CLICK HERE TO GO BACK

Curriculum in Fluid Dynamics and Environmental Engineering

Hydrology and water resources management

Project: Fluid-dynamics aspects and hydrological consequences of precipitation measurement biases

Keywords: Precipitation, Measurement biases, Hydrological models, Adjustment, CFD

Brief Description:
Accurate and reliable precipitation measurements play a central role in various applications such as water resources management, flood forecasting, and climate studies. However, in-situ liquid (rainfall) and solid (snowfall) precipitation measurements experienced little conceptual innovation for many decades now. One of the most relevant recent progresses is the development of non-catching instruments (disdrometers) to measure, beyond the precipitation amount or intensity, the Particle Size Distribution (PSD) and fall velocity of each hydrometeor (raindrop, snowflake, hailstone) in flight through the sensing area.
Precipitation measurement biases of traditional rain gauges were extensively investigated in literature, and their correction was shown to require knowledge of the microphysical characteristics of precipitation, typically the PSD and fall velocity of hydrometeors. The use of such information allowed derivation of suitable adjustment curves to reduce the wind-induced bias of traditional precipitation measurements. PSD information are also useful in several applications. Windshields were also tested to compare the performance of shielded vs. unshielded devices.
The proposed research aims at investigating the propagation of precipitation measurement biases in various hydrological applications, starting from the statistical analysis of precipitation extremes, the climatological trends, and the periods of water scarcity (droughts). Also, the propagation of measurement biases through hydrological models at the various scales of the catchment dynamics (from the rapid response of small-scale catchments to the aggregation process of large size basins) will be addressed by means of numerical models and Monte Carlo techniques to quantify the impact of the proposed adjustments on the various fields of application.

Referent: Prof. Luca G. Lanza, luca.lanza@unige.it

➡ CLICK HERE TO GO BACK

Project: Modeling the performance of nature-based solutions (NBSs) for sustainable urban drainage

Keywords: Urban drainage, Green technologies, Nature-based solutions, Sustainability, Resilience

Brief Description:
Nature Based Solutions (NBSs) for sustainable urban drainage are based on green technologies to manage the formation of surface drainage, basically through the recovering of fundamental hydrological processes (interception, evapotranspiration, and infiltration) that are generally compromised or strongly limited in urban areas, with deriving critical conditions of the urban drainage systems, floodings and the pollution of receiving water bodies.
The proposed research aims at defining and quantifying suitable indicators of the hydrologic performance of NBSs and their effect in terms of the resilience of cities in the Mediterranean area, where the rainfall climatology is characterised by intense and short-duration events in between of even quite long dry periods. Among the NBSs, quite relevant is the role of green roofs in providing a high potential for the prevention of critical conditions through the reduction of floods flows in urban drainage systems. Various technical solutions are emerging, based on the use of urban green areas that – though increasingly adopted in recent years – still suffer from the lack of reliable and standardised performance indexes.
The research will use experimental and numerical methods for the assessment and simulation of the hydrologic performance of various technical solutions for sustainable urban drainage (including green roofs) on a dedicated laboratory testbed and/or monitored installations.
The project favours an approach that is open to innovation for companies operating in the "green" sector and is based on a close interchange framework between research and industry.

Referent: Prof. Luca G. Lanza, luca.lanza@unige.it

➡ CLICK HERE TO GO BACK

Project: AI-based calibrations of numerical weather forecasts for extreme precipitations

Keywords: Machine Learning, Numerical Weather Models, Extreme Events, Floods, Risk management

Brief Description:
Extreme precipitation events affecting coastal areas of Mediterranean basin are quite common in the period starting from the end of summer until late autumn. Such events may produce devastating floods and represent a major problem inasmuch affect areas that are very densely populated, especially considering the northern part of the Mediterranean basin.
The most severe episodes in these regions are often associated to very intense quasi-stationary V-shaped convective systems characterized by a limited spatial extension (e.g., a few kilometers) and extraordinary heavy precipitations. In the worst situations, these phenomena can heavily affect the same areas for several hours. Liguria region, because of the morphology of its territory, characterized by steep orography exposed to southerly moist flows from the Mediterranean Sea and by a great number of small catchment areas, is one of the most affected areas.
The importance of an accurate and detailed description of this kind of events and of gaining a deeper understanding of the mechanisms leading to such extreme phenomena appears fundamental in order, at least, to limit damages and casualties.
The present project proposes the synergistic use of powerful Machine Learning (ML) techniques with state-of-the-art Numerical Weather Prediction Models (NWPM) to increase the skill of weather forecasts in relation to extreme events.
In order to perform the comparison between simulated extreme events that affected Liguria region in the past ten years and AI-based forecasts, the WRF model will be used as a representative state-of-the-art meteorological model. Quantitative precipitation forecasts will be compared with observed data obtained from the Ligurian regional rain gauge network, composed of about 200 professional WMO-compliant stations.

Referent: Prof. Andrea Mazzino, andrea.mazzino@unige.it

➡ **CLICK HERE TO GO BACK**

Project: The role of vegetation on urban climate and hydrology

Keywords: actual evapotranspiration, nature-based solutions, vegetation models

Brief Description:
Among nature-based solutions, particular attention has been posed on the role of vegetation since vegetation plays a crucial role in the urban environment: promoting the evapotranspiration (ET) process, limiting the urban heat island effect, increasing biodiversity, and achieving aesthetic and recreational objectives. Evapotranspiration (ET) is a key process that affects the hydrological performance of nature-based solution. ET is a primary process responsible for restoration of the water holding capacity of green infrastructure after a storm event. In this framework, the main objective of the research is to assess the role of the actual ET in restoring the water holding capacity of vegetated systems and to define a suitable model of the actual ET for different vegetated system characterized by different vegetation typologies (roof vegetation, ground vegetation, and urban trees).
The research is essential to understand the role of vegetation in nature-based solutions including its interactions between the built environment and hydrology of urban areas.

Referent: Prof.ssa Anna Palla, anna.palla@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Short-duration rainfall event in actual and future climate scenarios

Keywords: sub-hourly extreme rainfall, IDF curves, climate change impact

Brief Description:
The characterization of high intensity and short-duration rainfall events is crucial in small-catchment the field of hydrology of small-catchment and in urban hydrology. However short-duration rainfall data are rarely available and generally the length of the sub-hourly data series is significantly lower with respect to the long-duration ones. The representativeness of these series is also reduced due to the spatial dimension of short-term events, which can be even lower than the density of the pluviometric network.
The aim of the present research is to investigate the transition in the scaling regime of rainfall from sub-daily to sub-hourly timescales in order to improve the capability of the Intensity Duration Frequency curves to provide reliable estimate of the short-duration design storm depth, exploring also methodologies to integrate the distributed information provided by meteorological radars.
Furthermore, in the framework of a climate adaptation approach the estimates of extreme rainfall intensities from sub-daily to sub-hourly timescales in future climate scenarios are needed to tackle the design of resilient urban drainage systems.
Finally explore options for combining gauge, radar data into gridded sub-daily products to add to existing merged products as a key resource for the climate modelling community to validate model outputs.

Referent: Prof.ssa Ilaria Gnecco, ilaria.gnecco@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Development of generalized methodologies for the statistical characterization of drought severity/intensity

Keywords: hydrological statistics, hydrological extremes, drought, SDF curves

Brief Description:
Drought events significantly impact the risk management of water resources systems and seriously affect several sectors leading to stress in agro-ecosystems and water scarcity. Given the ongoing climate change, the assessment of expected changes in the frequency and duration of future drought is crucial to increase readiness through proactive solutions. Drought risk assessment based on probabilistic approaches is essential to properly implement effective risk mitigation policies. Several statistical methods are proposed in the literature, considering different intensity indices able to capture various drought mechanisms. This research proposal aims to develop a generalized methodology to evaluate current and future drought probability, to be compared and integrated with other current statical approaches used for other hydroclimatic extremes such as extreme rainfall. Indeed, given the expected increase in both flood and drought hazards and the interconnected nature of both hydroclimatic extremes, the research proposal tries to meet the growing need for integrated and holistic multi-hazard Disaster Risk Reduction (DRR) approaches.

Referents: Prof.ssa Silvia De Angeli, silvia.deangeli@unige.it
& Prof. Giorgio Boni, giorgio.boni@unige.it

➡ **CLICK HERE TO GO BACK**

Curriculum in Fluid Dynamics and Environmental Engineering

Biological fluid dynamics

Project: Mathematical modelling of water transport across the corneal endothelium and corneal hydration

Keywords: water and solute transport, corneal swelling, corneal metabolism

Brief Description:
The corneal is our window to the world and to maintain its transparency the tissue has to be in a proper stat of hydration. The innermost layer of the cornea is the corneal endothelium, which is a monolayer of cells that actively pumps water from the cornea into the anterior chamber of the eye (the region between the cornea and the iris). On the other hand the corneal tissue has a swelling pressure that tends to attract water back into the tissue. Thus corneal hydration is governed by a so called "pump and leak" mechanism. The physics behind these processes is still poorly understood. We propose to develop a mathematical model of corneal hydration. This will allow us to understand what are the key parameters involved and how water transport mechanisms in the cornea could be manipulated with drugs. Water transport in he cornea is also essential to understand corneal metabolism and transport of oxygen, nutrients and products of the metabolic processes in the tissue.

Referent: Prof. Rodolfo Repetto, rodolfo.repetto@unige.it

➡ CLICK HERE TO GO BACK

Project: Ocular and brain biomechanics and their connection with glaucoma

Keywords: ocular biomechanics, brain biomachanics, blood flow, cerebrospinal fluid, glaucoma

Brief Description:
Glaucoma is the leading cause of blindness in developed countries. It is the result of the death of cells in the optic nerve and is known to be strongly correlated with high values of the intraocular pressure. We propose to investigate possible causes of glaucoma with a mathematical model that will account for mechanisms regulating ocular and brain pressure, blood flow in the eye and cerebrospinal fluid pressure. The model will be based on a combination of zero and one dimensional models. A specific model of the optic nerve and optic nerve head will also be developed.

Referent: Prof. Rodolfo Repetto, rodolfo.repetto@unige.it

➡ CLICK HERE TO GO BACK

Project: Virtual surgery of the human nose via computational fluid dynamics

Keywords: biofluid dynamics, nasal flow, CFD

Brief Description:
Nasal breathing difficulties (NBD) are as widespread and important as difficult to diagnose, owing to the anatomical complexity and extreme inter-subject variability of the human nose. Surgical corrections are often necessary, but the failure rate of such corrections is extremely high, with e.g. corrections of septal deviations failing in more than 50% of the cases. Computational Fluid Dynamics (CFD) is emerging as a powerful tool to diagnose NBD and to plan/evaluate strategies for surgical corrections beforehand. However, for the pre-operative (pre-op) anatomy to be compared with the outcome of virtual surgery (post-op), one has to answer some fundamental questions: How shall the comparison be carried out? How can well-being of a correctly functioning nose be measured or evaluated from a simulation? How can such results be shared and communicated to the medical community? This topic is part of an ongoing collaboration with the polytechnical school of Milan and the Hospital San Paolo in Milan.

Referent: Prof. Jan Pralits, jan.pralits@unige.it

➡ **CLICK HERE TO GO BACK**

Curriculum in Fluid Dynamics and Environmental Engineering

Geomatics

Project: Ocean color remote sensing for shallow water hydrographic mapping

Keywords: ocean colour, remote sensing, shallow water bathymetry, optical images

Brief Description:
In open ocean waters, ocean colour is predominantly driven by the concentration of phytoplankton, and remote sensing of ocean colour has been used to estimate the amount of chlorophyll, the primary light-absorbing pigment in all phytoplankton. However, in the coastal and estuarine environment, water colour is significantly influenced by other light-absorbing and light-dispersing components in addition to phytoplankton. New approaches have been developed to assess ocean colour in relation to coloured dissolved organic matter, suspended sediments and also to characterise bathymetry and seafloor composition in optically shallow waters. Hence, ocean colour measurements are increasingly used for environmental monitoring.
This research aims to analyse the potential of using optical images, from satellite as well as from UAV, but also the latest hyperspectral images, in order to reconstruct accurate bathymetry in shallow water areas, depending on the different types of sea/river/estuarine bed, and to monitor coastal evolution, using Machine Learning and Artificial Intelligence (ML/AI) techniques. This will also require in-depth investigation of issues related to atmospheric correction of satellite images and automatic classification.

Referent: Prof.ssa Bianca Federici, bianca.federici@unige.it

➡ CLICK HERE TO GO BACK

Project: GNSS for meteorology

Keywords: GNSS, meteorological alert, low cost sensors network, atmosphere monitoring

Brief Description:
GNSS receivers allow to obtain the so-called Zenith Total Delay (ZTD), namely the effect of the troposphere on satellite signals. Such physical parameter, combined with Temperature and Pressure, allows to evaluate the Precipitable Water Vapour (PWV) in the vertical column above the GNSS antenna.
The Geomatics research group has implemented an automatic procedure for the spatio-temporal localisation of intense meteorological precipitation over a large and orographically complex area, as support for weather warnings.
A near real-time monitoring system for water vapour content in the atmosphere, constituted by networks of GNSS receivers integrated with pressure and temperature sensors, could improve the knowledge of the ongoing meteorological phenomenon.
An in depth research could be carried out on the following aspects:
- the use of low cost GNSS receivers, also the ones available in smartphones, to estimate ZTD, analysing its feasibility and accuracy for a dense distributed sensor network;
- validation of the GNSS monitoring system by comparing PWV values with those from the meteorological model, assessment of the positive contribution of assimilation of GNSS-derived PWV values to trigger the meteorological model;
- the tropospheric monitoring by GNSS receivers in open sea, using GNSS the instruments already mounted on ships to monitor their positioning.

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

➡ CLICK HERE TO GO BACK

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Structural Engineering and Mechanics

Project: Optimized use of phase change materials for energy and seismic retrofitting in existing structures

Keywords: Phase Change Materials; Thermal Energy Retrofitting; Structural Retrofitting; Optimization; Life Cycle Analysis

Brief Description:
This PhD proposal aims at investigating the use of optimization techniques for proposing novel design methods for both structural and energy retrofitting of existing either Reinforced Concrete (RC) or Masonry structures through the use of **Phase Change Materials (PCMs)**. Specifically, the use of PCM can be used for enhancing the building Thermal Energy Storage (TES) efficiency of materials and components employed in structural upgrading. The aim of this PhD call is thus to propose a multi-objective integrated optimization tool based on environmental, technical, and economic criteria. A novel research program will be developed for new interventions capable to exploit the use of PCM for structural retrofitting, designing an optimization procedure, minimizing the cost of these PCM-based interventions (measured via LCC/LCA-environmental costs), while ensuring the required structural and energy performance levels. The PhD steps can be subdivided into three main parts:

- **Material level** (characterization/collection of PCM-based composites).
- **Element/system level** (definition of PCM-based structural and non-structural interventions).
- **Building level** (implementation of the design/optimization procedure).

The first part of the work consists in the characterization/collection of PCM-based composites, from a mechanical and TES point of view, aiming to assess their use in retrofitting applications. Both structural and energy efficient systems will be investigated in the second step of the research, identifying and characterizing a number of possible structural/non-structural PCM-based interventions. In the third step, an integrated design approach will be implemented in the form of an optimization problem, formulated by assuming the cost as objective function, and using heuristic algorithms for its solution. Optimized solutions for achieving the required energetic and seismic performances will be assessed.

Referent: Prof.ssa Serena Cattari, serena.cattari@unige.it
& Prof. Antonio Caggiano, antonio.caggiano@unige.it

CLICK HERE TO GO BACK

Project: Computational mesoscale design of highly porous PCM-enhanced cementitious materials with DIODIC properties

Keywords: cementitious foams, meso-scale, meta-materials, PCM, thermal diodes

Brief Description:
A thermal diode is a smart system that has a strong preferential heat flow in one direction (Forward-Fwd) and a high resistance in the opposite one (Reverse-Rev). It can revolutionize the construction and building sector, with a huge impact on the realization of **Nearly-Zero-Energy-Buildings (NZEBs)** and the associated CO_2 reductions. It is a highly innovative but underexplored concept that will unleash a broad variety of smart energy-saving materials and components to be used in NZEBs and building envelopes.
Cementitious diodic systems are based on meta-optimized computational method for designing highly porous cementitious foams that work as thermal diodes. A synergetic cutting-edge modelling tool will be investigated across various disciplines (i.e., Computational Mechanics, Physics of Materials and Thermal Energy Storage) and scales (from micro/meso to building levels), with a breakthrough in the Construction and Building Materials community.
The specific hypothesis of this PhD program is that by tuning the dynamic and asymmetric interplaying properties of (low-cost) components, it will be possible to design an advanced and meta-optimized cementitious thermal diodic-foam. To this end, concrete foams designed with cementitious pastes, low-conductive hierarchical porous air-bubbles, high-conductive microfibers, and a combination of bio-based Phase Change Materials, will be shaped to achieve an optimized thermal diode.
Research Aims are:

- A1: Computational design of a thermal diode with properties “à la carte”, in Fwd and Rev mode.
- A2: Computational design of a thermal diode with Nearly-Zero conductivity/diffusivity in Rev mode.
- A3: Design a diodic-foam with extremely high thermal diodicity, at several scales.
- A4: Design an ultra-thin (skin) layer ~ 2.0 cm (max.) of diodic-foam for NZEBs.

Referent: Prof. Antonio Caggiano, antonio.caggiano@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Equivalent frame idealization of masonry buildings for the seismic assessment and retrofitting and implementation in the open-source software framework OpenSees

Keywords: seismic assessment, nonlinear modelling of masonry buildings, open-source implementation in OpenSees, fragility curves, modelling of strengthening interventions

Brief Description: The seismic assessment of existing masonry buildings requires the evaluation of the performance under earthquakes of different intensity, related to specific return periods, up to the ultimate collapse. To this end static and/or dynamic nonlinear analysis are needed. Nonlinear modelling of masonry buildings is a challenging task, due to the complexities of the structural configuration and of the masonry material constitutive laws. In order to reduce the computational effort, the equivalent frame modelling approach is widely used and proposed by codes for the engineering practice: in this case, the masonry wall is assumed as made by structural elements (piers and spandrels beams), with proper nonlinear constitutive laws, in terms of generalized forces and displacements. However, the interaction of piers and spandrels with other structural elements, such us tie-rods, reinforced concrete tie beams, stiff or flexible floors, is not straightforward. Moreover, the modelling of strengthening interventions is necessary, which requires the modification of failure criteria for masonry (in the case of mortar injections or other direct strengthening of masonry material) or the implementation of additional structural elements. This research project aims at the implementation of an equivalent frame model in the open-source program OpenSees, with a proper formulation of constitutive models and procedures for the seismic pushover and time-history analyses.

Referent: Prof. Sergio Lagomarsino, sergio.lagomarsino@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Probabilistic characterization of human-induced loading for vibration serviceability assessment of lightweight structures

Keywords: Human-induced vibrations, Numerical simulations, Probabilistic Model, Vibration serviceability

Brief Description:
Vibration serviceability assessment of lightweight structures requires a probabilistic model of human-induced loading taking into account the probabilistic distribution of human walking parameters, including step frequency, arrival time, walking speed. When pedestrian density is high, human walking parameters are also affected by the interaction among pedestrians.
The dynamic response can be evaluated in the time domain based on numerical simulations carried out taking into account the interaction among pedestrians. Such an interaction can be modelled by suitable macroscopic or microscopic crowd models (e.g. the social force model). Numerical simulations can be very time consuming and not practicable at the design stage. Frequency-domain spectral models represent a valid alternative for a reliable assessment of the dynamic response taking into account the randomness of human-induced loading and pedestrian interaction.
The present research project aims to provide a reliable probabilistic model of human-induced loading on structures. A wide review of the different models proposed in the literature to schematize pedestrian interaction is expected in order to select the most suitable models to be implemented. A probabilistic characterization of human-induced loading should be derived based on numerical simulations of pedestrian traffic on domains of variable geometries representative of floors and footbridges. The final goal of the research is the introduction of a general formulation for the equivalent spectral model of the loading that can be adopted for vibration serviceability assessment of structures with variable geometrical configurations and in different traffic conditions (mono/bi-directional, unrestricted/restricted). A possible experimental validation of the model could be based on an international collaboration.

Referent: Prof.ssa Federica Tubino, federica.tubino@nige.it

➡ CLICK HERE TO GO BACK

Project: Nonstationary dynamic response of structures to thunderstorm outflows

Keywords: Dynamic response, Evolutionary spectra, Nonstationariety, Thunderstorms

Brief Description:
In design codes, the calculation of wind effects on structures is based on a stationary model for the wind field, reliable for cyclonic phenomena at the synoptic scale. However, most of the wind damage to structures results from thunderstorms that generate highly transient wind fields. Within the THUNDERR Project, funded by the European Research Council (ERC) with an Advanced Grant 2016, a non-stationary evolutionary model of wind speed of thunderstorms measured at a single point was introduced and applied for the evaluation of the maximum dynamic response to thunderstorms of single-degree-of-freedom systems.
The goal of the present project is the extension of the non-stationary evolutionary loading model to spatially extended domains and the introduction of calculation methods for estimating the maximum dynamic response of structures, modelled as continuous mono-dimensional or discrete multi-degree-of-freedom dynamical systems.
The first task is the statistical analysis of LIDAR measurements database available at UNIGE in order to extract thunderstorm events and to provide the statistical characterization of the wind field along a linear domain. Then, suitable models for the coherence function of the wind velocity field should be provided. Base on such models, the most appropriate method for the statistical characterization of the dynamic response of muti degree-of-freedom systems should be selected, and the possibility of adopting the simplified equivalent wind spectrum technique evaluated.

Referent: Prof.ssa Federica Tubino, federica.tubino@nige.it

➡ CLICK HERE TO GO BACK

Project: Damage mitigation in sandwich composites for structural applications

Keywords: sandwich composites; extreme environments and loadings; modeling

Brief Description:
The project aims at the design of damage mitigation concepts for sandwich composite structures used for naval and aeronautical applications. Sandwich composites are materials made of two external stiff layers, typically in aluminum or fiber reinforced composites, and an internal core, with a foam or honeycomb structure. These materials are lightweight and are therefore extensively used in aircrafts and naval applications, also to improve energy efficiency. However, they are highly sensitive to the presence of flaws at the face/core interface, which may propagate and cause catastrophic collapses. In the project we will formulate analytical and numerical models to investigate the response of these structural systems and design concepts able to mitigate damage caused for instance by impacts and fatigue loadings and its effects. The theoretical work will be supported by experimental tests conducted at the technical University of Denmark, as part of a joint collaboration between the two institutions.

Referent: Prof.ssa Roberta Massabò, roberta.massabo@unige.it

➡ CLICK HERE TO GO BACK

Project: Analysis of non-stationary wind loading effects through experimental investigations in a conventional wind tunnel facility

Keywords: Non-stationary flow, Transient aerodynamics, Transient aeroelasticity, Wind engineering, Wind tunnel tests

Brief Description:
Thunderstorm downbursts and their intense non-stationary wind fields have emerged as a significant phenomenon requiring special analysis and attention from the wind engineering community. Technologies have advanced significantly over the years, allowing to design innovative wind tunnels able to reconstruct downburst-like outflows in laboratory. For conventional, horizontally-orientated wind tunnels, experimental tools that alter the oncoming flow have been also proposed in order to study non-stationary outflows but usually with a limited perspective. The present project aims to develop a specific device (e.g., an active grid) that can be installed within the working test chamber of a conventional wind tunnel (specifically the "Giovanni Solari Wind Tunnel" of the University of Genoa) to approximately replicate the main features of a thunderstorm downburst (e.g., the accelerating flow and the characteristic vertical nose-shaped wind profile). In addition to the design and construction of the specific active device, the goal of this study is to first examine the characteristics of the simulated flows, verifying the ability to replicate real downburst measurements deriving from the THUNDERR project results. Then, non-stationary aerodynamics and aeroelasticity experiments on sectional models of bridges and scaled models of buildings are planned, with the aim of making comparisons with results in steady conditions and with analytical and numerical models of structural response. It is planned to develop the project in cooperation with the Northeastern University's Wind Engineering Research Group (Boston, USA) who has recently developed an experimental apparatus of this type.

Referent: Prof. Giuseppe Piccardo, giuseppe.piccardo@unige.it

CLICK HERE TO GO BACK

Project: Dynamic integrated monitoring of flexible structures and infrastructures using traditional sensors and Digital Image Techniques

Keywords: Monitoring of flexible structures, Traditional sensors, Digital Image Techniques, laboratory and full-scale tests, dynamic identification of structures

Brief Description:
Structural Health Monitoring (SHM) of structures and infrastructures has experienced an extraordinary growth in importance recently. In this context the integration between different measurement techniques is desirable to achieve completeness of information and mutual control and validation of data coming from the different sources.
The use of Digital Image techniques (such as Digital Image Correlation) for SHM application seems very promising. It is a non-contact optical method for measuring displacements, deformations and vibrations that may provide long-distance, high-precision measurements insensitive to the electromagnetic disturbances. However, applications of these techniques for the structural monitoring of real scale structures are still under development and the procedure for obtaining reliable results still appears immature.
This research activity intends to couple the use of traditional measuring techniques (such as accelerometric and strain gauge monitoring) with results obtained from Digital Image techniques in the field of the dynamic identification of slender structures and infrastructures excited by environmental actions (e.g., wind). The investigation and the choice of the vision based algorithms will be carried out also performing laboratory experiments to calibrate and verify the results. Possible preliminary applications could be made on real case studies such as lighting poles and bridges already instrumented with traditional sensors.

Referent: Prof.ssa Luisa Pagnini, luisa.pagnini@unige.it ; Prof.Carlo Battini, carlo.battini@unige.it ; Prof. Giuseppe Piccardo, giuseppe.piccardo@unige.it

CLICK HERE TO GO BACK

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Mechanics of Materials

Project: Mechanical metamaterials for extreme engineering functionalities

Keywords: Mechanical metamaterials, smart microstructures, functional microstructural design, linear and nonlinear dynamics, materials engineering and performance

Brief Description:
The current era in material science is known as the century of metamaterials. Metamaterials are a class of composite architectured media, whose functional, extreme or smart physical behaviour are certainly destinated to outperform the mechanical, magneto-electric, and thermoacoustic response of the natural materials traditionally employed in many engineering branches. The internal architecture of metamaterials can be based on the geometric repetition of a periodic cell (e.g. honeycombs, truss grillages, beam lattices), whose microstructure can properly be designed to optimally govern all the macroscopic dynamic phenomena occurring at wavelengths larger than the elementary cellular size. Super strength, hyper stiffness, extra-lightness, ambient noise filtering, energy localization and harvesting, elastic wave polarization, ballistic impact absorption, acoustic negative refraction, seismic vibration shielding, sonar invisibility cloaking are only a few examples of the fascinating functionalities that can be achieved in the field of magneto-electro-elastic and mechanical metamaterials. Challenging scientific researches on the topic are continuously propelled by the recent advances in computational micromechanics (computer-aided design, parametric engineering), as well as by the extraordinary developments in additive manufacturing technologies (3D and 4D printing). Within this framework, the PhD research project aims at conceiving, modeling, analyzing and optimizing new mechanical metamaterials for functional applications in classical (civil, mechanical, naval) and emerging (sport, sound, biomechanical) engineering fields (see also https://bit.ly/3kms7Jq and https://bit.ly/36TWdRk). Physical-mathematical analytical formulations will be exploited to establish the governing equations, which will be solved by means of analytical and computational methods. Theoretical results will be optimized via numerical tools and verified by experimental laboratory tests.

Referent: Prof. Marco Lepidi, marco.lepidi@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Conception, modelization, analysis and optimization of avant-garde architected materials

Keywords: New-generation materials, hierarchical metamaterials, multi-field physical phenomena, homogenization and continualization, higher-order and non-local continua

Brief Description:

The advanced design of high-performance architectured materials and active metamaterials for cutting-edge and smart applications is becoming a key aspect in many engineering and technological fields. To this purpose, a multidisciplinary design approach must be developed, which combines physical-mathematical models, computational methods, data-driven optimization techniques, and innovative experimental test protocols to harness the complexity of phase heterogeneities, multi-field interactions, multi-scale bridges, geometrical and mechanical nonlinearities, multi-frequency energy sources and harvesters. This optimal design approach must be developed to exploit the features of the breakthrough 4D printing technology overcoming the limitations of 3D printing. Such innovation are expected to add the dimension of transformation over time allowing the additive manufacturing of objects that can be activated in a controlled fashion to change shape, configuration, or physical properties. Within this framework, the PhD research project aims at developing technologies that pave the way to almost endless opportunities of designing avant-garde active materials and metamaterials, able to morph their microstructure depending on external stimuli. Advancement of knowledge concerns the modelling, conceptualization and design, together with prototyping and proof-of-concept of reprogrammable multi-functional metadevices for wave propagation control, energy harvesting, sensing, self-healing and stress-controlled failure programs (see also https://bit.ly/3F2sAtz and https://bit.ly/36XVFd8). Physical-mathematical analytical formulations will be exploited to establish the governing equations, which will be solved by means of analytical and computational methods. Theoretical results will be optimized via numerical tools and verified by experimental laboratory tests.

Referent: Prof. Andrea Bacigalupo, andrea.bacigalupo@unige.it

➡ **CLICK HERE TO GO BACK**

Project: Peridynamic models for real world multiphysics

Keywords: Computational mechanics, Peridynamics, Fracture, Non-local models, Coupled-phenomena

Brief Description:
Understanding how standard and complex materials behave, their failure as well as their strength when deformed, is crucial for their proper usage and also for the design of new materials with potential impact on manufacturing, materials engineering, and related technologies. Classical continuum mechanics (CCM) has provided the foundation for models of the response of solids subjected to mechanical, thermal, electrical and other types of loading. The theoretical underpinnings provided by CCM have enabled the development of rigorous and robust analytical and computational techniques that capture complex behavior in solids and structures including large deformations and time-dependent nonlinear relationships between stress and strain. However, because of the intrinsic features and requirements of its governing equations, CCM is severely limited in its ability to describe non-local behaviors, strain localization, crack nucleation and general problems involving geometrical discontinuities such as cracks.
Peridynamics is a recent non-local continuum-molecular (CM) theory of mechanics that have proved to be very effective in modeling challenging phenomena in engineering such as spontaneous formation of cracks in solids, non-local transport mechanisms, anomalous diffusion and heat transfer/electrical conduction in bodies with evolving discontinuities.
The objective of the project is to develop new CM formulations providing a rigorous mathematical foundation along with a robust, open and extendable computational framework of wide applicability for challenging problems in engineering.

Referents: Prof. Vito Diana, vito.diana@unige.it
& Prof. Luigi Gambarotta, luigi.gambarotta@unige.it

CLICK HERE TO GO BACK

Project: Reusable materials for mechanical energy absorption

Keywords: Energy absorption, Architecture materials, Metamaterials, Reusable materials.

Brief Description:
The design of reusable energy absorption materials and devices to mitigate damages to the people and structures due to impact incidence or to obtain vibrational dampers appears to be a promising topic in various fields from aerospace, naval and civil engineering. Architected metamaterials may be designed to incorporate inelastic mechanisms to convert kinetic energy into dissipated energy. A challenging goal appears the design of reusable and self-recoverable meta-structures, in which the energy absorption mechanisms are conceived in such a way as to allow the material to return to its initial configuration before impact. Recently, periodic micro-structured materials have been proposed whose representative cell is composed of bistable beams that would snap to the other stable configuration with hysteresis under loading and unloading condition. A novel class of architected metamaterials with unit cells that absorb energy via sliding Coulombic friction have been proposed and is shown that these metamaterials provide dissipation akin to elastomers. A different conceptual design assembles two lattices with opposite chirality and coupled elasto-magnetically to obtain multi-stable systems. Plane stress fields trigger snap-through mechanisms and hysteresis curves with energy absorption (see http://bitly.ws/qKVr and http://bitly.ws/qKVQ). The present PhD project is focused to the optimal design of new reusable metamaterials for mechanical energy absorption based on periodic beam or block lattice microstructures. Analytical and computational techniques will be developed to evaluate the capabilities of the designed materials. Physical specimens obtained via addictive manufacturing will be tested to validate the efficiency of the energy absorption devices and the validity limits of the developed theoretical and computational approaches. Finally, based on the theoretical and experimental results, design optimization procedures to maximize the energy absorption without the collapse of the material microstructures will be developed

Referents: Prof. Andrea Bacigalupo andrea.bacigalupo@unige.it
& Prof. Luigi Gambarotta, luigi.gambarotta@unige.it

CLICK HERE TO GO BACK

Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Geotechnical Engineering

Project: Assessing the Resilience of infrastructure Earthworks subjected to extreme rainfall events: an advanced Unsaturated Soil mechanics approach (AREUS)

Keywords: Unsaturated soils; infrastructure resilience; climatic change; extreme rainfall; soil modelling.

Brief Description:
Earthworks such as dams and embankments, are crucial for the functioning of infrastructure networks and play a fundamental role in the socio-economic and environmental wellbeing of our society. However, the stability of earthworks can be compromised by the climatic change with the alternation between longer droughts (drying) and extreme rainfall (wetting) events. From an hydromechanical perspective, soils shrink during droughts due to water evaporation and this generates networks of large pores. During extreme rainfalls, these pores constitute preferential paths for water infiltration that eventually saturates the soil. In these conditions, three main phenomena can affect the stability of earthworks: a) the cyclic variation of dryings and wettings progressively deteriorates the mechanical properties of the soil, b) the loss of stability provided by water capillary actions during the transition to saturated states and c) the coupling of water flow and soil deformation. These three coupled phenomena are not accurately predicted by existing incremental models and still constitute matter of discussion within the scientific community. The main objective of this doctoral project is therefore to devise, via analytical and numerical modelling, practical solutions to enhance the resilience of infrastructure earthworks subjected to extreme rainfall events. The PhD candidate will work under the joint supervision of Dr Agostino Walter Bruno and Pr Domenico Gallipoli on the development of a closed-form constitutive model that predicts the hydromechanical behaviour of unsaturated soils subjected to different types of stress paths (i.e. isotropic loading and unloading, wetting and drying, shearing). The model will then be implemented into a numerical Finite Element code to assess the stability of infrastructure earthworks and evaluate the effectiveness of several stabilisation measures (e.g. drainages, water runoff interceptors, soil cementation).

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

➡ CLICK HERE TO GO BACK

Project: Recycling concrete to manufacture compressed earth eco-bricks

Keywords: Construction and demolition waste; Recycled concrete; Compressed earth bricks; hydromechanical behaviour; hygrothermal performance.

Brief Description:
The building sector generates an amount of construction and demolition waste (CDW) that accounts for more than 30% of the total waste produced in the European Union each year. CDW encompasses a broad variety of materials, such as concrete, fired earth bricks and plastics. Recently, the research community has attempted to recycle this abundant resource to manufacture new building materials, thus minimizing the consumption of raw minerals. However, most of the existing recycling techniques do not fully exploit the residual features of the recycled CWD, e.g. recycled concrete is only used as an aggregate in the formulation of new building materials and not as a binding agent. The main objective of the present PhD project consists therefore in exploiting the residual binding capacity of recycled CDW (e.g. concrete and fired earth bricks) to manufacture compressed earth eco-bricks with a low environmental impact. To achieve this aim, the PhD candidate will work on a) selecting CDW and base earth materials from local civil engineering works (e.g. demolition of buildings, excavations, dredging); b) characterizing both the physical and chemical properties of both CDW and earth materials, including microstructural properties (e.g. pore size distribution, specific surface, etc.) and mineralogical composition; c) devising the best procedure to manufacture compressed earth eco-bricks stabilized with CWD, thus defining pre-treatments of CWD, CWD content, water content, compaction pressure, etc.; d) characterizing the eco-bricks under mechanical, durability and hygrothermal tests conducted at the scale of the individual brick and small masonry wall. The successful implementation of the proposed recycling technique will drastically reduce the energy consumption and the greenhouse gas emissions related to the production of chemical binders. This in line with material circularity principles, which are indispensable to reach the ambitious goal of a carbon neutral construction sector.

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

CLICK HERE TO GO BACK

Project: MATER: Materiali Alternativi in Terra per l'Edilizia Residenziale

Keywords: rammed earth, hygro-thermal coupling, latent heat, capillary, moisture buffering

Brief Description:
Rammed earth is an ancient construction technique widely diffused among the ancient populations of the modern Iran, Iraq, and the African Mediterranean shore. In the recent years, this technique has been rediscovered as a new, more environmental friendly, construction material compared to the traditional industrial ones such as steel and concrete. Rammed earth elements may be present in the form of bricks or whole walls, and they are prepared directly on site compacting the soil at the optimum dry density. The material gains strength and stiffness with time as the initial water content reduces due to evaporation. In addition to the low energy required to construct the rammed earth walls, those appear to behave as excellent hygrothermal regulator of the indoor space allowing for a better comfort and a reducing the heating/cooling needs during the life cycle of the building.
To date, the major issues associated to the rammed earth are the durability under environmental conditions (temperature, rainfall, and relative humidity) and the correct estimation of the hygro-thermo-mechanical (HTM) coupling. The project aims to a better understanding of those processes by developing a theoretical and numerical framework to study the HTM modelling in such materials using the principles of unsaturated soil mechanics in porous materials. The latent heat of evaporation/condensation plays a major role in the HTM coupling processes. Current models use the latent heat of free water because the lack of better data. However, for rammed earth walls, this assumption is far to be respected as the water is entrapped into the micro and macro pores of the material. Theoretical hints suggest that this could significantly affects the values of the latent heat. The influence of the water confinement on the latent heat of evaporation will be experimentally and theoretically investigated with a jointed collaboration with the Chemical laboratory of the University of Genova.

Referent: Prof. Leonardo Maria Lalicata, leonardo.lalicata@unige.it
& Prof. Domenico Gallipoli, domenico.gallipoli@unige.it

➡ **CLICK HERE TO GO BACK**

Project: PILATUS: PIles under LATeral Loading in Unsaturated Soils

Keywords: piles, lateral loading, unsaturated soil, water table, water retention curve

Brief Description:
The interaction between a laterally loaded pile and the surrounding soil is typically limited to the shallower soil layer. Often, this zone is above the water table and therefore the interaction takes place under unsaturated conditions. The available evidence is scarce but suggests that unsaturated conditions play a major role on the pile's response. The influence of partial saturation is usually neglected because the general belief among researchers and practitioners is that this would lead to a conservative and simpler design of the foundation. However, a serious attempt to quantify the influence of partial saturation has not been done yet. In some cases, such as temporary works or piled retained walls, accounting for the conditions of partial saturation of the soil could lead to a significant material saving with beneficial consequences on the reduction of the carbon footprint. On the other hand, soil behaviour, and consequently the soil-pile interaction of permanent structures, is strongly affected by the seasonal variations of the environmental boundary conditions (e.g. water table fluctuation, rainfall events, evaporation). Those effects cannot be successfully analysed without the principles of unsaturated soil mechanics.
The project includes an experimental and a theoretical/numerical part. The latter will be developed at the University of Genova under the supervision of Dr. Lalicata and Prof. Dr. Gallipoli. The experimental part will be carried out by conducting centrifuge tests at the Eiffel University of Nantes (FR). Both experimental and numerical approach will provide an insight into the effect that the matrix suction, and its variations, have on the response of piles under lateral loading.

Referent: Prof. Leonardo Maria Lalicata, leonardo.lalicata@unige.it
& Prof. Domenico Gallipoli, domenico.gallipoli@unige.it

➡ **CLICK HERE TO GO BACK**