DOCTORAL
SCHOOL

MECHANICS

EPFL

As mechanics problems are found across the entire scope of industries and fields of application, research within the EPFL mechanics doctoral program spans the full range of relevant themes, including microfluidics, wind energy, geomechanics, nano- and micro-mechanics, energy harvesting, soft materials, biomechanics, composites, and fracture. Studies include innovative experiments, new theories, and advanced simulation methods, often in combination and including multiscale and micro-macro scale bridging.

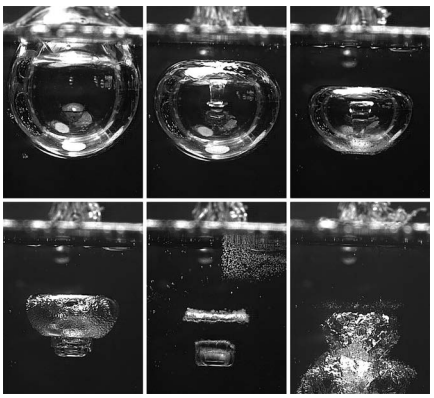
Bio-cemented soils: From the laboratory to the market

A technology developed at the Laboratory for Soil Mechanics (LMS) of EPFL is scaling up, targeting industrial applications. A research carried out at LMS since 2008 led to the conception of an innovative design and application method of soil bacteria for producing cementitious particles in subterranean applications. The technology aims to provide engineering consulting companies with innovative, cost-efficient and environmental-friendly solutions for stabilizing and strengthening soils in a series of geotechnical problems. A patent application has been filed in 2017 by EDME student Dimitrios Terzis and his supervisor Prof. Lyesse Laloui in collaboration with EPFL's technology transfer office.

During the last ten years two doctoral theses have been carried out at LMS putting the focus on the complex bio-chemo-mechanical phenomena involved in the utilization of bacteria for producing microbe cement in the subsurface. The project has recently received financial support from prestigious innovation grants including the Academia-Industry Training 2016, took place between Bangalore, India and Zurich, as well as the Innovation in Tradition grant provided by the Giovanni Lombardi Foundation and ENAC's InnoSeed program.

Investigations on collapsing cavitation bubbles

Cavitation, i.e. the formation of vapor cavities in depressurized liquid zones, is a major source of erosion and vibration damage in many industrial systems such as hydraulic machines. The damage is associated to the shooting of high-speed liquid jets, to the emission of shock waves and to the extremely high temperatures reached at the last stage of the collapse of a cavitation bubble.



The main purpose of my PhD research is to create and observe such a bubble in a highly controlled environment, and to understand how its energy is distributed into the different collapse phenomena. Such understanding would help not only to attenuate cavitation-induced damage, but also to harvest the power of these bubbles in beneficial applications such as in medicine or microfluidics. The work is mainly experimental and includes measurements of highly spherical bubbles in zero-gravity conditions taken aboard ESA parabolic flights, which are great fun.
EPFL is a thrilling environment to conduct research. A PhD is extremely challenging – anyway, it was never meant to be easy – but EPFL's outstanding facilities, international nature and the vibrant social activities are truly motivating. EDME is a rewarding program and provides significant support for designing a solid research plan. I particularly enjoy the informal EDME PhD symposia organized a couple of times every year, which give an excellent opportunity to meet other students outside your own lab, learn what they do and hang out!

Dr. Outi Supponen, PhD thesis in the Laboratory for Hydraulic Machines

Therapeutic solutions in biomechanical orthopedics

The knee is an essential joint of the lower extremity playing important role in our body kinetic chain. Articular cartilage is an avascular biphasic tissue covering load bearing joint surfaces and helps them to glide smoothly over each other. Cartilage homeostasis can be modulated under loading through induced spatiotemporal stress, strain, fluid pressure and velocity fields. I am a third year PhD student in the Laboratory of Biomechanical Orthopedics (LBO) working on mechanobiology of cartilage. My research is devoted to understanding the role of mechanical environment on biophysical response of chondrocytes (the cells forming the cartilage). This is an interdisciplinary project in which I integrate the modeling and optimization results with mechanical and biological experiments. To have contribution to find therapeutic solutions for the patients is the most rewarding aspect of the research in LBO. Particularly, I am glad that I have the opportunity to be a part of a multidisciplinary research group collaborating with biologist, surgeons and bioengineers. In addition, EPFL infrastructure makes it easy to access all required facilities and resources to develop your research plan and enrich your scientific outlook. Last but not least, being a member of EPFL community has also broaden my social interactions thanks to its international and multicultural environment.

Naser Nasrollahzadeh
PhD student in the Laboratory of Biomechanical Orthopedics

Numerical investigations on adhesive and abrasive wear

Wear is the removal of material from solid surfaces and it is a phenomenon widely present, both in nature and in artificial objects and at all scales. Its relevance is evident in many engineering applications, like in the durability of manufactured objects, but surprisingly the topic triggered scientific interest only in the last century. This is partly due to the complexity of the phenomenon. In fact, wear intertwines with other phenomena that take place at the interface between solids, like friction, revealing a high complexity that is responsible for the lack of a deep physical understanding of wear. By adopting numerical simulations, in my PhD research I aim at isolating the fundamental mechanisms that govern the two most common forms of wear (adhesive and abrasive wear), gaining meaningful insights on their physics.

This cutting edge research is possible thanks to the EDME program and the resources available at EPFL. In fact, high-performance computers are available for researchers and during the PhD it is possible to attend several classes, tailoring the choice according to one's needs. The participation to international conferences and summer schools is also highly encouraged. Personally, I am enjoying a lot being part of an international environment and having the possibility of meeting cultures which are different from mine. I am really excited by my experience here and I am looking forward for what is to come in the next years.

Enrico Milanese
PhD student in the Computational Solid Mechanics Laboratory

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You need to complete and submit the EPFL doctoral school online application form on the following link:
phd.epfl.ch/application

Beforehand, we encourage you to surf the EPFL doctoral school and EDME program webpages:
go.epfl.ch/phd-edme

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