PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

<table>
<thead>
<tr>
<th>Number of scholarship offered</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Dipartimento di Ingegneria Civile e Ambientale</td>
</tr>
</tbody>
</table>

Description of the PhD Programme

**General description**

Structural, Seismic and Geotechnical Engineering - SSGE - consists of the disciplines and techniques to understand, model and control the behavior of: (a) structural materials (concrete, steel, masonry, composites, bio-materials and materials for micro-systems), (b) structural systems (from constructions to bio-mechanical systems and micro-systems), (c) soils and (d) environment-construction interaction. Being deeply-rooted in civil engineering which is by its very nature highly inter-disciplinary, SSGE also focuses on environmental actions, either external (such as earthquakes, vibrations, irradiation, wind and fire) or ensuing from soil-structure interaction (such as those caused by retained-earth thrust, landslides and water-table fluctuations). Because of their generality in materials and structural modeling, the methods developed within the domain of SSGE are also very useful in other technical-scientific domains, whenever understanding and controlling mechanical aspects are necessary to guarantee both design reliability and structural safety, serviceability and durability. Many are the examples of typical SSGE issues: from tall buildings and bridges to industrial bio-mechanical and micro-electromechanical systems, from off-shore structures and dams to the rehabilitation of monumental buildings, from seismic design and structural dynamics to slope stability, tunnel behavior and foundations, not to mention many issues in common with several branches of industrial engineering.

**Administrative office**

Department of Civil and Environmental Engineering  Politecnico di Milano
Leonardo Campus  Building 5
Piazza Leonardo da Vinci, 32
20133 Milano
Dr. Emanuela Zonca
E-mail: emanuela.zonca@polimi.it
Phone: 0039 02 23994322
Mobile: 0039 331 6000165
Fax: 0039 02 23994300
Skype: emanuela.zonca.polimi
Scholarships and research areas
Scholarships within this Ph.D. programme respect the national departmental amount and no other increments are foreseen. The specific research subject will be assigned to the Ph.D. student within the first months of the Ph.D. activity, upon a mutual agreement between the candidate and the Academic Board of the Ph.D. programme. The herewith attached subject forms describe topics and research areas that Ph.D. students are encouraged to develop.

List of topics and research areas

- Smart materials and structures
- Computational mechanics of materials and structures
- Earthquake engineering and structural dynamics
- Advanced computational methods for coupled problems in porous media
- Micro Electro-Mechanical Systems and micromechanics
- Structural analysis of built heritage
- Microseismic monitoring of unstable rock slopes
- Life-cycle performance of bridges and structures
- Geotechnical earthquake engineering
- Computational and experimental mechanics
- D-zones and anchorages under severe conditions
- Cementitious materials and concrete structure under extreme and exceptional loading

Please note that the general call will have a second phase, in June, in which topic scholarships are announced. Please refer to the call for further information. The candidates have to apply separately for the topic scholarships, which will be listed in the PhD School web site.
**PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle**

Research Field: ADVANCED COMPUTATIONAL METHODS FOR COUPLED PROBLEMS IN POROUS MEDIA

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<thead>
<tr>
<th>Monthly net income of PhDscholarship (max 36 months)</th>
<th>€ 1027.73</th>
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<tbody>
<tr>
<td>In case of a change of the welfare rates during the three-year period, the amount could be modified.</td>
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</table>

**Context of the research activity**

| Motivation and objectives of the research in this field | Coupling is an inherent feature of the engineering behaviour of porous materials, and it requires multi-phase and multi-scale approach for its analysis. The interplaying role of different physical fields, e.g. electrical, chemical, thermal, hydraulic, mechanical, highly non-linear effects, moving interfaces, and large scale heterogeneities, definitely require numerical methods for their analysis. In the past, the bottleneck was given by the hardware limitations, while nowadays the most relevant difficulties are related on the one side to the determination of coupled mechanical properties and, on the other side, to the setup of robust numerical procedures able to cope with multithread and parallel treatment. Specifically, this proposal focuses on the development of innovative numerical tools to analyse problems related to the durability of porous materials, undergoing slow cyclic and fast dynamic or thermal excitation, chemical aggression and material degradation. The final aim of the investigation is life-cycle assessment of engineering and biological structures made of, or interacting with, porous materials. The proposal is inserted into a wider numerical and experimental activity, supported by different Italian and foreigner private companies and public agencies. |

| Methods and techniques that will be developed and used to carry out the research | Numerical modelling requires moving on with new techniques, stemming from standard finite element |
approaches, based on approximation methods more flexible in view of parallel implementation. A balanced combination of field and laboratory tests will also support accurate material characterisation.

### Educational objectives

| The proposed work can contribute to form a complete scientific personality. The three basic ingredient of education will combine: theoretical modelling, numerical developments and experimental testing. |

### Job opportunities

| The proposed research project will allow the Ph.D. student to come in contact with a broad family of geotechnical/structural/biomechanical problems and to get an in-depth knowledge of different theoretical subjects. Working in this project will be stimulating and will favour high-level career profile in advanced fields of engineering. |

### Composition of the research group

| 1 Full Professors |
| 1 Associated Professors |
| 2 Assistant Professors |
| 2 PhD Students |

### Name of the research directors

| Anna Pandolfi, Donatella Sterpi |

### Contacts

| anna.pandolfi@polimi.it tel. +390223994217 |
| donatella.sterpi@polimi.it tel. +390223994311 |
| www.dica.polimi.it |

### Additional support - Financial aid per PhD student per year (gross amount)

| Housing - Foreign Students |
| Housing - Out-of-town residents (more than 80Km out of Milano) |

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

### Educational activity

The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the second year. In some cases, students
will be allowed to use part of this funding also in the first year.

**Teaching assistantship**
Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, typically devoted to support classworks and exams.

**Computer availability**
Each Ph.D. student has his/her own computer for individual use.

**Desk availability**
Each Ph.D. student has his/her own desk, cabinet and locker.

**List of universities, companies, agencies and/or national or international institutions that are cooperating in the research**

- TU, Delft, Netherlands
- UPC, Barcelona, Spain
- Caltech, Pasadena, USA
- EPFL, Lausanne, CH
- University of Siegen, Siegen, Germany
- MIUR, Roma, Italy
- E.N.I., S. Donato, Italy
- Technital S.p.A., Milano, Italy
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: CEMENTITIOUS MATERIALS AND CONCRETE STRUCTURES UNDER EXTREME AND EXCEPTIONAL LOADING

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<tr>
<td>Concrete, reinforced/prestressed concrete and advanced cementitious composites are so extensively used today that many are the structures exposed to either extreme environmental conditions (high corrosion, high/low temperature) or exceptional loads (fire, explosions, vehicle impact, bombing, natural disasters). Hence, improving structural durability and preventing progressive structural failures is becoming one of the imperatives for structural engineering and code-writing bodies. The quantitative assessment of damage in any structure exposed to extreme and exceptional loads is a basic step for risk-mitigation design. To this purpose, non-standard experimental techniques, accurate material models and advanced computational approaches should be developed.</td>
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<tr>
<th>Motivation and objectives of the research in this field</th>
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<tr>
<td>Both experimental techniques and numerical methods are needed to solve the still-open problems in severely-corroded or fire/blast-damaged structures. For instance, assessing the decay of bar-concrete bond under chloride attack requires special techniques to accelerate the corrosion rate and to quantify the damage. Testing concrete at high temperature needs split-tube furnaces to be designed and constructed. Investigating materials and structural behaviors under blast requires special devices like shock tubes or scaled experimental models.</td>
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</tbody>
</table>
Evaluating fracture energy and size effect in concrete structures requires special specimens. Assessing concrete damage via non-destructive test methods based on concrete colorimetry, ultrasounds and x-rays, as well as linking concrete fresh-state properties to those after hardening are bringing in advanced techniques. At the same time, adequate theoretical and numerical models at the meso-structural and structural level are being developed, to be implemented into available FE codes.

**Educational objectives**

Designing concrete structures for durability, fire proofing and blast resistance requires a multi-disciplinary approach, since many and different topics are involved (materials, structures, human and structural safety, heat transfer, diffusion of chemical products, chemistry of combustion, chemistry of concrete, fluid-structure interaction...). Consequently, the Candidate will not only have the opportunity to contribute to the broadening of the knowledge in one or more directions, but will have also an insight into a variety of problems, with high technical and socio-economical impact.

**Job opportunities**

In-depth research activities concerning the mechanical environment-induced decay of structural materials and constructions is a sound basis for understanding and mastering not only corrosion-, fire- and blast-related events, but any incident that may regard other scenarios related to the safety of large and socially-relevant structures. The job opportunities are basically the same as for structural engineers (universities, public and private research centers, large engineering firms, consulting and insurance companies), but with a plus granted by a large-spectrum formation.

**Composition of the research group**

- 3 Full Professors
- 1 Associated Professors
- 6 Assistant Professors
- 4 PhD Students

**Name of the research directors**

Marco di Prisco
Contacts
marcodiprisco@polimi.it - tel. +390223994400
www.dica.polimi.it

<table>
<thead>
<tr>
<th>Additional support - Financial aid per PhD student per year (gross amount)</th>
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other informations

Educational activity
Teaching assistantship
Computer availability
Desk availability

List of universities, companies and agencies and/or national or international institutions that are cooperating in the research
SUPSI, Canobbio-Lugano (Switzerland) http://www.supsi.ch/
Ben Gurion University of the Negev (Israel) http://www.cs.bgu.ac.il/
University of Stuttgart (Germany) http://www.uni-stuttgart.de
Arizona State University (USA) http://www.asu.edu/
ETHZurich (Switzerland)
EPFLLausanne (Switzerland)
Northwestern University, Evanston (Illinois,USA)
INSAMech. et Durabilité des Constr., Toulouse (France)
CTG-Italcementi, Bergamo(Italy)
CSTB-Centre Scientifique et Technique du Batiment, Marne-La-Vallée (France)
RELUIS (http://www.reluis.it)
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: COMPUTATIONAL AND EXPERIMENTAL MECHANICS

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<th>Context of the research activity</th>
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<tr>
<td>The proposed subject represents an advanced topic for multi-disciplinary research activities, involving expertise in engineering, physics, and medicine. One biennial project (5 per mille Politecnico, 80.000,00), and another grant for equipment (Fondazione Banca del Monte) have been achieved on this topic by Dr. R. Fedele and are now concluded. The CARIPLO project coordinated by Prof. Mariani and granted for the next two years will include also X-ray microCT investigations on polymeric foam samples. The main innovative content is represented by the information provided through X-rays microCT, which, if properly analysed through computer tools, advanced mechanical models and inverse analyses, can represent a sound basis, not only qualitative but truly quantitative, for characterization and modeling of materials and constructs at different scales.</td>
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<tr>
<th>Motivation and objectives of the research in this field</th>
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<tr>
<td>The subject in point will combine non-conventional experiments, mathematical modeling in a framework artlessly multi-scale, and inverse analyses in a sequence (3D Digital Image Correlation, parameter identification). In particular, X-ray computed microtomography will allow one to reconstruct the inner (bulk) microstructure of heterogeneous samples, possibly evolving under complex loading. Moreover, conventional experimental techniques at the macroscale, so far applied in engineering and to be possibly improved, will be considered for a cross validation.</td>
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## Educational objectives

The main objective from an educational standpoint is represented by a full-immersion training into the world of experiments, computer simulations and multidisciplinary applications, rooted into the knowledge of computational mechanics, advanced technologies and matter physics. A doctoral course on this subject was activated last year.

## Job opportunities

From the standpoint of academic career, the work in this multidisciplinary topic will allow Ph.D. students to achieve a wide preparation, both experimental and numerical, oriented to a variety of engineering and biomedical applications, that is expected to be greatly appreciated by many research groups in Europe and in the US. Lately, one post-doc co-worker found a research position abroad. Also private enterprises will appreciate this expertise, at the frontier between several disciplines and especially suitable for R&D activities.

## Composition of the research group

- 0 Full Professors
- 2 Associated Professors
- 0 Assistant Professors
- 0 PhD Students

## Name of the research directors

Roberto Fedele, Stefano Mariani

## Contacts

roberto.fedele@polimi.it  tel. +390223994275  
stefano.mariani@polimi.it  tel. +390223994279  
www.dica.polimi.it

## Additional support - Financial aid per PhD student per year (gross amount)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tbody>
<tr>
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## Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other informations

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**List of universities, companies, agencies and/or national or international institutions that are cooperating in the research**
- Bologna, Dept Physics-INFN
- EMPA (Zurich)
- LMT-ENS Cachan
- University of Milano Bicocca - Geology
- University of Milano - Faculty of Medicine and Surgery
**PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle**

Research Field: COMPUTATIONAL MECHANICS OF MATERIALS AND STRUCTURES

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<th>Methods and techniques that will be developed and used to carry out the research</th>
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<tbody>
<tr>
<td>Advances in computational methodologies (by means of FEM, X-FEM, particle-FEM, and BEM) applied to various challenging and present-day engineering problems, also in multi-scale contexts; inverse analysis based on physical measurements for damage identification and for material characterization (at various scales).</td>
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<thead>
<tr>
<th>Educational objectives</th>
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<tbody>
<tr>
<td>The Ph.D. student engaged in this rather interdisciplinary project is expected to acquire the ability to tackle complex problems and to develop effective problem-tailored solution procedures.</td>
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<table>
<thead>
<tr>
<th>Job opportunities</th>
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<tbody>
<tr>
<td>There is a growing need for post-docs with specific</td>
</tr>
</tbody>
</table>
expertise in computational mechanics and in integrity-assessment methodologies applicable both to civil engineering structures/infrastructures and to industrial components.

| Composition of the research group | 4 Full Professors  
| 2 Associated Professors  
| 1 Assistant Professors  
| 2 PhD Students |
| Name of the research directors | Claudia Comi, Giorgio Novati, Umberto Perego |

**Contacts**

claudia.comi@polimi.it - tel. +390223994215  
giorgio.novati@polimi.it - tel. +390223994257  
umberto.perego@polimi.it - tel. +390223994214  
www.dica.polimi.it

**Additional support - Financial aid per PhD student per year (gross amount)**

| Housing - Foreign Students | -- |
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List of universities, companies, agencies and/or national and international institutions that are cooperating in the research

Universities:
- LMT-Cachan, Laboratoire de Mécanique et Technologie, Cachan (Paris)
- École Polytechnique, Paris
- Polish Academy of Sciences, Warsaw
- Poznan University, Poland

Companies:
- Ente Nazionale Idrocarburi (ENI)
- Venezia Tecnologie (VETEC)
- Dalmine S.p.A.
- Tetra Pak Packaging Solution
- Rtm Breda, Cormano (Milan)

National/International Institutions
- CESI Ricerca (Centro Elettrico Sperimentale Italiano, Milano)
- KMM-VIN (European Virtual Institute)
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: D-ZONES AND ANCHORAGES UNDER SEVERE CONDITIONS

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**Context of the research activity**

Several aspects of reinforced-concrete structures are still open to investigation. Among them the strengthening of existing members and the coupling of different members are considered in this research project. Structural strengthening via external bonding of fiber-reinforced polymer (FRP) composites has become a popular technique all over the world. The performance of the interface between FRP and concrete is one of the key factors affecting the behavior of the strengthened structure. Many experimental and theoretical results are available nowadays on the behavior of these bonded interfaces, but there is still a number of open questions regarding (a) how the bonded length and the FRC plate stiffness affect the behavior of the interface and (b) to what an extent the local phenomena at the ends of the interface affect the structural response. Nonetheless very few data exist regarding the variation of bond properties after exposure to fire.

The coupling of different R/C members and the steel to concrete connection are often performed by means of post-installed rebar or anchors, respectively. In both cases they aim to transfer externally-applied loads to the concrete member. Anchors fail in different ways, but anchors pull-out from the concrete is the best known, as it represents the biggest concern for structural-engineering applications. In the mid 1980s, unconservative and incorrect formulas for the prediction of the pullout capacity were proposed, on the basis of the theory of plasticity. Later, progressive crack propagation...
along a single fractured surface was recognized as the driving force behind headed-anchors pull-out, and linear-elastic fracture mechanics (LEFM) allowed to work out the so-called CCD method (Concrete Capacity Design formula, by Fuchs et al., 1995). However, several aspects are not considered, yet, like the behavior of anchors and post-installed rebar under seismic action or the modifications of strut-and-tie mechanism in D-regions or R/C elements induced by an anchor.

Methods and techniques that will be developed and used to carry out the research

Both the FRP layers bonded to the concrete and the anchors embedded in the concrete need suitable numerical models to be developed, in order to investigate the shear-stress distribution at the interface in the former case and the load-displacement response in the latter case, under both static and dynamic loads. In the former case, appropriate bi-linear bond laws will be implemented. From an experimental point of view, post-installed anchors and rebars will be tested under seismic-type loads, with two components (a shear component and an axial component) or in real scale beam-to-column and column-to-foundation nodes. Anchors behavior will be also modeled by means of 3-D FE codes.

Educational objectives

Concrete and Reinforced-Concrete Mechanics are rather multi-disciplinary, since many and different topics are involved (materials, structures, technological aspects, structural design, testing, modeling...). Consequently, the candidate will not only have the opportunity to contribute to the broadening of the knowledge in one or more directions, but will have also an insight into a variety of problems, with high technical and socio-economical impact.

Job opportunities

An in-depth research activity in the field of concrete and R/C mechanics is a sound basis for understanding and mastering not only concrete-related phenomena, but also the structural behavior in a broad sense, that are used today in a variety of applications. The opportunities are
basically the same as for any structural engineer, but with a plus granted by a large-spectrum formation. In addition, the specific knowledge in the field of post-installed connection can guarantee a career in the R&D department of anchor manufacturing companies.

| Composition of the research group | 1 Full Professors  
1 Associated Professors  
3 Assistant Professors  
0 PhD Students |
<table>
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<tbody>
<tr>
<td>Name of the research directors</td>
<td>Gianpaolo Rosati</td>
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**Contacts**
gianpaolo.rosati@polimi.it - tel. +390223994377  
www.dica.polimi.it

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• University of British Columbia (Vancouver, Canada)
• University of Stuttgart (Stuttgart, Germany)
• UPC (Barcellona, Spain)
• MAPEI
• HILTI
• CTG-Italcementi (Bergamo, Italy)
• ECAP-European Consortium of Anchor Producers
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: EARTHQUAKE ENGINEERING AND STRUCTURAL DYNAMICS

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<th>Context of the research activity</th>
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<tbody>
<tr>
<td>Topics:</td>
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<tr>
<td>Modelling of of r.c. structures under seismic actions</td>
</tr>
<tr>
<td>Modelling of steel structures under seismic actions</td>
</tr>
<tr>
<td>Safety assessment of isolated industrial buildings</td>
</tr>
<tr>
<td>Seismic design of modularized industrial structures</td>
</tr>
<tr>
<td>Dynamics of slender systems with geometrical and mechanical nonlinearities</td>
</tr>
<tr>
<td>Dynamics and control of bridges under wind and earthquake excitation</td>
</tr>
<tr>
<td>Vehicle-structure and pedestrian-structure interaction</td>
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<tr>
<td>Dynamic response of tall buildings under wind excitation</td>
</tr>
<tr>
<td>Dynamic response and seismic design of large machine foundations</td>
</tr>
<tr>
<td>Dynamic response of offshore structures</td>
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<tr>
<td>Experimental and numerical techniques in dynamic fluid-structure interaction</td>
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<table>
<thead>
<tr>
<th>Motivation and objectives of the research in this field</th>
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<tbody>
<tr>
<td>(a) Numerical procedures for the non-linear dynamic analysis of structural systems under dynamic environmental excitation;</td>
</tr>
<tr>
<td>(b) Analytical and numerical methods for the estimation of the response of uncertain structural systems under random dynamic excitation.</td>
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<th>Methods and techniques that will be developed and used to carry out the research</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Ph.D. student is expected to develop multi-disciplinary skills, that will allow him/her to communicate with researchers from different related fields, such as</td>
</tr>
</tbody>
</table>
seismologists, geologists, earthquake and geotechnical engineers.

Job opportunities
Employment is possible in research centers and in consulting companies.

Composition of the research group
1 Full Professors
3 Associated Professors
2 Assistant Professors
0 PhD Students

Name of the research directors
Maria G. Mulas, Federico Perotti, Lorenza Petrini

Contacts
mariagabriella.mulas@polimi.it  tel. +39022399
federico.perotti@polimi.it  tel. +390223994229
lorenza.petrini@polimi.it  tel. +390223994307
www.dica.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

| Housing - Foreign Students | -- |
| Housing - Out-of-town residents (more than 80Km out of Milano) | -- |

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

Educational activity
The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the second year. In some cases, students will be allowed to use part of this funding also in the first year.

Teaching assistantship
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Computer availability
Each Ph.D. student has his/her own computer for individual use.

Desk availability
Each Ph. D. student has his/her own desk, cabinet and locker.

List of universities, companies, agencies and/or national or international institutions that are cooperating in the research

- ENEA, Bologna
- ANIMP, Milano
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: GEOTECHNICAL EARTHQUAKE ENGINEERING

<table>
<thead>
<tr>
<th>Monthly net income of PhD scholarship (max 36 months)</th>
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</tr>
</tbody>
</table>

Context of the research activity

In most recent earthquakes, widespread damage was induced by soil instability and soil-structure interaction problems. The main objectives of research in this field are the following:

(a) advanced numerical and experimental techniques to study dynamic soil behavior for improved seismic characterization of sites, including slope stability and liquefaction;
(b) investigation of the role of nonlinear dynamic soil-structure interaction on the seismic response of structures;
(c) high-performance numerical approaches to study seismic wave propagation from the seismic source to the structure;
(d) investigations for improved seismic actions for design.

Motivation and objectives of the research in this field

Methods and techniques that will be developed and used to carry out the research

(a) 2D and 3D numerical codes for seismic wave propagation in the linear and nonlinear range;
(b) analytical and numerical methods for nonlinear soil-structure interaction analyses;
(c) macroelement constitutive approaches for shallow/deep foundations.

Educational objectives

The Ph.D. student is expected to develop multidisciplinary skills, that will allow him/her to communicate with researchers from different related fields, such as seismologists, geologists, earthquake and geotechnical
Job opportunities
The most direct career opportunities offered by this research field are within research institutions (universities, public or private research centers), large engineering firms and consulting companies.

Composition of the research group
- 2 Full Professors
- 1 Associated Professors
- 1 Assistant Professors
- 5 PhD Students

Name of the research directors
Roberto Paolucci, Claudio di Prisco

Contacts
roberto.paolucci@polimi.it  tel. +390223994353
claudio.diprisco@polimi.it  tel. +390223994298
www.dica.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

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Educational activity
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Desk availability
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List of universities, companies or agencies and/or national or international institutions that are cooperating in the research
Eucentre, Pavia (Italy) http://www.eucentre.it
Istituto Nazionale di Geofisica e Vulcanologia (Italy) http://www.ingv.it
RELUIS (http://ww.reluis.it)
University of Davis
Aristotle University of Thessaloniky, Greece (prof. K. Pitilakis) http://www.auth.gr
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: LIFE-CYCLE PERFORMANCE OF BRIDGES AND STRUCTURES

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Context of the research activity

Motivation and objectives of the research in this field

The aim of this research project is extending/optimizing the lifetime of bridges and structures experiencing damage due to material degradation (caused e.g. by corrosion), extreme events (e.g. earthquakes) or heavy sustained and repeated loads (e.g. high stress and fatigue). The following topics may be chosen by the candidate for her/his thesis: (a) modeling of damaged cables behavior; (b) assessment of residual load bearing capacity of bridges suspended by damaged cables; (c) residual lifetime of concrete structures exposed to corrosion; (d) assessment of lifetime seismic performance of structures and infrastructures; (e) methodologies and procedures for life-cycle analysis, design, and optimization of bridges and civil structures, including maintenance planning and decommissioning.

Methods and techniques that will be developed and used to carry out the research

The attainment of the objectives (a, b) of this research project will require both the theoretical modeling of corroded wires/ropes/cables and numerical non linear analysis of systems composed or suspended by corroded cables. Topics (c, d) will include criteria and methods for modeling damage effects in corroded structures, as well as theoretical modeling by using newly-developed codes or already available FE codes. For topic (e), performance-based techniques will be developed for the lifetime assessment and optimization of bridges and structures.
## Educational objectives

The proposed research is multi-disciplinary, since many and different topics are involved (mechanics of materials and structures, material degradation processes, structural safety and reliability, risk analysis, structural robustness, seismic resilience, among others). A solid knowledge and expertise in the fields of nonlinear mechanics of materials, structural analysis methods, applied chemistry, statistics and probability, are requested.

## Job opportunities

Job opportunities are available in companies involved in the design and retrofitting of bridges and buildings, in public authorities involved in life-cycle assessment and optimization of structures and infrastructure networks.

## Composition of the research group

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## Name of the research directors

Fabio Biondini, Pier Giorgio Malerba

## Contacts

fabio.biondini@polimi.it tel. +390223994394
piergiorgio.malerba@polimi.it tel. +390223994397
www.dica.polimi.it

## Additional support - Financial aid per PhD student per year (gross amount)

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### Educational activity

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activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, typically devoted to support classworks and exams.

**Computer availability**
Each Ph.D. student has his/her own computer for individual use.

**Desk availability**
Each Ph.D. student has his/her own desk, cabinet and locker.

**List of universities, companies, agencies and/or national or international institutions that are cooperating in the research**

- Czech Technical University, Prague, Czech Republic
- Lehigh University, Bethlehem, PA, USA
- Technical University of Catalunya, Barcelona, Spain
- Kansai University, Osaka, Japan
- University of Canterbury, Christchurch, New Zealand
- Tongji University, Shangai, China
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: MICRO ELECTRO-MECHANICAL SYSTEMS AND MICROMECHANICS

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**Context of the research activity**

**Motivation and objectives of the research in this field**

Studying, designing, testing and numerical modelling of Micro- and Nano- Electro Mechanical Systems (MEMS, NEMS) is quite demanding, since MEMS and NEMS are highly sophisticated devices, where electronics is coupled with mechanical parts to the purpose of creating micro- and nano-sensors, micro- and nano-actuators, as well as micro-fluidic devices. MEMS are commonly used in automotive, aerospace and consumer-oriented engineering. Other fields will take advantage of these devices in the next future, like structural engineering, where MEMS may be used for monitoring and self-actuation and biomedical engineering. Strictly related to the field of MEMS are issues related to micromechanics of materials and structures.

**Methods and techniques that will be developed and used to carry out the research**

MEMS-oriented research needs a highly multi-disciplinary approach and a deep knowledge of the fundamentals of physics, mechanics and electronics, as well as a certain familiarity with today's sophisticated techniques for numerical modelling and simulations.

**Educational objectives**

Since the proposed research project is highly multi-disciplinary, the candidate will have the opportunity to collaborate with a number of laboratories and research groups either in the Department of Civil and Environmental Engineering or in other Departments of the
Politecnico di Milano, in industries and in international research centers. He/she will acquire specialized knowledge on MEMS and their related research fields, like micromechanics.

Job opportunities
Direct employment in MEMS- and NEMS-research centers and industries in Europe and all-over the world. Job opportunities in other fields, where experts in multi-physics problems, micro-mechanics, testing and computational methods are requested.

Composition of the research group
- 2 Full Professors
- 2 Associated Professors
- 2 Assistant Professors
- 3 PhD Students

Name of the research directors
Alberto Corigliano, Attilio Frangi

Contacts
alberto.corigliano@polimi.it  tel. +390223994244
attilio.frangi@polimi.it  tel. +390223994213
www.mems.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

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

**Educational activity**
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Each Ph.D. student has his/her own desk, cabinet and locker.

List of universities, companies, agencies and/or national international institutions that are cooperating in the research

- STMicroelectronics www.st.com
- Eniac funded project Lab4MEMS http://www.lab4mems.upb.ro/
- EU funded project Go4Time http://www.go4time.eu/
- IMEC www.imec.be
- Massachusetts Institute of Technology web.mit.edu/
- BSAC BERKELEY SENSOR & ACTUATOR CENTER http://www-bsac.eecs.berkeley.edu/
- University of Freiburg, Freiburg Institute for Advanced Studies (FRIAS), http://simulation.uni-freiburg.de/
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: MICROSEISMIC MONITORING OF UNSTABLE ROCK SLOPES

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### Context of the research activity

The use of acoustic emissions in civil engineering is not new. However, its application to unstable rock slopes for monitoring the intensity of the fracturing activity is still very little explored. On the contrary, the application of this technology in the oil and gas industry for microseismic monitoring of hydrocarbon reservoirs stimulated with hydrofracturing techniques has been growing very rapidly. Thus, the objective is to explore the potential of this technology in its application to unstable rock slopes with the perspective of developing an early warning system.

The research project will take advantage of the last decade scientific and technological advancements achieved in the hydrocarbon industry but new developments are expected for tuning the technology for the specific application. The peculiarity of the environment of a rockslope requires new studies aimed at understanding how the microseismic signals generated by fracturing phenomena can be discriminated by natural noise induced by rainfalls, wind, storms, electromagnetic noise. Seasonal effects related with temperature must be studied and deconvolved from the data. New algorithms must be developed for statistical analysis of these data. Characterization and localization of microseismic events is needed in order to feed a database that the early warning system will use to detect unusual occurrences of events in terms of frequency, intensity, localization or other parameters.
| Methods and techniques that will be developed and used to carry out the research | A sensor network already installed on a rockslope will be available for this project. The candidate will have the opportunity to analyze the data of the last year plus the new data that will be recorded during the Ph.D. period. Possible developments where the candidate will have the chance to contribute are: (a) statistical data analysis and data denoising; (b) analysis of data correlation with meteorological events and study of seasonal cycles; (c) correlation with strain-gage measurements; (d) lab experiments on small rock specimens to simulate freeze-thaw cycles and measure microfracturing noise; (e) event localization through traveltime delay analysis and through amplitude analysis; (f) field tomographic experiments to characterize the rockslope in terms of seismic velocity and seismic attenuation distribution (the velocity and attenuation field are needed for event localization); (g) controlled simulations of small rockfalls to characterize the microseismic signature of rockfalls; (h) integration with other monitoring systems (e.g., photogrammetric systems); (i) development of early warning criteria. |
| Educational objectives | The candidate will increase her/his expertise in the fields of civil protection, geo-engineering techniques, geophysical data analysis, statistical classification, acoustic emission method, remote sensing methods (e.g., photogrammetry, GB-SAR), other geophysical and NDT methods. |
| Job opportunities | The research is expected to open job opportunities in: research institutions (universities, research centers), public or private organizations involved with civil protection activities, environmental consulting or service companies, engineering companies offering NDT and diagnostic services for the civil engineering sector, industries of the hydrocarbon sector. |
| Composition of the research group | 1 Full Professors 1 Associated Professors 2 Assistant Professors 1 PhD Students |
### Name of the research directors
Luigi Zanzi

### Contacts
luigi.zanzi@polimi.it  tel. +390223994271  
www.dica.polimi.it

### Additional support - Financial aid per PhD student per year (gross amount)

| Housing - Foreign Students | -- |
| Housing - Out-of-town residents (more than 80Km out of Milano) | -- |

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#### Desk availability
Each Ph.D. student has his/her own desk, cabinet and locker.

#### List of universities, companies, agencies and/or national or international institutions that are cooperating in the research
- J. Fourier University, Grenoble, France
- Stuttgart University, Germany
- NORSAR (Norway)
- ETH, Zurich, Switzerland
- CNR, Italy
**PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle**

Research Field: SMART MATERIALS AND STRUCTURES

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<tr>
<td><strong>Motivation and objectives of the research in this field</strong></td>
</tr>
<tr>
<td>Sensors and actuators can be conveniently embedded into composites to design smart structures, able to self-detect possible local failures or to react in real time to changing environmental conditions. Smart materials are instead optimized in their microstructure to tailor their stiffness, strength, toughness, and then better withstand the external loadings. Functionally graded and ionic polymer-metal composites will be adopted in the foreseen experimental activity.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Methods and techniques that will be developed and used to carry out the research</th>
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<tr>
<td>Computational mechanics: multi-physics approach to model the sensing and actuation processes, and the coupled materials behaviour. Experimental mechanics: embedding sensors into composite plates to build self-sensing, smart structures.</td>
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</tbody>
</table>

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<tr>
<th>Educational objectives</th>
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<tr>
<td>The research field is across materials and structural engineering. Hence, PhD students are expected to develop a multidisciplinary approach to the problem.</td>
</tr>
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</table>

<table>
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<tr>
<th>Job opportunities</th>
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</thead>
<tbody>
<tr>
<td>Due to the very research-oriented goal of the project, direct employment in research centers or agencies, and industries all-over the world.</td>
</tr>
</tbody>
</table>
**Composition of the research group**

1 Full Professors  
1 Associated Professors  
2 Assistant Professors  
1 PhD Students

**Name of the research directors**  
Stefano Mariani, Alberto Taliercio, Matteo Bruggi

**Contacts**

stefano.mariani@polimi.it  tel. +390223994279  
alberto.taliercio@polimi.it  tel. +390223994241  
bruggi@stru.polimi.it - tel. +390223994250  
www.dica.polimi.it  
www.mems.polimi.it

**Additional support - Financial aid per PhD student per year (gross amount)**

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**Educational activities**

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**List of universities, companies, agencies and/or national or international institutions that are cooperating in the research**

- Polytechnic Institute of New York University
• EADS Innovation Works
• CANEUS International
• STMicroelectronics
• Università La Sapienza, Roma
PhD in STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 30th cycle

Research Field: STRUCTURAL ANALYSIS OF BUILT HERITAGE

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<tr>
<td>The research program deals with the engineering of conservation of existing structures, with a focus on the structural analysis of architectural heritage. In details, the study of built heritage is a multi-disciplinary approach, which considers surveying, monitoring, diagnostic investigation, structural analysis, experimental tests, non-linear computer modelling, repairing and strengthening techniques, etc... The research project will take into account the estimated residual life of existing structures affected by damage due to aging, degradation of the material (for example caused by aggressive environment) and hazard events (such as earthquakes, landslides), with the objective of developing a methodology able to evaluate and compare, in terms of safety, reliability and cost, different scenarios of maintenance and/or rehabilitation and their applicability on civil or industrial existing constructions, with a focus on buildings with cultural value, included constructions built in the 50s and which already present different levels of damage.</td>
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<th>Motivation and objectives of the research in this field</th>
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<td>The following topics may be chosen by the candidate for her/his thesis:</td>
</tr>
<tr>
<td>(a) laboratory experimental research on material characteristics and constitutive laws;</td>
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<tr>
<td>(b) experimental research and calibration of different Non Destructive Techniques (NDT);</td>
</tr>
<tr>
<td>(c) modeling of the material deterioration;</td>
</tr>
<tr>
<td>(d) modeling of material and structural behavior during</td>
</tr>
</tbody>
</table>
hazardous events;
(e) assessment of residual lifetime of deteriorated structures;
(f) assessment of vulnerability of existing buildings in seismic area (e.g. historical centers).

Educational objectives
The candidate will increase her/his expertise in the fields of nonlinear mechanics of materials, structural analysis, applied chemistry, statistics and probability, NDT methods.

Job opportunities
The research is expected to open job opportunities as a researcher within research institutions (universities, research centers), as field engineer or architect in private companies involved in design and rehabilitation.

Composition of the research group
2 Full Professors
2 Associated Professors
5 Assistant Professors
0 PhD Students

Name of the research directors
Luigi Zanzi, Elsa Garavaglia, Lorenza Petrini

Contacts
luigi.zanzi@polimi.it  tel. +39022399
elsa.garavaglia@polimi.it  tel. +39022399
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Desk availability
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List of universities, companies, agencies and/or national or international institutions that are cooperating in the research

- TokyoDenkiUniversity
- TechnicalUniversityofCatalunya
- ThePennsylvaniaStateUniversity
- UniversityofMinho
- KULeuven
- UniversityofPadua
- RELUIS(http://ww.reluis.it)