



**POLITECNICO
DI MILANO**

PhD School of the Politecnico di Milano

**Regulations of the Ph.D. Programme in
Structural, Seismic and Geotechnical Engineering**

Cycle XXXI

Location: Milano Leonardo

1. General Information

Ph.D. School of Politecnico di Milano

Ph.D. Programme: Structural, Seismic and Geotechnical Engineering

Location of the Ph.D. Programme: Milano Leonardo

Subjects (SSD): ICAR/07 – Soil Mechanics
ICAR/08 – Structural Mechanics
ICAR/09 – Structural Design

Ph.D. School Website: <http://www.polimi.it/phd>

Ph.D. Programme Website: <http://www.dica.polimi.it/dottorato/dot-stru>

2. General presentation of the Ph.D. Programme

Structural, Seismic and Geotechnical Engineering - SSGE - consists of the disciplines and techniques that – traditionally deeply-rooted in the field of Civil Engineering, but with important industrial applications as well – allow to understand, model and control the behavior of structural materials, soils, buildings and the interaction between outdoor environment and construction. It is a highly inter-disciplinary field: the theoretical and applied study of materials and buildings goes along with the analysis of the environmental solicitations, either ensuing from action of natural or anthropic actions, and their interaction with the structure. 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.

3. Objectives

Within the context outlined above, the primary objective of this Ph.D. programme is to improve the advancement of knowledge, with reference to: (a) innovation in materials and structures; (b) building and product safety under exceptional static or dynamic solicitations or against the deterioration due to the structure life-cycle; (c) soil and surface/buried structure stability.

This objective is pursued in the framework of the research activities carried out at the Department of Civil and Environmental Engineering of Politecnico di Milano (see for reference http://www.dica.polimi.it/fileadmin/file/Direzione/brochure_DICA_2014_web.pdf). For this purpose, Ph.D. candidates are given advanced, research-oriented training, based on the pivotal role of Structural Engineering and on the multi-disciplinary nature of Seismic and Geotechnical Engineering. More specifically, the 3-year curriculum of the Ph.D. programme in Structural, Seismic and Geotechnical Engineering has the objective of providing the following professional skills that will be developed to a greater or lesser extent according to the specific interests of the candidate:

(a) Basic and operative knowledge of the main, up-to-date methods used in computational mechanics, in order to model and analyze the elastic, inelastic and cyclic behavior of materials, structures and soil.

- (b) Critical understanding and conscious use of numerical codes, depending on the level of the analysis (micro-, meso- and macro-structural levels).
- (c) Basic and operative knowledge of experimental mechanics, including the most up-to-date experimental techniques and their instrumentation, in order to test materials, structures and soil, either in a laboratory or on site.
- (d) Knowledge of the most common procedures for test-based identification of the parameters characterizing the mechanical properties of materials, soils, and structural damage (for assessment of structural safety).
- (e) Basic and operative knowledge of the design criteria and socio-economic implications governing any major structural project.

4. Professional opportunities and job market

The high-level education promised by the Ph.D. programme in Structural, Seismic and Geotechnical Engineering allows Ph.D.s to continue their activity along three paths: (a) in the academic field; (b) within other public or private research institutions or companies with an outstanding trend for research and development; (c) professional activities (typically as an independent self-employed professional or high-level consultant, mainly in the field of advanced structural design and monitoring - Civil and Environmental Engineering and Industrial Engineering). The inter-disciplinary approach of the Ph.D. programme allows to adopt the gained experience in very different spheres: from the design of great infrastructures to the preservation and restoration of the monumental and architectural heritage, from seismic design to slope stability, not to mention many issues in common with several branches of Industrial Engineering (mechanical, aerospace, nuclear and bioengineering).

5. Enrolment at the Ph.D. Programme

5.1 Admission requirements

Italian and foreign citizens can apply. They are requested to have graduated in accordance with the pre-existing laws D.M. 3.11.1999 n. 509 or they to have a master of science degree in accordance with D.M. 3.11.1999 n. 509 or a master of science in accordance with D.M. 22.10.2004 n. 270 or similar academic title obtained abroad, equivalent for duration and content to the Italian title and for an overall duration of university studies of at least five years.

The certified knowledge of the English language is a requirement for admission. Please refer to the Ph.D. School web site for details.

The admission to the programmes will be decided according to the evaluation of the curricula of the studies, the motivation letter and according to an illustrative paper about the development of a possible Ph.D. research, which candidates will send contextually with their application to the admission announcement.

5.2 Admission deadlines and number of vacancies

The number of vacancies is indicated in the Call for admission to the 31st Cycle of Ph.D. Programmes:

<http://www.dottorato.polimi.it/en/looking-for-a-phd/call-for-positions-and-scholarships/>

Scholarships both on general and on specific themes are available, in accordance with what is specified in the call for admission.

6. Contents of Ph.D. Programme

6.1 Requirements for the attainment of the title

The attainment of the Ph.D. title in Structural, Seismic and Geotechnical Engineering requires a study and research activity of at least three years equivalent to full time study, research and development of Ph.D. thesis.

The PhD in Structural, Seismic and Geotechnical Engineering foresees at least 35 credits from Ph.D. level courses to be acquired as indicated in the following paragraph 6.3. Additionally, candidates are required to attend seminar activities organized by the Department, according to the rules defined by the Academic Board.

6.2 Development of the research and of the Ph.D. thesis

The aim of the Ph.D. programmes of Politecnico di Milano is the development in the candidates of a research-oriented mind-set, with expertise and skills in a specific research topic.

To develop a research-oriented mind-set, the candidates have to acquire the capability of problem-solving in complex context, included a deep analysis of the problem, the identification of an original solution and the capability of evaluating a solution and its applicability in given contexts.

These skills provide the Ph.D. candidates with major opportunities of development in their research both in the academic field and in public and private organisations.

The main objective is the development of an original research contribution. The Ph.D. thesis has to contribute to increase the knowledge in the research field of the candidate. Besides, it has to be coherent with the research topics developed in the department, in which the Ph.D. programme chosen by the candidate, is carried out.

The original research has to be submitted through a Ph.D. thesis which contains and discusses the contribution, even in the field of the state of the art in the research community about the research issue.

The Ph.D. research will be developed according to the guideline of a supervisor, who supports the candidate in the setting-out and in the everyday activities regarding the development of the thesis.

The supervisor does not have to be a member of the Professors Board and can also belong to an institution different from Politecnico di Milano. The supervisor can be supported by one or more co-supervisors.

To develop the capability of carrying out research activities, the candidate will have to attend the courses according to the Ph.D. programme, defined for his/her study plan and pass them with a positive evaluation.

For each candidate admitted to the programme, a tutor, belonging to the Board of Professors, is appointed. The tutor supervises and supports the candidate him/her-self in the overall training path. The supervisor and the tutor can coincide. The choice of the courses will be overseen by the tutor, and it will be formalized in a study plan and approved by the Coordinator of the Ph.D. Programme.

Other activities for the development of own personal skill and research expertise are encouraged during the Ph.D. path.

The candidate has to acquire the capability to present and discuss his/her work in his/her research community. Consequently both the participation to international conferences and publication of the research results in international magazines with review are encouraged.

The candidates are also encouraged to carry out part of their research activities in contact with other research groups in their interest field, preferably abroad.

Research visits of at least three months are strongly encouraged at research groups through which the candidate can acquire further skills to develop his/her research work and the thesis.

The duration of the programme is normally three years.

6.3 Objectives and general framework of the teaching activities

The Ph.D. Programmes and the Ph.D. School can activate teaching forms of various kind and of different value (courses, seminars, project workshops, laboratories). All the activities will aim at:

- creating the starting knowledge common to the Ph.D. programme
- examining the basic research issues (problems, theories, research methods) which represent the founding element of the Ph.D. programme and which clearly identify its cultural position;
- deepening in a specialist way some research issues connected with the problems developed in the thesis

Lessons are usually in English language, except when indicated otherwise.

At least one path thoroughly in English language is foreseen in the Ph.D. Programme.

Some teaching activities provide with the rights to acquire ECTS credits (structured teaching activities); other activities, typically specialised and for which it is difficult to evaluate the learning and its quantification, fall within the scientific activities taken into account by the Board of Professors take in the overall evaluation; their value is not quantified in ECTS.

EDUCATIONAL STRUCTURE

The Ph.D. programme in Structural, Seismic and Geotechnical Engineering boasts a group of professors continuously working on the educational aspects of the programme, in order to ensure every year a wide selection of courses for the Ph.D. students, covering all the research areas involved in the programme.

EVALUATIONS

After attending a course, Ph.D. students are requested to pass an exam, whose form (oral, written test or written essay) will be defined within the end of the course by the professor holding the course itself.

Evaluations follow the following grade:

A (corresponding to 30 with Lode and 30)

B (corresponding to 29, 28)

C (corresponding to 27, 26, 25)

D (corresponding to 24 or less, until 18)

E (insufficient)

COURSE PROGRAMMES

Information about course programmes (contents and calendar) can be retrieved on one of these

three media:

Politecnico On-Line Services:

https://aunicalogin.polimi.it/aunicalogin/aunicalogin.jsp?id_servizio=376&profile=0&lang=EN&_pj0=0&_pj1=d61e045b2ec12080abad31210e0fbd22 (registration in AUnica is required to access)

Ph.D. Programme Website: <http://www.dica.polimi.it/dottorato/dot-stru>

The tables here below show the foreseen path for the candidates and they refer only to coursework activities. At the same time, the programme foresees that the candidate is devoted to the research activity in a continuous way, following the lead of his/her supervisor and of the Board of Professor.

First/Second Year (proposal structure to be tailored)

Courses	Possible details or reference to following tables	Number of credits (min-max)	Notes
Ph.D. School Courses	TABLE B	At least 5	Approval of the tutor prior attending is required
Characterising Courses from the Ph.D. programme in Structural, Seismic and Geotechnical Engineering	TABLE A	At least 30	At least 20 of these 30 credits are required to access the second year. Approval of the tutor prior selection of course is required
Other Ph.D. courses	Courses from other Ph.D. programmes held at Politecnico or other universities, such as CISM and Rose School Courses		Approval of the tutor prior selection of course is required

Third year

In the third year the candidate should be devoted entirely to the research and to the development of the Ph.D. thesis.

PH.D. COURSES

A) CHARACTERISING COURSES ORGANIZED BY THE PH.D. PROGRAMME IN STRUCTURAL, SEISMIC AND GEOTECHNICAL ENGINEERING (TABLE A)

The Ph.D. Programme in Structural, Seismic and Geotechnical Engineering organises the following **characterising Courses** (see Table A)

For the admission to the final exam the acquisition of **at least 30 credits** is **mandatory**. These credits have to be acquired through the “characterising” Ph.D. courses offered by the Ph.D. Programme in Structural, Seismic and Geotechnical Engineering.

During the first year, the acquisition of at least 20 credits is mandatory to be admitted to the second year of the Ph.D. programme.

B) GENERAL AND INTERDOCTORAL COURSES ORGANIZED BY THE PH.D. SCHOOL

The Ph.D. School organises every year general and interdoctoral courses and courses with foreign professors. The acquisition of **at least 5 credits is mandatory** among the courses from Table B or from other courses of the PhD School.

The list of the Ph.D. courses organized by the Ph.D. School is available at the following page: <http://www.dottorato.polimi.it/en/during-your-phd/phd-school-courses/>

C) OTHER PH.D. COURSES

The 35 mandatory credits can be obtained by choosing among the Ph.D. course from Table A or Table B, or among other courses provided by other Ph.D. programmes of Politecnico and/or external entities, such as CISM (www.cism.it) or Rose School (www.roseschool.it).

Please remember that the previous approval of the tutor is always mandatory.

D) PREPARATORY COURSES

If the supervisor and the tutor find useful or necessary that the candidate attends preparatory courses (chosen among the activated courses at the Politecnico di Milano) the Board of Professors of the Ph.D. programme can assign some extra-credits to be acquired to complete the training path. **The credits acquired in this way will be considered in addition to the 35 mandatory credits** to be acquired with the Ph.D. level courses.

E) SPECIALISTIC COURSES, LONG-TRAINING SEMINARS

The attendance of specialistic courses, workshops, winter or summer schools, seminars cycles is strongly encouraged and (if these seminars, workshops and so on are certified and evaluated) may permit to acquire credits according the modalities established by the Board of Professors.

For these activities and for the acquisition of credits, prior approval of the study plan by the tutor is mandatory.

These courses and workshops can be inserted in the study plan, even if they are not evaluated (and therefore not qualified as credits), as optional "additional teaching".

To guarantee a sufficiently broad overview of the scientific activities and results in the research areas of interest to the Ph.D. programme, **each year the candidate is required to attend seminar activities organized within the Department**. Specifically, 70% of the seminars suggested to the PhD candidates, or, alternatively, a minimum of 12 seminars per year, must be attended.

The scheduled plannings of the courses for the academic year 2015-2016 are reported below.

Other courses may be activated during the year; in this case, candidates will be promptly informed. The candidates will be able to insert these new courses in their study plan.

TABLE A: PH.D. COURSES CHARACTERISING THE PH.D. PROGRAMME IN STRUCTURAL, SEISMIC AND GEOTECHNICAL ENGINEERING

Area	SSD	Title of the Course	Professor(s)	Semester	Credits
General	ICAR/08	Advanced topics in the finite element method for structural analysis	Umberto Perego, Peter Wriggers, Nicolas Moës	First (november 2015 – January 2016)	5
Structural		Micro Electro Mechanical Systems and additive microfabrication (MEMS&3D)	Alberto Corigliano, Antonio Longoni, Luca Magagnini, Alfredo Cigada, Horacio Espinosa, Marco Cavallaro	First semester	
General	ICAR/08	Non-linear solid mechanics	Anna Pandolfi	To be defined	5
Structural/Seismic	ICAR/08	Advanced structural dynamics	Federico Perotti, Vitomir Racic	To be defined	5
Structural	ICAR/08	Inverse problems and finite element model updating	Roberto Fedele	To be defined	5
Structural	ICAR/09	Computational non-linear analysis of concrete structures	Fabio Biondini	January-February 2016	5
Seismic	ICAR/08	Selected topics in earthquake engineering	Maria Gabriella Mulas	To be defined	5
Structural		Mechanical behaviour of historic masonry structures	Giuliana Cardani	To be defined	5
Structural	ICAR/09	Summer School Textile Reinforced Concrete Design: material and structural behaviour	Marco di Prisco, J. Barros, W. Brameshuber, V. Mechtcherine	Second semester (July 2016)	5
Geotechnical	ICAR-07	Micromechanics of Granular Materials	Calvetti	To be defined	5

TABLE B: SUGGESTED GENERAL AND INTER-DOCTORAL COURSES ORGANIZED BY THE PH.D. SCHOOL

Title of the course	Professor(s)	Semester	Language	Credits
Advanced topics in the finite element method for structural analysis	Umberto Perego, Peter Wriggers, Nicolas Moës	First semester (november 2015 – January 2016)	English	5
Micro Electro Mechanical Systems and additive microfabrication (MEMS&3D)	Alberto Corigliano, Antonio Longoni, Luca Magagnini, Alfredo Cigada, Horacio Espinosa, Marco Cavallaro	First semester	English	5
Any other general or inter-doctoral course proposed by the PhD School				5

NOTES:

- All courses in Table A will be held in English
- Ph.D. students have to take: at least 2 (two) exams from the General Area;
at least 1 (one) exam from the Structural Area;
at least 1 (one) exam from either the Seismic or the Geotechnical area
- The previous requirement does not apply to Ph.D. students enjoying external funding, such as from industry (e.g., “borse a tema”) or from research projects (e.g., “asegni di ricerca”). For them, only the requirement of 2 exams from the General Area applies, while the further doctoral courses can be selected in the area more closely related to their research topic.
- The courses appearing in both Tables A and B can be chosen by the Ph.D. student either to comply with the 30 credits requirement for characterizing courses or with the 5 credits for General and Interdoctoral courses.

6.4 Presentation of the study plan

Each Ph.D. candidate will have to submit his/her study plan. The candidate will have the opportunity to review it periodically (every three months) in order to adequate it to every possible change of the training offer or to needs motivated by the development of his/her study plan. The study plan is approved by the Coordinator of the PhD programme, according to the modalities established by the Board of Professors of the Ph.D. programme itself.

6.5 Instructions for the annual exams

Every year the candidate is evaluated to be admitted to the next year.

In the annual exam of the third year the admission of the candidate to the final exam (held by an external Commission) is evaluated. The candidate presents his/her work to the Board of Professors at least once a year. A written report of the activities carried out during the year and some slides to support the oral presentation to the Board of Professors are required at the end of every year. After every annual evaluation, the candidate will receive an evaluation (A/B/C/D) or, in case the candidate does not pass the exam, he/she will be qualified "Repeating candidate" (Er) or "not able to carry on with the Ph.D. (Ei)".

The last year, the candidate who has achieved sufficient results, but needs more time to draw up his/her thesis, can obtain a prorogation of 6 or 12 months, depending on the evaluation of the Teaching Board.

6.6 Other foreseen reviews

No further reviews are foreseen.

6.7 Instruction for the preparation of the Ph.D. thesis

The Ph.D. study and research work will be carried out, full time, during the three years of the Ph.D. course. The possibility of stages or study periods in Italian or in foreign companies or external entities and universities is foreseen.

The main objective is the development of an original research contribute.

The Ph.D. thesis has to contribute to increase the knowledge in the research field of the candidate.

Besides, the thesis has to be coherent with the research issues developed in the department in which the Ph.D. programme, chosen by the candidate, is developed.

The candidate has to present his/her original thesis, discussing its contribution to the state of the art in the research field within the research community.

The Ph.D. research will be developed following the lead of a supervisor, who supports the candidate in the setting out and in the everyday activities regarding the thesis development.

At the conclusion of the studies, admission of the candidate to the final exam will be evaluated by the Board of Professors and, afterwards, a final exam for the attainment of the title, in which the research work carried out and he thesis will be evaluated by an examination Committee composed by three members, of which at least two external evaluation members.

7. Laboratories, Ph.D. Secretary Services

7.1 Experimental facilities

Experimental research activities related to the Ph.D. programme are supported by various laboratories devoted to structures, materials and geotechnics.

These laboratories are installed in various Politecnico buildings and halls, mainly on Leonardo Campus, namely: (1) a building with a strong floor for testing entire structures under static/dynamic/fatigue loads (steel and concrete structures); (2) a building with 3 presses (a hydraulic, force-controlled press for testing ropes and cables, capacity 500 tons; a hydraulic, fully-controlled press with a capacity of 200 tons and an electromechanical, fully-controlled press with a capacity of 100 tons); (3) a wing with a variety of presses for traditional tests on concrete and with one fully-

controlled, electromechanical press with a capacity of 10 tons, for testing concrete and quasi-brittle materials in tension/compression; (4) a wing containing the geotechnical laboratory; (5) a wing containing the masonry and brick-structure laboratory; (6) a hall containing a furnace for heating concrete and concrete elements up to 1000°C (the tests are performed after a thermal cycle) and a split-type furnace for simultaneous heating and loading of specimens; (7) a 600 m² hall for testing anchor bars with hydraulic actuators from 2.5 to 1000 kN, installed on frames with variable inclination. A biaxial traction device is also installed, with 15 electro-mechanical 25 kN actuators in controlled conditions.

Finally, experimental equipment is also available on the Lecco campus, mainly devoted to investigation of advanced cementitious composites. In particular the following devices are available: (a) set-up for workability measures (b) shrinkage test equipments (c) Hydraulic machines (250, 300 and 3000kN max load) and a universal electromechanical machine (max load 30kN) for mechanical characterization (d) furnace able to reach 1200°C (e) climatic chamber ranging between -40°C and 180°C for freezing and thawing. A specific lab for elements under shock loads is equipped with a shock tube generating a wave with a maximum reflected pressure of 2.5MPa and a velocity of 3Mach. Soil structure interaction and fire-blast interaction can also be investigated with this equipment.

7.2 Computational resources

All Ph.D. students will have a personal computer for their exclusive use.

For high performance computing applications, two clusters for parallel computing are currently available in the Department. It is also worth mentioning that Politecnico di Milano is partner of the consortium CINECA (www.cineca.it), which hosts FERMI, ranked 9th among the most powerful supercomputers in the world.

7.3 Ph.D. Student Secretary Service

Emanuela Zonca

Department of Civil and Environmental Engineering

Tel: +39 0223994322

Mobile: +39 331 6000165

Fax: +39 0223994300

e-mail: phdissg-dica@polimi.it – Skype: emanuela.zonca.polimi

8. Internationalisation and other activities

The carrying out of study and research activities at other laboratories is strongly recommended.

The university proposes also the opportunity of Ph.D. joint paths with foreign universities and of joint and double Ph.D. programmes. Further information are available on the Ph.D. School website and on the Ph.D. programme website.