

Safety assessment and retrofitting of existing structures and infrastructures

01UDLMX

A.A. 2019/20

Course Language

Inglese

Course degree

Master of science-level of the Bologna process in Civil Engineering - Torino

Course structure

Teaching	Hours
Lezioni	35
Esercitazioni in aula	25

Teachers

Teacher	Status	SSD	h.Les	h.Ex	h.Lab	h.Tut	Years teaching
Di Trapani Fabio	Ricercatore L240/10	ICAR/09	35	0	0	0	2

Teaching assistant

▼ Espandi

Context

SSD	CFU	Activities	Area context
ICAR/09	6	D - A scelta dello studente	A scelta dello studente

Anno accademico di inizio validità

2019/20

Course description

The course aims at completing the education of structural engineers under the profile of the assessment and analysis of the existing structures and infrastructures and their strengthening and retrofitting according to National and International technical code provisions. Lectures will first deepen the issue of the acquisition of an adequate level of knowledge of existing structures through structural surveys and inspections aimed at the definition of proper modelling and analysis strategies. After the course will face nonlinear structural analysis and modelling of reinforced concrete and masonry structures subject to static and dynamic loads and the approaches to assess their performance before and after retrofitting interventions using traditional and innovative techniques. References will be finally made to structural health monitoring.

Expected Learning Outcomes

Upon successful completion of this course, the following knowledge and skills are expected to be acquired.

Knowledge:

Theory-based knowledge of static instabilities and seismic damage mechanisms. Code prescriptions to assess and retrofit existing structures. Theory-based structural assessment and design of structural retrofit. Theory and principles of nonlinear analysis of structures. Strength-ductility-reduction factor relationships.

Skills:

Static and seismic damage interpretation. Design of survey campaigns for reinforced concrete and masonry structures. Assessment of "knowledge levels" and "confidence factors" of existing structures. Static and seismic vulnerability assessments. Seismic classification of buildings. Evaluation of strength and deformation capacity reinforced concrete and masonry structural elements after retrofitting interventions. Nonlinear structural analysis and modelling of RC and masonry structures with a FE software.

Prerequisites

Adequate knowledge of structural mechanics and structural engineering, design of concrete structures principles, definition of load conditions and load combinations, ultimate and service limit state analysis.

Adequate knowledge of structural dynamics and earthquake engineering, modal analysis, modal participation factors, modal mass, elastic and inelastic spectrum, reduction factor, response spectrum analysis, capacity design principles.

Basic knowledge of 2D and 3D structural modelling and analysis with a finite element software (elastic analysis).

Course topics

- Analysis of static instability and seismic damage of reinforced concrete and masonry buildings. (3h)
- Approach to the assessment of existing structures according to NTC 2018 and Circolare 2019. (6h)
- i) In situ and laboratory surveys and inspections for masonry and reinforced concrete structures, simulated design.
- ii) Definition of "knowledge levels" and "confidence factors" and individuation of allowed structural analysis methods (linear/nonlinear).
- iii) Definition of "safety retrofitting intervention", "safety improvement intervention", "local intervention".
- Confined concrete models; material ductility, cross-section ductility, structural ductility; Brittle mechanisms and ductile mechanisms. Effect of corrosion. (6h)
- Behaviour, modelling and verification principles of existing masonry structures. (6h)
- Nonlinear static analysis (pushover) theory and application. N2-Method. ADRS representation. Risk index calculation (4.5 h)
- Basic principles of nonlinear dynamic analysis (time history), ground motion selection and seismic fragility. (1.5h)
- Retrofitting interventions for reinforced concrete structures: steel-jacketing; concrete-jacketing; CFRP, FRCC, CAM. (9h)
- i) Flexural retrofitting, shear retrofitting, ductility retrofitting of beams and columns.
- ii) Retrofitting of beam-column joints.
- Retrofitting interventions for masonry structures: Steel and GFRP reinforced plaster, CFRP, CAM. (6h)
- i) In-plane and out-of-plane retrofitting of masonry walls.
- ii) Retrofitting intervention aimed at reducing local collapses.
- Modelling of nonlinear behaviour of reinforced concrete and masonry structures (lumped plasticity approach, fiber section approach) and nonlinear structural analysis examples. (4.5h)
- Retrofitting interventions on bridges (strengthening interventions, base isolation interventions). (3h)
- Retrofitting intervention using devices (base isolation, dampers, hysteretic bracing devices). (6h)
- Dynamic identification and structural health monitoring principles. (4.5h)

Additional information

Sustainable development goals



Course structure

The course will offer the following activities:
Slides and blackboard lessons.
Guided exercises and practical examples solved in the classroom.
Structural FE modelling seminars.
Attendance to laboratory tests (test of a RC beam with and without strengthening interventions).
Blind competitions of student teams simulate experimental test results.
Seminars by invited experts and company delegates.

Reading materials

- G. Manfredi, A. Masi, R. Pinho, G. Verderame, M. Vona. Valutazione degli edifici esistenti in Cemento Armato, Collana di Manuali di Progettazione Antisismica, Vol. 5, IUSS Press.
- Dipartimento Protezione Civile, ReLUIS. Linee guida per riparazione e rafforzamento di elementi strutturali, tamponature e partizioni. A cura di Mauro Dolce e Gaetano Manfredi.
- S. Lombardo. Vulnerabilita' Sismica degli edifici esistenti in cemento armato. Dario Flaccovio Editore;
- L. Cavaleri, V. Radice, Specificita' nella valutazione della capacita' delle strutture murarie di nuova costruzione, Aracne Editrice s.r.l., 2013.
- L. Cavaleri, L. La Mendola. La verifica sismica degli edifici in muratura. Aracne Editrice s.r.l., 2008.
- M. Vinci. Metodi di calcolo e tecniche di consolidamento per edifici in muratura. Flaccovio Editore, 2018.
- M. Dolce, F.C. Ponzo, A. Di Cesare, G. Arleo, Progetto di Edifici con Isolamento Sismico Seconda Edizione, IUSS Press.
- R. Pinho, F. Bianchi, R. Nascimbene. Valutazione sismica e tecniche di rinforzo per edifici esistenti in C.A.
- DM II TT 17 gennaio 2018. "Aggiornamento delle Norme tecniche per le costruzioni".
- CIRCOLARE 21 gennaio 2019, n. 7 C.S.LL.PP. "Istruzioni per l'applicazione dell'Aggiornamento delle "Norme tecniche per le costruzioni" di cui al decreto ministeriale 17 gennaio 2018.
- Eurocode 8.
- Notes and slides of the course provided at the end of the lectures.

Assessment and grading criteria up to 2019/20 a.y.

Exam: Compulsory oral exam; Group project;

The final exam will consist of an individual oral interview starting from the discussion of an assigned project and specific homework which can be realized in a team. The project will concern the assessment of the static and seismic vulnerability of a masonry or reinforced concrete structure and the design of the retrofitting interventions according to the Italian Technical Code and Eurocodes. During the examination, the student will be asked to discuss the design choices illustrating the engineering motivations adopted to define the proposed solution. The student will also be asked to discuss theoretical aspects illustrated in the course showing adequate mastery of the subjects. The exam is passed with a grade of 18/30. The final grade will consider 35% the team project and the homework and 65% the individual oral exam.
