



**Eng. Roberto Fedele, PhD**  
**Associate Professor of Solid Mechanics**  
**Hab as Full professor**  
**(Scienza delle Costruzioni)**

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autorizzo il Politecnico di Milano a pubblicare il presente curriculum sul sito WEB di Ateneo, ai fini istituzionali e in ottemperanza al D. Lgs n. 33 del 14 marzo 2013 “Decreto trasparenza” come modificato dal D. Lgs. 97 del 2016

## **Curriculum Vitae et Studiorum**

Roberto Fedele was born in Naples (Italy) September 13<sup>th</sup>, 1973.

He attended the Secondary School with emphasis on humanities (Liceo Classico), passing the final exam (Maturità Classica) with the mark of 60/60. After the propedeutic biennial courses in Civil Engineering at the Naples University with a high mean mark (over 29/30), He applied for “Scuola Normale Superiore di Pisa-Collegio Sant’Anna”, obtaining a judgement of admission from the put-in-charge commission. However, He renounced to that possibility and preferred to move one year later from Naples to Politecnico di Milano, where He attended the last two year courses in Civil Engineering. In 1999 He has achieved the (5 year) master degree 100/100 *cum laude* in Civil (Structural) Engineering at Politecnico di Milano.

After the Master degree he received the following honors and awards: 1999 Award “Istituto Lombardo Accademia di Scienza e Lettere” (Milan), for master students; 1999 Award of the Association “Carlo Maddalena” (Milan) for master students; 2000 Grant for young researchers by the University of Milan. In 2000 He achieved the qualification for the professional practice as a Structural Engineer, at Politecnico di Milano (mark 94/100).

In 1999 He obtained a PhD position in Structural Engineering at Politecnico di Milano. During the Doctoral School, He developed scientific collaborations with the Ecole Polytechnique of Palaiseau (France, A. Costantinescu), where He spent one week in 2000, and with Joint European Research Centre (JRC) of ISPRA (Varese), where He participated to an experimental campaign in 2001 (in collaboration with M. Whelan). In 2003 He achieved his PhD with a thesis titled “Some parameter identification problems in materials mechanics for civil and industrial applications”, under the supervision of Prof. G. Maier. Thereafter He obtained a Post-doc position on the subject: “Health assessment of large concrete dams”, at Politecnico di Milano.

As a collaborator, he participated to national and European Projects (several MIUR-PRIN projects on dam safety assessment, INCO-Copernicus Project on inverse problems), and to research contracts with private firms (CESI R&D on concrete deterioration, Lucchini R&D on wheels for high-speed trains). Once achieved a permanent position, he has been Principal Investigator or local Unit Coordinator of several multi-disciplinary projects awarded at a national, regional and local level, gathering significant funds.

From 2006 He is Assistant Professor of Solid Mechanics (“Scienza delle Costruzioni”, Sector 08/B2) at Politecnico di Milano, Faculty of Architecture, Regional Pole of Mantua, confirmed in 2009. He has acquired a huge teaching expertise, cumulating about 1,600 hours of frontal lessons for different classes (ranging from fundamentals of statics for architects to finite element programming for

doctoral students in engineering). In 2009 he has achieved the French Qualification as “Maitre de Conference” for the relevant disciplinary Sector.

In 2007 He has spent a 6-month research stay at the ENS Cachan (close to Paris), working with F. Hild’s group on Digital Image Correlation techniques in the framework of the European Project KMM-NoE. In the same research centre during 2008 He was invited for several months as visiting professor, also for high level teaching during doctoral schools. During 2009 He has spent a short research stay (1 month) at the Laboratory of Physics in Bologna (INFN) to investigate possible applications of X-ray micro-tomography to material mechanics. He participated to experimental stages in Grenoble (in 2009) and Trieste synchrotron facilities (2013). In January 2014 he has achieved the Italian Habilitation as Associate Professor of Solid, thereafter in September He won through public competition a position as associate professor at Politecnico di Milano, and from October 16<sup>th</sup> 2014 is officially in service as Associate Professor of Solid Mechanics at Politecnico di Milano. In March 2017 he has achieved the Italian Habilitation as Full Professor.

Number of publications on peer-reviewed international journals: 25;

Book Chapter: 1;

Full papers in conference proceedings: 42;

Short abstracts in congresses: 28.

SCOPUS. Products 40; h-index: 16, without self citations: 12; Overall citations =569 (without self-c.)=292.

ISI-Web of Science (WoS). Products: 35; h-index: 16: Sum of the Times Cited: 433 (w. s. c. 347); Average Citations per Item: 12.3.

GoogleScholar: Citations: 863; h-index =18; number of 10-index contributions: 20;

Research Gate: h-index =17 (without self cit =16); 2,000 reads and 598 citations; RG score: 25.38.

(bibliometric indices were updated on January 2018)

Spoken language: English and French (basic)

He is married, with three children.

### **Academic role and qualifications achieved**

From 2014 October 16<sup>th</sup> Associate Professor of Solid Mechanics in service at Politecnico di Milano.

2017 Italian scientific habilitation as Full Professor (I level Prof.) of Solid Mechanics (with 4 favorable votes over 5 examiners).

2014 Italian scientific habilitation as Associate Professor (II level Prof.) of Solid Mechanics (with 5 favorable votes over 5 examiners).

2006 to 2014, Assistant Professor of Solid Mechanics at Politecnico di Milano (achieved by comparative selection), Faculty of Architecture, confirmed in 2009.

2008, Qualification as “Maitre de Conference” in France, Sector 60: “Mecanique, genie mecanique, genie civil”, date 28/1 /2009, n. 09260197388.

### **Research stages (longer than 1 month)**

At Nantes (France)

2017-2018, 5 months as guest researcher.

At Zurich (Switzerland)

2017, 2 month as guest researcher in the Group "Ceramic based Composites" and at the Laboratory for high performance Ceramics, in Empa.

At Krakow (Poland)

2016, 1 month invited researcher at the Center for High-Temperature Studies at Foundry Research Institute in Krakow.

At Cachan LMT:

2011, 1 month as invited visiting professor, and invited lecturer at CNRS summer school (6 hour seminars) and IUTAM symposium at LMT Cachan;

2010, June and October, overall 1 month stage for an experimental campaign;

2008, 2 months as invited visiting professor;

2007, 6 months in the framework of European Project KMM;

At Bologna: 2009, September, 1 month, research stage on X-ray micro-tomography at the University of Bologna, Institute of Nuclear Physics INFN, radiation group, and several experimental stages.

### **Short stays (shorter than 1 month)**

At Montpellier

2013, invited lecturer at CNRS summer school (6 hour seminars) and participation to the whole school (over one week).

In 2009, At Grenoble participation to an experimental activity at the Grenoble Synchrotron facility ESRF (Beamline 17) for a high resolution X-ray micro-tomography (based on an innovative detector) of a human head phantom. In 2013, at Trieste Elettra synchrotron facility, in 2013 participation to an experimental campaign (Beamline 5) based on micro-tomography of material samples under loading.

### **Development and coordination of research Projects**

- Principal Investigation of the 18-month project (October 2016, September 2018) titled "BridgedJoint", funded by Regione Lombardia and Cariplo Foundation and reserved to ERC finalists achieving a high score ("B") after panel interview. Grant € 100,000.
- **Principal Investigator of a Project proposal submitted to the prestigious European Research Council (ERC) Consolidator Grant 2015, in the PE evaluation panel (Physical Sciences and Engineering). This project passed the Step 1 evaluation (June 2015), and the PI sustained the interview of Step 2 in Brussels in October 2015, but the project was not financed.**
- Principal Investigator of a biennial Project for young researchers (under 40) granted by Politecnico di Milano (Gen 2011-Dec 2012), titled: "Project CINEMAT, based on X-ray microTomography: from images to material properties". Grant € 80,000.
- Principal Investigator of a biennial Project granted by Fondazione Cariplo (a private foundation) on innovative materials (April 2011-March 2013): "Innovative joints between metals and ceramics for high and ultra high temperature applications (UHT)". The project included as partners Politecnico di Torino and CNR-IENI (Genua Unit) with expertise in material science. The call was open to all universities and research centres in Lombardia (North Italy) as Principal Investigators. Grant € 315,000.
- Local Coordinator of a Research Unit in PRIN '07, granted by National Ministry of Research (MIUR), during 2008-2010. The Project included five research units in Italy. Grant € 64,000.
- Principal Investigator of a project including the design and development of innovative experimental instrumentation, in collaboration with the Department of Applied Geology at State

University of Milan, granted by Fondazione Banca del Monte di Lombardia (2011). Grant € 30,000.

- Coordinator of a Research Group within a national Italian Project of university-industry cooperation (MISE-ICE-CRUI granted by Italian Rector Association CRUI and the Institute of Foreign Trade ICE), during 2009-2011. The project included an academic (as P.I.) and an industrial partner. Grant € 42,000.
- Organizer (together with other colleagues) of the following biennial young-researcher projects: "Characterization of FRP reinforced structures", granted by the Dept of Structural Engineering, Politecnico di Milano (2009-2011). Grant € 15,000, "Characterization of innovative materials by nanoindentation" (Gen 2011-Gen 2013), Grant €15,000.

For other several calls the proposals presented by Prof. R. Fedele were not awarded: he applied, as Principal Investigator, to national calls (3 FIRB Calls from the Italian Ministry of Research devoted to young researchers under 40, with projects including several research units in Italy), regional (3 Calls from CARIPLO Foundation, with multidisciplinary teams including Politecnico di Torino and CNR), local Call (1 Politecnico di Milano young research call, 1 Polisocial call for social interest projects); also he applied as National coordinator to 1 and as Local Unit coordinator to 3 Italian national PRIN Calls from the Italian Ministry of Research (with projects including several research units) 1 national MISE ICE CRUI call (the proposal included one academic and industrial partner), 1 bilateral Italy-France project.

- Responsible of the following research contracts:  
during 2017-2018, 1 Post-Doc position for highly qualified researcher, Prof. Eng. Fareeha Ahmeed (12 months) , currently working as an associate professor in Pakistan.  
during 2008-2009, Post-Doc position, Dr. Eng. Ada Zirpoli (11 months) , currently working as a geotechnical engineer.  
during 2010, Post-Doc position, Dr. Eng. Roberta Santoro (5 months) , currently habilitated as Ass. Prof. of Solid Mechanics.  
during 2011, Graduate Position, Dr. Luca Ragazzini (4 months) , now in the industry.  
during 2011-13, Post-Doc position, Dr. Luca Galantucci (28 months), post-doc in Italy.  
during 2011-13, Post-Doc position, Dr. Antonia Ciani (28 months), post-doc abroad.  
during 2011-13, Post-Doc position, Dr. Eng. Salvatore Sessa (24 months), currently working as a structural engineer.  
during 2013, brief collaboration contract with duration 2 months.
- Organizer (together with Professors G. Rosati and G. Milani) of a Mini-Symposium during 11<sup>th</sup> International Conference of Computational Methods in Sciences and Engineering 2015 (ICCMSE 2015), held in Athens (Greece) during April 2015, titled: "Advances in experiments and modelling of masonry elements".
- Organizer (together with Professors Hild and R  thor  ) of a Mini-Symposium at the WCCM XI Conference to be held in Barcellona 2014, titled: "Innovative experiments combined with mathematical modelling and inverse analyses".
- Organizer (together with Professors G. Rosati and G. Milani) of a Mini-Symposium during 10<sup>th</sup> International Conference of Computational Methods in Sciences and Engineering 2014 (ICCMSE 2014), held in Athens (Greece) during April 2014, titled: "Advances in experiments and modelling of masonry elements".
- Organizer (together with Professors Bertolino, Hild, R  thor  ) of a Mini-Symposium at the ECCM Conference held in Paris 2010, titled: "Innovative experiments combined with mathematical modelling and inverse analyses".
- Organizer (together with Professor A Morassi) of a Mini-Symposium at the AIMETA Italian National Conference to be held in Bologna 2011, titled: "Inverse Problems of Materials and Structures".

- Responsible for 2 foreign Master Student research stage at Politecnico di Milano (partly supported by Prof. Fedele)
  - Arno Rol, 1<sup>st</sup> year Master graduate course Engineering, 3 month during 2017, from ENSTA-ParisTech (Université Paris-Saclais).
  - Lina Oudrhiri, 2<sup>st</sup> year Master graduate course Engineering, 3 month during 2016, from university of Lille.
  - Dimitri Jalocha, 1<sup>st</sup> year Master graduate course Engineering, 3 month during 2011, from ENS Cachan, currently PhD student at Ecole Polytechnique.
- In Aprile 2015, Foreign Rapporteur in the Jury for PhD thesis defence by Eng. Pierre Baudoin, at University of Lille

### **Collaboration with Industrial Firms and Private Enterprise**

2016 Responsible for a 1-month contract with the Italian firm Faro s.r.l for the design of a specific mechanical test on structural pin € 1,850.

2013 Responsible for a 1-month contract with the Italian firm Altalab s.r.l for the design and structural assessment of a biomedical equipment € 2,500.

### **Invited Seminars**

2018, January 31, invited seminar on "Recent advances on Digital Image Correlation and inverse problems" at Ecole Centrale de Nantes.

2017, February 24, invited seminar on "Digital Image Correlation: computational features" in the at Empa, Dubendorf (Switzerland).

2017, February 20, invited seminar on "X-ray computed microtomography" at Empa Thun (Switzerland).

2017, January 11, invited seminar on "X-ray computed microtomography" at Empa, Dubendorf (Switzerland).

2016, December 7, invited seminar on "X-ray computed microtomography" at Foundry Research Institute, Krakow.

2016, invited lesson (1,5 hour) on "X-ray computed microtomography" in the Workshop on "Characterization of materials" for the Doctoral School, Department of Chemical engineering and Material Science, Politecnico di Milano.

2016, Invited communication in Minisymposium on "Applications of Digital Image Correlation" organized by Marc Francois and Gabriele Tebaldi, 8th RILEM International Conference on Mechanisms of Cracking and Debonding in Pavements, 7-9 June 2016, Université de Nantes, France.

2016, May, Politecnico di Milano, Dept. of Mathematics, invited communication on "Applications of X-ray microCT at Politecnico di Milano", at the Meeting on Tomography and Applications.

2013, May, 6 hour lesson at CNRS summer school on full-field measurements and identification techniques, at Laboratoire de Mécanique et Génie Civil (LMGC), Montpellier (France).

2011, June, 6 hour lesson at CNRS summer school on full-field measurements and identification techniques, at Laboratoire de Mécanique at Technologie (LMT), ENS-Cachan (France).

2011, July, Invited communication at IUTAM symposium on full-field measurements, at Laboratoire de Mécanique at Technologie (LMT), ENS-Cachan (France).

2014, May, Politecnico di Milano, Dept. of Mathematics, invited communication on 3D-Volume DIC combined with X-ray microCT, at the Meeting on Tomography and Applications.

2012, May, Politecnico di Milano, Dept. of Mathematics, invited communication on X-ray microCT under in situ loading, at the Meeting on Tomography and Applications.

2009, July, University of Cagliari, Mechanical Engineering: 1 hour seminar: "Identification of interface cohesive properties by DIC".

2007, May, at Laboratoire de Mécanique at Technologie, ENS-Cachan (France), 1 hour Seminar: "Inverse problems for civil applications".

2009, Politecnico di Milano, Dept. of Structural Engineering, 4 hour lessons within a Doctoral Course titled "Inverse problems in materials and structural mechanics".

2007, Politecnico di Milano, Dept. of Structural Engineering, 4 hour lessons for the Doctoral Course: "Inverse problems".

2003, Politecnico di Milano, Dept. of Structural Engineering, 2 hour lessons for the professional course for Engineers: "Properties and behavior of structural materials".

### Teaching activity

Responsible of the classes (see the legend below) with overall 184 credits (about 2,200 hours of frontal teaching), a part of which at the Regional Pole of Mantua (180 km far from Milan, 2 hour travel)

a.y.	Faculty /School	Course		Typology	Credits cfu	Year (over 5)	Hours theory	Hours exercise
2018-2019	Ing Ind – INF (BOVISA)	Fondamenti di Meccanica Strutturale		CM	10 alta onerosità	III	70/90	30
	Arc - URB - COST	STRUTTURE E CRITERI DI PROGETTAZIONE ANTISISMICA		CI	4	IV	20	25
	Arc - URB - COST	TIMBER, MEMBRANE AND GLASS STRUCTURES	English	CM	4	IV/V	40	
2017-2018	Arc - URB - COST	STRUTTURE E CRITERI DI PROGETTAZIONE ANTISISMICA		CI	4	IV	20	25
2016-2017	Architettura Studi Urbani Costruzioni	Scienza delle Costruzioni (Mantova)		CM	8	III	36	48
	Architettura Studi Urbani Costruzioni	Laboratorio di Prog. Architettura 2: Strutture		CI	4	II	20	40
	Architettura Studi Urbani Costruzioni	<b>Architecture Construction Studio: Structural Design</b>	English	CI	4	IV	20	40
	Architettura Studi Urbani Costruzioni	Laboratorio di Prog. Architettura 3: teoria e progetto di costruzioni e strutture		CI	6	III	25	40
2015-2016	Scienze dell' Architettura Mantova	Scienza delle Costruzioni		CM	8	III	36	48
	Scienze dell' Architettura Milano	Laboratorio di Prog. Architettura: Strutture		CI	4	II	18	24
	Scienze dell' Architettura Milano-Bovisa	Laboratorio. di Prog. Architettura: Teoria e progetto di Costr. e Strutture		CI	4	II	18	24
2014-2015	Scienze dell' Architettura Milano	Scienza delle Costruzioni		CM	8	III	36	48

	Scienze dell' Architettura Milano	Statica		CI	4	I	18	24
	Scienze dell' Architettura Mantova	Scienza delle Costruzioni		CM	8	III	36	48
2013-2014	Scienze dell' Architettura Milano	Scienza delle Costruzioni		CM	8	III	36	48
	Scienze dell' Architettura Mantova	Scienza delle Costruzioni		CM	8	III	36	48
2012-2013	Scienze dell' Architettura Milano	Scienza delle Costruzioni		CM	6	III	26	38
	Scienze dell' Architettura Mantova	Scienza delle Costruzioni		CM	6	III	26	38
2011-2012	Scienze dell' Architettura Milano	Scienza delle Costruzioni		CM	6	III	26	38
	Scienze dell' Architettura Mantova	Scienza delle Costruzioni		CM	6	III	26	38
2010-2011	Scienze dell' Architettura Mantova	Scienza delle Costruzioni	Meccanica delle strutture	CI	6	III	26	38
	Scienze dell' Architettura Mantova	Concezione e progetto di strutture		CM	4	III	17	26
2009 / 10	APE Edilizia Mantova	CI Teoria delle strutture		CI	6	II	26	38
	Scienze dell' Architettura Mantova	CI Scienza delle Costruzioni	Meccanica delle strutture	CI	6	III	26	38
2008 / 09	Scienze dell' Architettura Mantova	CI Teoria e progetto di costruzioni e strutture	Meccanica delle strutture	CI	4	II	17	26
	Scienze dell' Architettura Mantova	CI Teoria e progetto di costruzioni e strutture	Concezione strutturale	CI	4	II	17	26
	Architettura Ambientale Milano	Scienza delle costruzioni (pregressi)		CM	6	III	26	38

2007 / 08	Scienze dell' Architettura Milano	CI Teoria e progetto di costruzioni e strutture:	Meccanica delle strutture	CI	4	II	22	27
	Scienze dell' Architettura Milano	CI Teoria e progetto di costruzioni e strutture:	Concezione strutturale	CI	4	II	22	27
	Scienze dell' Architettura Mantova	CI Scienza delle costruzioni:	Meccanica computazionale	CI	2	III	11	14
	LS Architettura Mantova	CI Teoria delle strutture:	Teoria delle strutture	CI	4	IV	22	27
2006 / 07	Scienze dell' Architettura Milano	Teoria e progetto di costruzioni e strutture 2		CM	4	II	22	27
	Scienze dell' Architettura Mantova	Scienza delle costruzioni		CM	4	III	22	27
2005 / 06	Scienze dell' Architettura Mantova	Teoria e progetto di costruzioni e strutture 2		CM	4	II	22	27
	Architettura Ambientale Milano	Teoria e progetto di costruzioni e strutture 1		CM	4	I	22	27

**Legend:** CI=integrated course (divided into 2 coordinated parts, possibly with 2 diverse teachers), as opposite to CM=monographic course (unique teacher); LS=master degree (if no otherwise specified, graduate course) .

Seminars and Exams for support to other colleagues:

- 2006-2007. Faculty of Engineering: overall 24 hours for the course “Computational Mechanics I” (Prof. A. Corigliano, Civil Eng.).
- 2005-2006. Faculty of Engineering: overall 32 hours for the courses: “Computational Mechanics I”(Prof. A. Corigliano); “Solid Mechanics I” (Prof. A. Zavelani, Aerospace Eng.); “Materials mechanics and constitutive behaviours” (Prof. C. Comi, Civil Eng.).
- 2004-2005. Faculty of Engineering: overall 35 hours for the courses: “Solid Mechanics I”(Prof. A. Zavelani); “Computational Mechanics I” (Prof. A. Corigliano).
- 2003-2004. Faculty of Engineering: 25 hours for the course “Solid Mechanics I”(Prof. A. Zavelani).

#### Doctoral Courses

- Proponent and lecturer for the PhD course titled: “**Inverse problems and finite element model updating**”, held at Politecnico di Milano in the framework of the Doctoral School in Structural, Geotechnical and Seismic Engineering in 2013, 2015 and 2019, overall 25 hours, with participation of a foreign professor for a few hour lesson.
- Proponent and lecturer for the PhD course titled: “**Inverse problems and finite element model updating**”, held at University of Trento, November 2014, Doctoral School in Civil Engineering, overall 25 hours.
- Lecturer at CNRS Summer School in France (post Master teaching) in 2011 and 2013 (6 hour theoretical and practical lessons for each course)

#### Co-supervisor of Theses

He has been co-supervisor for the following theses:



- 2013, a Thesis for Third year Graduate Courses in Architecture, on simplified collapse analysis of ancient monumental buildings by rigid blocks.
- 2005-2007, a PhD thesis of Eng. Alaleh Tavakoli on the subject: "Diagnostic analyses of concrete dams by flat-jack tests";
- 2011-2012, a master-degree thesis ("tesi", 5 year) on the subject: "Delamination tests for FRP masonry pillars: experiments and simulations"; 2007-2008, a master-degree thesis ("tesina", 5 year) on the subject: "Experimental and numerical investigation of an adhesive for civil applications"; 2005-2006, a master-degree thesis ("tesi", 5 years) on the subject: "Identification of mechanical properties by flat-jacks"; 2004-2005, a master-degree thesis ("tesi", 5 year) on the subject: "Identification of mechanical properties of dam concrete by tests in situ by two hole tests"; a master-degree thesis ("tesina", 5 year) on the subject: "Simulation of concrete deterioration due to alkali-aggregate reaction".

R. Fedele is in the Editorial Board of the peer-reviewed open-access International Journal "Mathematical Problems in Engineering" (ISSN: 1024-123X (Print) ISSN: 1563-5147 (Online) DOI: 10.1155/2629 I.F. 1.082 according to 2013 Journal Citation Reports released by Thomson Reuters in 2014.) from March 2015. R. Fedele has been a reviewer during 2002-2014 for the Journals: "Construction and Building Materials", "Materials and Structures", "Optics and Lasers in Engineering", "Computational Material Science", "Journal of Engineering Mechanics", "Experimental Mechanics"; "International Journal of Solids and Structures"; "Composite Structures"; "Engineering and Computational Mechanics", "Archive of Applied Mechanics", "Computers and Structures"; "Composites part B", "Engineering Structures"; "Inverse Problems in Science and Engineering"; "Journal of Global Optimization", "Composite Structures", Proceedings of ImechE Part B-Journal of Engineering Manufacture", "Journal of Mechanical Engineering Science", "Journal of Sound and Vibration", "Journal of Materials Engineering and Performance".

Moreover, from 2011 He is been a reviewer for the National Science Foundation of Romania.

### **Internal Jobs and Commissions at Politecnico di Milano**

- (i) Head of the Commission for the bachelor degree session in Architecture.
- (ii) Invited Member of Doctorate Board in the Doctoral School of Civil, Geotechnical Engineering, from April 2016
- (iii) Responsible for the organization of Scientific Seminars at the Dept. DICA, together with Prof. Federica Migliaccio, from October 2013 to 2017.
- (iv) Scientific Commission at the Dept. DICA: Elected Member as representatives for assistant professors (2013-2014) Joint meetings and work for about 36 hours.
- (v) Commission for the admission to the Master Degree in Architecture (2008-2011) (Members: C. Di Biase, C. Peraboni, R. Fedele). Joint meetings for about 40 hours.
- (vi) Delegate to represent the Dean of Dept. DICA at the Mantua Regional Pole Council (2013) Meeting for about 4 hours.
- (vii) Department Commission for personnel evaluation UNA TANTUM (2014), 7 hour meeting.
- (viii) President of the put in charge Commission at Politecnico for X-ray microCT facility acquisition (European competition) (2014-2015), 15 hour meeting.

### **Brief description of research activity**

Research activity of Prof. Eng. R. Fedele concerns the following topics (on each topic only the main contributions are cited).

- (a) Strategies for Finite Element Model Updating (FEMU). Both deterministic and stochastic approaches for ill-posed parameter identification problems were investigated, improved by regularization provisions (Extended Kalman Filter, strategies based on information fusion such as Bayesian approach, Monte Carlo simulations with confidence interval estimation for sampling

moments). Strategies for sensitivity analyses were developed, for gradient computation and optimal data location (based on linear complementarity formulation or on more general Direct Differentiation Method): as an alternative, heuristic minimization strategies were utilized (genetic algorithms, ANNs, hybrid strategies). Both overall static data relevant to the whole specimen, and local full-field kinematic data concerning a monitored region were considered as measurable quantities. Codes were developed in Matlab and/or Fortran environments, coupled with FE programs available in commerce (such as Abaqus<sup>®</sup> or FEAP<sup>®</sup>) or developed by the user.

(b) Optimal design of mechanical tests. Innovative experiments at different scales were conceived, endowed by non-conventional monitoring techniques for the assessment of advanced materials and constructs and relevant parameter identification procedures. Ad-hoc loading apparatus and equipment were realized (also through LabView<sup>®</sup> interfaces), and novel experimental activities were developed, both in the laboratory (mechanical tests at different scales, with optical monitoring and possibly at high temperature by a novel furnace ad-hoc realized) and in situ (flat jacks on existing dams). X-ray microCT experiments on small samples under loading were performed by laboratory source or also synchrotron light.

(c) Cohesive fracture and debonding processes. Mechanical models for fracture were assessed on the basis of novel experimental campaigns and innovative tests, with reference to: quasi-brittle damaging materials (concrete and masonry elements, reinforced by external FRP sheets also along curved supports; concrete samples subjected to wedge splitting test), composites and joined assemblies (GLARE for aerospace applications, adhesives, innovative joints between metals and ceramics for aggressive environments). Novel strategies for the identification of local cohesive crack parameters were proposed, based on full-field kinematic measurements. To this purpose “virtual tests” were considered, focusing on small regions over the monitored sample surface for which boundary data can be prescribed, possibly regularized to reduce spurious oscillations and noise. Nonlinear FE codes were implemented in Matlab/Fortran environments, including interface elements and coupled with identification procedures (available in Matlab as built-in functions or developed ex-novo). Cohesive parameter sensitivities were computed by the Direct Differentiation Method and implemented in the same FE codes for forward analyses.

(d) Digital Image Correlation (DIC). Algorithms were developed to solve the inverse problem of motion estimation, on the basis of 2D (plane surface) and 3D (inside a volume, based on X-ray microtomography) digital images, respectively, acquired at different loading phases during innovative experiments. Such algorithms were extensively used for different applications also as an input for FE models and identification procedures, namely: debonding processes in composites and joined assemblies; delamination of FRP reinforcement from a damageable support; local cell deformation in polymer foams. A variational formulation for the continuum problem and a Galerkin discretization of the displacement field were developed (implemented in Matlab and/or Fortran), improved with: parallel strategies and block-wise computations to reduce memory storage when dealing with tomographic images; hierarchical, multi-scale strategies combined with image pyramids; Tychonoff regularization provisions. Experimental campaigns were developed, including 2D optical monitoring of sample surface, and X-ray microCT of small samples (approximately 1 cm thick) under in situ loading, both by laboratory and synchrotron sources (Grenoble in France, Elettra in Trieste).

(e) Diagnosis of existing dams. The health state of possibly deteriorated concrete dams was assessed on the basis of the overall response history (using conventional monitoring provisions under seasonal reservoir level and temperature variation, such as pendula and collimators, or by non conventional ones such as radar) and, as an alternative, by local experiments (i.e. flat jacks [9,38] and pressurized hole test). In situ tests on a large concrete dam in Italy were realized.

(f) Chemical-physical deterioration of concrete structures. Chemical-thermo-damage models for concrete affected by alkali-silica reaction (ASR) were investigated, and implemented in finite element codes (by Umat routine in Abaqus<sup>®</sup> code), for simulating the long-term structural response

of large massive structures (such as dams) taking into account mechanical loading as well as local temperature and humidity history, and the possible reduction of ultimate strength in terms of “overtopping wave” height. Strategies for the identification of governing parameters were proposed in a Matlab environment, based on the response of accelerated tests on small concrete samples affected by ASR available in the literature.

(g) FRP-reinforced masonry and concrete elements. Single-lap shear tests were performed on concrete and masonry elements (also with historical bricks or a curved support) reinforced by FRP sheets. Tangential slips between the reinforcement and the support during delamination experiments were monitored by conventional “point” sensors and by no-contact, full-field 2D Digital Image Correlation procedures. Advanced FE heterogeneous models, both plane and fully three dimensional, were developed to simulate the experimental response of reinforced pillars under the simplifying assumption of perfect adhesion and of damageable support. FE models were also used to assess design formulae for FRP-strengthened masonry elements proposed to practitioners.

(h) Mechanical response of railway wheels for high speed trains. Elastic-plastic models suitable to describe the cyclic behavior of ductile materials were investigated. In view of parameter estimation novel strategies were proposed, based on out-of-phase tension-torsion experiments on small compact specimens, extracted from different locations of the wheels.

(i) Homogenization of periodic media. Strategies for the homogenization of heterogeneous periodic materials with nonlinear ductile behaviour were investigated, and implemented into finite element codes (through kinematic periodicity conditions prescribed on a Representative Volume Element). The identification of phase constitutive parameters at the micro-scale, possibly altered by the production processes, was proposed on the basis of the overall response at the macroscale. The inverse strategy was validated through an experimental campaign on periodically perforated metal sheets, and matrix plastic properties comparatively assessed before and after the perforation process.

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A handwritten signature in black ink, reading "Roberto Fedele". The signature is written in a cursive, flowing style with a large initial 'R'.