Structural Health Monitoring by Full-Field Measurement Techniques and Simulation Models

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Overview

Existing structures and infrastructures of strategic relevance are under continuous surveillance to guarantee adequate safety levels, which may be compromised by accidental actions as well as by material deterioration due to aging. This is for instance the case of several large concrete dams built up in the50's and 60's in the Alpine region of Italy and still in operation. Similar issues concern also important Indian installations like Bhakra Dam (226 m high, 1963), near the border between Punjab and Himachal Pradesh, Koyna Dam (103 m, 1964), Cheruthoni Dam (138 m, 1972), Rihand Dam (91 m, 1962), just to quote a few. In this context, structural integrity can be assessed by the monitoring of the dam response to natural external actions, like seasonal temperature changes and the fluctuation of the reservoir level. The geometrical configuration changes can be detected by full-field non-contact measurement techniques resting on radar monitoring (in particular, by ground-based radar interferometry). This portable instrumentation can return the map of displacements of the monitored surface, as shown for instance in Figure 1 (a), with a mm precision.

Portable multifocal microscopes can provide similar information on a different scale (µm or sub-µm). As an example, Figure 1 (b) shows the mapping of the residual imprint left on the surface of a steel pipe by an instrumented indenter, Figure (1c). Simpler hardness tester can provide a similar output, which can be exploited for the non-destructive procedures in-situ diagnosis of steel components of structures and infrastructures, like pipeline networks for oil and gas transportation.

The mechanical response of structural components and laboratory samples of intermediate size with respect those considered in the above meaningful examples can be monitored during diagnostic experiments can be recovered by correlation technique applied to the digital images that can be acquired by (video)-cameras during properly designed experiments, as for instance shown by Figure 1(d). Stereoscopic vision system allow three-dimensional reconstructions.

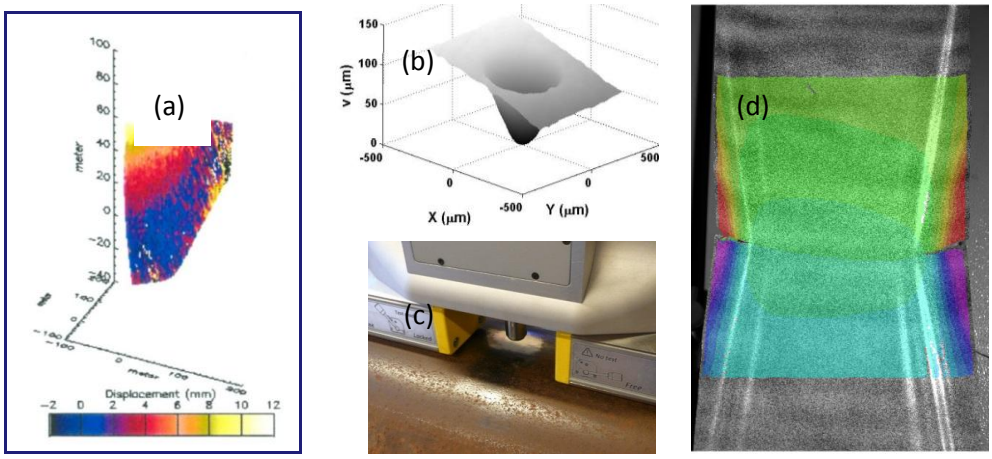

Figure 1. Radar reconstruction of the displacement distribution on the downstream face of a dam (a); map of the residual displacements left on the surface of a steel pipe by an instrumented indenter (b, c); digital image of a thin metal foil under tensile load and DIC reconstruction of the corresponding displacement distribution (d).

Full-field measurement techniques permit to collect a large amount of data to model verification and structural diagnostic purposes. The reliability of the predictions based on this kind of information can be improved with the support of interpretation models of increasing realism, which take into account the occurrence of non-linear phenomena associated to localized or distributed damages, or large inelastic deformations. On the other hand, measurements and modelling assumptions of damage structures can be subjected to significant uncertainties, which can be properly dealt with only by stochastic approaches, which are seldom implemented due to their high computing times and costs.

However, specific model reduction techniques permit to reduce dramatically the burden associated to the repetitive simulations required by stochastic analysis and by indirect parameter calibration. Effective material characterization procedures have been therefore developed, which combine experimental and computational tools and provide results in almost real time for routine use in industrial environment.

This short course will give a comprehensive overview on the main techniques at present available for:

- full-field monitoring ;
- interpretation models of the measurements;
- model verification and parameter identification;
- model reduction.

The lectures will illustrate the possibilities at present offered by computational tools to the effective exploitation of information returned by advanced experimental techniques. Fundamentals will be integrated with the critical review of recent experiences relevant to the synergetic coupling of the experimental and computational tools mentioned above, exploited to either model calibration or model verification purposes in materials mechanics context.

Modules	**A. Introduction to Structural Health Monitoring (SHM), 16th June 2018** **B. Application of SHM in the field of Civil, Industrial and Electrical Engineering, 17th June 2018** **C.. Full-field monitoring techniques 18th June, 2018** **D.. Interpretation models 19th June, 2018** **E. Model verification and parameter identification 20th June, 2018** **F. Model reduction techniques 21st June, 2018** **G Case studies 22nd June, 2018** **Number of participants for the course will be limited to Forty.**
You Should Attend If…	**A. Engineers, Faculty, Researchers and professionals engaged in structural Health Monitoring** **B. UG/PG/Research Students from Civil Engineering**
Fees	**The participation fees for taking the course is as follows:** **Participants from abroad : US $50** **Industry/ Research Organizations: ` Rs. 2000** **Academic Institutions: ` Rs. 1500** **Students (General) Rs. 1000** **Students (SC/ST) Rs. 500** **The above fees include all instructional materials, computer use for tutorials and assignments, lab. equipment usage charges, 24 hr free internet facility and Catering to the participants. Host Institute will arrange field visit to the site for participants during the course. The participant will have to bear the nominal accommodation charges as per institute norm. Fees must be paid in form of crossed Bank Draft drawn in favour of the Registrar, NIT Hamirpur payable at State Bank of India, NIT Hamirpur (Branch code No. 10367).**

The Faculty

Gabriella Bolzon is Associate Professor of Structural Engineering in the Department of Civil and Environmental Engineering at the Politecnico di Milano (POLIMI). POLIMI is one of the main technical universities in Italy and one of the most outstanding in Europe. Founded in 1863, it represents the largest school of Architecture, Design and Engineering in Italy, offering a wide experience in teaching and training from undergraduate (Bachelor) to PhD level. POLIMI staff members provide external services and research support to a number of customers (large Companies, SMEs, public bodies and administration) including business acceleration, patenting and licensing, life-long training opportunities. According to the QS World University Rankings by Subject 2015 (www.topuniversities.com), POLIMI is ranked 1st in Italy, 5th in Europe and 13th all over the world in the research area of Civil & Structural Engineering. Gabriella Bolzon is a lecturer in the POLIMI MSc course in Civil Engineering for Risk Mitigation, and serves as the reference person for the international exchanges in this area. She is faculty member of the PhD School in Structural, Seismic and Geothechnical Engineering at POLIMI and has been the supervisor of several PhD candidates from different Countries, including India (within Interweave EU exchange program). Her main research interests concern the design of materials calibration and structural diagnosis procedures supported by computational mechanics tools. In this area, she has provided more than 100 scientific contributions in international journals, books and conference proceedings. Gabriella Bolzon has participated to research projects and collaborative programs sponsored by national and international agencies (Italian Ministry of University and Research - MIUR, Australian Research Council - ARC, Japan Society for the Promotion of Science - JSPS, EU-HCM, EU-Copernicus, EU-IALAD, KMM-NoE, KMM-VIN, Macsi-Net). At present, she is the Director of the project 'Development of Novel Methods for the Prevention of Pipeline Failures' supported by a NATO Science for Peace and Security grant. Her research topics are often motivated by problems of industrial relevance. Thus, she has also contributed the development of a patented 'Integrated Experimental and Computational Tool for the Non-Destructive Analysis of Structural Components in Oil and Gas Industry' in cooperation with a service branch of the Italian oil and gas Company.

Dr. Hemant Kumar Vinayak, is an Assistant Professor in the Department of Civil Engineering, National Institute of Technology, Hamirpur (HP), with a teaching experience of 10 years. His areas of interest include Damage detection and health monitoring of structures, Earthquake Engineering, Structural Analysis and design, Project planning, Seismic evaluation of structures, Rapid Visual Survey of buildings, Retrofitting of Masonry and RCC Building. He has guided 3 PhD candidates and has worked/working in 10 sponsored research project. He has published over 20 papers in International and National Journals, and 10 papers in National and International Conferences. He has undertaken more than 35 Consultancy Projects. He has been involved in organizing nearly 25 International and National Conferences, Training Programs/ Courses/ Workshops and has delivered more than 50 expert lecture on earthquake Resistant construction practices. He is member of the committees under National Disaster Management Authority New Delhi India.

Dr. Ravinder Nath, is an Associate Professor in the Department of Electrical Engineering, National Institute of Technology Hamirpur (HP), with a teaching experience of 28 years. His areas of interest include Digital Signal Processing, Communication systems and Control Engineering. He has published over 15 papers in International and National Journals, and 40 papers in National and International Conferences. Mainly the research work is focused on Acoustic Echo Cancellation and Multimodal Biometric Systems. He has worked as Head of the Department for three years and headed the Consultancy Project established under TIFAC-CORE. He has organized number of National Conferences, Training Programs/ Courses/ Workshops. He has numerous academic interactions, collaborations outside Institute/Organization/Country. He has supervised 2 PhD thesis, some are ongoing, and about 40 M. Tech. Dissertations. He is fellow of Institution of engineers (IE) (India), and life member of India Society of Technical Education.

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