Special issue on structural identification and monitoring with dynamic data

Preface

Structural system identification aims at identifying the modal or structural properties of a structure. The identification results provide important information about the structure, minimising the knowledge gap between its constructed state and its design model. They can be used for condition assessment, updating response performance or other decision-making purposes such as maintenance and/or rehabilitation. Timely or continuous implementation of identification techniques allows structural monitoring that enhances the safety and sustainability of the structures. Complementing with visual inspection procedures and engineering experience, structural identification-based monitoring in the long run aspires to provide an efficient and reliable means for structural safety evaluation, against e.g., material degradation or damage after extreme events. The last few decades have seen significant advances in the use of dynamic or vibration data from sensors to provide a natural and conventional source of information for system identification and monitoring.

This special issue of Earthquakes and Structures focuses on recent advances in structural system identification and monitoring technologies using dynamic data, covering theoretical, computational, experimental and application issues. The issue comprises invited papers and extended versions of selected papers presented at the 2013 World Congress on Advances in Structural Engineering and Mechanics, 8-12 September 2013.

System identification provides important information, such as modal and structural properties of structures. Without a reliable methodology, it is difficult to accurately extract this important information from measured data for structural health monitoring process. Spiridonakos and Chatzi introduce a reduced order metamodeling framework for nonlinear structural systems subjected to earthquake excitation. The framework is developed based on nonlinear autoregressive models with exogenous input, which can be used for describing nonlinear dynamics and uncertainty propagation. Fujita and co-workers employ a shear-bending model and ARX model to identify shear and bending stiffness of building structures. They consider two different input conditions, base input motion by a modal shaker and unknown forced input on the top floor.

Once the modal or structural properties of structures were obtained, they can be used for detecting damages in structures. Lam and Yang demonstrate the use of measured modal parameters for detecting damaged braces of tower structures following a Bayesian model updating method. Their method not only determines the structural condition but also uncertainties associated with the damage detection results. Ng proposes a local two-stage approach to identify small defects in structural members. The method identifies the location and severity of defects in metallic plates using Lamb waves.

Understanding of the structural vibration characteristics, and efficient and reliable modelling procedures of structural responses are essential for carrying out system identification and monitoring. Dan and co-workers investigate the structural vibration characteristics of a university building with a semi-active based-isolation using records from the 2011 Great East Japan earthquake. They study the long-term and short-term changes in the natural frequencies and damping, and compared the vibration characteristics with and without the semi-active-controlled system in operation. Ni and co-workers employ a fast Bayesian modal identification method to carry out an operational modal analysis of Tsing Ma Suspension Bridge during long-, middle- and short-distance earthquakes. The identified natural frequencies, damping ratios and mode shapes are compared before and after the earthquake events.

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