Preface

Special Issue on Structural Damage Detection and Lifecycle Performance Assessment

Structural damage detection is a process of health assessment for structures in service and is a key element of integrated strategies for structural health monitoring and performance predictions. Structural damage detection techniques provide essential information for maintenance and management of existing structures. Structural damage detection methods integrated with lifecycle performance assessment is crucial for assessing current structural condition, predicting future structural performance, determining optimal maintenance strategy and, eventually, operating structures safely beyond their original design life.

Tremendous efforts have been made during the last two decades on the development of structural damage detection methods and applications of these methods to engineering practices. Many damage detection techniques have been demonstrated to be successful in practices to certain extent. However, the related and yet unsolved question is how to further utilise the monitored information for effectively identifying structural damage and evaluating the future structural safety. Lifecycle performance assessment, as a natural extension to damage detection problem, estimates the evolution in time of detected damage and predicted condition, thus allowing the prediction of future performance of deteriorating structures.

The special issue on "Structural Damage Detection and Lifecycle Performance Assessment" aims to reflect the advances and current challenges in structural health monitoring and to share the latest development in theoretical and experimental investigations of structural damage detection methods and lifecycle performance assessment technologies. The scope of the special issue includes vibration based damage detection, smart structures and infrastructure, monitoring and assessment of structures, structural safety and reliability, and case studies of structural damage detection and lifecycle performance assessment applications.

This special issue includes a total of 10 peer-reviewed papers. The vibration based structural damage detection is widely investigated in this issue. The paper "Detection and parametric identification of structural nonlinear restoring forces from partial measurements of structural responses" by Ying Lei, Wei Hua, Sujuan Luo and Mingyu He proposes an identification method for detection and parametric identification of structural nonlinear restoring forces using only partial measurements of structural responses. The parameters of structural nonlinear restoring forces at the locations of identified structural nonlinearities together with the rest linear part structural parameters are identified by the extended Kalman filter. In the paper "Structural damage alarming and localization of cable-supported bridges using multi-novelty indices: a feasibility study" by Yi-Qing Ni, Junfang Wang and Tommy H.T. Chan, a feasibility study on structural damage alarming and localization of long-span cable-supported bridges using multi-novelty indices formulated by monitoring-derived modal parameters is presented. The improved novelty index is extended to formulate multi-novelty indices in terms of the measured modal frequencies and incomplete mode shape components for damage region identification. The paper "Damage assessment of shear connectors with vibration measurements and power spectral density

transmissibility" by Jun Li, Hong Hao, Yong Xia and Hong-Ping Zhu further develops the power spectral density transmissibility between the auto-spectral densities of two responses in the frequency domain, and implements this method to condition assessment of shear connectors. Furthermore, the paper "Nonlinear damage detection using higher statistical moments of structural responses" by Ling Yu and Jun-Hua Zhu proposes an integrated method for structural nonlinear damage detection based on time series analysis and the higher statistical moments of structural responses. The proposed method combines the time series analysis, the higher statistical moments of auto-regressive model residual errors and the fuzzy c-means clustering techniques.

The condition of existing civil engineering structures can be assessed by using structural response such as strain measurements. The paper "Condition assessment for high-speed railway bridges based on train-induced strain response" by Zhonglong Li, Shunlong Li, Jia Lv and Hui Li presents the non-destructive evaluation of a high-speed railway bridge using train-induced strain responses. The damage identification of high-speed railways, such as the stiffness degradation location, can be undertaken by comparing the measured strain response under moving trains in different states. In the paper "Adaptive-scale damage detection strategy for plate structures based on wavelet finite element model" by Wen-Yu He and Songye Zhu, an adaptive-scale damage detection strategy based on a wavelet finite element model (WFEM) for thin plate structures is established. Sub-element damages are localized through the use of the change ratio of modal strain energy. Subsequently, such damages are adaptively quantified by a damage quantification equation deduced from differential equations of plate structure motion. Moreover, the paper "Structural damage detection by principle component analysis of long-gauge dynamic strains" by Q Xia, YD Tian, XW Zhu, DW Xu, J Zhang provides a damage detection approach using the long-gauge strain sensing technology and the principle component analysis technology. A new damage index is defined by performing the principle component analyses of the long-gauge strains measured from the intact and damaged structures, respectively. Structural health monitoring systems are also discussed in this issue. In the paper "Optimal sensor placement for health monitoring of high-rise structure based on collaborative-climb monkey algorithm" by Ting-Hua Yi, Guang-Dong Zhou, Hong-Nan Li and Xu-Dong Zhang, the implementation of a novel collaborative-climb monkey algorithm is described, which combines the artificial fish swarm algorithm with the monkey algorithm, as a strategy for the optimal placement of a predefined number of sensors.

Probabilistic approach is a powerful tool for lifecycle performance assessment of civil engineering infrastructure systems. The paper "Stochastic modelling and lifecycle performance assessment of bond strength of corroded reinforcement in concrete" by Hua-Peng Chen and Jaya Nepal provides a time-dependent reliability analysis of corrosion affected reinforced concrete structures associated with the bond strength degradation. In order to model the progression of bond strength deterioration during the life cycle of the concrete structure, a gamma process model is adopted for the stochastic deterioration modelling. The time-dependent reliability analysis is then applied to evaluate the probability of failure of the reinforced concrete structures. In addition, the paper "Probabilistic real-time updating for geotechnical properties evaluation" by Iok-Tong Ng, Ka-Veng Yuen, Le Dong proposes a probabilistic approach for real-time updating by incorporating new geotechnical information. The updated model by this method is advantageous because the method incorporates information from both existing database and the in-situ measurements.

As the Guest Editors of the special issue, we would like to express our sincere appreciation to the authors who contributed their work to this special issue and to the reviewers for their great efforts on shaping and improving this issue. The Guest Editors would also like to express our

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