Preface

Special Issue on Structural Monitoring for Probabilistic Damage Assessment and Performance Prediction

Recently, infrastructure management philosophy has changed considerably thanks to the development and applications of structural health monitoring technology. The structural health monitoring technology has the potential to improve the management of existing engineering structures in many ways: (a) the accuracy of structural damage assessment can be improved by analysing the monitored structural response data and environmental conditions; (b) inspections can be scheduled effectively on the basis of structure specific monitoring data and structural health evolution; (c) lifetime reliability can be assessed using monitored load conditions and predictive deterioration models through probabilistic approaches; (d) as a result of lifetime reliability analysis, risk and cost balanced maintenance strategy can be determined using advanced optimisation techniques.

Engineering structures need to be monitored over the whole life span in particular during their service phase. During the service phase, the construction materials of engineering structures are subjected to degradation over time. The degradation of materials is generally caused by mechanical factors, such as fatigue loading and unexpected loads (e.g., earthquake), and physicochemical factors, such as steel corrosion. As a result of material degradation, the capacity and durability of the structure decrease. Monitoring during service offers information on structural behaviour under expected loads, and also records the effects of unexpected overloading. Data collected by monitoring can be used for damage identification, evaluation of safety, and determination of the remaining useful life of the structure. The continuously measured data from the monitoring system can be utilised for assessing current state and forecasting future performance of the structure from probabilistic reliability analysis.

The special issue on “Structural Monitoring for Probabilistic Damage Assessment and Performance Prediction” aims to reflect the advances and current challenges in structural health monitoring and probabilistic performance assessment and to share the latest development in theoretical and experimental investigations of structural damage assessment methods and probabilistic performance assessment technologies. The scope of the special issue includes structural monitoring, vibration based damage detection, probabilistic damage assessment, stochastic deterioration modelling, structural performance assessment, and case studies of structural health monitoring.

This special issue includes a total of 15 peer-reviewed papers. The structural monitoring and signal analysis are widely investigated in this issue. The paper “Spurious mode distinguish by eigensystem realization algorithm with improved stabilization diagram” by C. Qu, T.H. Yi, X. Yang and H.N. Li proposes an improved stabilisation diagram method in eigensystem realisation algorithm to distinguish the spurious modes for identifying modal parameters from the monitored vibration data. In the paper “Wavelet-based automatic identification method of axle distribution information” by N.B. Wang, W.X. Ren and Z.W. Chen, the wavelet transformation is adopted and the wavelet coefficient curve is used as a substitute for dynamic response for identifying axle distribution of traffics. In order to measure the pedestrian-induced loads on structures, a method using smartphones is presented in the paper "Measurements of pedestrian's load using smartphones" by Z. Pan and J. Chen. Furthermore, the paper "Experimental study of vibration characteristics of FRP cables based on long-gauge strain" by Q. Xia, J.J. Wu, X.W. Zhu, J. Zhang studies two methods to evaluate dynamical damping characteristic of basalt FRP(BFRP) and glass FRP(GFRP) cables based on long-gauge strain sensors and experimental results. In the paper "Comparative study on different walking load models" by J. Wang and J. Chen, a total of 19 popular walking load models are collected and compared against each other in terms of model parameters and structural responses when subjected to the human walking loads.

The performance of existing civil engineering structures can be assessed by using data collected from the installed structural health monitoring systems. The paper "Stochastic modelling fatigue crack evolution and optimum maintenance strategy for composite blades of wind turbines" by H.P. Chen and C. Zhang investigates various fatigue crack models for reproducing crack development in composite blades and proposes a stochastic approach to predict fatigue crack evolution and to analyse failure probability for the composite blades. In the paper "Interaction analysis of continuous slab track (CST) on long-span continuous high-speed rail bridges" by G. Dai, H. Ge, W. Liu and Y.F. Chen, the performance of longitudinal continuous slab track on a long-span bridge is investigated using the spatial finite element model. To study the long-term performance of reinforced concrete structures, the effects of rebar corrosion on bond performance between rebar and two different concrete mixes are investigated in the paper "Bond deterioration of corroded steel in two different concrete mixes" by H. Zhou, X. Liang, Z. Wang, X. Zhang and F. Xing. Moreover, in the paper "The fluctuating wind field analysis based on random Fourier spectrum for high-rise structure wind induced response" by L. Lin, A. HS. Ang, H.T. Hu, D.D. Xia and F.Q. He, the spatial correlation of structural wind field is considered based on the time domain method. A method for calculating the stochastic wind field based on cross stochastic Fourier spectrum is proposed. The paper "A structural health monitoring system based on multifractal detrended cross-correlation analysis" by T.K. Lin and Y.H. Chien conducts damage assessment by exploiting the concept of multifractal theory to quantify the complexity of the vibration signal measured from a structure.

Probabilistic approach is a powerful tool for structural damage assessment and performance predictions of civil engineering infrastructure systems. In the paper "Probabilistic damage detection of structures with uncertainties under unknown excitations based on parametric Kalman filter with unknown input" by L.J. Liu, H. Su and Y. Lei, a parametric Kalman filter with unknown inputs (PKF-UI) is proposed based on the conventional PKF for the simultaneous identification of structural parameters and the unmeasured external inputs. Two scenarios of linear observation equations and nonlinear observation equations are discussed, respectively. The paper "On-line integration of structural identification/damage detection and structural reliability evaluation of stochastic building structures" by Y. Lei, L.F. Wang and L.X. Lu investigates the on-line integration of structural identification/damage detection and reliability evaluation of stochastic building structures subjected to measured or unknown excitations, respectively. To efficiently identify the dominant failure modes and quantify the structural reliability for a long-span bridge system, an innovative procedure is proposed by X. Gao and S.L. Li in their paper "Dominant failure modes identification and structural reliability analysis for a CFST arch bridge system". In addition, the paper "Analysis and probabilistic modelling of wind characteristics of an arch bridge using structural health monitoring data during typhoons" by X.W. Ye, P.S. Xi, Y.H. Su and B. Chen presents an expectation maximization algorithm-based angular-linear approach for probabilistic modeling of field-measured wind characteristics. The proposed method has been applied to model the wind speed and direction data during typhoons recorded by the structural health monitoring system. Finally, the paper “A novel PSO-based algorithm for structural damage detection using Bayesian multi-sample objective function” by Z.P. Chen and L. Yu proposes an algorithm, combining particle swarm optimization (PSO) algorithm and an improved Nelder-Mead method (INM), to solve multi-sample objective function defined based on Bayesian inference. Advantages of multi-sample objective function and its superior over traditional objective function are studied.

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 particularly to the reviewers for their great efforts on shaping and improving this issue. The Guest Editors would also like to express our sincere gratitude to the Editors-in-Chief of the journal Structural Engineering and Mechanics, Prof. Chang-Koon Choi and Prof. Phill-Seung Lee, for their kind guidance and support leading to success of this special issue.

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