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Editorial

Special Issue Editorial "Symmetry in Structural Health Monitoring"

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Introduction

Structural health monitoring refers to the strategy and process of the damage diagnosis and characterization of civil engineering structures, also showing the importance of structural health monitoring where symmetry is widely used, such as the building collapse accident in Changsha city, Hunan Province, in May 2022.

In this Special Issue of *Symmetry*, invited researchers elaborated on 'Recent Advances in Structural Health Monitoring', demonstrating how sensitive the mechanism and practical applications of structural environment interactions are concerning the symmetry and asymmetry of different structures. Through research articles and reviews, experts, scholars and practical engineers engaged in civil engineering to explore signal processing methods, structural feature parameter mechanisms and the vibration control method to determine the safety of various types of structures, including buildings, bridges, tunnels, roads and offshore oil platforms.

Henceforth, Yang et al. [1] reviewed the vibration-based SHM methods in terms of the vibrational parameters used, to be considered in regards to the structure and evaluation as a special symmetry. Among several SHM methods, vibration-based SHM techniques have been widely adopted recently. The technical codes on vibration-based SHM systems have also been investigated, since they are more important in engineering applications. Several related ISO standards and national codes have been developed and implemented, while more specific technical codes are still required to provide more detailed guidelines in practice to maintain structure safety and natural symmetry.

Zhao et al. [2] proposed a method that uses terrestrial laser scanning (TLS) technology to collect the full-range measurements of a high formwork and develop a genetic algorithm (GA)-optimized artificial neutral network (ANN) model to improve measurement accuracy. In view of the current inspection of the installation quality of high formwork conducted by site managers based on personal experience and intuition, a non-systematic inspection cannot be properly conducted due to cost factors associated with common inspection methods.

Liang et al. [3] established a novel coupling dynamic model to reflect the relationship between the moving vehicle and the road and the dynamic performance, which not only provides theoretical support for the design parameters of heavy-duty vehicles, but also a reference for the design of road durability.

Li et al.'s [4] study on the curved unsymmetrical bridge model with non-uniform contact collision between adjacent components for seismic mitigation and unseating prevention, the damping devices and the pounding mitigation device can be used as a combinatorial seismic mitigation system to form three kinds of combined seismic mitigation cases. The results indicated that it is effective at reducing the response to a pounding force, stress, damage, girder torsion and displacement, and achieved the goals of seismic mitigation and unseating prevention.

Xiang et al. [5] used a three-dimensional laser scanner (3DLS) to detect the flatness of the initial support of a tunnel project for the symmetry of the tunnel in rapidity effectively, and proposed a calculation method for the overall field of view distance and the

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development of small blocks. A comparison with traditional methods showed that the three-dimensional laser scanning technology is feasible in the detection of the initial branch of a tunnel, meeting the requirements of a high degree of accuracy.

Lin et al. [6] thoroughly researched triple square loops-string dome structures under seismic excitation. With a finite element model of a practical gymnasium, the interaction between multiple loops and string cables was analyzed to provide an important reference for structural monitoring and seismic resistance in large-span spatial symmetry structures.

Liu et al. [7] found that digital twins (DTs) are a key technology for the safety assessment of prestressed steel structures during the development process of an intelligent construction. By analyzing the characteristics of the construction safety assessment, a DTs framework for construction safety assessment was built. Driven by DTs, a framework can be effectively applied to the construction of a symmetrical structure.

Fu et al. [8] focused on substructure shake table testing (SSTT) for the investigation of the symmetrical and unsymmetrical vibration control of secondary structure-type dampers. In this study, the control effects of four dampers on a frame were examined by conducting virtual SSTTs. The influences of the auxiliary mass ratio, integration parameters, time step and time delay on the SSTTs were investigated.

Yao et al. [9] implemented a lightweight neural network based on the YOLOv4 model to detect concrete surface cracks by using the symmetry concept. The model modules were improved to reduce the depth and complexity of the overall network structure, allowing it to performed better in terms of the real-time detection of concrete surface cracks.

Yang et al. [10] discussed the fitting effect of the symmetrical high formwork monitoring data using the autoregressive moving average (ARMA) model and back-propagation neural network (BPNN) combined model for processing. In this paper, back-propagation neural networks (BPNN) were used to simulate the ARMA process, and this approach successfully modeled the stress sequence and obtained the stress change trend.

Li et al. [11] investigated the cable clamp slippage of a suspension bridge to reveal the effect of this sliding on the force acting on the full symmetrical structure. The forces acting on the bridge before and after the slippage were analyzed to study the effect of cable clamp slippage, ensuring the safety of suspension bridges.

Wang et al. [12] proposed a combined Hilbert–Huang transform (HHT) and variational mode decomposition (VMD) method to extract multidimensional dynamic response characteristics of the time, frequency and energy of symmetrical structures. The frequency-domain integration approach and a complementary filtering algorithm were combined for the analysis, and the performance was validated using a series of simulation shaking-table tests and a field test conducted on an offshore oil platform.

Zhang et al. [13] explored a data anomaly detection method based on structural vibration signals and a convolutional neural network (CNN) to remove abnormal data through manual elimination because of the massive number of data obtained by monitoring systems. The down-sampling method of symmetrically extracting the maximum value and the minimum value at the same time could effectively reduce the dimensionality of the input sample, while retaining the characteristics of the data to the greatest extent.

Ning [14] provided a mixed control method for the real-time hybrid simulation (RTHS) of a powerful technique to obtain responses and then to assess the seismic performance of civil engineering structures. During symmetric and asymmetric dynamic loads, the mixed control method used for RTHS was feasible, exhibiting an excellent tracking performance and robustness.

Finally, this volume hopes to be of interest to civil engineering researchers and engineers specializing in structural health monitoring theories, methods, techniques and beyond. Many of the results presented here could prove to be very useful in demonstrating novel results.

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