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Editorial

Editorial on the Special Issue: Advanced Structural Health Monitoring: From Theory to Applications

Hugo Rodrigues [1,*] and Ivan Duvnjak [2]

[1] RISCO, Civil Engineering Department, University of Aveiro, 3810-193 Aveiro, Portugal
[2] Department for Engineering Mechanics, Faculty of Civil Engineering, University of Zagreb, 10000 Zagreb, Croatia; ivan.duvnjak@grad.unizg.hr
* Correspondence: hrodrigues@ua.pt

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This editorial focuses on the interesting studies published within the present Special Issue related to Advanced Structural Health Monitoring. Moreover, it highlights different techniques and approaches for the structural health assessment of Civil Engineering Structures and reports some interesting studies and their outcomes in this specific field.

Structural Health Monitoring (SHM) is a strategic tool for the monitoring and non-invasive assessment of the health state of existing structures' infrastructures and systems and can be applied in several areas, such as aeronautics, mechanical, civil, and electrical engineering. During their lives, systems are exposed to several actions and environmental conditions that can lead to structural and nonstructural damage. Recent advances in sensor technology and techniques have allowed us to gain insight into the diagnosing of material degradation and structural and nonstructural damages.

Nowadays, there is a trend of increasing the service life of structures. Structures are commonly assessed periodically based on the results of visual inspection or local limited nondestructive testing methods. Although visual inspections are essential, the results can often lead to subjective conclusions; therefore, structural health monitoring is essential as a tool that can detect degradation continuously at an early stage of their occurrence. SHM can provide decision support for reducing operational costs and risks throughout their life cycle.

In this Special Issue, six research papers and one review paper deal with the recent developments in the theoretical, computational, experimental, and practical aspects of this field and aim to cover the following topics: sensors for structural health monitoring; algorithms for damage detection and characterization; structural warning systems; model-based methods for predicting the structural service life; the application of SHM for various exceptional loads; the influence of environmental and operational conditions; innovative sensing solutions for SHM; cultural heritage damage detection and health monitoring; bridge damage detection and health monitoring; case study applications; and short-term monitoring systems for diagnostic load testing of structures.

The review paper is focused on the assessment methods and damage detection technologies for existing masonry structures, discussing the traditional methods and the new technologies with a special focus on unmanned aerial vehicles, as well as photogrammetry and close-range remote sensing as a technology that can complement traditional ways of assessment. In addition, the authors presented an example of a graphical interpretation of a case study after an earthquake. This tool may be very useful, especially in large and dispersed affected areas, where it is difficult to have a first assessment of the damage distribution [1].

Vibration-based damage detection in structures to interpret the structures' changes in dynamic properties is a common technique, and Duvnjak et al. [2] proposed a new Mode Shape Damage Index (MSDI) based on the difference between modified modal displacements in the undamaged and damaged state of the structure. The MSDI method

can be used to detect the presence of damage, identify single and/or multiple damage locations, and distinguish damage of different severity. It must be emphasized that the severity of damage detected by this method depends on the boundary conditions and location of the damage. The method was tested based on experimental modal analysis on a reinforced concrete plate under different damage cases.

Wang et al. [3] presented a scale physical model test to study the plane gate vibration and holding force under the conditions of the fixed gate opening and closing processes, considering the gate vibration, holding force, and the failure of gate-closing in the closing process and the correlation between the parameters, considering the vibration properties and the correlation of the changes in the different system properties.

Mobaraki et al. [4] presented and validated the application of the observability technique for the structural system identification of 2D models. The main highlight of this work is the changes in variables proposed to linearize the system of equations, in order to shift the non-linear problem and impossible to solve to a linearized system of equations.

Two papers are related to the SHM proposals that can be applied in large infrastructures. The first one proposes an intelligent judgment method for improving the sensitivity of analyzing mechanical parameters of prestressed cables based on the digital twin based on the information collected on large-span prestressed cables by field sensors [5]. The other paper proposes a method for monitoring the structural health of concrete bridges using a condition index by the analytical hierarchy process based on eight indices that are scored based on the experts' views. The method was implemented in several case studies to prove application of the method as an easy-to-use optimization tool in health monitoring and prioritizing programs [6].

Finally, another paper studies the effect of particle size in the pH measurement of cement-based materials, a topic related to a characteristic that is gaining importance in the analysis of cement-based materials, as well as in structural health monitoring and forensic engineering applications. It focuses on the material and structural durability in the context of the structural and non-structural monitorization to ensure that reinforced concrete is highly alkaline to safeguard the passive protective of film for reinforcement of steel bars against corrosion [7].

The topics addressed in the papers are from several fields, including the proposal and validation of new methods, development of techniques to assess the SHM of infrastructures, and methods to evaluate the evolution of chemical material properties.

The editors are confident that the papers reflect significant contributions to the research and development in the various topics addressed. We hope that readers will find all articles of the Special Issue useful and exciting and that the articles will stimulate further research activities in the area of structural health monitoring, sensing and measurement techniques, damage-detection algorithms and characterization, data analysis and structural assessment, and the new and complex solutions and their impacts on the SHM of civil engineering structures.

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