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Editorial: Advanced materials and technique for structural monitoring, analysis, and control

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Editorial on the Research Topic
Advanced materials and technic for structural monitoring, analysis and control

Structural control, monitoring, and analysis complement each other to ensure the maximum safety of structures, including bridges, buildings, transmission towers, and wharfs. Assessing the use and maintaining the safety of various engineering structures are essential for their sustainable operation. The static mechanical properties and dynamic mechanical response of a structure are the basis for analyzing and predicting its operational status; structural monitoring and analysis technology has thus become an active focus in the engineering field. In order to improve an aging structure to minimize natural disaster, structural control devices have been widely used in modern structural engineering. Structural control technology includes passive, active, or semi-active reverse force. Its main purpose is to change the stiffness, mass, and damping of a structure with minimum control force. In order to meet the requirements of modern engineering structural application scenarios and environments, nanosmart materials and new technologies are constantly emerging which provide strong support for monitoring technologies to cope with various challenges. This research topic shares the latest research results of advanced materials and technologies in the field of structural monitoring, analysis, and control, including the theoretical methods of structural health monitoring (SHM), mechanical analysis and control analysis of structures, engineering vulnerability assessment methods, the application of advanced intelligent materials in health monitoring, the integration of intelligent algorithms and health monitoring technologies, and other related aspects.

There has been much research on the monitoring theory and method of civil engineering structures. Zhang et al. propose a new method that utilizes a three-stage criterion that considers overall structural impact to obtain local modal information of the tensioned cable segment. Chi et al. determine an engineering vulnerability assessment method that takes into account the effects of corrosion, based on the analytic hierarchy process method and fuzzy comprehensive evaluation. Zhao et al. innovatively utilize fiber optic monitoring for excavating deformations in foundation pits and propose a back-analysis method for HSS model parameters based on the SSA-BP neural network. Zhang et al. propose a two-stage method for model modification and damage identification.

The analysis of structural operation performance is critical for the use and maintenance of the structure. Zhang et al. study the mechanical properties of transmission tower K-joints through numerical methods, focusing on three aspects: failure mode, load–displacement hysteresis curve, and stiffness degradation. Bian et al. investigate the uplift capacity of single straight and belled piles in sloping ground, revealing a decrease in capacity with an increase in slope angle. Additionally, a practical method of quantifying the slope effect is proposed. Bian et al. use a finite element model to simulate the nonlinear interaction between piles and soil, investigating the relationship between the bearing capacity of single piles and horizontal forces and bending moments in sloping ground. Pan et al. investigate the impact of crack dip angles on the mechanical characteristics of rock masses through uniaxial and true triaxial compression tests.

Smart materials and new technologies continue to emerge, providing strong support for monitoring technology to meet various challenges. Wang et al. replace manufactured sand with glass sand and added carbon fiber to prepare high-performance shotcrete and then testing its mechanical properties and self-sensing performance.

The essence of SHM is monitoring the vibration and displacement response of a structure under external loading or excitation. Xue et al. use numerical analysis of a damaged bridge abutment supported by inclined piles during a specific earthquake where soil liquefaction occurred to clarify that the main cause of the forward rotation of the abutment was the increase in soil pressure behind it. Bian et al. propose a simplified analytical methodology for analyzing the lateral dynamic responses of a transmission tower structure due to the impact of rockfall. Mu et al. investigate and evaluate three different boom replacement methods for suspension bridges using finite element calculations, determine optimal methods for varying boom lengths, and propose a quantitative basis for classifying boom lengths. Hongbin et al. investigate the characteristics of main girders' longitudinal motion in long-span suspension bridges, analyzing the influence of restraint devices such as viscous dampers and supports. Yao et al. utilize a sophisticated numerical model based on actual engineering data to assess the reliability of prefabricated perimeter walls in substations during flood events.

Structural control is another effective way of rendering a structure safe. Zhang et al. focus on the interaction between ice and offshore platforms in the Bohai Sea, discussing strategies to mitigate ice-induced vibrations of offshore wind turbine foundations.

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