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Editorial

Risk, Reliability, and Uncertainty Quantification of Structural Systems Subjected to Shock and Vibration

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Deterministic analysis methods, even when they are based on detailed modeling, may not precisely reflect the reliability of engineering structures. The alternative is to perform risk analysis under the probabilistic assumption and propagate the uncertainty in different design variables. This is an important and crucial task, especially for structures subjected to shock and vibration. The design and analysis of ordinary structures subjected to single and multiple hazard dynamic loads are real-world related engineering applications such as critical dams and nuclear power plants under hydrodynamic shock and earthquake impact; synoptic and nonsynoptic wind-induced structural vibrations; vehicle-induced vibrations in bridges; wind, wave, and seismic impact on offshore structures and wind turbines; and earthquake-induced vibrations in structures.

The articles presented in this special issue are focused on the state-of-the-art techniques, methods, and applications in risk, reliability, and uncertainty quantification of structural and infrastructure systems under shock and vibration loadings. Overall, 29 submissions were received by the editorial team, and 16 manuscripts have been accepted for publication. Figure 1 shows "word cloud" data mined from all accepted papers, indicating repetition of relevant keywords.

Nonlinear dynamic analysis and design of concrete dams are affected by two main uncertainty sources, i.e., epistemic and aleatory. In the paper by M. A. Hariri-Ardebili et al. "Response Surface Method for Material Uncertainty Quantification of Infrastructures," the authors proposed a response surface metamodel in order to quantify the material uncertainty in arch dams subjected to seismic excitation. The proposed technique revealed a good agreement with Latin hypercube sampling while reducing the computational efforts considerably. A concrete damage index was shown in terms of the fragility curves.

Quantitative analysis of the dynamic behaviors of soft soils during the metro train operation is a very important task for risk analysis. In the paper by W. Shi et al. "The Influence of the Track Parameters on Vibration Characteristics of Subway Tunnel," the authors performed a series of parametric nonlinear finite element coupled simulations to compute the time-variant vertical acceleration of the rail, the sleepers, and the surface of the tunnel. The results are applicable to metro design and provide guidance during tunnel construction.

Rolling bearings are critical components that determine the remaining lifetime of machinery in which their failure may lead to catastrophic accidents. In the paper by F. Wang et al. "Remaining Useful Life Prediction Method of Rolling Bearings Based on Pchip-EEMD-GM(1, 1) Model," the authors proposed a trend prediction method for the remaining useful life of a rolling bearing. The model is based on the feature's dimension reduction via kernel principal components, as well as the calculation of the temporal hazard rate. Full life testing of rolling bearings is provided, showing that the proposed model has higher accuracy compared to existing methods, revealing its feasibility and effectiveness for predicting the remaining life.

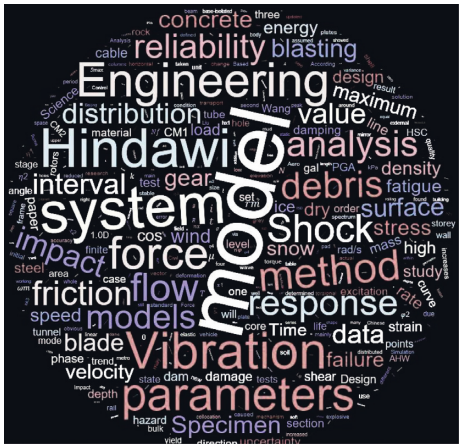

Figure 1: Word cloud from all accepted papers.

Although the uncertainty quantification with probabilistic methods is a useful technique in reliability analysis, the model parameters may not be precisely represented due to several reasons in engineering practices. In the paper by X. Yang et al. "Hybrid Structural Reliability Analysis under Multisource Uncertainties Based on Universal Grey Numbers," the authors proposed an efficient approach to analyze structural reliability with random-interval-fuzzy hybrid parameters. Also, they employed the universal grey mathematics to solve this nonprobabilistic problem.

The applications of high-strength concrete are widely observed in complex structures of modern architectures which may undergo fatigue after exposure to high temperatures. In the paper by L. Wang et al. "Research on the Fatigue Properties of High Strength Concrete after Exposure to High Temperature under Low Cyclic Compressive Loading," the authors performed low cyclic compressive loading on high strength concrete exposed to high temperatures, using an electrohydraulic servo fatigue testing machine. Several analytical models were proposed based on regression analysis.

The accuracy of finite element modeling can be increased by updating the uncertain parameters during reliability analysis. In the paper by X. Chen et al. "A Copula-Based and Monte Carlo Sampling Approach for Structural Dynamics Model Updating with Interval Uncertainty," the authors proposed a model updating approach in structural dynamics with interval uncertain parameters. They computed the confidence intervals of updating parameters using the nonparametric kernel density estimation approach.

The nonlinear dry friction force produced by the dovetail interface plays an important role in vibration attenuation. The effect of dry friction vibration reduction is significant when the rotating speed is slow or the friction coefficient is small. In the paper by C. Li et al. "Study on the Nonlinear Characteristics of a Rotating Flexible Blade with Dovetail Interface Feature," the authors proposed a dynamical model to simulate the nonlinear characteristics of a flexible blade. The model is based on macro-stick-slip mechanical modeling of dry friction to simulate the constraint condition of the flexible blade.

The force of debris flow on the dam distributes unevenly, and the impact force is large in the middle and decreases gradually to both sides. In the paper by H. Zhao et al. "Experimental Study of the Debris Flow Slurry Impact and Distribution," the authors present a new method to calculate debris flow slurry impact. A series of experimental tests were conducted on a dam with various densities, channel slopes, and dam front angles.

In a concrete-encased steel frame-reinforced concrete core tube building, the core tube bears major loading and exhibits overturning failure; afterwards, the frame transfers the surplus load and exhibits column tensile failure and joint panel shear failure. In the paper by L. Zeng et al. "Quasi-Static Cyclic Test on a Concrete-Encased Frame-Reinforced Concrete Tube Building Model," the authors performed a 1 : 5 reduced-scale quasi-static testing with multipoint loading and quantified parameters such as hysteretic characteristics, strain distribution, and energy dissipation.

In numerical simulation of thin solids, the sources of uncertainty are related to material parameters and geometry representing manufacturing imperfections. In the paper by H. Hakula et al. "Cylindrical Shell with Junctions: Uncertainty Quantification of Free Vibration and Frequency Response Analysis," the authors solved the multiparametric free vibration of the complex shell under uncertainty using stochastic collocation with the p-version of the finite element method.

The wind-induced erosion coefficient is a function of air density, sow particle density, snow particle radius, and snow particle strength bond. In the paper by K. Yan et al. "A New Erosion Model for Wind-Induced Structural Vibrations," the authors proposed an advanced erosion coefficient model including the probability distribution and value range. Detailed randomness of the structural vibrations is studied as well.

Vertical and torsional vibrations of ice-accreted stay cables are increased with the increase of vertical and yaw angles. Also, larger ice thickness increases vertical and torsional vibration amplitudes. In the paper by S. Cao et al. "Wind-Induced Response of Inclined and Yawed Ice-Accreted Stay Cable Models," the authors performed several wind tunnel tests and CFD simulations. The ice-accretion profiles dimensions and yaw and vertical inclination angles were studied parametrically.

The rational resistant line or explosive charge depth in mines should be 0.86 times the optimal resistant line. In the paper by X.-l. Zhang et al. "Blast Parameter Optimization Study Based on a Blast Crater Experiment," the authors conducted a small charge-forward blast crater experiment to study the relationship among the rock volume blasted, the explosive unit consumption, the bulk yield, and the depth ratio. The proposed regression-based equations are shown to be optimized, efficient, and economical.

Planetary gear systems are widely used in technological systems which have the advantages of compact structures, high transmission efficiency, and large transmission ratio. In the paper by P. Gao et al. "Reliability and Random Lifetime Models of Planetary Gear Systems," the authors developed dynamic reliability models in which load, geometric, and

material parameters are considered inputs for random lifetime models. Monte Carlo simulations are adopted for validation.

Improved assembly of horizontal wall connections in base-isolated precast concrete shear wall structures is useful and effective, and it fulfils the requirements to withstand seismic excitations. In the paper by W. Wang et al. "Seismic Performance of Base-Isolated Precast Concrete Shear Wall Structure with AHW Connections," the authors conduced two 1 : 4 small-scaled shake table tests: a lead-rubber bearing base-isolated structure model and a base-fixed structure model.

The spring stiffness, the installation angular of the motor, and rotation direction of the rotors have a large influence on the stability of the synchronization state in the coupling system, and the mass ratios of the system are irrelevant. In the paper by F. Pan et al. "Theoretical Study of Synchronous Behavior in a Dual-Pendulum-Rotor System," the authors proposed a simplified mechanical model of the dual-pendulum-rotor systems.

We hope that this special issue would shed light on recent advances and developments in the area of uncertainty quantification in structural systems and attract attention of the scientific community to pursue further research and studies, leading to rapid implementation of advanced reliable and risk-based models in various aspects of Civil, Mechanical, and Materials Engineering.

Conflicts of Interest

The editors declare that they have no conflicts of interest.

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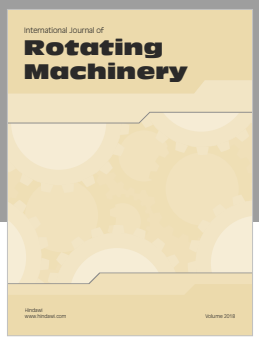

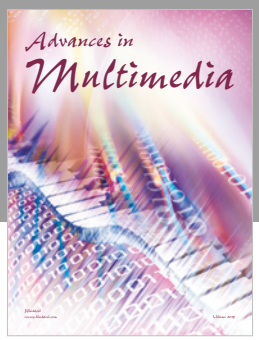

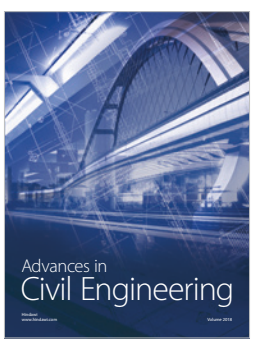

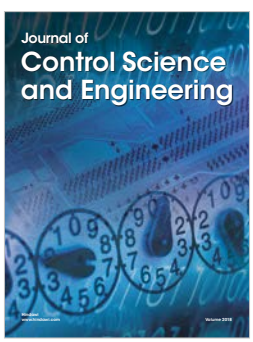

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