**The 15th International Conference on Quality, Reliability, Risk, Maintenance, and Safety Engineering & The 8th International Conference on Materials and Reliability (QR2MSE2025 & ICMR2025)**

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**Special Session on:**

**Advanced Approaches for Structural Health Monitoring and Uncertainty Quantification**

Engineering structures, from bridges and skyscrapers to aircraft and automotive systems, are subject to diverse uncertainties, such as material variability, geometric imperfections, and unpredictable external loads. These uncertainties significantly affect structural performance, reliability, and safety, potentially leading to catastrophic failures if not properly managed. Structural Health Monitoring (SHM) addresses these risks by continuously or periodically assessing structural integrity through advanced sensing technologies, data analytics, and diagnostic algorithms, enabling real-time detection of damage, degradation, or anomalies to inform maintenance and decision-making. By integrating Uncertainty Quantification (UQ) i.e., uncertainty modeling, propagation, reliability analysis, design optimization, and so on, SHM data can be leveraged to quantify risks and enhance predictive accuracy, forming a robust framework for ensuring the safety and longevity of structures. For instance, SHM provides high-fidelity data that UQ employs to model stochastic behaviors, while UQ’s reliability estimates guide SHM’s monitoring strategies. Nevertheless, monitoring and quantifying uncertainties in complex, strongly nonlinear, or high-dimensional systems remain significant challenges, necessitating innovative methodologies.

In recent years, advanced approaches, particularly those leveraging machine learning techniques such as Gaussian processes, artificial neural networks, and large language models, have emerged as transformative tools for tackling these challenges. This special session invites contributions that advance the fields of SHM and UQ through cutting-edge methodologies. We seek submissions that explore novel SHM techniques, including sensor fusion, digital twins, and data-driven diagnostics, as well as UQ methods tailored for strongly nonlinear dynamics, high-dimensional parameter spaces, and multi-source uncertainties. Topics of interest include, but are not limited to, time-independent and time-dependent reliability analysis, rare event probability estimation, adaptive monitoring strategies, and optimization under uncertainty. Particular emphasis will be placed on integrating SHM and UQ to address real-world engineering problems in disciplines such as civil engineering, aerospace engineering, mechanical engineering, automotive engineering, and construction engineering.

We warmly welcome submissions that present theoretical advancements, practical implementations, and case studies demonstrating the application of advanced approaches to SHM and UQ. Contributions that bridge the gap between theoretical innovation and engineering practice, particularly those addressing scalability, computational efficiency, or robustness in operational environments, are especially encouraged.

   

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