

Digitalizing Infrastructure:

Advancing Structural Health Monitoring for Smarter Asset Management

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ABSTRACT:

Our transportation infrastructure faces increasing demands, driven by larger and heavier trucks that place growing stress on bridges with ever-higher frequency. At the same time, much of this infrastructure is aging, with many structures having reached or exceeded their intended service lives and operating near their capacity limits. Addressing these challenges requires innovative tools and approaches to monitor, evaluate, and maintain infrastructure assets effectively.

Structural Health Monitoring (SHM) offers a transformative solution by enabling continuous, sensor-based condition assessment. SHM systems can track changes in structural behavior, detect damages, and provide valuable data for condition evaluation and prediction. However, to fully realize the potential of SHM, the integration of sensor data into a seamless digital process chain—built on Building Information Modeling (BIM)—is essential. This linkage ensures that data is not only collected but also analyzed and utilized in a way that is directly connected to the structure's digital twin.

Within the DTEC-SHM project, we equipped two bridges with over 400 sensors to enable comprehensive monitoring. These included conventional sensors for measuring accelerations, inclinations, and temperatures, as well as weather stations for capturing environmental conditions. Additionally, innovative sensors were deployed for durability monitoring and axle load measurement through Bridge Weigh-In-Motion (B-WIM) technology. To complement the sensor network, a detailed finite element (FE) model was developed and calibrated using monitoring data and load testing results, enabling a deeper understanding of the bridges' structural behavior.

Now, we focus on advancing SHM applications by developing a predictive maintenance management system based on Key Performance Indicators (KPIs). This will allow for proactive and efficient maintenance planning. Furthermore, the digital twin of bridges will be refined and tested to enhance its integration with SHM systems. In addition, by prioritizing the preservation of infrastructure over new construction, the project promotes significantly more sustainable practices in infrastructure management.

For asset owners, SHM provides critical insights into the health of their structures, enabling informed decision-making to prioritize repairs, optimize maintenance schedules, and allocate resources efficiently. By leveraging SHM and digital twin technologies, asset owners can transition from reactive to predictive maintenance, enhance safety, and ensure the long-term sustainability of infrastructure. This keynote will explore these innovations, emphasizing what asset owners need to harness the full potential of SHM in addressing today's infrastructure challenges. In addition, the keynote provides an overview about the datasets collected through the DTEC-SHM project, which we are committed to sharing with the broader research and engineering community to foster collaboration and innovation.

