The Taisei Chair in Civil Engineering

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THE TAISEI CHAIR IN CIVIL ENGINEERING

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It is my pleasure to have **The Taisei Chair in Civil Engineering**. I am honored to carry the name of Taisei, which is associated with a very important corporation founded in 1873 and is focused on building construction, civil engineering, and real estate development. These areas are emphasized in my research activities as a professor of structural engineering and as the director of the Pacific Earthquake Engineering Research (PEER) Center.

Professor Khalid Mosalam's research group members are focused on developing experimental, analytical, and data-driven tools for resilient structural systems, including monitoring in the face of natural hazards.

My research group focuses on six areas of research activities. Their common thread is advanced computational and data-driven research integrated with large-scale experiments to solve practical structural engineering problems.

1. ***Evaluation and retrofit of transportation structures (bridges and tunnels)***: Several earthquakes and environmental effects have caused damage to bridges and tunnels that should have functioned as escape routes and arteries for the transport of emergency goods. A more reliable network of bridges, highways, and tunnels that is immune to disasters needs to be built. In addition, current networks need to be evaluated. To enhance the reliability of the built environment, retrofit methods should be developed to improve deteriorated structural performance in a timely and cost-effective manner.

2. ***Probabilistic modeling and holistic design for sustainable and resilient structures***: The concept of seismic fragility (conditional probability of damage or failure given the seismic hazard) is important for the adopted performance-based design methodology in my research activities. In that regard, I follow a comprehensive approach to model structures considering uncertainties related to loading, material, or geometry, as pioneered by the PEER Center.

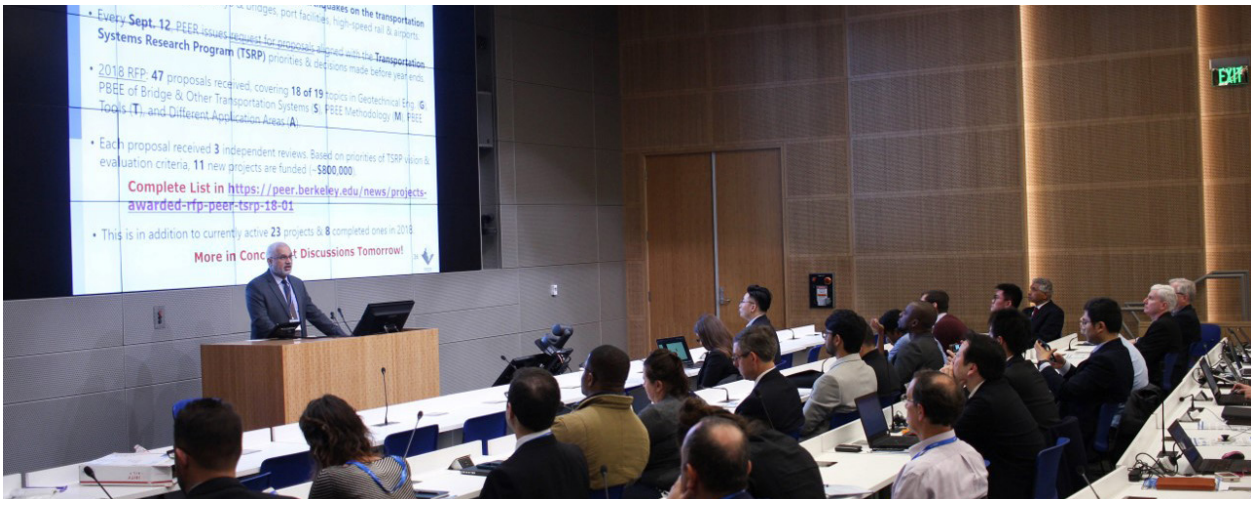
3. ***Efficient computational solutions including collapse modeling and hybrid simulations of structures***: The concept of hybrid simulation is one of the important research areas of my group. New features of hybrid simulations are being developed for use in experimental research of complex structural systems that also require efficient computational solution strategies to handle the structural response determination up to collapse. My pioneering work on progressive collapse simulation using the element removal approach was combined with modeling the in-plane/out-of-plane interaction of infill masonry walls. The novelty of this approach was recognized by the EERI Outstanding Paper Award.

PEER Structural Engineering Lab at the Richmond Field Station.

4. ***Structural performance of electrical equipment and non-structural building components***: One of the highest priority research items is the need to improve the seismic performance of substation electrical equipment as it is directly related to community resilience after natural hazards. This active area of my research aims towards developing the knowledge and data to identify the failure modes of porcelain and composite insulators used in electrical substations. These components are essential for the electrical grid and should remain operational after major earthquakes and natural hazard events to avoid power outages and business interruptions.

5. ***Evaluation and development of energy-efficient building envelopes***: I am one of the leaders in developing a major research program focused on building efficiency and sustainability in the tropics. Current activities include:

    - Thermal efficiency related to energy-efficient structural insulated panels.
    - Optical efficiency for innovative translucent structural concrete materials using embedded optical fibers for efficient use of daylight.
    - Probabilistic modeling and holistic design for sustainable and resilient structures.
    - Hybrid simulations to effectively determine illuminance values inside buildings due to daylight.



Professor Mosalam welcoming attendees and presenting an overview of the PEER Center during the PEER Annual Meeting at UCLA on January 17, 2019.

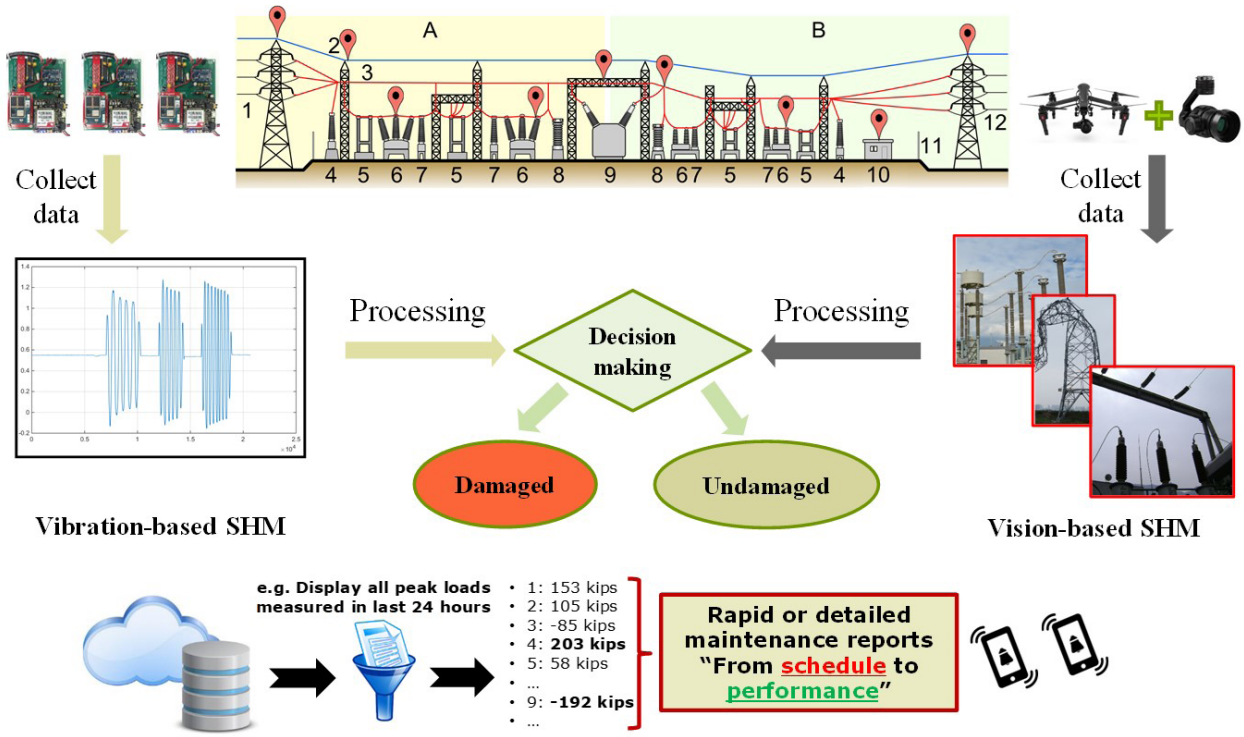


Illustration of the data-driven SHM used in Mosalam's research group (an electric substation is shown as an example).

6. ***Machine learning for structural health monitoring and reconnaissance***: My recent research activities focus on structural health monitoring (SHM) using computer vision to conduct structural damage classification from images. In that regard, I make use of deep and transfer learning techniques. I organized for the first time a structural image classification challenge, namely PEER Hub ImageNet (PHI-NET). I also perform SHM making use of machine learning techniques to train models with available data from instrumented bridges and buildings or simulated data from their detailed finite elements models (digital twins). These trained models are subsequently used to perform damage assessment for test data to extract features indicative of the structural conditions. My group is actively involved in the Structural Extreme Events Reconnaissance (StEER) Network, which I was instrumental in developing.

CONCLUSION

Thank you once again for your generous support. I welcome the opportunity to talk with you in greater depth about our work should you be interested.

Cover art adapted from illustration by Pedro Lemos, *Blue and Gold*, 1917.

For questions about this report, please contact
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