Infrastructure resilience against multiple hazards: from earthquakes to sea-level rise

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Natural and anthropogenic hazards pose significant challenges to the built environment especially in an increasingly urbanized world. This presents opportunities in investigating site-specific hazards in structural engineering to aid mitigation and adaptation efforts. HazSus works on the engineering-geoscience interface to improve infrastructure resilience against multiple hazards in the face of climate change. Embracing both probabilistic and physics-based approaches, recent research focuses on earthquake and sea-level rise hazards for engineering decisions.

Building upon previous work on hazard consistency, a pilot study integrates earthquake engineering and geophysics to examine ground motion effects on tall buildings using CyberShake simulations. With two million nonlinear response history analyses to date, this end-to-end direct analysis provides insights from ruptures to waveforms, from hazards to risk. Such a rupture-to-rafters probabilistic approach addresses the questions: What causes failure? How likely is it?

Similarly, another study connects climate science and civil engineering via probabilistic sea-level rise hazard analysis, tracing sea-level rise back to its major contributing sources of ocean thermal expansion, glacier, and ice sheet melting. This is analogous to tracing ground motions back to their causal earthquake ruptures. As sea-level rise projections are highly dependent on emission scenarios and climate models, they can be updated with new observations and emerging data collection missions such as GRACE-FO and ICESat-2.

Just as earthquake ground motion inputs are important for computing the design target for structural engineering applications, sea-level rise projections are critical for defining the planning target for coastal infrastructure adaptation. The probabilistic hazard analysis of earthquakes and sea-level rise can be combined with other hazards to evaluate the impact of multiple hazards on infrastructure systems. Advanced technologies such as high performance computing, virtual reality, and artificial intelligence further facilitate hazard research and outreach for disaster risk reduction and infrastructure resilience.