A Framework of Models for Maximizing the Resiliency of Structures and Networks

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This talk presents new models aimed at improving our understanding and design of structures in particular, and the built environment in general. Adopting a holistic perspective, considering impacts ranging from life safety to environmental impacts, the objective is to identify the "best" design. When engineers today make design decisions for buildings, bridges, roadways, and networks the deliberations are often component-based. Code provisions are applied that primarily address life safety. However, the cost of recent natural disasters and the impacts of climate change have served notice that a broader perspective is needed. To qualify as a truly optimal design the considerations must include damage, repair, infrastructure dependencies, carbon emissions, business downtime, etc. in addition to the traditional consideration of construction cost and life safety.

The quality of a decision depends on the quality of the models behind it. To make good design decisions, particularly for multi-hazard and multi-impact problems, it is necessary to have good models for a wide range of hazards, structures, and costs. This talk puts forward a framework of such models, with a discussion of each model and their interaction during the search for the optimal design. The goal is to complement, not replace, current design codes by showing actual costs and probabilities without conservative bias. Examples are presented for individual buildings and also a transportation network affected by infrastructure interdependencies. The result of the analyses is the design, or retrofit decisions, that maximize resiliency. Resiliency is selected as the objective because it includes vulnerability, i.e., direct costs, as well as indirect costs associated with the recovery after hazard events.