

## ENGINEERING/TECHNOLOGY

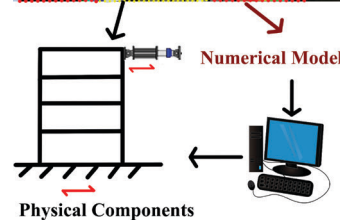
### Enabling Fast and Accurate Hybrid Simulations of Structures Subject to Earthquakes

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Real-time hybrid simulation (RTHS) is a technique that is used to study the behavior of critical structural components subject to dynamic loads, such as earthquakes. In RTHS, a physical specimen of the component being studied and a numerical model of the rest of the structure are coupled together, using a transfer system that enforces compatibility between them in real time. The physical component is usually tested at a high frequency (1024 Hz) to ensure stability. This necessitates that the numerical model also be computed at a correspondingly small time-step (1 millisecond), which creates a limitation on the complexity of numerical models that can be used within RTHS.

In this study, we develop a method to speed up the numerical part of RTHS so that more advanced numerical models can be used to improve accuracy. This is accomplished by dividing the numerical model into several parts and choosing a small timestep for the parts closest to the experimental component, while solving the remaining parts at a larger timestep to reduce total computation time. A detailed case study of this multi-timestep RTHS was conducted to study the effect of using different timestep ratios on RTHS accuracy and computational time. Results show that the use of larger,

more realistic numerical models can be made feasible with this approach, while still preserving accuracy of the computed result. This research will enhance our ability to understand the dynamical behavior of structures subject to earthquakes and thereby contribute to safer designs in the future.



*Research advisor Arun Prakash writes, "Real-time hybrid simulation is a new and exciting area of research in the field of structural dynamics and earthquake engineering. Advances made as part of this research will enhance our capabilities to use this technique to study large, real-life structures subject to earthquakes, such as tall buildings or long-span bridges."*

Conceptual representation of real-time hybrid simulation.