Structural Simulations Under Earthquake Conditions

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Reliable structural modeling requires analytical tools that can accurately predict strength and stiffness deterioration of structural elements in response to earthquake conditions. Computer simulations allow engineers to test different structural ideas and concepts to find a balance between a cost effective design and structural integrity. In our approach, we used Opensees to create structural models and assess their response to earthquake conditions through dynamic analysis. We ran Particle Swarm Optimization (PSO) in MATLAB to optimize the Ibarra-Medina-Krawinkler (IMK) strength vs stiffness parameters to improve the accuracy of our computational simulations in relation to real world observations. Using optimized parameters as a benchmark, we ran dynamic analysis on a single-column structure in Opensees and used Markov Chain Monte Carlo (MCMC) simulation to produce uncertainty quantifications for structural collapse. From preliminary literature reviews and data analysis, we can model uncertainty quantifications for structural collapse to a 95% confidence interval when comparing individual IMK parameters to structural responses to earthquake conditions. The goal of this research project is to explore the application of Particle Swarm Optimization to calibrate the modified IMK deterioration model parameters and the corresponding uncertainty quantifications of structural models through computational simulations of building collapse under earthquake conditions. In the post-internship survey, research interns reported major improvements both in understanding and preparedness for future research programs. Student interns also reported that conducting research in their specific fields of study have given them greater confidence to pursue a master's degree in STEM. In working alongside graduate mentors and faculty, the student research interns have gained valuable experience in conducting research projects addressing real world issues.