TOWARDS PRACTICAL SIMULATION OF STEEL FRACTURE IN STRUCTURAL AND EARTHQUAKE ENGINEERING APPLICAITONS

Gregory G. Deierlein[1]*

[1]*Stanford University, Stanford, CA, USA*
** Presenting Author email: ggd@stanford.edu*

Over twenty-five years ago, unexpected fractures occurred in dozens of welded steel frame buildings during the 1994 Northridge earthquake. This prompted major research programs to (1) develop more reliable connection details for new buildings, (2) develop strategies to repair and retrofit damaged buildings, and (3) to assess the seismic safety of buildings. Efforts to develop alternative designs for new and retrofitted steel connections primarily relied on large-scale laboratory testing of connection subassemblies. Since then, significant advancements have been made in nonlinear finite element techniques to simulate the inelastic behavior of structural components and systems, although challenges remain to reliably simulate fracture, particularly for seismic design, where structural components are designed to undergo large-scale yielding. This presentation will summarize research on continuum-based fracture mechanics, where cyclic void growth models are used to assess ductile fracture initiation and propagation under large scale cyclic yielding. The models are implemented through finite element analyses and validated through a series of tests on notched axial bars, compact tension specimens, and large scale steel subassembly tests of braces and column base connections. Applications to use detailed finite element models to calibrate macro-scale models for incorporating fracture limit states in overall structural system response are also described.