Computational Modeling of Delayed Progressive Collapse of Reinforced Concrete Building Structures

Roberto Ballarini
Thomas and Laura Hsu Professor
Chair, Department of Civil and Environmental Engineering
University of Houston

Abstract

Recent discussions in technical committees revealed that reinforced concrete (RC) structures may be susceptible to delayed collapse, thus prompting the consideration of time-dependent material behavior as part of progressive collapse analysis and design. This work investigates the influence of time-dependent bond slip and static fatigue-like damage on the delayed failure behavior of reinforced concrete frames. The slip and fatigue constitutive models are incorporated into a reduced-order numerical model that represents potential damage zones as cohesive elements, thus allowing computationally efficient simulations of the progressive collapse of RC frames. It is shown that by accounting for viscoelastic deformation and the time-dependent damage mechanisms, the model can capture the essential deformation mechanisms of the frame under both monotonic loading and sustained fatigue. The simulation shows that the time dependence of bond slip could have a profound influence on the delayed failure of RC frames especially under moderate sustained loading. This finding highlights the importance of understanding the time-dependent bond slip for future study of the delayed progressive collapse of RC structures.