

# **PROGRESSIVE COLLAPSE ASSESSMENT OF BUILDINGS FOR CONFORMANCE WITH “UFC 4-023-03, DESIGN OF BUILDINGS TO RESIST PROGRESSIVE COLLAPSE” (PC UFC)**

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In response to terrorist attacks, the Department of Defense (DoD) currently requires that all buildings of three stories or more be designed to avoid progressive collapse. These requirements are found in the Unified Facilities Criteria 4-023-03 “Design of Buildings to Resist Progressive Collapse” (PC UFC). The PC UFC uses a combination of the indirect and direct methods to ensure that minimum values of strength, reinforcement continuity, and ductility of the components and connections are provided for resisting progressive collapse.

In a recent project for the US Army Corps of Engineers Protective Design Center, ARA utilized the guidelines given in the PC UFC to perform progressive collapse assessments on five different buildings. ARA performed assessments of tie forces, upward loads, and doubled column lengths on all five buildings to verify their capacity to provide Low Level of Protection (LLOP) against progressive collapse. Additionally, an Alternate Path (AP) analysis using *LS-DYNA* was performed on one of the buildings with inadequate vertical ties to verify its ability to bridge over the deficient element. Finally, retrofit designs along with cost estimates were developed for four structural components chosen from the deficient elements found in the five buildings.

The results of these analyses show that only two of the five buildings have adequate tie forces to meet the requirements in the PC UFC to provide LLOP against progressive collapse. Additionally, the AP analysis demonstrated that if a vertical member does not have adequate tie forces, the structure in some cases can still transfer the load by bridging over the deficient element. Finally, it was demonstrated that the cost associated with the design and implementation of structural retrofits can be very high. Therefore, it is recommended that measurements to prevent progressive collapse be taken during the design stages to avoid the implementation of costly structural retrofits.