Public Abstract
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Graduation Term:SP 2011
Department:Civil Engineering
Degree:MS
Title:EVALUATION OF ALTERNATIVE RESISTANCE MECHANISMS FOR PROGRESSIVE COLLAPSE

The purpose of this research is to better understand the collapse resistance mechanisms of reinforced concrete buildings. A building must have sufficient strength, ductility and redundancy to resist collapse and ensure life safety. Extreme loading events, such as earthquakes and explosions, may cause severe local damage that triggers a chain reaction of large-scale structural failure or progressive collapse such as in the Oklahoma City building and the World Trade Center. Currently, resisting progressive collapse is generally outside the design considerations for ordinary buildings due to a lack of information on how to economically provide that resistance. Reinforced concrete frame structures, however, may possess inherent structural redundancy and ability to withstand collapse if the structure is properly detailed to provide alternative resistance mechanisms. A more accurate progressive analysis procedure that takes into account alternative collapse resisting mechanisms will lead to the identification of detailing requirements that could be implemented economically on new buildings (regardless of whether a progressive collapse analysis was conducted) or retrofit measures for existing buildings and therefore ensure a limited ability to resist collapse and save lives.

Collapse resisting mechanisms studied in this research include catenary action, Vierendeel action, compressive arch action, and contributions from infill walls. Typical progressive collapse analysis procedures do not usually consider these mechanisms because they are not well understood. This research tested a series of three quarter scale two bay by two story frames. The column between the two bays was removed to simulate a collapse scenario. The design of the three frames consisted of discontinuous reinforcement, continuous reinforcement, and infill walls placed in the bays. Although a typical flexural analysis of the frame with discontinuous reinforcement would indicate that it had little load capacity, it was able to reach a load of 2.34 kips under compressive arch action and 8.19 kips under catenary tension. The frame with continuous reinforcement reached a load of 5.81 kips under the flexural action. However, due to limited rotational capacity of the hinge regions, the reinforcement fractured and continuity was lost. Upon further loading, the frame reached 8.30 kips under catenary tension. The frame with the infill wall did not perform significantly different than the discontinuous reinforcement frame indicating that the partial height infill wall did little to improve the collapse resistance of the frame. The results show that both compressive arch and catenary action are viable resistance mechanisms in frames under a collapse loading, and if incorporated into design guidelines could reduce the required sizes and reinforcement of structural members.