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Seismic Load Distribution in Retrofitted RC Frames with Advanced Dampers

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Introduction

Retrofitting Reinforced Concrete (RC) frames with advanced energy-dissipating devices has emerged as a highly effective approach to improve structural resilience during earthquakes. Seismic performance in RC buildings is largely governed by the way loads are distributed and absorbed through structural components under dynamic stress. Traditional RC moment-resisting frames, while strong, often lack the flexibility to dissipate seismic energy efficiently. This can lead to concentration of forces in brittle elements, risking severe damage or collapse. The integration of advanced dampers such as Added Damping and Stiffness (ADAS), Triangular ADAS (TADAS) and Buckling-Restrained Braces (BRBs)—has been shown to significantly enhance seismic load distribution by redirecting energy away from primary structural members and into specially designed yielding components. These dampers not only help reduce inter-story drifts but also minimize stress concentrations, resulting in more uniform structural response during seismic events [1].

Description

Experimental and computational studies have demonstrated that the introduction of ADAS and TADAS dampers into RC frames creates a dual load path system, where seismic energy is shared between the main structural skeleton and the supplemental damping devices. This energy redistribution allows critical frame elements such as beams, columns and joints to experience lower strain levels during peak motion. Moreover, yielding dampers absorb inelastic energy through controlled deformation, thereby converting potential structural damage into recoverable damper action. In cases where BRBs are incorporated, especially with shear connector gusset plates, the braces act as fuse elements that yield under axial loading without buckling, maintaining their load-carrying capacity across multiple seismic cycles. These systems not only lower the demand on the concrete frame but also exhibit stable hysteresis behavior and enhanced energy dissipation capacity, reducing the risk of collapse. Notably, experimental tests have confirmed that even under strong ground motion, the retrofitted RC frames maintain structural integrity and failure is directed into the replaceable damper components.

In terms of design application, integrating advanced dampers into existing or new RC frame systems requires careful consideration of load transfer mechanisms, damping ratios and frame-damper interaction under lateral loading. Finite element models and shaking table experiments have been instrumental in capturing the load distribution patterns and confirming that retrofitted frames with these devices exhibit significant reductions in base shear forces and floor accelerations. Furthermore, dampers improve the overall ductility and displacement capacity of the frame, leading to improved post-earthquake serviceability. Engineers can optimize damper placement and stiffness values based on modal participation and anticipated demand locations. This targeted retrofitting strategy ensures that the dampers engage effectively during seismic excitation and prevents the concentration of loads at critical joints or story levels, which often act as weak points in unretrofitted frames [2].

Conclusion

In conclusion, the use of advanced dampers in retrofitted RC frames dramatically transforms how seismic loads are distributed throughout the structural system. By facilitating controlled energy dissipation and reducing stress concentrations in concrete elements, these devices enhance the earthquake performance and safety of buildings. As urban infrastructure continues to age and face increasing seismic threats, the incorporation of these dampers offers a practical, cost-effective and performance-based solution for enhancing the resilience of reinforced concrete structures.

Acknowledgement

None.

Conflict of Interest

None.

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