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Hybrid Energy Dissipation Devices Consisting of Steel Slits and Rotational Friction Damping Devices

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ABSTRACT

The current seismic design philosophy allows structures to undergo plastic deformation subjected to large earthquakes, while remaining elastic subjected to small or moderate earthquakes. In order to mitigate earthquake induced structural damages instead of sacrificing the plastic deformation of structural members, various types of energy dissipating devices (EDDs) have been adopted in the structures located in strong earthquake regions. This study introduces a hybrid EDDs combined effective characteristics of two different EDDs which might be utilized to multi seismic hazards and investigates their applicability on the building structures located on low-to-moderate seismicity regions. The hybrid EDD considered in this study consists of an in-plane deformational steel slits and rotational friction EDDs connected in parallel which can be operated for both minor and major earthquakes. Subjected to minor earthquakes or strong winds, the in-plane deformational steel slits remain their elastic states and the rotational friction EDDs are only operated to dissipate seismic energy. Both of steel slits and rotational EDDs could be simultaneously activated to sufficiently dissipate seismic energy during relatively strong earthquakes.

1. INTRODUCTION

Existing non-seismically detailed low-rise RC buildings have higher seismic risks that are dependent on their seismic capacities and demand of building sites. In order to mitigate earthquake induced structural damages on RC structures, various types of energy dissipating devices (EDDs) have been developed and implemented into building structures (Harada and Akiyama 1998). Most of existing EDDs generally dissipate seismic energy attacking into building structures by utilizing the frictional or hysteretic behaviors of steel or other materials (Mualla and Belev 2002, Chan and Albermani

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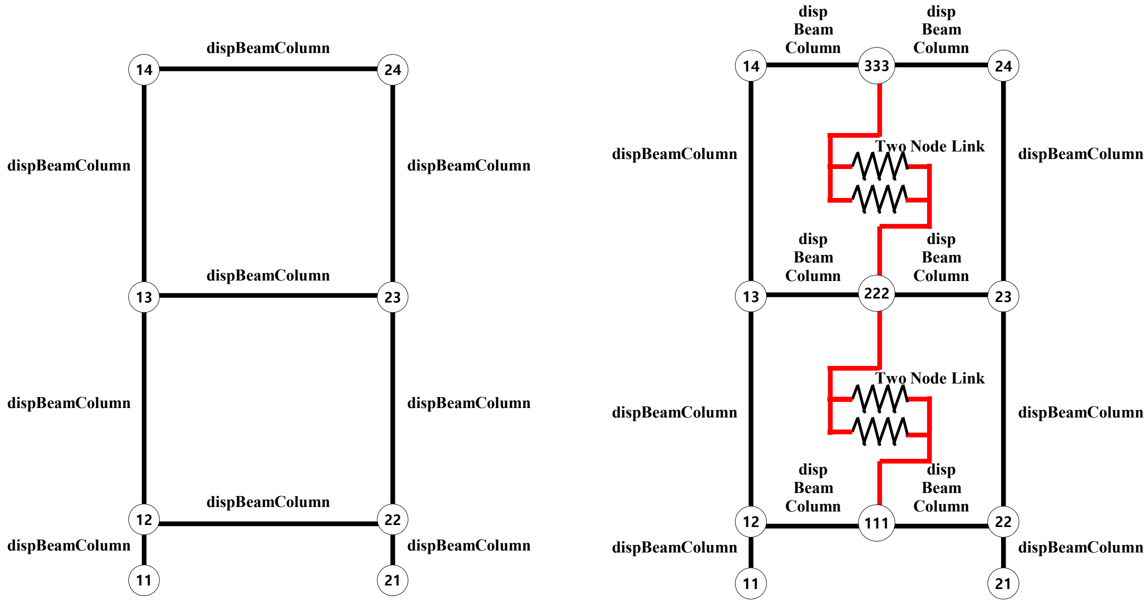
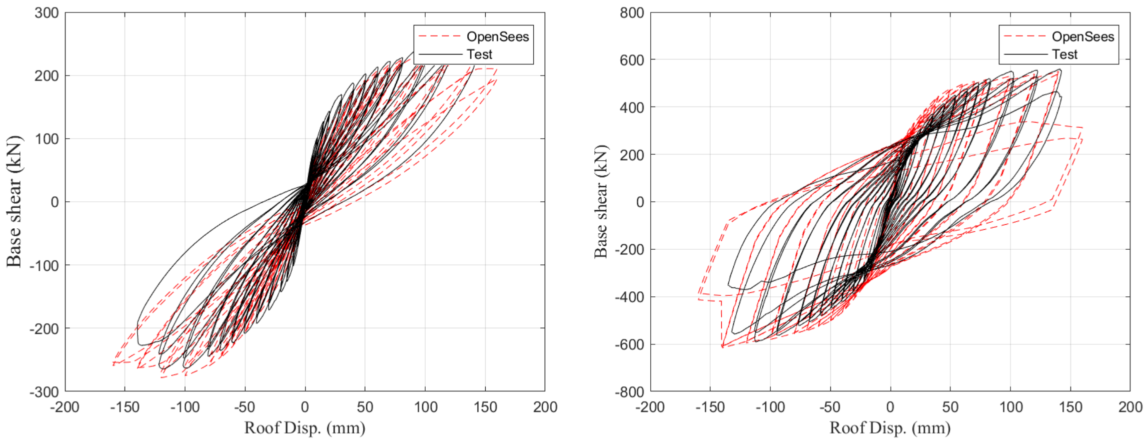
displacement relation obtained from the analysis with test results. It was confirmed that both non-retrofit and retrofit specimens showed similar behavior to the results of the cyclic test in terms of stiffness and strength, and strength reduction also appeared to occur at similar points. In addition, the application of “MinMax” model can reasonably capture the fracture of the steel slits which can be recognized as important failure modes of RC frames installing hybrid EDD systems.



(a) RC frame (b) Retrofitted by hybrid EDDs

Fig. 4 Analytical models for simulating nonlinear behaviors of frames



(a) RC frame (b) Retrofitted by hybrid EDDs

Fig. 5 Comparison of cyclic tests and analysis results

3. CONCLUSIONS

In this study, the hybrid EDD combining rotating friction pads and steel slits was introduced and a modeling method of nonlinear analysis for non-seismic detailed reinforced concrete structures with hybrid EDD is presented. Each EDD is modeled independently, and it is concluded that the cyclic behavior of the RC frame of which the hybrid EDDs are installed can be sufficiently simulated by reflecting the deformation limit of the steel slit. For more practical application of the hybrid EDDs, more researches on the development of design procedure are required in the future more through analytical investigations to demonstrate their dynamic response subjected to earthquakes.

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