Friction Damper in Steel Coupling Beams for Enhanced Seismic Resilience of High-rise Buildings

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Summary

A friction damper is proposed and tested for the use in steel coupling beams in high-rise buildings. Multiple brake pad-to-steel interfaces are jacketed by disc springs and high-strength bolts to yield stable frictional resistance. One can easily disassemble the damper and remove the brake pads by loosening the bolts, either for damage inspection or for replacement when necessary. Cyclic loading tests on steel coupling beams with the proposed friction dampers were conducted to show the reliable frictional behavior of the chosen material.

Keywords: friction damper; steel coupling beam; friction coefficient; brake pad.

1. Introduction

A friction damper is proposed for the use in steel coupling beams (Figure 1b). Multiple brake pad-to-steel interfaces are jacketed by disc springs and fastened by high-strength bolts to provide stable frictional behavior. Damage is only likely to take place on the brake pad-to-steel friction interface. One can easily disassemble the damper and remove the brake pads by loosening the bolts, either for damage inspection or for replacement when necessary (Figure 1c).

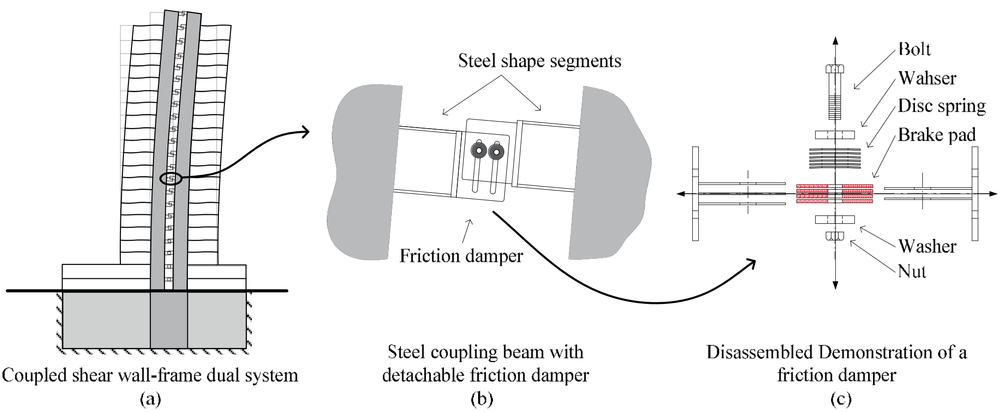

Fig. 1: Proposed friction damper and its use in steel coupling beams in high-rise building.

2. Specimen and loading setup

Cyclic loading test of a steel coupling beam equipped with the proposed friction damper in the mid-span was conducted. The proportion of the steel beam segments and the damper was intended to mimic the mechanical properties of a prototype reinforced concrete (RC) coupling beam in a prototype 27-story building of RC frame-core dual system in a high seismicity region in China. Figure 2 depicts the configuration of the specimen and the test setup.

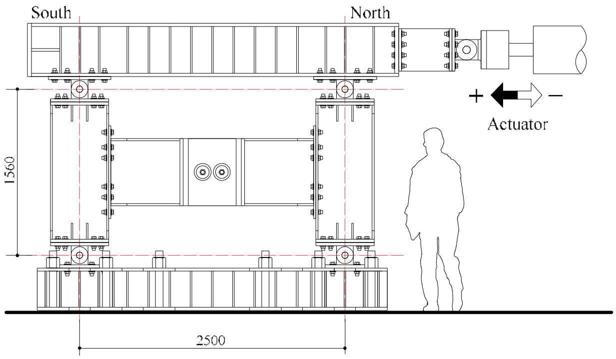

Fig. 2: Loading setup.

3. Results and discussions

The ratio of the friction damper-to-coupling beam deformation rises to about 95%. In other words, the friction damper concentrates most of the deformation of the coupling beam. Figure 3 shows the shear force ratio-shear deformation relationship of the friction damper in all the three loading phases. The hysteresis is very stable even during the 30 cycles of constant amplitude.

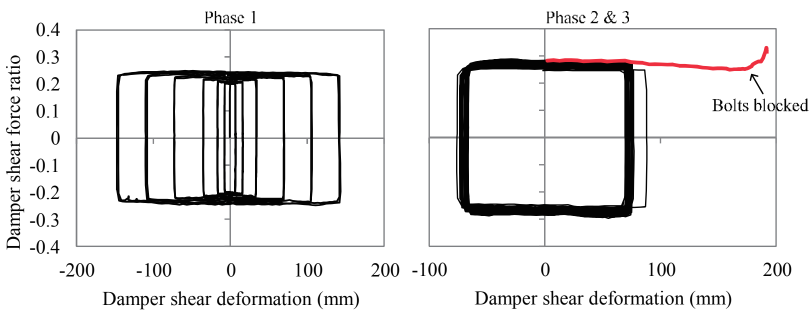

Fig. 3: Load-deformation hysteresis of friction damper.

4. Summary

A friction damper is proposed and tested for the use in steel coupling beams in high-rise buildings. The preliminary test shows that the hysteresis of the friction damper is full and stable, indicating superior energy dissipating capacity. The easy-to-disassemble feature also makes it promising in terms of damage inspection and rapid recovery. Issues that remain problematic and deserve further investigations before such dampers can be implemented in realistic construction are identified.