Enhancing seismic resilience of buildings using self-centering hysteretic damper

Engr. Dr. Asad Naeem (asadnaeem101@gmail.com)
Long-term Visiting Researcher (2021-2022)

1. Introduction

During the stay at the Earthquake Research Institute (ERI) University of Tokyo, I worked with Professor Kusunoki Koichi laboratory. As for my research I developed an innovative self-centering box slit damper to enhance the seismic performance of building structures. This low-damage device aims to minimize earthquake-induced damage, residual displacement, and incurred downtime to achieve performance targets functionality under design-level shaking. The self-centering box slit damper composes of two hollow steel boxes assembled in a telescopic fashion, combined with prestressed disc springs in the inner box to provide self-centering forces. This is an advantage over conventional slit dampers which, despite its wide usage to provide energy dissipation, cannot return to their original position after yielding of the slits.

2. Self-centering Box Slit Damper

I designed the damper prototype and manufactured the prototype with the state-of-the-art facility for manufacturing and machining available at the ERI. A schematic of the damper is shown in Figure 1, below with the recentering hysteresis loop. The outer box of the damper composed of slit dampers trimmed into each side of a hollow square steel section. The slits are to then be plug welded to an inner steel box so that both boxes are connected in a telescopic configuration.

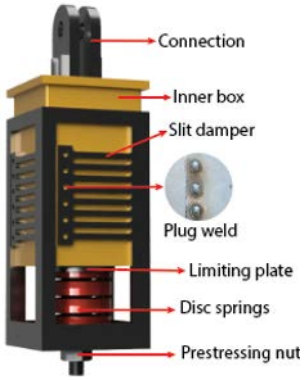


Figure 1. Self-centering box slit damper

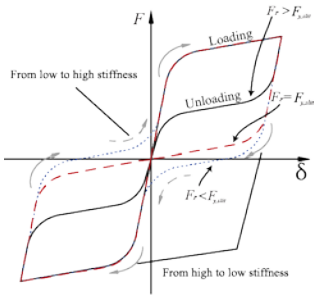
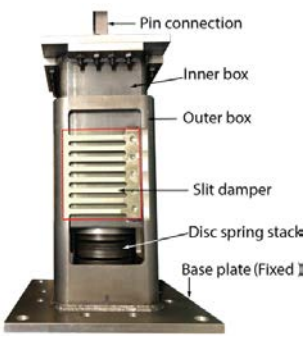


Figure 2. Hysteresis of proposed device

The relative movement of the boxes causes the steel strips of the damper to dissipate energy. The recentering capability of the proposed device is provided by prestressed stacks of disc springs with limiting plates installed between the outer and inner box.

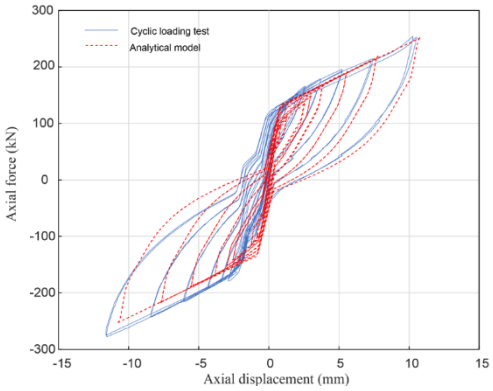
An analytical model of the device was developed to predict the flag shape force-displacement relationship. I did the cyclic loading test of the damper prototype and compared the results with the analytical model developed.

The figure below shows the before and after the test pictures of the test. The result of the test and comparison using the analytical model is also depicted.



(a) Before the experiment

(b) After the experiment



(c) Comparison of test and analytical model hysteresis

After the completion of test, I applied the proposed damper in the model structure to evaluate the seismic performance of the building structure under different earthquakes. Furthermore, I wrote the international journal paper with the finding in this research.

3. Acknowledgement

I am thankful to the **University of Tokyo, and Earthquake Research Institute, Professor Kusunoki** and staff at International Office for providing such an interesting opportunity to study and research in Japan's finest institute and pleasant stay in Japan. I worked and learned a lot from my peers and understand the latest research being done in the field of earthquake engineering.

Sincerely,

Dr. Asad Naeem