7th International Conference on Seismology & Earthquake Engineering
00380-SC
7th International Conference on Seismology & Earthquake Engineering
18-21 May 2015

# ENHANCING PERFORMANCE OF OVAL-SHAPED DAMPERS IN CHEVRON-BRACED STEEL FRAMES USING LATERAL STIFFENING PLATES

Seyed Mehdi ZAHRAI
*Associate Professor, Civil Engineering Department, The University of Tehran, Tehran, Iran*
*mzahrai@ut.ac.ir*

Mohamad Hossein MORTEZAGHOLI
*M.Sc. Student, The University of Tehran, Tehran, Iran*
*m.mortezagholi@ut.ac.ir*

**Keywords:** Passive Damper, Oval Damper, Chevron-Braced, Energy Dissipation

Nowadays passive dampers are currently used as a tool to absorb most of the earthquake energy in structures. While yielding dampers reach through plastic limit, they use input energy of the structure for their non-plastic change (Whittaker, et al., 1989).

Oval shaped dampers in chevron-braced steel frames attract a major part of seismic energy through their yielding and prevent buckling of braces like a fuse. Lateral strength of these dampers should be arranged to be optimum as the damper will not work with small strength. On the other hand, too much strength causes easy buckling of dampers and thus it is inefficient .Appropriate use of flexible components is considered to delay buckling until yielding happens (Najari Varzaneh et al., 2012).

Furthermore, to enhance efficiency of yielding dampers, geometrical properties of damper must be defined in a way that most parts of damper reach yielding point. Oval-shaped damper might buckle under influence of shear forces resulting from lateral movement of frame and will have no appropriate energy dissipation. In such case, a small force is created within braces and frame practically behaves in bending behavior.

Increase in thickness of oval-shaped damper has no significant effect on enhancement of their performance under lateral forces and is not suitable option to solve this problem. Using stiffening plates in dampers significantly improves efficiency and prevents its buckling. Thickness and number of stiffening plates connected to damper are among main factors leading to better achievement.

This study investigates and compares the proposed models using ABAQUS Finite Element Analysis program leading to the most appropriate model (ABAQUS Inc., 2004). At first place, through increasing thickness of damper, appropriate stiffness of damper is achieved. Then, using stiffening plates as an appropriate method, necessary stiffness is obtained. Loading is conducted based on ATC24 protocol and displacement defined dislocation is applied cyclically (Applied Technology Council, 1992).

Placement of oval-shaped damper in a chevron-braced steel frame is shown in Figure 1. Also, a modified oval-shaped damper is shown in Figure 2 using stiffening plates.

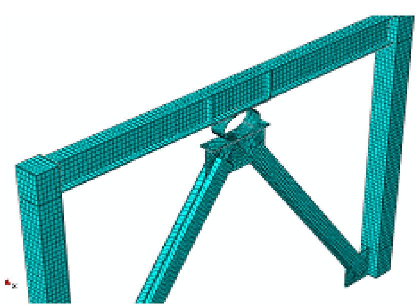

Figure 1. Oval-shaped damper in a chevron-braced frame

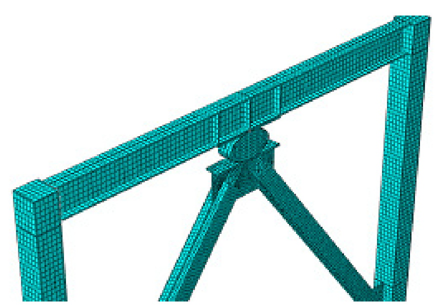

Figure 2 . Oval-shaped damper using stiffening plates

Moreover, cyclic loading curves of braced frame (base shear according to displacement of upper flange of beam) using normal oval-shaped damper and modified damper with stiffening plates are shown respectively in Figures 3 and 4.

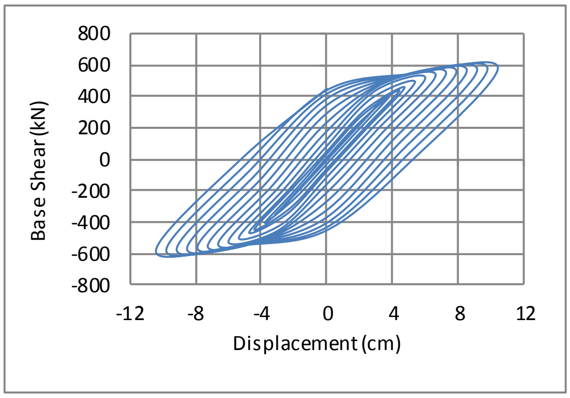


Figure 3. Hysteresis curve of normal oval-shaped damper

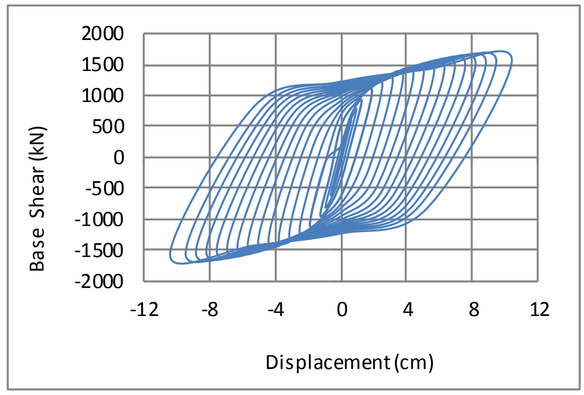


Figure 4. Hysteresis curve of modified oval-shaped damper

As it is shown in the graphs, due to increase in the hardness of the frame with modified damper, base shear has increased 3 times, whereas equivalent damping ratio for normal damper in the last cycle of loading is 12.8%, which will be reached up to 17.4% for modified damper (Zahrai and Moslehi Tabar, 2013; Zahrai, 2014).

## REFERENCES

ABAQUS Inc. (2004) ABAQUS Analysis User's Manual, Version 6.8.1, Pawtucket, Rhode Island

Applied Technology Council (1992) Guidelines for Seismic Testing of Components of Steel Structures, Report ATC-24

Najari Varzaneh M et al. (2012) Study on the Performance of Oval-shaped Steel Dampers in Seismic Retrofitting of Steel Frames, *3th National Conference Steel and Structure,* 950-957

Whittaker A et al. (1989) Earthquake Simulator Testing of Steel Plate Added Damping and Stiffness Elements, Report No. UCB/EERC – 89/02, Earthquake Engineering Research Center, University of California, Berkeley

Zahrai SM and Moslehi Tabar A (2013) Analytical study on cyclic behavior of chevron braced frames with shear panel system considering post-yield deformation, *Canadian Journal of Civil Engineering*, 40(7): 633-643

Zahrai SM (2014) Cyclic Testing of Chevron Braced Steel Frames with IPE shear panels, *Engineering Structures*, *Steel and composite structures*, *An International Journal*, Accepted for publication