AN EFFICIENT ENERGY DISSIPATING DEVICE CALLED COMB-TEETH DAMPER

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ABSTRACT

In this paper, a new type of yielding metallic damper called comb-teeth damper, CTD, is introduced. CTD is made of steel plates and includes a number of teeth that dissipate energy through in-plane flexural yielding. An optimum geometry of teeth is suggested, which assures uniform distribution of stress along them and prevents strain localization. Numerical FE modeling and test results are used to verify the design of proposed damper. Three full scale specimens have been made and tested under cyclic loading. The samples tolerated considerable cumulative displacement in their hysteresis cycles without any significant loss of strength. After these studies, the behavior of three simple steel frame equipped with proposed damper has been evaluated experimentally. The test results show that if this type of frames is designed appropriately, they can have a high energy dissipation capacity.

INTRODUCTION

Passive energy dissipation devices have been widely used in structures in the last decades, as effective and relatively low-cost systems to reduce the earthquake damage. Inelastic deformation of ductile metals in metallic dampers, sliding in friction dampers, flow of viscous fluids through narrow orifices in viscous dampers, and deformation of viscoelastic materials in viscoelastic dampers are some alternative mechanisms, which may be used to dissipate seismic energy (Soong and Spencer, 2002). Due to simpler manufacturing process, the yielding metallic dampers have found more widespread application in building construction compared to other types of energy dissipation systems.

The research on yielding metallic dampers was started by the pioneering works of Kelly et al. (1972), which was continuously followed by other researchers. Yielding metallic dampers, if effectively used, can dissipate significant portion of seismic energy through inelastic deformation of ductile metals. Generally, depending on the yielding mechanism, metallic dampers can be divided into four groups of flexural, axial, shear, and torsional.

The yielding dampers most widely used, are Added Damping and Stiffness, ADAS, Triangular-ADAS, TADAS (Bergman and Goel, 1987- Tsai et al., 1993- Xia et al., 1992) and Buckling restrained braces, BRBs (Wada and Nakashima, 2004- Tremblay et al., 2006). Yielding shear panels (Chana et al., 2009) and slit dampers (Jacobsen et al., 2010- Lee et al., 2002- Benavent, 2010- Li and Li, 2007-Chana and Albermani, 2008- Eatherton and Hajjar, 2010- Ghabraie et al., 2010- Oh et al., 2008) are other types of yielding dampers that are studied more recently.

Slit dampers are known as a special type of metallic dampers, in which plates with a number of slits or openings are subjected to in-plane shear deformations. The slits/openings divide the steel plate to a series of links acting in flexure under the global in-plane shear deformation of damper. Li and Li (2007) tested some slit dampers and applied them to a real structure. Based on the concept of slit dampers, Benavent (2010)