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THE VERIFICATION OF VISCO-PLASTIC DAMPER

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Due to the significant development and extent of different types of dampers and their applications in the construction industry, the need for more attention in this field is essential. Generally, energy absorber dampers are used to reduce the dynamic response of the structure against wind loading, earthquake and so on. One of the main purposes of designing a structure with dampers is to determine the ideal condition in which both stiffness and damping are increased. Creating such a balance is very difficult due to the dependence of these two factors. The Visco-plastic damper (VPD) is a combination of Visco-elastic and Yielding Dampers, which was invented by Ibrahim in 2005. So far, limited research has been done on this kind of dampers. Due to the physical structure of this damper, which includes curved steel elements and viscoelastic material with high damping (see Figure 1), stiffness and damping factors can be well controlled. For the low and moderate level of earthquake, the energy dissipated through viscoelastic material and for the high level of the earthquake in addition of viscoelastic material the energy dissipated by yielding of the steel elements. The most important characteristics of the VPD as follows:

- Build, install and produce easy without the need for sophisticated technology
- The minimum cost for construction and maintenance and need to be replaced only by a severe earthquake
- Capability to control the structure linear and nonlinear response against medium and severe earthquakes
- Existence of hybrid control system (yield mechanism of steel profile and vertical deformation of viscose material)
- Control damper behavior by changing various parameters used in the design of the damper (such as element's length, breadth, and thickness, the size, and rigidity of viscoelastic material, etc.) (Ibrahim et al., 2007).

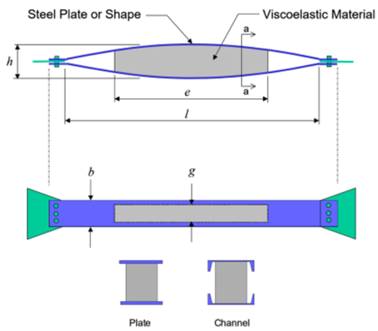

Figure 1. Details of Visco-plastic damper (Ibrahim, 2005).

In this research, first, the verification of three types of Visco-plastic damper with names M1, M2, and M3 under Sinusoidal harmonic displacements are introduced and all of its formulations are thoroughly discussed. Because of the M3 model had the best matching with the finite element analysis results it was selected for adding to the steel frame. The simplified model of the VPD and their results have shown in Figure 2. For completing the verification and investigate the effectiveness of the device on the response of multi-story structures, the simplified model of the VPD (M3) was attached at each floor to the model of a nine-story five-bay steel frame designed for the SAC building project located in Los

Angeles (Gupta & Krawinkler, 1998). The model was analyzed under scaled records of El Centro and Northridge earthquakes. The earthquakes were scaled to produce a first mode spectral acceleration of 0.35 g. Nonlinear time history analysis was conducted using SAP2000 including P-delta and Large Displacement in the analysis. Part of the comparison results has been shown in Figure 3. The results show more than 90% verification matching.

(a) The simplified model, M1

(b) The simplified model, M2

(c) The simplified model, M3

Figure 2. Simplified visco-plastic model and their comparison results under harmonic displacement (3.75sin2πt).

According to Figure 3, the maximum displacement of the floor has been reduced by 20% compared to the frame without VPD. The evaluation of the results suggests that the use of Visco-plastic damper will improve the behavior of the structures during the earthquake.

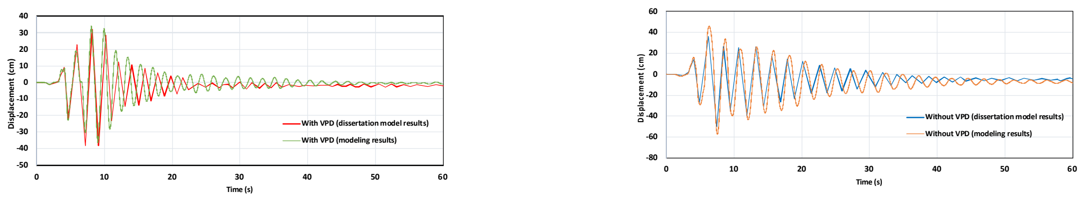

Figure 3. Comparison between the floor displacement of the dissertation and modeling nine-story frame with and without VPD under Northridge earthquake.

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