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EFFECTS OF ADAS DAMPERS ON PLASTIC HINGE ROTATION OF DUAL STEEL FRAMES SUBJECTED TO NEAR-FIELD AND FAR-FIELD EARTHQUAKES

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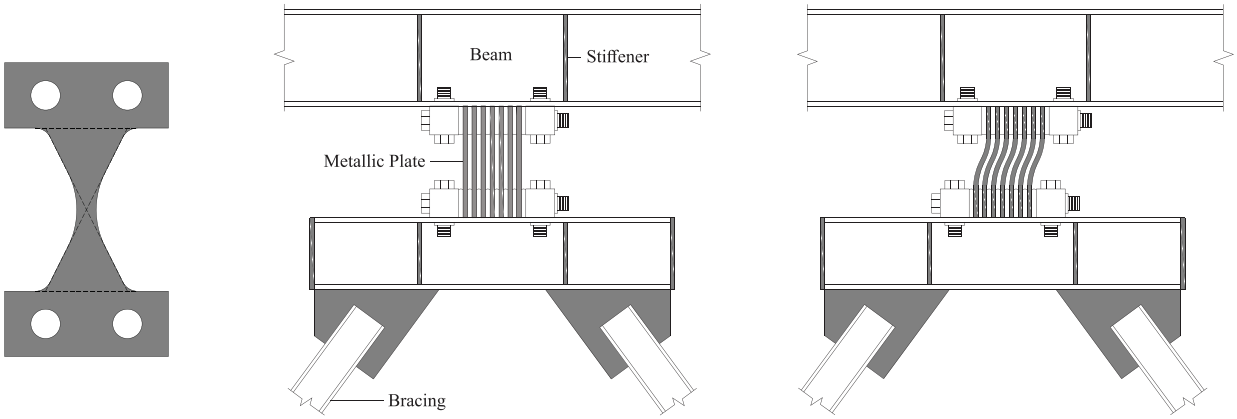
In this investigation, the effects of ADAS yielding dampers on plastic hinge rotation of dual seismic-resistance steel frames and the energy absorption of the dampers, subjected to far-field and near-field earthquakes, are discussed. Over the years of construction in Iran, many steel buildings with moment frame resisting system have been built. Some of these structures need seismic retrofit because of some reasons, including poor design, increasing in loading during the serviceability period, and changing in loading and design codes. In presenting a proper strengthening design, some important factors such as performance ability, minimum destructions needed, and minimum changes in available architecture should be considered. Dampers play a key role in controlling the structural responses subjected to seismic loads as the energy dissipater of the earthquake, and they can prevent the nonlinear behaviour of the gravitational load resisting members of a structure. In this context, the proper function of the ADAS yielding dampers on increasing stiffness and damping of the structures is considered. ADAS was first used as damping support for piping systems and then used for structural systems. The geometry of these structures is in a way that the X-shape metal yielding plates are placed continuously beside each other (Figure 1). In this paper, this damper is used in the connection of two concentrically inverted V (Chevron) braces.



(a) X-shape metal plate. (b) Using 7-plate ADAS element in a chevron brace. (c) Behavior of ADAS damper during earthquake

Figure 1. Schematic view of an ADAS yielding damper.

To study the effects of ADAS dampers on plastic hinge rotation of structure and energy absorption of ADAS element, two steel intermediate moment frames one with 8 stories and the other with 12, having three spans each, in two-dimensional form, are being considered. Two frames are designed in a way that they are sufficient for strength issues and not satisfied the drift criterion. For strengthening purpose, once a concentrically inverted V (Chevron) brace in each story and then with an ADAS damper in their connection area are used and the results are being compared with each other.

The loading and structural steel design codes used in this research are ASCE7-16 and AISC 360-16, respectively. To

develop the DBE spectra, the spectral parameters of Los Angeles region for site class C are used. With regard to the residential usage, the seismic importance factor (I_e) is considered 1 with risk category II. Moreover, the response modification coefficient (R) is given as 4.5. Designing the dual frames is done by CSi ETABS 2016 software. Values of gravity loading containing dead and live loads are presented in Table 1. In order to analysis of dual steel braced frames, the finite element software, OpenSees, is used. For modeling structural elements and ADAS damper, the "dispbeamcolumn" and "zerolength" elements are employed respectively.

Table 1. Gravity loading containing dead and live loads.

Load Type	Value (kN/m^2)	Value (kN/m) for a 5m span
Distributed dead load (except roof)	6	30
Distributed live load (except roof)	2.5	12.5
Roof distributed dead load	5.5	27.5
Roof distributed live load	1.5	7.5

For exciting the earthquake load, two record sets including three near-source accelerograms and three far-source accelerograms chosen from FEMA-P695 ground motion series are considered and applied as time history analysis. For each of these sets, the average elastic response spectrum of accelerograms is scaled in DBE level, based on the damping ratio of 5%. The results are gained according to maximum demand for each of these two record sets of near-field and far-field and then compared. These results include the plastic hinge rotation of frames and energy dissipation of dampers. They show that using the ADAS dampers has a major impact on controlling the dual frame's responses compared with Chevron braces.

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