Seismic Behavior and Performance of Pure Bending Yielding Dissipater under Combined In-Plane and Out-of-Plane Loading

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Throughout history, human society has created structures with different uses to resist the natural forces of the earth especially earthquake. The structural resisting members suffer displacements and forces of different intensities and directions. Therefore, the design should be done based on all the internal forces. For decreasing the damage to the structures, the performance-based design method has replaced with the force-based design method. In this design method, engineers are able to predict the performance of the structures under the forces caused by earthquake. In the past decades the use of vibration control systems has become popular, in order to increase the performance of structures. In the meantime, metal-yielding dissipaters as subsets of passive control systems have received more attention. Due to the existence of little research in the investigating the effect of all-round vibrations caused by earthquakes on the behavior and performance of dissipaters, including yielding dissipater, in this thesis, the behavior and performance of a type of metal yielding dissipater named Pure Bending Yielding Dissipater is considered under the combination of possible displacements. Due to the special geometry used in it, this damper has a mechanism for creating a pure bending moment in the damper plates, and one of its advantages can be pointed out to be suitable ductility, high energy absorption capacity, and stable hysteresis behavior. In order to study the behavior of this type of damper 6 specimens with different geometric and design specifications, in terms of the thickness of the damper plates, the length and width of the damper plates, the number of damper plates and the total axial strength of the damper, are considered. Due to the high costs of making specimens in laboratories and the limitations of loading devices, the numerical method has been used as an alternative. ABAQUS software has been chosen as a tool in simulating in this research. In the initial simulation, comparing the numerical results of the FEM with the experimental ones is done. The difference between FEM and experimental results in ultimate capacity and the energy absorption capacity is up to 20% and 15% respectively. Therefore, the efficiency of ABAQUS finite element software in simulating the behavior of this type of damper was proven. In the following, the numerical model was modified for multi-directional loading conditions and displacements in different directions was checked. Observing the distribution of stress and strain in different components shows the capability of ABAQUS in simulating of this damper under multi-directional displacements. The comparison of the load-displacement diagram of these models shows that the cyclic behavior of this damper under bi-directional and 3-directional loading is affected by the free distance between damper's middle and side parts. So in case of collision between different parts, in addition to damper plates, other parts also participate in absorbing energy. The portion of absorbed energy in damper plates, holder plates, and the lateral constraint blocks is about 70-80%, 0-20%, and 0-10% of the entire energy consumption capacity of damper, respectively. These results indicate that the ductility capacity and energy consumption of the pure bending damper, even with the multi-directional loading conditions caused by the earthquake, are largely dependent on the ductile components, i.e. the damper plates. In addition, the comparison of all the results for both bi-directional and 3-directional loading conditions shows the negligible effect of out-of-plane loading on the cyclic behavior and the energy consumption capacity of the dampers.

Keywords:

Pure bending yielding damper, Metal yielding damper, 2-directional and 3-directional loading, energy dissipation capacity, stable hysteresis behavior, ABAQUS software.