Chapter 5
Passive Dampers:
Fluid Viscous Dampers

ABSTRACT

Civil structures are subjected to various types of loading, which induce severe damage to the structures. Many techniques have been developed for structural rehabilitation; one of the emerging technologies is the use of energy dissipation systems such as fluid viscous dampers (referred to hereafter by FVD). In this chapter, the effect of these devices on the dynamic behavior of an RC building is investigated, with an optimal choice of the linear FVD parameter (i.e., damping coefficient), using a simplified and effective approach. It was found that the maximum inter-story drift of the analyzed retrofitted structures can be significantly reduced compared to the original ones.

INTRODUCTION

In this chapter, our efforts are focused on the effect of Fluid Viscous Dampers (FVD); which is a case of a passive dampers; in the dynamic behavior of an RC building.

As we know civil structure are usually designed to resist a moderate to mild seismic intensity; these structures may sustain significant damage and deformation during their functionality. In order to limit seismic induced structural displacement and peak accelerations to acceptable levels many rehabilitation techniques are used to extend their lifetime and ensure the functionality. Two main options are available for engineers to reduce seismic effects; enhance the building's lateral stiffness either by increasing the structural size and material quantity, or by increasing the level of damping by means of supplemental devices (Duflot et al., 2008). Retrofitting consists in the addition of supplemental devices in the lateral motion of a structural system without a major modification in the building (Rodrigo et al., 2003). Fluid Viscous Dampers (FVD) are energy dissipation systems, their use for civil applications have emerged after their proven efficiency in various military branches. Many researchers (Canstantinou et al., 1993) (Soong et al., 2002) proceeded in their testing and proved their efficiency for improving the seismic behavior of full-scale civil structures.

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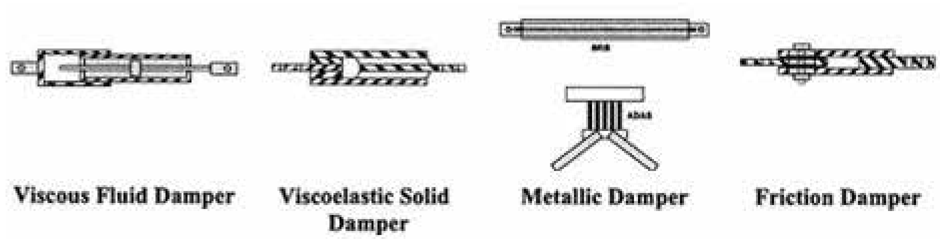
Their ability to dissipate large quantities of the input energy and reducing the deformation demand is why they are used more frequently for seismic design and retrofitting (Pollini et al., 2016). Since they have proved their efficiency in such applications, this work focuses mainly on the design of linear FVDs with optimum damping coefficient in such way the computation time is reduced, along with an illustration that studies an RC building, where the reduction amount will be shown and facilitating the comprehension of their preliminary design method.

DIFFRENCE BETWEEN ACTIVE AND PASSIVE CONTROL SYSTEMS

Active control systems are considered as a more advanced technology, their concept is based on a real time processing that allows them to act accordingly to the excitation, thanks to the sensors integrated within the device. These sensors collect information about the excitation and the structural response, then adapts the device's behavior based on the collected data (Saaed & Nikolakopoulos, 2015, Soong & Spencer, 2002).

Passive control systems consists in materials and devices that enhance damping, strength and stiffness, the most common devices of this class operate generally on principles such as deformation of fluids and fluid orificing (the case of this chapter), deformation of viscoelastic solids, frictional sliding and yielding of metals (Soong & Spencer, 2002). A passive dissipation device utilizes the motion of the structure to generate the control force (no external power source needed). In the following, it will be mainly focused on fluid viscous dampers i.e. FVD, and their design optimization, which is seen as intensive task, all illustrated with an example. Figure 1 shows some of the passive dissipation devices followed by a brief definition and a summary of their advantages and disadvantages.

Figure 1. Passive energy dissipation systems.



Friction damper consists of four links located at the intersection of cross bracings (tension brace and compression brace) (Canstantinou & Spencer, 1992). A slippage is permitted for one of the braces then the other slips, which allow the device to dissipate energy in both braces. Filiatrault & Cherry (1990) tested and confirmed that this type of devices can increase substantially the capacity of dissipation in one cycle and reduce the amount of drifts. However Symans & al (2008), cited some reliability issues that concerns this sliding option, which can change the interface condition with time, and since their behavior is highly nonlinear, it may provoke undesirable structural behavior by exciting higher modes.

Metallic damper or also called yielding steel elements, many concepts are proposed, it can consist on round steel bar integrated in the bracing frame (Canstantinou & Symans, 1992, Tyler, 1985 and