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SEMI-ACTIVE CONTROL OF BUILDING STRUCTURES SUBJECTED TO NEAR-FAULT EARTHQUAKE EXCITATIONS USING VISCOUS DAMPERS

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Abstract

In this paper, the semi active control of seismic vibrations of structures equipped with viscous dampers is studied. Due to sensitivity of viscous dampers to velocity and fast loading in near-fault earthquakes, it is expected that these dampers to be able to have acceptable operation in near-fault earthquakes. For a numerical example, a nine-story building is chosen. The building is modeled whit three degrees of freedom at each story level including two lateral and one torsional degree of freedom, By programming in MATLAB software, the dynamic behavior of the example building equipped whit viscous dampers to earthquake excitations are studied and the responses of the building including maximum displacement, acceleration, and shear of stories level have been evaluated. Finally, the results of controlled and uncontrolled structures are compared. This comparison shows that the use of viscous dampers, make considerable reduction in seismic response of structures subjected to near-fault earthquakes

Keywords: near-fault, semi-active, LQR controller

1. INTRODUCTION

Use from damper is an efficient way for structures to achieve optimal performance when it is subjected to seismic load, wind, or other types of vibration or shock disturbances. Last two decades major earthquakes such as (Landers, Northridge, Kobe, Chi-Chi) caused attention to control of structure is increased.
Control of structures based on semi-active is one of the major control way. Kurata et al.[1] presented the first utilization of a semi-active damper system in an actual building. They demonstrated the electiveness of the semi-active system in reduction of the building responses [1]. After kurata many researches on semi –active show that this control device has many advantages compared whit other devises such active and passive controls. Semi-active control system could be used in different control devices such as friction damper, and fluid viscous dampers. In semi-active structural control using hydraulic fluid dampers, a controllable electro-mechanical, variable orifice valve is added to a conventional damper to alter the resistance to flow of the fluid, and thus the damping provided by the device. Depending on the control objective and algorithm, a control force is determined at any instant, and then, the damping coefficient of the device is modified in such a way that the resulting force is as close as possible to the calculated control force [1]. The force provided in Viscous dampers is proportional to the relative velocity between the ends of the damper [2]. A viscous fluid damper generally consists of a piston within a damper housing filled with a compound of silicone or similar type of oil. The force developed by a viscous damper could be expressed as:

$$F=CV^N \qquad (1)$$

Where F is the damper force, V is the relative velocity between two ends of the damper, and N is the damping force exponent ranging from 0.2 to 1 for seismic applications [3]. In this paper the liner viscous damper issued and therefore N=1.Figure1 show a typical viscous damper [4].