Semi-active Vibration Control of Buildings using MR Dampers: Numerical and Experimental Verification.

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ABSTRACT:
The present work describes part of the R&D on using a semi-active structural control technique in a civil engineering experimental model frame equipped with a MR damper, developed within COVICOCEPAD project approved in the framework of Eurocores program S3T. Some results are provided associated with the calibration of a MR damper at FEUP as well as on the experimental modal identification of the dynamic properties of a small-scale metallic frame, without and with inclusion of a specific MR device. Some numerical results of the controlled frame under simulated earthquakes are given, to be later compared with the experimental results of such frame installed in a Quanser shaking table.

Keywords: Semi-active Control, Control of Vibrations for Smart Structures, Semi-Active Devices

1. INTRODUCTION

Seismic isolation and passive energy dissipation are two well-established techniques validated by a huge amount of real applications (Naeim and Kelly, 1999; Cesar and Barros, 2007). Magneto-rheological fluid based devices have the appropriate features justifying the relevance of these for possible civil engineering applications and therefore the attention of researchers to study its potential as vibration control hardware (Dyke *et al*., 1996 ; Gatulli *et al*., 2010). The control strategy for these devices is based on semi-active control that may be more reliable and stable than active control.

In the last two decades R&D of structural vibration control devices for buildings and bridges has been intensified to reply to construction market needs that demand more effective systems to decrease the damage caused on structures by seismic and wind loading. Although the main purpose of a seismic design is to protect the population from the consequences of a severe earthquake, the protection of investment may also be regarded as an important option during the conception and design process. In this paper is addressed some on-going R&D on the vibration control of a 3-DOF scaled metallic frame with a MR damper (Cesar and Barros, 2010). An equivalent device was tested in the laboratory to obtain the main rheological characteristics in order to develop a numerical model to simulate its behaviour. Then a 3-DOF scaled frame was assembled and system identification techniques using an impact hammer procedure were performed to obtain the experimental dynamic properties of this structural system. Based on these results a numerical model was created to initiate the semi-active control research process in order to investigate and calibrate the frame behaviour with the MR damper.

2. SEMI-ACTIVE CONTROL OF STRUCTURES WITH MR DAMPERS

MR fluids have become an extensively studied “smart” fluid and some experimental research has been done in the last years to produce a “smart” control device. The MR damper performance is often characterized by using the force vs. velocity relationship. MR dampers have the possibility to change the damping characteristics leads to a force vs. velocity envelope that can be described as an area rather than a line in the force-velocity plane.