A SURVEY OF SEMI-ACTIVE CONTROL WITH MR DAMPERS

Manuel T. Braz-César[1], Rui C. Barros[2]
1- Polytechnic Institute of Bragança (IPB), Campus de Santa Apolónia – Apt. 134, 5301-857 Bragança Portugal
2- Faculty of Engineering of the University of Porto (FEUP), Rua Dr. Roberto Frias, 4200-465 Porto PORTUGAL
rcb@fe.up.pt

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 magneto-rheological (MR) damper at FEUP (Faculdade de Engenharia da Universidade do Porto) as well as on the experimental modal identification of the dynamic properties of a small-scale metallic frame, with and without the 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: Response control, Clipped optimal control, MR dampers, Semi-active control.

1. INTRODUCTION

In the last two decades R&D of structural vibration control devices for buildings and bridges has been intensified in order to answer the construction market needs that demand more effective systems to reduce the damage caused on structures by seismic and wind loadings. Although the main purpose of a seismic design is to protect the population from the consequences of a severe earthquake, the protection of the building stock 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 three degree-of-freedom (3-DOF) scaled metallic frame with a MR damper [1, 2].
A MR device was tested in the laboratory to obtain the main rheological characteristics in order to develop a numerical model to simulate its behavior. 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 behavior with the MR damper.

2. SEMI-ACTIVE CONTROL OF MR DAMPERS

The MR damper performance is often characterized by using the force versus velocity relationship. MR dampers have the possibility to change the damping characteristics based on a force versus velocity envelope, which can be described as an area rather than a line in the force-velocity plane.
Many authors have developed modeling techniques for the MR dampers. The Bouc-Wen model shown in Fig. 1 allows modeling nonlinear hysteretic systems and is frequently used to model MR dampers [3].

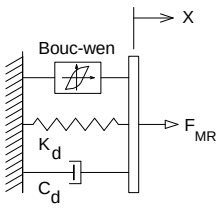

Figure 1: Bouc-Wen model for a MR damper.