Proceedings of the 7th International Conference on Mechanics and Materials in Design,
Albufeira/Portugal 11-15 June 2017. Editors J.F. Silva Gomes and S.A. Meguid.
Publ. INEGI/FEUP (2017)

PAPER REF: 7007

ASSESSMENT OF LONG TERM USE AND AGING IN THE ELECTROMAGNETIC AND MECHANICAL CHARACTERISTICS OF A MAGNETO-RHEOLOGICAL FLUID SPONGE DAMPER

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ABSTRACT

This paper aims to evaluate the long term use and aging effects on the electromagnetic and mechanical characteristics of a magneto-rheological (MR) fluid sponge damper. The device was used in several experimental research projects for ten years followed by four years of inactivity. It was used back in the last year during an experimental campaign to evaluate its effectiveness after these years of heavy use and inactivity. Thus, the dynamic behaviour of a MR fluid sponge damper at several mechanic and magnetic excitations is studied. Finally, the possible causes of the variation in the electromagnetic and mechanical responses of the MR damper with respect to the initial specifications are discussed.

Keywords: magneto-rheological fluid, semi-active devices, MR damper.

INTRODUCTION

Controllable MR fluid based systems are a relatively new and promising technology for structural control of earthquake and wind induced vibrations. Among these, MR dampers are semi-active devices whose mechanical behaviour (stiffness and/or damping characteristics) can be modified in real time according to properly chosen conditions provided by control algorithms based on the structural response.

It is known that durability issues of MR dampers are mostly related to fluid thickening, particle settling and oxidation and seal wearing. Since structural systems are usually designed for a life span of several decades, seismic control devices might be inoperative for a long period of time until the earthquake event actually happens. Thus, medium and long term durability of (MR) dampers is a main concern to ensure that these devices can operate properly after several years of inactivity.

MR fluid sponge dampers are inexpensive and typically small semi-active devices aimed to be used in cost sensitive applications such as moderate-force vibration control in small systems such as washing machines. Besides, they have been widely used in several research projects to study the performance of semi-active control systems in reduced scaled mockups. These devices have conventional cylindrical body configuration and the main difference between this type of devices and typical MR dampers is that sponge based dampers have an absorbent matrix saturated with MR fluid in the piston rod instead of a chamber filled with MR fluid like traditional dampers. In this case a small sponge type MR damper model RD-

1097-1 (Lord Corp., USA) was used to evaluate long term use and aging effects on its mechanical and electromagnetic properties (Figure 1).

The enclosing cylinder is 32 mm in diameter and the damper is 253 mm long in its extended position with ±2.5 cm stroke. The device can operate within a current range from 0.0 A up to 1.0 A with a recommended input value of 0.5 A for continuous operation and can deliver a peak force of 100 N at a velocity of 51 mm/s with a continuous current level of 1.0 A.

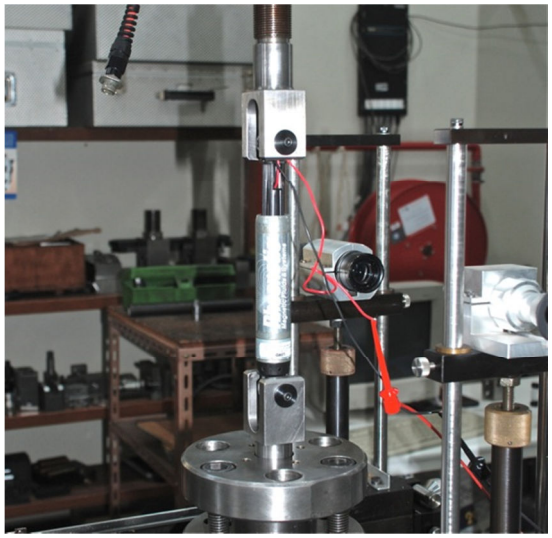

Fig. 1 - MR fluid sponge damper (RD-1097-1 by Lord Corp, USA)

Initially, the input-to-output electric response was studied in order to measure the output control current in the device with respect to an input control signal when the MR damper is powered up. The tests were carried out for six constant input voltages (0.0 V, 0.5 V, 1.0 V, 1.5 V, 2.0 V and 2.5 V) and the corresponding output signals were acquired and recorded. Then, a series of mechanical excitation tests were performed to obtain the response for different operating current inputs. The experimental results were compared with the expected mechanical and electromagnetic specifications for this device.

RESULTS AND CONCLUSIONS

This study shows that long term use and aging of MR fluid sponge dampers have a substantial effect on the mechanical and electromagnetic behavior of this type of devices. This issue continued to be studied and further tests will be carried out in order to monitor and analyze the evolution of the deterioration of the characteristics of the MR sponge damper.

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