Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7282

DYNAMIC CHARACTERIZATION OF MAGNETORHEOLOGICAL DAMPER AND EXPERIMENTAL ADJUSTMENT OF MODIFIED BOUC-WEN NUMERICAL MODEL

Said Boukerroum[1(*)], Nadhira Kheznadji[(1)], Nacer Hamzaoui[2]
[1]USTHB/FGMGP, LMA, BP 32 El Allia 16111, Bab Ezouar, Alger, Algérie
[2]INSA de Lyon, LVA, Bâtiment A de ST Exupéry, 25 bis avenue Jean Capelle 69621, France
[(*)]*Email:* sboukerroum@yahoo.fr

ABSTRACT

In this work, we present an analysis through the hysteresis loops of the performances of the modified Bouc-Wen model governing the internal dynamics of a MR buffer. The analysis of the energy dissipated by vibration cycle is carried out by a dynamic characterization of this damper on a dynamic traction machine in order to examine the effect of the frequency and the excitation current on the energy dissipated and by consequently on the equivalent damping coefficient. The dynamic responses of the modified Bouc-Wen numerical model have been confronted with the experimental responses, and then re-calibrated to them, by adjusting the most influential parameters of this model.

Keywords: MR damper, modified Bouc-Wen model, hysteresis, dissipated energy.

INTRODUCTION

A large domain of use of Magneto-rheological (MR) dampers allowed the researchers to improve the performance of the latter, by focusing on their internal dynamics. Indeed several mathematical models highlighting the physical and energy characteristics (electric current, magnetic fields, flow, viscosity) of MR fluids allowed the development of several digital models governing the internal dynamics of these dampers such as hysteretic models Bouc-Wen (1976) and modified Bouc-Wen (1997).

Hysteresis is a phenomenon observed in many scientific fields, in particular mechanical and materials and magnetism. The Bouc-Wen model is a smooth endochronic model that is often used to describe these phenomena. It was introduced by Bouc in 1967 and later extended by Wen in 1976 and modified by Spencer *et al*. in 1997. It has been widely used for the modeling of MR dampers (Yoshioka *et al*., 2002) and others. That they are treated by identification or optimization calculations, these modeling due to significant progress in the theoretical fields and calculations, are compelled to targets more ambitious quality and reliability.

It is in this context that we present this work, where we analyze through the hysteresis loops modified Bouc-Wen model Figure 1 performances governing the internal dynamics of a Magneto-Rheological damper. The analysis of the energy dissipated per cycle of vibration is performed by dynamic characterization of this damper on a dynamic traction machine Figure 2 in order to examine the effect of the frequency, amplitude and the excitation current on the dissipated energy and therefore the equivalent damping coefficient. The dynamic responses of the modified Bouc-Wen digital model will be compared with experimental answers and readjusted on the latter, while performing an adjustment of the most influential model parameters.

RESULTS AND CONCLUSIONS

From this study we can see first through the characterization of the MR damper, the equivalent damping coefficient experimentally obtained (Figure 3), is a factor very complex, difficult to quantify because it depends on several parameters which are the frequency and amplitude of oscillation supplied thereto as well as the intensity of current issued to it. However, this will allow us to better approximate the parameters of the internal dynamics of the MR damper polynomial functions that take into account the effect of the excitation frequency also.

Finally this work allowed through confrontation hysteresis curves force/displacement and force/velocity (Figure 4), obtained by experimental measurements and calculations on the modified Bouc-Wen model, readjust the responses calculated from the experimentation for a representative numerical model for real damper.

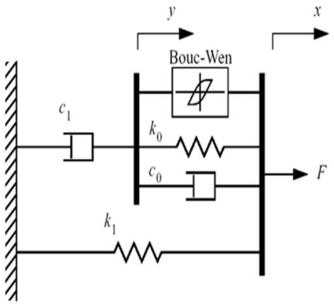

Fig. 1 - Modified Bouc-Wen model by Spencer et al, 1997.

Fig. 2 - Characterization of the MR damper (RD-1005-3) on traction machine 'MTS 810'

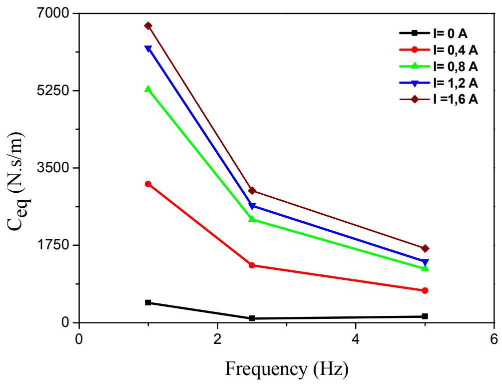

Fig. 3 - Equivalent damping coefficient variation of MR damper according frequency, for 20 mm of displacement

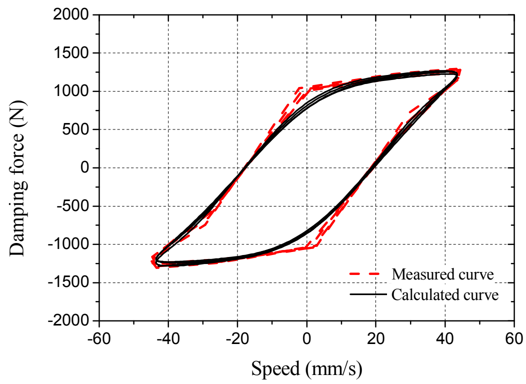

Fig. 4 - Hysteresis curves force/velocity calculated and measured for a 15 mm displacement imposed on the frequency of 1 Hz and a current of 1A

REFERENCES

[1] Bouc R. (1967), ''Modèle mathematique d'hysteresis'', Acustica, vol. 24, n∘ 3, pp 16-25.

[2] Wen Y. (1976), ''Method for random vibration of hysteretic systems'', Journal of the engineering mechanics division, vol. 102, n∘ 2, pp. 249-263.

[3] Spencer Jr B. F. *et al.*, (1997), ''Phenomenological Model of a Magneto Rheological Damper'', Journal of Engineering Mechanics, Vol 123, N°3, pp. 230-238.

[4] Yoshioka H. *et al.*, (2002), "Smart" Base Isolation Strategies Employing Magnetorheological Dampers'', Journal of Engineering Mechanics, 128(5), pp. 540-551.