International Journal of Mechanical Engineering (IJME)
ISSN: 2319-2240
Vol.1, Issue 2 Nov 2012 37-40
© IASET

DYNAMIC CHARACTERIZATION OF MAGNETO-RHEOLOGICAL ELASTOMERS UNDER COMPRESSIVE LOADINGS

[1]S. R. KUMBHAR, [2]SUBHASIS MAJI & [3]BIMLESH KUMAR

[1]Research Scholar, School of Engg. & Technology (SOET), IGNOU, New Delhi- 110068, India

[2]Director, School of Engg. & Technology (SOET), IGNOU, New Delhi- 110068, India

[3]Principal, J.T. Mahajan College of Engg., Faizpur – 425 424 Maharashtra, India

ABSTRACT

Magneto-Rheological Elastomers (MREs) are a class of smart materials whose elastic modulus or stiffness can be varied depending on the magnitude of an applied magnetic field. As controllable stiffness elements, MREs can offer innovative engineering solutions to various engineering challenges. This study focuses on the dynamic characteristics of MREs under compressive loadings. It presents the results of dynamic compression testing of MRE samples, and captures their dynamic response characteristics.

KEYWORDS: Elastomer, MRE, Stiffness

INTRODUCTION

Magneto-Rheological Elastomers (MREs) are a class of smart materials whose elastic modulus or stiffness can be varied depending on the magnitude of an applied magnetic field. As controllable stiffness elements, MREs can offer innovative engineering solutions to various engineering challenges. For the application of MRE materials, it is essential to understand and model the dynamic characteristics of the materials under various conditions. A number of researchers have investigated the shear properties of MRE materials over the past decade [1-5]. However, limited research has been performed in characterizing the compression properties of MREs. This study focuses on the dynamic characteristics of Magneto-Rheological Elastomers (MREs) under compressive loadings. It presents the results of dynamic compression testing of MRE samples, and captures their dynamic response characteristics.

FABRICATION OF MRE BLOCKS

Full-proof process for MRE preparation is not given anywhere in previous literature. So trial and error method was used in order to get solid mould. Different types of rubbers available in market. Selection of particular rubber depends on its properties and availability. Here Sylgard’s 184 silicone elastomer was selected for the preparation of moulds. Initially normal rubber was used for mould preparation in order to study curing procedure because Sylgard’s184 silicone elastomer is much costlier. It was observed that as material combination changes curing time and properties of final mould also changes. In some cases even solid mould was not formed even after heating or curing mould for 48 hours. By taking lots of efforts and observation under expert guidance finally fabrication of MRE moulds was carried out using Sylgard’s184 silicone elastomer. We have prepared MRE moulds as shown in Figure 1. It was prepared by using Sylgard’s 184 Silicone Elastomer cured with magnetic field (designated as mMRE 184) and without magnetic field (designated as nMRE 184).

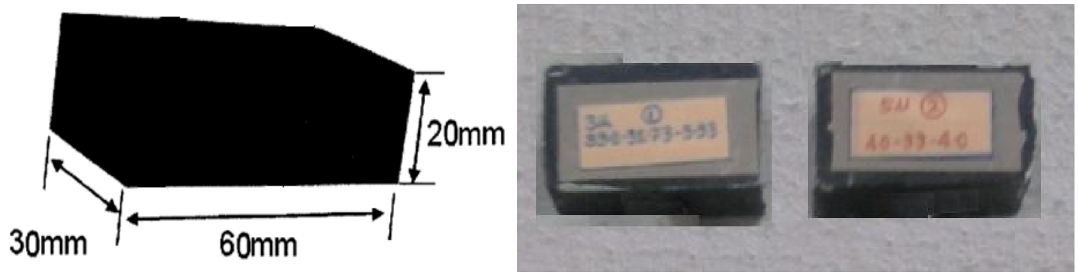


Figure 1: Fabricated MRE Blocks

EXPERIMENTAL SETUP

The shape and dimensions of the MRE Moulds have been shown in fig.1. For compression testing UTM machine along with dial gauge was used as shown in figure 2. In order to vary the magnetic field during compressive testing, a high-stiffness fixture was designed and fabricated in which two permanent high-strength magnets could be variably positioned on either sides of the specimen. By changing the distance between the magnets, the fixture allowed for varying the magnetic field that passes uniformly through the sample. Using the test setup and a dial gauge, a series of compression tests of MRE samples was per-formed by varying the magnetic field. Figure 2 shows the experimental setup.

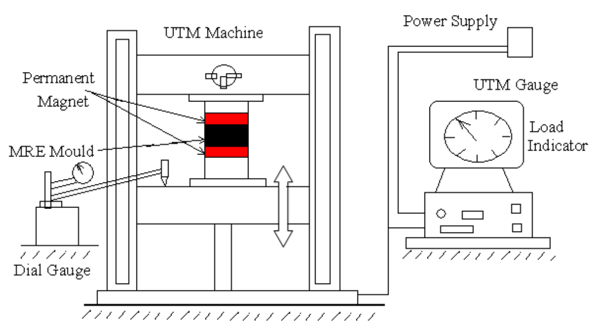
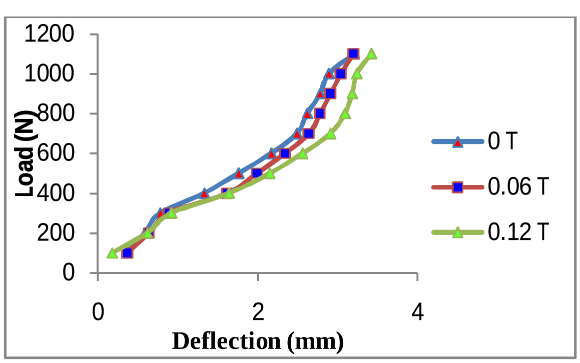


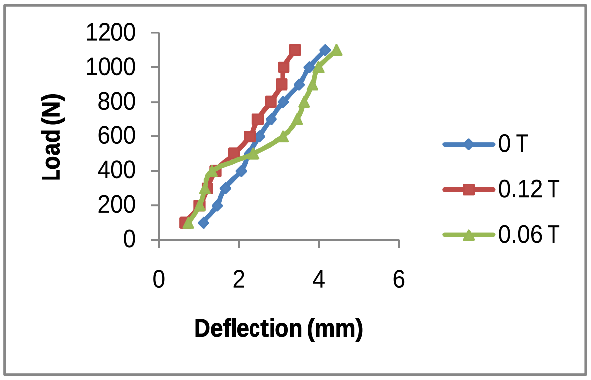
Figure 2: MRE Test Setup using UTM Machine

EXPERIMENTAL RESULTS & DISCUSSIONS

In all compression tests, the MRE samples were axially compressed; load and deflection reading were noted. To investigate the effect of a varying magnetic field, the magnitude of the field was varied from 0 T, 0.06 T and 0.12 T. Then graph of load v/s deflection were plotted for various test configurations. Using the graphs, we determined the stiffness values and the effect of magnetic field were studied.



a) mMRE 184



b) nMRE 184

Figure 3: Laod V/s Deflection (Magnetic field varies from 0 Tesla to 0.12 Tesla)

Figure 3 shows the MR effect variation of MRE sample, nMRE 184 and mMRE 184, with varying magnetic field. It was clear from above graph that with change in magnetic strength, there is significant change in deflection with respect to applied load. After calculating the stiffness, it was found that there is significant increase in the stiffness with increase in applied magnetic field.

The change in the stiffness are also varies with MRE samples prepared with and without magnetic field while curing process. This dynamic characteristic of the MRE can be used in many applications, where it is required to have the changing value of stiffness's.

CONCLUSIONS

The dynamic characteristics of Magneto-Rheological Elastomers (MREs) under compressive loadings have been studied. The result shows that stiffness of the MRE can be changed by varying the magnetic field. This controllable stiffness element of MREs can offer innovative engineering solutions to various engineering challenges, e.g. controllable stiffness for automotive suspension bushing.

REFERENCES

1. C. Ruddy, E. Ahearne and G. Byrne (2007). A Review of Magnetorheological Elastomers: Properties and Applications, Advanced Manufacturing Science (AMS) Research Centre, Mechanical Engineering, University College Dublin, Belfield, Dublin 4, Ireland.

2. Hua-xia Deng, Xing-long Gong, (2008). Application of Magnetorheological Elastomers to Vibration Absorber, Journal of Nonlinear Science and Numerical Simulation, Vol.13.

3. H. Bose and R. Roder. (2008). Magnetorheological Elastomers with High Variability of Their Mechanical Properties, 11th International Conference on Electrorheological Fluids and Magnetorheological Suspensions, Dresden, August 25th - 29th 2008.

4. G. Y. Zhou (2003). Shear Properties of Magnetorheological Elastomers, Smart Material. Struct. 12 139, 2003.

5. M. Lokander and B. Stenberg (2003). Performance of Isotropic Magnetorheological Rubber Materials, Polymer Testing, 22, 2003.