International Journal of Scientific Research and Engineering Development-– Volume 4 Issue 6, Nov-Dec 2021

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Preparation and Response Replication of Unstructured and Prestructured Magneto Rheological Elastomer and Elastomer with Steel Net

Bharat Bhagwat Waghode*, Dr. Netra Pal Singh**

*(Research Scholar, Oriental University, Indore, Madhya Pradesh, India)
**(Professor Oriental University, Indore, Madhya Pradesh, India)

*Corresponding author. Email: bharatwaghode6@gmail.com

Abstract

The magneto rheological (MR) elastomer has evolved into a very strong and modern smart material that can be tweaked and acted immediately in terms of mechanical properties with or without the use of a magnetic field. They are elastomer materials with embedded iron particles in an elastomer matrix. Isotropic and anisotropic MR elastomers are classed based on the application of a magnetic field during the fabrication process. The distribution of magnetizable particles in the matrix of an elastomer is highly defined and organized by kind. Another fabrication was carried out after seeing the structural and behavioral modifications of MREs by layering steel net in between elastomeric medium to imitate the response compared to MREs. Fast Fourier Transform (FFT) study revealed their performance. They can be employed in a variety of applications, such as vibration absorbers, isolators, and seismic devices, etc. due to their superior mechanical qualities.

***Keywords* –** smart material, magneto rheological elastomer, carbonyl iron particles, scanning electron microscopy

I. INTRODUCTION

In recent years, sophisticated smart and bright functional provisions have received a lot of attention, as the growing trend of superior and relaxed regime has led to increased demand for both new technologies and materials. Smart resources are those that are well-adjusted to environmental factors including electrical or magnetic fields, mechanical stress, heat, and light, Kamila *et al.* (2013). In terms of their immense economic potential, magneto rheological (MR) resources have emerged as the most important smart resource. They are classified as practical smart material resources with rheological and viscoelastic properties such as yield and shear stress, as well as damping properties when exposed to an external magnetic field. MREs, on the other hand, may be classified into two distinct groups: isotropic (unstructured) and anisotropic (prestructured) MREs, based on the MREs' beautifully polarised particle structure. The polarised particles are uniformly dispersed in an isotropic MRE, resulting in physical performances that are consistent in all directions. The magnetic particles in an anisotropic MRE are ranged along with the input magnetic field direction, Kumbhar*et al.* (2012, 2013) and Danas *et al.* (2012). These materials were chosen for this study because of their intrinsic properties under external magnetic flux and their practical application in vibration absorbing devices, Zhou *et al.* (2014) and Ge*et al.* (2013).

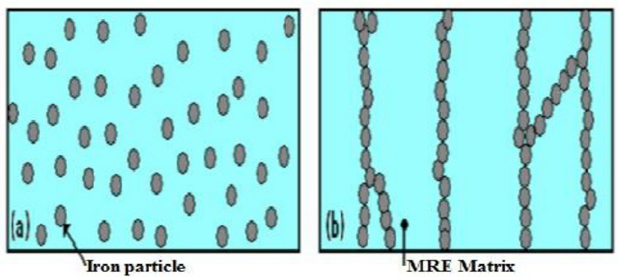

Fig. 1:*Isotropic and anisotropic MRE's*

Fabrication of isotropic (unstructured) and anisotropic (prestructured) MREs with 350 percent iron particles by weight of elastomer matrix was done in this study Kumbhar*et al.* (2012, 2013) and Zhou *et al.* (2014) and Hegde*et al.* (2014). Another fabrication was carried out by putting steel net layer by layer in between the elastomeric medium after seeing the structural and behavioural modifications of MREs. And, using Fast Fourier Transforms (FFT) analysis, they looked at samples for transmissibility and percentage of vibration absorption Kumbhar*et al.* (2012, 2013). To view the interior morphology of isotropic and anisotropic material materials, SEM examination is required, Zhou *et al.* (2014) and Ge*et al.* (2013) and Khimi*et al.* (2015)

II. FABRICATION OF ISOTROPIC / ANISOTROPIC MAGNETORHEOLOGICAL ELASTOMER AND ELASTOMER WITH STEEL NET

An anisotropic magnetic elastomer (MRE) is a helpful pre-structured magnetic elastomer. An outside magnetic flux is applied to the mixture of elastomer matrix and magnetic particles during the curing process. The isotropic MR elastomer is one of the most beneficial unstructured magnetic elastomers available. There was no external magnetic flux added to the mixture during the curing process. MRE is an elastomer matrix that contains ferromagnetic particles and is cured in the presence or absence of magnetic flux, depending on the kind Kumbhar*et al.* (2012, 2013).. Iron particles were employed with 350 percent by weight of elastomer matrix mixed with Si oil in MRE, whichis available in type A (liquid reagent) and type B (curing reagent). The PDMS elastomer was chosen because of its simple curing procedure and wide temperature range, Tang *et al.* (2015). During the curing process of anisotropic MREs, a magnetic field was applied using permanent magnets. Both samples were given a 48-hour cure time. There are three samples in total, two of which are isotropic and anisotropic MRE. While the other one is elastomer with steel net.. For making sample 1 and 2, 350g of CIP was used. The presence or absence of magnetic flux is determined by the type of magnetic flux. MRE samples 1 and 2 were isotropic (unstructured) and anisotropic (prestructured) respectively, Li *et al.* (2013) andHiruddin *et al.* (2014) and Kang *et al.* (2020).

Table 1: Content by weight used for Sample 1 and 2

Sample Type	Part A	Part B	Si Oil	CIP	Curing Time
Unstructured & Prestructured MRE	50	5	50	350	48

(Both samples are of same contents, Sample 1 and 2)

Sample 3 has been prepared by elastomer with steel net having weight of 20gm inserting layer by layer in elastomeric medium of weight 55gm (50 +5) with 10gm of Si oil.

Table 2: Content by weight used for Sample 3

Sample Type	Part A	Part B	Si Oil	CIP	Curing Time
Elastomer with Steel Net	50	5	10	Steel Net=20	48

(In Sample 3, Steel net is to be inserted in place of CIP)

Real image of isotropic (unstructured) MRE and anisotropic (prestructured) MRE with 350gm of CIP is as shown in fig. 2. Real image of elastomer with steel net is as shown in fig. 3.

Fig. 2: *Unstructured (Sample 1) and Prestructured (Sample 2) And Elastomer with Steel net (Sample 3)*

III. RESPONSE ANALYSIS OF MRE's

To find proficiency of organized MRE samples in vibration absorbing parameters in regards to transmissibility plus percentage of vibration absorption, it was necessary to go through the investigational examination which was concisely deliberated in given research article. The design of testing was shown in figure 6. The test framework comprises of a useful channel FFT, an excitation table, and a system, as well as two accelerometer sensors. The accelerometers sensed the frequency and amplitude of vibrations, which were subsequently recorded in the FFT analyzer. Both accelerometer sensors detected the amplitude force.

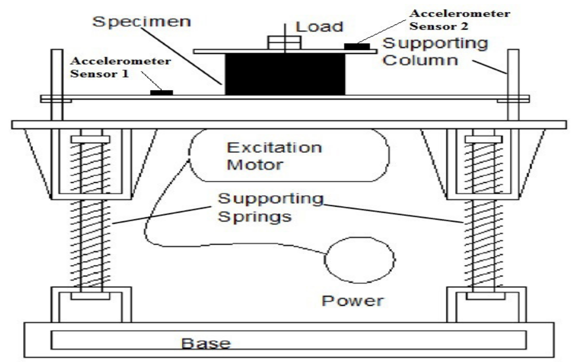

Fig. 3: *Design of Experimental Setup*

The experiment was carried out with both unstructured and prestructured MRE samples under various loading circumstances. Depending on the size of MRE samples, we chose different loads such as 0N, 10N, 20N, and 30N. All MREs had their amplitude and frequency tested under these load conditions.

A) Sample 1

Table 3: Result table for Sample 1

Position	Amplitude	Transmis-sibility	Vibrat. Absorb %
	Under No Load		
Upper Amp.	7.38	0.793	20.703
Lower Amp.	9.31		
	Under 10N		
Upper Amp.	7.27	0.791	20.892
Lower Amp.	9.19		
	Under 20N		
Upper Amp.	6.74	0.786	21.354
Lower Amp.	8.57		
	Under 30N		
Upper Amp.	6.58	0.781	21.853
Lower Amp.	8.42		

All reading are computed by FFT analyzer at 48.3 Hz

Sample 1 with no load and 10N load condition

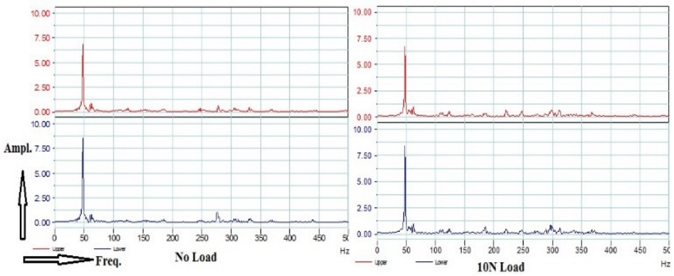

Fig. 4:*FFT graph for Sample 1 with no load and 10N*

Sample 1 with 20N load and 30N load condition

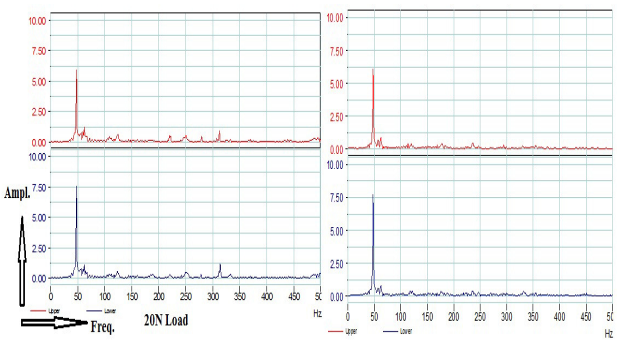

Fig. 5:*FFT graph for Sample 1 with 20N and 30N*

The vibration amplitude of both positions is detected at natural frequency 48.3Hz by both accelerometer sensors in all loading situations, as shown in the FFT graph for sample 1. The transmissibility ratio and percentages of vibration absorption must be determined from the measured amplitude. At 30N load, Sample 1 displays 21.853 percent vibration absorption and 0.781 transmissibility ratio, which is the best result in terms of concern objectives.

B) Sample 2

Table 4: Result table for Sample 2

Position	Amplitude	Transmissi-bility	Vibrat. Absorb %
	Under No load		
Upper Amp.	6.77	0.781	21.915
Lower Amp.	8.67		
	Under 10N		
Upper Amp.	6.39	0.783	21.691
Lower Amp.	8.16		
	Under 20N		
Upper Amp.	5.71	0.784	21.566
Lower Amp.	7.28		
	Under 30N		
Upper Amp.	5.68	0.791	20.113
Lower Amp.	7.11		

All reading are computed by FFT analyzer at 48.3 Hz

Sample 2 with no load and 10N load condition

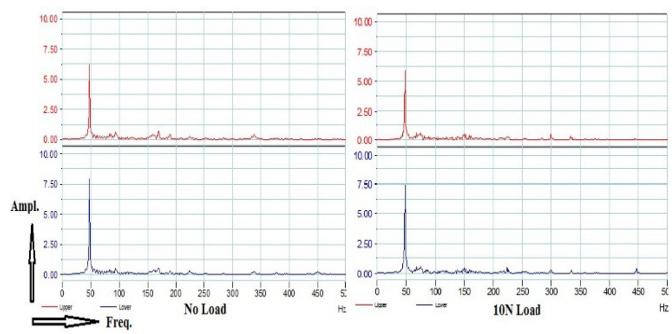

Fig. 6:*FFT graph for Sample 2 with no load and 10N*

Sample 2 with 20N load and 30N load condition

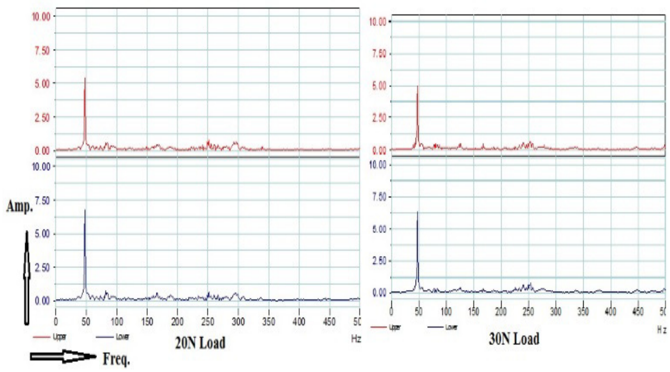

Fig. 7: FFT graph for Sample 2 with 20N and 30N

The vibration amplitude of both positions is detected at natural frequency 48.3Hz by both accelerometer sensors in all loading situations, as shown in the FFT graph for sample 2. The transmissibility ratio and percentages of vibration absorption must be determined from the measured amplitude. At no load, Sample 2 displays 21.915 percent vibration absorption and 0.781 transmissibility ratio, which is the best result in terms of concern objectives.

The vibration amplitudes, transmissibility, and vibration absorption percentage of unstructured and prestructured MRE samples with 350gm of CIPs by weight were measured, and both samples showed satisfactory results in terms of the parameters studied. Transmissibility is defined as a lower percentage of absorption along a material's length. For a satisfactory result, a low transmissibility ratio is required, together with a high percentage of absorption. Prestructured MRE outperformed unstructured MRE in terms of MR performance.

C) Sample 3

Table 5: Result table for Sample 3

Position	Amplitude	Transmissi-bility	Vibrat. Absorb %
	Under No load		
Upper Amp.	7.19	0.772	22.77
Lower Amp.	9.31		
	Under 10N		
Upper Amp.	7.08	0.77	22.96
Lower Amp.	9.19		
	Under 20N		
Upper Amp.	6.59	0.769	23.104
Lower Amp.	8.57		
	Under 30N		
Upper Amp.	6.46	0.769	23.278
Lower Amp.	8.42		

All reading are computed by FFT analyzer at 48.3 Hz

Sample 3 with no load and 10N load condition

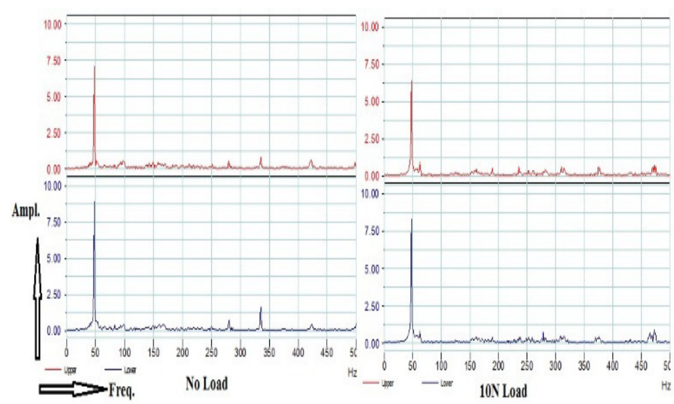

Fig. 8:*FFT graph for Sample 3 with no load and 10N*

Sample 3 with 20N and 30 N load condition

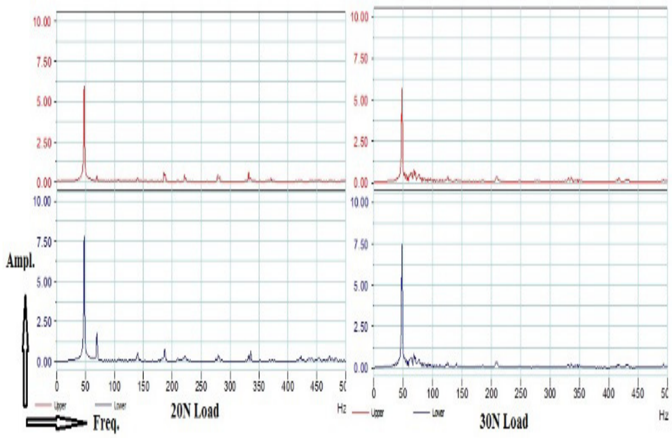

Fig. 9:*FFT graph for Sample 3 with 20N and 30N*

The vibration amplitude of both positions is detected at natural frequency 48.3Hz by both accelerometer sensors in all loading situations, as shown in the FFT graph for sample 3. The transmissibility ratio and percentages of vibration absorption must be determined from the measured amplitude. At 30N load, Sample 3 displays 23.278 percent vibration absorption and 0.769 transmissibility ratio, which is the best result in terms of concern objectives. In comparison to the first two MRE samples, sample 3 exhibits good results in terms of transmissibility and vibration absorption percentages.

IV. CONCLUSION

We looked into the fabrication, categories, belongings, and uses of smart MREs in this study. Vibration properties of MREs and elastomers with steel net are also explained using transmissibility and vibration absorption percentages. Prestructured MRE outperformed unstructured MRE in terms of MR performance. When the MRE was confirmed without a magnetic field (for isotropic MRE samples) at zero load, 10N load, 20N load, and 30N load individually decreased the lower amplitude of vibration at the same frequency, transmissibility decreased, and percentage of vibration absorption increased as the load increased. And, just as the MR damper was proven with magnetic flux under zero load, the transmissibility of 10N, 20N, and 30N loads increases individually, while the proportion of vibration absorption falls as the load increases. Transmissibility is defined as a lower percentage of absorption along a material's length. For a satisfactory result, a low transmissibility ratio is required, together with a high percentage of absorption. In comparison to the first two MRE samples, sample 3 exhibits good results in terms of transmissibility and vibration absorption percentages. It may be concluded that, because sample 3 is easier to prepare than samples 1 and 2, when a modest level of isolation is required, an elastomer with steel net should be selected for the application.

REFERENCES

[1] Susmita Kamila, "Introduction, Classification and Applications of Smart Materials: An Overview", *American Journal of Applied Sciences* 10 (8): 876-880, 2013

[2] S. R. Kumbhar, SubhasisMaji and Bimlesh Kumar, "Fabrication and Response Analysis of Magnetorheological Elastomer", *Material Science Research India*, Vol. 9(1), 111-116, 2012

[3] S. R. Kumbhar, SubhasisMaji, Bimlesh Kumar "Development and Characterization of Isotropic Magnetorheological Elastomer", *Universal Journal of Mechanical Engineering* 1(1): 18-21, 2013

[4] K. Danas, S. V. Kankanala, N. Triantafyllidis, "Experiments and modeling of iron- particle-filled magnetorheological elastomers", *Journal of the Mechanics and Physics of Solids* 60, 120–138, 2012

[5] Yanfen Zhou, Stephen Jerrams, Anthony Betts, Lin Chen "Fatigue life prediction of magnetorheological elastomers subjected to dynamic equibiaxial cyclic loading"*Materials Chemistry and Physics*, vol. 146 , 487-492, 2014

[6] Lin Ge, Xinglong Gong, Yanceng Fan and ShouhuXuan, "Preparation and mechanical properties of the magnetorheological elastomer based on natural rubber/rosin glycerin hybrid matrix", *Smart Materials and Structures* 22, 115029 (8pp), 2013

[7] SriharshaHegde, K.V. Gangadharan, **"**Testing of RTV-Silicone based thick magneto-rheological elastomers under harmonic loading conditions" *International Journal of Scientific & Engineering Research*, Volume 5, Issue 2, ISSN 2229-5518, 2014

[8] S. Raa Khimi, K. L. Pickering, "Comparison of dynamic properties of magnetorheological elastomers with existing antivibration rubbers", *Composites Part B*, 2015

[9] BenxiangJu, Rui Tang, Dengyou Zhang, Bailian Yang, Miao Yu, Changrong Liao, "Temperature-dependent dynamic mechanical properties of magnetorheological elastomers under magnetic field", *Journal of Magnetism and Magnetic Materials*, 374, 283–288, 2015

[10] Weihua Li, Xianzhou Zhang, TongfeiTian, and Weijia Wen, "Fabrication and characterisation of patterned magnetorheological elastomers",*AIP Conference Proceedings* 1542, 129, 2013

[11] KhairunnisaHairuddin, SaifulAmriMazlan, Ubaidillah, HairiZamzuri and NorazmanMohamad "A Feasibility Study of Magnetorheological Elastomer Base Isolator"*Applied Mechanics and Materials*, Vol. 660, 763-767, 2014

[12] Sung Soon Kang, Kisuk Choi, Jae-Do Nam and Hyoung Jin Choi, "Magnetorheological Elastomers: Fabrication, Characteristics, and Applications", *Materials 2020*, 13, 4597, 2020