

Experimental Analysis of MRE Isolator for With and Without Magnetic Field Condition

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Abstract: Vibration isolator made of rubber is used in numerous engineering applications to isolate structure from undesirable effect of vibrations. MS Elastomer are the type of smart material consisting of Elastomer matrix, such as natural or synthetic rubber, to which iron particle are added displaying properties changed by applying an external magnetic field. The Elastomer which shows the response to the magnetic field that Elastomer are called as Magneto rheological Elastomer or Magneto sensitive vibration isolator. In this the Experimentation has carried out on MRE Isolator contains zero iron particles as well as some percentage of iron particles in it. The experimental results are taken for both without and with magnetic field condition. The results are carried out in terms of natural frequency and the amplitude of acceleration.

Keywords: Magnetic field, Natural frequency, Amplitude of acceleration, damping etc.

1. INTRODUCTION

1.1 Introduction to working of MRE Isolator:

The MRE isolator consists of the silicon rubber and the iron particles are dispersed. When such isolator are tested under magnetic field then iron particles in the rubber are attracted towards the magnetic field. The initially the rubber particles are in randomly dispersed position when the magnetic field apply to the isolator then they forms a chain like structure and that results in the its stiffness goes on increases. The percentage of the iron particle plays the important role in the isolation of the isolators. Bellow fig shows the internal structure of isolator in which iron particles and rubber are shown.

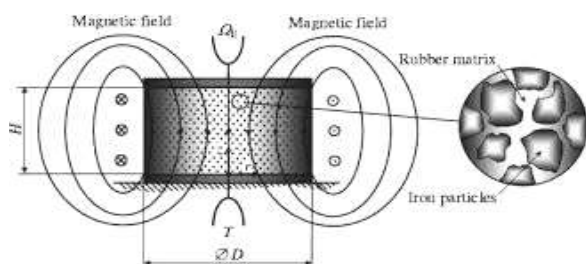


Fig 1: Working Principle MRE Isolator

In this paper we have manufactured the MRE isolator with different amount of iron particle percentage in it that is 0%, 15%, 25%, 35% in the vibration isolator. The iron particle and the silicon rubber are mixed with the help of the bra bender mixing chamber machine. After the manufacturing the isolators we have tested this isolators in the influence of magnetic field and without magnetic field and results are calculated in terms of natural frequency and reduction in amplitude of acceleration.

1.2 About the MRE isolator:

The Material is used for the manufacturing of MRE isolator (Magneto Sensitive Vibration Isolator) are silicon rubber and the iron particle of size less than 300 micron. Different isolators are made by changing the weight in grams of iron particle and the silicon rubber. If we add more than 40% iron particles the Elastomer becomes more hard and it does not shows any elastic properties so that's why we have select the iron particle percentage in between 10 to 35.



Fig 2: MRE Isolator with 35% iron particles

The above figure shows the MRE isolator which is used for analysis having specifications of 75 mm diameter and 72 mm height. The same dimension isolator is used for analysis by only varying the percentage of iron particles in it that is 0%, 15%, 35%.

2. EXPERIMENTAL STUDY

2.1 Experimental Setup:

The Experimental setup consists of MRE Isolator, Copper coil, 12 Volt DC batteries, FFT Analyzer, Accelerometer, and Exciter. The Experimental Study has carried out on the different MRE Isolators with and without Magnetic Field.



Fig 3: Experimental Setup for Testing MRE Isolator in without and with Magnetic field

2.2 Experimental results for 0% Iron particles Isolator (with and without Magnetic field)

The 0% iron particle isolator tested under the influence of without and with magnetic field the results are obtained as listed below shows the frequency along with amplitude of acceleration.

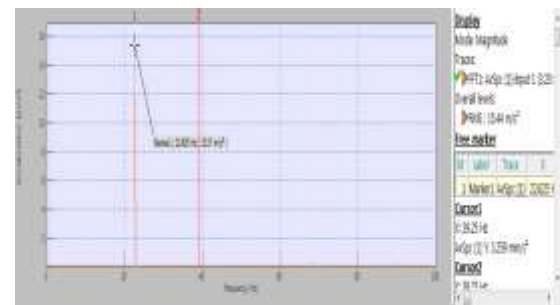
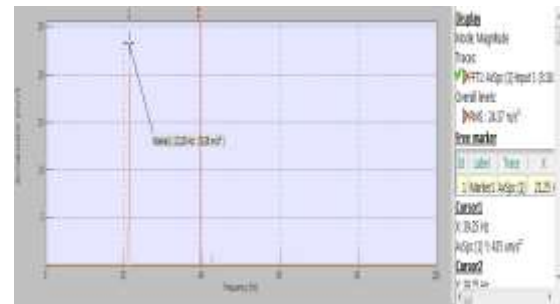
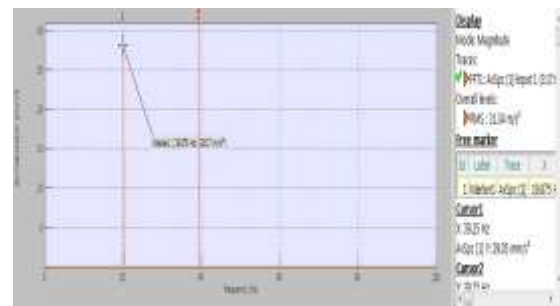
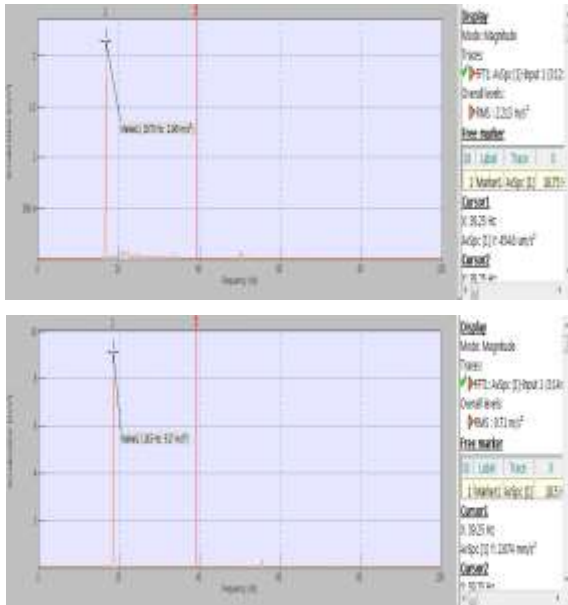


Fig 4: FFT graphs for 0% Iron particle isolator
(Without magnetic field)

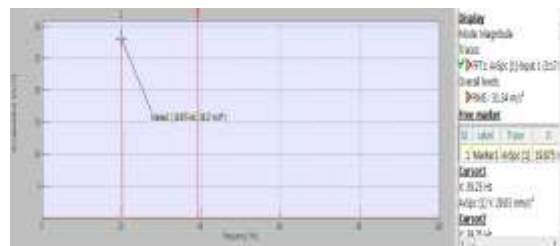


Fig 5: FFT graphs for 0% Iron particle isolator

(With magnetic field)

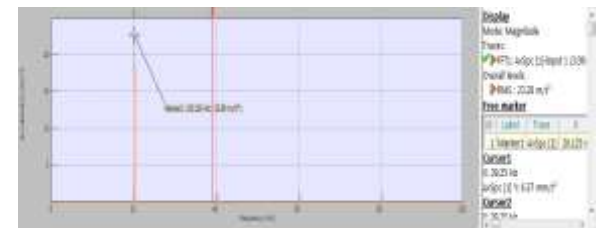
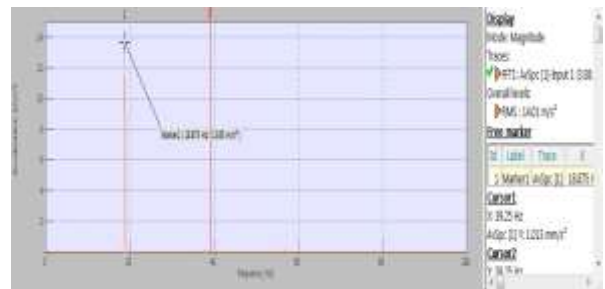
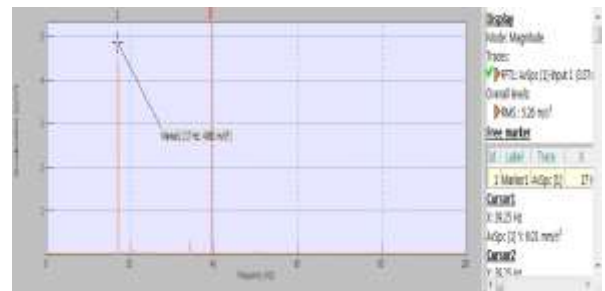
Table 1: Amplitudes of MRE isolator for different frequencies for with and without magnetic field (0% iron Particles Isolator)

Sr No	Frequencies of isolators (Hz)	Amplitude of acceleration without Magnetic field (m/s ²)	Amplitude of acceleration with Magnetic field (m/s ²)	Percentage reduction in amplitude of acceleration
1	16.75	2.149	-	
2	18.5	9.17	-	
3	19.875	28.17	28.17	0 %
4	21.25	23.26	-	
5	22.625	15.37	-	

In the 0%iron particle isolator there is no change in amplitude of acceleration is shown by above table. Hence the percentage reduction in amplitude of acceleration is zero percent.

2.3 Experimental results for 15% Iron particles (with and without Magnetic field)

The 15% iron particle isolator tested under the influence of without and with magnetic field the graphs obtained during testing as shown bellow.



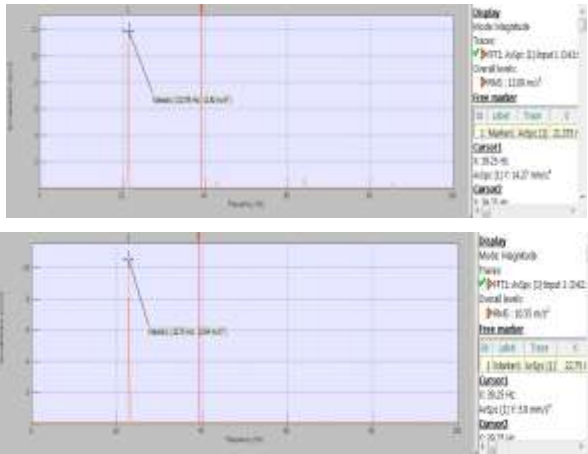


Fig 6: FFT Graphs for 15% Iron particle Isolator (Without Magnetic Field)

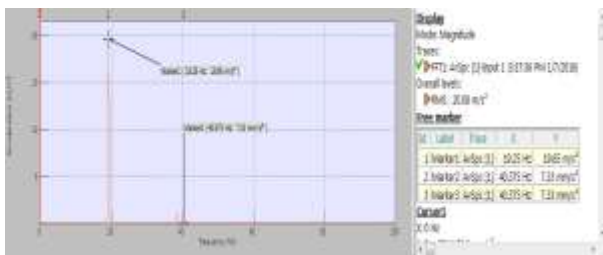


Fig 7 : FFT Graphs for 15% Iron particle isolator (With Magnetic Field)

Table 2: Amplitudes of MRE isolator for different Frequencies for with and without Magnetic Field (15% Iron Particle Isolator)

Sr. No	Freq uenci es of isolat ors (Hz)	Amplitud e of accelerati on without Magneti c field (m/s ²)	Amplit ude of acceler ation with Magneti c field (m/s ²)	Percent age reducti on in amplitu de of accelera tion
1	17	4.861	-	
2	18.87			
3	5	13.65	-	
4	20.12		19.65	13.01%
5	5	22.59		
6	21.37			
7	5	11.92	-	
8	22.75			
9	5	10.54	-	

For the 15%iron particle MRE isolator the amplitude of acceleration get reduced. The percentage reduction in amplitude of acceleration is 13.01%. if 15% Iron particles presents in the Isolator.

2.4 Experimental results for 25% Iron particles (with and without Magnetic Field)

The 25% iron particle isolator tested under the influence of without and with magnetic field. The results are obtained as listed fellow.

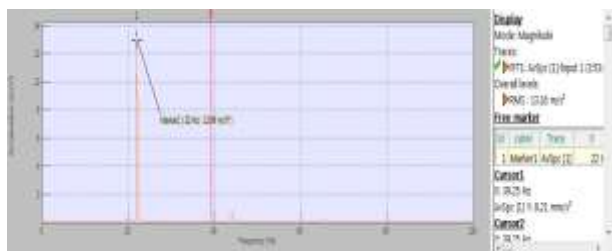
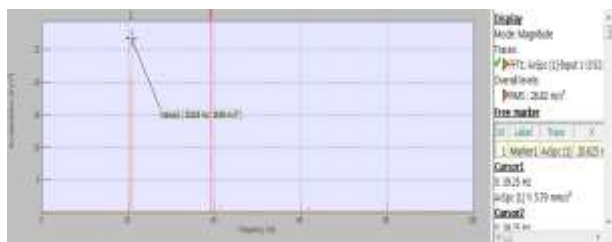
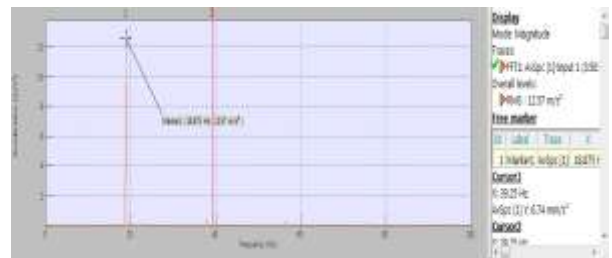
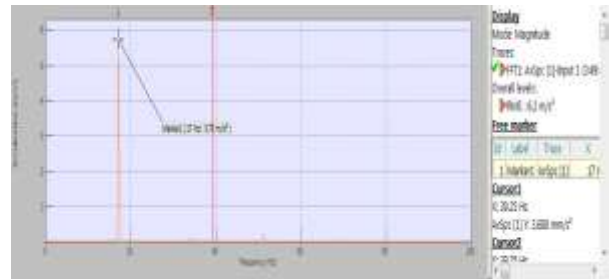


Fig 8: FFT Graphs for 25% Iron particle Isolator (Without Magnetic Field)

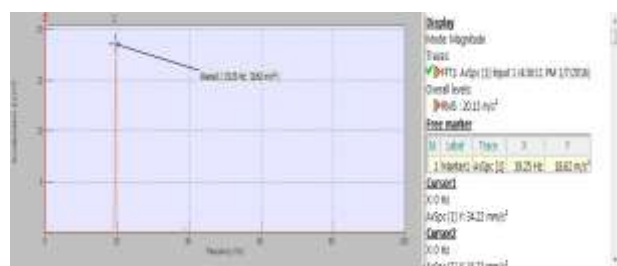


Figure 9: FFT graphs for 25% Iron particle isolator (With magnetic field)

Table 3: Amplitudes of MRE isolator for different frequencies for with and without magnetic field (25% iron particle)

Sr No	Frequencies of Isolators (Hz)	Amplitude of acceleration without Magnetic field (m/s ²)	Amplitude of acceleration with Magnetic Field (m/s ²)	Percentage reduction in Amplitude of Acceleration
1	17	5.75	-	
2	18.875	12.57	-	
3	20.625	26.69	18.62	30.25%
4	22	12.99	-	

In the 25% iron particle MRE isolator again there is reduction in amplitude of acceleration get reduced. The percentage reduction in amplitude of acceleration is 30.25%

2.5 Experimental results for 35% Iron particles (with and without Magnetic field)

The 35% iron particle isolator tested under the influence of without and with magnetic field. The results are obtained as listed shows the frequency gives to Isolator and amplitude of acceleration.

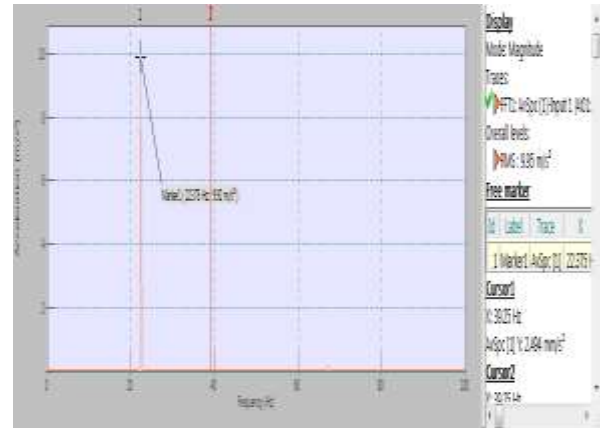


Fig 10: FFT Graphs for 35% Iron particle Isolator (Without Magnetic Field)

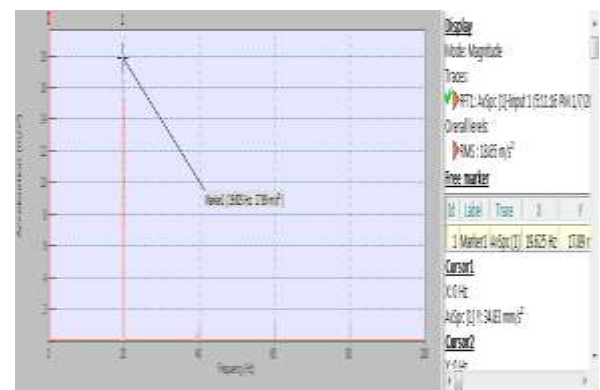


Fig 11: FFT graphs for 35% Iron particle Isolator (With Magnetic Field)

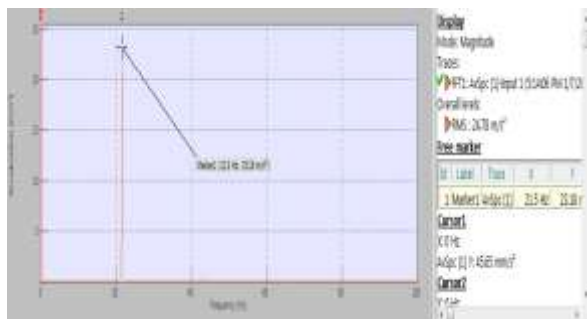
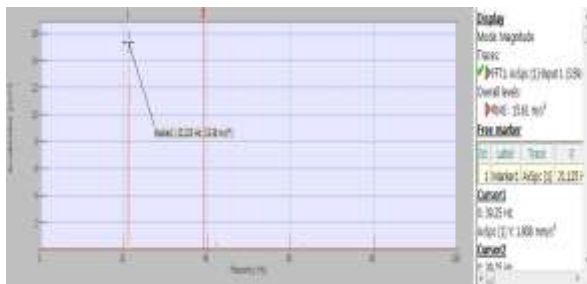
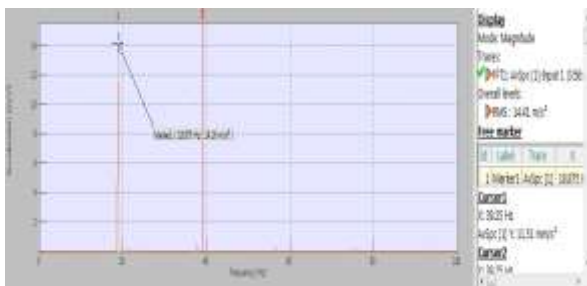


Table 4: Amplitudes of MRE Isolator for different Frequencies for with and without Magnetic Field with 35% Iron particle

Sr No	Frequencies of isolators (Hz)	Amplitude of acceleration without Magnetic Field (m/s ²)	Amplitude of acceleration with Magnetic Field (m/s ²)	Percentage reduction in Amplitude of Acceleration
1	18.875	14.16	-	
2	21.125	15.38	-	
3	21.5	23.18	17.89	22.82 %
4	22	12.99	-	
5	22.375	9.92	-	

For the 35% iron particle MRE isolator also again there is reduction in the amplitude of acceleration. The percentage reduction in amplitude of acceleration is 22.82%. Shown in above table.

3. RESULT AND DISCUSSION

Table 5: Percentage of Iron particle and Natural Frequency of MRE Isolator

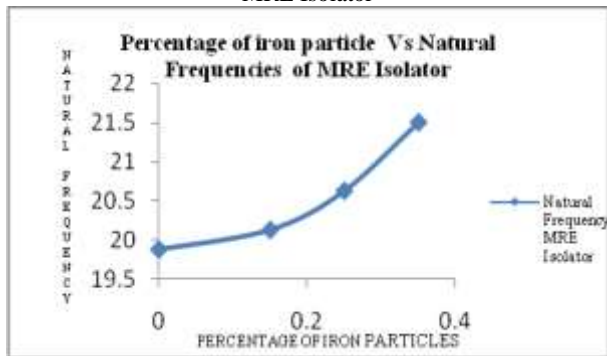


Fig 12: Graph of Percentage of Iron particle Vs Natural Frequencies of MRE Isolator

The above graph represents as the iron particles increases in the MRE Isolator the Natural Frequency goes on increases. The natural frequency of 0% iron particle isolator is 19.875 Hz is shown by above tables. The natural frequency is increases by 1.24%, if 15% iron particles are presents or added in isolator. Similarly, if 25% iron particles are added in isolator then 2.42% and for 35% iron particle Isolator 7% to 8% Natural Frequency increases than 0% iron Particle Isolator.

Table 6: Percentage of Iron Particles and Amplitude of Acceleration

% Iron particles	Amplitude of Acceleration at Natural Frequency Without Magnetic Field (m/s ²)	Amplitude of acceleration at natural frequency With Magnetic Field (m/s ²)	Percentage in Reduction in Amplitude of Acceleration
0%	28.17	28.17	0
15%	22.59	19.65	13.01%
25%	26.69	18.62	30.25%
35%	23.18	17.89	22.82%

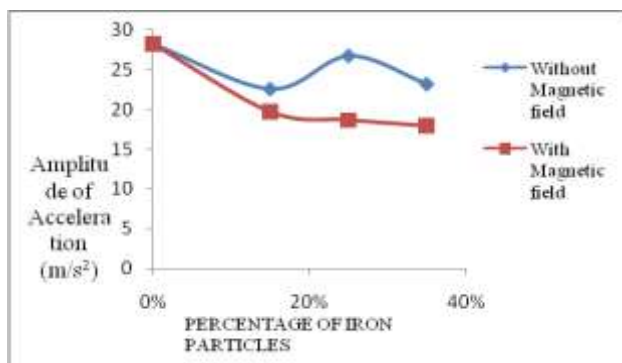


Fig 13: Graph of Percentage of Iron Particle Vs Amplitude of Isolators for with and without Magnetic Field

The above graph represents the % of iron particle in isolator verses Amplitude of Acceleration. The Magnetic Field is applied to vibrating isolator there is maximum reduction in amplitude of acceleration is shown by the

table 6 and also shown in graphic form. The figure is shows the Maximum reduction in amplitude of acceleration if Magnetic field is applied to MRE isolator.

Iron particle Percentage in Isolator	Natural Frequency MRE Isolator (Hz)
0%	19.875
15%	20.125
25%	20.625
35%	21.5

4. CONCLUSION

Initially experimentation has carried out on isolators to find out its natural frequency, for 0% iron particle isolator the natural frequency is obtained as 19.875 Hz. Again same study has carried out on another isolator having different percentage of iron particle and its natural frequencies are find out along with its amplitude of accelerations also it is observed that if iron particle percentage is increases continuously then the natural frequency is also increases. Then, magnetic field has applied to all isolators and again same experimentation has carried out. The natural frequency is set to isolator and same time field is applied to check or analyze the percentage reduction in amplitude of accelerations. From this it is analyzes that if percentage of iron particles in isolators increases then there is maximum reduction in amplitude of accelerations has achieved and it also help to increase the damping effect. Finally, it is concluded that the increasing iron particles in isolators are help to increase the natural frequency of it and reduce the damping by reducing the amplitudes of accelerations.

5. REFERENCES

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