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Vibration Analysis of Cantilever Beam of Magneto Rheological Fluid

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Abstract
This study presents techniques used to minimize an active vibration in smart beam. It consists of an aluminum beam model in cantilever configuration. Magneto Rheological fluid (MRF) has variety of application in all industrial vibration control system. Now-a-days this fluid is used in design of buildings and bridges, robotics, home appliances, seat suspensions, clutches, automobile suspension etc. The main purpose of MRF used in this application because of ability of MR fluid i.e. when an magnetic field applied it changes rheological properties rapidly and its precise controllability. By detecting the vibration produced in any application we can apply this concept of vibration control to that system. We can use quantity of fluid depends on dimension of MR pocket and intensity of vibration in system. The testing is all about the reduction in the amplitude of vibration of system by increase in applied voltage to MR cantilever beam (MRF-336AG).
Form the table and graph; we conclude that when amplitude of vibration decrease, magnification factor also decreases. When damping increases, damping coefficient is increases and transmissibility decreases. Hence vibration is reduces.
Keywords: *Cantilever Beam, Vibration, MR Fluids, FFT analysis.*

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I. INTRODUCTION

The output of a vibrating system is generally depends on the applied initial conditions on system and external excitations. For any physical system, vibration analysis is carried out in below steps,

1. Generate System Mathematical modeling.
2. Required Governing equation Formulation.
3. Find governing equations mathematical solution.
4. Interpretation of the result.

The mathematical modeling is used to determine the existence and nature of the system, its features and aspects and the physical elements or components involved in the physical system. All component of physical system is linear. Depending on given physical system, resulting mathematical model may be linear or non-linear. In generally every physical system has non-linear behavior.
E.g. “Modeling and Performance Simulation on Source Initiative Routing Protocol in Wireless Network”

II. LITERATURE REVIEW

- M. N. HamdanAnd B. A. Jubrananalyzed vibrations of a uniform cantilever beam tip having translational elastic constraint and concentrated mass at intermediate point. In this paper, obtain mode shape functions by solving beam equation of motion. This satisfies natural and geometric boundary conditions of beam. [1]
- J.D.Carlson, D. M. Catanzarite and K. A. St. Clair**,** in this paper magneto rheological (MR) fluid device reaches at stage where commercial they produced. In real world situations, these devices are find variety of application ranging. Examples of several, commercial MR fluid devices and the comparison of MR and ER fluids devices are discussed. [2]
- Mateusz Romaszko, this paper covers MR sandwich cantilever beam identification and modeling of beam. In this beam have two outer layers, first one aluminum and second is MR fluid layer placed between silicone rubbers. Using the ANSYS finite element (FE) model is created. By varying the FE model parameters, interactions of the magnetic field is taken. [3]

III. THEORY OF CANTILEVER BEAM

3.1 Cantilever Beam

A Cantilever beam is a Beam in which one end is fixed and another end is set to be free. Cantilever beam is simple in construction. It does not require a support on the opposite side. Some of cantilever beam structures are shown below

Fig.1- Cantilever Beam

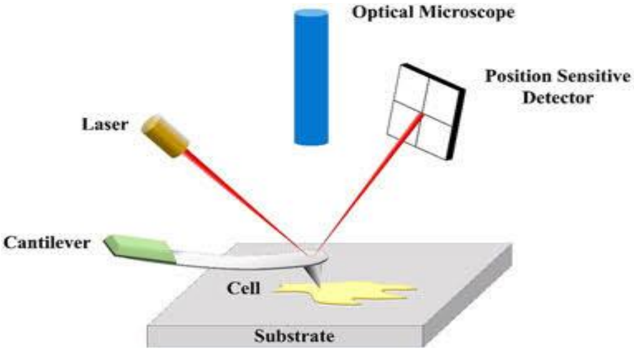

Fig.2 Atomic Force Microscopy

3.2. Model Analysis of cantilever Beam

Mathematical Model:-

In mathematical modeling, when cantilever beam subjected to free vibration and it considered as continuous system in which mass of beam considered to distributed along the stiffness of the shaft. In this, we use Meirovitch equation as below,

$$\frac{d^2}{dx^2}\left\{EI(x)\frac{d^2Y(x)}{dx^2}\right\} = \omega^2 m(x)Y(x)$$

Where, E = Modulus of rigidity, I = Moment of Inertia of beam cross section, ω = circular natural frequency, Y(x) = Beam Displacement in y direction from fixed end of beam at a distance of x, m= Mass per unit length, m=ρA(x), ρ= Material Density of beam and x = distance.

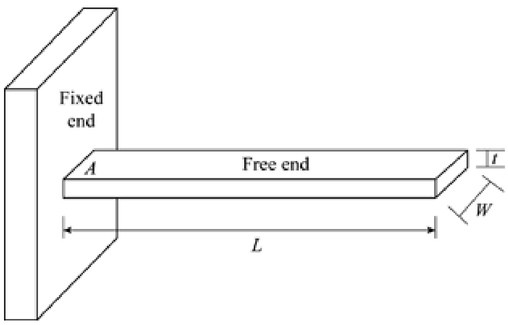

Fig.3 Cantilever Beam Structure

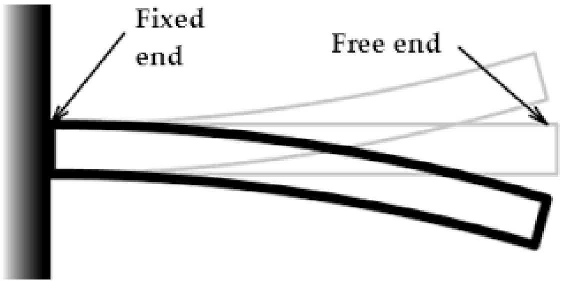

Fig.4 Cantilever beam under free vibration

3.3 Magneto Rheological Fluid

Magneto Rheological Fluid denoted as MR Fluid. It is smart fluid generally type of an oil. When fluid subjected to magnetic field, it increases viscosity greatly. In industry, variety of application of vibration control system now-a-days uses MR fluid because of it changes rheological behavior drastically when applied magnetic field on system.

When magnetic field is applied to magneto rheological fluids, causes particles to align it in chains structure shown in below

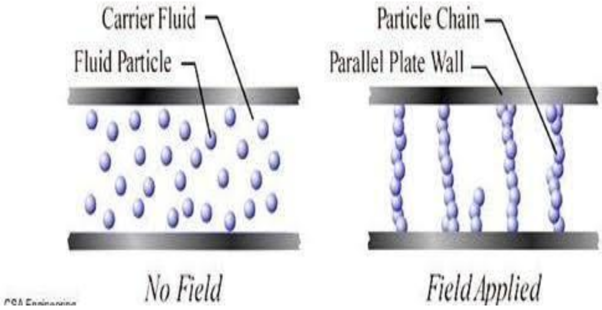

Fig.5Behavior of MR Fluid

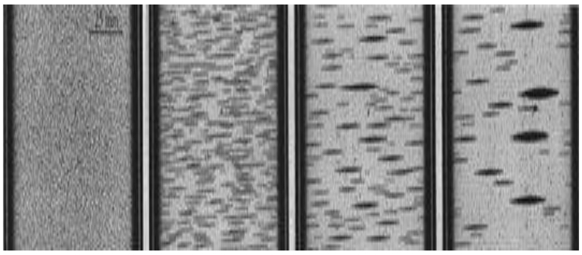

Fig.6 Behavior of MR fluid in sequential manner

Whenan alternating field is applied to MR fluid then it gradually changes the structure of particles in it. Above figuresshow that, how fluid exposed in1 second of applied magnetic field in leftmost picture.From a strong and fibrous network these particles are suspended. In right hand side pictures shows fluid behavior after 3 minutes, 15 minutes and 1 hour after the magnetic field applied. Then Clumped particles show structural support.

IV. EXPERIMENTAL STUDY AND ANALYSIS

Experimental Procedure to conduct experiment:

1. As shown in below figure, fix the cantilever beam on experimental setup that is above the exciter.
2. Make the copper wire connection coming from beam properly to demonstrate the experiment.
3. Switch on power supply of experiment setup and on the computer to record the readings.
4. For first reading- smart material which is MRF is not present in the cantilever beam pocket i.e first reading we will take without MRF. At one end of cantilever beam we observe vibration when exciter starts excitation and using FFT software present in computer we get deflection and damping frequency table.
5. Now second reading is taking with MR fluid present in cantilever beam. The fluid is inserted in beam using injection method then we apply the 2.75 V voltage on the beam. In this step also exciter starts excitation of beam and we get another tables of deflection and damping frequency.
6. Repeat same procedure for all readings.
7. Collect the all readings from software and draw required graphs then we get final results.

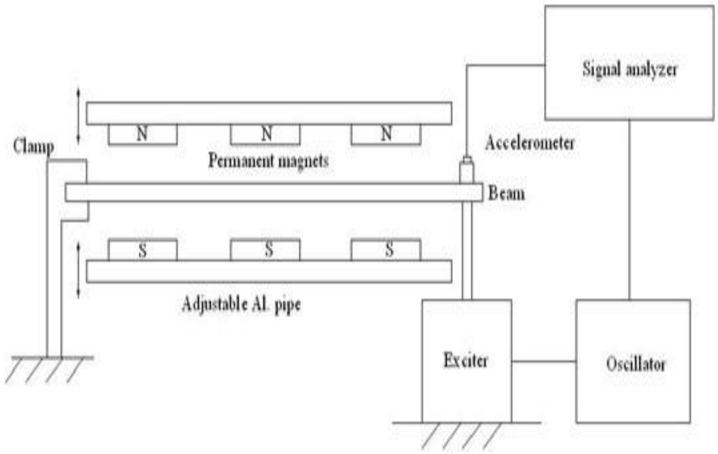

Fig.7Experimental Setup

V. OBSERVATION TABLES, RESULT AND CALCULATION

5.1 Result without current:

Sr. No	Damp Freq. rad/s	Natu. Frq rad/s	Frq Ratio	Time in Sec Td(s)	Defn (micron)	Mag. Factor M.F	Trby T
1	128.5	131	0.98	2.8	300	2.41	1.68
2	171.5	175.5	0.97	2.1	379	2.43	2.62
3	200.5	205	0.97	1.8	434	2.43	2.62
4	229	234	0.97	1.5	500	2.43	2.62
5	258	263.7	0.97	1.4	530	2.43	2.62
6	300.8	307	0.97	1.2	550	2.43	2.62
7	329	336	0.97	1.1	497	2.43	2.62
8	358	366	0.97	1	460	2.43	2.62
9	401	410	0.97	0.9	262	2.43	2.62
10	129	439	0.97	0.8	315	2.43	2.62

Table 1. Result without current

From above table we get several values of damping frequency, natural frequency, required time in second, frequency ration, Deflection of beam, transmissibility and magnification factor after the experiment is carried out on beam. From above table for corresponding damping frequency, frequency ration is 0.97, magnification factor is 2.43 and transmissibility is 2.62.

5.2 Result with 2.75 volt:

Sr. No	Damp Freq. rad/s	Natu. Frq rad/s	Frq Ratio	Time in Sec Td(s)	Defn (micron)	Mag. Factor M.F	Trbty T
1	57.3	59.50	0.96	3.6	185	1.9	2.14
2	100	104	0.96	2.8	214	1.9	2.14
3	128.5	133	0.96	2.1	290	1.9	2.14
4	171.5	178	0.96	1.6	321	1.9	2.14
5	215	223	0.96	1.4	416	1.9	2.14
6	243	253	0.96	1.3	449	1.9	2.14
7	272	282	0.96	1.14	512	1.9	2.14
8	315	327	0.96	1	469	1.9	2.14
9	343	357	0.96	0.9	463	1.9	2.14
10	386	401	0.96	0.8	357	1.9	2.14

Table 2. Result with 2.75 volt

From above table we get several values of damping frequency, natural frequency, required time in second, and frequency ratio, Deflection of beam, transmissibility and magnification factor after the experiment is carried out on beam. From above table for corresponding damping frequency, frequency ration is 0.96, magnification factor is 1.9 and transmissibility is 2.14.

5.3 Result of Calculations:

Sr.No	Log. Decrement	Damp Ratio	Damp Freq. rad/s	Natu. Frq rad/s	Stiffness K N/m	Damp. Coeff.
1	1.352	0.21	128.5	131	2.23 x 10^4	71.526
2	1.8	0.27	276	286	1.06334 x 10^5	200.7
3	2.1	0.31	257	270.3	9.49807 x 10^5	218
4	2.2	0.33	257	272.2	9.63206 x 10^5	233
5	2.6	0.38	276.9	299.4	1.165324 x 10^6	296

Table 3. Result of calculations

The above table shows many values of damping ration, damping frequency, natural frequency, stiffness and damping coefficient which we got form calculation.

From above table we conclude that,

1. When deflection increases, damping ration increases.
2. When stiffness increases, damping coefficient is increases.

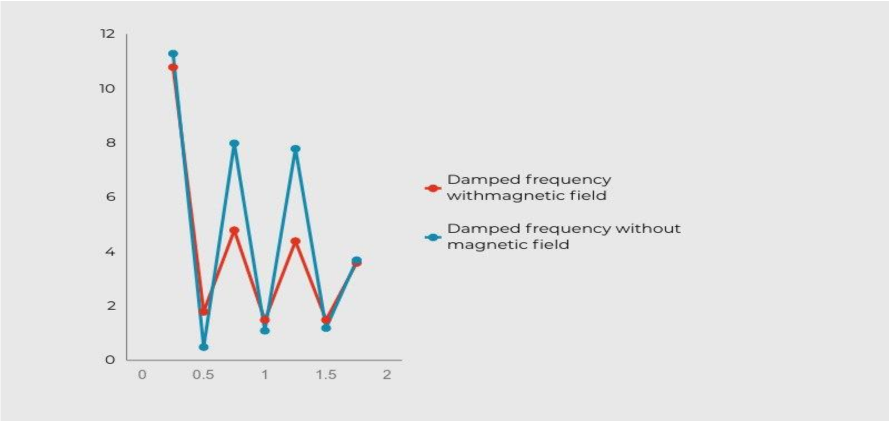

Fig.8. Logarithmic Decrement

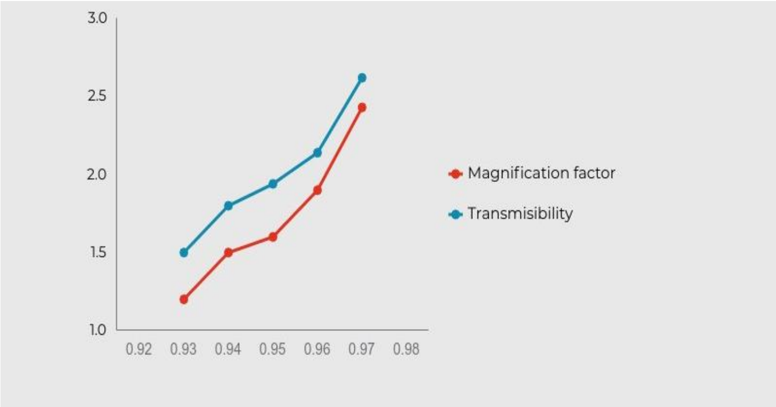

Fig.9. Result of calculations.

VI. CONCLUSION

The question arises "What makes MR fluid as a good fluid?" Answer to this question is depends on many factors such as type of application where it used, conditions applied on fluid to expose and time required of exposure. MR fluid properties are not same for all applications. If MR fluid is considered good for one application then it is not same good for another application. This development of fluid is equilibrium act which coupled with design of MR Fluid. For use of good quality of MR fluid, it is required not only rheological behavior of fluid measured under normal condition but also remember the actual conditions where fluid exposed. The testing is all about the reduction in the amplitude of vibration of system by increase in applied voltage to MR cantilever beam (MRF-336AG).

By detecting the vibration produced in any application we can apply this concept of vibration control to that system. We can use quantity of fluid depends on dimension of MR pocket and intensity of vibration in system.

Form the table and graphs we conclude that when amplitude of vibration decrease, magnification factor also decreases. When damping increases, damping coefficient is increases and transmissibility decreases. Hence vibration is reduces.

REFERENCES

[1]. M.N.HAMDAN AND B.A.JUDRAN, "FREE AND FORCE VIBRATION OF A RESTRAINED CANTILEVER BEAM CARRYING A CONCENTRATED MASS", J KAU ENG, SCI. VOL 03, JUNE 2015.

[2]. J.D.CARLSON, D.M.CATANZARITE AND K.A.ST.CAIR, "COMMERCIAL MAGNETO RHEOLOGICAL FLUID DEVICES", INTERNATIONAL JOURNAL OF MODERN PHYSICS, VOL.10, PP 2857-2865 (1996).

[3]. MATEUSZ ROMASZKO AND M. WEGRZYNOWSKI, "FEM ANALSYIS OF A CATILEVER SANDWITCH BEAM WITH MR FLUID BASED ON ANSIS", SCIENTIFIC NET, SEPTEMBER 2015.

[4]. S. BASHAH, A. SALEHI-KHOJIN AND N. JALILI, "FORCED VIBRATION OF FLEXIBLE EULER-BERNOULLI BEAM WITH GEOMETRICAL DISCNTINUITIES", 2008.

[5]. MARK R. JOLLY, JONATHAN W. BENDER AND J. DAVID CARLSON, "PROPERTIES AND APPLICATIONS OF COMMERCIAL MAGNETO RHEOLOGICAL FLUIDS", JOURNAL OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, JAN.1999.

[6]. J. WANG AND G. MENG. "MAGNETO RHEOLOGICAL FLUID DEVICES: PRINCIPLE, CHARACTERISTICS, AND APPLICATIONS IN MECHANICAL ENGINEERING", JULY 2001.

[7]. J.D.CARLSON AL, "COMMERICAL MAGNETO-RHEOLOGICAL FLUID DEVICES".

[8]. JERZY KALETA, "MAGNETO RHEOLOGICAL COMPOSITES AS ACTIVE ELEMENTS OF DAMPERS".

[9]. THE PAPER "PROPERIES AND APPLICATION OF MAGNETO RHEOLOGICAL FLUID" BY M. KCIUK, R. TURCZYN.

[10]. THE PAPER "DESIGNING WITH MR FLUIDS", BY LORD CORPORTION.

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