PASSIVE VIBRATION CONTROL OF INBUILD STRUCTURE L-SHAPED BEAM BY USING VISCO-ELASTIC MATERIAL

Ummidi Gopi[1] | Dr.Naveen Kumar[2]

[1](Dept of Mechanical, Acharya Nagarjuna University, Guntur, Nagarjuna Nagar, India, ummidigopi.anu@gmail.com)

[2](HOD, Dept of Mechanical, Indian Institute of Technology Ropar, Rupnagar, Punjab-140001, India, nkumar@iitrpr.ac.in)

Abstract—*In this paper, Vibrations is a molecular phenomenon. Vibration plays an important role in machines and structures by improving performance & stability, reducing noise and increasing lifetime. At the same time vibrations of structures is major problem. Vibrations us everywhere and in most cases these vibrations are undesirable. they can lead to excessive wear. Vibration may results in the failure of machines or there critical components. Therefore vibration control is very important. passive vibration control refers to minimizing vibrations by the use of dampers, absorbers, stiffness, structural modification. Generally lead to viscos-elastic material to control vibrations simple, reliable and highly effective. Several polymers exhibit the viscoelastic properties of naturally dissipating vibratory energy into heat energy. This is way they are largely used in aerospace, aeronautical, automobile, civil structures, machine design industries to provide passive vibration damping. In this experiment, experimental model testing of L-shaped beam made of aluminum has been performed of obtain the mode shape & frequencies by using an analysis software. So the points of max strain energy have been observed using the software. Then later the viscoelastic material is applied to the points of max strain to reduce the vibrations passively.*

Keywords—Passive vibrations; Visco-Elastic material; Control

1. INTRODUCTION

The Vibration is a periodic motion of small magnitude. But for sake of simplicity we can assume it as simple harmonic motion of small amplitude[1].

There has been continuous interest in the dynamics of L-shaped structures since 1960's[2].

In the Study of vibrations is the process of energy dissipation is generally refered to as damping. The motion of vibration systems is governed by law of machanics and 2^{nd} law of motion. Vibration is the motion of a particle or a body or a system of connected bodies displaced from a position of equilibrium. Most vibrations are undesirable in machines and structures because they produced to increase stresses, energy losses, cause added wear, increase bearing loads, fatigue , create passenger discomfort in vehicle, and absorbed energy from the system. Vibrations occurs when a system is displaced from a position of stable equilibrium. The system tends to refers to this equilibrium position under the action of restoring forces. The effect of vibration depends on the magnitude in terms of displacement, velocity or accelerations, exciting frequency and the total duration of the vibration[3].

In vibration analysis, we are generally concerned with damping in terms of system response. The loss of energy from the oscillatory system results in the decay of amplitude of free vibration[4].

L-shaped elements are very important as many of the mechanical machines have similar structure them, as in a drill press, milling, sloting and drilling machines etc., [7].

2. OBJECTIVES

- The understand the vibration of L shaped structure.
- The characteristics of vibratory motion at different temperatures and different percentages of patches.
- Frequency response factor(FRF).
- Strain value & Zeta value at different temperatures and different percentages.
- Apply viscoelastic material at those points to reduce the vibrations passively.
- Compare the theory with a real structure which fabricated by us.

3. EXPERMENTAL SETUP

EQUIPMENTS USED:

a) Heating Chamber: It is used to heat the experimental piece temperatures range from 30 degree's Celsius to 90 degree's Celsius.

b) Laser Vibrometre: It is used to measure Zeta. Simply it is used to calculate the characteristics of this vibratory motion are period, frequency, displacement, velocity, acceleration, amplitude and phase[8].

c) Data Acquation system: It is media of resource to ultimate output .

d) Viscos-elastic material(3M C002-03): the idealized linear behavior generally assumed for this class of material is amenable to the laws of superposition and other conventional[9].

e) L-Shaped Beam: It is made of aluminum metal piece and apply patches on back side of beam and speckle pattern apply front of beam these reduce unwanted errors of measurements. the base beam is almost made of lightly damped material such as steel and aluminum.

4. SPECIFICATIONS OF PART MATERIAL

- Mass density 2700kg/m3
- Young's modulus 210Gpa
- Poisson ratio 0.33
- length of beam 19.5cm
- width of beam 11cm

5. SOFTWARE TO BE USED

1. Polytec Vibrometre software.
2. MATLAB

6. EXPERMENTAL PROCEDURE

L shapes structure making according to required dimensions. Hold the L-shape structure properly in fixture as required position. After check it with help of Try-square. This whole structure is place in heating chamber . Setup all loop system as per our experiment. Heating the structure about different temperatures and takes readings three times at different percentage of patches. First press the single shot (shift+F8) in polytech vibrometer software then strike the L-Shape structure . Strike should be made by model hammer slowly on patch. Taken all data is compare and plotting in MATLAB software and Analysis this data as per consider software. Finally check the output values manually with using Log-decrement method is it correct or not. Then plotting graphs.

Fig. 1. Fabricated model of L-shape beam

7. USEFUL EQUATIONS

Equation of equilibrium $mx+cx+sx = 0$

Natural circular frequency(wn) $w_n = \sqrt{s/n}$

Natural linear frequency $f_n = 1/2\pi\sqrt{s/m}$

Damping factor = actual damping coefficient/critical

Damping coefficient, $C_c = c/2\sqrt{sm}$

Logarithmic decrement(δ) = $\ln(X_n/X_{n+1})$

$$\delta = 2\pi\xi/\sqrt{1-\xi^2}.$$

Half-power method is (omega2-omega1)/omegaN $= 2\xi$

8. EXPERMENTAL RESULTS OF 3M C-1002-03 SELF ADHESIVE VISCO-ELASTIC MATERIAL

A. *Experimental values of patch No.01*

TABLE I. EXPERIMENTAL VALUES OF PATCH NO.01

PERCENTAGE	TEMPERATURE	OmegaN	ZETA	ZETA (LM)	OmegaN	ZETA	ZETA (LM)	OmegaN	ZETA	ZETA (LM)
50	30	13	0.0164	0.0223	13	0.022	0.02	13	0.026	0.0176
	40	12.75	0.0164	0.0128	12.75	0.016	0.013	12.75	0.0141	0.0096
	50	13.2813	0.0127	0.0109	13.2813	0.021	0.0113	13.2813	0.0176	0.0074
	60	13.8125	0.0152	0.0093	13.8125	0.017	0.0079	13.5417	0.0194	0.0067
	70	14.0625	0.0199	0.0064	14.0625	0.014	0.0051	14.0625	0.0122	0.0058
	80	14.5833	0.0133	0.0046	14.5833	0.014	0.0051	14.5833	0.013	0.0057
	90	15.1042	0.017	0.0046	15.1042	0.017	0.0043	15.1042	0.0169	0.0043
40	30	13	0.019	0.0167	13	0.017	0.0136	13	0.0175	0.0195
	40	13	0.0212	0.0139	12.75	0.016	0.0111	12.75	0.0179	0.0121
	50	12.75	0.0156	0.0108	12.75	0.015	0.0078	12.75	0.0148	0.0078
	60	12.75	0.0122	0.006	12.75	0.013	0.0071	12.75	0.0188	0.0063
	70	12.75	0.0155	0.0054	12.75	0.017	0.0057	12.5	0.0173	0.0048
	80	12.5	0.0174	0.0048	12.75	0.016	0.0058	12.75	0.0148	0.0054
	90	12.5	0.0173	0.0048	12.5	0.012	0.0049	12.5	0.0161	0.0046
30	30	13	0.0165	0.0122	13	0.017	0.0123	13	0.0167	0.0111
	40	12.75	0.0131	0.0086	12.75	0.015	0.0075	12.75	0.0139	0.0066
	50	12.75	0.012	0.0056	12.75	0.012	0.0058	12.75	0.0119	0.0065
	60	12.75	0.0119	0.0064	12.75	0.015	0.0051	12.75	0.0155	0.0046
	70	12.75	0.0169	0.005	12.5	0.017	0.0045	12.5	0.0162	0.004
	80	12.5	0.0168	0.0046	12.5	0.017	0.0048	12.5	0.0168	0.0055
	90	12.5	0.0153	0.0038	12.5	0.013	0.0039	12.5	0.0145	0.0046
20	30	12.75	0.016	0.0062	12.75	0.015	0.0072	12.75	0.0138	0.0064
	40	12.75	0.0124	0.0064	12.75	0.015	0.0042	12.75	0.0137	0.0051
	50	12.75	0.0169	0.0036	12.75	0.017	0.0054	12.5	0.0158	0.0066
	60	12.5	0.0174	0.004	12.5	0.016	0.0044	12.5	0.0162	0.0049
	70	12.5	0.0124	0.0041	12.5	0.017	0.0038	12.5	0.0162	0.0049
	80	12.5	0.0148	0.0037	12.5	0.013	0.0041	12.5	0.0119	0.003
	90	15.1042	0.0124	0.0032	15.1042	0.014	0.0047	15.1042	0.0145	0.0058
10	30	12.75	0.0173	0.006	12.75	0.016	0.0059	12.75	0.0146	0.0036
	40	12.5	0.017	0.0024	12.5	0.015	0.0029	12.5	0.0174	0.0023
	50	12.5	0.0129	0.0032	12.5	0.012	0.003	12.5	0.012	0.0041
	60	12.5	0.0169	0.0034	12.5	0.013	0.0025	12.5	0.0127	0.0034
	70	12.5	0.0148	0.003	12.5	0.014	0.003	12.5	0.0126	0.0033
	80	12.5	0.0163	0.0033	12.25	0.015	0.0117	12.5	0.0163	0.0041
	90	15.1042	0.0134	0.0028	14.8021	0.015	0.0107	14.8021	0.0112	0.011

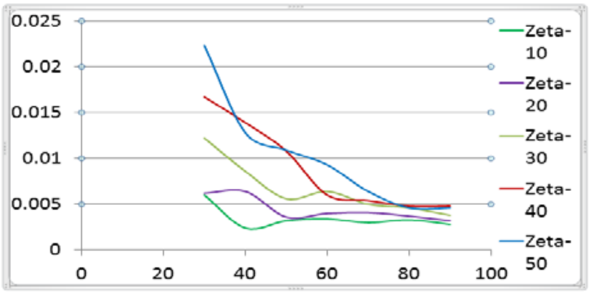

Fig. 2. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.1)

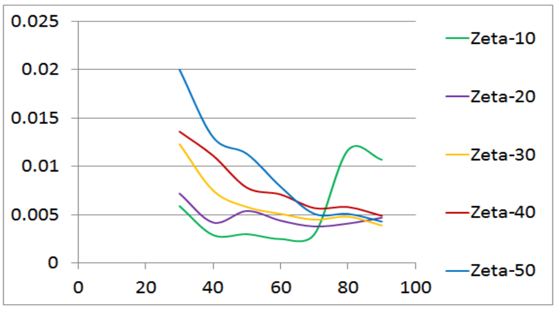

Fig. 3. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.2)

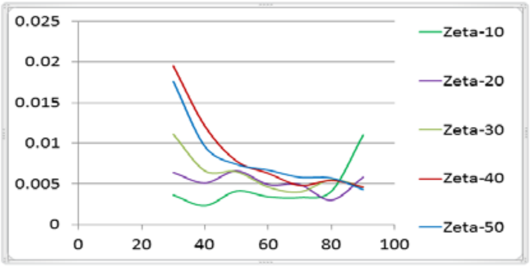

Fig. 4. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.3)

Note: *in shown graphs Zeta-10 means 10 percentage patch, Zeta-20 means 20 percentage patch, Zeta-30 means 30 percentage patch, Zeta-40 means 40 percentage patch, Zeta-50 means 50 percentage patch and this statement is applicable to all graphs.*

B. Experimental values of patch No.02

TABLE II. EXPERIMENTAL VALUES OF PATCH NO.02

percenta	temperatur	omega	omegi	omegi	ZET	ZETA(L	omega'	omega'	omega'	ZET	ZETA(LM	omega'	omega'	omega'	ZETA(	ZET
50	30	12.5	12.1801	12.6009	0.02	0.0025	12.5	12.1919	12.6003	0.017	0.0027	12.5	12.1807	12.6046	0.0178	
	40	12.25	12.1552	12.5745	0.02	0.0022	12.25	12.152	12.5562	0.017	0.0033	12.25	12.1496	12.5454	0.0162	
	50	12.7604	12.6524	13.0795	0.02	0.0018	12.7604	12.6411	13.0768	0.017	0.0028	12.7604	12.6349	12.9876	0.0138	
	60	13.2708	13.1355	13.4857	0.01	0.0023	13.2708	13.106	13.4298	0.012	0.0032	13.2708	13.1337	13.4656	0.0125	
	70	13.7813	13.4991	13.9145	0.02	0.0025	13.7813	13.4407	13.8926	0.016	0.0037	13.7813	13.4506	13.8968	0.0162	
	80	14	13.8792	14.3784	0.02	0.0043	14.2917	13.8888	14.3999	0.018	0.0035	14.2917	13.8997	14.4147	0.018	
	90	14.8021	14.4140	14.9309	0.02	0.0064	14.8021	14.6554	15.1244	0.016	0.0041	14.0021	14.6646	15.1489	0.0164	
40	30	12.25	12.1533	12.569	0.02	0.0027	12.25	12.1563	12.5805	0.017	0.0026	12.5	12.1727	12.5930	0.0160	
	40	12.25	12.1497	12.5557	0.02	0.0022	12.25	12.1501	12.5539	0.017	0.0029	12.25	12.1468	12.5397	0.016	
	50	12.25	12.1346	12.5144	0.02	0.003	12.25	12.1373	12.5309	0.016	0.005	12.25	12.1311	12.5044	0.0152	
	60	12.25	12.127	12.4594	0.01	0.0034	12.25	12.1197	12.4553	0.014	0.0034	12.25	12.1242	12.4913	0.015	
	70	12.25	12.1157	12.4207	0.01	0.0031	12.25	12.0486	12.4116	0.015	0.0039	12.25	12.1151	12.4141	0.0122	
	80	12.25	12.0957	12.3973	0.01	0.0033	12.25	12.072	12.3905	0.013	0.0064	12.25	12.0720	12.3076	0.0128	
	90	12.25	12.0573	12.380	0.01	0.005	12.25	12.0069	12.3645	0.015	0.0039	12.25	11.9922	12.3689	0.0154	
30	30	12.25	12.1433	12.4910	0.01	0.0037	12.25	12.0947	12.4040	0.013	0.0067	12.25	12.1096	12.4100	0.0123	
	40	12.25	12.096	12.38	0.01	0.0076	12.25	12.0156	12.3521	0.014	0.0175	12.25	12.0031	12.3562	0.0144	
	50	12.5	12.1916	12.598	0.02	0.0026	12.5	12.1817	12.5998	0.017	0.0026	12.5	12.1597	12.5924	0.0173	
	60	12.25	12.1238	12.5038	0.02	0.0035	12.25	12.1453	12.5719	0.017	0.0029	12.25	12.1444	12.5614	0.017	
	70	12.25	12.0823	12.4295	0.01	0.004	12.25	12.1167	12.4543	0.014	0.004	12.25	12.1465	12.5457	0.0163	
	80	12.25	12.1479	12.5590	0.02	0.0042	12.25	12.1401	12.5100	0.015	0.0024	12.25	12.1250	12.4545	0.0134	
	90	12.25	12.1344	12.5425	0.02	0.0047	12.25	12.1391	12.5146	0.015	0.0032	12.25	12.1455	12.5631	0.017	
20	30	12.25	12.1535	12.5712	0.02	0.003	12.25	12.1511	12.5579	0.017	0.0027	12.25	12.1497	12.5509	0.0164	
	40	12.25	12.1484	12.5577	0.02	0.0025	12.25	12.1507	12.5569	0.017	0.0024	12.25	12.1498	12.5642	0.0169	
	50	12.25	12.1511	12.5539	0.02	0.0036	12.25	12.1475	12.5777	0.018	0.0022	12.25	12.1396	12.5656	0.0174	
	60	12.25	12.1329	12.4944	0.01	0.0026	12.25	12.1369	12.5106	0.015	0.003	12.25	12.1522	12.5623	0.0167	
	70	12.25	12.0987	12.4073	0.01	0.0037	12.25	12.1396	12.5593	0.017	0.0026	12.25	12.1185	12.4231	0.0124	
	80	12.25	12.0839	12.3936	0.01	0.0039	12.25	12.1203	12.4479	0.013	0.004	12.25	12.1483	12.5522	0.0165	
	90	12.25	12.0761	12.3077	0.01	0.0045	12.25	12.1022	12.4104	0.013	0.0042	12.25	12.0394	12.3702	0.0135	
10	30	12.25	12.1238	12.4325	0.01	0.0023	12.25	12.1226	12.429	0.013	0.0034	12.25	12.1222	12.426	0.0124	
	40	12.25	12.0306	12.3649	0.01	0.003	12.25	11.9202	12.3436	0.017	0.0037	12.25	11.9421	12.349	0.0166	
	50	12	11.8297	12.1376	0.01	0.0038	12	11.8607	12.1753	0.013	0.0034	12.25	12.0628	12.3722	0.0126	
	60	12.25	11.9899	12.3598	0.02	0.0035	12.25	11.9165	12.3443	0.018	0.0044	12.25	11.9122	12.3451	0.0177	
	70	12	11.6917	12.1059	0.02	0.0042	12	11.8471	12.1761	0.014	0.0049	12	11.8867	12.1003	0.0131	
	80	12.25	12.0609	12.383	0.01	0.0037	12.25	12.0372	12.3697	0.014	0.0041	12.25	12.0143	12.3640	0.0143	
	90	12.25	11.9286	12.3517	0.02	0.0054	12.25	12.0562	12.3756	0.013	0.0049	12.25	12.0516	12.3756	0.0132	

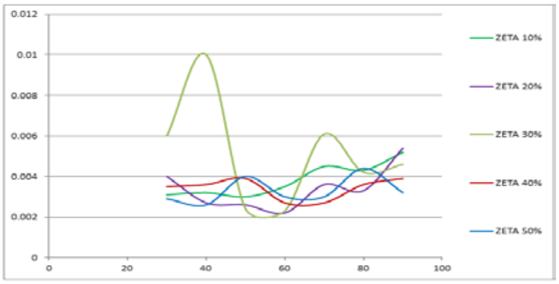

Fig. 5. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.1)

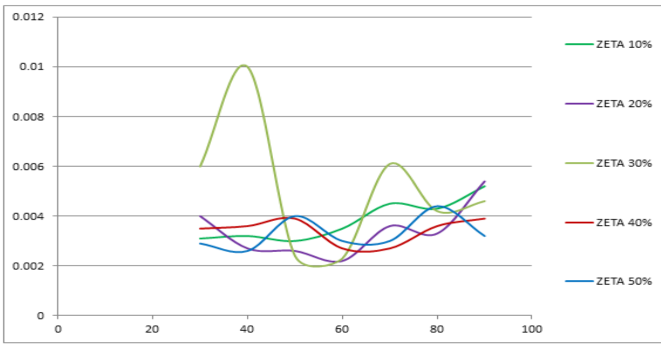

Fig. 6. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.2)

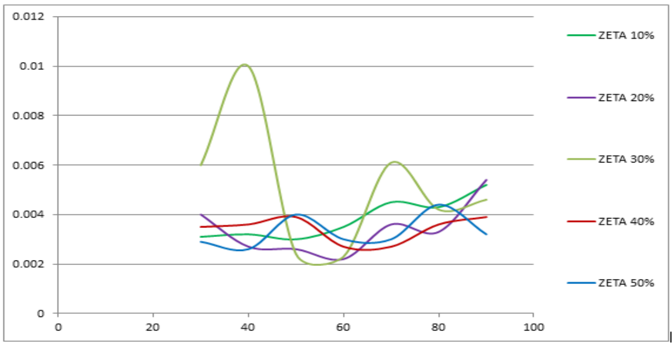

Fig. 7. Fabricated model of L-shape beam Temperature Vs Zeta(Reading.3)

9. CONCLUSION

Added the structural modification can be thought of as a passive control. Added the stiffness choose to improve the vibrational response of the system, then it can be thought of as a passive control procedure. Passive control consists of added layers of damping material applied to various structures to increase the damping ratios of trouble some modes. damping treatment increase the rate of decay of vibrations.Adding mass & changing stiffness values are also methods of passive control used to adjust a frequency away from resonance.

It's taken values good as per Experiment and maintain same temperature limits but change(Reduce)) thickness of material. It will get better results at same experimental procedure.

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REFERENCES

[1] https://www.youtube.com/watch?v=hWNpID0TWYU&list=PLbMVogVj5nJQXSOgNkmP2kLM9m7BUQIUK
[2] http://nptel.ac.in/courses/112107087/
[3] Mechanical Vibrations 8th edition published by G K Grover(Author) new chand & bros,Roorkee,U.K.,India.
[4] A text book of Theory of Vibration with Applications 3rd edition(CBS) by W.T.Thomson.
[5] A handbook on mechanical engineering ,IES,GATE,PSUs & Other Competitive book by Made Easy.
[6] A Text book of Mechanical Vibrations by Rao V. Dukkipati & J.Srinivas of 3rd edition (Eastern Economy Editions).
[7] Microsoft powerpoint mech300_1_2.ppt Fundamentals of Vibration by Dr. Mostafa Ranjbar.
[8] https://en.wikipedia.org/wiki/Vibration_control
[9] https://www.google.co.in/
[10] https://en.wikipedia.org/wiki/Viscoelasticity