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EXPERIMENTAL INVESTIGATION OF DAMPING PERFORMANCE OF MIXED PARTICLE-VISCOUS DAMPER

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ABSTRACT: As the need for passive damping technology increases and the particle dampers are advantageous than other passive damping techniques, we have to study the performance of the particle damper. This paper gives a review on the improvements in particle damping technology and results of some experiments which are done to prove the performance of a mixed particle damper in which particle damping is applied along with the viscous damping technology.

INTRODUCTION:

Active and passive damping techniques are common methods of attenuating the resonant vibrations excited in a structure. Active damping techniques are not applicable under all circumstances due, for example, to power requirements, cost, environment, etc. Under such circumstances, passive damping techniques are a viable alternative. Various forms of passive damping exist, including viscous damping, viscoelastic damping, friction damping, and impact damping. Viscous and viscoelastic damping usually have a relatively strong dependence on temperature. Friction dampers, while applicable over wide temperature ranges, may degrade with wear. Due to these limitations, attention has been focused on impact dampers, particularly for application in cryogenic environments or at elevated temperatures.

To increase the performance of any machine, it is desired to reduce the weight of the machine and the losses that are occurred in the machine. To reduce weight of the machine, some material is removed from the machine by making it as a hollow structure. By making the solid structure to hollow structure the stiffness of the structure is reduced. Thus, increases vibrations induced in the structure. These induced vibrations are undesired as they consume some power that is produced by the machine.

Particle damping is new development in passive damping. Particle damping is a derivative of impact damping. The damping is obtained by filling metal or granular particles within the holes of the primary vibrating structure or it can be attached as an external capsule. The performance of damping is strongly dependant on particle size, density and volumetric packing ratio. Particle damping offers good passive vibration control over a wide range of frequencies and temperatures. Studies conducted over recent years demonstrated the effectiveness and potential application of particle damping.

In this paper, a mixed damper is prepared by introducing powder particles into the viscous particles and the performance is compared with pure viscous damper. Also the performance of various compositions of fluid particles in viscous medium is evaluated. And the variation of damping with change in damper position is evaluated.

EXPERIMENTATION:

A test specimen made of mild steel having rectangular cross section with dimensions 20mm X 8 mm and length 850 mm is used to conduct experimentation. One end of the specimen is hinged and the other end is connected to frame using a spring. An exciter is placed at 450 mm from the hinged end. A DC motor of capacity 1500 rpm with a disc connected to the shaft with eccentric masses is used as exciter. A recorder is mounted on the frame such that vibrations of the specimen can be recorded.

A dashpot is connected to the specimen as shown in the figure which acts as the damper for the system. This dashpot is filled with viscous fluid which is water in our case. Particles are filled along with the viscous fluid. Particles are mixed with fluid in percentage by volume of the dashpot.

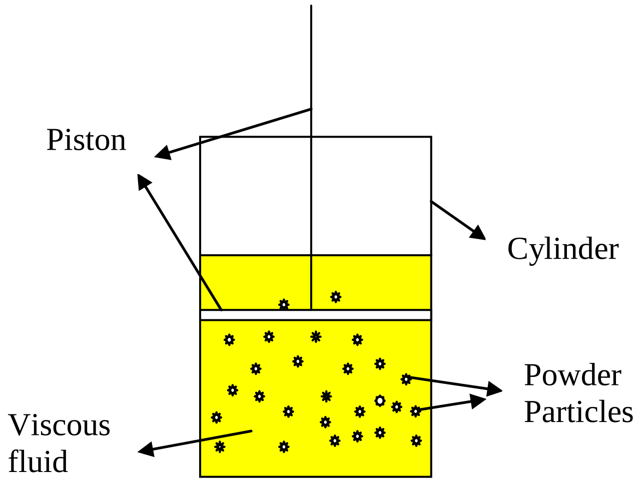


Figure1: A schematic of a mixed particle damper

The particles are collected from the chips obtained from the power hacksaw. Mild steel swarf particles are used as the particles for damping. In this paper, the performance of the mixture of particles is observed and they are compared with the performance of pure viscous damper.

Three sets of particles and fluid mixtures are compared with pure viscous damper. The three mixtures are 10% particles and 90% viscous fluid, 20% particles and 80% viscous fluid, 30% particles and 70% viscous fluid. These three compositions are compared with the pure viscous damper. The oscillation graph is obtained from the vib-lab apparatus. This graph is taken for a time period of 30 seconds in order to get the stability.

Also this procedure is repeated for different positions of damper from the exciter. The damper is placed in two different positions. The two different positions are 15 cms from the exciter towards fixed end and exactly below the exciter.

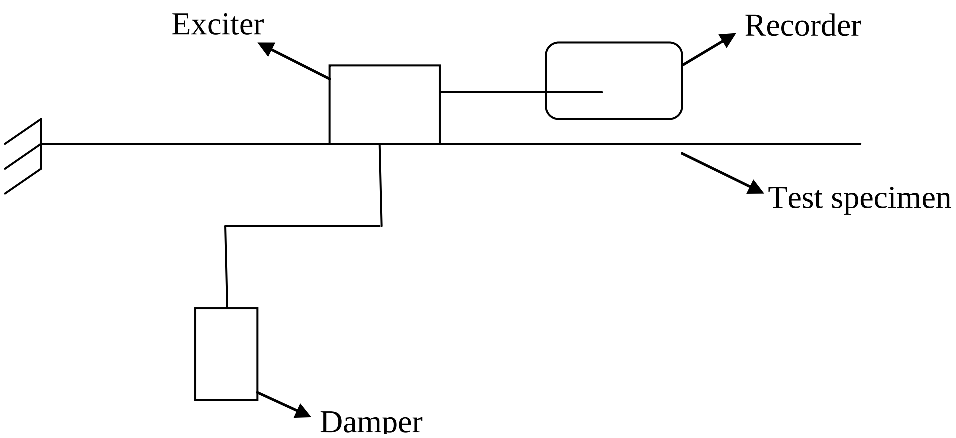


Figure2: First position of damper

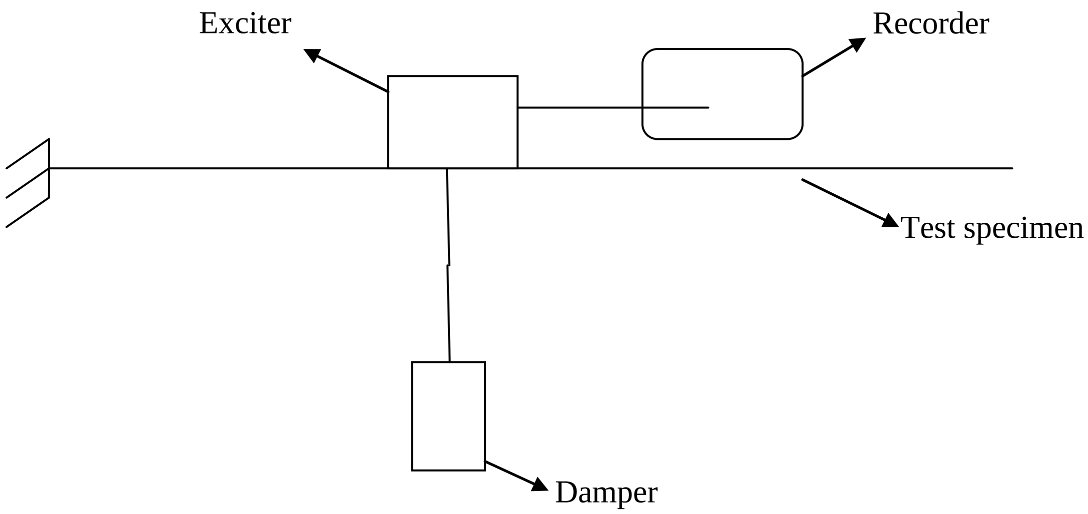


Figure3: Second position of damper

RESULTS:

The exciter was controlled by a variable speed controller and a set of speed values of the exciter motor were calculated according to the input frequencies. The results were collected by conducting experiments at seven different input frequencies as 153, 193, 231, 272, 310, 344 and 384 rpm. And the results are tabulated in the following tabular forms.

For 30% particles and 70% fluid composition, the damper is placed at the first position and the plots are taken from the recorder. And from those plots, the values are calculated and are tabulated as below. The sample plot is as shown below and the amplitude value is directly measured from the plot. Frequency is calculated from the formula

Frequency = no. of oscillation per time.

Also the natural frequency of the system is calculated experimentally and is found as 25.26 rad/sec.

S.no	***Speed (rpm)***	***No of oscillations***	***Time(sec)***	***Frequency(rad/sec)***	***Amplitude(mm)***
1	153	80	30	16.7552	3.5
2	193	100	30	20.9439	7.5
3	231	120	30	25.1327	6.5
4	272	142	30	29.7404	5.5
5	310	162	30	33.9292	5
6	344	180	30	37.6991	4.5
7	384	200	30	41.8879	4.25

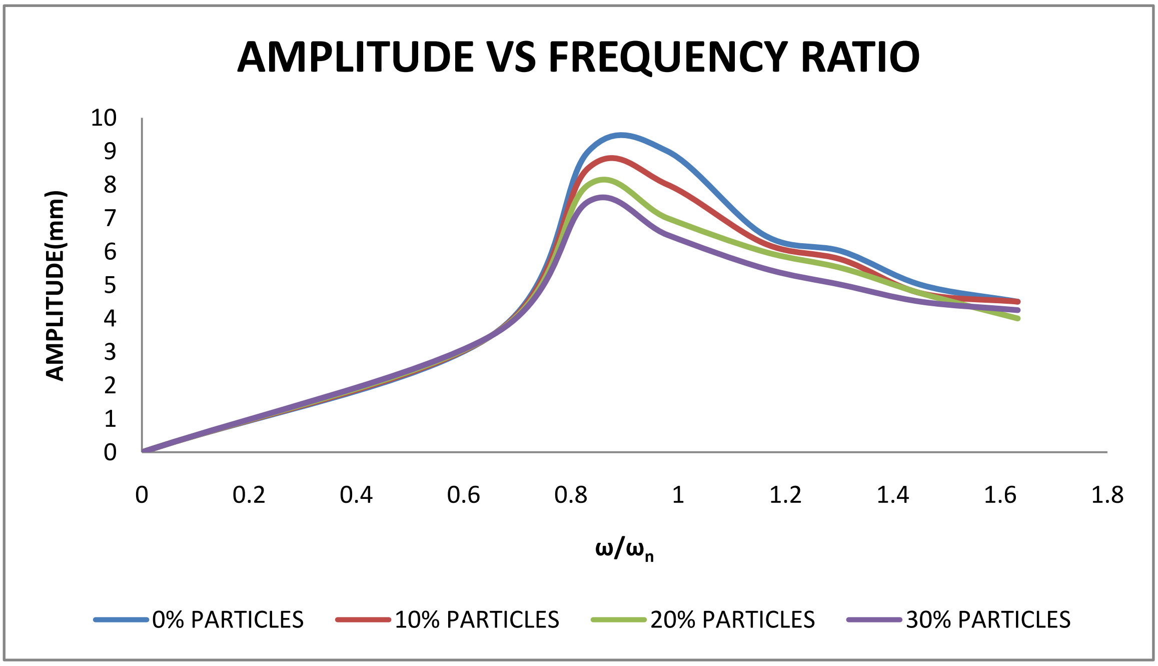
Table1: Amplitude and frequency of test specimen for a composition of 30% particles and 70% liquid for first position of damper

In similar, for same damper position, the experiments are repeated with compositions of 0% particles, 10% particles, 20% particles with same input frequencies and the values of amplitudes are tabulated as below.

S.no	***Speed (rpm)***	***Frequency(rad/sec)***	***Amplitude(mm)***			
			0%	***10%***	***20%***	***30%***
1	153	16.7552	3.5	3.5	3.5	3.5
2	193	20.9439	9	8.5	8	7.5
3	231	25.1327	9	8	7	6.5
4	272	29.7404	6.5	6.25	6	5.5
5	310	33.9292	6	5.75	5.5	5
6	344	37.6991	5	4.75	4.75	4.5
7	384	41.8879	4.5	4.5	4	4.25

Table2: Amplitudes of test specimen for all compositions liquid for first position of damper.

The variation of the amplitude of various all the compositions against the frequency ratio is plotted in the below graph. This graph shows that damping is done more effectively in the final composition as the cure shows that the composition of 30% has low amplitudes compared to other compositions. However, the amplitude value increases with increasing the frequency ratio.



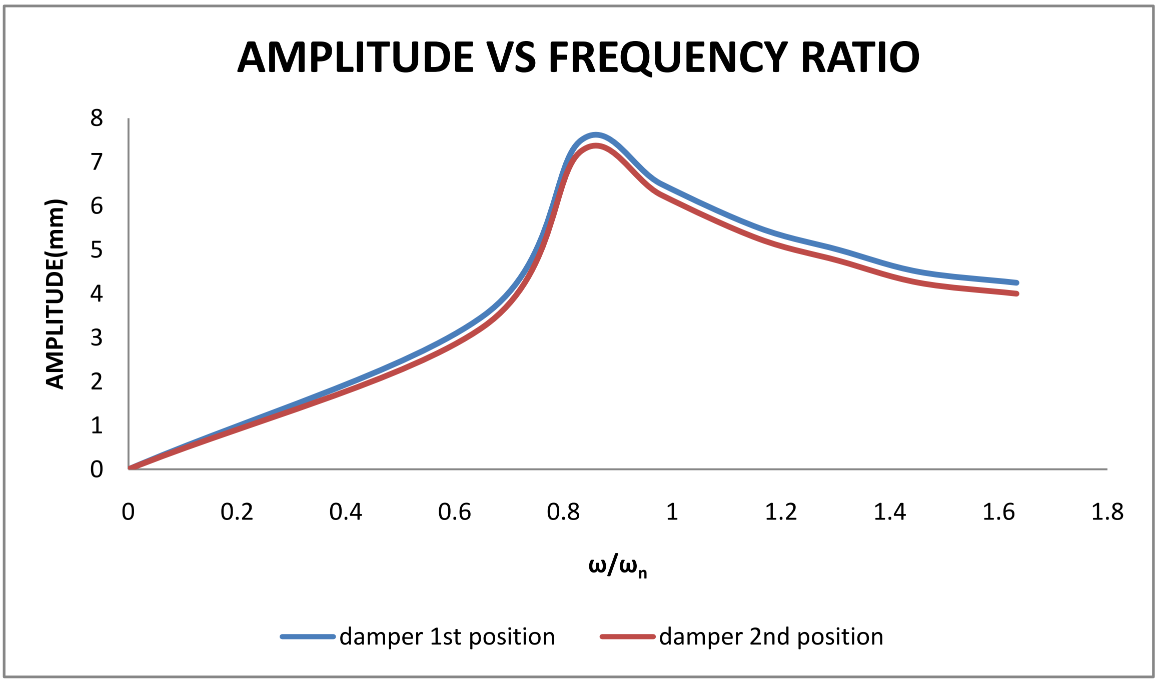
Graph1: Variation of amplitude againest frquency ratio for different compositions for first position of damper.

For the second position of the damper, same experiment is repeated with 30% particle and 70% particle composition and calculations where repeated forming the below table.

S.no	***Speed (rpm)***	***No of oscillations***	***Time(sec)***	***Frequency(rad/sec)***	***Amplitude(mm)***
1	153	81	30	16.956	3.25
2	193	99	30	20.724	7.25
3	231	122	30	25.53867	6.25
4	272	143	30	29.93467	5.25
5	310	161	30	33.70267	4.75
6	344	181	30	37.88933	4.25
7	384	200	30	41.86667	4

Table3: Amplitude and frequency of test specimen for a composition of 30% particles and 70% liquid for second position of damper

The variation of amplitude for change in the damper position is as shown in the followinf graph. The graph shows that the amplitudes of the second position of damper are less than the amplitudes of the first position of damper. This means the damping is done more effectively in the second position of the damper.



Graph2: Variation of amplitude againest frquency ratio for different positions of damper.

CONCLUSION:

The paper presents a new passive vibration control device- a mixed particle damper in which the viscous medium is mixed up with a metal powder particles. An experimental study is carried out with various liquid and power compositions and the results were compared with pure viscous damper. This experiments shows that the damping performance is good in mixed damper compared to pure viscous damper. The damping performance of mixed damper increases with increase in the percentage of powder particles in total volume. Also another set of experiments show that damping performance is good if the damper is placed nearer to the source of vibrations.

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