EFFECT OF PARTICLE SIZE ON THE PERFORMANCE OF MULTI UNIT PARTICLE DAMPER

M. R. Sapali[1] , D. S. Kolekar[2]
[1 & 2]Assistant Professor, Department Mechanical Engg, N B Navale college of Engineering, Solapur University, Solapur, Maharashtra, India
Email –sapalimr@gmail.com, kolekardjs@gmail.com

Abstract: *A particle damper generally consists of a mass, which is allowed to travel freely in a cavity. When the optimum dimensions of the cavity are large, the optimum cavity may not be attached from a practical design point of view. In such a case, the damper performance is retained when particle dampers are replaced by multi-unit particle damper with a moderate number of small cavities and number of particles of small size. Presented here is experimental results of Multi Unit Particle Damper are compared with earlier results. The effects of particle size on the performance of the damper are considered.*

Key Words: *Multi- Unit Particle Damper, cavity,*

1. INTRODUCTION:

Multi-unit particle dampers are passive damping devices involving granular particles in some cavities of a primary system. The damping efficiency of particle damping depends on cavity dimensions. When the optimum dimensions of the cavity are large, the optimum cavity may not be attached from a practical design point of view. In such a case, the damper performance is retained when particle dampers are replaced by multi-unit dampers with a moderate number of small cavities. An impact damper generally consists of a single mass, which is allowed to travel freely between two defined stops. At the point of impact, large accelerations are imparted to the structure, which may be undesirable; particularly for occupied structures Particle damping is a derivative of impact damping where multiple auxiliary masses of small size are placed inside a cavity attached to the vibrating structure. However, these models provide a suitable means of internal friction and impact interactions between the individual particles and particles and container wall. The damping efficiency of particle damping depends on cavity dimensions. When the optimum dimensions of the cavity are large, the optimum cavity may not be attached from a practical design point of view. In such a case, the damper performance is retained when particle dampers are replaced by multi-unit dampers with a moderate number of small cavities. Thus members of this class of dampers include the single particle impact damper, multi-unit/single-particle impact dampers, multi-particle impact dampers, arrays of particle dampers, and hybrid impact dampers that utilize a combination of momentum transfer devices with features characteristic of other classes of linear or nonlinear dampers. Many researchers have been studying particle impact dampers. However, most previous studies have focused on particle impact dampers equipped with a single cavity. This paper investigates the damping efficiency of a particle damper equipped with a number of cavities (termed the multiunit particle damper in the following). The objective of this work is to study the effect of different parameters like particle size, cavity dimensions, number of cavities on the damping performance of multi-unit particle damper.

2. EXPERIMENTAL SET-UP:

Fig. 1 shows the experimental apparatus used in this study. The experimental apparatus consists of the primary structure, and acts as an equivalent single-degree-of-freedom system. The structure is supported by two leaf springs. The particle damper consists of five cylindrical cavities. To investigate the effect of the number of cavities, cavity diameter and packing ratio on the damping efficiency, 3, 4 and 5 cavities were partially filled with granular particles of the same size.

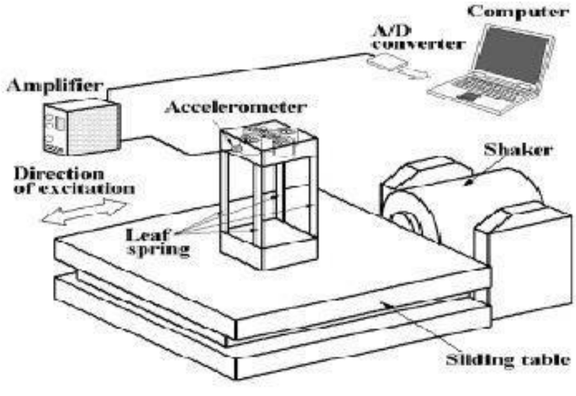

Figure 1 Experimental Set-up of multi unit PID

The experimental model (Figure 1) consists of two aluminum plates of dimensions 300 X 300 X 3 mm thick connected with two 3 mm thick, 25mm wide, and 300 mm long aluminum beams, which function as leaf springs. The lower plate rests on horizontal sliding table, which is free to move forward and backward. The shaker is connected to the horizontal sliding table, which can be considered as the base of the primary mass, the top plate. Therefore, when the shaker is excited, base excitation is imposed on the primary mass. There are five cylindrical cavities (29 mm diameter each and 34 mm diameter each), with height of 25 mm on the top plate that act as multi unit particle damper. The motion of the primary system was measured with an accelerometer. The impacting granular spherical particles in each

Cavity used in this study is made of copper, and are of uniform size (diameter 1mm & 3 mm). The natural frequency of the primary system was tuned while the Cavity was not in place. The primary mass is given an initial excitation and let to oscillate freely, while the displacement data is recorded for 10 seconds. By using a F.F.T. (OROS Seris3/ NVGate), the natural frequency of the model was obtained. The desired mass ratio was obtained by filling the multi- unit particle damper with particles as required. In Multi-Unit Particle Damper, numbers of cavities are to be varied. The arrangement for 3 cavities, 4 cavities & 5 cavities are as shown in figure 2.

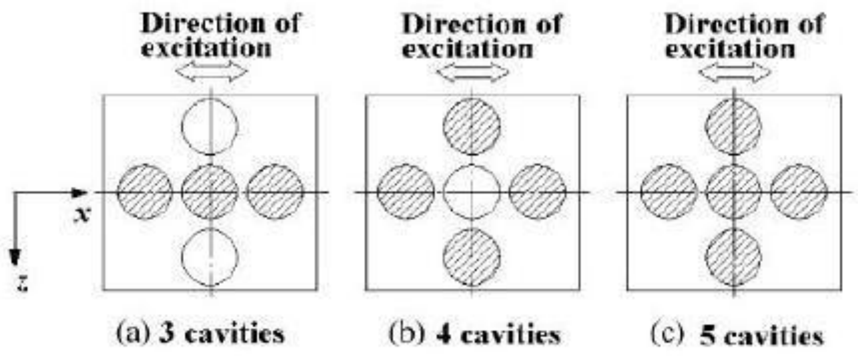

Fig. 2. Cavity Arrangement

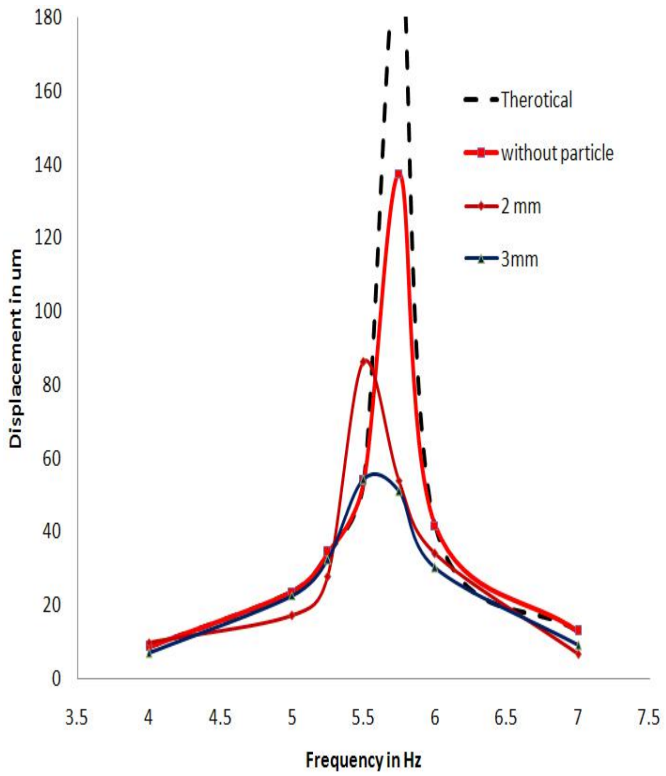

Fig. 3. Particles 2mm& 3mm Copper, Cavity Diameter 29mm, 3 cavity, packing ratio 5 % Displacement 100µm

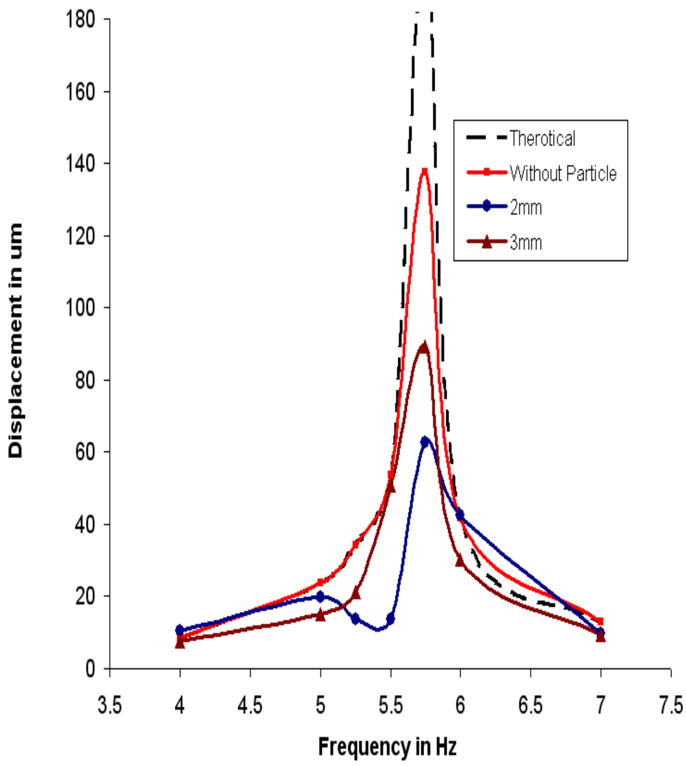

Fig. 4. Particles 2mm& 3mm Copper, Cavity diameter 29mm, 4 cavity, packing ratio 5 % Displacement 100µm

From the figures3 & 4, it shows the behavior of granular particles in the cavity having packing ratio 5%. For particle size, 2mm, the behavior of granular material is just like as lumped mass and moving in same direction as that of primary mass. In this case, energy dissipated through impacts are less, as number of particles are more as compared to numbers of particle for 3 mm size particle for the same mass ratio. But for the particle size 3 mm, numbers of particles are less so, number of impacts between particle & particle and particle & cavity wall are more and energy dissipated through it is also more so it is observed that damping effect is more for 3 mm size particles.

From the figure 5, it shows the behavior of granular particles in the cavity of 29mm diameter& 5 cavities having packing ratio 5%. For particle size, 2mm and 3 mm the behavior of granular material is just like same .In this case, energy dissipated through impacts and friction for the both case are same, because in both cases particles will get sufficient space for movement and for impacts also. In such cases of optimum size and mass ratio, damping does not depend on the particle size.

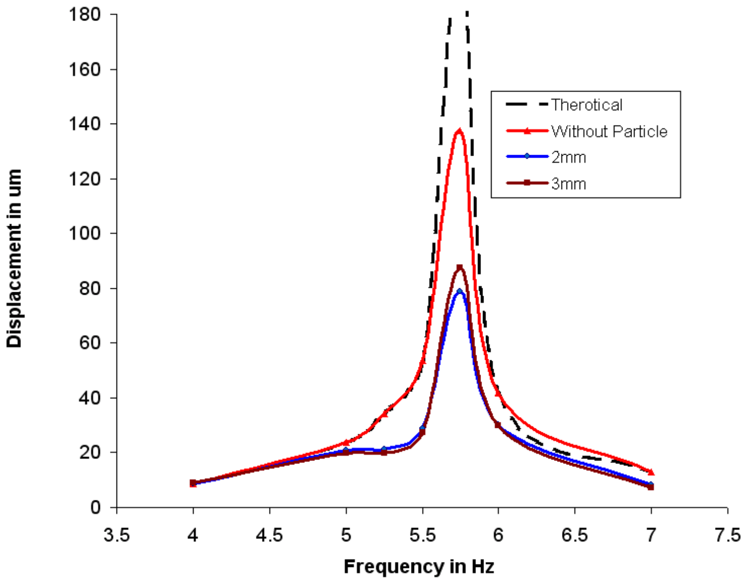

Fig 5 Particles 2mm& 3mm Copper, Cavity diameter 29mm,5 cavity, packing ratio 5 % Displacement 100μm

3. CONCLUSION:

1. The optimum diameter size of multi-unit particle damper increases with increase in effective mass ratio.
2. Maximum energy is dissipated through impacts rather than friction.
3. The damping performance of multi-unit particle damper is depends on particle size, Cavity radius and packing ratio.

REFERENCES:

1. S.Mehdi Zahrai, Amir F.Rod, : Effect of Impact Damper on SDOF System Vibrations under Harmonic and Impulsive Excitations. (2009)
2. E. Ehsan Maani Miandoab, A. Yousefi-Koma, D.Ehyaei, Optimal Design of an Impact Damper for a Nonlinear Friction-Driven Oscillator, international journal of mathematical models and methods in applied sciences, Issue 2,Volume 2, 2008
3. M.R. Duncan, C.R. Wassgren, C.M. Krousgrill, The damping performance of a single particle impact damper, Journal of Sound and Vibration 286 (2005) 123–144.
4. K. Li, A.P. Darby, An experimental investigation into the use of a buffered impact damper, Journal of Sound and Vibration 291 (2006) 844–860
5. R. D. Nayeri , S. F. Masri, J. P. Caffrey, Studies of the Performance of Multi-Unit Impact Dampers Under Stochastic Excitation , Journal of Vibration and Acoustics APRIL 2007, Vol. 129 / 247
6. Bryce L. Fowler, Eric M. Flint, Steven E. Olson, Effectiveness and Predictability of Particle Damping,
7. CHEN Tianning, MAO Kuanmin, HUANG Xieqing, Michael Yu WANG, Dissipation mechanisms of nonobstructive particle damping using discrete element method
8. Michael Yu WANG, Kuanmin MAO, Zhiwei XU, and Tianning CHEN, Efficient Computation of Particle Motions in Discrete Element Modeling of Particle Damping
9. M.R. Duncan, C.R. Wassgren_, C.M. Krousgrill, The damping performance of a single particle impact damper.