Rotary Damper using elastomer particles: Effect on damping torque due to type of elastomer particles

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Abstract. In this paper a prototype of rotary damper using elastomer particles has been introduced. The investigation was conducted experimentally and change in damping torque was analysed by changing two different types of silicon rubber elastomer particles of TSE3466 and TSE3453 (Momentive). It was observed through experiments that particles made of materials with higher tensile strength and hardness resulted in higher damping torque.

Introduction

Dampers are devices used to control the kinetic energy from a system. There are several types of damper used as shock absorbers and to control the vibration of a system. Some are hydraulic dampers which consist of fluid and that fluid is used as medium to control the vibrating forces acting on the system. Another type of dampers is elastomer particle dampers. Elastomer particle dampers are devices used to control mechanical vibration due to interaction between particles to particles and particles to damper walls [1]. Particle dampers have several advantages over fluid dampers such as no leakage, easy maintenance, easy and simple manufacturing, simple design and structure. Particle damper consists of particles enclosed inside the main body. Several articles have been published on spherical particle dampers but most of them are using metal spheres [2, 3, 4]. Metal spheres and elastomer spheres are different in nature and properties so they behave differently in different situations [5, 6]. It is important to analysis that which type of elastomer particles can improve the damping capabilities of elastomer particle dampers because particle dampers have several advantages over fluid dampers. Therefore, here we performed experiments on two types mold making silicone rubbers changing their mechanical properties.

Fabrication of Elastomer Particles

Two different types of elastomer particles were manufactured and tested. TSE3466 and TSE3453 both were used as main ingredient to prepare two different types of particle samples. Both of these are mold making liquid silicone rubbers.TSE3466-A and TSE3453-A produced by Momentive are the main raw materials but these were mixed with TSE3466-B and TSE3453-B respectively with a ratio of 10:1. After that the mixture was inserted into molds and molds were kept closed for 24 hours. In both the cases the product B worked as a catalyst and their job was to speed up the process. Spherical elastomer particles of TSE3466 and TSE3453 were prepared, size of both the samples were kept 3mm.

Working mechanism of damper and test setup

The damper consists of the body, cover, rotor, holder, shaft and bearings. The shaft and rotor were attached together. The rotor of the damper is rectangular cross-section as shown in the figure 1. Elastomer particles were pushed by rotor to move forward. Elastomers generated resistive forces in the motion of rotor. These resistive forces are elastic forces, frictional forces and viscous forces. These forces act between particles to particles and particles to walls of the damper. Due to influence of these resistive forces the damper generated damping torque. Test setup consisted of servo motor, torque meter, couplings, control unit and a computer.

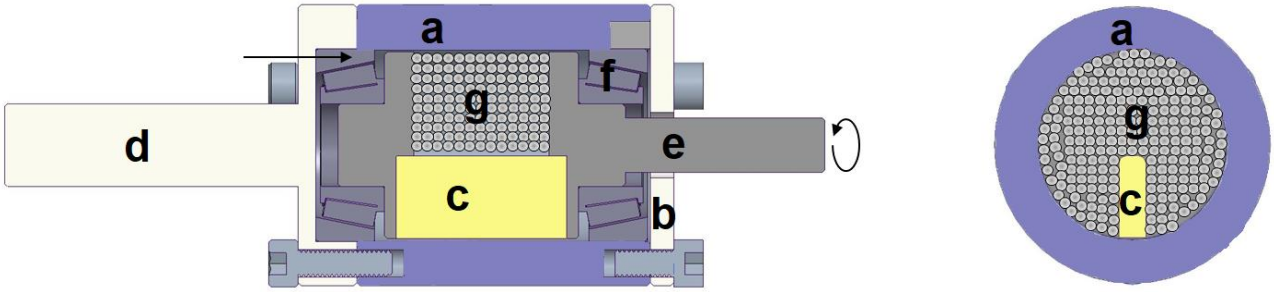

Fig. 1 Schematic diagram of rotary damper a. Body, b. Cover, c. Rotor, d. Holder, e. Shaft, f. Bearings, g. elastomer particles

Results and Discussion

Rotary elastomer particle damper showed change in damping torque when different elastomers particle were used inside the damper. Figure 2 shows the results of TSE3466 3mm and TSE3453 3mm. In both the cases the damper showed high damping torque at 60% packing fraction so both the cases were tested at 60% packing fraction. In the graph the line with symbol □ and ○ represents the TSE3453 and TSE3466 respectively. TSE3466 had maximum damping torque of 3.28 Nm at 60% packing fraction and TSE3453 had maximum damping torque of 1.8116 Nm at 60% packing fraction. The damping torque of the designed damper using TSE3466 is higher compare to the particles of TSE3453 because the tensile strength and hardness of TSE3466 is a higher than TSE3453. The tensile strength of TSE3466 is 7.4 MPa and the hardness is 60 whereas the tensile strength of TSE3453 is 6.4 MPa and the hardness is 40.

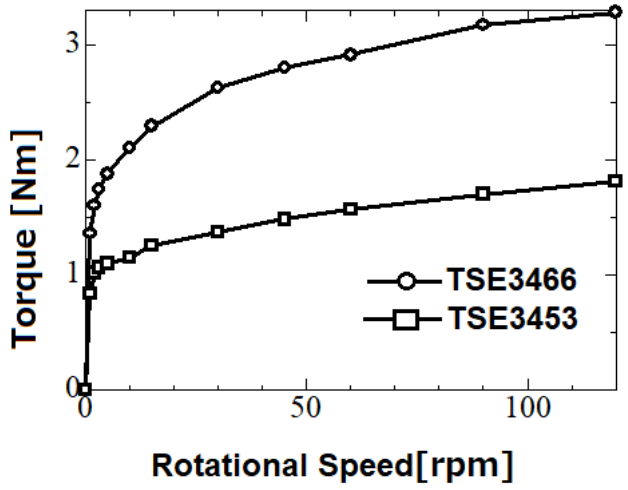

Fig.2 Torque vs. rotational speed curve using TSE3466 and TSE3453 silicon rubber elastomers

References

[1] H. V. Panossian: *Structural Damping Enhancement Via Non-Obstructive Particle Damping Technique*, ASME. J. Vib. Acoust vol.114 (1992), p.101–105

[2] W. Liu, G.R. Tomlinson and J.A. Rongong: *The dynamic characterization of disk geometry particle dampers,* J. Sound and Vibration, Vol. 280(2003), p. 849-861.

[3] A. Papalou and S.F. Masri: *Response of Impact Dampers with Granular Materials Under Random Excitatio*n, Earthquake Engineering and Structural Dynamics, Vol.25 (1996), p.253-267

[4] R.D. Friend and V.K. Kinra: *Particle Impact Damping*, J. Sound and Vibration, Vol.233 (2000), p.93-118.

[5] Kun S.Marhadi and Vikram K.Kinra: *Particle impact damping: effect of mass ratio, material, and shape*, J. Sound and Vibration, Vol.286 (2005), p.433-448

[6] Hussain Abbas, Huang Hai, Jem Rongong:, *Damping performance of metal swarfs in a horizontal hollow structure* J. Mechanical Science and Technology, Vol.28 (2014), p.9-13.