802. Modifying the brake drum geometry to avoid self-excited vibrations and noise

Pevec Miha[1], Vranešević Darko[2], Oder Grega[3], Potrč Iztok[4], Šraml Matjaž[5]
[1, 2]Cimos D. D. Automotive Industry, Slovenia
[3, 4]University of Maribor, Faculty of Mechanical Engineering, Slovenia
[5]University of Maribor, Faculty of Civil Engineering, Slovenia
E-mail: [1]*miha.pevec@cimos.eu*, [2]*darko.vranesevic@cimos.eu*, [3]*grega.oder@uni-mb.si*, [4]*iztok.potrc@uni-mb.si*, [5]*sraml.matjaz@uni-mb.si*

(Received 27 March 2012; accepted 14 May 2012)

Abstract. A squealing noise of 50 dB was measured on a vehicle homologation test at around 900 Hz on the existing brake drum design, mounted on the rear axle of the mid-sized passenger automobile. Therefore, analysis of eigenfrequencies of the original drum design was performed using the impact hammer test and numerical analysis. It was established that a critical mode shape 0/2 exists at around 900 Hz, exactly where the squeal noise was recorded at the brake road noise evaluation vehicle test. The analysis was carried out with the intention to eliminate the possibility of the squealing noise by increasing the critical mode above 900 Hz. The relation between different brake drum modifications parameters and the eigenfrequencies was determined and the best solution was obtained. The first eigenfrequency of the proposed drum design was increased by 58 Hz and the difference between the in-plane and out-of plane mode shape was sufficient. We can conclude that the modified drum design will not have squeal issues at 900 Hz as there are no eigenfrequencies of the brake drum in that range and therefore the problem of the loud brake is solved.

Keywords: brake squeal, drum brake, eigenfrequency, impact hammer test, finite element method.

Introduction

Reduction of the friction-induced noise, especially under nonstationary friction conditions, is one of the most complex problems in the transport industry. Expenditures on experimental and theoretical research studies on noise and vibration have recently constituted more than 50 % of the total budgets of the leading companies dealing with frictional materials and brake systems [1, 2]. The braking process in an automobile involves a contact of metallic solids sliding against each other, which sometimes generates undesirable noise, vibration, and harshness (NVH). Brake squeal is an annoying, usually single-tone and high-pitched noise. Brake noise below 1 kHz often depends strongly on the modal characteristics of suspension systems [3]. Brake squeal is a phenomenon of dynamic instability that occurs at one or more of the eigenfrequencies of the brake system. The excitation that is the cause of dynamic instability comes from the friction couple. The brake drum is acting like a resonator, as sound waves radiates from its surfaces. There are several of investigations, analyses and validation tools available such as vehicle test, dynamometer test, modal test – impact hammer test and finite element analyses. Once a problem is detected, common solutions to reduce the noise are decrease of the excitation (brake shoe chamfer design), increase of damping (insulator, grease) or shifting of component eigenfrequencies.

Problem background

At the simplest level, the vibration characteristics of brake drums and discs are interpreted as bending vibrations of an idealized disc or plate. Although somewhat distinct from the real brake