Volume 38, Number 3, 2012.

Mobility & Vehicle Mechanics

International Journal for Vehicle Mechanics, Engines and Transportation Systems

ISSN 1450 - 5304

UDC 621 + 629(05)=802.0

Dušan Gruden	POWER UNITS FOR FUTURE - QUO VADIS?	7-26
Ljiljana Veljović Dragan Milosavljević Gordana Bogdanović Aleksandar Radaković Mirjana Lazić	NONLINEAR DYNAMICS OF HEAVY GYRO ROTORS	25-42
Aleksandar Đurić Snežana Jovanović	CEPSTRUM ANALYSIS OF VIBRATION IN TRANSMISSION SYSTEM OF THE VEHICLE	43-60
Jasna Glišović Miroslav Demić Jovanka Lukić Danijela Miloradović	DYNAMOMETER FOR TESTING HIGH-FREQUENCY NOISE OF DISC BRAKES	61-82

UNIVERSITY OF KRAGUJEVAC, FACULTY OF ENGINEERING

SERBIAN SOCIETY OF AUTOMOTIVE ENGINEERS

M V M **M**obility **V**ehicle **M**echanics

*Editors: Prof. dr **Jovanka Lukić**; Prof. dr **Čedomir Duboka***

MVM *Editorial Board*
University of Kragujevac
Faculty of Engineering
Sestre Janjić 6, 34000 Kragujevac, Serbia
Tel.: +381/34/335990; Fax: + 381/34/333192

For Publisher: Prof. dr Miroslav Babić, dean, University of Kragujevac, Faculty of Engineering

Publishing of this Journal is financially supported from:
Ministry of Education, Science and Technological Development, Republic Serbia

MVM – International Journal for Vehicle Mechanics, Engines and Transportation Systems

NOTIFICATION TO AUTHORS

The Journal MVM publishes original papers which have not been previously published in other journals. This is responsibility of the author. The authors agree that the copyright for their article is transferred to the publisher when the article is accepted for publication.

The language of the Journal is English.

Journal ***Mobility & Vehicles Mechanics*** is at the SSCI list.

All submitted manuscripts will be reviewed. Entire correspondence will be performed with the first-named author.

Authors will be notified of acceptance of their manuscripts, if their manuscripts are adopted.

INSTRUCTIONS TO AUTHORS AS REGARDS THE TECHNICAL ARRANGEMENTS OF MANUSCRIPTS:

Abstract is a separate Word document, "*First author family name_ABSTRACT.doc*". Native authors should write the abstract in both languages (Serbian and English). The abstracts of foreign authors will be translated in Serbian.

This document should include the following: 1) author's name, affiliation and title, the first named author's address and e-mail – for correspondence, 2) working title of the paper, 3) abstract containing no more then 100 words, 4) abstract containing no more than 5 key words.

The manuscript is the separate file, „*First author family name_Paper.doc*" which includes appendices and figures involved within the text. At the end of the paper, a reference list and eventual acknowledgements should be given. References to published literature should be quoted in the text brackets and grouped together at the end of the paper in numerical order.

Paper size: Max 16 pages of B5 format, excluding abstract
Text processor: Microsoft Word
Margins: left/right: mirror margin, inside: 2.5 cm, outside: 2 cm, top: 2.5 cm, bottom: 2 cm
Font: Times New Roman, 10 pt
Paper title: Uppercase, bold, 11 pt
Chapter title: Uppercase, bold, 10 pt
Subchapter title: Lowercase, bold, 10 pt
Table and chart width: max 125 mm
Figure and table title: Figure _ (Table _): Times New Roman, italic 10 pt

Manuscript submission: application should be sent to the following e-mail:

mvm@kg.ac.rs ; lukicj@kg.ac.rs
or posted to address of the Journal:
University of Kragujevac – Faculty of Engineering
International Journal M V M
Sestre Janjić 6, 34000 Kragujevac, Serbia

The Journal editorial board will send to the first-named author a copy of the Journal offprint.

MVM – International Journal for Vehicle Mechanics, Engines and Transportation Systems

OBAVEŠTENJE AUTORIMA

Časopis MVM objavljuje orginalne radove koji nisu prethodno objavljivani u drugim časopisima, što je odgovornost autora. Za rad koji je prihvaćen za štampu, prava umnožavanja pripadaju izdavaču.

Časopis se izdaje na engleskom jeziku.

Časopis ***Mobility & Vehicles Mechanics*** se nalazi na SSCI listi.

Svi prispeli radovi se recenziraju. Sva komunikacija se obavlja sa prvim autorom.

UPUTSTVO AUTORIMA ZA TEHNIČKU PRIPREMU RADOVA

Rezime je poseban Word dokument, "*First author family name_ABSTRACT.doc*". Za domaće autore je dvojezičan (srpski i engleski). Inostranim autorima rezime se prevodi na srpski jezik. Ovaj dokument treba da sadrži: 1) ime autora, zanimanje i zvanje, adresu prvog autora preko koje se obavlja sva potrebna korespondencija; 2) naslov rada; 3) kratak sažetak, do 100 reči, 4) do 5 ključnih reči.

Rad je poseban fajl, „*First author family name_Paper.doc*" koji sadrži priloge i slike uključene u tekst. Na kraju rada nalazi se spisak literature i eventualno zahvalnost. Numeraciju korišćenih referenci treba navesti u srednjim zagradama i grupisati ih na kraju rada po rastućem redosledu.

Dužina rada: Najviše 16 stranica B5 formata, ne uključujući rezime
Tekst procesor: Microsoft Word
Margine: levo/desno: mirror margine; unurašnja: 2.5 cm; spoljna: 2 cm, gore: 2.5 cm, dole: 2 cm
Font: Times New Roman, 10 pt
Naslov rada: Velika slova, bold, 11 pt
Naslov poglavlja: Velika slova, bold, 10 pt
Naslov potpoglavlja: Mala slova, bold, 10 pt
Širina tabela,dijagrama: max 125 mm
Nazivi slika, tabela: Figure __ (Table _): Times New Roman, italic 10 pt

Dostavljanje rada elektronski na E-mail: **mvm@kg.ac.rs ; lukicj@kg.ac.rs**

ili poštom na adresu Časopisa
Redakcija časopisa M V M
Fakultet inženjerskih nauka
Sestre Janjić 6, 34000 Kragujevac, Srbija

Po objavljivanju rada, Redakcija časopisa šalje prvom autoru jedan primerak časopisa.

Mobility & **V**ehicle **M**echanics

Motorna **V**ozila i **M**otori

Volume 38
Number 3
2012.

Dušan Gruden	POWER UNITS FOR FUTURE - QUO VADIS?	7-26
Ljiljana Veljović Dragan Milosavljević Gordana Bogdanović Aleksandar Radaković Mirjana Lazić	NONLINEAR DYNAMICS OF HEAVY GYRO ROTORS	27-40
Aleksandar Đurić Snežana Jovanović	CEPSTRUM ANALYSIS OF VIBRATION IN TRANSMISSION SYSTEM OF THE VEHICLE	41-57
Jasna Glišović Miroslav Demić Jovanka Lukić Danijela Miloradović	DYNAMOMETER FOR TESTING HIGH-FREQUENCY NOISE OF DISC BRAKES	59-76

Mobility & **V**ehicle **M**echanics

Motorna **V**ozila i **M**otori

Volume 38
Number 3
2012.

Dušan Gruden	POGONSKE JEDINICE ZA BUDUĆNOST - QUO VADIS?	7-26
Ljiljana Veljović Dragan Milosavljević Gordana Bogdanović Aleksandar Radaković Mirjana Lazić	NELINEARNA DINAMIKA TEŠKIH GIRO ROTORA	27-40
Aleksandar Đurić Snežana Jovanović	CEPSTRUM ANALIZA VIBRACIJA SISTEMA ZA PRENOS SNAGE VOZILA	41-57
Jasna Glišović Miroslav Demić Jovanka Lukić Danijela Miloradović	DINAMOMETAR ZA ISPITIVANJE VISOKOFREKVENTNE BUKE DISK KOČNICA	59-76

[1]DYNAMOMETER FOR TESTING HIGH-FREQUENCY NOISE OF DISC BRAKES

Jasna Glišović, Miroslav Demić, Jovanka Lukić, Danijela Miloradović

UDC:629.1.07

Abstract

Brake squeal phenomenon has been studied for nearly 70 years now. During this period, majority of tests were based on subjective assessments and measurements with a moving vehicle on the road. Over the years, many laboratory tests have been developed with a wide range of options and approaches. The modern brake noise dynamometer has become a sophisticated test platform for the identifying the propensity of a brake to generate squeal and diagnosing squeal noise problems. Re-creating brake squeal is not an easy task. In many cases, brake noise occurs only during a portion of the process of deceleration or during braking with maintaining a constant speed - drag. Brake components often have to work in exactly the right conditions. These conditions may include speed, temperature, humidity, pressure and brake wear.

Key words: disc, brake, noise, laboratory, testing

DINAMOMETAR ZA ISPITIVANJE VISOKOFREKVENTNE BUKE DISK KOČNICA

UDC: 629.1.07

Rezime

Fenomen škripe kočnica se istražuje skoro 70 godina unazad. Tokom ovog perioda, većina ispitivanja bila su zasnovana na subjektivnim procenama i merenjima sa vozilom u pokretu na putu. Tokom godina, razvijena su mnoga laboratorijska ispitivanja sa širokim spektrom opcija i pristupa. Moderni dinamometri za ispitivanje buke kočnica su postali sofisticirane test platforme za identifikaciju sklonosti kočnica da generiše škripu i pri dijagnostikovanju problema buke. Ponovo stvaranje škripe kočnica nije lak zadatak. U mnogim slučajevima, buka kočnica javlja se samo tokom jednog dela procesa usporavanja ili tokom kočenja sa održavanjem konstantne brzine. Kočione komponente često moraju da rade u tačno određenim uslovima. Ovi uslovi mogu da uključuju brzinu, temperaturu, vlažnost, pritisak i habanje kočnica.

Ključne reči: disk, kočnica, buka, laboratorija, ispitivanje

[1] *Received: July 2012, Accepted: August 2012.*

Intentionally blank

DYNAMOMETER FOR TESTING HIGH-FREQUENCY NOISE OF DISC BRAKES

Jasna Glišović[1], Miroslav Demić, Jovanka Lukić, Danijela Miloradović

UDC:629.1.07

1. INTRODUCTION

Even if every noise during a vehicle test is recorded with a data acquisition device, the majority of the release procedures of a new brake system - at least in Europe - are based solely on the subjective noise ratings of the drivers during a vehicle test. The best known tests for researching the brake noise in road conditions are the Los Angeles City Traffic test (LACT) in urban conditions in the United States and Mojacar test in Europe. The length of Los Angeles City Traffic test is normally 5000 miles or 8000 km. An average of 250 miles or 400 km is driven per day. Some tests might run for more or less days than the normal 20 day length. On average, the number of braking per mile is 4 to 5. This is a slightly higher brake application rate than normal city traffic. As a result of years of experience, this test was unanimously accepted between automotive manufacturers and their suppliers in the United States. These vehicle tests can fully assess the actual brake noise performance and are very representative in terms of the end customer perception. However, all of these vehicle tests are expensive, time consuming, and usually occur too late to affect any structural changes if noise is detected on a test vehicle brakes. That's why the leading manufacturers have developed laboratory dynamometer tests that can shorten the brake noise development cycle and provide accurate and objective statistical data to evaluate brake noise performance. Results from the laboratory can be used to quickly affect the structural changes to optimize the brake noise performance.

Besides dynamometer tests, non-contact measurement techniques-laser metrology can be performed in laboratory conditions too. Holographic interferometry, Electronic Speckle Pattern Interferometry (ESPI) and laser Doppler velocity measurement are methodologies that are used to identify the cause of the brake noise and for evaluation of engineering solutions [1].

1.1 *Holographic interferometry*

Holographic interferometry is a proven technique for the measurement and analysis of the absolute displacement, both out-of-plane and in-plane, of a disc brake generating noise. The standard holographic interferometry technique has been developed such that both separate dynamic images of the in-plane and out-of-plane vibration, together with the combined dynamic image indicating absolute displacement can be represented. The technique makes use of a series of time-related holograms recorded from three different viewing perspectives of the brake. Each image records absolute displacement, but as each of the three holograms view the brake from a different viewpoint then each comprises varying degrees of out-of-

[1] Jasna Glišović, jaca@kg.ac.rs, University of Kragujevac, Faculty of Engineering, 6 Sestre Janjić Street, 34000 Kragujevac, Serbia