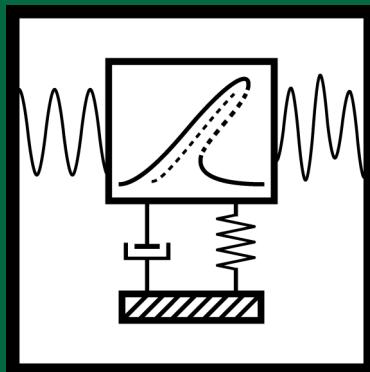


June 2019, Volume 25  
ISSN Print 2345-0533  
ISSN Online 2538-8479

# Vibroengineering PROCEDIA



**Editor in Chief**

M. Ragulskis

Kaunas University of Technology, (Lithuania)

minvydas.ragulskis@ktu.lt

**Editorial Board**

|                       |                                                                 |                                 |
|-----------------------|-----------------------------------------------------------------|---------------------------------|
| H. Adeli              | The Ohio State University, (USA)                                | adeli.1@osu.edu                 |
| V. Babitsky           | Loughborough University, (UK)                                   | v.i.babitsky@lboro.ac.uk        |
| R. Bansevičius        | Kaunas University of Technology, (Lithuania)                    | ramutis.bansevicius@ktu.lt      |
| M. Bayat              | Roudehen Branch, Islamic Azad University, (Iran)                | mbayat14@yahoo.com              |
| I. Blekhman           | Mekhanobr – Tekhnika Corporation, (Russia)                      | iliya.i.blekhman@gmail.com      |
| K. Bousson            | University of Beira Interior, (Portugal)                        | bousson@ubi.pt                  |
| A. Bubulis            | Kaunas University of Technology, (Lithuania)                    | algimantas.bubulis@ktu.lt       |
| R. Burdzik            | Silesian University of Technology, (Poland)                     | rafał.burdzik@polsl.pl          |
| M. S. Cao             | Hohai University, (China)                                       | cmszhy@hhu.edu.cn               |
| Lu Chen               | Beihang University, (China)                                     | luchen@buaa.edu.cn              |
| F. Chernousko         | Institute for Problems in Mechanics, (Russia)                   | chern@ipmnet.ru                 |
| Z. Dabrowski          | Warsaw University of Technology, (Poland)                       | zdabrow@simr.pw.edu.pl          |
| Y. Davydov            | Institute of Machine Building Mechanics, (Russia)               | 1institut@bk.ru                 |
| J. Duhovnik           | University of Ljubljana, (Slovenia)                             | joze.duhovnik@lecad.uni-lj.si   |
| S. Ersoy              | Marmara University, (Turkey)                                    | sersoy@marmara.edu.tr           |
| A. Fedaravičius       | Kaunas University of Technology, (Lithuania)                    | algimantas.fedaravicius@ktu.lt  |
| R. Ganiev             | Blagonravov Mechanical Engineering Research Institute, (Russia) | rganiev@nwmtc.ac.ru             |
| W. H. Hsieh           | National Formosa University, (Taiwan)                           | allen@nfu.edu.tw                |
| V. Kaminskas          | Vytautas Magnus University, (Lithuania)                         | v.kaminskas@if.vdu.lt           |
| V. Kappatos           | University of Southern Denmark, (Denmark)                       | vk@iti.sdu.dk                   |
| V. Klyuev             | Association Spektr – Group, (Russia)                            | v.klyuev@spektr.ru              |
| G. Kulvietis          | Vilnius Gediminas Technical University, (Lithuania)             | genadijus.kulvietis@vgtu.lt     |
| V. Lyalin             | Izhevsk State Technical University, (Russia)                    | velyalin@mail.ru                |
| R. Martonka           | Technical University of Liberec, (Czech Republic)               | rudolf.martonka@tul.cz          |
| R. Maskeliūnas        | Vilnius Gediminas Technical University, (Lithuania)             | rimas.maskeliunas@vgtu.lt       |
| L. E. Muñoz           | Universidad de los Andes, (Colombia)                            | lui-muno@uniandes.edu.co        |
| N. Nistico            | University of Roma La Sapienza, (Italy)                         | nicola.nistico@uniroma1.it      |
| V. Ostaševičius       | Kaunas University of Technology, (Lithuania)                    | vytautas.ostasevicius@ktu.lt    |
| A. Palevičius         | Kaunas University of Technology, (Lithuania)                    | arvydas.palevicius@ktu.lt       |
| G. Panovko            | Blagonravov Mechanical Engineering Research Institute, (Russia) | gpanovko@yandex.ru              |
| L. Qiu                | Nanjing University of Aeronautics and Astronautics, (China)     | lei.qiu@nuaa.edu.cn             |
| K. Ragulskis          | Lithuanian Academy of Sciences, (Lithuania)                     | k.ragulskis@jve.lt              |
| S. Rakheja            | Concordia University, (Canada)                                  | subhash.rakheja@concordia.ca    |
| V. Ranjan             | Bennett University, (India)                                     | vinayak.ranjan@bennett.edu.in   |
| G. E. Sandoval-Romero | The National Autonomous University of Mexico, (Mexico)          | eduardo.sandoval@ccadet.unam.mx |
| M. A. F. Sanjuan      | University Rey Juan Carlos, (Spain)                             | miguel.sanjuan@urjc.es          |
| E. Shahmatov          | Samara State Aerospace University, (Russia)                     | shakhm@ssau.ru                  |
| A. El Sinawi          | The Petroleum Institute, (United Arab Emirates)                 | aelsinawi@pi.ac.ae              |
| G. Song               | University of Houston, (USA)                                    | gsong@uh.edu                    |
| S. Toyama             | Tokyo A&T University, (Japan)                                   | toyama@cc.tuat.ac.jp            |
| K. Uchino             | The Pennsylvania State University, (USA)                        | kenjiuchino@psu.edu             |
| A. Vakhguel't         | Nazarbayev University, (Kazakhstan)                             | anatoli.vakhguel't@nu.edu.kz    |
| A. Valiulis           | Vilnius Gediminas Technical University, (Lithuania)             | algirdas.valiulis@vgtu.lt       |
| P. Vasiljev           | Lithuanian University of Educational Sciences, (Lithuania)      | piotr.vasiljev@leu.lt           |
| V. Veikutis           | Lithuanian University of Health Sciences, (Lithuania)           | vincentas.veikutis@lsmuni.lt    |
| J. Viba               | Riga Technical University, (Latvia)                             | janis.viba@rtu.lv               |
| J. Wallaschek         | Leibniz University Hannover, (Germany)                          | wallaschek@ids.uni-hannover.de  |
| Xiao-Jun Yang         | China University of Mining and Technology, (China)              | dyangxiaojun@163.com            |

# **VP Vibroengineering PROCEDIA**

Vibroengineering PROCEDIA Volume 25 contains papers presented at the 39th International Conference on VIBROENGINEERING held in St. Petersburg, Russia, June 25-26, 2019. The main theme of the Conference is “Nonlinear Dynamics and Chaos in Engineering Applications”.

## **Aims and Scope**

Journal publishes original papers presenting the state of the art in vibroengineering of dynamical systems.  
The list of principal topics:

- Measurements in engineering
- Mathematical models in engineering
- Acoustics, noise control and engineering applications
- Mechanical vibrations and applications
- Fault diagnosis based on vibration signal analysis
- Vibration generation and control
- Seismic engineering and applications
- Modal analysis and applications
- Vibration in transportation engineering
- Flow induced structural vibrations
- Oscillations in biomedical engineering
- Chaos, non-linear dynamics and applications
- Oscillations in electrical engineering
- Fractional dynamics and applications
- System dynamics in manufacturing system modeling
- Dynamics of smart and functionally graded materials

**All published papers are peer reviewed and crosschecked by plagiarism detection tools.**

More information is available online <https://www.jvejournals.com>

## **Vibroengineering PROCEDIA is referred in:**

**SCOPUS:** ELSEVIER Bibliographic Database.

**COMPENDEX:** ELSEVIER Bibliographic Database.

**EBSCO:** Academic Search Complete;

Computers & Applied Sciences Complete;

Central & Eastern European Academic Source;

Current Abstracts;

TOC Premier.

**GALE Cengage Learning:**

Academic OneFile Custom Periodical;

Science in Context.

**INSPEC:** OCLC. The Database for Physics, Electronics and Computing.

**GOOGLE SCHOLAR:** <https://scholar.google.com>

**CNKI SCHOLAR:** <http://eng.scholar.cnki.net>

**CROSSREF:** <https://www.crossref.org>

**Internet:** <https://www.jveconferences.com>; <https://www.jvejournals.com>

**E-mail:** [info@jveconferences.com](mailto:info@jveconferences.com); [publish@jvejournals.com](mailto:publish@jvejournals.com)

**Address:** Geliu ratas 15A, LT-50282, Kaunas, Lithuania

**Publisher:** JVE International Ltd.

# VP Vibroengineering PROCEDIA

---

JUNE 2019, VOLUME 25, PAGES (1-226), ISSN PRINT 2345-0533, ISSN ONLINE 2538-8479

## Contents

### MECHANICAL VIBRATIONS AND APPLICATIONS

|                                                                                                                            |           |
|----------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>MOTION MODES OF THE NONLINEAR MECHANICAL SYSTEM OF THE ROTOR AUTOBALANCER</b>                                           | <b>1</b>  |
| ALEXANDER GORBENKO, GUNTIS STRAUTMANIS, GENNADIY FILIMONIKHIN,<br>MAREKS MEZITIS                                           |           |
| <b>LOAD ANALYSIS OF PITCH BEARING CONSIDERING NON-QUENCHING ZONE</b>                                                       | <b>7</b>  |
| J. X. GUI, G. B. WANG, Z. ZHOU                                                                                             |           |
| <b>ON VIBROTRANSPORTATION OF A MATERIAL ON A SURFACE PERFORMING ROTARY OSCILLATIONS</b>                                    | <b>13</b> |
| I. I. BLEKHMAN, V. B. VASILKOV, YU A. SEMENOV                                                                              |           |
| <b>THE RESULTS OF CALCULATED AND EXPERIMENTAL DETERMINATION OF THE FREQUENCY RESPONSE OF A MECHANICAL SYSTEM WITH GAPS</b> | <b>20</b> |
| MIKHAIL LEONTIEV, DMITRY NASONOV, VLADIMIR RAEVSKY,<br>ANZHELika VOLKHONSKAYA                                              |           |
| <b>VIBRATION RECYCLING TECHNOLOGIES FOR MINING AND MINERAL PROCESSING WASTE FOR CONSTRUCTION PURPOSES</b>                  | <b>26</b> |
| ALEXANDR SAMUKOV, MARGARITA CHERKASOVA                                                                                     |           |
| <b>VIBRATION EFFECTS ON COLLOIDAL GAS-LIQUID SYSTEMS</b>                                                                   | <b>32</b> |
| ANDREI GERASIMOV, VICTORIA LAZAREVA                                                                                        |           |
| <b>VIBRATION EFFECTS IN CONDITIONING OF METAL POWDERS</b>                                                                  | <b>36</b> |
| ANTON MEZENIN, SERGEY DMITRIEV, MARGARITA CHERKASOVA                                                                       |           |
| <b>MATHEMATICAL MODEL OF THE VIBRATION CONE CRUSHER WITH THREE DEGREES OF FREEDOM</b>                                      | <b>42</b> |
| PETR MOROZOV, SERGE MIHEEV                                                                                                 |           |
| <b>VIBRATION ANALYSIS OF PERFORATED PLATE IN NON-STATIONARY MOTION</b>                                                     | <b>48</b> |
| IGORS TIPANS, JANIS VIBA, SHRAVAN KOUNDINYA VUTUKURU, MARTINS IRBE                                                         |           |

CONTENTS

|                                                                                                                                                                                                           |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>THE DYNAMIC-SELSIMILAR LATTICE AS THE VIBROISOLATION SYSTEMS<br/>LUDMILA BANAKH</b>                                                                                                                    | <b>54</b>  |
| <b>MECHANICS OF ROBOT INSPECTOR ON ELECTRICAL TRANSMISSION LINES<br/>CONDUCTORS: PERFORMANCE ANALYSIS OF DYNAMIC VIBRATION ABSORBER<br/>MOHAMMAD REZA BAHRAMI, SALAM AHMED ABED</b>                       | <b>60</b>  |
| <b>VIBRATIONAL DYNAMIC SYSTEM FOR THE REDUCTION OF SOLID MATERIALS<br/>SERGEY KAZAKOV, EVGENIY SHISHKIN</b>                                                                                               | <b>65</b>  |
| <b>DETERMINATION OF MASS-GEOMETRIC CHARACTERISTICS OF SELF-REGULATING<br/>DEBALANCE OF AN INERTIAL VIBRATION EXCITER<br/>KONSTANTIN KRESTNIKOVSKII, ILYA LYAN, GRIGORIY PANOVKO,<br/>ALEXANDR SHOKHIN</b> | <b>70</b>  |
| <b>VIBRATION TECHNOLOGY RESEARCH ACHIEVEMENTS OF THE MEKHANOBR<br/>SCIENTIFIC SCHOOL AND THEIR PRACTICAL IMPLEMENTATION<br/>LEONID VAISBERG</b>                                                           | <b>76</b>  |
| <b>ON OSCILLATIONS OF A VIBRATORY JAW CRUSHER WITH ASYMMETRIC INTERACTION<br/>OF THE JAWS WITH THE PROCESSED MEDIUM<br/>GRIGORY PANOVKO, ALEXANDER SHOKHIN, ILYA LYAN</b>                                 | <b>83</b>  |
| <br><b>FAULT DIAGNOSIS BASED ON VIBRATION SIGNAL ANALYSIS</b>                                                                                                                                             |            |
| <b>VIBRATION DIAGNOSTICS OF EQUIPMENT UNITS WITH GAS TURBINE ENGINES<br/>NATALIA BARKOVA, ALEKSEY BARKOV, DMITRIY GRISHCHENKO</b>                                                                         | <b>89</b>  |
| <b>RESEARCH ON BEARING CURRENT DAMAGE DESCRIPTION MODEL OF VARIABLE<br/>FREQUENCY MOTOR<br/>HUANGE CHENG, GUANGBIN WANG, JIANHUA WANG, HAIJIANG LI</b>                                                    | <b>95</b>  |
| <br><b>MODAL ANALYSIS AND APPLICATIONS</b>                                                                                                                                                                |            |
| <b>THE SYMMETRICAL CELL EIGENFREQUENCY METHOD FOR PERIODIC STRUCTURE<br/>STOP-BAND DEFINITION<br/>ALEXANDER HVATOV</b>                                                                                    | <b>100</b> |
| <br><b>VIBRATION IN TRANSPORTATION ENGINEERING</b>                                                                                                                                                        |            |
| <b>FE MODELING OF MOVING LOAD EFFECT ON TWO SPAN BRIDGE<br/>VERONIKA VALAŠKOVÁ, DANIELA KUCHÁROVÁ</b>                                                                                                     | <b>106</b> |
| <br><b>FLOW INDUCED STRUCTURAL VIBRATIONS</b>                                                                                                                                                             |            |
| <b>MODELING OF WAVE PROCESSES WHEN THE HETEROGENEOUS FLOW IS MOVING IN A<br/>LOW-FREQUENCY MAGNETIC PERISTALTIC PUMP OF PULSATING TYPE<br/>MARIA VASILEYVA</b>                                            | <b>111</b> |
| <b>OPTIMIZATION OF SUB-GRID SCALE MODEL FOR ABRASIVE FLOW MACHINING<br/>CURVED TUBE BASED ON LARGE EDDY SIMULATION<br/>GUOSONG LIU, ZHIBAO ZHU, JUNYE LI, NINGNING SU, XINMING ZHANG,<br/>WENDUAN YAN</b> | <b>116</b> |

|                                                                                                                                                                   |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| BIOMECHANICS AND BIOMEDICAL ENGINEERING                                                                                                                           |            |
| <b>THE USE OF AN EXTENDED SET OF KEY TEXTURE FEATURES HARALICK IN THE DIAGNOSIS OF PLANT DISEASES ON LEAF IMAGES</b>                                              | <b>122</b> |
| V. S. TUTYGIN, X. M. A. AL-VINDI BASIM, D. O. LELIUHIN                                                                                                            |            |
| <br>                                                                                                                                                              |            |
| CHAOS, NONLINEAR DYNAMICS AND APPLICATIONS                                                                                                                        |            |
| <b>ON A METHOD OF APPLIED SYMBOLIC DYNAMICS FOR INVESTIGATION OF DYNAMICAL SYSTEMS</b>                                                                            | <b>128</b> |
| NATALIA AMPILOVA, IGOR SOLOVIEV                                                                                                                                   |            |
| <br>                                                                                                                                                              |            |
| ACOUSTICS, NOISE CONTROL AND ENGINEERING APPLICATIONS                                                                                                             |            |
| <b>DEVELOPMENT OF DESIGN SOLUTIONS OF EXHAUST SYSTEM FOR GASDYNAMIC NOISE REDUCTION</b>                                                                           | <b>135</b> |
| R. I. RAKHMATOV, V. E. KRUTOLAPOV, V. N. ZUZOV                                                                                                                    |            |
| <br>                                                                                                                                                              |            |
| MATERIALS AND MEASUREMENTS IN ENGINEERING                                                                                                                         |            |
| <b>DYNAMIC TESTING OF THE SUB-BASE LAYER MADE FROM FOAM CONCRETE USING LIGHT WEIGHT DEFLECTOMETER</b>                                                             | <b>139</b> |
| VERONIKA VALASKOVA, JOZEF VLCEK, FILIP GAGO, MARIAN DRUSA                                                                                                         |            |
| <br>                                                                                                                                                              |            |
| MATHEMATICAL MODELS IN ENGINEERING                                                                                                                                |            |
| <b>DYNAMIC OPTIMIZATION MATHEMATICAL MODEL OF THE MILITARY SUBORDINATING INTERACTION OF TWO STATES</b>                                                            | <b>143</b> |
| VALERIY K. ZAKHAROV                                                                                                                                               |            |
| <b>DEVELOPMENT OF OFFERS ON APPLICATION OF ADDITIONAL JET IMPACT ON THE FIXED PITCH PROPELLER FOR THE PURPOSE OF RATIONAL USE OF THE POWER OF THE MAIN ENGINE</b> | <b>151</b> |
| DMITRII OSOVSKII, ALEKSEY SHARATOV                                                                                                                                |            |
| <b>THE CALCULATION OF SKEWS IN PLANETARY TRANSMISSIONS AND THEIR INFLUENCE ON THE SYSTEM DYNAMICS</b>                                                             | <b>157</b> |
| DMITRY NASONOV, MIKHAIL LEONTIEV, VLADIMIR RAEVSKY                                                                                                                |            |
| <b>THE CALCULATION AUTOMATION OF A GRAPPLE OF A GRAB CRANE</b>                                                                                                    | <b>161</b> |
| VLADIMIR RAEVSKY, MIKHAIL LEONTIEV, DMITRY NASONOV                                                                                                                |            |
| <b>MATHEMATICAL ANALYSIS OF TRANSPORT SYSTEMS MODELED BY THE STATIONARY KOLMOGOROV-FELLER EQUATION WITH A NONLINEAR DRIFT COEFFICIENT</b>                         | <b>166</b> |
| ANDREI FIRSOV, ANTON ZHILENKOV                                                                                                                                    |            |
| <b>DEVELOPMENT OF COMPLEX MATHEMATICAL MODEL OF HYDRAULIC DRIVE, SENSITIVE TO THE LOADING VARIATIONS</b>                                                          | <b>171</b> |
| IVANOVSKAYA ALEXANDRA, POPOV VLADIMIR, BOGATYREVA ELENA, SERGEY BIDENKO                                                                                           |            |
| <b>ANALYSIS OF OSCILLATIONS IN DISCONTINUOUS LURIE SYSTEMS VIA LPRS METHOD</b>                                                                                    | <b>177</b> |
| E. D. AKIMOVA, I. M. BOIKO, N. V. KUZNETSOV, R. N. MOKAEV                                                                                                         |            |

CONTENTS

|                                                                                                                            |            |
|----------------------------------------------------------------------------------------------------------------------------|------------|
| <b>NUMERICAL SIMULATION OF THE EFFECT OF FLANGE RADIAL LENGTH ON STRAIN GROWTH OF CYLINDRICAL CONTAINMENT VESSELS</b>      | <b>182</b> |
| YUNHAO HU, WENBIN GU, JIANQING LIU, XIN LIU, YANGMING HAN,<br>JINGLIN XU, ZHENXIONG WANG                                   |            |
| <b>DYNAMIC ANALYSIS OF IMPACT ON NEEDLE VALVE ASSEMBLY</b>                                                                 | <b>188</b> |
| XINYU ZHANG, XIONG YAN, HAO WU, YANG YANG, YAN LUO, XIAOJUN ZHOU                                                           |            |
| <b>SIMULATION OF THE CONTROLLED MOVEMENT BASED ON THE COMPLEXITY PRINCIPLE FOR AN AUTOMATIC UNDERWATER VEHICLE</b>         | <b>194</b> |
| YURI SIEK, SERGEY SAKOVICH                                                                                                 |            |
| <b>STIFFNESS IDENTIFICATION OF BOUNDARY CONDITIONS BY USING THIN-LAYER ELEMENT FOR PARAMETERIZATION</b>                    | <b>201</b> |
| DONG JIANG, YU TIAN, WU YIMENG, YU XU                                                                                      |            |
| SYSTEM DYNAMICS IN MANUFACTURING SYSTEM MODELING                                                                           |            |
| <b>VIBRATION TECHNOLOGIES FOR PRODUCING METAL POWDERS</b>                                                                  | <b>208</b> |
| MARGARITA CHERKASOVA, ALEXANDR SAMUKOV, SERGEY DMITRIEV                                                                    |            |
| <b>METHOD FOR THE STUDY OF DYNAMIC CHARACTERISTICS IN THE MECHANISMS OF MOTION TRANSMISSION</b>                            | <b>214</b> |
| LUBOV MIRONOVA, LEONID KONDRAHENKO                                                                                         |            |
| <b>LOSS OF STABILITY OF OPEN TWO-LINK MECHANISMS</b>                                                                       | <b>220</b> |
| LEONID KONDRAHENKO, LUBOV MIRONOVA, VLADIMIR DMITRIEV                                                                      |            |
| <b>ERRATUM: SEISMIC ISOLATION EFFECT OF FOAMED CONCRETE LAYER ALONG THE LONGITUDINAL DIRECTION OF A MOUNTAINOUS TUNNEL</b> | <b>226</b> |



