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Contact Mechanics

1. THEORETICAL AND EXPERIMENTAL EVALUATION OF RESIDUAL STRESSES IN CASE-HARDENED AND THROUGH-HARDENED BEARING STEELS

pp. 3-7

by Gabriel POPESCU[1]

[1] *Department of Mechanical Engineering, Mechatronics and Robotics, Faculty of Mechanical Engineering, Technical University "Gheorghe Asachi" of Iasi, ROMANIA*

Abstract: A newly developed algorithm for three-dimensional elastic-plastic rolling contact analysis was extended in order to simulate cyclic behavior of case-hardened steel. The model also includes the presence of initial stress, i.e. from mechanical operations and heat treatment. In the case of through-hardened steel AISI 52100 (100Cr6), the initial level of retained austenite plays a significant role in attaining shakedown (around 50 cycles). In case-hardened steel, the relatively high number of material factors depends mainly on both carbon and retained austenite distribution along the depth (shakedown is usually reached after 3-4 cycles).

Keywords: *elastic-plastic rolling contact, case-hardened, through-hardened, retained austenite, residual stresses.*

2. THE INFLUENCE OF OPERATING TEMPERATURE IN THREE-DIMENSIONAL ELASTIC-PLASTIC ROLLING CONTACTS

pp. 8-11

by Gabriel POPESCU[1]

[1] *Department of Mechanical Engineering, Mechatronics and Robotics, Faculty of Mechanical Engineering, Technical University "Gheorghe Asachi" of Iasi, ROMANIA*

Abstract: The influence of operating temperature in three-dimensional elliptic point rolling contact was investigated in case of through-hardened bearing steel AISI 52100 (100Cr6). Material parameters were obtained from half-compressive loading cycles and verified using a Rockwell-C hardness indenter apparatus. The elastic-plastic rolling contact between a ceramic ball and a steel roller at ambient temperature and 1000C was simulated by using a numerical solver. Experimental values were recorded at 5 GPa contact pressure.

Keywords: *elastic-plastic rolling contact, operating temperature, residual profile, retained austenite.*

3. LOCAL SCUFFING IN LUBRICATED ROLLER CONTACTS

by Liviu BALAN[1], Marcelin BENCHEA[2], Ana TUFESCU[2], Dumitru OLARU[2] & Spiridon CRETU[2]

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[2]Technical University "Gheorghe Asachi"of Iasi, Department of Mechanical Engineering, Mechatronics and Robotics, **ROMANIA**

Abstract: The authors evaluated the scuffing risk in a point contact between two discs according to the roughness, rolling/sliding ratio and lubricant. The real pressure distribution in rolling/sliding contact operating in mixed lubrication conditions has been determined and the local scuffing criterion SL was calculated.

Keywords: *rolling/sliding contacts, scuffing criteria, real pressure, lubricant parameter.*

4. CONSIDERATIONS UPON HYPERELASTIC CONTACTS MODELING BY AID OF FEM

by Ionuţ Cristian ROMÂNU[1] & Ilie MUSCĂ[1]

[1] Department of Mechanical Engineering, University of Suceava, **ROMANIA**

Abstract: The paper presents aspects regarding the modeling of elastic contacts between hyperelastic materials by aid of finite elements. Also, some limitations of classical contact theories are presented. The nonlinear elastic behavior is modeled using a Mooney – Rivlin model. Advantages and disadvantages of using Nastran for contact modeling by aid of finite elements are presented.

Keywords: *finite element method, contact, hyperelastic.*

5. PRELIMINARY RESULTS ON HYPERELASTIC CONTACTS ANALYSIS USING FEM

by Ionuţ Cristian ROMÂNU[1] & Ilie MUSCĂ[1]

[1] Department of Mechanical Engineering, University of Suceava, **ROMANIA**

Abstract: The present paper illustrates a series of preliminary results regarding the elastic contacts between hyperelastic materials. Circular and line contacts between rubber bodies were investigated assuming that the contacting bodies have nonlinear elastic behavior. Bodies are considered incompressible and isotropic. Influences of temperature and adhesion forces were neglected.

Keywords: *finite element method, contact, nonlinear elastic.*

6. WAVINESS AND MATERIAL HARDENING INFLUENCE UPON TECHNICALLY DRY CIRCULAR CONTACTS IN THE ELASTO-PLASTIC DOMAIN

pp. 32-37

by Dorel PRODAN[1], Alexandru POTORAC[1] & Cornel SUCIU[1]

[1] *Department of Mechanics and Technologies, University of Suceava, ROMANIA*

Abstract: The present paper illustrates a series of numerical investigations conducted on circular contacts between wavy surfaces and compares these results to ones obtained for smooth surfaces. The influences of surface waviness as well as that of material hardening upon contact pressure distributions are discussed. The influences of material hardening and surface waviness on the plastic imprint are also investigated.

Keywords: *material hardening, circular contact, waviness, numerical simulation, contact pressure.*

7. REAL SURFACE MICROTOPOGRAPHY INFLUENCE UPON TECHNICALLY DRY CIRCULAR CONTACTS IN THE ELASTO-PLASTIC DOMAIN

pp. 38-43

by Dorel PRODAN[1], Alexandru POTORAC[1] & Cornel SUCIU[1]

[1] *Department of Mechanics and Technologies, University of Suceava, ROMANIA*

Abstract: The present paper advances series of numerical and experimental investigations conducted on circular contacts between real surfaces. The influence of surface microtopography upon contact pressure distributions and sub-superficial stresses is discussed. Numerical results obtained using a previously advanced application under FORTRAN 10 are compared to experimental investigations regarding real contact pressure assessment by aid of reflectivity.

Keywords: *circular contact, real surface, numerical simulation, experimental investigations, pressure distribution.*

8. CAN THE COLLISION BETWEEN A FREE FALLING BALL AND A ROTATING DISK BE REGARDED AS A PLANE IMPACT?

pp. 44-50

by Stelian ALACI[1], Florina Carmen CIORNEI[1], Ionuţ Românu[1], Dan Valentin Amarandei[1]

[1] *Department of Mechanics and Technologies, University of Suceava, ROMANIA*

Abstract: A plane impact with friction can be characterized, as shown in literature, by a reputable method due to Routh, based on using the impulses plane. The present paper discusses, following experimental results, the applicability of Routh method to a spatial case, approximated as a plane one, specifically to the study of collision between a free falling ball and the plane face of a disk rotating around a vertical axis.

Keywords: *friction collision, coefficient of restitution, experimental device, plane impact.*

Basic Problems of Lubrication.
Micro and Nano Tribology

by Cristian PÎRGHIE[1] & Ana-Camelia PÎRGHIE[1]

[1] *Department of Mechanics and Technologies, University of Suceava,* **ROMANIA**

Abstract: It is well known that the lubrication by thin films exists in nano-scale engineering applications, dealing in this regime with nanometric thicknesses of the lubricant film. Here, our attention is focused on the PFPE-Z lubricant behavior confined between two gold walls. At this scale, to get accurate results of the involved processes, the molecular dynamics simulations are necessary. Thus, we investigated the interaction between the thin film lubricant and the walls, using the velocity and radial distribution function of the lubricant film, and also the velocity of the lubricant atoms as a function of time, and no less important the x position of lubricant atoms as a function of time.

Keywords: *molecular dynamics, nanotribology, nanolubrication, thin films, PFPE-Z.*

by Ilie MUSCĂ[1] & Cristian PÎRGHIE[1]

[1] *Department of Mechanics and Technologies, University of Suceava,* **ROMANIA**

Abstract: In the presence of high pressure, lubricant oils properties can be affected, especially density and viscosity. After a lubricant's compressibility studies review, this paper presents some numerical and experimental results of the authors. All results confirm that in conditions of high pressure from heavy loaded EHD contacts important change in lubricant volume can occur.

Keywords: *lubricants compressibility, simple liquids theory.*

by Cristian PÎRGHIE[1] & Ilie MUSCĂ[1]

[1] *Department of Mechanics and Technologies, University of Suceava,* **ROMANIA**

Abstract: In the last decades, the thicknesses of the lubricant film involved in nanotribological systems are continuously decreasing. The main goal of this work is to investigate the compressibility of PFPE –

Zdol lubricant confined between two gold walls. A modern and very accurate method to investigate the lubricant behavior is molecular dynamics simulation. In this respect, the computer simulations are proven to be very useful. In this paper, the lubricant film is composed of PFPE-Zdol molecules, thin film which was simulated using Molecular Dynamics (MD). Using the thickness of the lubricant as a function of applied pressure and the density of the lubricant as a function of lubricant gap we investigated the compressibility of the lubricant film.

Keywords: *molecular dynamics, nanolubrication, compressibility, thin films, PFPE-Zdol.*

12. MODERN METHODS FOR THE ANALYSIS AND EVALUATION OF SURFACES MICROTOPOGRAPHY

pp. 71-73

by Alexandru POTORAC[1] & Dorel PRODAN[1]

[1] *Department of Mechanics and Technologies, University of Suceava,* **ROMANIA**

Abstract: The importance of surfaces roughness in many technical systems and especially in tribological applications determined the development of computer assisted methods, approaches and equipment, for its complex analysis. The paper presents the modern approaches concerning the characterization and investigation of surfaces microgeometry.

Keywords: surfaces, roughness, microtopography, microgeometry, investigation, characterization.

13. RHEOLOGY OF BIO-DEGRADABLE CUTTING FLUIDS

pp. 74-78

by Alexandru Valentin RADULESCU[1] & Irina RADULESCU[2]

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Abstract: The paper studies the ALKAMULS EL-719 E bio-degradable fluid based on castor oil, that can be used in drilling process to replace the commonly used mineral oil based emulsion. The rheological properties of this fluid (fresh emulsion and used) were investigated using shear viscosity rheological measurements. Supplementary tests have been made, regarding their thermal behavior.

Keywords: *rheology, bio-degradable fluid, drilling process, thermal.*

Lubrication and Traction

14. THE EFFECT OF WORKING PARAMETERS UPON EHD GREASE FILMS SUBJECTED TO LATERAL VIBRATIONS

by Yuichiro Nagata[1], Konstantinos Kalogiannis[2] & Romeo Glovnea[3]

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[2] *MAHLE Engine Systems Ltd, 2 Central Park Drive, Rugby, CV23 0GX, **UNITED KINGDOM***

[3] *Department of Engineering and Design, University of Sussex Brighton, BN1 9QT **UNITED KINGDOM***

Abstract: Rolling element bearings lubricated by grease, are prone to starvation at large speeds, as the semi-solid consistence of grease makes the replenishment of the track more difficult. There are nevertheless mechanisms, which ensure that grease-lubricated rolling element bearings do not fail due to lack of adequate lubricant supply; these include ball spin, cage effects, loading un-loading or start-stop of the contact. In this research another mechanism which helps track replenishment is presented, that is lateral vibrations. The effect of stroke length, frequency and main rolling speed are investigated. It has been found that lateral oscillations helps track replenishment even at amplitudes smaller than the radius of the Hertzian contact.

Keywords: elastohydrodynamic lubrication, stravation, lateral oscillations, film thickness, optical interferometry.

15. CONSTANT SPEED SQUEEZE PROCESS IN XPHD CONDITIONS - CYLINDER ON PLANE CONFIGURATION

by Mihaela RADU[1] & Traian CICONE[1]

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Abstract: Ex-poro-hydrodynamic (XPHD) lubrication has been recently introduced to describe the lifting effect of a fluid flow through an extremely compressible porous layer subjected to elastic deformation. Studies developed recently on various configurations - plane-to-plane (disk or rectangular), sphere-to-plane and cylinder-on-cylinder (inner contact), showed a great potential in shock absorption. The present study widens the concept to infinitely long cylinder-on-plane configuration. Based on typical approximations, the squeeze problem at constant speed is analytically solved. The accuracy of this analytical model is evaluated using numerical approaches. Two other loading cases (constant force and impact) are numerically solved.

Keywords: *XPHD lubrication, porous layer, squeeze, cylinder on plane, impact.*

16. SQUEEZE FLOW OF A POWER-LAW FLUID BETWEEN PARALLEL CIRCULAR PLATES

by Petrică TURTOI[1], Traian CICONE[2] & Mircea D. PASCOVICI[2]

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[2] University POLITEHNICA of Bucharest, **ROMANIA**

Abstract: This paper presents experimental and theoretical results for squeeze flow of a non-Newtonian fluid between parallel surfaces at constant speed. A mathematical model for circular plates squeeze (disc configuration) is proposed for a fluid with a rheological behavior described by power law. Experiments were conducted on CETR UMT 2 test rig for a shear-thinning fluid: water-soluble gel mixture used in ice packs for hot / cold therapies. Comparison between experimental data and theoretical predictions show acceptable consistency for thin film and a higher average error for extremely thin films.

Keywords: *squeeze, power-law, plates, parallel, circular.*

17. INFLUENCE OF FRICTION IN THE DYNAMIC RESPONSE OF A FOUR-BAR MECHANISM WITH CLEARANCE JOINTS

by Mihai BAICEANU[1], Cezar OPRISAN[1] & Dumitru OLARU[1]

[1] Department of Mechanical Engineering, Mechatronics and Robotics, Faculty of Mechanical Engineering, Technical University "Gheorghe Asachi" of Iasi, **ROMANIA**

Abstract: The main purpose of this paper is to present the influence of the dry friction in one mechanical system with clearance revolute joints. The present work shows that including the friction phenomenon on the dynamic analysis of one mechanical system, the peaks of the accelerations and normal force contact are reduced, in comparison with the results of a mechanical system in which the friction is not included. Numerical results are presented for a four-bar mechanism with one clearance joint between coupler and follower.

Keywords: *clearance joints, four-bar mechanism, friction, dynamic response, revolute joint.*

18. EXPERIMENTAL STUDIES ON USE OF POROUS PERMEABLE LAYERS AS MECHANICAL SHOCK ADSORBERS

by Christian RUSSU[1]

[1] Department of Machine Parts and Tribology, Politehnica University of Bucharest, **ROMANIA**

Abstract: Adsorption of shock energy as possible application of lubrication in the presence of deformable porous permeable layers was object of both theoretical and experimental studies in the last decade. This paper presents a method and the results for experimental research over shock energy absorption of a free falling rigid sphere on a plastic substrate covered with a porous layer imbibed in lubricant and acting as damper.

Keywords: *tribology, shock adsorbtion, poro-hydrodinamic lubrication, porous permeable layers.*

Biotribology

by Ciprian STAMATE[1] & Dumitru OLARU[1]

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Abstract*: The testing method used in the researches, based on microtribometer CETR UMT-2, and testing the following aspects: • the study of friction force and coefficient of friction between a steel ball and human skin dry or hydrated; • study the friction behavior the various creams applied to human skin; • study the friction behavior of various substances (oil, soap) adherent to the skin surface.*

Keywords: *biotribology, friction forces, friction coefficient, CETR microtribometer.*

Contact Wear and Fatigue

by Dănuţa GRAD[1], Andrei TUDOR[1] & Valeriu DRAGAN[1]

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Abstract*:* The goal of this paper is to explore the possibility of erosion rate quantification in flows with adverse pressure gradient. Such estimations are important since the angle of impact model cannot be applied because it would lead to physically impossible results. Hence a method was derived which uses the skin friction coefficient as an input for the erosion calculations. We show that this parameter is suitable even for the case of adverse pressure gradients and provide a computational fluid dynamics example. Further experimental studies will determine the level of accuracy of the combined CFD – analytical model and also any correction coefficients that may be required.

Keywords: *erosive wear, solid – gas flow, aerospace applications, analytical wear model, Coandã effect, adverse pressure gradients.*

by Liviu PALAGHIAN[1], Svetlana BAICEAN[1], Mihaela BUCIUMEANU[1] & Zinaida DONI[1]

[1] Faculty of Mechanical Engineering, "Dunarea de Jos" University of Galati, ROMANIA

Abstract*:* The results presented in this work show the electrochemical response of a naval steel (grade EN36) under corrosion fatigue conditions (3% solution NaCl). The corrosion fatigue tests were carried out using two different specimens: with homogeneous and welded structures. Tafel analysis is performed in order to obtain the variation with time of some kinetic parameters, such as: corrosion potential, polarization resistance, current density, corrosion rate and Tafel slopes. It is found: the oscillatory evolution of these parameters with time (due to the breaking and recovering processes of oxide films); the evolution of the reactivity and stability with time of welded and seamless state; and also, the tendency of pitting degradation of the superficial layer.

Keywords: *electrochemical parameters, Tafel analysis, fatigue and corrosion.*

Plenary Session

By Benyebka BOU-SAID[1], Ahcene MOUASSA[2] & Mustapha LAHMAR[2]

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[2]*Laboratory of Mechanics & Structures (LMS), Guelma University, **ALGERIA***

Abstract*:   The combined effects of surface roughness and lubricant rheology on the performance characteristics of a hydrodynamic inclined slider bearing are investigated by means of the homogenized method. The pad surface is rough and stationary while the lower surface is assumed to be smooth and moving. The V. K. Stokes couple stress fluid model is adopted to describe the rheological behavior of the lubricant flowing between the two surfaces. The numerical simulations are performed by considering three roughness patterns (transverse, longitudinal and anisotropic), and various values of the couple stress parameter. It is found that the homogenization method is rigorous and efficient for the three roughness patterns considered. It is also found that the combined effects of the surface roughness as well as the couple stress due to the presence of polymer additives on the hydrodynamic performance characteristics such as load carrying capacity, friction factor are significant.*

Keywords: *Hydrodynamic lubrication/ Surface roughness/ Slider bearing/ Polar fluid/ Homogenization method/ Deterministic method.*

by Mihaela Rodica BALAN[1], Vasile Ciprian STAMATE[1] & Dumitru OLARU[1]

[1] *Department of Mechanical Engineering, Mechatronics and Robotics, Faculty of Mechanical Engineering, Technical University "Gheorghe Asachi" of Iasi, **ROMANIA***

Abstract*: The paper proposes a simplified theoretical and experimental methodology to determine the global rolling friction torque in a modified axial ball bearing operating in mixed lubrication conditions. The rolling friction torques in low normal loads conditions, for a maximum Hertzian contact pressure of 0.26 GPa and for lubricant parameter Λ having values between 0.05 to 3.8 was determined. A good correlation between the proposed methodology and Biboulet-Houpert's equations for full film lubrication conditions were obtained. For low normal loads the variation of the rolling friction torque in*

a ball-race contact, as a function of lubrication parameter Λ continuously increases from dry conditions to full film lubrication conditions.

Keywords: *Rolling friction, Lubricated contacts, Ball bearing, Spin-down method.*

24. THE MARANGONI EFFECT AND THE ADHESION FOR ELECTRONIC INTERCONNECT STRUCTURES OBTAINED BY VAPOR PHASE SOLDERING

pp. 141-150

by Andrei TUDOR[1], Georgiana Ionela DUMITRU[1] & Ioan PLOTOG[2]

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*[2]Department of Electronic Technologies and Reliability, "POLITEHNICA" University of Bucharest, **ROMANIA***

Abstract: Reflow interconnection is a metal surface heat joint process with the help of an addition material in liquid phase and who does not imply the melting of the surfaces that will be interconnected. It is analyzed the Marangoni flow of electronic paste for soldering interconnects. The spread and Marangoni flow of liquid paste and vapor are compared.

Keywords: *Electronic interconnect, Paste flow, Spread, Marangoni flow.*

21. INFLUENCE OF THE FEED SPEED ON THE SURFACE QUALITY FOR GRANITE AND MARBLE

pp. 151-123

by Andrei MIHEREA[1], Mihai Botan[1], Constantin GEORGESCU[1] & Lorena DELEANU[1]

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Abstract: This study of finishing two stones with milling-cut CNC machine is of great interest in building industry. When using a diamond milling cut tool, the feed speed affects the surface quality as determined by the authors with the help of 3D texture parameters. These results are useful in optimizing the cutting regime when the texture parameters are imposed for the following step in manufacturing the stones or as the final values characterizing the surfaces. Analyzing the influence of the cutting regime on the stone surface, the engineer could elaborate an optimum manufacturing process that could be less time consuming but fulfills the requirements for surface quality.

Also, the authors wanted to emphasis the use of 3D parameters in evaluating the surface quality as they are still rarely used, especially as a set of parameters and based on texture parameters developed by ISO 25 178-2: 2010.

For marble the feed speed of the milling tool of higher value gave better results, but for granite this cutting regime parameter had no significant influence on the surface quality, recommending the higher feed speed as a time-saving parameter in granite finishing.