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Hydrodinamic Lubrication

contact geometry, Power Law (Ostwald de Waele) for rheologic behavior. The paper present analytical considerations leading to the equation that define the pressure gradient and some numerical results that allows especially a qualitative comparison between the squeeze process in the parallel circular plate model and our model and between a newtonian fluid and a power law fluid which simulate a pseudo-plastic behavior characteristic to sinovial fluid.

6. ÉTANCHEMENT FRONTAL EXTÉRIEUR AUX IMPULSIONS. LE CALCUL DE LA FORCE AXIALE D'OUVERTURE DE L'INTERFACE D'ÉTANCHEMENT

pp. 41-48

by Marius PUSTAN

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***Abstract**: Nous nous intéressons au calcul de la force axiale d'ouverture de l'interface d'étanchement, dans un système présentant un étanchement frontal extérieur aux impulsions. Les impulsions sont le résultat d'une variation de pression au niveau des chambres exécutées sur la surface frontale du stator de l'étanchement. Suite à ces impulsions, l'anneau du stator subit de faibles perturbations.*

Elastohidrodynamic Lubrication

***Abstract**: Anti-wear film thickness and friction coefficients have been measured in elastohydrodynamic contacts for different pairs of surface coatings in the presence of a common antiwear additive, zinc dialkyldithiophosphate. The materials used were, 52100 steel, chromium, and titanium nitride. Comparative tests were carried out using a base stock mineral oil, and a blend of it and ZDDP. It has been found that steel gave the thickest antiwear film, in comparison with titanium nitride and chromium. The film produced on the titanium nitride surface was formed very quickly and, in the same time, even and constant in time. The chromium surface initially generated a film with a thickness similar to that obtained for titanium nitride, which was later removed together with the chromium coating, and allowed the steel underneath to react and form a film typical to this material.*

***Abstract**: An efficient method for thermoelastohydrodynamic (TEHD) lubrication journal bearings analysis is presented. Lubrication film temperature is treated as a time-dependent two-dimensional variable, which is averaged over the film thickness. The oil non-Newtonian behavior is included. The non-Newtonian effect is introduced by modifying the viscosity for each point of a 3D numerical film mesh and for each iteration. Using a convenient iterative solution procedure, the converged solutions for lubricant flow and elastic deformation fields are obtained. The algorithm efficiency for studying complex bearing configuration is demonstrated by solving a connecting rod bearing TEHD lubrication problem. It has been proved that the non-Newtonian shear-thinning effect cannot be neglected in an accurate lubrication analysis.*

Biotribology

***Abstract**: The focus of this paper is on the tribological behavior of natural synovial joint. The rheological behavior of synovial fluid is complex and related with distance between articular surfaces. At smaller distance (little than hyaluronic acid molecule diameter) between articular surfaces synovial fluid behavior is biphasic, and at greater distance (greater than hyaluronic acid molecule diameter) between articular surfaces synovial fluid behaviour is newtonian. When the distance between articular surfaces is approximate with hyaluronic acid molecule diameter, synovial fluid is a thixotropic fluid. According with load and motion (for knee), the type of lubrication of natural synovial joints is different: after prolonged stance – boosted lubrication; heel strike – squeeze film combined with weeping lubrication; weight transfer – EHD lubrication; toe off – boundary combined with weeping lubrication; swing – hydrodynamic lubrication.*

***Abstract**: The real rheological behavior of synovia is highly dependent on the running conditions in articular joints. Complex mechanical and physico-chemical properties of articular cartilage define the boundary conditions for the real dynamics of the synovial fluid; that is why the rheological study should be done in the presence of the two articular cartilages which leads to a complex tribological study. The resolution of the in vivo means of investigation is insufficient to characterize the local tribological mechanisms, in particular at molecular scale. It is thus necessary to define an experimental ex vivo simulation including models of synovia and cartilage. We propose a model of articular contact, made of a gel, a polymeric membrane, and artificial synovia, which respects the mechanical and physical properties of articular cartilage and synovia. This model will allow ex vivo tribological tests aiming to a better understanding of the real tribological mechanisms of a healthy articular joint.*

15. VARIATION OF FRICTION FACTOR THROUGH THE GAIT CYCLE IN AN UHMWPE-CoCrMo HIP ENDOPROSTHESIS

by Florin MUNTEANU[1] & Mihai GAFIŢANU[2]

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[2] Technical University "Gh. Asachi" Iasi, Romania

***Abstract**: The frictional factor of three new bipolar hip prostheses were measured using one hip function simulators designed in Biomechanics Laboratory of Medical Bioengineering Faculty. Hip simulator respect physiological condition (variable load, variable motion). The friction factor value for dry regime through the gait cycle was found variable.*

16. INFLUENCE OF WEAR DEBRIS IN JOINT REPLACEMENTS

by Paul BOTEZ, Adrian CARTALEANU & Florin MUNTEANU

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***Abstract**: Progressive generation of particulate wear debris has been widely observed in joint replacements after several decades of clinical experience. Most of prosthetic materials are usually well tolerated in the bulk form. Nevertheless, there is a continuous release of particulate debris generated from cemented fixation and wear of prosthetic surfaces, whether plastic, metallic or ceramic, which highly increases the contact area between the implanted material and the biological environment. The widespread dissemination of debris and the large surface area produce a potentially toxic effect on the local bone metabolism, contributing to the early failure of implant. Particulate debris trigger a complex biological response consisting in macrophages recruitment, phagocytosis, release of inflammatory mediators and proliferation of fibroblastic pseudomembranes which induce progressive bone resorption (osteolysis). Initially attributed to cement debris, periprosthetic osteolysis was also observed in cementless implants. This process is supposed to occur earlier, more frequently and accelerated in such implants, leading to early revision procedures. Polyethylene, metals and ceramics are the common materials used in both cemented and cementless systems. Such particles have been identified in retrieved membranes from the bone - implant interfaces and osteolytic cavities in failed arthroplasties during revision operations. Efforts of biomaterial scientists, tribologists, cell biologists and orthopaedic surgeons should be combined to improve the design and biomaterials of prosthetic joints. Continuous research must be made to minimize wear and friction, as well as corrosion, with the aim of decreasing the production of particulate debris from articular and nonarticular interfaces. The longevity of joint arthroplasties should be improved with decreased generation of this debris.*

Microtribology

17. L`INFLUENCE DE LA MICROTOPOGRAPHIE DES SURFACES SUR LA DEFORMATION PLASTIQUE POUR UN CONTACT CIRCULAIRE LIMITE DES SURFACES RUGUEUSES REELES

by Dorel PRODAN & E.N. DIACONESCU

"Stefan cel Mare" University of Suceava - Romania, Department of Applied Mechanics

***Abstract**: We recommend to investigate the pressure distribution and the stress state in a real elasto-plastic circular contact, bearing balls of three different degrees of surface finishing were used. These were pressed against a polished flat surface made of a softer steel. The surface microtopography measured in each case by a laser profilometry was introduced in a numerical program developed to evaluate the pressure distribution, stress state and residual deformations for an elasto-plastic material with non-linear hardening. The dimension of calculated contact plastic deformations compare favorably with those experimentally by aid of a laser profilometer..*

18. L'INFLUENCE CUMULATIVE DE LA MICROTOPOGRAPHIE, DE LA DURETE ET DE LA CHARGEMENT SUR LA DEFORMATION PLASTIQUE POUR UN CONTACT CIRCULAIRE LIMITE DES SURFACES RUGUEUSES REELES

by Dorel PRODAN & E.N. DIACONESCU

"Stefan cel Mare" University of Suceava - Romania, Department of Applied Mechanics

***Abstract**: Dans ce travail on essaie la distinction des influences plusieurs facteurs qui détermine la qualité du couche superficielle: microtopographie et dureté. Par des graphes tridimensionnels et diagrammes ternaires on a mis en évidence leur influence cumulative en fonction de la charge. Pour une certaine dimension d'une sphère avec trois degrés de finition en contact avec une éprouvette plane ayant trois duretés différentes on a applique des chargements différente. Les déformations plastiques ont été analyse par UBM (profilométrie laser) et les résultats ont été représenté par diagrammes spatiales et diagrammes ternaires avec l'aide du programme STATISTICA.*

21. FRICTION IN THE MICRO LINEAR BALL BEARING FOR MEMS APPLICATIONS

pp. 194-207

by Dumitru OLARU[1], Peter LORENZ[2] & Dietmar RUDY[3]

[1] Technical University ''Gh. Asachi'' of Iasi, Romania

[2] Hochschule fur Technik und Wirtshaft des Saarlandes HTW, Germany,

[3] INA Lineartechnik oHG, Homburg, Germany

Abstract: *A complex analytical model to evaluate the friction losses in a micro linear ball bearing has been developed. The model includes following losses sources: pivoting motion between ball and races, elastic resistance in rolling of the ball over the races, hydrodynamic effects in ball-races and the losses in the ball-ball contacts. Both adhesion between balls and the races and capillary effects in the ball- ball contacts was considered. To validate the model, the numerical results was performed for a micro linear ball bearing studied experimental by [1]. The numerical results are in the same range of values with experimental results.*

Contact Mechanics

by Sorin CIORTAN, Lorena DELEANU, Minodora RÎPĂ

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***Abstract**: This paper presents a comparison between the stress state of a smooth ideal lap joint and one having the adherent surfaces characterised by a profile, using finite element method. The results pointed out local peaks of the stresses even for a model having 1mm as joint width. These local maximum stresses will certainly influence the durability of the bonded joint and could be introduced in simplified calculus by a coefficient related to the profile parameters.*

Friction

by T. T. H. TRAN, T. ZEGHLOUL, D. BONNEAU & B. VILLECHAISE

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***Abstract**: This experimental study belongs to the scope of a modeling of interactions between the different bodies of a connecting rod big end bearing. We propose to determine the value of the friction coefficient for the mating surface between the body and the cap of connecting rod. We are in the presence of a contact in lubrication or lack (dry contact). The results indicate the evolution of the charge tangential / normal load ratio for different situations of contact and loading. These ratios depend significantly on the presence or not of the lubricant and on the intensity of the normal load no matter the. However, for a given loading velocity, we note little influence of the loading process on the obtained results.*

dependence with contact pressure. By extrapolation of experimental values, the corresponding function is obtained. Assuming the linear dependence of hysteresis losses on volume of stressed material, a relation between the energy loss in rolling and that in collision is found.

36. FRICTION IN BALL SCREWS SYSTEMS

by Dumitru N. OLARU[1], Vasile PUIU[2] & George V. PUIU[2]

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[2] Dept. of Mechanical Engineering, University of Bacau, Bacau, Romania

***Abstract**: A new model to estimate all friction losses between the balls and the circular – arch grooves races (two contact points) from screw and nut has been developed. Based on the equilibrium of the forces and moments acting on the ball, the sliding forces between ball and both screw and nut races are determined without an integrating of the shear stress on contact ellipses. The sliding forces include the rolling forces on the two contacts, the friction moments due to the races curvature, the elastic resistance moments in ball-races contacts, the contact force between the balls and the friction moment between the balls. The program was adapted for a ball – screw system and influence of the speed and load on total friction torque was investigated. The efficiency of the system was computed and good agreement with the literature results was obtained.*

37. OIL RING FRICTION LOSS SIMULATION CONSIDERING THE MIXED LUBRICATION REGIME

by Adolfo SENATORE[1] & Sorin CIORTAN[2]

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[2] Department of Mechanical Engineering, "Dunarea de Jos" University of Galati, Romania

***Abstract**: An important portion of the total power loss in a modern automotive engine is due to piston ring/cylinder bore friction. This paper introduces the results of simulations about the friction interaction of the oil ring of a SI engine performed taking into account the mixed lubrication regime. The friction coefficient calculations show a sensible improvement of this crucial parameter whit low-roughness surfaces. The effects of engine speed, radial tension, surface roughness and ring shape are shown.*

Wear

40. PRELIMINARY ANALYSIS OF THE DRIVING MECHANISMS FOR SUPERFICIAL TRIBOLOGICAL TRANSFORMATIONS (STT): EXPERIMENTATION AND MODELLING IN THE CASE OF PURE IRON

by A. Hachem Haj mourad, Yves Berthier, Magali Busquet & Laurent Baillet

Laboratoire de Mécanique des Contacts et des Solides, I.N.S.A de Lyon, France

***Abstract**: Superficial Tribological Transformations (or STT) are usually the less damaging response of materials to tribological conditions by producing the proper solid third body for safe behaviour of 'dry' contacts. As a consequence, one solution to control wear is to control STT's formation. The main objectives of this work are to produce STT (i) in more controlled mechanical conditions than in a contact and (ii) if possible, in a volume which is more important and finally to follow the STT's formation to identify their driving mechanisms. A Bridgman Anvil Apparatus is used to shear by rotation pure iron cylindrical samples under a quasi-hydrostatic pressure of 1 to 3 GPa. Two STT layers are observed to appear after about 240° of anvil rotation within the 'skins' of the sample (i.e. the first 20 µm below the surface). The sample structural evolution is analysed as a function of measured global parameters: the torque (C), the hydrostatic pressure (Ph), sliding (S) and sample depth (h). This first experimental analysis is coupled with finite element analysis to calculate sample local sollicitations. Modelling allows to better identify local different driving mechanisms that control experiments: volume shearing, material work hardening, sliding at the interfaces. The experimentally observed STT areas are directly correlated to a specific calculated behavior of the sample 'skin'.*

41. STUDY OF THE BEHAVIOUR IN FRETTING OF A STEEL /POLYCARBONATE COUPLE USING A COMPLETE FACTORIAL EXPERIMENT METHOD

by Adelina HAN[1, 2], Gianni PILLON[1], Bernard VANNES[3]

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[2] Université « Politehnica » Timisoara, Faculté de Mécanique, Roumanie

[3] Ecole Centrale de Lyon, Laboratoire LTDS – UMR 5513, France

***Abstract**: Le frottement et l'usure qui sont les principales causes de la perte d'énergie donc des performances des systèmes mécaniques, restent toujours des thèmes majeurs de recherche. La dégradation des surfaces des premiers corps en contact nécessite une approche pluridisciplinaire faisant appel aux notions de mécanique, de matériaux, de physico-chimie. Les difficultés rencontrées pour prédire l'usure et pour sélectionner des couples de matériaux résultent du fait que le frottement et l'usure ne sont pas directement des propriétés intrinsèques de matériaux et que les sollicitations du*

système tribologique sont en général complexes. Une approche statistique pour l'étude du comportement d'un couple de contact permet une caractérisation plus globale des processus et des phénomènes qui interviennent.

42. CONTACT TEMPERATURE IN A FRETTING CONTACT

pp. 395-402

by A. TUDOR[1], M. M. KHONSARI[2]

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***Abstract**: Friction mechanisms for fretting contacts are the cause for the surface temperature. The determination of the sliding velocity is of primary importance in describing the thermal conditions in a contact. The tangential displacement for a ball- flat contact was expressed by assuming Mindlin hypotheses for an elastic ball on flat contact. The present paper argues that plastic deformation in the contact zone may contribute to relative displacement and to thermal heat flux. Temperatures in the fretting contact can be obtained by the integrating the fundamental solution of conduction. The integral function is solved in dimensionless form for divers parameters of fretting phenomena (friction coefficient, normal load and frequency).*

43. BEARINGS SCUFFING FAILURE MONITORING BY VIRTUAL INSTRUMENTATION

pp. 403-408

by Carmen BUJOREANU, Spiridon CRETU

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***Abstract**: Scuffing diagnose of rolling element bearings can be made by the analysis of the bearing friction forces which are the most sensitive indicator of bearing defects. Such analysis is possible only when an adequate model of the monitored process is known. We have studied the interdependence between the Kinematics, dynamic, lubrication and friction phenomena realised in bearing's rolling contacts subjected to an important sliding. As consequence, we elaborate an original algorithm and computer code leading to scuffing criterion ($\mu \cdot p \cdot V^{0.8}$). The evidence of scuffing onset is a sudden increase of friction force. Data acquisition and transducers signal processing were realised using NI-DAQ board and LabVIEW 5.1 soft. A virtual instrument with two channels readings monitoring the friction force and the braking torque was created.*

44. TEMPERATURE - A BEARING SCUFFING FAILURE CRITERION

pp. 409-414

by Carmen BUJOREANU, Spiridon CRETU

"Gh. Asachi" Technical University Iasi, Romania

***Abstract**: Scuffing is a complex phenomenon of severe adhesive wear generated under particular combinations including contact pressure, lubrication, speed and friction. Scuffing involves the sudden collapse of the lubricant film and is generally regarded as resulting from thermal phenomena. Under particular combinations including contact pressure, lubrication, speed and friction, a critical temperature is reached in the vicinity of the contact. At this temperature, the breakdown film with local welding or adhesion of the contacting surfaces can appear. The paper presents a temperature distribution model for ball bearings contacts related to the scuffing risk. The own experimental and theoretical results are in good agreement with the literature.*

45. THEORETICAL MODEL FOR GENERAL ROLLING CONTACT FATIGUE

pp. 415-419

by Delia-Aurora CERLINCĂ & Emanuel DIACONESCU

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***Abstract**: Datorită interacţiunii simultane a unui număr mare de factori, oboseala de contact este un fenomen extrem de complicat. După cum se ştie, fenomenul de oboseală de contact poate fi iniţiat în adâncime, pe suprafaţă sau, simultan, în adâncime şi pe suprafaţă. Prin urmare, lucrarea propune un model teoretic general pentru oboseala de contact, propunându-se un model de tip Lundberg – Palmgren pentru evaluarea durabilităţii de iniţiere atât pe suprafaţă cât şi în adâncime, şi legea lui Paris pentru evaluarea durabilităţii de propagare a fisurii.*