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Hydrodinamic Lubrication

***Abstract**: Compliant and permeable layered surfaces are used in natural synovial joints and have been proposed for the bearing surface in artificial joint replacements. The squeeze-film lubrication mechanism plays an important role in long-term performance of both natural and artificial joints. The full lubrication solution of the present problem including compliance and permeability is not available yet in the literature. The present study analyses the squeeze effect of a porous and deformable layer with variable permeability, imbibed with lubricant, based on a novel mechanism, named Ex-Poro-Hydrodynamic Lubrication (XPHD). The results obtained put in evidence an optimum initial compacticity for the porous matrix. The comparison with the well-known model of McCutchen [4] shows good agreement.*

***Abstract**: Reynolds' solving of differential pressures has been an issue of great interest for past and current researchers. Although the very first attempts at solving differential equation were analytical, because of the solutions' imprecision and the limits of putting the issue into practice, after 1956 the numerical solving became the actual development. The numerical obtained solutions boast without any doubt some acceptable degree of precision, yet the necessary knowledge implied; the complexity of the programs as well as the amount of time thrown in can be daunting. For this reason, in certain recent papers a tendency to reconsider the analytical approach has been noted. Modern installations, devices and machines frequently manifest, embedded in their structures, constructive solutions which must ensure the load acquisition and the transmission of the rotation movement with great and excessive circumferential speeds. Many of such occurrences imply usage of radial sliding bearings. For functional reasons that include, among others, the oil film thermal regime, in the case of great rotations, these bearings work under small eccentricities. The main objective of this paper is to propose a calculus relation which could allow for the analytical evaluation of the main functional parameters of the hydrodynamic radial bearings working under small eccentricities.*

Basic and Applied Elastohidrodynamics

3. MODELISATION THERMOHYDRODYNAMIQUE D'UNLUBRIFIANT NON NEWTONIEN EN FILM MINCE

by Fatima BOUYAHIA[1], Mohamed HAJJAM[2], Dominique SOUCHET[2] & Mohamed EL KHLIFI[1]

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[2] Laboratoire de Mécanique des Solides (UMR 6610) 4, Av. de Varsovie,16021 Angoulême Cedex, France

***Abstract**: A numerical three-dimensional thermohydrodynamic model is developed to predict the non-Newtonian lubricant behavior, with a slider bearing of different shapes. The generalized Reynolds equation, modeling this type of flow, is established using the concept of the Generalized Newtonian Fluids (GNF). The temperature field is determined by the help of the energy equation. All dimensionless equations are discretized and solved by the finite difference method. The rheological models chosen in this study include Bingham, Hershel-Bulkley, Rabinowisch and the power-law. The Bingham and the Hershel-Bulkley laws are described using the approach proposed by Papanastasiou to hold uniformly in yielded and unyielded regions. The evolution of the velocity, the pressure and the thermal fields, according to the lubricant characteristics, are presented and discussed. Comparisons are made with Newtonian lubricant and some other recent non-Newtonian numerical works.*

4. ETUDE ELASTOHYDRODYNAMIQUE D'UN JOINT A LEVRE

by Mohamed HAJJAM & Dominique BONNEAU

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***Abstract**: In the present study, a realistic model of lip seal is used. An elastohydodynamic analysis is developed to generate predictions of such seal operating characteristics as thickness distribution, hydrodynamic pressure, contact and cavitation area, torque of friction and a reverse leakage pumping.*

5. A SIMPLIFIED MACRO-THERMO-ELASTIC MODEL FOR A MECHANICAL FACE SEAL IN TRANSIENT OPERATION

by Aurelian FĂTU[1], Bernard TOURNERIE[1] & Traian CICONE[2]

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***Abstract**: The primary goals of a mechanical face seal (MFS), low leakage and long life, require the seal to operate with very thin films between the mating faces. Thus, heat dissipation and its major effects on the (a) viscosity of the sealed fluid (thermo-viscous effect) and on the (b) elastic deformations of the seal rings (thermo-elastic effect) become major concerns. Experiments have shown that these coupled effects are at the origin of seal instabilities. Despite of a large amount of work dedicated to these aspects, the majority of the proposed models have been restricted to only one of these effects. Only a few papers treated the coupled thermo-elastic effect [4, 6 ,8, 12]. All these models are axisymmetric (2-D) and most of them use standard commercial software tools to solve for temperatures and deformations of the rings. The aim of this paper is to present a simple but comprehensive thermo-elasto-hydrodynamic (TEHD) model, for MFS operating in transient conditions. This model is also axisymmetric but assumes that temperature varies only axially in the seal rings, assumption validated experimentally. From this point of view, the present model can be considered a 1-D TEHD model. The key factor in the present model is coning of the seal interface.*

6. SCUFFING FAILURE CRITERIA APPLIED TO ANGULAR CONTACT BALL-BEARINGS

by Carmen BUJOREANU & Spiridon CREŢU

Technical University “Gh Asachi” of Iasi - Romania

***Abstract**: The literature underlines that the scuffing failure models suppose the settlement of a complex function including mechanical, physical and chemical effects of rolling contacts in running. Therefore, it is difficult to predict the solution of such a complex problem. From the scuffing approaches, it can be detached the idea that, any scuffing mechanism considered, there is an energetically unbalance in the rolling contact. This unbalance generates disruptions in lubrication conditions and the scuffing risk appears. This is the reason we consider an energetically criterion the most adequate to estimate scuffing limits. In ball bearings contacts (ball-inner race), scuffing limits were settled by the dissipated energy quantified through fluid, boundary, or asperity friction in the specified contact. The proposed scuffing criterion has a character of generality in order to be used for any lubrication conditions. In angular contact ball bearing 7206, the own experimental and theoretical researches show that the scuffing initiation is generated for the value of energy dissipated about $1.5 \cdot 10^{8}$ $W \cdot m^{-2}$. The same limits have been noticed in experiments attained on discs test specimen.*

7. EXPERIMENTAL SCUFFING FAILURE APPROACH IN ANGULAR CONTACT BALL-BEARINGS

pp. 45-52

by Carmen BUJOREANU[1], Spiridon CREŢU[1] & Daniel NELIAS[2]

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[2]Institut National des Sciences Appliquées , Lyon, France

***Abstract**: The diversity of running conditions and, implicitly, of their typical influences on scuffing failure in bearings rolling contacts limits researcher's options to a global study. Occasionally abnormal operation causes premature bearing failure, that is usually micro-scuffing and/orscuffing. An experimental study has been performed both on the specimens and bearing test rig to estimate scuffing limits in angular contact ball bearings. Some scuffing tests have been carried out on the high-speed twin-disk machine available at LMC facilities. The specimens were manufactured in order to agree a simulative tribotesting with scuffing risk. The simulation criteria reefer to material, geometrical characteristics and the lubrication regime of the practical system, which is 7206 angular ball bearing. Specimen's tests were high-speed performed in order to obtain an important ballinner race contact sliding (>10 m/s) promoting scuffing failure. Another series of scuffing tests were applied on the 7206 angular contact ball bearing included in an original test rig. An electromagnetic brake fixed on the cages of bearings system, through disk-cage device, realized the cage's braking. Owing to the cage's braking, the ball-inner race sliding speeds were substantially increased and the scuffing appeared. Accurate choose of simulation criteria leads to establishment of unique scuffing limits in the given ball bearing for imposed running conditions.*

Rheology

Contact Mechanics

space force-displacement relations, pressure distribution is quickly obtained even in case of large number of contact points. The convergence exists in any rolling or/and sliding contact problem, even in the presence of roughness.

14. AN AUTOMATIC MESH PROCEDURE IN NON-HERTZIAN CONTACT ANALYSIS

by Gabriel POPESCU

Technical University "Gh. Asachi" Iasi, Romania

***Abstract**: Real three-dimensional contact problems require numerical analysis in order to obtain both the true contact area and pressure distribution. Since the contact area cannot be known in advance and has to be obtained together with the positive pressures, in case when the initial chosen contact domain is small than real one, spurious stress concentration arise along the domain border. The contact surface must be extended, and for this reason, a special procedure was developed, in order to deal with the possible presence of skew and/or misalignment angles in roller bearings.*

15. CONFORMITY ASPECTS IN DEEP GROOVE BALL BEARINGS-INFLUENCE OF LOAD AND CONTACT ANGLE

by Gabriel POPESCU

Technical University "Gh. Asachi" Iasi, Romania

***Abstract**: Deep groove ball bearings are used in a wide variety of application, due to ability to carry combined load. Depending on the internal geometry, applied load and effective contact angle, the contact area is no longer hertzian and significant differences occur. Due to the high conformity of the contact, which violates the hertzian assumption of parabolic bodies, a threedimensiona numerical analysis must be performed. In case of high loads, a receding contact occurs, with a corresponding increase in the maximum value of the contact pressure. Several cases were investigated and the results were compared with available solutions in the literature.*

16. THE APPLICABILITY OF HERTZ FORMULAE FOR HEAVILY LOADED CIRCULAR CONTACTS

by E.N. DIACONESCU, M.L. GLOVNEA & D. CERLINCA

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

***Abstract**: Hertz developed his theory under the assumption that contact area dimensions are small in comparison to main curvature radii of bounding surfaces in initial contact point. This assumption fails at high loads or for very compliant materials. This paper performs an analysis of the problem by using higher terms in series development of sphere equation, derives new formulae for contact radius, maximum pressure and normal approach and compares these results with the predictions of Hertz theory.*

17. EFFECT OF WAVINESS AND STRAIN HARDENING UPON AN ELASTO-PLASTIC CIRCULAR CONTACT

by Dorel PRODAN & E.N. DIACONESCU

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

***Abstract**: On considère un corps sphérique de rayon R=3,175 mm, ayant les ondulations caractérise par amplitude A et longueur d`onde λ, c`est a dire les cases suivantes: 1) A=0,002 mm et λ=0,100 mm; 2) A=0,001 mm et λ=0,050 mm; 3) A=0,001 mm et λ=0,100 mm. Le contact est charge pour des pressions hertziennes maximales calculées entre 3,5-6 GPa, de 0,5 en 0,5 GPa. On considère aussi le cas d`écrouissage linéaire.*

Sont présentées les variations des profondeurs, et les variations des diamètres de la déformation plastique de contact pour toutes les trois ondulations périodiques considérées et pour toutes les six niveaux de chargement.

Pour investiguer l`influence de la composante non périodique des ondulations, on a superpose une série des nombres aléatoire ayant le même ordre de grandeur avec l`amplitude.

Dans cet étude on a analysé aussi trois cases différente du comportement élasto-plastique: a) élastique parfait plastique; b) élasto-plastique avec écrouissage linéaire; c) élasto-plastique avec écrouissage non linéaire.

18. EFFECT OF REAL MICROTOPOGRAPHY UPON AN ELASTO-PLASTIC CIRCULAR CONTACT

by Dorel PRODAN & E.N. DIACONESCU

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

Abstract: *Des recherches se sont faites pour déterminer le comportement des surfaces sphériques réelles dans le contact circulaire entre surfaces rugueuses réelles, dans le domaine élasto-plastique avec écrouissage non linéaire. On a considère une dimension de bille (Φ = 6,35 mm) et trois degrés de finition différentes (rectification, superfinition initiale et superfinition finale). Les surfaces réelles ont été mesure a l`aide du profilographe UBM-14 qui existe dans le Laboratoire de Mécanique du Contact de la Faculté de Génie Mécanique Suceava. Cette surfaces ont été utilisé dans les programmes de calcul numérique réalisées antérieurement. On a calculé et représente l`évolution de la distribution de pression et de la déformation plastique pou des pressions hertzienne maximales calculées entre 3,5-6 GPa, de 0,5 en 0,5 GPa, pour toutes les trois degrés de finition différentes. Sont présentées les variations des profondeurs, et les variations des diamètres de la déformation plastique de contact pour toutes les trois degrés de finition différentes et pour toutes les six niveaux de chargement.*

19. CONTACT AREA BETWEEN A RIGID HALF SPACE AND A VOIGT-KELVIN SPHERE, FOR DIFFERENT LOADING TYPES

by Florina Carmen CIORNEI & Emanuel DIACONESCU

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

Abstract: *The contact theory for linear viscoelastic materials, in the absence of adhesion, was developed by Ting. The solutions depend on the elastic solutions, monotony of the contact radius, loading variation, geometry of the indenter and creep and relaxation functions of the material. The paper presents the contact radius for several types of loading, (step function, linearly increasing or decreasing, cyclic) in the case of a rigid paraboloid pressed against a Voigt-Kelvin half-space. Boltzmann's superposition principle can be applied in deducing contact radius for loading expressed as a linear combination of simple loading.*

can be obtained in a plane that is stretched on one direction and compressed, with the same intensity, on a normal one. Holes presence shows that angle between principal directions for the two loading is 45^o.

23. STRESS STATE IN A BENDING ELASTIC PLANE WITH TWO IDENTICAL HOLES (CENTRE AXIS ALONG NEUTRAL AXIS)

by Stelian ALACI & Emanuel DIACONESCU

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

***Abstract**: In the paper an elastic plane with two similar holes is considered. Axis of holes centre is the same with the neutral line of the plane. Stress concentration factor of the hole is estimated. A comparison with a photoelastic isochromatics pattern validates the results.*

24. STRESS STATE IN A BENDING ELASTIC PLANE WITH TWO IDENTICAL HOLES (HOLES SYMMETRICALLY PLACED WITH RESPECT TO THE NEUTRAL AXIS)

by Stelian ALACI & Emanuel DIACONESCU

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

***Abstract**: The stress state in a bent at infinity elastic plane with two identical holes is found. The axis centres of the holes is normal to the neutral axis of the plane. Influence of rapport between hole radius and distance of centres on stress concentration factor is estimated. Finally, a comparison between theoretical and photoelastic isochromatics validates theoretical results.*

25. THE INFLUENCE OF SHAFT STIFNESS ON LOAD DISTRIBUTION IN ANGULAR-CONTACT BALL BEARING

by Ioan DAMIAN, Spiridon CREŢU & Ion OANCEA

Technical University "Gh. Asachi" of Iasi - Romania

***Abstract**: A vectorial method to solve the quasi-static equilibrium in an angular-contact ball bearing is presented. The method has five degree of freedom and includes the presence of the misalignment between bearing's rings.*

by Stelian ALACI

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

***Abstract**: In this paper, relative velocity and curvature radius of a cam from a superior pair cam-follower, for a rotating cam and an eccentric follower mechanism, are found. The relations can be applied before designing of cam profile when only motion law and geometric characteristics are known. An intrinsic co-ordinate system of the mechanism is shown. In this system, cam eccentricity, without ambiguity, can be found.*

Friction and Wear

by Luminiţa IRIMESCU[1], Emanuel DIACONESCU[1] & Yves BERTHIER[2]

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

[2] INSA de Lyon, France

***Abstract**: Le papier analyse l'influence du glissement impose sur le microglissement à l'interface d'un contact en roulement. Les résultats numériques montrent qu'un glissement imposé g, aussi petit soit-il, a comme effet l'apparition des zones de microglissement de signe alterné sur l'aire de contact. Le nombre de ces zones et leur étendue sont déterminés par la valeur du glissement imposé au contact.*

28. CONSIDERATIONS THEORIQUES SUR LE COEFFICIENT DE FROTTEMENT EN ROULEMENT

by Luminiţa IRIMESCU[1], Emanuel DIACONESCU[1] & Yves BERTHIER[2]

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

[2] INSA de Lyon, France

***Abstract**: Le frottement représente une perte d'énergie qui, dans le cas d'un contact en roulement est produit par deux facteurs ayant une contribution plus ou moins importante: les microglissements à l'interface du contact et l'hystérésis élastique. L'article présente un modèle théorique capable de décrire à la fois la puissance perdue par microglissements à l'interface et la composante du coefficient de frottement en roulement induite par les microglissement..*

29. THE EFFECT OF MISALIGNMENT ON POWER LOSS IN ANGULAR CONTACT BALL BEARINGS

by Spiridon CREŢU & Ioan DAMIAN

Technical University "Gh. Asachi" of Iasi - Romania

***Abstract**: The vectorial analysis of the quasi-dynamic equilibrium in angular-contact ball bearings is validated by comparison with results obtained theoretically or numerical by other researchers. Also, experimental data obtained by authors with an original device correlate quite well with numerical values. The major contribution on bearing power loss is due to the frictional processes achieved on inner raceway. Both, numerical and experimental studies pointed out that the presence of the misalignment between bearing's raceways has strongly increases the value of the total power loss, jeopardizing bearing's reliability.*

30. ROLLING CONTACT FATIGUE EXPERIMENTS IN THE PRESENCE OF A SURFACE FURROW

by Delia-Aurora CERLINCĂ & Emanuel DIACONESCU

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

***Abstract**: Rolling contact fatigue depends essentially on both surface and subsurface population of defects. This paper describes experimental results obtained in rolling contact fatigue tests in the presence of a furrow oriented transversally to the raceway.*

31. TRANSFER MECHANISMS AT A BONE-IMPLANT INTERFACE IN BIOMECAHANICAL FATIGUE

by Gheorghe FRUNZĂ

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***Abstract**: Whether natural or artificial, any biocontact is the locus of biophysical, biochemical, and metabolic mechanisms taking place on both the molecular and the supramolecular levels. The first mechanism is influenced by biomechanical and bioelectric, the second comprises biochemical reactions that depend on the nature of interface materials, and the third manifests itself by the action of the enzymes that hold the potential of degrading all components of the extracellular matrix. These mechanisms mutually interact and may yield complex interface phenomena within the biosystem. The three mechanisms may be quantified into one, currently called biotensegrity mechanism.*

The most frequent cause of failure of artificial joint embedded in bone solid is mechanical and ascetic weakening. Bone and implant stability is a decisive factor in longevity. Among the causes influencing mechanical and ascetic weakening range bone necrosis (death) due to cement polymerising, surgical mechanical deterioration, organic wear residue, and interface mechanical weakening. The two final factors in this series are mechanical in nature and may be attributed to implant design and manufacturing.

Implant material improvement, surgical technology, patient selection, and fastening technology positively increase total articulation durability, so that the most active patients around the age of 60 may expect 10 to 15 years of activity without any pain subsequent to total joint replacement. Beyond this, even in the case of younger patients, biomechanical fatigue is a significant factor resulting in a revision of artificial joint after a certain time.

32. ROLLING FRICTION – EXPERIMENTAL INVESTIGATIONS

by Ilie MUSCĂ

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

***Abstract**: The paper presents an experimental research of rolling friction between a ball and a ring of a ball bearing. The contacts were tested on an original test rig. Influences of contact geometry, cinematic and lubricant upon rolling friction were revealed. A direct correlation of rolling friction coefficient with rolling speed was observed.*