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Contact Mechanics

1. NUMERICAL MODELLING OF 3D IMPACT

pp. 69-79

by Alaci Stelian, Florina Ciornei, Luminița Irimescu, Delia Cerlincă & Ovidiu Rusu

“Ștefan cel Mare” University, Suceava

Abstract: *The paper presents a virtual device designed for study of tri-dimensional impact. The main goal of the work is to present a solution for finding the coefficient of restitution for the tri-dimensional case of a sphere impacting frontally a rotating cylinder. The ADAMS/View software was used to solve the problem. The validation of the problem was made by applying the software for a particular case, for which the authors previously have had obtained experimentally the value for the coefficient of restitution. There was found a very good agreement between the experimental data and the results obtained using the virtual model. This concordance validates the veridical results obtained using a virtual device.*

2. THE INFLUENCE OF THE RAIL INCLINATION AND LATERAL SHIFT ON PRESSURE DISTRIBUTION IN WHEEL-RAIL CONTACT

pp. 44-52

by Constantin-Ioan BARBINȚĂ & Spiridon CREȚU

Machine Design Department “Gheorghe Asachi” Technical University – Iasi, ROMANIA

Abstract: *Even the UIC60 wheel profile and the S1002 rail are the most used combination in the European rail transportation the interoperability is affected by the different rail inclination that varies between the values of 1/40 and 1/20. The hunting motion and the specific train motion in curve determine a permanently lateral shift of the axle and consequently a permanent change of the initial wheel-rail contact point. To find out the influence of these modifications on pressure distributions a fast and robust algorithm has been used to solve the stress state in the general case of non-Hertzian contacts. Brent’s method has been involved to find the contact point for the unload conditions. To limit the pressure, an elastic-perfect plastic material has been incorporated into the computer code.*

3. PRELIMINARY THEORETICAL SOLUTION FOR ELECTRIC CONTACT RESISTANCE BETWEEN ROUGH SURFACES

pp. 28-33

by Cristina Ciornei & Emanuel DIACONESCU

Department of Mechanical Engineering, University of Suceava, Romania

Abstract: *In contacts design, it is important to know the contact pressure, the real contact area and the electrical contact resistance. This depends on the material conductivity, on the geometry of the contacting surfaces, on the applied load and on the current through the contact. This paper aims to numerically determine by CG-DCFFT technique of the contact area configuration and dimensions, in the case of rough surfaces. Knowing the microcontact areas configuration and dimensions, the electrical resistance is computed with analytical formulae.*

4. STATIC LINE CONTACT OF RUBBER COATED BODIES

pp. 34-43

by Emanuel Diaconescu, Marilena Glovnea & Ovidiu Chiş

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

Abstract: *Recent work was carried out on mechanical contacts between rubber and metal bodies and simple approach procedures were advanced. In practice, contacts between two metal bodies, one of which is coated by a rubber layer often operate. This paper deals theoretically with these contacts by employing these new solutions on rubber bodies as well as other recent results concerning the effect of the finite thickness of one of the bodies upon contact area and pressure distribution.*

5. A STUDY OF A FINGER - PLANE CONTACT

pp. 9-14

by Ilie MUSCA, Florina Carmen CIORNEI & Remus PRODAN

Faculty of Mechanical Engineering Mechatronics and Management University “Stefan cel Mare” – Suceava, Romania

Abstract: *The study of finger contact occurring during manual grasp is significant for shape optimization. The paper presents the test rig, the subsequent method and results concerning the study of contact between the fingertip and a glass flat surface, with simultaneous measurements of contact area, global normal force and relative displacement. Some conclusions are presented too.*

6. NUMERICAL SIMULATION OF ELASTIC-PLASTIC CONTACT

pp. 53-60

by Sergiu SPINU

University "Stefan cel Mare" of Suceava, Romania

Abstract: *A fast algorithm for elastic-plastic non-conforming contact simulation is presented in this paper. The plastic strain increment is determined using an universal integration algorithm for isotropic elastoplasticity proposed by Fotiu and Nemat-Nasser. Elastic-plastic normal contact problem is solved iteratively based on the relation between pressure distribution and plastic strain, until the latter converges. The contact between a rigid sphere and an elastic-plastic half-space is modeled using the newly proposed computer program. Numerical simulations predict that residual stresses decrease the peak intensity of the stresses induced by contact pressure, thus impeding further plastic flow. Computed pressure distributions appear flattened compared to elastic case, due to changes in both hardening state of the elastic-plastic softer material and contact conformity.*

7. RESIDUAL STRESSES IN ELASTIC-PLASTIC CONTACT PROBLEM

pp. 61-69

by Sergiu SPINU & Dorin GRADINARU

University "Stefan cel Mare" of Suceava, Romania

Abstract: *A fast algorithm to predict residual stresses related to development of plastic strain in elastic-plastic contact is advanced in this paper. The plastic zone is partitioned in a set of cuboids of uniform strains, and solutions for each individual cuboid, derived by Chiu in closed form expressions, are superimposed. Computation is accelerated by implementing three-dimensional spectral methods, in a hybrid convolution-correlation algorithm. Pressure-free boundary condition is imposed with the aid of Boussinesq formulas and superposition principle, resulting in increased computational efficiency. Predictions of residual stresses due to a spherical plastic zone are compared with existing analytical and/or numerical results, and a good agreement is found.*

8. PRELIMINARY THEORETICAL RESULTS UPON CONTACT PRESSURE ASSESSMENT BY AID OF REFLECTIVITY

pp. 19-27

by Cornel SUCIU & Emanuel DIACONESCU

Department of Mechanical Engineering, University of Suceava, Romania

Abstract: *Several different experimental methods for investigating contact features can be found in literature. The idea to optically investigate the surfaces of contacting bodies [1-8], led to the development of a new technique to measure the pressure distributions in a real contact [9-11].*

One of the contacting surfaces is covered, prior to contact establishment, by a special gel. The contact closing removes the excess gel and, during a certain time interval, the contact pressure transforms the entrapped substance in an amorphous solid. In each point, the refractive index of this solid depends on the pressure acting during transformation. After contact opening, the reflectivity of this coating depends on the former contact pressure and it is mapped by aid of a laser profilometer, thus becoming an indicator of contact pressure.

This paper studies the effect of pressure on the refractive index of the solidified gel layer, as well as the different parameters that influence its reflectivity. Using molecular physics and optics, a theoretical model of reflectivity is studied and it is found to be strongly influenced by both pressure and gel layer thickness. From this model, pressure distribution laws are found for different ranges of reflectivity and gel layer thickness.

9. A NUMERICAL PROCEDURE TO GENERATE NON-GAUSSIAN ROUGH SURFACES

pp. 1-8

by Ana Urzică & Spiridon Crețu

Department of Machine Design, Technical University of Iași, ROMANIA

Abstract: *The paper presents an algorithm for computer simulation of non-Gaussian surfaces. By using a random number generator a input matrix is formed as a first representation of a Gaussian roughness with zero mean, and unit standard deviation. The autocorrelation function was assumed to have an exponential form. To fulfill this requirement, in the first step, the matrix containing the roughness heights was obtained by a linear transformation of the input matrix. In the second step the skewness and kurtosis of the input sequence have been established for the desired skewness and kurtosis of an output sequence. Finally the non-Gaussian random series have been generated by using the Johnson translator system. The numerical results pointed out that the developed algorithm can be further used to simulate manufacturing processes that produce real surfaces which may present a non-Gaussian distribution, as well as the abrasive wear and running in phenomena.*

Biotribology

10. SOME ASPECTS CONCERNING CONTACT STRESSES FROM A DENTAL ARTICULATOR JOINT

pp. 96-105

by Florina Ciornei, Stelian Alaci, Ilie Muscă, Gheorghe Frunză, Luminița Irimescu & Delia Cerlincă

“Ștefan cel Mare” University of Suceava, Romania

Abstract: A dental articulator is a mechanical device which simulates the temporo-mandibular joint. The articulator is important because it replicates the basic revolve action of the upper and lower mandibles, as well as translational motions. In the present paper the stresses from an articulator TMJ modelled as a sphere into a spherical/cylindrical cavity are analyzed by two methods, first applying the Hertzian contact theory and secondly using a FEA simulation.

11. INFLUENCE OF LUBRICANT PHYSICO-CHEMICAL PROPERTIES ON THE TRIBOLOGICAL OPERATION OF FLUID PHASE PHOSPHOLIPID BIOMIMETIC SURFACES

pp. 130-136

by M.C. Corneci^{1,2}, A.-M. Trunfio-Sfarghiu¹, F. Dekkiche^{3,4}, Y. Berthier¹, M.-H. Meurisse¹ & J.-P. Rieu³

¹Laboratoire de Mécanique des Contacts et des Structures, INSA-Lyon, FRANCE

² Université Technique “Gh. Asachi”, Faculté de Mécanique, 700050, Iasi, Roumanie

³Laboratoire de Physique de la Matière Condensée et Nanostructures, Université Claude Bernard Lyon, France

⁴ Département de Chimie, Faculté de Sciences exactes. Université Mentouri Constantine (25000), Algérie

Abstract: Phospholipid bilayers appear to play a key role in joint lubrication in controlling and reducing frictional forces between biological surfaces. We have investigated the mechanical and tribological properties of Dioleoyl phosphatidylcholine (DOPC) bilayers prepared by the micelle and vesicle method in different solutions (ultrapure water and Tris buffer pH 7.2 with or without 150 mM NaCl). Friction forces are measured using a homemade biotribometer. Mechanical resistance to indentation is measured by AFM and lipid bilayer degradation is controlled in-situ during friction testing using fluorescence microscopy. This study confirms that mechanical stability under shear or normal load is essential to obtain low and constant friction coefficients. The major result is that the Tris buffer pH 7.2 improves

mechanical and tribological stability of the studied bilayers. In ultrapure water, bilayers obtained by the micelle method are not resistant and spontaneously adsorb to the other contacting surface. Bilayers prepared by the vesicle method show slightly better lubricant properties than those prepared by the micelle method. Additional salt (150 mM NaCl) has existing but secondary effects on the mechanical and tribological properties of the bilayers.

12. PHOSPHOLIPIDES DANS LE FLUID SYNOVIAL - INFLUENCE SUR LE FONCTIONNEMENT TRIBOLOGIQUE DES ARTICULATIONS SYNOVIALES PATHOLOGIQUES

pp. 122-129

by M.C. Corneci^{1,2}, A.-M. Trunfio-Sfarghiu¹, F. Dekkiche^{3,4}, Y. Berthier¹, M.-H. Meurisse¹, J.-P. Rieu³, M. Lagarde⁵ & M. Guichardant⁵

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⁵ Institut Multidisciplinaire de Biochimie des Lipides, INSERM / INSA de Lyon, UMR870, F69621, Villeurbanne, France

Abstract: *Des études récentes ont montré le rôle des assemblages lipidiques associées à la structure discontinue du fluide synovial dans les performances du fonctionnement tribologique d'une articulation saine. Dans le cas des pathologies articulaire, ce fonctionnement est modifié. Ce travail cherche ainsi à identifier l'influence de la variation en composition lipidique des fluides synoviaux pathologiques sur le fonctionnement tribologique des articulations synoviales atteintes de différentes pathologies (arthrite, arthrose).*

13. MICRODEFECTS ANALYSIS OF DENTAL CONTACT SURFACES

pp. 106-111

by Gheorghe FRUNZA¹, Mihai Catalin FRUNZA² & Cornel SUCIU¹

¹ University of Suceava, Romania, Faculty of Mechanical Engineering, Mechatronics and Management

² University of Medicine and Pharmacy, Bucharest, Romania, Faculty of Dental Medicine

Abstract: *The tribological processes influence the behaviour of the biocontacts between biological bodies, between biomaterials, or between biological bodies and biomaterials. 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 changes, 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 stomatognathic system.

This paper presents a tribological model concerning dental contacts deterioration, based on contact mechanics elements, fracture mechanics and on the actual topography of the tooth surface.

14. IMAGERIE MEDICALE POUR EVALUER LES CONDITIONS DU FONCTIONNEMENT TRIBOLOGIQUES DES ARTICULATIONS SYNOVIALES

pp. 137-149

by Simon LE FLOC'H^{1,2}, M.C. Corneci^{2,3}, A.-M. Trunfio-Sfarghiu², M.-H. Meurisse², J.-P. Rieu⁴, J. Duhamel², C. Dayot², F. Dang², M. Bouvier², C. Godeau², A. Saulot², Y. Berthier

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Abstract: *Le but de ce travail est d'évaluer avec précision les conditions tribologiques macroscopiques subies par l'articulation du genou au cours de la marche en essayant de considérer les interactions entre elles ; Le contexte plus global est la compréhension du fonctionnement tribologique de l'articulation saine lui permettant de durer 70 ans. Dans une première partie, les vitesses relatives tangentielles entre les surfaces en contact ont été évaluées au cours de la marche. L'étude a été consacrée aussi à l'évaluation des conditions géométriques du contact lorsque le pied subit un effort de compression de l'ordre de 300 N (patiente de 29 ans pesant 60 kg ayant subi une ménisctomie). Les résultats sur la déformée sont validés qualitativement par des éléments bibliographiques. Ils permettent d'émettre une hypothèse quant à la capacité du cartilage à se déformer de quelques dixièmes de mm suivant son épaisseur sans que la pression locale de contact soit importante, permettant une répartition de la pression très efficace. L'étude a été complétée par l'évaluation de l'influence des efforts musculaires sur la réaction de contact et sur les déplacements relatifs des os (patient de 36 ans et de 62 kg (avec une lésion des ménisques) a subi une compression du membre inférieur). Il est conclu que l'action des muscles augmente énormément la pression moyenne de contact, mais que cette action peut aussi permettre d'optimiser les conditions de contact en déplaçant le tibia par rapport au fémur.*

15. ANALYSE MECANIQUE ET PHYSICO-CHIMIQUE MULTIECHELLE DU FONCTIONNEMENT TRIBOLOGIQUE DES IMPLANTS ORTHOPEDIQUES

pp. 150-162

by A.M. Trunfio-Sfarghiu¹, M.C. Corneci^{1,2}, Y. Berthier¹, M.H. Meurisse¹ & J.P. Rieu³

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Abstract: *The aim of this work is to identify the coupled role of the biological components of synovial fluid in the remarkable tribological operation of a healthy natural joint, as well as in the friction of steel and polythene implants. It uses a realistic ex-vivo model capable of reproducing the mechanical and physicochemical characteristics of the entire tribological triplet of the joint, whether healthy or implanted. It particularly focuses on the lipidic bilayers and vesicle structures associated with synovial fluid. The analysis of the friction measurements and fluorescence microscopy images confirm the role of lipidic bilayers in maintaining a very low friction coefficient. In addition, we observe that the substitute cartilage favours the formation and maintenance of these bilayers, which is not the case of implant materials.*

16. A WEAR MODEL OF UHMWPE IN HUMAN PROSTHESIS

pp. 112-121

by Andrei TUDOR, Georgiana CHISIU & Alina POPESCU

Polytechnic University of Bucharest, Romania

Abstract: *The wear rate of ultra-high molecular polyethylene (UHMWPE) total joint prosthesis is known to be influenced by various factors such as material and design. However, it is not known if these factors affect the size or morphology of the wear particles. A theoretical model of wear particle that is based of intimate conical asperity with spherical tape and prismatic asperity with cylindrical tape interactions are proposed to account for the observed differences in sliding and rolling wear. Archard's wear coefficient has determined for plastic contact of UHMWPE with the rigid asperity of biocompatible steel used in the prosthesis.*

Friction and Wear

17. EVALUATING TRIBOLOGICAL DAMAGES BY 3D PROFILOMETRY

pp. 163-169

by Lorena Deleanu & Sorin Ciortan

Machine Design and Graphics, University Dunarea de Jos – Galati, Romania

Abstract: *The authors present a study on using 3D roughness parameters for assessing the quality of worn surfaces of polymeric composites. A set of three plates was tested under water lubrication in contact with a steel disc, being tested at 2.5m/s (the sliding speed at plate center) and average pressure 2.02 MPa. The plates (6 x 20 x 30 mm) were made of PTFE composites with glass fibers (0% for the polymer, 15%, 25% and 40%, respectively).*

18. ROLLING FRICTION TORQUE IN MICROSYSTEMS

pp. 170-177

by D. N. Olaru, C. Stamate, A. Dumitrascu & Gh. Prisacaru

Department of Machine Elements and Mechatronics, Technical University “Gheorghe Asachi” –Iasi, Romania

Abstract: *To determine the rolling friction torque in the micro rolling systems the authors developed an analytical model based on the dissipation of the inertial energy of a rotating microdisc in three rolling microballs. Using an original microtribometer with two steel rotating discs and three steel micro balls was determined the rolling friction torque in dry conditions for contacts loaded with normal forces of 8.68 mN to 33.2 mN and with rotational speed between 30 to 210 rpm. The experimental results confirm the hypothesis that the rolling friction torque in dry contacts is not depending of the rotational speed*

19. CHARACTERISATION OF LASER CLADDING WITH Ni–Cr–B–Fe– Al ALLOY BY PROFILOMETRIC STUDY OF THE SCRATCH TRACKS

pp. 188-196

by Minodora Rîpă & Simona Boiciuc

University “Dunarea de Jos” of Galati, Galati, Romania

Abstract:

20. ABOUT A „TRIBOLOGICAL PASSPORT” OF WHEEL-RAIL CONTACT IN METRO SYSTEM

pp. 178-187

by Andrei TUDOR¹, Nicolae SANDU² & Ilias TOUNTAS³

¹Polytechnic University of Bucharest, Romania

²Romanian Authority of Rail Way, Bucharest, Romania, ³Attiko Metro A.E. Athena, Greece

Abstract: *The adhesion coefficient in the rail-wheel contact is known to be influenced by various factors such as material and longitudinal creepage, contact pressure and environmental conditions (dry, contaminated contact with water or hydraulic oil). The adhesion map contains the friction coefficients which are represented as a function of the relative longitudinal sliding velocity and the contact pressure. Dimensionless contact pressure is defined as the ratio of the hertzian contact pressure and the minimum contact surface hardness. The experimental results of adhesion coefficient obtained by the Amsler friction and wear machine are fitted by analytical curves (parabola and line).*

21. AN ANALYTICAL WEAR MODEL OF THE PIPES FOR CONCRETE TRANSPORTATION

pp. 197-206

by Monica VLASE¹ & Andrei TUDOR²

¹Technical University of Civil Engineering of Bucharest, Romania

²University POLITEHNICA of Bucharest, Romania

Abstract: *The flow of fresh concrete in the pipe can be realized only when the concrete is saturated. The tribological solutions are formulate to obtained the saturation of concrete. The effect of flow in pipe is evaluated by the friction with the wall and the pipe wear. It is defined a critical angle of concrete impact in transition between horizontal and vertical pipe as a function to the friction coefficient, the velocity and the mean radius of solid particle in fresh concrete. The erosion wear model is proposed for inside of pipe in contact with concrete.*

Rheology

22. INFLUENCE OF NANOPARTICLES ON LUBRICITY OF BASE MINERAL OIL

pp. 92-95

by Juozas Padgurskas¹, Raimondas Kreivaitis¹, Arturas Kupčinskas¹, Raimundas Rukuiža¹, Vytenis Jankauskas¹ & Igoris Prosyčėvas²

¹Department of Mechanical Engineering Lithuanian University of Agriculture – Kaunas, Lithuania

²Institute of Physical Electronics, Kaunas University of Technology – Kaunas, Lithuania

Abstract: *The tribological properties of mineral oil SAE 10 modified with metallic nanoparticles were investigated. The tribological tests were performed using four-ball test rig. Friction and wear reduction properties were measured. There was observed the positive influence of nanoparticles on lubricity of mineral oil. The best result was obtained when using the copper nanoparticles for a single metal nanosuspension (0.25 % Cu). Using double metal nanoparticles the best result show iron – copper nanosuspension (0.125 % Fe + 0.125 % Cu). The use of those suspensions was most efficient for pure base mineral oil. The cobalt nanosuspension does not show the significant increase in lubricity. It was observed that nanosuspensions stabilise and decrease the friction during the tests.*

23. INFLUENCE OF THE RHEOMETER GEOMETRY ON THE RHEOLOGICAL PROPERTIES OF INDUSTRIAL LUBRICANTS

pp. 80-85

by Alexandru V. Radulescu¹ & Irina Radulescu²

¹Department of Machine Elements and Tribology, University POLITEHNICA Bucharest, Romania

²Mechanical Engineering and Research Institute S. C. ICTCM S.A. Bucharest, Romania

Abstract: *The rheological properties of two transmission lubricants (75W90 and 75W140), in fresh and used state, were investigated using shear viscosity rheological measurements. It was found that the lubricants do not exhibit a yield stress and that, above a critical shear rate, they exhibit shear-thinning behaviour, well described by the Cross model. The rheological measurements were performed on a Brookfield viscometer CAP2000+ equipped with four cone-and-plate geometry, for a range of temperature between 20 ... 70°C, using the viscometer Peltier system. The experiments have shown that only two geometries are appropriate for testing the transmission lubricants. Another important conclusion refers to the influence of the wear degree of the lubricant on the rheological parameter of the model.*

24. MEASUREMENT OF LUBRICANT OIL MICROVISCOSITY BASED ON RESONANT FREQUENCY SHIFT OF AFM CANTILEVER

pp. 86-91

by Vlad Flaviu ZEGREAN & Emanuel DIACONESCU

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

Abstract: *Experimental investigations on microviscosity of T90 lubricant oil were conducted using an atomic force microscope. The resonant frequency of the cantilever beams was measured in air, in pure water and in sample oil. Based on the resonant frequency shift the viscosity of the lubricant was calculated using the formula deduced by Papi [1] for uncalibrated cantilevers. The results obtained are in good agreement with those of Ionescu [2], measured with a Rheotest2 rheometer, for the same lubricant.*

PhD Students

28. LITERATURE SURVEY OF BIOARTICULAR CONTACT RESEARCH ISSUES

pp. 230-238

by Brîndușa Bejinariu & Emanuel Diaconescu

Department of Mechanical Engineering, University of Suceava, Romania

Abstract: *In past years many researchers tried to determine the roles cartilages play within bioarticulations, in order to advance an articular repairing techniques. This paper presents a synthetic literary survey of the current state in cartilage research, as well as lubrication mechanisms encountered in bioarticulations.*

27. CURRENT ISSUES ON ELASTIC CONTACTS IN PRESENCE OF A THIN LAYER

pp. 222-229

by Maria Ciornei & Emanuel Diaconescu

Department of Mechanical Engineering Stefan cel Mare University, Suceava, Romania

Abstract: *Mechanical systems often employ thin elastic layers. Their behavior is different from bodies they come in contact with, which can usually be approximated by elastic halfspaces. Therefore knowledge of the stress and strain states in a normally and/or tangentially loaded thin layer is of great importance. Present paper synthesizes a number of analytical and numerical research works on the subject of contact involving thin layers.*

25. BIOARTICULAR FRICTION

pp. 207-212

by Ionut Cristian Romanu & Emanuel Diaconescu

Department of Mechanical Engineering, University of Suceava, Romania

Abstract: *The present paper illustrates experimental investigations of bioarticular friction. The first set of experiments was conducted on a pig synovial joint and the second one investigates the friction between a spherical cap made out of cartilage and an elastic half-space. For the experimental investigations, a device was conceived and built that ensures rolling and sliding movements of the joint.*

26. RESEARCH ISSUES ON PUNCH – CIRCULAR PLATE ELASTIC CONTACTS

pp. 213-221

by Marius TRANDAFIR & Emanuel Diaconescu

Department of Mechanical Engineering, University of Suceava, Romania

Abstract: *Circular plates enter into category of finite dimension bodies. Solutions regarding the displacements and stresses which appear at the contact involving finite dimension bodies and also numerical and analytical results regarding some plate were reviewed in this study. For thin bodies and small transversal dimension bodies Diaconescu and Glovnea [1], [2] advanced analytical solutions solving a Boussinesq type problem for a elastic layer and a Boussinesq type problem for a cylindrical body. The obtained results satisfy all elasticity requirements so they are the searched ones. Experimental set-ups build by Glovnea [3] and Ovcharenko [4], used to investigate contact problems via laser profilometry or direct optical methods were also reviewed.*