1. A rolling contact fatigue model of flexible ball screw actuators incorporating microscopic stress cycles

Zhang, Yuhao (1, 2); An, Linxue (3); Cui, Peijuan (3); Miao, Jianghai (1, 2); Mu, Fei (4); Pu, Wei (1, 2)
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Abstract: The flexibility deformation of ball screw actuators induces non-uniform load distribution, which contributes more asperity contact and thereby introduces microscopic stress cycles. How flexibility and microscopic stress cycles influence contact fatigue remain unclear. This study establishes a rolling contact fatigue model for flexible ball screw actuators considering microscopic stress cycles. The load distribution and axial rigidity of ball screw actuators are simulated through low-order finite element. Based on unified mixed lubrication theory, a novel fatigue life prediction model incorporating microscopic stress cycles is proposed. The effects of rough surface, load distribution, preload, and radial load on contact fatigue are analyzed. The results demonstrated that smooth surface solutions overestimate fatigue life compared to rough surface. Increased radial load reduces fatigue life in both locating bearings and ball screws, but with greater severity in bearings. Furthermore, the axial rigidity rises sharply then plateaus with increasing preload, while fatigue life declines steadily then drops sharply. Applying preload within the transition region from two-point to four-point contact offers an optimal trade-off between extended fatigue life and enhanced rigidity. This new model provides a theoretical basis for fatigue assessment of ball screw actuators. © 2025 Elsevier Ltd (47 refs)
Main heading: Ball screws
Controlled terms: Electric power plant loads - End effectors - Fatigue of materials - Friction - Lubrication - Point contacts - Rigidity - Surface measurement
Uncontrolled terms: Ball screw actuator - Ball-screw - Fatigue model - Flexibility effect - Load distributions - Microscopic stress cycle - Mixed lubrication - Pre loads - Rolling contact fatigue - Stress cycle
Classification Code: 214 Materials Science - 606.2 Lubrication - 704.1 Electric Components - 706.1.2 Electric Power Distribution - 714.2 Semiconductor Devices and Integrated Circuits - 731.5 Robotics - 732.1 Control Equipment - 941.5 Mechanical Variables Measurements - 971 Social Sciences - 1301.1.1 Mechanics
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Database: Compendex
Data Provider: Engineering Village

2. Rolling Contact Fatigue Failure Analysis of Ball Bearing in Gear Box

Palit, Piyas (1); Sri, Padma (1, 2); Gokarn, Prabhash (1, 2); Kumar, Anup (1, 2); Das, Santanu (2)
Source: *Journal of Failure Analysis and Prevention*, v 25, n 1, p 62-69, February 2025; **ISSN:** 15477029, **E-ISSN:** 18641245; **DOI:** 10.1007/s11668-025-02109-7; **Publisher:** Springer
Author affiliation: (1) Scientific Services Division, Tata Steel Limited, Kalinganagar, India (2) Mechanical Maintenance, Blast Furnace, Tata Steel Limited, Kalinganagar, India
Abstract: Bearing is an important machinery part in industry. When bearings fail to meet their expected life, the consequences are increased down time, loss of revenue and missed delivery. This article describes the failure of a gear box bearing in rolling contact fatigue. The investigation consists of visual observation, chemical analysis, characterization of microstructures using optical microscopes and hardness test. The present study also considers bearing life as well as operational condition of bearings. Surface-initiated rolling contact fatigue, leading to a surface failure known as pitting, is a life-limiting failure mode in many modern machine elements, particularly rolling element bearings. Metallography analysis of crack propagation and crack morphology was also described. Indication of fatigue spalling in ferrography test was also discussed. Analysis suggested the probable reasons of such kind of failure in operation. © ASM International 2025. (7 refs)
Main heading: Cracks
Controlled terms: Ball bearings - Brinell hardness testing - Corrosion fatigue - Fatigue testing - Fracture mechanics - Gears - Phosphorus - Roller bearings - Rolling
Uncontrolled terms: Bearing - Bearing life - Chemical analyse - Down time - Expected life - Fatigue failure analysis - Gear-box - Optical microscopes - Rolling contact fatigue - Visual observations
Classification Code: 201.5.1 Metal Rolling - 201.9.1 Metals Corrosion - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 804 Chemical Products - 1301.1.1 Mechanics

Database: Compendex
Data Provider: Engineering Village

3. Rolling contact fatigue failure mechanism with the multi-scale analysis of BG801 high temperature bearing steel

Lin, Feihu (1); Wang, Liqin (1, 2); Li, Zhen (1); Yin, Longcheng (1, 4); Wu, Jiqiang (1); Zheng, Dezhi (1); Bao, Maokuan (1); Liu, Peng (1); Zhai, Han (1); Shu, Kun (1, 3)
Source: *International Journal of Fatigue*, v 193, April 2025; **ISSN:** 01421123; **DOI:** 10.1016/j.ijfatigue.2024.108760; **Article number:** 108760; **Publisher:** Elsevier Ltd
Author affiliation: (1) MIIT Key Laboratory of Aerospace Bearing Technology and Equipment, Harbin Institute of Technology, Harbin; 150001, China (2) State Key Laboratory of Robotics and Systems, Harbin Institute of Technology, Heilongjiang, Harbin, China (3) Zhengzhou Research Institute, Harbin Institute of Technology, Zhengzhou; 450007, China (4) AECC Harbin Bearing Co., Ltd, Harbin; 150000, China
Abstract: With the development of the aviation industry, the operating conditions of aero-engine bearings have become increasingly severe. To improve the lifespan of bearings, a new type of high-temperature bearing steel BG801 has been produced. In this study, a ball-on-rod rolling contact fatigue (RCF) tester is used to examine the RCF damage evolution process and failure mechanism of BG801 bearing steel. The mechanical properties and organizational structure of BG801 bearing steel are characterized at the millimeter, micrometer, and nanometer scales. The damage evolution during the test is explored and the failure mechanism is analyzed. The research results show that the uniformly distributed refined M_7C_3 carbides and matric grains refinement produced in the subsurface layer during the carburizing process are the main factors that improve the anti-RCF performance of BG801 bearing steel. The RCF of BG801 bearing steel is caused by the interaction of the non-uniform distribution of subsurface M_7C_3 carbides, the existence of the second phase inside the M_7C_3 carbides, and the degradation of the mechanical properties of the matrix. This study provides an in-depth analysis of the RCF failure mechanism of BG801 bearing steel for the first time. The results provide data for the material's performance optimization and engineering applications. © 2024 (33 refs)
Main heading: Carburizing
Controlled terms: Aerospace industry - Fatigue damage - Fracture mechanics - Hydroelasticity - Roller bearings - Thermal fatigue
Uncontrolled terms: Bearing steels - Bg801 - Damage evolution - Failure mechanism - Fatigue failures - Highest temperature - Mechanical - Multi scale analysis - Property - Rolling contact fatigue
Classification Code: 201.7.1 Heat Treatment Processes - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 301.2 Hydrodynamics - 601.2 Machine Components - 657 Aerospace Engineering, Other Topics - 1301.1.1 Mechanics
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Database: Compendex
Data Provider: Engineering Village

4. Simulation and experimental investigation of rolling contact fatigue crack propagation in pitch-bearing gears of offshore wind turbines

Yue, Yong (1, 3); Jin, Xin (1); Ren, Yidong (1); Wu, An (1, 2); Chen, Junchi (1)
Source: *Engineering Fracture Mechanics*, v 333, February 21, 2026; **ISSN:** 00137944; **DOI:** 10.1016/j.engfracmech.2025.111803; **Article number:** 111803; **Publisher:** Elsevier Ltd
Author affiliation: (1) College of Mechanical and Vehicle Engineering, Chongqing University, Chongqing; 400030, China (2) Goldwind Science& Technology Co., Ltd, Beijing; 100176, China (3) College of Mechanical and Electrical Engineering, Xinjiang Agricultural University, Urumqi; 830052, China
Abstract: This study investigates rolling contact fatigue crack propagation in offshore wind turbine pitch-bearing gears using combined numerical and experimental methods. A 5 MW gear pair FEM model identified stress distributions and crack initiation sites, while a novel peridynamics approach simulated rolling contact fatigue (RCF)-driven crack evolution. Simulation results show maximum contact stress (1029.26 MPa) during single-tooth meshing under emergency braking, critically affecting crack behavior. Cracks exhibited dynamic "opening-closing-reopening" cycles, transitioning from Mode I to Mode II-dominant mixed-mode propagation at loads '1000 MPa. The initial crack inclination angle significantly influences the propagation path: shallow-angle cracks ('60°) tend to deflect towards the surface, leading to spalling, whereas

steeper cracks (≥60°) promote vertical growth into the material interior, accompanied by branching. The study further identifies the interfaces of the material gradient layers (hardened-transition-substrate) as critical zones for crack deflection and branching. An increase in the friction coefficient (μ = 0.4) accelerates both surface spalling and crack branching. Experimental validation confirms the effectiveness of the numerical predictions, with the observed crack paths showing strong agreement with the simulation results. This research provides important theoretical insights for early damage detection and life prediction of pitch bearings in wind turbines. © 2025 Elsevier Ltd. (49 refs)
Main heading: Offshore wind turbines
Controlled terms: Damage detection - Fatigue crack - Fatigue crack propagation - Friction - Gears - Interfaces (materials) - Offshore oil well production - Roller bearings
Uncontrolled terms: Combined numerical methods - Crack branching - Cracks propagation - Experimental investigations - Fatigue cracks propagation - Offshore winds - Peridynamics - Pitch-bearing gear - Rolling contact fatigue - Rolling contact fatigue cracks
Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 511.1 Oil Field Production Operations - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 913.3.1 Inspection - 1008.5 Wind Power and Wind Power Generation - 1301.1.1 Mechanics
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Database: Compendex
Data Provider: Engineering Village

5. Rolling contact fatigue tests on pre-damaged slewing bearings (*Open Access*)

Behnke, Karsten (1); Menck, Oliver (1)
Source: *Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology*, 2025; **ISSN:** 13506501, **E-ISSN:** 2041305X; **DOI:** 10.1177/13506501251385051; **Publisher:** SAGE Publications Ltd, Article in Press
Author affiliation: (1) Large Bearing Laboratory, Fraunhofer Institute for Wind Energy Systems IWES, Hamburg, Germany
Abstract: Blade bearings of wind turbines are grease-lubricated rolling bearings which are operated in an oscillating manner. They can be subjected to both rolling contact fatigue and wear, in particular standstill marks and false brinelling. Rolling contact fatigue arises from alternating stresses due to the passage of rolling elements under high loads, standstill marks and false brinelling occur during cyclic motion and are often exacerbated by inadequate lubrication. In this paper, we want to understand fatigue and the influence of false brinelling on fatigue better and to investigate whether it is advantageous to avoid false brinelling. We performed fatigue tests with four blade bearings. Three of them had existing false brinelling damage. In addition, we repeated tests on much smaller angular contact ball bearings. To contextualize the results, we calculated the fatigue life of a pitch bearing from a reference turbine matching our test bearing design and compared the calculation to the test results. Although the stochastic fatigue behavior in combination with the low number of tests makes it difficult to draw general conclusions, the results indicate that false brinelling shortens fatigue life, even if the blade bearings pass the fatigue test. © IMechE 2025. This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access page (https://us.sagepub.com/en-us/nam/open-access-at-sage). (33 refs)
Main heading: Roller bearings
Controlled terms: Angular contact ball bearings - Bearings (structural) - Cell proliferation - Fatigue damage - Fatigue testing - Friction - Lubricating greases - Lubrication - Stochastic systems - Turbine components - Turbomachine blades
Uncontrolled terms: Alternating stress - False brinelling - Fatigue calculations - Pitch bearing - Rolling bearings - Rolling contact fatigue - Rolling contact fatigue test - Rolling contact wears - Slewing bearings - Test
Classification Code: 103 Biology - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 408 Structural Design - 408.1 Structural Members and Shapes - 601.2 Machine Components - 606.1 Lubricants - 606.2 Lubrication - 1007 Turbomachinery - 1007.1 Turbines and Steam Turbines - 1008.5 Wind Power and Wind Power Generation - 1202.1 Probability Theory - 1301.1.1 Mechanics
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Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

6. A combined rolling contact fatigue damage mechanism for EMU train axle box bearings

Zhang, Zhewei (1); Chen, Zilong (2); Wu, Yi (1); Fu, Hanwei (2)
Source: *International Journal of Fatigue*, v 208, July 2026; **ISSN:** 01421123; **DOI:** 10.1016/j.ijfatigue.2026.109533; **Article number:** 109533; **Publisher:** Elsevier Ltd
Author affiliation: (1) Institute of Metals & Chemistry, China Academy of Railway Sciences Corporation Limited, Beijing; 100081, China (2) School of Materials Science and Engineering, Beihang University, 37 Xueyuan Road, Beijing; 100191, China
Abstract: The fatigue fracture of bearings is a major threat to the service safety of EMU trains. This study systematically investigates the evolution of spalling in axle box bearing outer rings through detailed characterization and in-depth analysis, proposing a combined rolling contact mechanism. Two distinct regions are identified in the spalls, respectively corresponding to subsurface- and surface-induced rolling contact fatigue (RCF) damages. Crack propagation and branching behaviors are thoroughly revealed in different spalling regions. According to this study, spalling begins with subsurface cracks originating at the depth consistent with the peak maximum shear stress under Hertzian contact, forming concentric ellipses with deep pits. As spalling progresses, surface-initiated cracks from spall-edge stress concentration can lead to further, shallow material removal that broadens with increasing over-rolling cycles. Electron backscatter diffraction and nanoindentation show that local microstructural refinement and hardening occur along with crack formation. A critical threshold stress intensity factor that dominates RCF crack growth is found, which is crucial for RCF modelling and life prediction. The study also identifies two crack-carbide interaction modes, cutting-through and bypassing, with the transition between them determined by a critical carbide diameter of 1 μm. These findings provide crucial insight into the RCF mechanism and offer practical guidance for long-life railway bearing steels. © 2026 Elsevier Ltd. (67 refs)
Main heading: Spalling
Controlled terms: Axles - Carbides - Electric railroads - Fatigue crack propagation - Fatigue damage - Fracture - Railroads - Roller bearings - Shear stress - Stress intensity factors - Surface defects
Uncontrolled terms: Axle boxes - Cracks propagation - EMU train bearing - Fatigue damage mechanism - Fatigue fracture - Fatigue mechanism - Rolling contact fatigue - Service safeties - Train bearings
Classification Code: 204.1 Ceramics - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 662.3 Automobile Components and Materials - 663.2 Heavy Duty Motor Vehicle Components - 681 Railway Plant and Structures - 804.2 Inorganic Compounds - 1501.1.1 Sustainable Transport
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Funding text: This study was financially supported by National Science and Technology Major Project for Key New Materials R&D and Applications \u201CLong-life Bearing Steel and Application for New-Generation High-Speed Train\u201D (Grant number: 2025ZD0610801). H. Fu acknowledges the support from National Natural Science Foundation of China (Grant number: 51971011).
Database: Compendex
Data Provider: Engineering Village

7. Rolling contact fatigue calculation of a three-row roller pitch bearing in a wind turbine (*Open Access*)

Menck, Oliver (1); Schleich, Florian (1); Stammler, Matthias (1)
Source: *Wind Energy Science*, v 10, n 11, p 2771-2789, November 27, 2025; **ISSN:** 23667443, **E-ISSN:** 23667451; **DOI:** 10.5194/wes-10-2771-2025; **Publisher:** Copernicus Publications
Author affiliation: (1) Fraunhofer Institute for Wind Energy Systems (IWES), Hamburg; 21029, Germany
Abstract: Rolling contact fatigue calculations of wind turbine pitch bearings need to consider the oscillating operation and the complex dynamic load distribution in the bearing. The present work proposes a methodology to calculate the life of a pitch bearing that is a roller bearing, specifically a three-row roller bearing. Previous publications in this field have discussed the life calculation of ball pitch bearings. Methodologies applicable to any pitch rolling bearing are partly improved upon in the present work. Several aspects not applicable to roller bearings are re-thought. In comparison to ball bearings, the rolling contact fatigue calculation of roller bearings adds another level of complexity, since they have a long contact that is typically discretized if strong deformation is present, leading to significantly more degrees of freedom. Exemplary calculations are carried out using a slightly modified version of an extensively validated finite-element (FE) model of a three-row roller bearing of a wind turbine. This paper focuses on the methodology used to calculate the life. The axial rows were found to have a much lower fatigue life than the radial row, and thus the axial rows are the main determinant of the fatigue life of the bearing. They also were shown to have a much lower uncertainty than the radial row using the approach proposed in this paper. © Author(s) 2025. This work is distributed under. (34 refs)
Main heading: Degrees of freedom (mechanics)
Controlled terms: Ball bearings - Bearings (structural) - Dynamic loads - Fatigue of materials - Roller bearings - Rollers (machine components)

Uncontrolled terms: Complex dynamics - Dynamic load distribution - Fatigue calculations - Finite element modelling (FEM) - Rolling bearings - Rolling contact fatigue - Uncertainty
Classification Code: 214 Materials Science - 408 Structural Design - 408.1 Structural Members and Shapes - 601.2 Machine Components - 1008.5 Wind Power and Wind Power Generation - 1301.1.1 Mechanics
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8. Effect of Primary Carbides on the Rolling Contact Fatigue Behavior of M50 Bearing Steel

Alza, Victor Alcantara (1)
Source: *Minerals, Metals and Materials Series*, p 1597-1605, 2026, *TMS 2026 155th Annual Meeting and Exhibition Supplemental Proceedings*; **ISSN:** 23671181, **E-ISSN:** 23671696; **ISBN-13:** 9783032138279; **DOI:** 10.1007/978-3-032-13828-6_135; **Conference:** 155th Annual Meeting and Exhibition of The Minerals, Metals and Materials Society, TMS 2026, March 15, 2026 - March 19, 2026;
Publisher: Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) Mechanical Engineering and Energy, National University of Trujillo, Trujillo, Peru
Abstract: The fatigue performance of all high-strengthStrengthsteelsSteel is affected by internal defects. Primary carbidesPrimary carbides have been shown to be the main type of defects in M50 bearing steelsSteel used in the aerospace industry. Therefore, these steelsSteel must be characterized under service conditions, and their rolling contact fatigueRolling contact fatigue (RCF) propertiesProperties must be evaluated under different friction conditions. A method for analyzing the response of primary carbidesPrimary carbides is proposed; the RCF processProcess is further separated into a period of plastic instability and an elastic period. The accumulation of plastic deformation around the carbides before elastic deformation is proposed as the RCF damage parameter, and the influence of primary carbidesPrimary carbides is studied based on the damage criterion. The competition between surface and internal fatigue initiation is revealed through different coefficients of friction. A predictive model for RCF initiation is proposed, which could predict critical sizesCritical sizes for different types of primary carbidesPrimary carbides that are not detrimental to RCF performance, and critical sizesCritical sizes are calculated under typical industrial service conditions. © The Minerals, Metals & Materials Society 2026. (32 refs)
Main heading: Plastic deformation
Controlled terms: Aerospace industry - Carbides - Defects - Fatigue damage - Friction - Roller bearings
Uncontrolled terms: Bearing steels - Critical size - Fatigue behaviour - Fatigue performance - Internal defects - Plastic deformation accumulation - Primary carbides - Rolling contact fatigue - Rolling contacts - Service conditions
Classification Code: 201.1.2 Metallography - 204.1 Ceramics - 214 Materials Science - 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 601.2 Machine Components - 657 Aerospace Engineering, Other Topics - 804.2 Inorganic Compounds - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

9. Coupling mechanism of rolling contact fatigue and corrosion on bearing steel in brine contaminated lubricant oil under heavy load

Xia, Zhuofan (1, 2); Wang, Youzhi (4, 7); Wu, Di (1, 3); Zhang, Xiaochen (1, 2); Li, Yifeng (5); Hao, Long (1, 4); Wang, Jianqiu (2, 6); Han, En-Hou (2, 6)
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Abstract: The interaction mechanism of rolling contact fatigue (RCF) and corrosion on bearing steel in salt water contaminated lubricating oil is systematically studied in combination with characterization of damage behavior and electrochemical impedance spectroscopy. The results compared the rolling contact corrosion fatigue damage behavior and life of bearing steel in two different lubricating oils. The rolling contact fatigue life of bearing steel will reduce after salt water contaminated lubricating oil. However, the magnitude of the effect of salt water contaminated lubricating oil on fatigue life is determined by the dissolved state of salt water and lubricating oil. In water soluble lubricating oil, salt water and chloride ions can be evenly dispersed in the lubricating oil causing a large number of deep pitting corrosion on contact surface. The bearing steel surface will form dense corrosive pits and small-size spalling pit, resulting in failure of vibration. In water insoluble lubricating oil, salt water containing chloride ions are just dispersed as droplets in the lubricating oil to form shallow uniform corrosion on the contact surface. The predominant failure mechanism in bearing steel manifests as rolling contact fatigue. Therefore, it is suggested that the high viscosity and water insoluble lubricant should be considered at the same time when selecting the lubricating oil for the bearing steel under heavy load and corrosive environment. © 2025 Elsevier Ltd (49 refs)
Main heading: Steel corrosion
Controlled terms: Atmospheric corrosion - Corrosion fatigue - Corrosive effects - Electrochemical corrosion - Fatigue damage - Fracture mechanics - Lubricating oils - Pitting - Pollution induced corrosion - Roller bearings - Seawater corrosion - Spalling
Uncontrolled terms: Bearing steels - Chloride ions - Contact corrosion - Contact surface - Coupling mechanism - Damage behaviour - Heavy loads - Rolling contact fatigue - Surface-initiated - Surface-initiated failure
Classification Code: 201.9.1 Metals Corrosion - 202.5.3 Steel - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 443.1 Atmospheric Properties - 471.4 Seawater, Tides and Waves - 601.2 Machine Components - 606.1 Lubricants - 801.3.1 Electrochemistry - 802.2 Chemical Reactions - 1301.1.1 Mechanics
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Funding text: Academy of Sciences, Grant No. XDC04030400This work was funded by the Strategic Priority Research Program of the Chinese Academy of Sciences, Grant No. XDC04030400.
Database: Compendex
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10. Enhanced rolling contact fatigue property of a rare earth addition bearing steel with a gradient nanostructured surface layer

Dong, G.S. (1, 2); Gao, B. (1); Yang, C.Y. (1); Wang, Z.B. (1)
Source: *Journal of Materials Science and Technology*, v 211, p 267-277, March 10, 2025; **ISSN:** 10050302; **DOI:** 10.1016/j.jmst.2024.06.005; **Publisher:** Chinese Society of Metals
Author affiliation: (1) Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, 72 Wenhua Road, Shenyang; 110016, China (2) School of Materials Science and Engineering, University of Science and Technology of China, 72 Wenhua Road, Shenyang; 110016, China
Abstract: Rolling contact fatigue performance is among the most important issues for applications of bearing steels. In this work, a recently developed surface modification technique, surface mechanical rolling treatment, was applied on a rare-earth addition bearing steel. And rolling contact fatigue behavior of treated samples was compared with that of as-received counterparts at different contacting stresses. The results demonstrated that a 700 μm-thick gradient nanostructured surface layer is produced on samples by surface mechanical rolling treatment. The grain size decreases while the microhardness increases gradually with decreasing depth, reaching #23 nm and #10.2 GPa, respectively, at the top surface. Consequently, the rolling contact fatigue property is significantly enhanced. The characteristic life of treated samples is #3.2 times that of untreated counterparts according to Weibull curves at 5.6 GPa. Analyses of fatigue mechanisms demonstrated that the gradient nanostructured surface layer might not only retard material degradation and microcrack formation, but also prolong the steady-state elastic response stage under rolling contact fatigue. © 2024 (53 refs)
Main heading: Friction
Controlled terms: Fatigue of materials - Nanostructured materials - Rare earths - Roller bearings - Surface treatment
Uncontrolled terms: Bearing steels - Fatigue properties - Gradient nanostructured - Mechanical - Nano-structured - Nanostructured surface layer - Rare earth addition bearing steel - Rolling contact fatigue - Rolling treatment - Surface mechanical rolling treatment

Classification Code: 601.2 Machine Components - 761 Nanotechnology - 804.2 Inorganic Compounds - 933.1 Crystalline Solids - 951 Materials Science
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Funding text: The financial supports by the Chinese Academy of Science s (Nos. XDC04030300 and XDB0510303), CAS-HK Joint Laboratory of Nanomaterials and Mechanics, and Shenyang National Laboratory for Materials Science are acknowledged. We are also indebted to Prof. Dianzhong Li for constructive discussions, to Prof. Zhong Han for assistances in RCF tests, to Profs. Paixian Fu and Yikun Luan for supplying RE-GCr15 billets and valuable discussion.
Database: Compendex
Data Provider: Engineering Village

11. [Revealing the butterfly white etching area and crack formation mechanism under rolling contact fatigue in M50 bearing steel]

Deng, Yahui (1); Sheng, Junjie (1); Liu, Tengshi (1, 2); Wang, Yangxin (1); Hu, Chundong (1, 2); Dong, Han (1, 2)
Source: *Materials Characterization*, v 223, May 2025; **ISSN:** 10445803; **DOI:** 10.1016/j.matchar.2025.114936; **Article number:** 114936; **Publisher:** Elsevier Inc.
Author affiliation: (1) School of Materials Science and Engineering, Shanghai University, Shanghai; 200444, China (2) Zhejiang Institute of Advanced Materials, SHU, Jiashan; 314100, China
Abstract: White etching area (WEA) and the associated white etching crack (WEC) are mainly responsible for failure of widely spread aerospace materials such as M50 bearing steel The microstructural evolution and formation mechanism of butterfly WEA and WEC in M50 steel during rolling contact fatigue (RCF) at micro-cale to nano-cale are systematically analyzed. The results demonstrate that the butterfly WEA comprises a nanocrystalline α-Fe phase, M_2C and M_7C_3 nanocrystallites, and an amorphous phase. We propose that H can serve as the driving force for WEC and induce the segregation of C, Cr, and V atoms. Moreover, with the extension of cycles, the refinement of the matrix structure, the dissolution of M_3C carbide, and the diffusion of metal elements are accelerated, promoting the formation of nanocrystalline and amorphous phases. Subsequently, the formation and propagation of WEC lead to bearing steel failure. © 2025 (56 refs)
Main heading: Cracks
Controlled terms: Amorphous materials - Fatigue of materials - Fracture mechanics - Nanoclay - Nanocrystalline materials - Nanocrystallites - Nanocrystals - Roller bearings - Single crystals - Ternary alloys
Uncontrolled terms: Aerospace materials - Amorphous phasis - Bearing steels - Butterfly white etching area - Crack formation mechanisms - M50 bearing steel - Nanocrystallines - Rolling contact fatigue - White etching areas - White etching crack
Classification Code: 201.1.1 Metallurgy - 204.1 Ceramics - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 761 Nanotechnology - 1301.1.1 Mechanics - 1301.4 Solid State Physics - 1301.4.1 Crystalline Solids and Crystallography - 1301.4.2 Amorphous Solids
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Funding text: The financial support from the National Natural Science Foundation of China (Key Program): 52031004.
Database: Compendex
Data Provider: Engineering Village

12. [Investigation of white etching area at non-carbides origin in M50 bearing steel under rolling contact fatigue]

Jiang, Ganghui (1); Cheng, Ansheng (1); Li, Shuxin (1, 2); Lu, Siyuan (1, 2)
Source: *Tribology International*, v 201, January 2025; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2024.110222; **Article number:** 110222; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Mechanical Engineering and Mechanics, Ningbo University, Ningbo; 315211, China (2) Key Laboratory of Impact and Safety Engineering of MOE, Ningbo; 315211, China
Abstract: White etching areas (WEAs) were originated in regions free of carbides or non-metallic inclusions under rolling contact fatigue (RCF) in M50 bearing steel. Two types of WEAs with largely sheared and compact morphologies were observed. They were investigated using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). The results show that WEAs involve martensite-to-austenite phase transformation and amorphization, in contrast to the butterfly-winged WEAs consisting of only ferrite nanocrystallines. It is suggested that the nanocrystallines are the result of recrystallization. The high micro shear strain of 0.9–1.1 drives phase transformation. The solid-state amorphization occurs due to accumulation of high dislocation density. The dislocation density in the compact WEA is much higher than that in the sheared WEA. © 2024 Elsevier Ltd (56 refs)

Main heading: Nanocrystals
Controlled terms: Amorphization - Dislocations (crystals) - High resolution transmission electron microscopy - Roller bearings - Shear strain
Uncontrolled terms: Bearing steels - Compact morphology - M50 bearing steel - Nanocrystallines - Non-metallic inclusions - Phases transformation - Rolling contact fatigue - Rolling contract fatigue - Scanning electrons - White etching areas
Classification Code: 201.1.1 Metallurgy - 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components - 761 Nanotechnology - 802.3 Chemical Operations - 1301.1.1 Mechanics - 1301.3.1 Microscopy - 1301.4.1 Crystalline Solids and Crystallography
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Funding text: This work was financially supported by Natural Science Foundation of China NSFC (No. 52075271), Ningbo Key Technologies R & D Programme (2022Z050), Ningbo Cixi Industry Common Technology Research and Development Project (CZ2022009) and K.C. Wong Magna Fund in Ningbo University.
Database: Compendex
Data Provider: Engineering Village

13. Maximum Depth Distribution of Flaking Failure of PPS Thrust Bearing Under Rolling Contact Fatigue of 290 N in Water

Harada, Tomonori (1); Kajiwara, Shuhei (1); Kida, Katsuyuki (1)
Source: *Springer Proceedings in Materials*, v 90, p 85-92, 2025; **ISSN:** 26623161, **E-ISSN:** 2662317X; **DOI:** 10.1007/978-981-95-0293-6_10; **Publisher:** Springer
Author affiliation: (1) University of Toyama, Gofuku 3190, Toyama; 930-8555, Japan
Abstract: PPS thrust ball bearing failures under rolling contact fatigue (RCF) in water were caused by flaking. Crack propagation was the main reason of the flaking failure. Subsurface cracks grew in a direction which was parallel to the surface caused the flaking. To investigate the distribution of maximum values of the crack depths, we observed subsurface cracks in whole cross-sections and surface cracks in the present work. The subsurface cracks on whole cross-sections were observed with LCM. The whole cross-section observation was started from the boundary between outer shoulder and groove. The observations were made at intervals of 0.1 or 0.25 mm. The distribution of the maximum values of crack depths and the deepest cracks among all sections were obtained. The deepest cracks among all sections were distributed between the outer shoulder and the centre of contact groove. The positions of maximum values of crack depths distribute around crack initiation area and the deepest cracks are located between the centre of the contact groove and the outer shoulder. © The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2025. (10 refs)
Main heading: Ball bearings
Controlled terms: Crack propagation - Failure (mechanical) - Fatigue of materials - Surface defects
Uncontrolled terms: Ball bearing failure - Crack depths - Cracks initiations - Cracks propagation - Depth distribution - Polymer bearings - PPS - Rolling contact fatigue - Subsurface cracks - Surface cracks
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components
Database: Compendex
Data Provider: Engineering Village

14. Numerical Analysis Model of Contact Stress in the Raceway of Double Row Tapered Roller Bearing Under Overturning Torque in Wind Turbine (*Open Access*)

Li, Chang (1); Wu, Wensong (2); Du, Jing (1); Wang, Shuang (1); Jiang, Shuxin (1); Sun, Weiwei (1)
Source: *Lecture Notes in Mechanical Engineering*, p 715-726, 2025, *Mechanical Design and Simulation: Exploring Innovations for the Future - Proceedings of the 4th International Conference on Mechanical Design and Simulation*; **ISSN:** 21954356, **E-ISSN:** 21954364; **ISBN-13:** 9789819778867; **DOI:** 10.1007/978-981-97-7887-4_62; **Conference:** 4th International Conference on Mechanical Design and Simulation, MDS 2024, February 29, 2024 - March 2, 2024; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) College of Mechanical and Vehicle Engineering, Chongqing University, Chongqing; 400033, China (2) CSSC Haizhuang Wind Power Co. Chongqing, Chongqing; 401123, China
Abstract: This article extends the force analysis of the single rolling element in the whole double row tapered roller bearing to the establishment of a global static equilibrium equation. And further analyzes the position relationship between the roller and the raceway after deflection under overturning torque. Based on non-Hertz line contact theory and bearing force balance equation, a numerical analysis model for the contact stress of the raceway in a double row tapered roller bearing

is proposed; To verify this model, a local finite element model of bearing contact was established based on ANSYS to obtain the stress distribution of the raceway. The results show that the stress calculation model for wind turbine spindle double row tapered roller bearings under overturning torque proposed in this paper has good simulation accuracy. © The Author(s) 2025. (11 refs)
Main heading: Tapered roller bearings
Controlled terms: Numerical analysis - Rollers (machine components) - Rollers (roadbuilding machinery) - Stress analysis - Wind turbines
Uncontrolled terms: Contact Stress - Double rows - Force analysis - Main bearings - Numerical analysis/modeling - Overturning moment - Power - Rolling elements - Tapered roller - Wind power main bearing
Classification Code: 214.1.1 Stress and Strain - 405.1 Construction Equipment - 406.2 Roads and Streets - 601.2 Machine Components - 1008.5 Wind Power and Wind Power Generation - 1201.2 Calculus and Analysis - 1201.9 Numerical Methods
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

15. Analysis of the Influence of Preload Loading Deviation of Pitch Bearing Bolt Group on the Contact Stress of Rolling Elements (*Open Access*)

Ouyang, Weijin (1); Zhao, Bing (1); Qiao, Yueqi (1); Li, Heng (1); Deng, Dingshan (1); Zhang, Shen (1)
Source: *Lecture Notes in Mechanical Engineering*, p 631-640, 2025, *Mechanical Design and Simulation: Exploring Innovations for the Future - Proceedings of the 4th International Conference on Mechanical Design and Simulation*; **ISSN:** 21954356, **E-ISSN:** 21954364; **ISBN-13:** 9789819778867; **DOI:** 10.1007/978-981-97-7887-4_54; **Conference:** 4th International Conference on Mechanical Design and Simulation, MDS 2024, February 29, 2024 - March 2, 2024; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) School of Mechanical Engineering, Qinghai University, Xining, China
Abstract: This paper aims to study the influence of bolt preload distribution on structural performance in the bolted connection structure model of pitch bearings of wind turbines. The preload application deviation and the change of contact stress of the rolling element of the pitch bearing were analyzed by finite element modeling. The results show that the bolt preload loading deviation will cause the rolling element contact stress of the pitch bearing to fluctuate, and the rolling element contact stress near the blade is greater than the rolling element contact stress far away from the blade. In the case of large fluctuations in preload, the contact stress fluctuations of the lower rolling elements are more affected. Therefore, in order to extend the working life of pitch bearings, the bolt preload should be precisely controlled during assembly. © The Author(s) 2025. (9 refs)
Main heading: Wind turbines
Controlled terms: Bolts - Fracture mechanics - Pressure vessels - Roller bearings
Uncontrolled terms: Bolt groups - Bolt preload - Bolted connections - Connection structures - Contact Stress - Finite element - Pitch bearing - Pre loads - Rolling elements - Structural performance
Classification Code: 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 605.2 Small Tools, Unpowered - 610.2 Tanks and Accessories - 1008.5 Wind Power and Wind Power Generation - 1301.1.1 Mechanics
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

16. Influence of subsurface non-metallic inclusions on rolling contact fatigue behavior in bearing steels - Experimental and numerical investigations (*Open Access*)

Peela, Agastya (1); Mikitisin, Adrian (2); Steinweg, Florian (1); Janitzky, Thomas (1); Schwedt, Alexander (2); Broeckmann, Christoph (1); Mayer, Joachim (2)
Source: *Wear*, v 566-567, April 15, 2025; **ISSN:** 00431648; **DOI:** 10.1016/j.wear.2025.205767; **Article number:** 205767; **Publisher:** Elsevier Ltd
Author affiliation: (1) Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Augustinerbach 4, Aachen; 52062, Germany (2) Central Facility for Electron Microscopy, RWTH Aachen University, Ahornstr. 55, Aachen; 52074, Germany
Abstract: The early failures in rolling bearings made of 100Cr6 (SAE 52100) steel have been observed in various industrial applications, which are associated with high maintenance and downtime costs. The damage is usually characterized in the form of axial cracks or volumetric breakouts on the running surface of the bearing components. Metallographic examinations revealed areas below the raceway that do not react to etching with alcoholic nitric acid and therefore appear visually white. These areas are referred to as "white etching areas" or "WEA" for short. Cracks that lead to bearing damage

along these WEA are accordingly referred to as "white etching cracks" (WEC). This subsurface damage initiated from non-metallic inclusions has been identified as the dominant initiation mechanism in the formation of butterflies. This study presents a comprehensive analysis of the intricate mechanisms governing the formation of butterflies in SAE 52100 bearing steel, utilizing multiscale finite element modeling and detailed microstructural investigations. The research offers valuable insights into the role of non-metallic inclusions, such as MnS, in butterfly formation, emphasizing that MnS influences butterfly formation through its size, orientation, and interactions with the inclusion-matrix interface. Moreover, it classifies butterflies into propagating and non-propagating types based on their interactions with the inclusion-matrix interface, revealing that non-propagating butterflies can coexist within the steel without causing bearing failure under specific conditions. In contrast, propagating butterflies, which lead to WEA formation, are unequivocally linked with bearing failure. © 2025 The Authors (104 refs)
Main heading: Cracks
Controlled terms: Chromium steel - Etching - Fatigue of materials - Fracture mechanics - Hardening - Manganese alloys - Manganese metallography - Manganese metallurgy - Manganese steel - Molybdenum steel - Roller bearings
Uncontrolled terms: Bearing steels - Butterfly wings - Cyclic plasticity - Element models - Finite element modeling - Kinematic hardening - Multiscale modeling - Non-metallic inclusions - Ratcheting - Rolling contact fatigue - WEA - White etching areas - White etching crack"
Classification Code: 201.1.1 Metallurgy - 201.1.2 Metallography - 201.7.1 Heat Treatment Processes - 202.3.2 Manganese and Alloys - 202.5.3 Steel - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 802.2 Chemical Reactions - 1301.1.1 Mechanics
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Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

17. Effect of hardness distribution in rolling contact fatigue performance of high-speed train axlebox bearings

Liu, Su (1); Yang, Zhiyong (1); Liu, Tao (2); Li, Zhiqiang (1); Cong, Tao (3); Zhuang, Quan (4); Jiang, Le (4)
Source: *Materials Science and Technology (United Kingdom)*, v 41, n 17, p 1350-1366, December 2025; **ISSN:** 02670836, **E-ISSN:** 17432847; **DOI:** 10.1177/02670836241281879; **Publisher:** SAGE Publications Inc.
Author affiliation: (1) School of Mechanical Electronic & Control Engineering, Beijing Jiaotong University, Beijing, China (2) MFA AS, Beijing Benz Automotive Corporation Limited, Beijing, China (3) Metals & Chemistry Research Institute, Academy of Railway Sciences Corporation Limited, Beijing, China (4) Wafangdian Bearing Group Corporation Limited, Dalian, China
Abstract: To investigate the effect of hardness distribution on rolling contact fatigue (RCF) properties of axlebox bearings under deeper carburizing conditions, a two-dimensional finite element model based on continuum damage mechanics was developed. A method combined with an artificial neural network and genetic algorithm was used to search the hardness distribution with the longest RCF lifetime within the process parameters. The results showed that a hardness distribution with high surface hardness and proper carburized case depth had a higher RCF lifetime. The surface hardness of 693 HV and case depth of 1.71 mm were more suitable. It is expected that the results could promote the understanding of the heat-treatment process of carburized bearings and ensure more reliable carburized bearings production. © The Author(s) 2024 (37 refs)
Main heading: Rockwell hardness
Controlled terms: Axles - Brinell Hardness - Carburizing - Continuum damage mechanics - Fatigue damage - Roller bearings
Uncontrolled terms: Axlebox bearing - Carburized bearing - Fatigue lifetime - Fatigue performance - Fatigue properties - Hardness distribution - High speed trains - Neural-networks - Rolling contact fatigue - Surface hardness
Classification Code: 201.7.1 Heat Treatment Processes - 214 Materials Science - 214.1 Mechanical Properties of Materials - 215.1.1 Mechanical Properties Testing Equipment - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 662.3 Automobile Components and Materials - 663.2 Heavy Duty Motor Vehicle Components - 1301.1.1 Mechanics
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Database: Compendex
Data Provider: Engineering Village

18. The Role of PTFE Lubricant Additives in Enhancing Rolling Contact Fatigue Life

Ranju, M.R. (1); Kesavan, D. (1)
Source: *Lubrication Science*, v 37, n 7, p 410-421, November 2025; **ISSN:** 09540075, **E-ISSN:** 15576833; **DOI:** 10.1002/ls.70003;
Publisher: John Wiley and Sons Ltd
Author affiliation: (1) Indian Institute of Technology Palakkad, Kerala, Palakkad, India
Abstract: Rolling contact fatigue (RCF) is the default mode of failure observed in Hertzian rolling contact elements, such as bearings. Experimentally, the current study examines the influence of the existence of solid lubricant dispersed in liquid base lubricant on RCF life. Polytetrafluoroethylene (PTFE), a solid lubricant additive, is selected for this purpose, and the RCF performance of varying percentages of PTFE (0.1–2.5 wt%) on the base lubricant has been examined. RCF tests were carried out on a two-disc on-cylinder test rig under pure rolling conditions within the mixed lubrication regime. The RCF life was enhanced for every concentration of PTFE-added lubricant composition. The base lubricant containing 2 wt% PTFE concentration exhibits the highest improvement in mean and L10 RCF life, yielding a 2.3-fold increase in improvement over the base lubricant. The excellent RCF performance is attributed to the decreased wear rate, PTFE particle adsorption and tribo-chemical film formation, and there is a decreased likelihood of metal-to-metal contact and a delayed onset of micropitting. © 2025 John Wiley & Sons Ltd. (49 refs)
Main heading: Adsorption
Controlled terms: Additives - Fatigue of materials - Friction - Roller bearings - Rolling - Solid lubricants - Tribology
Uncontrolled terms: Fatigue performance - Hertzian - Lubricant additives - Lubricant formulation - Mode of failures - Polytetrafluoroethylene additive - Rolling contact fatigue - Rolling contact fatigue life - Rolling contacts - Tribofilms
Classification Code: 201.5.1 Metal Rolling - 214 Materials Science - 601.2 Machine Components - 606 Lubrication and Tribology - 606.1 Lubricants - 802.3 Chemical Operations - 803 Chemical Agents and Basic Industrial Chemicals - 1301.1.1 Mechanics
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Funding text: This work was supported by the IIT Palakkad Technology IHub Foundation (IPTIF) under the project titled \u2018Methods to Improve the Reliability of the Wind Turbine Gearbox System\u2019 (Project No. 2024\u2010198\u2010ME \u2010DKE\u2010IPTIF\u2010SP) This work was supported by IIT Palakkad Technology IHub Foundation (IPTIF), 2024\u2010198\u2010ME\u2010DKE\u2010IPTIF\u2010SP. Funding:
Database: Compendex
Data Provider: Engineering Village

19. Conductive lubricants to prevent hydrogen assisted rolling contact fatigue (*Open Access*)

Kürten, Dominik (1); Khader, Iyas (1, 2); Amann, Tobias (1); Gatti, Felix (1); Baur, Maximilian (1); Oberle, Natalie (1); Grundei, Stefan (3); Franke, Jörg (4); Kailer, Andreas (1)
Source: *Engineering Failure Analysis*, v 180, October 1, 2025; **ISSN:** 13506307; **DOI:** 10.1016/j.engfailanal.2025.109819; **Article number:** 109819; **Publisher:** Elsevier Ltd
Author affiliation: (1) Fraunhofer Institute for Mechanics of Materials IWM, Woehlerstr. 11, Freiburg; 79108, Germany (2) German Jordanian University, Madaba Str. 1, Amman; 11180, Jordan (3) Klüber Lubrication München GmbH & Co. KG, Geisenhausenerstr. 7, Muenchen; 81379, Germany (4) Schaeffler Technologies AG & Co. KG, Industriestraße 1–3, Herzogenaurach; 91074, Germany
Abstract: The effectiveness of conductive lubricants, particularly ionic liquids (ILs), in mitigating premature failure such as hydrogen-assisted rolling contact fatigue (HARCF) in rolling-contact bearings is investigated. The degradation of lubricants under tribological load leads to hydrogen generation, contributing to HARCF. The addition of ILs to lubricants significantly enhances their electrical conductivity, thereby preventing premature failure and extending bearing lifespan. Experimental investigations, including linear-oscillation sliding and rolling-contact fatigue tests, confirm the superior performance of a lubricant containing 3.0 vol% Trihexyltetradecylphosphonium-bis(trifluoromethylsulfonyl)-imide [P66614][BTA]. These findings provide valuable insights into enhancing bearing reliability in industrial applications. © 2025 The Authors (70 refs)
Main heading: Hydrogen embrittlement
Controlled terms: Corrosion - Fatigue testing - Friction - Hydrogen production - Lubricants - Roller bearings - Tribology
Uncontrolled terms: Degradation of lubricants - Electrically conductive - Electrically conductive lubricant - Electrochemical tribology - Electrochemicals - Hydrogen generations - Premature failures - Rolling contact fatigue - Rolling-contact bearings - White etching crack
Classification Code: 201.1.1 Metallurgy - 201.9.1 Metals Corrosion - 201.9.2 Corrosion Protection - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 301 Fluids - 522.1 Gas Fuels - 601.2 Machine Components - 606 Lubrication and Tribology - 606.1 Lubricants - 804 Chemical Products - 1301.1.1 Mechanics
Funding Details: Number: 0324208B, Acronym: BMWi, Sponsor: Bundesministerium für Wirtschaft und Energie; Number: -, Acronym: BMWi, Sponsor: Bundesministerium für Wirtschaft und Energie;

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Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

20. [Evolution of a contact force network in a 2D granular assembly: II—the impact of particle plasticity: Using experimentally determined individual particle stress tensors to validate a contact model that considers plastic deformation in combination with discrete element modelling]

Kirstein, O. (1); Wensrich, C.M. (2)
Source: *Granular Matter*, v 27, n 1, February 2025; **ISSN:** 14345021, **E-ISSN:** 14347636; **DOI:** [10.1007/s10035-025-01504-z]; **Article number:** 25; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) European Spallation Source ERIC, P.O. Box 176, Lund; SE-221 00, Sweden (2) School of Engineering, The University of Newcastle, University Drive, Callaghan; NSW; 2308, Australia
Abstract: This study investigates the impact of particle plasticity on the mechanical behaviour of a model granular system under plane stress conditions simulated with the Discrete Element Method. A contact model transitioning from nonlinear elasticity to linear plastic deformation is integrated to analyse its effects on a 576-ball-bearing assembly subjected to varying loads. Simulations were conducted using Yade, comparing them with experimental results and traditional elastic models. The findings show that incorporating plastic deformation improves the accuracy of simulated force distributions and the material's frictional response, particularly under high external loads. These results underscore the need for plasticity-inclusive models in realistic granular simulations, providing valuable insights for practical applications in industries handling high-stress granular systems. © The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2025. (33 refs)
Main heading: Ball bearings
Controlled terms: Plastic deformation - Residual stresses - Stress tensor
Uncontrolled terms: Contact forces - Contact modeling - Discrete element models - Force chains - Force networks - Granular assembly - Granular mechanics - Granular system - Individual particles - Particle stress
Classification Code: 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 601.2 Machine Components - 1201.4 Applied Mathematics
Funding Details: Number: -, Acronym: DMSC, Sponsor: Dipartimento di Medicina Sperimentale e Clinica, Università degli Studi di Firenze; Number: DP130104290,PP2881, Acronym: ARC, Sponsor: Australian Research Council;
Funding text: OK gratefully acknowledges Brian Lindgren Jensen from the ESS Data Management & Software Centre (DMSC) in Copenhagen for all the support provided for getting Yade to run on the DMSC\u2019s CentOS8 high-performance cluster. The authors would like to acknowledge financial assistance provided by the Australian Research Council (ARC) under Grant DP130104290. Access to the KOWARI and DINGO instruments to perform the initial experiment was made possible by the Australian Centre for Neutron Scattering (ACNS Proposal PP2881).The work was carried out with financial assistance provided by the Australian Research Council (ARC) under Grant DP130104290.
Database: Compendex
Data Provider: Engineering Village

21. [Wear and subsurface stress evolution in tractive rolling contact]

Juliá, Javier M. (1); Rodríguez-Tembleque, Luis (1)
Source: *International Journal of Mechanical Sciences*, v 294, May 15, 2025; **ISSN:** 00207403; **DOI:** [10.1016/j.ijmecsci.2025.110195]; **Article number:** 110195; **Publisher:** Elsevier Ltd
Author affiliation: (1) Escuela Técnica Superior de Ingeniería, Universidad de Sevilla, Camino de los Descubrimientos s/n, Sevilla; 41092, Spain
Abstract: Wear phenomenon is inherent to tractive rolling contact problems e.g., in rolling bearings or in rail–wheel interaction. It takes place in the sliding regions of the rolling contact area, and it accumulates as particles from the rolling bodies cross the contact region. Wear modifies the solids' surface, the contact tractions, the subsurface stresses, and the tangential forces transmitted between the rolling solids, which are fundamental contact variables in sectors such as rolling fatigue or vehicle system dynamics. Thus, ignoring wear in tractive rolling contact analysis could lead to underestimations of bearing fatigue lives or inaccurate lateral guiding forces in multibody vehicle models. This work presents a robust SAM-based formulation on rolling contact to study how wear, contact tractions, resultant rolling contact-forces, and surface and subsurface stresses evolve with the number of revolutions. For the first time, subsurface stress distributions are computed as a function of revolutions under orthotropic friction and wear conditions, highlighting the influence of tribological axes

orientation and wear evolution on stress and force reactions. After validating the proposed formulation, several numerical examples are presented to show how considering orthotropic friction and wear laws impacts stress distributions and resultant rolling contact forces. These findings could provide important insights into the role of wear in tractive rolling contact for applications in engineering and industrial design. © 2025 The Authors (108 refs)
Main heading: Tribology
Controlled terms: Fatigue of materials - Residual stresses - Roller bearings - Stress analysis - Stress concentration - Structural dynamics - Traction (friction)
Uncontrolled terms: Contact forces - Contact Mechanics - Contact tractions - Friction and wear - Orthotropic friction - Rolling contacts - Stress evolution - Stresses distribution - Subsurface stress - Wear phenomena
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 408 Structural Design - 601.2 Machine Components - 606 Lubrication and Tribology - 1301.1.1 Mechanics
Funding Details: Number: -, Acronym: MCIU, Sponsor: Ministerio de Ciencia, Innovación y Universidades; Number: -, Acronym: MCIN, Sponsor: Ministerio de Ciencia e Innovación; Number: -, Acronym: EC, Sponsor: European Commission; Number: -, Acronym: AEI, Sponsor: Agencia Estatal de Investigación; Number: -, Acronym: FEDER, Sponsor: Federación Española de Enfermedades Raras; Number: PID2022- 137903OB-I00, Acronym: -, Sponsor: -;
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Database: Compendex
Data Provider: Engineering Village

22. Research on the Calculation Method for the Contact Stress of Wind Turbine Main Shaft Bearings Based on Finite Element Analysis (*Open Access*)

Zou, Yi (1); Sun, Wenlei (1); Wang, Hongwei (1); Xu, Tiantian (1); Wang, Bingkai (1)
Source: *Lubricants*, v 13, n 5, May 2025; **E-ISSN:** 20754442; **DOI:** 10.3390/lubricants13050226; **Article number:** 226; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) School of Mechanical Engineering, Xinjiang University, Urumqi; 830047, China
Abstract: Under alternating loads, the contact situation for self-aligning roller bearings in the main shaft of a wind turbine is complex. Few methodologies exist for calculating the contact stress of main shaft bearings. We propose a method for calculating the contact stress of main shaft bearings in wind turbines; by simulating alternating loads that affect the turbine's lifespan with a probability of 99%, analyzing the operational characteristics of the bearings under these loads using the roller slice method, and establishing a load–displacement model, this model serves as the boundary condition for contact stress simulation. We present the approach for building a three-dimensional finite element simulation model of contact stress, followed by model validation. The findings reveal that the maximum stress within the spindle bearing is concentrated in the contact zone, taking on an elliptical configuration. The maximum contact stress, as computed by the proposed method, amounts to 1356.3 MPa, and the bearing's load-bearing performance adequately fulfills the design requirements. A comparative analysis with the calculation results documented in the existing literature shows that the average discrepancies in the computed outcomes for the roller's contact with the inner and outer rings are 2.55% and 2.48%, respectively, and this validates the high reliability of the proposed approach. The research conducted in this thesis can further enhance the credibility of the contact stress calculation method for large-scale wind turbine spindle bearings. © 2025 by the authors. (36 refs)
Main heading: Wind turbines
Controlled terms: Design for testability - Machine design - Roller bearings - Rollers (machine components)
Uncontrolled terms: Alternating loads - Contact Stress - Finite element - Finite element analyse - Load displacements - Main shaft bearing - Main-shaft - Self-aligning - Shaft bearing - Spindle bearing
Classification Code: 601 Mechanical Design - 601.2 Machine Components - 904 Design - 1008.5 Wind Power and Wind Power Generation
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23. [Parameter investigation of bearing based on rolling–sliding contact fatigue crack growth considering load history]

Li, Feng (1, 3); Li, Xueyuan (2); Liu, He (2); Deng, Sier (1, 2)
Source: *Mechanism and Machine Theory*, v 218, December 15, 2025; **ISSN:** 0094114X; **DOI:** 10.1016/j.mechmachtheory.2025.106268; **Article number:** 106268; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Mechanical Engineering, Northwestern Polytechnical University, Xi'an; 710072, China (2) School of Mechatronics Engineering, Henan University of Science and Technology, Luoyang; 471003, China (3) of Engineering, Kyushu University, Moto-oka 744, Fukuoka, Nishi-ku; 819-0395, Japan
Abstract: Parameter investigation is critical in the field of rolling bearing design. This study investigates the influence of geometric and operational parameters on fatigue crack growth under rolling–sliding contact using stress intensity factor. A variable–amplitude load history of ring is incorporated through a linear superposition approach. Our findings reveal that Mode II crack growth dominates under light load conditions, whereas both Mode I and Mode II mechanisms become significant under heavy loads. The geometric configuration of the bearing significantly influences crack growth behavior. Specifically, the optimal radial clearance is identified as approximately 0.05 mm. To balance the load–carrying capacity with crack growth, the recommended number of balls ranges from 10 to 13. The ball diameter should be maximized without compromising structural rigidity. Additionally, a smaller groove curvature radius coefficient for inner ring is beneficial in mitigating crack growth. These findings offer a theoretical basis for parameter selection in rolling bearing design, enhancing the accuracy of fatigue life prediction. © 2025 (36 refs)
Main heading: Stress intensity factors
Controlled terms: Fatigue crack - Fatigue crack propagation - Roller bearings
Uncontrolled terms: Bearing designs - Bearing parameter investigation - Fatigue cracks - Load history - Operational parameters - Rolling bearings - Rolling sliding contact - Rolling-sliding conditions - Rolling-sliding contact fatigue - Stress-intensity factors
Classification Code: 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components
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24. [Failure Analysis of a QJ222-N2-MPA Thrust Bearing via Vibration Diagnostics and Signal Processing under Process Instabilities]

Hemati, Ali (1, 2)
Source: *Journal of Failure Analysis and Prevention*, v 26, n 2, p 571-579, April 2026; **ISSN:** 15477029, **E-ISSN:** 18641245; **DOI:** 10.1007/s11668-026-02400-1; **Publisher:** Springer
Author affiliation: (1) Parsglycol Company, Aasalouyeh, Bushehr, Iran (2) Department of Engineering, Bu Ali Sina University, Hamedan, Iran
Abstract: Centrifugal pumps in process industries often experience hydraulic instabilities that may accelerate component degradation. This case study presents a detailed root cause analysis of repeated failures of a QJ222-N2-MPA four-point contact thrust bearing in a horizontal centrifugal pump. Vibration monitoring and signal processing revealed that fluid pulsations under unstable operating conditions excited the vane pass frequency (VPF), which subsequently coupled with the bearing ball pass frequency outer ring (BPFO). This dynamic excitation initiated localized cracking at the impeller blade edges. The propagation of cracks altered the hydraulic balance, leading to abnormal axial thrust loads. These thrust forces were directly transmitted to the thrust bearing, resulting in progressive damage to the rolling elements and ultimately leading to premature failure. The results demonstrate the sequential interaction between process-induced pulsations, structural integrity loss, and mechanical degradation. The study emphasizes the importance of vibration-based diagnostics, advanced signal analysis, and proactive maintenance in preventing similar bearing failures in pumps subjected to fluctuating hydraulic conditions. © ASM International 2026. (16 refs)

Main heading: Thrust bearings
Controlled terms: Centrifugal pumps - Centrifugation - Cracks - Failure (mechanical) - Failure analysis - Impellers - Roller bearings - Signal analysis - Structural analysis - Vibration measurement
Uncontrolled terms: Diagnostic processing - Fluctuation - Impeller blades - Qj222-n2-MPA - Signal-processing - Vane pass frequency - Vibration diagnostics - Vibration monitoring - Vibration signal - Vibrations analysis
Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.2 Fatigue, Cracks and Fracture - 408 Structural Design - 601.2 Machine Components - 609.2 Pumps - 716.1 Information Theory and Signal Processing - 802.3 Chemical Operations - 941.5 Mechanical Variables Measurements
Database: Compendex
Data Provider: Engineering Village

25. Relative Sensitivity of Rolling Bearing Fatigue Life and Scatter to Macroscopic Parameters and Crystalline Heterogeneity

Liu, He (1, 2); Li, Xueyuan (1); Li, Feng (3)
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Abstract: Subsurface rolling contact fatigue (RCF) failure is one of the primary failure modes in properly installed and lubricated rolling bearings. Its actual service life often exhibits significant scatter, posing a formidable challenge to the reliable life prediction and operational safety of bearings. This study establishes a macro-meso-coupled rolling contact fatigue model that accounts for crystalline anisotropy and grain topological structures. This model utilizes Voronoi tessellations and random Euler angles to construct a polycrystalline mesoscopic model, which is subsequently integrated with a macroscopic Hertzian contact finite element analysis to simulate the roller bearing loading cycles and determine the localized stress responses within the material. The results indicate that variations in macroscopic structural and operating parameters primarily affect the overall stress level of the subsurface RCF failure. The relative fatigue life of the bearing exhibits an exceptionally high sensitivity to changes in macroscopic and operating parameters. Specifically, an increase in radial load leads to an exponential decrease in relative life, with the Weibull slope ranging between 1.001 and 1.129, which is broadly consistent with the classical Lundberg–Palmgren experimental value of 1.125. Conversely, the heterogeneity of the mesoscopic crystalline structure strongly influences the statistical variance of localized extreme stresses. The scatter in bearing fatigue life demonstrates a much more pronounced sensitivity to mesostructural alterations; as the grain size increases from 10 μm to 40 μm, the Weibull slope drops from 1.041 to 0.784. This study provides an analytical basis for the reliable life prediction of rolling bearings. © 2026 by the authors. (38 refs)
Main heading: Roller bearings
Controlled terms: Anisotropy - Fatigue of materials - Polycrystalline materials - Stress analysis - Superconducting films - Weibull distribution
Uncontrolled terms: Contact fatigue life - Crystal anisotropy - Fatigue failures - Life predictions - Macroscopic parameters - Reliable lives - Rolling bearings - Rolling contact fatigue - Scatter - Voronoi tessellations
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components - 708.3 Superconducting Materials - 1202.2 Mathematical Statistics - 1301.1.2 Physical Properties of Gases, Liquids and Solids - 1301.4.1 Crystalline Solids and Crystallography
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