1. 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)
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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, M2C and M7C3 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

2. Formation mechanism of subsurface white etching area and white etching crack of failed bearings in wind turbine gearbox

Dai, R. (1); Long, H. (1)
Source: *Wear*, v 582-583, November 15, 2025; **ISSN:** 00431648; **DOI:** 10.1016/j.wear.2025.206335; **Article number:** 206335; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Mechanical, Aerospace and Civil Engineering, The University of Sheffield, United Kingdom
Abstract: Bearings of some wind turbine (WT) gearboxes experienced premature failures due to bearing steel microstructural damage under rolling contact fatigue (RCF). However, the formation mechanism of the microstructural damage and its progression to the final bearing failure is still being debated. In this study, subsurface damage sustained in two bearing raceways of a failed gearbox from a field-operated WT is investigated. The study provides evidence of damage initiation and progression from non-metallic inclusions in the subsurface by using actually failed WT bearings as a case study. Damage characterisation has found various microstructural damage in the raceway subsurface including non-metallic inclusions, butterfly wing cracks, White Etching Areas (WEAs), and White Etching Cracks (WECs). Complex interactions between cyclic rolling contact loading with inclusions and cracks are observed. Their roles in the formation of butterfly wing cracks, WEAs and WECs in the raceway subsurface are evaluated. It has been found that the butterfly wing cracks initiated at damaged inclusions is the original cause of the microstructural damage. The propagation of butterfly wing cracks and WEAs to form subsurface crack networks, with WEAs to create WECs, under RCF loading they have accelerated surface flaking and spalling of the raceways, leading to the final failure of the bearings. The formation mechanism of the subsurface initiated WEAs and WECs is evaluated and a damage progression hypothesis leading to the final bearing failure is proposed, including six stages of the microstructural damage development. © 2025 (46 refs)
Main heading: Bearings (structural)
Controlled terms: Composite structures - Crack propagation - Etching - Failure (mechanical) - Fatigue damage - Gears - Outages - Roller bearings - Structural analysis - Wind turbines
Uncontrolled terms: Bearing - Bearing failures - Butterfly wings - Formation mechanism - Micro-structural damages - Rolling contact fatigue - White etching areas - White etching crack - Wind turbine gearboxes - Wing crack
Classification Code: 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 408 Structural Design - 408.1 Structural Members and Shapes - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 706.1.2 Electric Power Distribution - 802.2 Chemical Reactions - 1008.5 Wind Power and Wind Power Generation

Funding Details: Number: -, Acronym: FE, Sponsor: Office of Fossil Energy;
Funding text: The FE stress modelling results support the observation of extensive subsurface butterfly wing damage observed from the failed bearing raceways, as shown in Figs. 3, 4 and 10. The majority of these butterflies are found at inclusions located in the depth of 0.4 mm–0.6 mm, deeper than the modelled depth of the maximum shear stress at 0.4 mm. Considering the flaking/spalling damage of the contact surface of the raceways, the actual contact pressure may be much higher than the rated condition (2.069 GPa) modelled in this study due to the uneven surfaces after the occurrence of flaking/spalling damage. Higher contact pressure increases the depth of the maximum shear stress, as well as the length of butterfly wings in the deeper subsurface region. Repeated large variations of the orthogonal shear stress at the damaged inclusions, both internal cracking and boundary separation, significantly increase the risk of initiating fatigue cracks at critical locations of the inclusion (points 1–4), similar to that observed in the microstructure damage of the butterfly wing cracks. With multiple inclusions in the subsurface, micro cracks propagating from various inclusions can form crack networks in the subsurface.
Database: Compendex
Data Provider: Engineering Village

3. Investigation on skidding characteristics and dynamic responses of rolling element bearing under thermal elastohyrdodynamic lubrication

Kang, Jianxiong (1, 2); Luo, Wei (1); Yan, Changfeng (1); Liu, Yaofeng (1); Lü, Yanjun (3); Wu, Lixiao (1)
Source: *Mechanical Systems and Signal Processing*, v 254, June 15, 2026; **ISSN:** 08883270, **E-ISSN:** 10961216; **DOI:** 10.1016/j.ymssp.2026.114403; **Article number:** 114403; **Publisher:** Academic Press
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Abstract: The unstable movement of the cage will lead to frequent collisions between rolling elements and cage, which inevitably results in wear and failure of the cage or the rolling element bearing. However, most studies assume that the rolling elements move under pure rolling conditions. Hence, this study abandons the assumption of pure rolling, and the thermal elastohydrodynamic lubrication, cage flexibility and pocket clearance are considered to establish a multi-DOF skidding dynamic model of rolling element bearings based on time-varying comprehensive stiffness and damping. The intrinsic relationship between thermal elastohydrodynamic lubrication and oil film thickness, contact damping, and stiffness is studied. Considering the viscous resistance and centrifugal force acting on the rolling elements, a flexible cage model is established, and the effects of pocket clearance, radial clearance, and the rolling element deformation on interaction force between the cage and rolling elements are analyzed. The influence of operational conditions and bearing parameters on skidding characteristics is explored, and the model is validated using an existing model and experiment. The results indicate that thermal elastohydrodynamic lubrication has a significant impact on oil thickness, pressure, and temperature. The skidding speed and rate increase with the increase of the rotational speed, and decrease with the increase of the radial load. As the cage pocket clearance and equivalent stiffness increase, the skidding speed and rate are decreased. This study can provide support for the optimization design, friction reduction, and early failure prevention of rolling element bearings. © 2026 Elsevier Ltd. All rights are reserved, including those for text and data mining, AI training, and similar technologies. (51 refs)
Main heading: Dynamic models
Controlled terms: Elastohydrodynamic lubrication - Elastohydrodynamics - Friction - Lubricating oils - Roller bearings - Skidding - Stiffness
Uncontrolled terms: Contact forces - Dynamics models - Lubrication / - Pure rolling - Rolling conditions - Rolling Element Bearing - Rolling elements - Skidding characteristic - Thermal - Thermal elastohydrodynamic lubrication
Classification Code: 214 Materials Science - 301.1.1 Liquid Dynamics - 601.2 Machine Components - 606.1 Lubricants - 606.2 Lubrication - 662.1 Automobiles - 1301.1.1 Mechanics - 1301.7 Statistical and Nonlinear Physics
Funding text: This work is supported by National Natural Science Foundation of China (Grant Nos.52365011, 51765034), the Open Fund of Liaoning Provincial Key Laboratory of Aero-engine Materials tribology (Grant No. LKLAMTF202604), and Gansu Province Youth Science and Technology Fund Project (Grant No. 24JRRA972).
Database: Compendex
Data Provider: Engineering Village

4. Effects of Prior Heat Treatment and Induction Hardening on the Properties of JIS SUJ3 Bearing Steel (*Open Access*)

Lu, Shao-Quan (1, 2); Chiu, Liu-Ho (1, 2); Chang, Pei-Jung (2, 3); Lin, Chung-Kwei (1, 2, 4)

Source: *Materials*, v 18, n 8, April 2025; **E-ISSN:** 19961944; **DOI:** 10.3390/ma18081797; **Article number:** 1797; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
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Abstract: Bearing steels are frequently used in highly loaded components, such as roller bearings, due to their excellent hardenability and wear resistance. Microstructure, hardness, and residual stress distribution of the bearings significantly affect the wear resistance of the parts. In the present study, experiments investigated the effects of austenitizing temperature (850, 900, and 950 °C), with or without cryogenic treatment, and induction hardening treatment (9 and 12 kW) on the microstructure, microhardness, the amount of retained austenite, surface residual stress, and wear behavior of JIS SUJ3 steel. The experimental results revealed that the austenitized specimens' microstructure consisted of martensite, retained austenite, and dispersed granular alloy carbide exhibiting high hardness. After cryogenic or induction hardening treatment, the surface residual stress of austenitized specimens exhibited compressive stress rather than its original tensile stress state. The induction hardening treatment can significantly increase the microhardness of austenitized specimens, followed by quenching. Furthermore, the induction-hardened surface possessed less retained austenite. For practical industrial applications, a prior austenitizing heat treatment at 950 °C followed by hardening with an induction power of 12 kW was the optimal parameter for JIS SUJ3 bearing steel. The maximum microhardness and surface residual stress were 920 HV0.3 and −1083 MPa, respectively, while the lowest weight loss was 0.5 mg after the 10,000-revolution wear test. © 2025 by the authors. (31 refs)
Main heading: Microhardness
Controlled terms: After-heat treatment - Compressive stress - Quenching - Roller bearings - Steel heat treatment - Strain hardening - Surface hardening
Uncontrolled terms: 950° C - Bearing steels - Hardenability - Hardening treatment - Highly loaded - Induction hardening - Prior heat treatment - Property - Retained austenite - Surface residual stress
Classification Code: 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components
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Data Provider: Engineering Village

5. Bearing Over-Skidding Detection Using Frequency Analysis During Constant Speed Working Condition

Haghdoust Manjili, Mohammadjavad (1); Liang, Xihui (1)
Source: *Mechanisms and Machine Science*, v 184, p 75-86, 2025, *Proceedings of the 2025 CCToMM Symposium on Mechanisms, Machines, and Mechatronics*; **ISSN:** 22110984, **E-ISSN:** 22110992; **ISBN-13:** 9783031954887; **DOI:** 10.1007/978-3-031-95489-4_7; **Conference:** 13th CCToMM Symposium on Mechanisms, Machines, and Mechatronics, CCToMM M3 2025, June 19, 2025 - June 20, 2025; **Publisher:** Springer Science and Business Media B.V.
Author affiliation: (1) University of Manitoba, Winnipeg; R3T 5V6, Canada
Abstract: Bearings are critical components in rotating machinery, and their performance significantly affects system stability, reliability, and safety. Over-skidding is a newly identified and critical phenomenon in rolling element bearings that demands increased attention. While skidding occurs when the rollers' tangential speed is below the shaft speed, over-skidding arises when the rollers exceed the speed imposed by the shaft rotation. Under pure rolling conditions, the rollers and the inner ring are expected to operate at the same tangential speed; However, in specific situations, the roller speed may exceed the theoretical speed determined by the shaft speed, resulting in over-sliding. Consequently, the friction between rolling elements will increase, potentially leading to premature bearing defects. To determine the over-skidding rate, two parameters must be obtained: theoretical and actual Ball Pass Frequency of Outer Race (BPFO). For this purpose, frequency domain analysis is employed to extract this information from the raw vibration signal. Specifically, the Fast Fourier Transform (FFT) is applied to convert the time-domain signal into the frequency domain. Within this domain, the frequency of the shaft is first extracted. Using the corresponding theoretical equation, the theoretical BPFO is then calculated, while the actual BPFO is obtained directly from the frequency spectrum. By comparing theoretical and measured actual BPFO, over-skidding rate could be estimated. The results show that, contrary to skidding—which typically arises under low-load, high-speed conditions—over-skidding occurs when the load is high, and the speed is low. Furthermore, reducing the load and increasing the speed were found to diminish over-skidding. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2025. (19 refs)
Main heading: Frequency domain analysis

Controlled terms: Fast Fourier transforms - Roller bearings - Rollers (machine components) - Skidding - System stability - Time domain analysis - Vibration analysis
Uncontrolled terms: Condition - Constant speed - Critical component - Frequency Analysis - Outer races - Over-skidding detection - Rolling Element Bearing - Shaft speed - Signal-processing - Tangential speed
Classification Code: 601.2 Machine Components - 662.1 Automobiles - 716.1 Information Theory and Signal Processing - 941.5 Mechanical Variables Measurements - 961 Systems Science - 1201 Mathematics - 1201.3 Mathematical Transformations - 1201.4 Applied Mathematics - 1201.5 Computational Mathematics - 1201.6 Control Theory
Funding Details: Number: RGPIN-2019-05361, Acronym: CRSNG, Sponsor: Natural Sciences and Engineering Research Council of Canada; Number: -, Acronym: CRSNG, Sponsor: Natural Sciences and Engineering Research Council of Canada;
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Database: Compendex
Data Provider: Engineering Village

6. 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.

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
Funding Details: Number: GZ: BR 1844/26-1,MA 1280/57-1, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft;
Funding text: The authors would like to thank Deutsche Forschungsgemeinschaft (DFG) for the financial support under grant number GZ: BR 1844/26-1, MA 1280/57-1. The authors gratefully acknowledged the assistance with TEM sample preparation and investigation provided by Kevin Kistermann and Sebastian Zischke.
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

7. Dynamic modelling and skidding behavior analysis of deep groove ball bearing under different pocket clearances

Wang, Mingchun (1); Zhai, Zhengzheng (1); Xu, Minmin (1, 2); Yu, Wennian (3); Huang, Junming (1); Huang, Wei (1)
Source: *Nonlinear Dynamics*, v 114, n 7, April 2026; **ISSN:** 0924090X, **E-ISSN:** 1573269X; **DOI:** 10.1007/s11071-026-12370-6; **Article number:** 514; **Publisher:** Springer Science and Business Media B.V.
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Abstract: Bearing skidding is an inevitable phenomenon in operation, which damages the lubricant film, leading to scuffing on the surfaces of bearing raceways and rolling elements. To reveal the bearing skidding mechanism, this study investigates the effects of pocket clearance variations on skidding dynamics in deep-groove ball bearings. By integrating theoretical modeling with numerical simulations, a nonlinear dynamic model for deep groove ball bearing is developed. Moreover, factor of the lubricating oil film into account based on the elastohydrodynamic lubrication theory is considered. Systematic analysis is conducted on self-rotation and skidding characteristics of rolling balls under different specific clearance values, along with ball-cage contact mechanics examination. Key findings demonstrate that pocket clearance critically affects ball-cage dynamic interactions. The skidding rate shows a non-monotonic relationship with clearance size, which shows an initial decrease followed by subsequent increase. Collision forces in both loaded and unloaded zones correspondingly exhibit analogous trend reversal patterns. Kinematic analysis reveals that collision forces concentrate on the cage's rear (cage drive ball) in the first half of the loaded zone, while the forces transition to the cage's front (ball drive cage) in the latter half of the loaded zone. The unloaded zone shows cage-propelled rotation initially, with minor lateral collisions during ball transit. Optimal pocket clearance in bearing cages effectively mitigates skidding and frictional energy dissipation, thereby improving rotational stability and prolonging fatigue life. This study provides a fundamental theoretical framework for anti-skidding bearing design, offering actionable insights into cage geometry optimization and holistic enhancement of mechanical system reliability. © The Author(s), under exclusive licence to Springer Nature B.V. 2026. (39 refs)
Main heading: Deep groove ball bearings
Controlled terms: Dynamic models - Elastohydrodynamic lubrication - Elastohydrodynamics - Energy dissipation - Fatigue of materials - Friction - Lubricant films - Lubricating oils - Reliability theory - Rotation - Skidding
Uncontrolled terms: Behavior analysis - Collision forces - Collision mechanic - Deep groove - Dynamics models - Lubricant films - Nonlinear dynamic models - Pocket clearance - Scuffings - Skidding behavior
Classification Code: 214 Materials Science - 301.1.1 Liquid Dynamics - 601.2 Machine Components - 606.1 Lubricants - 606.2 Lubrication - 662.1 Automobiles - 1009.1 Energy Conservation - 1009.2 Energy Consumption - 1202.2 Mathematical Statistics - 1301.1.1 Mechanics - 1301.7 Statistical and Nonlinear Physics
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Database: Compendex
Data Provider: Engineering Village

8. Friction power loss in ball bearings: Correlation with bearing skidding and cage motion stability (*Open Access*)

Wang, Mingkai (1, 2); Zhu, Linbo (1); Ooi, Kim Tiow (2); Li, Haizhen (1); Yan, Ke (1); Hong, Jun (1)
Source: *Friction*, v 13, n 7, July 2025; **ISSN:** 22237690, **E-ISSN:** 22237704; **DOI:** 10.26599/FRICT.2025.9440980; **Article number:** 9440980; **Publisher:** Tsinghua University Press
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Abstract: This study introduces a prediction method for bearing friction power loss, focusing on the interplay of bearing skidding and cage motion stability on the tribological properties of ball bearings. The internal friction source is first identified in eight forms according to the interaction analysis among bearing components. Then, the ring flexibility generated by the assembly state of a rotor-bearing system and the cage flexibility caused by the centrifugal effect are considered, and the effects of the spatial displacement of outer ring and contact force on the outer ring deformation are also analyzed. Furthermore, the traction effect of the ball-raceway and the hydrodynamic lubrication of the cage-guiding ring are discussed to establish an improved bearing dynamic model. The validity and reliability of the present method are confirmed through

a comparative analysis with experimental data. Finally, the relationships between the dynamic behavior and friction power loss are investigated. The results highlight the critical role of the friction loss of bearing components subjected to lubricant viscosity resistance and the sliding friction loss of the cage-guiding ring in determining the total tribological properties. The dynamic behavior can also be optimized by adjusting the bearing preload and cage structure to effectively weaken the bearing friction power loss. © The Author(s) 2025. (50 refs)
Main heading: Ball bearings
Controlled terms: Convergence of numerical methods - Friction - Reliability analysis - Rings (components) - Tribology
Uncontrolled terms: Bearing friction - Bearing skidding - Cage motion stability - Dynamic behaviors - Friction loss - Friction power loss - Interaction analysis - Motion stability - Prediction methods - Tribological properties
Classification Code: 601.2 Machine Components - 606 Lubrication and Tribology - 913.3 Quality Assurance and Control - 1201.9 Numerical Methods - 1301.1.1 Mechanics
Funding Details: Number: -, Acronym: CSC, Sponsor: China Scholarship Council; Number: TC220H05VHZ, Acronym: MIIT, Sponsor: Ministry of Industry and Information Technology of the People's Republic of China; Number: 52175250, Acronym: NNSF, Sponsor: National Natural Science Foundation of China;
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Database: Compendex
Data Provider: Engineering Village

9. A novel self-powering planetary gear bearing skidding sensor using dual triboelectric nanogenerators

Gao, Shuai (1); Ma, Tenghao (2); Pu, Huayan (1); Kong, Yun (3); Wang, Tianyang (2); Zhan, Yupeng (4); Luo, Jun (1); Chu, Fulei (2); Han, Qinkai (2)
Source: *Measurement: Journal of the International Measurement Confederation*, v 256, December 1, 2025; **ISSN:** 02632241; **DOI:** 10.1016/j.measurement.2025.118576; **Article number:** 118576; **Publisher:** Elsevier B.V.
Author affiliation: (1) State Key Laboratory of Mechanical Transmission for Advanced Equipment, College of Mechanical Engineering, Chongqing University, Chongqing; 400044, China (2) State Key Laboratory of Tribology, Department of Mechanical Engineering, Tsinghua University, Beijing; 100084, China (3) School of Mechanical Engineering, Beijing Institute of Technology, Beijing; 100081, China (4) China International Engineering Consulting Corporation, Beijing; 100048, China
Abstract: Wind turbines, positioned as advanced devices with significant potential for optimizing the global energy landscape, have garnered widespread attention. Among the integral components of a wind turbine, the planetary gearbox (PGB) plays a crucial role. Real-time monitoring of the PGB holds immense promise for enhancing its service life and quality. The main objective of this study is to design a novel type self-powering planetary gear sensor of PGB that can measure the speed of PGB system and monitor the skidding state of planetary gear bearings in real-time under stationary and non-stationary conditions. The planetary gear speed and bearing skidding sensors are introduced by dual triboelectric nanogenerators (PBSS), comprised of two sets of concentric floating freestanding layer mode triboelectric nanogenerators (TENGs) designed for the planetary gear (G-TENG) and its bearing cage (C-TENG). The assembly ensures the structural integrity and original functionality of the PGB. The study investigates the impact of rotational speed, composite dielectric material, internal clearance on optimizing the output of the PBSS. The speed sensing function on PGB system and planetary bearing cage of PBSS has been rigorously validated by commercial sensors. Results from self-sensing tests reveal that the featured frequency of triboelectric signal accurately quantifies the speed of G-TENG, while its amplitude effectively qualifies it. C-TENG proves capable of perceiving the overall skidding and transient cage stability of the planetary gear bearing under variable speeds and torque loads. Furthermore, the superiority of the PBSS over traditional sensors in precise speed sensing under non-stationary conditions is verified. © 2025 Elsevier Ltd (55 refs)
Main heading: Nanogenerators
Controlled terms: Crystallography - Dielectric materials - Gears - Skidding - Triboelectricity - Wind turbines
Uncontrolled terms: Gearbox systems - Nanogenerators - Non-stationary condition - Planetary gearboxes - Planetary Gears - Rolling bearings - Self-powering - Self-sensing - Speed sensing - Triboelectric nanogenerator
Classification Code: 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 662.1 Automobiles - 701.1 Electricity: Basic Concepts and Phenomena - 705.2 Electric Generators - 708.1 Dielectric Materials - 1008.5 Wind Power and Wind Power Generation - 1301.4.1 Crystalline Solids and Crystallography
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ZZKT-2025Z04, Acronym: SKLMT, Sponsor: State Key Laboratory of Mechanical Transmissions; Number: -, Acronym: SKLMT, Sponsor: State Key Laboratory of Mechanical Transmissions; Number: 2024CDJZDQT-001, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities;
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10. Multi-point contact and skidding dynamics of four-point contact ball bearings under variable-speed conditions

Chen, Shiyu (1); Liu, Yuqing (1); Chen, Zaigang (1); Zhai, Wanming (1)
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Article number: 106468; **Publisher:** Elsevier Ltd
Author affiliation: (1) State Key Laboratory of Rail Transit Vehicle System, Southwest Jiaotong University, Chengdu; 610031, China
Abstract: Owing to the double-arched raceway geometry, the contact state of four-point contact ball bearings (FPCBBs) is highly sensitive to rotational speed. Variations in centrifugal force alter the number of ball-raceway contact points and reconfigure kinematic constraints, significantly influencing skidding behavior. To capture this complex dynamic process, a skidding dynamics model of FPCBBs is established in this study, including nonlinear interactions among bearing components and the lubrication effect. Specifically, a flexible cage formulation is incorporated to account for circumferential deformation, while the lubrication is characterized via oil film stiffness, time-varying friction coefficients, and fluid drag forces. Based on this model, transient skidding characteristics under variable-speed conditions are analyzed. The effect of key raceway structural parameters on skidding behavior is further discussed at different rotational speeds. The results indicate that friction forces play distinct roles within different contact areas. The sensitivity of skidding to raceway structural parameters is speed-dependent. Furthermore, the skidding degree is closely related to the contact angle of the main-contact pair in the inner raceway. The results provide a theoretical basis for the optimization design of FPCBBs. © 2026 Elsevier Ltd (38 refs)
Main heading: Dynamic models
Controlled terms: Ball bearings - End effectors - Friction - Lubrication - Point contacts - Rotating machinery - Skidding
Uncontrolled terms: Contact points - Contact state - Dynamics models - Four-contact-point ball bearing - Four-point - Multi-point contacts - Rotational speed - Skidding characteristic - Structural parameter - Variable speed conditions
Classification Code: 601.1 Mechanical Devices - 601.2 Machine Components - 606.2 Lubrication - 662.1 Automobiles - 704.1 Electric Components - 714.2 Semiconductor Devices and Integrated Circuits - 731.5 Robotics - 1301.1.1 Mechanics - 1301.7 Statistical and Nonlinear Physics
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Database: Compendex
Data Provider: Engineering Village

11. The Effect of Cold Ring Rolling on the Heat Treatment Microstructure and Wear Resistance of GCr15 Bearing Steel (*Open Access*)

Hao, Tianci (1); Yu, Xingfu (2); Yu, Penghan (3); Wei, Yinghua (4); Su, Yong (5)
Source: *Steel Research International*, v 96, n 6, June 2025; **ISSN:** 16113683, **E-ISSN:** 1869344X; **DOI:** 10.1002/srin.202400773;
Article number: 2400773; **Publisher:** John Wiley and Sons Inc
Author affiliation: (1) School of Materials Science and Engineering, Shenyang University of Technology, Shenyang; 110870, China (2) School of Mechanical Engineering, Shenyang University of Technology, Shenyang; 110870, China (3) Supporting Undertakings Department, Genertec Shenyang Machine Tool Co., Ltd., Shenyang; 110142, China (4) School of Chemical Equipment, Shenyang University of Technology, Liaoyang; 111000, China (5) School of Mechanical and Power Engineering, Shenyang University of Chemical Technology, Shenyang; 110142, China

Abstract: By means of cold ring rolling (CRR), quenching and tempering treatments, microstructure observation, and mechanical-property tests, the effects of CRR on the heat treatment microstructure and wear resistance of GCr15 bearing steel are studied. The results show that, CRR reduces the size of carbides in the spheroidized microstructure and increases their quantity. The carbide particle size before and after CRR are 1.264 and 0.697 μm, respectively. After solution treatment and quenching, the number of undissolved carbides significantly decreases in the CRR samples. When the solution treatment time is 20 min, the carbide size in the steel without and with CRR is 0.684 and 0.628 μm, indicating that CRR promotes carbide dissolution during solution treatment. After tempering, the CRR steel exhibits an increase in carbide precipitation, and a great number of particulate carbides are precipitated. The hardness of the CRR steel after tempering is notably enhanced, and the wear resistance is improved. When the solution treatment time is 15 min under the same quenching and tempering conditions, the CRR steel achieves the highest hardness of HRC 62.0 and the best wear resistance with the wear loss of only 4.73 × 10−5mg (N m)−1. © 2024 Wiley-VCH GmbH. (18 refs)
Main heading: Quenching
Controlled terms: After-heat treatment - Brinell Hardness - Chromium steel - Roller bearings - Steel heat treatment - Steel metallurgy - Tempering - Wear of materials
Uncontrolled terms: Cold ring-rolling - GCr15 bearing steel - Microstructure observation - Quenching and tempering - Quenching treatment - Rolling steel - Rolling treatment - Solution treatment time - Solution treatments - Tempering treatments
Classification Code: 201.1.1 Metallurgy - 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 214 Materials Science - 214.1 Mechanical Properties of Materials - 601.2 Machine Components
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Open Access type(s): All Open Access, Bronze
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Data Provider: Engineering Village

12. A study on the influence of electrochemical and immersion hydrogen uptake methodologies on 100Cr6 bearing steel integrity

López-Uruñuela, Fernando José (1, 2); López-Ortega, Ainara (1); Bayón, Raquel (1); Pinedo, Bihotz (1); Aguirrebeitia, Josu (2)
Source: *International Journal of Hydrogen Energy*, v 142, p 712-722, June 27, 2025; **ISSN:** 03603199; **DOI:** 10.1016/j.ijhydene.2025.02.273; **Publisher:** Elsevier Ltd
Author affiliation: (1) Tekniker, Basque Research and Technology Alliance (BRTA), C/ Iñaki Goenaga, 5, Eibar; 20600, Spain (2) Department of Mechanical Engineering, University of the Basque Country (UPV/EHU), Bilbao, Spain
Abstract: In the last decades, wind turbine rolling bearings have suffered from hydrogen-induced damage, leading to premature failures such as the White Etching Crack. To recreate these failures, hydrogen uptakes were conducted before the tribological tests. However, the specimens were generally not characterised after the uptakes but only after the fatigue tests. In this work, the influence of electrochemical and immersion hydrogen uptake methodologies on bearing steel integrity has been studied. It was found that certain electrochemical uptakes can generate subsurface cracks, thus the uptake leads to hydrogen-induced cracking instead of hydrogen embrittlement, changing the way WEC is generated. Furthermore, it was found that surface and subsurface corrosion was induced by both types of uptakes. © 2025 Hydrogen Energy Publications LLC (59 refs)
Main heading: Hydrogen embrittlement
Controlled terms: Cracks - Electrochemical corrosion - Etching - Fatigue testing - Fracture mechanics - Roller bearings - Steel corrosion - Wind turbines
Uncontrolled terms: Bearing steels - Electrochemical hydrogen uptake - Electrochemicals - Hydrogen uptake - Immersion hydrogen uptake - Rolling bearings - White etching crack - Wind turbine gearbox bearing steel - Wind turbine gearboxes
Classification Code: 201.1.1 Metallurgy - 201.9.1 Metals Corrosion - 202.5.3 Steel - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 801.3.1 Electrochemistry - 802.2 Chemical Reactions - 1008.5 Wind Power and Wind Power Generation - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

13. Residual stress engineering for highly loaded rolling-sliding contacts: Finding the sweet spot for maximum durability by hard turning and deep rolling (*Open Access*)

Dechant, Simon (1); Nordmeyer, Henke (2); Pape, Florian (1); Breidenstein, Bernd (2); Poll, Gerhard (1); Marian, Max (1, 3)

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Abstract: The durability of highly loaded rolling-sliding contacts, such as those in rolling bearings, is critically determined by subsurface microstructure and residual stresses engineered during manufacturing. This study systematically investigates the interplay between thermal and mechanical process parameters during deep rolling, using bearing inner rings as a representative example, to identify optimal conditions for maximizing fatigue life. By isolating the effects of process temperature (20–400 °C) and deep rolling pressure (200–400 bar), we demonstrate that moderate mechanical loading at room temperature can more than double bearing life through beneficial compressive residual stresses, while excessive pressure or thermal input above 200 °C sharply reduces durability. Notably, we reveal a previously unrecognized mechanism of hidden thermal degradation that limits lifetime, even when conventional hardness or microstructural metrics remain unchanged. These results define a process window for residual stress engineering in bearing steels and provide generic guidelines for hybrid manufacturing of rolling-sliding components subjected to severe tribological loading. The findings advance fundamental understanding of process-induced fatigue mechanisms and offer a framework for the rational design of subsurface-optimized, durable, and sustainable machine elements. © 2025 The Authors (46 refs)
Main heading: Durability
Controlled terms: Friction - Residual stresses - Roller bearings - Stress analysis - Thermal fatigue - Tribology - Turning
Uncontrolled terms: Deep rolling - Hard turning - Highly loaded - Machine element - Rolling bearings - Rolling contact fatigue - Rolling sliding contact - Stress engineering - Subsurface - Sweet spot
Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 601.2 Machine Components - 604.2 Machining Operations - 606 Lubrication and Tribology - 1301.1.1 Mechanics
Funding Details: Number: BR 2967/28–1,PO-675/22–1,PA-3279/8–1, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft; Number: -, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft;
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Database: Compendex
Data Provider: Engineering Village

14. Femto-second laser ablated surface-textures in AISI 440C martensitic stainless steel for precision bearings: Hardness, residual stress, lubricant wettability, friction and wear assessment

Anand, P. (1); Biswas, Jyoti (1); Singh, Sanasam Sunderlal (1); Samuel, G.L. (1); Ramkumar, P. (1); Edachery, Vimal (1)
Source: *Optics and Laser Technology*, v 183, May 2025; **ISSN:** 00303992; **DOI:** 10.1016/j.optlastec.2024.112359; **Article number:** 112359; **Publisher:** Elsevier Ltd
Author affiliation: (1) Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai; 600036, India
Abstract: Precision ball bearing applications have demanding operating conditions of low friction, variable speeds and high lifetimes. Even though the primary mode of operation in such bearings is Elasto-Hydrodynamic Lubrication (EHL) regime, they undergo transitions between EHL, mixed & boundary lubrication conditions and contact skidding due to accelerations/deceleration cycles at high speed. The performance and life of these bearings can be improved by developing new lubricant formulations, surface coatings, surface texturing etc. Laser Surface Texturing (LST) of bearing rings using pulsed laser beams is a viable option for improving the tribological properties of bearings. The criticality in developing textures for precision bearing races is to produce burr free shallow micro-textures. This study attempts to design, generate and characterize micro-textures in hardened martensitic AISI 440C steel plates for precision bearing applications. The effects of various laser beam parameters with femtosecond laser (FSL) ablation technique in such hardened stainless steel plates is discussed in this study. Laser beam energy, pulse repetition rate (PRR), and number of laser pulses (NOP) determine the final size and profile of the micro-textures. The generated micro-textures (in the form of circular dimples) are characterized for variations in hardness, residual stresses, lubricant wettability and tribological properties. The right selection of femtosecond laser beam parameters yielded the desired dimple geometry with no heat affected zone, residual stress which is compressive in nature, similar lubricant wettability and improved tribological properties in starved lubrication condition, compared to a smooth non-textured surface. © 2024 (54 refs)
Main heading: Femtosecond lasers
Controlled terms: Ball bearings - Hardening - Laser ablation - Martensitic stainless steel - Pulse repetition rate - Pulsed laser applications - Wetting

Uncontrolled terms: AISI 440c - Elasto-hydrodynamic lubrication - Femto-second laser - Femtosecond laser surface texturing - Femtoseconds - Laser beam parameters - Laser surface texturing - Lubrication / - Micro-texture - Tribological properties
Classification Code: 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 601.2 Machine Components - 744 Lasers and Masers - 744.5 Laser Beam Interactions - 744.6 Laser Applications - 1301.1.2 Physical Properties of Gases, Liquids and Solids
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Database: Compendex
Data Provider: Engineering Village

15. Numerical analysis of the influence of coating and texture on the performance of hybrid journal bearing

Wang, Jiawei (1); Zhang, Hui (1); Meng, Zhaozhe (1); Jiang, Sen (1); Kouediatouka, Ange Nsilani (1); Hu, Jingwei (2); Dong, Guangneng (1)
Source: *Tribology International*, v 212, December 2025; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2025.110975; **Article number:** 110975; **Publisher:** Elsevier Ltd
Author affiliation: (1) Key Laboratory of Education Ministry for Modern Design and Rotor-bearing System, Xi'an Jiaotong University, Shaanxi, Xi'an; 710049, China (2) NSK (China) Research and Development Co., Ltd, Jiangsu, Suzhou; 215332, China
Abstract: This paper aims to investigate the effects of coating, surface texture, and their synergies on the load capacity and lubrication performance of hybrid journal bearing under mixed lubrication conditions. A mixed lubrication model considering surface elastic deformation is developed to explore the influence of coatings with various elastic moduli and textures at different positions and their combinations on the friction coefficient, fluid load capacity, and asperity load capacity under various hydrodynamic and hydrostatic pressure ratios. The film thickness, fluid pressure distribution, and asperity pressure distribution are presented to illustrate the mechanisms of high-load capacity and low friction by the coatings and textures. Results indicate that the soft coatings exhibit higher fluid load capacity under high hydrostatic pressure and improve anti-friction property. Appropriate texture design increases fluid load capacity and reduces friction coefficient under low hydrodynamic pressure. Additionally, different surface treatment sequences significantly affect load capacity and lubrication performance. © 2025 (38 refs)
Main heading: Coatings
Controlled terms: Friction - Hydraulics - Hydrodynamics - Hydrostatic pressure - Pressure distribution - Surface treatment - Tribology
Uncontrolled terms: Capacity performance - Coating surface - Friction coefficients - Hybrid journal bearing - Load capacity - Lubrication condition - Lubrication performance - Mixed lubrication - Performance - Surface textures
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 208.2 Coating Materials - 301.2 Hydrodynamics - 606 Lubrication and Tribology - 1301.1.1 Mechanics - 1401.1 Hydraulics
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Database: Compendex
Data Provider: Engineering Village

16. Analysis of Skidding Characteristics of Solid-Lubricated Angular Contact Ball Bearings During Acceleration (*Open Access*)

Zhang, Shijie (1); Zhao, Yuhao (2); Wei, Jing (2); Zi, Yanyang (3)
Source: *Lubricants*, v 13, n 5, May 2025; **E-ISSN:** 20754442; **DOI:** 10.3390/lubricants13050218; **Article number:** 218; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) College of Information Technology, Luoyang Normal University, Luoyang; 471934, China (2) College of Mechanical and Vehicle Engineering, Chongqing University, Chongqing; 400044, China (3) College of Mechanical Engineering, Xi'an Jiaotong University, Xi'an; 710049, China
Abstract: Solid-lubricated rolling bearings are widely used in the aerospace field and are key components to support spacecraft rotors. During the start-up of the engine, the sharp acceleration may cause bearing skidding, resulting in damage

of the solid lubricating film and a reduction in the remaining useful life of the bearing. However, the existing research on the tribo-dynamic responses of solid-lubricated ball bearings mostly relies on semi-empirical tribological models, which are limited in their ability to reveal the micro–macro sliding mechanisms of the ball–raceway contact interface. In this paper, a novel tribo-dynamic model for solid-lubricated angular contact ball bearings is developed by applying Kalker's rolling contact theory to the Gupta dynamic model. The interpolation method is adopted to calculate contact parameters to improve the model's efficiency. Using the proposed model, the dynamic response of the bearing in the acceleration process is studied, and the mechanism and influence characteristics of skidding, over-skidding, and creepage of the rolling element are analyzed. The results show that the main reason for skidding is that the traction force is not enough to overcome the resistance, and the gyroscopic effect is the main cause of over-skidding, which follows the principle of conservation of the angular momentum of the ball. © 2025 by the authors. (51 refs)
Main heading: Ball bearings
Controlled terms: Angular momentum - Roller bearings - Tribology
Uncontrolled terms: % reductions - Aerospace field - Angular contacts - Dynamics models - Remaining useful lives - Rolling bearings - Semi-empirical - Solid lubricating films - Solid lubrication - Tribological models
Classification Code: 601.2 Machine Components - 606 Lubrication and Tribology
Funding Details: Number: 242102241021,252102210140,252102321137, Acronym: -, Sponsor: -; Number: 232300420155, Acronym: -, Sponsor: Natural Science Foundation of Henan Province; Number: -, Acronym: -, Sponsor: Natural Science Foundation of Henan Province; Number: 231111241300, Acronym: -, Sponsor: Key Research and Development Project of Hainan Province; Number: -, Acronym: -, Sponsor: Key Research and Development Project of Hainan Province; Number: 24A460020, Acronym: -, Sponsor: -;
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Open Access type(s): All Open Access, Gold, Green
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17. Investigation of skidding characteristics of high-speed cylindrical roller bearings based on the improved ADORE model with thermal analysis and lubricant distribution

Zhang, Jiaming (1); Qiu, Ming (1, 2); Dong, Yanfang (1); Yang, Chuanmeng (1)
Source: *Tribology International*, v 204, April 2025; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2025.110523; **Article number:** 110523;
Publisher: Elsevier Ltd
Author affiliation: (1) School of Mechatronics Engineering, Henan University of Science and Technology, Henan, Luoyang; 471000, China (2) Collaborative Innovation Center of Machinery Equipment Advanced Manufacturing of Henan Province, Henan University of Science and Technology, Henan, Luoyang; 471000, China
Abstract: The research focuses on the issue of excessive skidding for cylindrical roller bearings. The oversimplified thermal analysis module of the rolling bearing dynamics analysis software ADORE was improved with the thermal resistance network method and lubricant distribution. Based on the improved ADORE, the variation mechanism of skidding and the critical radial load for skidding of cylindrical roller bearings were analyzed. The findings indicate that the slip rate and the sliding velocity decreases exponentially with increasing radial load, and 5 % is chosen as the evaluation criterion for the degree of skidding. A method for calculating the critical radial load for skidding of NU-type bearings is proposed, which has reference value for the design of cylindrical roller bearings with low slip rates. © 2025 Elsevier Ltd (44 refs)
Main heading: Critical temperature
Controlled terms: Roller bearings - Rollers (machine components) - Thermal modeling
Uncontrolled terms: Critical load - Cylindrical roller-bearing - High Speed - Lubricant distribution - Radial loads - Research focus - Rolling bearings - Slip rates - Thermal - Thermal-solid couple
Classification Code: 302.1 Thermodynamics - 601.2 Machine Components - 1201.12 Modeling and Simulation
Funding Details: Number: 52275186, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: SKLTKF20A03, Acronym: SKLT, Sponsor: State Key Laboratory of Tribology;
Funding text: This work is supported by the National Natural Science Foundation of China (No. 52275186) and the Open Foud of State Key Laboratory of Tribology in Advanced Equipment (SKLTKF20A03).
Database: Compendex
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18. Cage whirl characteristics of cylindrical roller bearings considering skidding under high-speed and light-load

Zhang, Jiaming (1); Qiu, Ming (1, 2); Dong, Yanfang (1); Yang, Chuanmeng (1)
Source: *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, v 239, n 14, p 5383-5394, July 2025; **ISSN:** 09544062, **E-ISSN:** 20412983; **DOI:** 10.1177/09544062251324334; **Publisher:** SAGE Publications Ltd
Author affiliation: (1) School of Mechatronics Engineering, Henan University of Science and Technology, Luoyang, China (2) Collaborative Innovation Center of Machinery Equipment Advanced Manufacturing of Henan Province, Henan University of Science and Technology, Luoyang, China
Abstract: Aimed at addressing the issues of cage instability and excessive skidding of cylindrical roller bearings under high-speed and light-load conditions. Dynamic Time Warping method was employed to quantitatively assess the stability of cage motion by calculating the similarity between the tracks of the cage mass center. Additionally, the effects of cage force and roller skidding on the whirling characteristics of the cage were analyzed under various whirling states. The findings indicate that the cage motion is most stable during local periodic whirling, followed by regular circular whirling. The force acting on the cage, which determines the whirling characteristics, varies across different whirling states. The rate of roller slip variation directly affects the normal force, subsequently influencing the whirling characteristics. By reducing the degree of bearing skidding, the collision force between the cage and the roller is lessened, thereby enhancing the stability of cage whirling. © IMechE 2025 (40 refs)
Main heading: Skidding
Controlled terms: Cylinders (shapes) - Roller bearings - Rollers (machine components)
Uncontrolled terms: Cage whirling - Cylindrical roller-bearing - Dynamic time warping - High lights - High Speed - Lightload - Load condition - Mass centers - Roller slip - Time warping methods
Classification Code: 408.1 Structural Members and Shapes - 601.2 Machine Components - 662.1 Automobiles
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Database: Compendex
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19. The Test Bench for Determining Impact of Polymer Housing Material on the Bearing's Internal Friction

Tasić, Marko M. (1); Mitrović, Radivoje M. (2); Mišković, Žarko Z. (2)
Source: *Mechanisms and Machine Science*, v 174 MMS, p 504-512, 2025, *Machine and Industrial Design in Mechanical Engineering - Proceedings of KOD 2024*; **ISSN:** 22110984, **E-ISSN:** 22110992; **ISBN-13:** 9783031805110; **DOI:** 10.1007/978-3-031-80512-7_50;
Conference: 12th International Conference of Machine and Industrial Design in Mechanical Engineering, KOD 2024, May 23, 2024 - May 26, 2024; **Sponsor:** TERMOMETAL d.o.o. Ada, Serbia; **Publisher:** Springer Science and Business Media B.V.
Author affiliation: (1) Department Zemun, Academy of Applied Studies Politehnika, Belgrade, Serbia (2) Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia
Abstract: The test bench for research of the influence of housing material on internal friction of the idler bearing is presented in this paper. Different internal friction is the consequence of different temperature field caused by various housing materials and heat conductivity coefficients respectively. The test bench was created by the special modification of the existing pulley test bench in the laboratory LIMES. Several radial loads and rotational speeds were applied to the test bench. The results of temperature and internal resistance force were monitored and recorded for the whole period until both variables reached stationary stage. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2025. (14 refs)
Main heading: Internal friction
Controlled terms: Ball bearings - Equipment testing - Friction materials - Supersaturation - Tribology
Uncontrolled terms: Friction test - Heat-conductivity coefficients - Housing materials - Internal friction test bench - Load speed - Material conductivities - Polymer housing - Radial ball bearing - Radial loads - Test-bench
Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 601.2 Machine Components - 606 Lubrication and Tribology - 801.3 Physical Chemistry - 942.2.1 Testing Devices and Equipment - 1301.4 Solid State Physics
Database: Compendex
Data Provider: Engineering Village

20. Investigation on the material damage and correlation analysis of GCr15SiMn bearing steel under unsteady lubrication based on poor information

Liu, Zeyuan (1); He, Tiantian (1); Tian, Jie (1); Jin, Zihao (1); Song, Gaoang (1); Du, Sanming (1); Zhang, Yongzhen (1)
Source: *Materials Today Communications*, v 43, February 2025; **E-ISSN:** 23524928; **DOI:** 10.1016/j.mtcomm.2025.111608; **Article number:** 111608; **Publisher:** Elsevier Ltd
Author affiliation: (1) National United Engineering Laboratory for Advanced Bearing Tribology, Henan University of Science and Technology, Luoyang; 471000, China
Abstract: Rolling bearings are affected by many factors such as harsh environmental conditions during their functioning. Therefore, the tribological behavior of bearings under unsteady lubrication conditions is of great research significance. In this paper, four friction and wear experiments of unsteady lubrication were carried out on GCr15SiMn bearing steel under three contact stress conditions, namely, lean lubrication, transition stage, initial stage of dry friction and 30 min dry friction. Grey absolute correlation method, grey relative correlation method and grey correlation method were used to analyze the correlation. The experimental results show that when the material lubrication environment goes from the lean lubrication to the final dry friction stage, the friction and wear performance undergoes an abrupt change in the friction coefficient and wear rate. The wear mechanism on the material surface transitions from abrasive wear in the lean lubrication to adhesive wear in the transitional stage and then to a combination of oxidative and adhesive wear in the dry friction stage. In lean lubrication, there is a slight plastic flow on the material surface; cracks and spalling pits appear on the surface of the wear scar in the transition stage; and cracks and spalling pits intensify in the dry friction condition. Comprehensive analysis of the three correlation analyses concludes that the change of friction coefficient is the most important factor affecting the damage of unsteady bearings. © 2025 Elsevier Ltd (34 refs)
Main heading: Tribology
Controlled terms: Adhesives - Chromium steel - Cracks - Manganese alloys - Manganese steel - Roller bearings - Silicon alloys - Spalling - Surface defects - Wear of materials
Uncontrolled terms: Adhesive wears - Bearing steels - Correlation analysis - Dry friction - Friction coefficients - Gcr15simn bearing steel - Lubrication / - Material's surface - Transition stage - Unsteady lubrication
Classification Code: 202.3.2 Manganese and Alloys - 202.5.3 Steel - 202.9.3 Others, including Bismuth, Boron, Cadmium, Cobalt, Mercury, Niobium, Selenium, Silicon, Tellurium and Zirconium - 208 Coatings, Surfaces, Finishes, Films and Deposition - 210 Adhesive Materials - 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 - 606 Lubrication and Tribology
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Database: Compendex
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21. Characterization of the skidding dynamics of rolling bearings considering cage flexibility

Tu, Wenbing (1, 2); Huang, Yibin (2); Zhang, Guiyuan (2); Yu, Wennian (3)
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Abstract: Cage is the most vulnerable component in the rolling bearing structure. Its flexibility directly affects the deformation of the cage, which changes the contact state between the cage and the rolling element, and thus affecting the skidding characteristics of the rolling bearings. The cage is discretized into mass blocks connected by springs and dampers to consider its circumferential flexibility, and a dynamic model of the shaft-bearing-housing system is proposed by considering contact force, damping force, friction force, oil film stiffness, viscous drag force, and elastic support of the shaft and housing. The variations of the contact force between the cage and rolling element and the internal force of the cage are analyzed. The effects of the cage's connect stiffness, rotational speed, and load on the skidding characteristics of the rolling bearings are investigated. The results show that the dynamic interaction between the cage and rolling element is influenced by cage flexibility. The dynamic model considering cage flexibility can more realistically reflect the skidding in rolling bearings. Increasing the connect stiffness results in higher internal forces in the cage and a lower skidding ratio. © IMechE 2025 (38 refs)
Main heading: Dynamic models
Controlled terms: Friction - Housing - Stiffness

Uncontrolled terms: Bearing structure - Cage flexibility - Contact forces - Contact state - Dynamics models - Internal forces - Mass block - Rolling bearings - Rolling elements - Shaft bearing
Classification Code: 214 Materials Science - 403.1 Urban Planning and Development - 601.2 Machine Components - 662.1 Automobiles - 1301.1.1 Mechanics - 1301.7 Statistical and Nonlinear Physics
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Database: Compendex
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22. Theoretical and Experimental Study on a Novel Porous Tilting Pad Gas Thrust Bearing with Umbrella-Type Dampers

Han, Shaocun (1, 2); Li, Jian (1); Wang, Jianwei (1); Yang, Jinggui (1); Zhang, Pengfei (1); Feng, Kai (1, 2)
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Abstract: To expand the application scope of gas bearings in oil-free turbomachinery, this paper presents a novel porous tilting pad gas thrust bearing (PTPGTB) with umbrella-type dampers (UDs) incorporating viscoelastic material. This damper, fabricated using additive manufacturing, can shrink like an umbrella to squeeze the viscoelastic material from all directions so as to dissipate more energy. A comprehensive theoretical model is proposed by coupling the PTPGTB model and the UD model. Dynamic load tests and load capacity tests are carried out. The experimental results generally agree with the predicted results. The effects of nominal clearance, supply pressure, rotational speed, and UD geometry parameters are discussed. The variations of hydrostatic and hydrodynamic effects in PTPGTBs with different parameters are revealed. The results show that smaller clearances, lower rotational speeds, higher supply pressures, and greater axial stiffness increase the load capacity of PTPGTBs. The research can provide a new design idea and theoretical guidance for improving the load capacity of gas thrust bearings. © 2025 Society of Tribologists and Lubrication Engineers. (34 refs)
Main heading: Gas bearings
Controlled terms: Bearing pads - Dynamic loads - Gas lubricated bearings - Gas turbines - Hydrodynamics - Hydrostatic bearings - Thrust bearings - Tribology
Uncontrolled terms: Gas thrust bearing - Load capacity - Oil-free - Rotational speed - Supply pressure - Theoretical modeling - Tilting pad - Umbrella-type damper - Visco-elastic material - Viscoelastic material
Classification Code: 301.2 Hydrodynamics - 408 Structural Design - 601.2 Machine Components - 606 Lubrication and Tribology - 606.2 Lubrication - 608.3 Gas Turbines and Engines
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23. A modeling-and-material framework for scuffing failure: Machine learning accelerated prediction and graphene-based mitigation in greased ball bearing

Li, Jiaqi (1); An, Ben (1); Li, Zhenshun (1); Chen, Gen (1); Li, Rui (1)
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Abstract: Ball bearings are prone to local scuffing failure due to poor lubrication and high temperature, seriously affecting the service life of equipment. Graphene has great potential application in improving lubrication properties as additive. In this paper, the scuffing failure criterion of ball bearing is proposed based on the mixed thermal elastohydrodynamic lubrication (TEHL) model of greased point contacts. But solving this model is time-consuming. Hence, a GA-BP neural network is established using the numerical results. The determination coefficient R 2 is exceeding 0.9, showing great prediction performance. SHAP analysis reveals that the importance order of features on tribological properties is working conditions, grease properties, roughness. For 6209 deep groove ball bearing lubricated by lithium grease, its safe operating zone is below 10 kN loading. Heavy load and high speed will increase the risk of scuffing failure. In a specific boundary lubrication state, the nanogrease with 0.08 wt% graphene exhibits the best reducing friction and wear capability (23.11 % and 26.18 % decrease). It is attributed to the protective film formation, surface repairing and chemical passivation barrier mechanism. This study achieves efficient prediction of interfacial tribological properties and mitigation of scuffing failure in bearing systems. © 2026 Elsevier Ltd. (44 refs)
Main heading: Point contacts
Controlled terms: Additives - Deep groove ball bearings - Elastohydrodynamic lubrication - Failure (mechanical) - Lubricating greases - Passivation - Tribology
Uncontrolled terms: BP neural networks - GA-BP neural network - Graphene additive - Graphenes - Grease lubrication - Highest temperature - Lubrication / - Machine-learning - Scuffing failures - Tribological properties
Classification Code: 201.9.2.1 Protection Methods - 214 Materials Science - 601.2 Machine Components - 606 Lubrication and Tribology - 606.1 Lubricants - 606.2 Lubrication - 704.1 Electric Components - 714.2 Semiconductor Devices and Integrated Circuits - 803 Chemical Agents and Basic Industrial Chemicals
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24. Effect of prior cold rolling on the dry wear performance of GCr15 bearing steel with multiphase microsturcture

Qian, Dongsheng (1, 2, 3); Li, Tianqi (1, 2, 3); Wang, Feng (1, 2, 3); Deng, Jiadong (1, 3)
Source: *Materials Science and Technology (United Kingdom)*, v 41, n 17, p 1367-1376, December 2025; **ISSN:** 02670836, **E-ISSN:** 17432847; **DOI:** 10.1177/02670836241282557; **Publisher:** SAGE Publications Inc.
Author affiliation: (1) Hubei Longzhong Laboratory, Xiangyang, China (2) School of Materials Science and Engineering, Wuhan University of Technology, Wuhan, China (3) Hubei Engineering Research Center for Green Precision Material Forming, Wuhan, China
Abstract: In this work, the effect of cold rolling on the wear performance of GCr15 bearing steel with multiphase microstructure has been investigated. The microstructural observation shows that prior cold rolling facilitates to the dissolution of carbides during austenitization. With the increase of cold rolling reduction, the residual austenite content is increased after multiphase heat treatment. The wear results indicate that friction coefficient as well as wear rate distinctly decreases with the increase of rolling reduction. It is also found that the transformation of martensite from residual austenite induced by wear stress increases the surface compressive stress and hardness for the rolled specimens, thereby leading to the enhancement of dry wear resistance. © The Author(s) 2024 (33 refs)
Main heading: Austenite
Controlled terms: Brinell Hardness - Chromium steel - Compressive stress - Rockwell hardness - Roller bearings - Steel heat treatment - Steel metallography - Steel metallurgy - Wear of materials
Uncontrolled terms: Austenitization - Dry wear - GCr15 bearing steel - Micro-structural observations - Multiphase heat treatment - Multiphase microstructure - Multiphases - Prior cold rolling - Residual austenite - Wear performance
Classification Code: 201.1.1 Metallurgy - 201.1.2 Metallography - 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 215.1.1 Mechanical Properties Testing Equipment - 601.2 Machine Components - 1301.1.1 Mechanics
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25. Characteristic of Shaft Voltage According to Ball Bearing Geometry and Material

Jo, Byoung-Wook (1); Heo, Jun-Hyeok (1); Hur, Jin (1)
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Author affiliation: (1) Incheon National University, Dept. of Electrical Engineering, Incheon, Korea, Republic of
Abstract: Electrical corrosion of bearing due to shaft voltage has been causing bearing failures in various applications such as mobility, home appliances, and industry. In order to derive the shaft voltage accurately, it is important to derive the parasitic capacitance. Most existing studies have focused on shaft voltage based on motor structures and steel ball bearings, whereas research on ceramic ball bearings remains relatively limited. Furthermore, even for steel ball bearings, the parasitic capacitance values fail to reflect the complex structure of the bearing. Therefore, this paper proposes a method for analyzing and deriving the parasitic capacitance of bearings according to the geometry and material properties of ceramic ball and steel ball. Additionally, shaft voltage is analyzed according to the capacitance of the bearings. Finally, proposed method is compared and validated against the experiments. © 2025 IEEE. (9 refs)
Main heading: Ball bearings
Controlled terms: Ceramic materials - Corrosion - Domestic appliances - Steel research
Uncontrolled terms: Bearing failures - Capacitance values - Ceramic ball bearing - Ceramic balls - Complexes structure - Electrical corrosion - Parasitics capacitance - Property - Shaft voltage - Steel balls
Classification Code: 201.9.1 Metals Corrosion - 201.9.2 Corrosion Protection - 202.5.3 Steel - 204.1 Ceramics - 601.2 Machine Components - 701.1 Electricity: Basic Concepts and Phenomena - 704.2 Electric Equipment - 901.3 Engineering Research
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