1. Dodecenylsuccinic acid-functionalized phosphate ionic liquid additive for enhanced micropitting resistance and lubrication performance

Su, Tong (1, 2); Ju, Chao (2, 3); Zheng, Dongdong (4); Zhang, Quande (1, 2); Zhao, Qin (2); Zhao, Gaiqing (2, 3); Guo, Feng (1); Wang, Xiaobo (2, 3)
Source: *Journal of Molecular Liquids*, v 435, October 1, 2025; **ISSN:** 01677322; **DOI:** 10.1016/j.molliq.2025.128140; **Article number:** 128140; **Publisher:** Elsevier B.V.
Author affiliation: (1) School of Mechanical and Automotive Engineering, Qingdao University of Technology, Shandong, Qingdao; 266520, China (2) State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Gansu, Lanzhou; 730000, China (3) Qingdao Center of Resource Chemistry and New Materials, Shandong, Qingdao; 266000, China (4) School of Materials and Chemical Engineering, Xuzhou University of Technology, Jiangsu, Xuzhou; 221018, China
Abstract: Micropitting corrosion poses a significant challenge to the reliability of wind turbine gear systems, with conventional additives such as zinc dialkyldithiophosphate (ZDDP) paradoxically exacerbating this failure mechanism while providing wear protection. To address this critical industry dilemma, we facilely synthesize a novel dodecenylsuccinic acid-functionalized phosphate protic ionic liquid (DDSA-AP) as a lubricant additive. This sulfur-free additive exhibits excellent copper corrosion resistance, addressing a critical limitation of sulfur-containing counterparts. Tribological evaluations via SRV and MPR tests demonstrate that the incorporation of merely 1 wt% DDSA-AP in PAO base oil reduces the friction coefficient by 40 % and wear volume by 60.6 % compared to pure base oil, while simultaneously suppressing the micropitting area by 29 %. Surface analyses (SEM, XPS) reveal a robust tribofilm composed of phosphate oligomers and nitrogen-rich coordination compounds, attributed to DDSA-AP's strong adsorption capacity. Quantum chemical calculations and QCM-D experiments further confirm its superior reactivity and film-forming ability over ZDDP and sulfurized isobutylene (T321). This research offers a promising sulfur-free additive for effectively mitigating micropitting in challenging lubrication environments. © 2025 Elsevier B.V. (34 refs)
Main heading: Ionic liquids
Controlled terms: Additives - Chemical resistance - Corrosion protection - Corrosion resistance - Failure (mechanical) - Friction - Gears - Quantum chemistry - Sulfur - Tribology - Wear of materials - Zinc compounds
Uncontrolled terms: Base oil - Dialkyldithiophosphate - Functionalized - Ionic liquid additives - Lubricant additives - Lubrication / - Micro-pitting - Micropitting resistance - Quantum chemical calculations - Quantum-chemical calculation
Classification Code: 201.9.1 Metals Corrosion - 201.9.2 Corrosion Protection - 214 Materials Science - 301 Fluids - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 606 Lubrication and Tribology - 801.3 Physical Chemistry - 802.2 Chemical Reactions - 803 Chemical Agents and Basic Industrial Chemicals - 804 Chemical Products - 804.2 Inorganic Compounds - 1301.1.1 Mechanics
Funding Details: Number: 23ZDKA0003,23ZDKA012, Acronym: -, Sponsor: Major Science and Technology Projects in Yunnan Province; Number: -, Acronym: -, Sponsor: Major Science and Technology Projects in Yunnan Province; Number: XDC0180203, Acronym: CAS, Sponsor: Chinese Academy of Sciences; Number: -, Acronym: CAS, Sponsor: Chinese Academy of Sciences; Number: 2022CXGC020309, Acronym: -, Sponsor: Key Technology Research and Development Program of Shandong Province; Number: -, Acronym: -, Sponsor: Key Technology Research and Development Program of Shandong Province; Number: gx2023022, Acronym: -, Sponsor: -;
Funding text: The authors are grateful for the financial support provided by the Strategic Priority Research Program of the Chinese Academy of Sciences (XDC0180203), the Gansu Province Science and Technology Major Special Projects (23ZDKA0003 , 23ZDKA012), Key Research and Development Program of Shandong Province (2022CXGC020309), and the \u201C343\u201D Industrial Development Projects Fund of Xuzhou (gx2023022).
Database: Compendex
Data Provider: Engineering Village

2. Analysis of Contact and Bending Fatigue for Double-Helical Planetary Gear Train Based on Efficient Critical Plane Methods

Chen, Zhuang (1, 2); Dong, Qingbing (1, 2); Shi, Xiujiang (3); Huang, Weimin (2); Zhao, Bo (4)
Source: *Fatigue and Fracture of Engineering Materials and Structures*, v 48, n 4, p 1429-1446, April 2025; **ISSN:** 8756758X, **E-ISSN:** 14602695; **DOI:** 10.1111/ffe.14555; **Publisher:** John Wiley and Sons Inc
Author affiliation: (1) State Key Laboratory of Mechanical Transmission for Advanced Equipment, Chongqing University, Chongqing, China (2) School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore, Singapore (3) College of Power and Energy Engineering, Harbin Engineering University, Heilongjiang, Harbin, China (4) School of Marine Engineering and Technology, Sun Yat-sen University & Southern Marine Science and Engineering Guangdong Laboratory Zhuhai, Zhuhai, China
Abstract: Contact and bending fatigue are the main failure modes in gears. In this study, we propose a finite element model to investigate the fatigue behavior of a double-helical planetary gearbox based on the critical plane methods with a search algorithm to improve calculation efficiency. The finite element mesh is generated along the direction of the contact line to

accurately capture contact stress. The time-varying coefficient of friction between contact surfaces and the residual stress in the hardened layer are considered in the developed model. The effectiveness of the model is demonstrated by comparing the predicted fatigue life with measured data from experiments for a spur gear planetary train. It is concluded that the ability of the planet gear to resist contact fatigue dominates the service duration with fatigue cracks initiating nearly parallel to the surface. The surface hardness gradient is recommended to ensure reliable operation throughout its designed life. © 2025 John Wiley & Sons Ltd. (78 refs)

Main heading: Gear trains

Controlled terms: Epicyclic gears - Fatigue crack - Fatigue of materials - Friction - Helical gears - Rockwell hardness - Spur gears

Uncontrolled terms: Bending fatigue - Coefficient of frictions - Contact fatigues - Critical plane method - Double-helical - Double-helical planetary gear train - Finite element modelling (FEM) - Planetary gear train - Time-varying coefficient - Time-varying coefficient of friction

Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 661 Automotive Engines and Related Equipment - 1301.1.1 Mechanics

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Funding text: Funding: This work was supported by the State Key Laboratory of Mechanical Transmission for Advanced Equipment (SKLMT-MSKFKT-202211), the National Natural Science Foundation of China (52275175, 52375226), and the China Scholarship Council (202306050081, 202308500160). We appreciate the support from the State Key Laboratory of Mechanical Transmission for Advanced Equipment at Chongqing University, Chongqing, China (Grant No. SKLMT-MSKFKT-202211), the support of the National Natural Science Foundation of China (Grant No. 52275175 and 52375226), and the support of the China Scholarship Council (Grant No. 202308500160 and 202306050081).This work was supported by the State Key Laboratory of Mechanical Transmission for Advanced Equipment (SKLMT\u2010MSKFKT\u2010202211), the National Natural Science Foundation of China (52275175, 52375226), and the China Scholarship Council (202306050081, 202308500160). Funding:We appreciate the support from the State Key Laboratory of Mechanical Transmission for Advanced Equipment at Chongqing University, Chongqing, China (Grant No. SKLMT\u2010MSKFKT\u2010202211), the support of the National Natural Science Foundation of China (Grant No. 52275175 and 52375226), and the support of the China Scholarship Council (Grant No. 202308500160 and 202306050081).

Database: Compendex

Data Provider: Engineering Village

3. Modeling and analysis of relative fatigue life under 3D mixed lubrication in marine helical gears

Li, Renze (1); Ma, Jianqiang (2); Zhang, Xiaoyun (2); Shi, Xiujiang (1); Sun, Wen (1); Lu, Xiqun (1)

Source: *Tribology International*, v 211, November 2025; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2025.110834; **Article number:** 110834; **Publisher:** Elsevier Ltd

Author affiliation: (1) College of Power and Energy Engineering, Harbin Engineering University, Heilongjiang, Harbin; 150001, China (2) 703rd Research Institute of China Shipbuilding Industry Corporation, Heilongjiang, Harbin; 150001, China

Abstract: The helical gears of marine diesel engines work in a harsh mixed lubrication environment with lubrication-contact coexistence for a long time. Tooth surface stress concentration and micro-pitting corrosion caused by local rough peak contact are difficult to avoid. It will even shorten the contact fatigue life of helical gears. This report comprehensively considers the influence of real machined surface roughness and transient conditions of helical gears,establish a 3D dynamic stress and relative fatigue life calculation model of helical gear pair under mixed lubrication and obtain the oil film thickness, oil film pressure distribution under mixed lubrication conditions. It is also gain three-dimensional dynamic stress distribution and relative fatigue life under different measured machined surfaces. The results showed:affected by the surface roughness of the real machining, the helical gear is in a mixed lubrication state for a long time, and the lubrication state is relatively bad. Besides,the honed surface and shaved surface film thickness is relatively low,which make the tooth surface micro convex body direct contact and the overall Von Mises stress is higher. This induces the honed surface and shaved surface have a smaller relative fatigue life than the polished surface. In addition, the Von Mises stress of helical gears increases and the relative fatigue life decreases under high RMS roughness and heavy load conditions. Finally, in order to prolong the service life of helical gears, the polished surface should be selected as much as possible. © 2025 (30 refs)

Main heading: Helical gears

Controlled terms: Corrosion fatigue - Diesel engines - Film thickness - Friction - Lubricating oils - Lubrication - Marine engines - Stress concentration - Surface roughness

Uncontrolled terms: Dynamic stress - Honed surfaces - Lubrication state - Mixed lubrication - Modelling and analysis - Polished surfaces - Relative fatigue life - Rolling contact fatigue - Teeth surface - VonMises stress

Classification Code: 201.9.1 Metals Corrosion - 208 Coatings, Surfaces, Finishes, Films and Deposition - 208.4 Thin films - 214.1.1 Stress and Strain - 601.2 Machine Components - 606.1 Lubricants - 606.2 Lubrication - 608.2 Diesel Engines - 671.2 Ship Equipment - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

4. Analysis of bending fatigue strength performance test for corrosion-resistant nitrided aviation gear steel cylindrical gears (*Open Access*)

Sha, Jian (1); Wang, Chunlei (2); Tang, Xin (2); Li, Yong (3); Li, Leilei (3); Li, Fajia (1)
Source: *Journal of Physics: Conference Series*, v 3175, n 1, 2026; **ISSN:** 17426588, **E-ISSN:** 17426596; **DOI:** 10.1088/1742-6596/3175/1/012023; **Article number:** 012023; **Conference:** 6th International Conference on Advanced Materials and Intelligent Manufacturing, ICAMIM 2025, November 21, 2025 - November 23, 2025; **Publisher:** Institute of Physics
Author affiliation: (1) Shandong Provincial Key Laboratory of Sensor Technology and High Precision Weighing Instruments, School of Mechanical Engineering, University of Jinan, Jinan; 250022, China (2) Hunan Aviation Powerplant Research Institute, Aero Engine Corporation of China, Zhuzhou; 412002, China (3) Institute for Special Steel Research, Central Iron and Steel Research Institute Co. Ltd., Beijing; 100081, China
Abstract: This investigation examines the bending fatigue characteristics of next generation corrosion-resistant aviation gear steel in cylindrical gears. Standard compliant cylindrical gear parameters were developed specifically for the bending fatigue experiments. The testing plan was established and carried out to perform bending fatigue assessments on the gears. The experimental data were analyzed employing the Dixon-Mood (D-M) approach integrated with Monte Carlo simulation and a standard deviation adjustment technique for data processing. A comparison was made between the gear fatigue limits derived from the two techniques across different reliability levels. The findings reveal that the test gear's bending fatigue limit reaches 578.06 MPa at 95% confidence and 90% reliability. This outcome establishes an essential foundation for implementing this material in aviation gear systems, highlighting its favorable fatigue properties. © Published under licence by IOP Publishing Ltd. (18 refs)
Main heading: Intelligent systems
Controlled terms: Bending strength - Corrosion fatigue - Data handling - Fatigue testing - Gears - Monte Carlo methods - Reliability
Uncontrolled terms: Bending fatigue - Bending fatigue strengths - Corrosion-resistant - Cylindrical gear - Fatigue characteristics - Gear parameter - Gear steels - Nitrided - Performance tests - Strength performance
Classification Code: 201.9.1 Metals Corrosion - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 913.3 Quality Assurance and Control - 1101 Artificial Intelligence - 1106.2 Data Handling and Data Processing - 1202.2 Mathematical Statistics
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

5. Contact fatigue life forecasting model considering micro-scale subsurface stress for aerospace spiral bevel gears

Dong, Hongtao (1, 2, 3); Deng, Xiongyao (1, 2); Yin, Feng (1, 2, 3); Lu, Wenchao (4); Zhang, Xiaoqing (4); Wang, Qiang (1, 2); Zhou, Zhenyu (1, 2, 3); Ding, Han (1, 2)
Source: *Advances in Engineering Software*, v 199, January 2025; **ISSN:** 09659978, **E-ISSN:** 18735339; **DOI:** 10.1016/j.advengsoft.2024.103813; **Article number:** 103813; **Publisher:** Elsevier Ltd
Author affiliation: (1) State Key Laboratory of Precision Manufacturing for Extreme Services Performance, Central South University, Changsha; 410083, China (2) School of Mechanical and Electrical Engineering, Central South University, Changsha; 410083, China (3) AECC Hunan Aviation Powerplant Research Institute, Zhuzhou; 412002, China (4) Automotive Research Institute, China National Heavy Duty Truck Group, Jinan; 250100, China
Abstract: Focusing on stress distribution at subsurface layer under aerospace service condition in roughness tooth flank meshing interface, a new loaded contact fatigue life forecasting model is developed by considering micro-scale surface effect for aerospace spiral bevel gears. Firstly, tooth flank modeling considering the actual manufacturing process is used for accurate tooth flank point determination having high and uniform grid density. Then, with application geometric approximation and operation, discrete convolution and fast Fourier transformation (DC-FFT) based conjugate gradient (CG) method is applied to determine time-varying load distribution. While at normal direction of each point from the high-density tooth flank discretization after accurate interpolation is added the roughness height from the actual micro-scale geometric topography measurement, a tooth flank reconstruction is performed to determine the micro- scale geometric topography. Then, elastic half-space loaded contact model and DC-FFT method are employed to compute subsurface stress distribution

for roughness tooth flank. Von Mises stress is selected as design variable and introduced into Zaretsky model to establish the contact fatigue life forecasting model. Finally, a spiral bevel gear set in aerospace industrial application is exercised to verify the impact of subsurface stress on contact fatigue life. © 2024 (58 refs)
Main heading: Bevel gears
Controlled terms: Conjugate gradient method - Discrete Fourier transforms - Fatigue of materials - Gear manufacture - Gear teeth - Stress concentration
Uncontrolled terms: Aerospace spiral bevel gear - Contact fatigue life - Contact fatigue life forecasting model - Discrete convolution - Discrete convolution and fast fourier transformation - Fast Fourier transformations - Forecasting models - Life-forecasting - Roughness tooth flank - Spiral bevel gears - Stresses distribution - Subsurface stress - Subsurface stress distribution - Tooth flank
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components - 1201.3 Mathematical Transformations - 1201.8 Discrete Mathematics and Combinatorics, Includes Graph Theory, Set Theory - 1201.9 Numerical Methods
Funding Details: Number: 52205507,52475079, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: No.KY-1044–2023–0442,KY-1044-2023-0442, Acronym: -, Sponsor: -; Number: KY-1003-2022-0014, Acronym: -, Sponsor: -; Number: KY-1044-2024-0149,No.KY-1044–2024–0149, Acronym: -, Sponsor: -; Number: No.KY-1003–2022–0014, Acronym: AECC, Sponsor: Aero Engine Corporation of China; Number: -, Acronym: AECC, Sponsor: Aero Engine Corporation of China;
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Database: Compendex
Data Provider: Engineering Village

6. [Fatigue life and transmission efficiency prediction of marine timing gears under 3D mixed lubrication state]

Sun, Wen (1); Shi, Xiujiang (1); Lu, Xiqun (1); Hua, Deliang (1); Li, Renze (1); Liu, He (1); Wu, Gang (2)
Source: *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering*, v 240, n 1, p 204-215, February 2026; **ISSN:** 09544089, **E-ISSN:** 20413009; **DOI:** 10.1177/09544089241230879; **Publisher:** SAGE Publications Ltd
Author affiliation: (1) College of Power and Energy Engineering, Harbin Engineering University, Harbin, China (2) Wuhan Second Ship Design and Research Institute, Wuhan, China
Abstract: The timing gears are the core transmission components of marine diesel engine, whose working conditions are complex and harsh, transient and coupled with the microscopic lubrication state, meshing in the mixed lubrication environment with lubrication-contact coexistence, local asperity contact brings stress concentration, further affects the fatigue life and friction loss. In this study, based on a three-dimensional (3D) line-contact mixed lubrication model, dynamic subsurface stress calculation, fatigue life prediction, and friction loss power study were carried out on timing gears, taking into account transient operating conditions and actual surface roughness. For the established simulation model, an equivalent simulation test of line-contact friction of timing gears was carried out, which can realize the measurement of friction coefficient under the condition of different slip-roll ratios, and make up for the deficiency that the traditional test equipment can only carry out the test under the fixed slip-roll ratio. Although the gear meshing process can only be simulated by the disc specimen due to the limitation of the specimen form, this limitation is similar to the simplified form of the simulation model, which can meet the needs of the verification test. The influence of structure and material on the lubrication state, fatigue life and friction power consumption are studied, which provide theoretical guidance for the tribological optimization design and reliability analysis for the marine timing gears. © IMechE 2024 (33 refs)
Main heading: Surface roughness
Controlled terms: Diesel engines - Efficiency - Equipment testing - Fatigue of materials - Friction - Gears - Reliability analysis - Timing circuits - Tribology
Uncontrolled terms: 3d mixed lubrication - Condition - Efficiency predictions - Friction loss - Line contact - Lubrication state - Mixed lubrication - Simulation model - Timing gear - Transmission efficiency
Classification Code: 601.2 Machine Components - 713.4 Pulse Circuits - 913.1 Production Engineering
Database: Compendex
Data Provider: Engineering Village

7. Experimental and numerical analysis of low-cycle tooth bending fatigue in case-carburized gears (*Open Access*)

Pagliari, Lorenzo (1); Hong, Isaac (2); Kahraman, Ahmet (2); Concli, Franco (1)
Source: *International Journal of Fatigue*, v 202, January 2026; **ISSN:** 01421123; **DOI:** 10.1016/j.ijfatigue.2025.109237; **Article number:** 109237; **Publisher:** Elsevier Ltd
Author affiliation: (1) Faculty of Engineering, Free University of Bozen-Bolzano, Bolzano; 39100, Italy (2) Department of Mechanical and Aerospace Engineering, The Ohio State University, Columbus; OH; 43210, United States
Abstract: Tooth root bending fatigue represents one of the main failure modes of gears. While most of the available literature focuses on tooth root bending under high-cycle fatigue, little has been researched regarding tooth root bending under low-cycle fatigue, even though it is encountered in high-demand industrial sectors. This work evaluates the single tooth bending low-cycle fatigue behaviour of case-carburized gears and presents a novel framework for its prediction, based on the combination of experiments and numerical analysis. Specifically, pulsator single tooth bending tests were performed on case-carburized AISI 8620 spur gears instrumented with strain gages to detect crack initiation. The same tests were replicated in a finite element simulation framework capable of accounting for residual stresses induced by case-carburizing. Simulation results were numerically processed through critical plane criteria for multiaxial fatigue, obtaining predictions about fatigue life, location of crack nucleation and crack initial trajectory, which were compared with test results. Numerically predicted crack initiation locations and trajectories agreed with the experimental means, with errors of 2.6 % and 8 %, respectively. This study presents a new use of critical plane criteria implemented with residual stresses for the analysis of tooth bending fatigue, providing a novel and comprehensive framework for the prediction of such phenomenon, supported by experimental validation. © 2025 The Authors (41 refs)
Main heading: Plasticity
Controlled terms: Bending tests - Carburizing - Crack detection - Crack initiation - Fatigue testing - Low-cycle fatigue - Numerical analysis - Spur gears - Strain gages
Uncontrolled terms: Bending fatigue - Carburized gears - Cracks initiations - Critical plane criteria - Critical planes - Experimental and numerical analysis - Low cycle fatigues - Multi-axial fatigue - Single tooth - Tooth root bending
Classification Code: 201.7.1 Heat Treatment Processes - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 942.1.6 Mechanical and Miscellaneous Measuring Instruments - 1201.2 Calculus and Analysis - 1201.9 Numerical Methods
Funding Details: Number: -, Acronym: SWT, Sponsor: Sweet Water Trust;
Funding text: life to crack initiation (N) was conservatively estimated by the SWT model and more accurately captured by the CXH model. CHX predictions aligned with trends observed in past literature and were corroborated by strain-gage results.
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

8. Crack Initiation, Propagation and Fatigue Life Prediction of Spur Gear Under a Moving Contact Load

Wang, Zhiyun (1); Gao, Jianxiong (1); Yuan, Yiping (1); Zhou, Jianxing (1); Zhang, Hui (1); Pan, Rui (1); Zhang, Junbao (2)
Source: *International Journal for Numerical Methods in Engineering*, v 126, n 22, November 30, 2025; **ISSN:** 00295981, **E-ISSN:** 10970207; **DOI:** 10.1002/nme.70178; **Article number:** e70178; **Publisher:** John Wiley and Sons Ltd
Author affiliation: (1) School of Mechanical Engineering, Xinjiang University, Urumqi, China (2) Goldwind Technology Co., Ltd, Urumqi, China
Abstract: This study investigates the failure mechanisms of spur gears under bending fatigue loading, focusing on crack initiation, propagation paths, and stress field distribution. Finite element simulations are conducted to obtain linear elastic stress–strain data at the tooth root, which are then incorporated into the Smith-Watson-Topper (SWT) multi-axial fatigue model to predict the crack initiation location. Subsequently, a moving contact load model with time-dependent magnitude and direction is developed through the secondary implementation of an Abaqus DLOAD user subroutine using Fortran programming. During crack propagation analysis, variations in stress intensity factors (SIF), crack propagation paths, and stress field distribution are examined, whereas the NASGRO model is applied to estimate fatigue life under different operating conditions. The results indicate that the predicted fatigue life under moving contact load closely matches experimental values. During crack propagation, merging cracks lead to interactions and overlapping of stress fields, which ultimately reach a new equilibrium after merging. Furthermore, compared to loading at the highest position of single-tooth contact (HPSTC), the dynamic effect of the moving contact load effectively alleviates stress concentration and reduces the crack propagation rate. © 2025 John Wiley & Sons Ltd. (51 refs)
Main heading: Stress intensity factors

Controlled terms: ABAQUS - Crack initiation - Failure (mechanical) - Fatigue crack propagation - FORTRAN (programming language) - Merging - Spur gears - Stress analysis - Stress concentration - Subroutines
Uncontrolled terms: Bending fatigue - Cracks initiations - Cracks propagation - Failure mechanism - Fatigue life prediction - Fatigue loadings - Gear system - Moving contact loads - Stress field distribution - Stress-intensity factors
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 1106.1 Computer Programming - 1106.1.1 Computer Programming Languages - 1106.2 Data Handling and Data Processing - 1106.5 Computer Applications - 1201.5 Computational Mathematics
Funding Details: Number: 52465019, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: ZYYD2025JD07, Acronym: -, Sponsor: -; Number: 2024D01C27, Acronym: -, Sponsor: Natural Science Foundation of Xinjiang Uygur Autonomous Region; Number: 2023B01024 - 3, Acronym: -, Sponsor: -;
Funding text: This work was supported by National Natural Science Foundation of China (52465019), Natural Science Foundation of Xinjiang Uygur Autonomous Region (2024D01C27), Xinjiang Uygur Autonomous Region Central Guidance Local Science and Technology Development Fund Project (ZYYD2025JD07), Key Research and Development Program of Xinjiang Uygur Autonomous Region (2023B01024\u20103). Funding:This work was supported by the National Natural Science Foundation of China (52465019), the Natural Science Foundation of Xinjiang Uygur Autonomous Region (2024D01C27), the Xinjiang Uygur Autonomous Region Central Guidance Local Science and Technology Development Fund Project (ZYYD2025JD07), and the Key Research and Development Program of Xinjiang Uygur Autonomous Region (2023B01024\u20103).
Database: Compendex
Data Provider: Engineering Village

9. The improvement of bending fatigue properties of 20Cr2Ni4 steel gears based on multi-dimensional synergistic strengthening mechanism

Long, Bangzhuan (1); Wang, Hao (1); Zhu, Lei (1); Li, Lingze (1); Zhao, Huihao (1); Li, Tao (1); Yang, Ying (1); Ma, Wenbo (1); Shi, Lubing (2); Yan, Fuyao (1); Zhang, Yanxiang (1); Yan, Mufu (1)
Source: *International Journal of Fatigue*, v 204, March 2026; **ISSN:** 01421123; **DOI:** 10.1016/j.ijfatigue.2025.109363; **Article number:** 109363; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Materials Science and Engineering, Harbin Institute of Technology, Heilongjiang, Harbin; 150001, China (2) China Academy of Machinery Zhengzhou Rescarch Institute of Mechanical Engineering Co., Ltd, Henan, Zhengzhou; 450052, China
Abstract: The comparative experiments of rare earth equivalent plasma carburizing and conventional gas carburizing on 20Cr2Ni4 steel gears reveal the multi-dimensionally synergistic strengthening mechanisms of carburizing in enhancing bending fatigue performance. The rare earth equivalent plasma carburizing induces dual-gradient refinement of both grain microstructure and carbides within the effective carburized layer of the gear. The ultrafine martensitic matrix with an average grain size of 0.82 μm forms at the carburized layer surface, accompanied by the dispersion of submicron spherical carbides with an average size of 0.37 μm, and the sizes of the two change continuously in a gradient along the depth direction of the effective carburized layer. This microstructure consisting of ultrafine grains and submicron carbides increases the microhardness to 842 HV0.1 and forms a gradient compressive residual stress field in the carburized layer with a peak value of −667 MPa and a width of 1000 μm. Compared with gas carburized gears, the ultimate bending fatigue strength of rare earth equivalent plasma carburized gears is increased by 56 % to 616 MPa, and the fatigue life is increased by two orders of magnitude. The bending fatigue strength of earth equivalent plasma carburizing gears is increased by 130.2 MPa and 91.8 MPa by the formation of ultrafine grains and high-volume fraction of fine carbides on the gear surface. Then the strengthening effect gradually diminishes as the grains coarsen and the carbides decrease. The enhanced bending fatigue resistance originates from the multi-dimensionally synergistic effect of crack initiation retardation by high gradient residual compressive stress, crack energy dissipation via ultrafine-grained microstructure, and fatigue striation segmentation through submicron spherical carbide pinning effects. This synergistic strengthening mechanism— stress regulation, microstructure refinement and second-phase strengthening - establishes an optimal surface condition for subsequent shot peening. Copyright © 2025. Published by Elsevier Ltd. (60 refs)
Main heading: Energy dissipation
Controlled terms: Binary alloys - Carbides - Carburizing - Chromium alloys - Compressive stress - Cracks - Fatigue of materials - Gears - Grain refinement - Grain size and shape - Microstructure - Nitrogen compounds - Plasma applications - Residual stresses - Strengthening (metal) - Ternary alloys
Uncontrolled terms: Bending fatigue - Bending fatigue performance - Fatigue performance - Gradient residual compressive stress field - Grain microstructure - Residual compressive stress - Spheroidal carbides - Stress field - Submicron - Submicron spheroidal carbide - Synergistic strengthening - Ultra fine grain - Ultrafine grain microstructure
Classification Code: 201.1.1 Metallurgy - 201.1.2 Metallography - 201.7.1 Heat Treatment Processes - 202.3.1 Chromium and Alloys - 204.1 Ceramics - 214 Materials Science - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 301.2

Hydrodynamics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 804.1 Organic Compounds - 804.2 Inorganic Compounds - 1009.1 Energy Conservation - 1009.2 Energy Consumption
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Funding text: The authors gratefully acknowledge the National Key Research and Development Program of China (Nos. 2023YFB3408001) and National Defense Basic Scientific Research Program of China (JCKYS2024603C008).
Database: Compendex
Data Provider: Engineering Village

10. Scuffing Calculation of Cylindrical Gears Facing Loss of Lubrication (*Open Access*)

Morhard, Bernd (1); Lohner, Thomas (1); Stahl, Karsten (1)
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Publisher: Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) Gear Research Center (FZG), Department of Mechanical Engineering, School of Engineering and Design, Technical University of Munich, Boltzmannstraße 15, Garching near Munich; 85748, Germany
Abstract: Loss of lubrication in aeronautic drivetrains can lead to catastrophic gearbox failure, and drivetrains must be tested to prove their resistance to loss of lubrication. Research led to a better understanding of the modes of action, interdependencies, and effective measures to optimize drivetrains for a loss of lubrication event. However, there are currently no calculation methods available, so gear design against loss of lubrication is mainly based on experience. This study proposes a novel calculation method that builds upon the scuffing load calculation from ISO/TS 6336-21 to allow for scuffing safety calculation for cylindrical gears facing loss of lubrication. The proposed method synthesizes existing knowledge in the context of loss of lubrication and incorporates further research results concerning the friction, temperature, and scuffing of gears. The calculation method considers relevant gear design aspects and enables estimation of the time-to-failure. A calculation study is used to compare different measures for cylindrical gears facing loss of lubrication. The results demonstrate the remarkable potential for enhancing loss of lubrication performance through increased oil share in the fluid flow, the application of coatings, the adoption of low-loss gear designs, the use of low-friction lubricants, and the incorporation of additives that increase the scuffing temperature. © 2025 by the authors. (60 refs)
Main heading: Friction
Controlled terms: Additives - Electric load loss - Electric power transmission - Facings - Failure (mechanical) - Flow of fluids - Lubricants - Machine design - Outages - Powertrains - Transmissions - Tribology
Uncontrolled terms: Cylindrical gear - Gear design - Interdependency measures - Loss of lubrication - Lubrication / - Mode of action - Powerloss - Scuffings - Time to failure - Time-to-failure calculation
Classification Code: 214 Materials Science - 301.1 Fluid Flow - 402 Buildings and Towers - 408.1 Structural Members and Shapes - 601 Mechanical Design - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 606 Lubrication and Tribology - 606.1 Lubricants - 662.3 Automobile Components and Materials - 663.2 Heavy Duty Motor Vehicle Components - 706.1.1 Electric Power Transmission - 706.1.2 Electric Power Distribution - 803 Chemical Agents and Basic Industrial Chemicals - 904 Design - 1301.1.1 Mechanics
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Open Access type(s): All Open Access, Gold, Green
Database: Compendex
Data Provider: Engineering Village

11. Bending fatigue and impact strength of repeated case-carburized gears

Ikuta, Tomoaki (1); Ando, Natsuki (2); Kanamura, Kazuki (3); Hanamoto, Koki (2); Omura, Toshiyasu (4); Nojima, Kengo (5); Nishi, Ryosuke (3); Ono, Yuichi (3); Koide, Takao (6)
Source: *Journal of Mechanical Science and Technology*, v 39, n 12, p 7211-7221, December 2025; **ISSN:** 1738494X, **E-ISSN:** 19763824; **DOI:** 10.1007/s12206-025-2503-4; **Publisher:** Korean Society of Mechanical Engineers
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Abstract: Repeated case carburizing (RCC) is expected to increase the number of gears placed in a furnace at a time, and realize more cost-effective and flexible case carburizing. This study experimentally investigated the influence of RCC of up to five cycles with the same total carburizing and diffusion times on bending fatigue and impact strength of SCM420H spur gears. The RCC caused coarse grains near tooth root surfaces. Moreover, the RCC reduced the bending fatigue limit (BFL) and impact limit energy (ILE) from three and two cycles, respectively. The percentage reduction in ILE was greater than that in BFL. Both the BFL and ILE tended to decrease with increasing effective case depth. ILE also roughly tended to decrease with increasing area ratio of coarse grains. Thus, we should pay attention to RCC from two cycles, and more attention to the reduction in ILE than that in BFL. © The Korean Society of Mechanical Engineers and Springer-Verlag GmbH Germany, part of Springer Nature 2025. (52 refs)
Main heading: Hardness
Controlled terms: Bending strength - Carburizing - Compressive strength - Cost effectiveness - Fatigue of materials - Reduction - Spur gears
Uncontrolled terms: % reductions - Bending fatigue - Bending fatigue limit - Bending fatigue strengths - Carburized gears - Case carburizing - Coarse grains - Compressive residual stress - Limit energy - Repeated case carburizing
Classification Code: 201.7.1 Heat Treatment Processes - 214 Materials Science - 214.1 Mechanical Properties of Materials - 601.2 Machine Components - 802.2 Chemical Reactions - 911.2 Industrial Economics
Database: Compendex
Data Provider: Engineering Village

12. A numerical model for total contact fatigue life prediction of carburized spur gears considering the surface integrity

Sun, Xianshun (1, 2); Zhao, Jun (1, 2); Song, Shaokang (1, 2); Lu, Yongliang (1, 2); Sun, Huiyang (1, 2); Tang, Xujie (1, 2)
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Author affiliation: (1) Key Laboratory of High Efficiency and Clean Mechanical Manufacture of MOE, School of Mechanical Engineering, Shandong University, Jinan; 250061, China (2) National Demonstration Center for Experimental Mechanical Engineering Education (Shandong University), Jinan; 250061, China
Abstract: Surface integrity has a significant influence on the tooth contact fatigue performance of carburized gears. This paper proposed a total contact fatigue life prediction model considering the hardness gradients, residual stress, and surface roughness. The contact pressure distributions are determined using the elastohydrodynamic lubrication numerical model. The crack initiation life and location are forecasted by the modified Brown-Miller fatigue criterion, considering the surface integrity, loading conditions, and lubrication state. The tooth surface of the spur gear is divided into layers through the thin slicing technique, and the fatigue performance parameters for each layer are determined using the multilayer approach. The crack propagation path and lifespan are predicted by the extended finite element method based on linear elastic fracture mechanics. Contact fatigue life testing is employed to verify the effectiveness of the proposed method for predicting total fatigue life. The damaged areas measured by image analysis are used to monitor crack initiation and determine fatigue failure. Fracture surface analysis conducted with SEM identifies the path of crack propagation. The predicted total contact fatigue life, crack initiation location, and crack extension path agree well with the experimental findings. © Springer Nature B.V. 2025. (51 refs)
Main heading: Elastohydrodynamic lubrication
Controlled terms: Crack initiation - Fatigue crack - Fatigue crack propagation - Fatigue damage - Fatigue testing - Fracture - Fracture testing - Gear cutting - Gear teeth - Spur gears - Surface analysis
Uncontrolled terms: Carburized spur gear - Contact fatigue life - Contact fatigue life prediction - Cracks initiations - Fatigue life prediction - Fatigue performance - Multiaxial fatigue criteria - Surface integrity - Teeth contact - XFEM
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 604.1 Metal Cutting - 606.2 Lubrication
Funding Details: Number: 51775315, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China;
Funding text: This work was supported by the National Natural Science Foundation of China (51775315).
Database: Compendex
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13. An investigation on the lubrication characteristics of asymmetric helical face gear drives: An emphasis on balance between pressure angle and contact ratio

Jia, Chao (1); Liu, Chengxiong (1); Yao, Ligang (1); Mu, Yanming (2); Fang, Zongde (3)
Source: *Tribology International*, v 217, May 2026; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2026.111683; **Article number:** 111683;
Publisher: Elsevier Ltd
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Abstract: Under high-speed and heavy-load conditions, the lubrication performance of asymmetric helical face gears has a crucial impact on the reliability of the transmission system. For asymmetric gears, an important issue to note is that while increasing the pressure angle helps reduce the curvature of the meshing contact point and thus improves lubrication load capacity, it also leads to a decrease in the contact ratio, thereby increasing the load density of a single tooth and reducing lubrication performance. Therefore, to systematically evaluate the influence of pressure angle on the lubrication characteristics of asymmetric helical face gears, a mathematical model combining loaded tooth contact analysis (LTCA) and thermal-elastohydrodynamic lubrication (TEHL) is established in this paper. A numerical example is given, and the pressure distribution, temperature distribution, and film thickness distribution on the tooth surface of the mesh-in area, mesh-mid area and mesh-out area are calculated under a pressure angle of 30°/20°. Calculation results show that the worst lubrication conditions are found in the meshing-in area. Furthermore, the maximum contact temperature and minimum oil film thickness along the meshing line are calculated and compared for four cases with pressure angles of 20°/20°, 25°/20°, 30°/20°, and 35°/20°. The comparison results show that increasing the pressure angle can improve the lubrication in the meshing-in and meshing-out areas, but it will worsen the lubrication of the middle area of the tooth surface. © 2026 Elsevier Ltd (45 refs)
Main heading: Mesh generation
Controlled terms: Contact angle - Elastohydrodynamic lubrication - Elastohydrodynamics - Electric power transmission - Film thickness - Gear teeth - Helical gears - High pressure effects
Uncontrolled terms: Asymmetric tooth profiles - Contact ratio - Face gear drive - Helical face gear drive - Lubrication / - Lubrication characteristics - Lubrication performance - Pressure angle and contact ratio - Pressure angles - Pressure contacts
Classification Code: 208.4 Thin films - 301.1.1 Liquid Dynamics - 601.2 Machine Components - 606.2 Lubrication - 706.1.1 Electric Power Transmission - 1201.8 Discrete Mathematics and Combinatorics, Includes Graph Theory, Set Theory - 1301.1.2 Physical Properties of Gases, Liquids and Solids
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Database: Compendex
Data Provider: Engineering Village

14. Exploring health-to-instability transitions in geared Systems based on tooth surface contact fatigue failure

Shi, Jian-Fei (1, 2); Wang, Kai (1); Han, Chuang (1); Jin, Wu-Yin (1)
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Author affiliation: (1) School of Mechanical and Electrical Engineering, Lanzhou University of Technology, Lanzhou; 730050, China (2) Key Laboratory of Intelligent Integration Technology for Complete Equipment, Ministry of Education, Lanzhou University of Technology, Lanzhou; 730050, China
Abstract: Conventional gear design methodologies suffer from a critical disconnect: contact fatigue analysis typically relies on static load assumptions, neglecting the profound influence of nonlinear dynamics, while dynamic studies rarely link instability states directly to fatigue failure. To bridge this gap, this study establishes a novel integrated framework that couples a high-fidelity, multi-state nonlinear dynamic model of a spur gear system with an enhanced contact stress analysis. By defining a "Health Region" constrained by the allowable contact fatigue stress under dynamically calculated loads, we reveal that this region is co-determined by system parameters and initial conditions. Crucially, the phenomenon of incomplete bifurcation under multiple initial conditions is identified as the core mechanism triggering abrupt transitions from healthy to unstable coexisting responses. Parameters such as meshing frequency, load, and transmission error amplitude significantly govern these transitions. This work provides a fundamental theoretical advancement by unifying nonlinear dynamics with fatigue failure criteria, offering a powerful paradigm for designing more robust and durable gear transmissions. The proposed framework and insights pave the way for next-generation prognostic health management strategies in precision mechanical systems. © 2026 Elsevier B.V. (56 refs)
Main heading: Bifurcation (mathematics)

Controlled terms: Dynamics - Failure (mechanical) - Fatigue of materials - Nonlinear analysis - Spur gears - Stress analysis
Uncontrolled terms: Coexistence dynamic - Contact fatigues - Fatigue failures - Geared systems - Incomplete bifurcation - Initial conditions - Surface contact fatigue - Teeth contact - Tooth contact fatigue - Tooth surface contacts
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components - 1201 Mathematics - 1201.7 Optimization Techniques - 1201.9 Numerical Methods - 1301.1.1 Mechanics - 1301.7 Statistical and Nonlinear Physics
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Data Provider: Engineering Village

15. Experimental Study on Bending Fatigue Performance of ADI Gears Under Different Applied Load Levels (*Open Access*)

Wang, Lijun (1); Wei, Hui (1); Ho, Hsinshen (2); Hu, Bo (2); Li, Yangyang (1); Wang, Dongfei (3)
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Abstract: As austempered ductile iron (ADI) is a key gear material for meeting the lightweight and cost-effective demands of new energy vehicles, its bending fatigue performance has a direct impact on vehicle transmission efficiency. In the present work, QTD 800 gears were subjected to bending fatigue testing using a combination of the conventional group method and the staircase method, with considerations given to fatigue life and fatigue limit at different reliability levels. Subsequently, the gears were characterized using optical microscopy and a microhardness tester to examine their metallographic structure and determine their hardness. The results indicate that the bending fatigue limits corresponding to gear reliability levels of 50%, 90%, and 99% are 390.00 MPa, 372.55 MPa, and 358.32 MPa, respectively. It was also observed that higher gear life stability corresponds to a lower sustainable fatigue limit stress. The analyses further reveal that under low loads, the main crack exhibits a relatively straight and smooth propagation trajectory, formed through the slow extension of an existing crack, whereas under high loads, the main crack displays a rough and serrated appearance, arising from the coalescence of microcracks initiated around graphite nodules. © 2025 by the authors. (25 refs)
Main heading: Fatigue testing
Controlled terms: Cost effectiveness - Cracks - Gears - Light weight vehicles - Load testing - Metallography - Vehicle transmissions
Uncontrolled terms: Austempered ductile iron gears - Bending fatigue - Bending fatigue testing - Crack analysis - Fatigue performance - Fatigue performance curve - Main crack - Metallographic analysis - Performance curve - Reliability level
Classification Code: 201.1.2 Metallography - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 662.2 Smaller Vehicles - 911.2 Industrial Economics
Funding Details: Number: 2023SJGLX021Y, Acronym: DGE, Sponsor: Division of Graduate Education; Number: -, Acronym: DGE, Sponsor: Division of Graduate Education; Number: Yukeshi2024-01, Acronym: -, Sponsor: -;
Funding text: This research was supported by the \u201CZHONGYUAN Talent Program\u201D (ZYYCYU202012112), Graduate Education Reform Project of Henan Province (2023SJGLX021Y), and the Water Conservancy Equipment and Intelligent Operation and Maintenance Engineering Technology Research Centre in Henan Province (Yukeshi2024-01).
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Database: Compendex
Data Provider: Engineering Village

16. Numerical Analysis of Lubrication and Oil Churning Power Loss of High Contact Ratio Internal Gear Pair (*Open Access*)

Chu, Xiaomeng (1); Gao, Zhijun (1); Shen, Jia (2)
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Author affiliation: (1) College of Mechanical Engineering and Automation, Liaoning University of Technology, Jinzhou; 121000, China (2) Jinzhou JH Automobile Safety System Co., Ltd., Jinzhou; 121010, China
Abstract: Planetary gear is the mainstream deceleration transmission device, and its derivative form of high contact ratio internal gear adopts the structure of full internal meshing. While improving the compactness and efficiency of the transmission, it is necessary to focus on its lubrication characteristics and churning power consumption. In this paper, based on the actual meshing state of high contact ratio internal gear, combined with its geometric parameters, motion speed, and pressure bearing state, the Computational Fluid Dynamics (CFD) model is used to analyze the oil distribution during gear motion. According to the oil state, the oil pressure and viscous force on the gear surface are extracted, the churning loss of the gear is calculated, and the influence of different parameters on the churning loss is analyzed. Finally, based on the influence of the oil churning parameters on the lubrication performance, the representative oil churning parameters are selected for the test. The test results are consistent with the results obtained by the simulation analysis, which provides data support for the study of the lubrication of high contact ratio internal gears. © 2025 by the authors. (30 refs)
Main heading: Computational fluid dynamics
Controlled terms: Energy efficiency - Gears - Lubrication
Uncontrolled terms: Computational fluid - Contact ratio - Fluid-dynamics - High contact ratio internal gear - Internal gear - Oil churning power loss - Oil distributions - Oil lubrication - Powerloss - Stirring oil lubrication
Classification Code: 301.1.4 Computational Fluid Dynamics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 606.2 Lubrication - 1009 Energy Management
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Database: Compendex
Data Provider: Engineering Village

17. Study on transient lubrication of floating bush in high-pressure fuel pump coupling with camshaft bending vibration

Guo, Huaiqian (1); Li, Yazhou (2, 3); Zhao, Bin (1); Guo, Yuan (2); Xie, Zhongliang (4); Lu, Xiqun (1); Xu, Hanzhang (5); Wang, Mengqi (1, 6); Morina, Ardian (1, 7)
Source: *Tribology International*, v 215, March 2026; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2025.111357; **Article number:** 111357; **Publisher:** Elsevier Ltd
Author affiliation: (1) College of Power and Energy Engineering, Harbin Engineering University, Harbin; 150001, China (2) School of Design, Shanghai Jiao Tong University, Shanghai; 20030, China (3) Chongqing Hongjiang Machinery Co. Ltd., Chongqing; 402160, China (4) Department of Engineering Mechanics, Northwestern Polytechnical University, Xi'an; 710072, China (5) Innovation Laboratory for Sciences and Technologies of Energy Materials of Fujian Province (IKKEM), Xiamen; 361005, China (6) Harbin Marine Boiler & Turbine Research Institute, Harbin; 150078, China (7) School of Mechanical Engineering, University of Leeds, Leeds; LS2 9JT, United Kingdom
Abstract: The roller-floating bush-pin (RFBP) structure is one of the critical transmission components in high-pressure fuel pumps for marine diesel engines, and its lubrication performance significantly impacts equipment stability. In this study, a coupled model of camshaft bending vibration and the transient lubrication of the RFBP structure was established, and the time-varying tilt angle of the roller is used as the transmission variable from vibration to lubrication. The coupling model was validated through the experimental bench tests. The interaction mechanism between the camshaft bending vibration and the lubrication characteristics of the RFBP structure was systematically analyzed. Furthermore, the impact of camshaft bending vibration on the RFBP structure lubrication characteristics was compared across varying structural designs and operating conditions. The results show that the camshaft bending vibration adversely affects the lubrication of the RFBP structure, and its influence on the outer film is greater than that on the inner film. The findings of the study provide theoretical support for the dynamic and lubrication design of fuel pump cam mechanisms. Copyright © 2025. Published by Elsevier Ltd. (42 refs)
Main heading: Camshafts
Controlled terms: Diesel engines - Gears - High pressure engineering - Lubrication - Marine engines - Rollers (machine components) - Structural design - Transmissions - Vibration analysis
Uncontrolled terms: Bending vibrations - Cam-roller - Coupled analysis - High pressure - Lubrication / - Lubrication characteristics - P-i-n structure - PIN structures - Pump coupling - Roller-floating bush-pin structure

Classification Code: 408 Structural Design - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 606.2 Lubrication - 608.2 Diesel Engines - 609.2 Pumps - 671.2 Ship Equipment - 901 Engineering Profession - 941.5 Mechanical Variables Measurements - 1301.1.2 Physical Properties of Gases, Liquids and Solids
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Database: Compendex
Data Provider: Engineering Village

18. The effect of gear module on bending fatigue failure location in carburized and shot-peened spur gears

Čular, Ivan (1); Galić, Ivica (1); Mašović, Robert (1); Vučković, Krešimir (1)
Source: *International Journal of Fatigue*, v 196, July 2025; **ISSN:** 01421123; **DOI:** 10.1016/j.ijfatigue.2025.108901; **Article number:** 108901; **Publisher:** Elsevier Ltd
Author affiliation: (1) University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Ivana Lučića 5, Zagreb; 10000, Croatia
Abstract: Shot-peening is an emerging method used to improve the bending fatigue resistance of carburized gears. However, even though this method improves the bending fatigue resistance at the surface, bending fatigue crack initiation often shifts below the surface, making it harder to detect during regular service intervals. In this paper, an experimentally validated computational model based on the finite element analysis and the multilayer method is used to investigate the effect of gear geometry, specifically its module, on the probability of subsurface bending fatigue failure. The main goal is to reduce the chance of subsurface bending fatigue failure while retaining the beneficial effects of shot-peening. Four optimal gear modules are chosen for the investigation with respect to bending fatigue while maintaining constant fatigue properties and residual stress profiles. The results demonstrate that choosing a lower module decreases the probability of subsurface bending fatigue crack initiation in carburized and shot-peened gears. Lastly, it is also suggested that optimizing carburization parameters may enhance the beneficial compressive residual stresses below the surface, lowering the probability of subsurface bending fatigue crack initiation. © 2025 Elsevier Ltd (35 refs)
Main heading: Fatigue crack
Controlled terms: Fatigue crack propagation - Shot peening - Spur gears
Uncontrolled terms: Bending fatigue - Bending fatigue resistances - Carburized gears - Failure locations - Fatigue crack initiation - Fatigue failures - Finite element analyse - Gear modules - Shot-peening - Subsurface failure
Classification Code: 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components
Database: Compendex
Data Provider: Engineering Village

19. Modeling on rolling contact fatigue life of gear steel with gradient structure

Chang, Haiyang (1); Wang, Xi (1); Liu, Xiaolong (1); Ren, Guoqiang (2); Chen, Qiang (3); Fu, Cheng (1); Yang, Muxin (4)
Source: *Wear*, v 580-581, October 15, 2025; **ISSN:** 00431648; **DOI:** 10.1016/j.wear.2025.206243; **Article number:** 206243; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Mechanical Electronic & Control Engineering, Beijing Jiaotong University, Beijing; 100044, China (2) Standards & Metrology Research Institute, China Academy of Railway Sciences Corporation Limited, Beijing; 100081, China (3) Department of Mechanical Engineering, Kyushu University, Fukuoka, 819-0395, Japan (4) State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, 15 Beisihuan West Road, Beijing; 100190, China
Abstract: Gradient structure design is an excellent method for improving the rolling contact fatigue of gear steel. The rolling contact fatigue (RCF) behavior of gradient structure gear steel was investigated by experimental and modeling methods. RCF tests were conducted on two cylindrical contact specimens under oil lubrication conditions with a slip ratio of 0 %. The fatigue performance indicated by the nominal Hertzian contact stress is similar. The increase of the temperature will decrease the Hertzian stress. This offsets the impact of temperature on the material's fatigue performance degradation, thereby showing that the nominal fatigue properties at low and high temperatures are similar. Cracks and significant plastic deformation regions were observed beneath the contact surface. A RCF life model considering material gradient structure was proposed based on the I-H life prediction model. The actual fatigue life obtained from RCF tests fell within the failure probability prediction range of the model, validating the effectiveness of the life prediction model. © 2025 (44 refs)
Main heading: Forecasting
Controlled terms: Gears - Structural design - Thermal fatigue

Uncontrolled terms: Fatigue performance - Gear steels - Gradient structure - Highest temperature - Life models - Life prediction models - Rolling contact fatigue - Rolling contact fatigue life - Rolling contact fatigue test - Structure design
Classification Code: 214 Materials Science - 408 Structural Design - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 1202 Statistical Methods
Funding Details: Number: 2024JBMC012, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities; Number: U2468209, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 2022YFE012470 0, Acronym: -, Sponsor: -; Number: K2022J023, Acronym: CR, Sponsor: China Railway; Number: -, Acronym: CR, Sponsor: China Railway;
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Database: Compendex
Data Provider: Engineering Village

20. Experimental study on the bending fatigue characteristics of shot peening gears (*Open Access*)

Zhong, Zhenyuan (1); Huang, Xianhua (1); Zhang, Chen (1); Zou, Jiayuan (1); Zhu, Yongming (1); Liu, Xuewu (1)
Source: *Journal of Physics: Conference Series*, v 3068, n 1, 2025; **ISSN:** 17426588, **E-ISSN:** 17426596; **DOI:** 10.1088/1742-6596/3068/1/012030; **Article number:** 012030; **Conference:** 12th International Conference on Advanced Manufacturing Technology and Materials Engineering, AMTME 2025, March 21, 2025 - March 23, 2025; **Publisher:** Institute of Physics
Author affiliation: (1) GAC Automotive Research & Development Center, Guangzhou; 511400, China
Abstract: This paper investigates the influence of shot peening on the bending fatigue characteristics of 20MnCr5 carburized involute cylindrical spur gears, which are widely used in vehicle transmission systems. Surface integrity is analyzed for gears with and without the shot peening process to illustrate the effect of shot peening. A bending fatigue test is carried out for both two kinds of gears, and the differences in crack failure characteristics in the source area are analyzed using a scanning electron microscope (SEM). It is found that shot peening can greatly improve gear surface integrity, although it harms surface waviness. Shot peening can effectively increase gear bending strength and restrain the crack initiation from the gear surface. © Published under licence by IOP Publishing Ltd. (15 refs)
Main heading: Gears
Controlled terms: Bending strength - Binary alloys - Cracks - Fatigue testing - Gear trains - Gear transmissions - Shot peening - Vehicle transmissions
Uncontrolled terms: Bending fatigue - Bending fatigue tests - Crack failure - Cylindrical spur gears - Failure characteristics - Fatigue characteristics - Shot-peening - Source area - Surface integrity - Transmission systems
Classification Code: 201.1.1 Metallurgy - 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 661 Automotive Engines and Related Equipment - 662.3 Automobile Components and Materials
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Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

21. Contact fatigue limit prediction method for heavy-duty gears considering hardness gradient characteristics (*Open Access*)

Zhang, Boyu (1); He, Yongyong (1); Wang, Zhengwei (1)
Source: *Friction*, v 13, n 8, August 2025; **ISSN:** 22237690, **E-ISSN:** 22237704; **DOI:** 10.26599/FRICT.2025.9441019; **Article number:** 9441019; **Publisher:** Tsinghua University Press
Author affiliation: (1) Department of Mechanical Engineering, Tsinghua University, Beijing; 100084, China
Abstract: Hardening gradients have been introduced to heavy-duty gears to enhance their bearing capacity, but this has led to an increase in the complexity and difficulty of fatigue analysis. To explore ways to mitigate this, in this work, a contact fatigue model of an 18CrNiMo7-6 gear pair with a hardness gradient was established, and the Brown–Miller–Morrow multiaxial fatigue criterion was adopted to calculate the contact fatigue lifespan under different contact pressures. The gear

contact fatigue limit was then determined by fitting the stress–number of cycles (S–N) curve. The results of this method are verified by gear contact fatigue tests. Furthermore, the effects of case hardening depth (CHD) and surface hardness (SH) on the contact fatigue lifespan and limits were explored, and we found that the contact fatigue limit of a typical carburized gear was more affected by SH than CHD. In addition, we also examined which hardness gradients were more beneficial for the fatigue performance of gears with atypical hardening gradients. © The Author(s) 2025. (46 refs)
Main heading: Curve fitting
Controlled terms: Binary alloys - Chromium alloys - Fatigue testing - Friction - Gears - Hardness
Uncontrolled terms: Contact fatigue limit prediction - Contact fatigues - Fatigue Limit - Fatigue limit prediction - Gear contacts - Hardening depth - Hardness gradient - Heavy duty gears - Lifespans - Multiaxial fatigue criteria
Classification Code: 201.1.1 Metallurgy - 202.3.1 Chromium and Alloys - 214.1 Mechanical Properties of Materials - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 1201.9 Numerical Methods - 1301.1.1 Mechanics
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Open Access type(s): All Open Access, Gold, Green
Database: Compendex
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22. A strategy for contact fatigue life prediction of polymer gears via an experimental-simulated hybrid data-driven model (*Open Access*)

Lu, Zehua (1, 2); Liu, Huaiju (1); Wei, Peitang (1); Zorko, Damijan (3)
Source: *Friction*, v 14, n 2, February 2026; **ISSN:** 22237690, **E-ISSN:** 22237704; **DOI:** 10.26599/FRICT.2025.9441077; **Article number:** 9441077; **Publisher:** Tsinghua University Press
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Abstract: A timely trend in gear transmission involves the replacement of steel with polymers. Nevertheless, the absence of fundamental durability data for polymer gears impedes their reliable application during power transmission. The expensive and time-consuming gear fatigue experiments make it impossible to rely merely on experimental data. In this study, a strategy for contact fatigue life prediction of polymer gears via an experimental-simulated hybrid data-driven model is presented. The hybrid data are established with a certain mixture ratio of experimental and simulation data and are augmented by the conditional tabular generative adversarial network (CTAB-GAN) algorithm. This specific algorithm was combined with the extreme gradient boosting (XGBoost) algorithm to predict the contact fatigue life of gears made from different polymer materials, with the prediction accuracy controlled within a 3-fold scatter band. Moreover, an empirical predictive formula for contact fatigue life was developed. The hybrid data-driven model, which merges experimental and simulated data, allows for efficient estimation of fatigue life and material selection strategies, generating insight into the anti-fatigue design of polymer gears. © The Author(s) 2026. (38 refs)
Main heading: Forecasting
Controlled terms: Fatigue testing - Gear transmissions - Gears - Hybrid materials - Power transmission
Uncontrolled terms: Contact fatigue life - Contact fatigues - Data driven - Data-driven model - Fatigue life prediction - Gear transmissions - Hybrid data driven - Life predictions - Polymer gear - Power-transmission
Classification Code: 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 662.3 Automobile Components and Materials - 1202 Statistical Methods
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23. Experimental and numerical analysis of fatigue crack growth by means of passive thermography during single tooth bending fatigue tests (*Open Access*)

Fraccaroli, Lorenzo (1); Corsaro, Luca (2); Curà, Francesca (2); Concli, Franco (1)

Source: *Forschung im Ingenieurwesen/Engineering Research*, v 89, n 1, December 2025; **ISSN:** 00157899, **E-ISSN:** 14340860; **DOI:** 10.1007/s10010-025-00923-x; **Article number:** 156; **Publisher:** Springer Vieweg
Author affiliation: (1) Faculty of Engineering, Free University of Bozen-Bolzano, Bolzano; 39100, Italy (2) Department of Mechanical and Aerospace Engineering (DIMEAS), Politecnico Di Torino, Torino; 10129, Italy
Abstract: Crack propagation at the tooth root leads to one of the most critical failure modes in gears when subjected to bending fatigue conditions. The processes of crack nucleation and propagation had been widely investigated over the years through numerical analysis, and several fatigue crack growth models had been developed and reported in the literature. The objective of this work is to analyse the phenomenon of crack growth in gears during Single Tooth Bending Fatigue tests, with a particular focus on the thermal emissions produced during the fatigue tests. A device for conducting bending fatigue tests on gears was developed with the aim of carrying out the tests at the mechanical pulsator. The crack growth analysis was experimentally conducted by using two thermal cameras positioned in front of the later faces of the tested gear. Thermal maps were acquired in real time during the fatigue tests, enabling the analysis of crack evolution in terms of thermal emissions variations produced during the fatigue process, even when the crack process was still in the gears. Subsequently, the experimental results were compared with the numerical analysis in order to assess the evolution of the crack growth. A dedicated fatigue crack growth model was implemented based on the Paris law through the use of eXtended Finite Element Methods within an open-source software, namely Salome-Meca/Code_Aster. Then, the experimental activity was utilized for a comparison with the corresponding numerical analysis, and the overall results well match in terms of fatigue crack growth. © The Author(s) 2025. (30 refs)
Main heading: Bending tests
Controlled terms: Fatigue crack - Fatigue crack propagation - Finite element method - Gears - Open source software - Open systems - Thermal fatigue
Uncontrolled terms: Bending fatigue - Bending fatigue tests - Crack growth model - Cracks propagation - Critical failures - Experimental and numerical analysis - Fatigue cracks - Single tooth - Thermal emissions - Tooth root
Classification Code: 214 Materials Science - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 1103.4 Digital Computers and Systems - 1106 Computer Software, Data Handling and Applications - 1201.9 Numerical Methods
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24. Bending Fatigue Life Simulation and Experimental Validation of Carburized Spur Gears Based on Geometric Design Parameters

Yildiz, Ahmet Can (1); Sekercioglu, Tezcan (1)
Source: *Fatigue and Fracture of Engineering Materials and Structures*, v 49, n 2, p 528-545, February 2026; **ISSN:** 8756758X, **E-ISSN:** 14602695; **DOI:** 10.1111/ffe.70134; **Publisher:** John Wiley and Sons Inc
Author affiliation: (1) Department of Mechanical Engineering, Faculty of Engineering, Pamukkale University, Denizli, Turkey
Abstract: A simulation model was developed to predict the bending fatigue life of carburized spur gears. The crack initiation location and life were estimated using a strain-life approach with a multilayer model, and the crack propagation life was determined using the Paris–Erdoğan equation based on the linear elastic fracture mechanics approach and the separating morphing and adaptive remeshing technology (SMART). The present study investigates the effect of gear design parameters, including the pressure angle, profile shift, and tooth width, on tooth root fracture. The final step in the validation process entailed the use of single-tooth bending fatigue (STBF) experiments to assess the reliability of the simulation results. Consequently, the findings from comprehensive simulation and experimental investigations have demonstrated that augmenting the pressure angle results in substantial enhancements in root crack propagation and fatigue life. The predicted bending fatigue life, crack initiation, and propagation demonstrate a strong correlation with experimental findings. © 2025 John Wiley & Sons Ltd. (54 refs)
Main heading: Crack initiation
Controlled terms: Fatigue crack propagation - Gear teeth
Uncontrolled terms: Bending fatigue - Bending fatigue life - Carburized gears - Cracks initiations - Fatigue cracks propagation - Fatigue life simulation - Gear tooth fracture - Pressure angles - Simulation validation - Tooth fracture
Classification Code: 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components
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25. An experimental analysis of the gear tooth bending strength predictions from ISO 6336 in low and high cycle fatigue (*Open Access*)

Pagliari, Lorenzo (1); Hong, Isaac (2); Concli, Franco (1)
Source: *Forschung im Ingenieurwesen/Engineering Research*, v 89, n 1, December 2025; **ISSN:** 00157899, **E-ISSN:** 14340860; **DOI:** 10.1007/s10010-025-00928-6; **Article number:** 160; **Publisher:** Springer Vieweg
Author affiliation: (1) Faculty of Engineering, Free University of Bozen-Bolzano, Bolzano; 39100, Italy (2) Department of Mechanical and Aerospace Engineering, The Ohio State University, Ohio, Columbus; 43210, Italy
Abstract: Gears are mission critical machine elements used for primary and accessory power transmission in many industrial, automotive and aerospace mechanical systems. In normal operation gear teeth experience torque dependent cyclic loading which can initiate and propagate fatigue cracks. One of the most prevalent manifestations of this fatigue action are fractures through the tooth root resulting in tooth separation, commonly called tooth bending fatigue. Probably the most cited and applied methodology for designing gears to resist these fractures is the ISO 6336 "Calculation of Load Carrying Capacity of Spur and Helical Gears" which provides analytical equations and tabulated reference data to estimate design safety factors against bending fatigue. Method A of the ISO standard considers experimental evaluations of fatigue resistance while Method B relies on tabulated reference data. It is important that gear designers understand potential differences in the resulting fatigue strength and location of failure on the tooth root (critical location) between different design methods to ensure designs are safe from fracture. However, there is little information available in English and with tabulated data that gives a comparison on the accuracy (critical location and fatigue life) between experimental methods and analytical results. Even less information is available in terms of failure due to cyclic loads exceeding the yield strength (Low Cycle Fatigue), even if such type of loading should be carefully analyzed in case of applications involving severe loading, such as aerospace applications, or to account for unexpected load peaks. This work explores bending fatigue failure in gears under cyclic plastic loading. A gear Single Tooth Bending (STB) fatigue methodology is used to perform Low Cycle Fatigue (© The Author(s) 2025. (30 refs)
Main heading: Aerospace applications
Controlled terms: Bending tests - Cyclic loads - Failure (mechanical) - Fatigue crack propagation - Gear teeth - Helical gears - ISO Standards - Loading - Low-cycle fatigue - Safety factor
Uncontrolled terms: Analytical results - Bending fatigue - Critical location - Experimental analysis - Fatigue strength - High cycle fatigue - Low cycle fatigues - Reference data - Single tooth - Tooth root
Classification Code: 214 Materials Science - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 408 Structural Design - 601.2 Machine Components - 657 Aerospace Engineering, Other Topics - 691.2 Materials Handling Methods - 902.2 Codes and Standards - 912 Industrial Engineering and Management - 914 Safety Engineering - 914.1 Accidents and Accident Prevention
Funding Details: Number: -, Acronym: UNIBZ, Sponsor: Libera Università di Bolzano;
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