1. Thermo-mechanical modeling of 20Cr2Ni4A gear in micro-shot peening

Lv, Liangliang (1, 2); Zhao, Jiuyue (3); Li, Xin (1, 2); Chen, Jiling (1, 2); Tang, Jinyuan (1, 2); Shao, Wen (1, 2)
Source: *Journal of Manufacturing Processes*, v 169, p 297-315, July 15, 2026; **ISSN:** 15266125; **DOI:** 10.1016/j.jmapro.2026.04.070; **Publisher:** Elsevier Ltd
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Abstract: Thermal effects induced by high speed particle impacts have been conventionally neglected in shot peening. While this simplification may be acceptable for conventional shot peening processes, the extremely high velocities in micro-shot peening make thermal effects non-negligible, as their omission introduces significant uncertainties in residual stress and surface topography predictions. In order to tackle this key challenge, this paper presents the first development of an innovative thermo-mechanical coupled finite element modeling approach to capture the thermal effects and their influence on residual stress and surface roughness in micro-shot peening of gears. It uncovers the existence of two thermal effect mechanisms in micro-shot peening, namely, plastic deformation induced heating and frictional heating. Furthermore, quantitative estimation of the heat generation contributions revealed that plastic deformation heating dominates the thermal effects, accounting for over 80% of the total heat generation. Neglecting thermal effects in micro-shot peening will reduce the prediction accuracy of surface roughness parameters Sa and Sq by 5.65% and 7.25%, respectively. Additionally, it will increase the prediction error of residual stress along the tooth width direction by 10.00%. This inaccuracy originates from the unconsidered temperature-dependent material softening effect. Crucially, the strain rate sensitivity of plastic heating becomes particularly significant in micro-shot peening, fundamentally distinguishing it from conventional shot peening where thermal effects can be safely ignored. This work establishes essential theoretical foundations for advanced gear surface enhancement technologies and fills a critical knowledge gap in micro-shot peening simulation methodologies.
 (86 refs)
Main heading: Residual stresses
Controlled terms: Binary alloys - Data mining - Forecasting - Friction - Gears - Heat generation - Plastic deformation - Shot peening - Thermal effects - Topography
Uncontrolled terms: High velocity - High-speed particles - Micro-shot peening - Particles impacts - Shot-peening - Thermal - Thermo-mechanical - Thermo-mechanical coupled - Thermomechanical modelling - Uncertainty
Classification Code: 201.1.1 Metallurgy - 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 215.2 Testing of Non-mechanical Properties of Materials - 302 Thermodynamics and Heat Transfer - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 1106.2.1 Data Mining - 1202 Statistical Methods - 1301.1.1 Mechanics
Funding Details: Number: 2023YFB3406404, Acronym: -, Sponsor: National Key Research and Development Program of China; Number: 52475500, Acronym: -, Sponsor: National Natural Science Foundation of China;
Funding text: The authors gratefully acknowledge the support of the National Key Research and Development Program of China (Grant No. 2023YFB3406404); the National Natural Science Foundation of China (Grants No. 52475500).
Database: Compendex
Data Provider: Engineering Village

2. Ultrasonic shot peening-induced gradient nanostructures in tempered AISI 9310 gear steel: Microstructural evolution and enhanced wear performance (*Open Access*)

Yi, Yuxuan (1, 2, 3, 4); Wang, Guangchao (5); Zhao, Xinhao (5); Li, Xinying (6); Zhang, Zhihua (6); Xiong, Zhengang (7); Zou, Ji (7); Cheng, Gary J. (8, 9); Yin, Fei (1, 2, 3, 4)
Source: *Journal of Materials Research and Technology*, v 41, p 2349-2364, March - April 2026; **ISSN:** 22387854, **E-ISSN:** 22140697; **DOI:** 10.1016/j.jmrt.2026.01.184; **Publisher:** Elsevier Editora Ltda
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Abstract: Ultrasonic shot peening (USP), a surface severe plastic deformation (SPD) technique, provides an effective route to improve the mechanical and tribological performance of high-strength gear steels. In this work, gradient nanostructured

(GNS) layers exceeding 200 μm in thickness were fabricated on tempered AISI 9310 steel via USP. The original ferritic–martensitic lath structure (average width #6.71 μm) was progressively refined under high strain rates, forming a hierarchical gradient from coarse laths to subgrains and ultimately to equiaxed nanograins near the surface. This transformation was driven by dislocation accumulation, subgrain formation, and the evolution of high-angle grain boundaries (HAGBs), with HAGBs comprising up to 71.8 % near the top surface. As a result, surface microhardness increased to 579.8 HV, with an effective hardened depth of #960 μm. Pin-on-disk tests revealed a 26.9 % reduction in wear width and a 54.1 % decrease in wear rate relative to untreated steel. The improved wear resistance is attributed to the stable gradient nanostructure, which enhances strain accommodation and mechanical stability under sliding contact. These findings provide mechanistic insight into ferrite-dominated nanocrystallization induced by USP and offer guidance for surface gradient design in high-performance aerospace gear steels. Copyright © 2026. Published by Elsevier B.V. (62 refs)
Main heading: Strain rate
Controlled terms: Ferrite - Gears - Grain boundaries - Mechanical stability - Microstructural evolution - Nanocrystals - Plastic deformation - Shot peening - Tribology - Ultrasonic testing - Wear resistance
Uncontrolled terms: AISI 9310 gear steel - Deformation techniques - Gear steels - High angle grain boundaries - Micro-structural - Severe plastic deformations - Shot-peening - Surface severe plastic deformation - Ultrasonic shot peening - Wear performance
Classification Code: 201.1.2 Metallography - 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 606 Lubrication and Tribology - 753.3 Ultrasonic Applications - 761 Nanotechnology - 1301.1.1 Mechanics - 1301.4.1 Crystalline Solids and Crystallography
Funding Details: Number: 2025AFA014, Acronym: -, Sponsor: Natural Science Foundation of Hubei Province; Number: -, Acronym: -, Sponsor: Natural Science Foundation of Hubei Province; Number: 2025AFD044, Acronym: -, Sponsor: -; Number: IRT_17R83, Acronym: MOE, Sponsor: Ministry of Education of the People's Republic of China; Number: -, Acronym: MOE, Sponsor: Ministry of Education of the People's Republic of China; Number: SAST2024-046, Acronym: -, Sponsor: Shanghai Aerospace Science and Technology Innovation Foundation; Number: -, Acronym: -, Sponsor: Shanghai Aerospace Science and Technology Innovation Foundation; Number: 2024 KF-18, Acronym: -, Sponsor: -; Number: CXPT-2023-043, Acronym: -, Sponsor: -;
Funding text: This work was financially supported by the AECC Aviation Gear Manufacturing Technology Innovation Center (CXPT-2023-043), Shanghai Aerospace Science and Technology Innovation Fund (SAST2024-046), Hubei Natural Science Foundation Innovation and Development Joint Fund (2025AFD044), the Independent Innovation Projects of the Hubei Longzhong Laboratory (2024 KF-18), Innovative Research Group Project of Hubei Provincial Natural Science Foundation (2025AFA014) and the Innovative Research Team Development Program of the Ministry of Education of China (IRT_17R83).
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

3. 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
Funding Details: Number: 2024B1212020006, Acronym: -, Sponsor: -;
Funding text: This work was financially supported by the Guangdong Provincial Key Laboratory of Clean Automotive Propulsion and Energy Application Technology (2024). (2024B1212020006).
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

4. Effect of Induction Heating Composite Shot Peening on the Wear Resistance and Fatigue Strength of 20CrMnTi Spiral Bevel Gears

Zhang, Yin (1, 2); Hu, Yunbo (1, 2, 3); Yan, Hongzhi (1, 2); Li, Songbai (1, 2)
Source: *JOM*, v 77, n 2, p 884-897, February 2025; **ISSN:** 10474838, **E-ISSN:** 15431851; **DOI:** 10.1007/s11837-024-06984-7; **Publisher:** Springer
Author affiliation: (1) State Key Laboratory of Precision Manufacturing for Extreme Service Performance, Central South University, Changsha; 410012, China (2) College of Mechanical and Electrical Engineering, Central South University, Changsha; 410012, China (3) NFAIC High Precision Transmission Co., Ltd., Zhuzhou; 412000, China
Abstract: Aiming at the problems of surface wear and fatigue failure of spiral bevel gears of heavy-duty axles, a new surface strengthening technology of induction heating composite shot peening (IHCSP) is proposed. This article designs an IHCSP test scheme to achieve surface composite strengthening of spiral bevel gears. The wear performance and fatigue strength of the gears were analyzed by using the gear fatigue transmission test bench, and the residual stress, microhardness, surface topography, and microstructure of the gears' surface were measured. The results show that IHCSP increases the maximum compressive residual stress of the gear surface to – 1082.79 MPa, the corresponding layer depth is 87 um, the gear surface microhardness is 782.7 HV, and the hardened layer depth is increased by 43%. Meanwhile, the wear resistance of spiral bevel gears is improved, the gear surface wear error is reduced by 30.5%, and the fatigue life is increased by 31.4%, which proves the effectiveness of IHCSP in improving the fatigue strength of spiral bevel gears. © The Minerals, Metals & Materials Society 2024. (43 refs)
Main heading: Induction heating
Controlled terms: Bevel gears - Blast cleaning - Fatigue of materials - Microhardness - Shot peening - Strengthening (metal) - Surface hardening - Surface topography - Wear resistance
Uncontrolled terms: Fatigue failures - Fatigue strength - Heavy duty - Shot-peening - Spiral bevel gears - Strengthening technologies - Surface fatigues - Surface strengthening - Surface wear - Test scheme
Classification Code: 201.1.1 Metallurgy - 201.7.1 Heat Treatment Processes - 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 303.1 Process Heating - 601.2 Machine Components - 942.2.3 Abrasive Devices and Processes
Funding Details: Number: 52075552, Acronym: NSFC, Sponsor: National Natural Science Foundation of China;
Funding text: This research is supported by National Natural Science Foundation of China (Grant No. 52075552).
Database: Compendex
Data Provider: Engineering Village

5. Effect of composite micro-shot peening on contact fatigue life of 20MnCrS5 helical gears (*Open Access*)

Jia, Jipeng (1); Zang, Libin (2, 3); Chen, Yong (4); Xu, Renzong (1); Li, Guangxin (1); Zhao, Pengbo (1)
Source: *Results in Engineering*, v 29, March 2026; **E-ISSN:** 25901230; **DOI:** 10.1016/j.rineng.2025.108930; **Article number:** 108930; **Publisher:** Elsevier B.V.
Author affiliation: (1) Tianjin Key Laboratory of Power Transmission and Safety Technology for New Energy Vehicles, School of Mechanical Engineering, Hebei University of Technology, Tianjin, 300130, China (2) School of Mechanical Engineering, Tianjin University, Tianjin, 300350, China (3) Tianjin Key Laboratory of Microgravity and Hypogravity Environment Simulation Technology, Tianjin Institute of Aerospace Mechanical and Electrical Equipment, Tianjin, 300301, China (4) School of Mechanical Engineering, Guangxi University, Nanning; 530004, China
Abstract: Fatigue damage represents the predominant failure mode in automotive transmission gears. Investigating the effect of composite micro-shot peening (CMSP) on the contact fatigue life of the transmission helical gears holds significant practical engineering value for enhancing gear performance. In this paper, a simulation model for the fatigue life of CMSP helical gears was established to investigate the influence of CMSP. Tests were conducted to evaluate the running-in performance and contact fatigue life of CMSP gears. The strengthening mechanism was analyzed through residual stress distribution and surface microhardness. Furthermore, the influence mechanism of CMSP on tooth surface wear and contact fatigue failure was further explored. Research demonstrated that the fatigue life of CMSP gears was increased by 246%

compared to unpeened (UP) gears. The maximum residual compressive stress and surface microhardness reached 1260 MPa and 737 HV, representing increases of 104% and 12%, respectively, compared to the UP gears. Additionally, the gradient strengthening layer formed by CMSP at depths of 0 to 80 μm improved the gear meshing quality while synergistically suppressed surface wear and fatigue pitting. This research provides theoretical guidance and process optimization directions for the surface strengthening design of high-reliability gears. © 2025 The Author(s). (47 refs)
Main heading: Wear resistance
Controlled terms: Automobile transmissions - Compressive stress - Failure (mechanical) - Fatigue damage - Gear transmissions - Helical gears - Microhardness - Strengthening (metal)
Uncontrolled terms: Composite micro-shot peening - Contact fatigue life - Fatigue pitting - Performance - Pittings - Running-in - Running-in performance - Shot-peening - Surface microhardness - Surface wear
Classification Code: 201.1.1 Metallurgy - 214 Materials Science - 214.1.1 Stress and Strain - 601.2 Machine Components - 602.2 Mechanical Transmissions - 661.1 Automotive Engines and Components - 662.3 Automobile Components and Materials
Funding Details: Number: 2018YFE0207000, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China;
Funding text: The work of this article was once part of the national key research and development plan (NO.2018YFE0207000) and received support from this study.
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

6. Optimization of the Operating Behavior of Spur Gears Through Machine Hammer Peening (*Open Access*)

Dadgar, Mohammad (1); Sklenak, Sebastian (2); Müller, Martina (1); Herrig, Tim (1); Greschert, René (2); Mevissen, Dieter (2); Brecher, Christian (2, 3); Bergs, Thomas (1, 3)
Source: *Journal of Manufacturing and Materials Processing*, v 10, n 3, March 2026; **E-ISSN:** 25044494; **DOI:** 10.3390/jmmp10030082; **Article number:** 82; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) Manufacturing Technology Institute (MTI), RWTH Aachen University, Campus-Boulevard 30, Aachen; 52074, Germany (2) Laboratory for Machine Tools and Production Engineering (WZL), RWTH Aachen University, Steinbachstr. 19, Aachen; 52074, Germany (3) Fraunhofer Institute for Production Technology (IPT), Steinbachstr. 17, Aachen; 52074, Germany
Abstract: Gear systems operate under high mechanical and tribological loads, making their surfaces vulnerable to wear and fatigue. Improving surface durability requires finishing processes that improve near-surface properties and extend service life. Since machine hammer peening (MHP) offers such potential, this study investigates its influence on the performance of case-hardened spur gears and evaluates its suitability as an alternative to shot peening as a conventional finishing method. Analog specimens with simplified geometries were treated using various MHP parameters to identify effective process settings. These optimized settings were then applied to real spur gears to assess performance under practical conditions. The experiments showed that MHP can significantly modify surface integrity, achieving surface roughness reductions of up to 55%, surface hardness increases of up to 30%, and compressive residual stresses exceeding −1400 MPa with stability to depths of 200 μm. These modifications resulted in improved wear and fatigue performance, with increases in load cycle number in the tooth flank up to 99% and an increase in load amplitude in the tooth root of more than 5%. For comparison, specimens were also treated with shot peening. Although MHP induced stronger surface integrity modifications, shot peening achieved higher overall load-carrying capacity because several critical areas could not be fully accessed by MHP, limiting its effectiveness. Overall, MHP shows promise as a finishing process, but its full potential depends on overcoming accessibility limitations in complex gear geometries. © 2026 by the authors. (40 refs)
Main heading: Hardness
Controlled terms: Fatigue of materials - Gear teeth - Shot peening - Tribology
Uncontrolled terms: Finishing process - Gear system - Machine hammer peening - Mechanical - Operating behavior - Optimisations - Performance - Shot-peening - Surface integrity - Surface structuring
Classification Code: 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 601.2 Machine Components - 606 Lubrication and Tribology
Funding Details: Number: 390969378, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft; Number: -, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft;
Funding text: This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), project number: 390969378.
Open Access type(s): All Open Access, Gold, Green
Database: Compendex
Data Provider: Engineering Village

7. 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

8. Optimizing the Surface Integrity of Gears: Combined Effects of Peening and Superfinishing Processes

de Oliveira Gomes, Gilberto Martins (1); Souza, Naiane (1); Rego, Ronnie (1); Santana, Andre (2)
Source: *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*, p 427-438, 2025, *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*; **ISBN-13:** 9781643532035; **Conference:** American Gear Manufacturers Association Fall Technical Meeting, FTM 2025, October 22, 2025 - October 24, 2025; **Publisher:** AGMA American Gear Manufacturers Association
Author affiliation: (1) Aeronautics Institute of Technology, Brazil (2) AGCO Corporation, United States
Abstract: Increasing the load capacity of agricultural transmissions presents the challenge of enhancing fatigue resistance while maintaining or reducing the size of rotating components. In this context, processes that define the surface integrity properties have been considered as a possibility for optimizing gear flanks. This study addressed the combined effect of gear flank optimization on the residual stress state and topography. Case hardened gears were submitted to a shot peening process to induce compressive residual stress, followed by an isotropic superfinishing process to homogenize the peaks and valleys of the gear's contact surface. Among the groups evaluated, the shot peening (SP), isotropic superfinishing (IS) processes, and the combined effect of both (SP+IS) were examined. Roughness, profile deviation, residual stress, hardness, and microstructure tests were conducted to assess the surface. These evaluations were used to classify the heterogeneity of the surface integrity achieved by the different manufacturing processes. It was found that the SP+IS samples exhibited more compressive residual stresses and lower roughness, along with a reduction in intergranular surface oxidation. The surface also showed a slight variation in its manufacturing quality class, changing from a status of DIN class 7-8 to a class range of 8-9. By evaluating the residual stress states of different manufacturing routes, it was observed that the IS process preserved the heterogeneity of residual stresses previously established by the SP process. Copyright © (2025) by American Gear Manufacturers Association. All rights reserved. (28 refs)
Main heading: Shot peening
Controlled terms: Fatigue load - Gear transmissions - Gears - Residual stresses - Surface roughness
Uncontrolled terms: Combined effect - Compressive residual stress - Fatigue-resistance - Gear flank - Isotropics - Load capacity - Property - Residual stress state - Shot-peening - Surface integrity
Classification Code: 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 662.3 Automobile Components and Materials
Database: Compendex
Data Provider: Engineering Village

9. AN INNOVATIVE APPROACH TO GEAR MANUFACTURING: POWER SKIVING ON CNC LATHES (*Open Access*)

Peterka, Jozef ; Skurský, Igor
Source: *Annals of DAAAM and Proceedings of the International DAAAM Symposium*, v 36, n 1, p 21-28, 2025; **ISSN:** 17269679; **ISBN-13:** 9783902734471; **DOI:** 10.2507/36th.daaam.proceedings.003; **Conference:** 36th International DAAAM Symposium on Intelligent Manufacturing and Automation, DAAAM 2025, October 30, 2025 - October 31, 2025; **Publisher:** DAAAM International Vienna
Abstract: Power skiving represents a modern and highly efficient method of gear manufacturing, which in recent years has become an attractive alternative to traditional technologies such as hobbing and broaching. The principle of power skiving is based on the precise angular positioning of the tool and the simultaneous rotation of the workpiece, which makes it possible to achieve high productivity and accuracy. Its implementation on multifunctional CNC lathes enables the combination of turning and milling operations in a single setup, significantly reducing the need for subsequent technological steps in the overall production time. The article focuses on the analysis of the power skiving principle, describing its geometrical and technological aspects, the requirements for CNC lathes, and the specifics of using suitable tools. © 2025 Danube Adria Association for Automation and Manufacturing, DAAAM. All rights reserved. (20 refs)
Main heading: Lathes
Controlled terms: Gear manufacture - Gears
Uncontrolled terms: Angular positioning - CNC lathe - Gear hobbing - Gear manufacturing - High productivity - Hobbing - Innovative approaches - Power - Power skiving - Workpiece
Classification Code: 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 603 Machine Tools
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

10. Mathematical modeling and implementation of power-skiving for ZI-type worm machining

Tsai, Chung-Yu (1); Liang, Chang-Jing (1)
Source: *Journal of Manufacturing Processes*, v 136, p 43-55, February 28, 2025; **ISSN:** 15266125; **DOI:** 10.1016/j.jmapro.2025.01.059; **Publisher:** Elsevier Ltd
Author affiliation: (1) Department of Mechanical Engineering, National Chung Cheng University, No.168, Sec. 1, University Rd., Chiayi, Minhsiung; 62102, Taiwan
Abstract: This study presents an approach for machining ZI-type worms base on the concept of power-skiving method used to machine cylindrical gears. The proposed method can efficiently manufacture multi-thread ZI-type worms in a single cutting process, without the need for multiple back-and-forth cutting. The tool design process and mathematical modeling of the power-skiving operation are presented and discussed. A comprehensive analysis of the working clearance angles and linear cutting speeds at each point on the cutting edge during the power-skiving process is also presented. Machining a ZI-type worm on a multitasking turning center (Tongtai TD-2000YBC) substantiates the effectiveness of the proposed methodology. The results validate that the proposed methodology offers a straightforward, yet efficient and accurate technique performing the power-skiving operation to manufacture worm on a standard multi-axis CNC turning-milling machining center. © 2025 (40 refs)
Main heading: Worm gears
Controlled terms: Cutting tools - Gear cutting - Gear manufacture - Machining centers - Milling (machining) - Thread cutting
Uncontrolled terms: Cutting process - Cylindrical gear - Design-process - Multi-thread - Power - Power-skiving - Tool designs - Working angle - Working angle analyze - ZI-type worm
Classification Code: 601.2 Machine Components - 603 Machine Tools - 603.1 Machine Tool Accessories - 604.1 Metal Cutting - 604.2 Machining Operations
Funding Details: Number: NSTC 113-2622-E-194-003, Acronym: NSTC, Sponsor: National Science and Technology Council; Number: -, Acronym: NSTC, Sponsor: National Science and Technology Council;
Funding text: This study was supported by the National Science and Technology Council of Taiwan under Grant No. NSTC 113-2622-E-194-003 and the Advanced Institute of Manufacturing with High-tech Innovations (AIM-HI).
Database: Compendex
Data Provider: Engineering Village

11. [The Modularized Development of a Wheel-Side Electric Drive System Using the Process of Hobbing and Form Grinding]() (*Open Access*)

Ding, Xiaoyu (1, 2); Wang, Wei (3); Chen, Xinbo (2)
Source: *Applied Sciences (Switzerland)*, v 15, n 3, February 2025; **E-ISSN:** 20763417; **DOI:** 10.3390/app15031483; **Article number:** 1483; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) R&D Innovation Headquarters, SAIC Motor, Shanghai; 201804, China (2) School of Automotives Studies, Tongji University, Shanghai; 201804, China (3) Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, Tokyo; 184-8588, Japan
Abstract: The wheel-side electric drive system is a melding of a vehicle powertrain and suspension system, which saves chassis space and can adapt to different models. To achieve the goal of highly modularized development, the system is supposed to meet the requirements of various working conditions without changing the interface state. The electric motor drives the wheel through two-stage fixed axis helical gears, so the transmission is short in path and acts as the suspension arm at the same time. As a result, the gears are critical to output robustness and NVH performance. The modeling accuracy is decisive for simulations and tests, so it is necessary to build a precise geometric model instead of the data-fitting estimation. The gears are manufactured by a hobbing and form grinding process, which is described functionally along with the relationship between the tooling parameters and tooth profile curves. Based on the rain flow methodology and extrapolation theory, a comprehensive load spectrum with nine stages is formulated, which can cover the working conditions of a basic version, a NVH version, and a durability version. According to the Miner cumulative damage hypothesis, the equivalent durability mileage of 150,000 km is converted. The prototype machine is simulated and verified on the test bench, and the test results show that the wheel-side electric drive system has a reliable output performance. The equivalent damage of the comprehensive load spectrum is 63.27%, where the 2# stage driving gear is the most vulnerable component of the whole system. The research in this paper can provide data support for damage calculation and lightweight optimization with modularized development and applications in the future. © 2025 by the authors. (33 refs)
Main heading: Grinding (machining)
Controlled terms: Electric motors - Gear manufacture - Gear teeth - Gear transmissions - Grinding wheels - Helical gears - Magnetic levitation vehicles - Vehicle suspensions - Vehicle wheels
Uncontrolled terms: Comprehensive loads - Condition - Durability test - Electric drive system - Form grinding - Hobbing - Hobbing and form grinding - Load spectrum - Modularized - Wheel-side electric drive system
Classification Code: 433 Rail Transportation - 601.2 Machine Components - 602.2 Mechanical Transmissions - 604.2 Machining Operations - 662.3 Automobile Components and Materials - 705.3 Electric Motors - 942.2.3 Abrasive Devices and Processes
Funding Details: Number: 5227052034, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China;
Funding text: This research was funded by the National Natural Science Foundation of China project \u201CResearch on the Mechanism Principle and Multi-source Information Processing Mechanism of a Load-sensing Distributed Drive System\u201D (No. 5227052034).
Open Access type(s): All Open Access, Gold, Green
Database: Compendex
Data Provider: Engineering Village

12. [A novel conical cutter design approach and skiving process for manufacturing multiple-thread toroidal involute worms]()

Luu, Trong-Thuan (1); Wu, Yu-Ren (2)
Source: *International Journal of Advanced Manufacturing Technology*, v 143, n 9-10, p 5443-5463, April 2026; **ISSN:** 02683768, **E-ISSN:** 14333015; **DOI:** 10.1007/s00170-026-17728-z; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) School of Mechanical Engineering, Hanoi University of Science and Technology, 01 Dai Co Viet Rd, Hanoi, Viet Nam (2) Department of Mechanical Engineering, National Central University, 300, Zhongda Rd., Zhongli District, Taoyuan; 320317, Taiwan
Abstract: The toroidal involute worm (TI worm) drive, consisting of an hourglass worm and an involute helical gear, is a critical component in heavy-duty power transmission. Existing manufacturing methods for TI worms rely primarily on conventional turning and milling processes, which result in low processing efficiency. Therefore, this study proposes a cutter design method and a skiving process using a conical cutter to enhance machining efficiency while maintaining necessary accuracy. First, the TI worm surface is determined as the enveloping surface of the worm gear. The cutting edge of the skiving cutter is then proposed as the intersecting curve between the rake plane and the barrel gear, where the barrel gear correctly meshes with the TI worm. By employing an iterative process, the generating rack model and the conical cutter flank are concurrently derived from the proposed cutting edge. Finally, a skiving model is formulated by synchronizing the enveloping and circular feed motions within a gear-hobbing CNC machine architecture to simulate the machining process and numerically assess geometry accuracy. The results demonstrate the effectiveness and practicality of the proposed approach. © The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2026. (34 refs)

Main heading: Efficiency
Controlled terms: Computer aided design - Gear cutters - Gear cutting - Helical gears - Iterative methods - Milling (machining) - Power transmission - Turning - Worm gears
Uncontrolled terms: Cutter design - Cutting edges - Design approaches - Generating rack - Hourglass worm - Involute worm - Power - Power skiving - Skiving cutter generation - Toroidal involute worm
Classification Code: 601.2 Machine Components - 602.2 Mechanical Transmissions - 604.1 Metal Cutting - 604.2 Machining Operations - 904 Design - 913.1 Production Engineering - 1201.9 Numerical Methods
Funding Details: Number: T2024-TĐ-029, Acronym: HUST, Sponsor: Trường Đại học Bách Khoa Hà Nội; Number: -, Acronym: HUST, Sponsor: Trường Đại học Bách Khoa Hà Nội; Number: NSTC 113-2221-E-008-035-MY3, Acronym: NSTC, Sponsor: National Science and Technology Council; Number: -, Acronym: NSTC, Sponsor: National Science and Technology Council;
Funding text: This research is funded by Hanoi University of Science and Technology (HUST) under project number T2024-T\u0110-029 and financially supported by National Science and Technology Council in Taiwan (R.O.C.) under project number NSTC 113-2221-E-008-035-MY3.This research was supported by the Hanoi University of Science and Technology (HUST) in Vietnam, project number T2024-T\u0110-029, and National Science and Technology Council in Taiwan (R.O.C.), project number NSTC 113-2221-E-008-035-MY3.
Database: Compendex
Data Provider: Engineering Village

13. A robust approach to enhance adaptability of skiving cutter in manufacturing gear injection molds with variable shrinkage rates

Luu, Trong-Thuan (1); Le, Van-Tuan (1)
Source: *International Journal of Advanced Manufacturing Technology*, v 142, n 3-4, p 1151-1168, January 2026; **ISSN:** 02683768, **E-ISSN:** 14333015; **DOI:** 10.1007/s00170-025-17083-5; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) School of Mechanical Engineering, Hanoi University of Science and Technology, 01 Dai Co Viet Rd, Hanoi City, Viet Nam
Abstract: Gear mold is typically manufactured through an EDM process employing a gear electrode core. In addition, the gear electrode is commonly machined using a milling or hobbing process. Nevertheless, the milling process generates only a single tooth groove in one machining cycle. Additionally, the hob cutter geometry is redesigned when changing the plastic's shrinkage rate. Therefore, this study introduces a robust approach to applying the skiving process, focusing on cutter reutilization in manufacturing gear electrodes with different shrinkage rates. First, the cutting edge of the skiving cutter is located on the imaginary gear, where the imaginary gear correctly meshes with the basic rack of the gear electrode at a predefined shrinkage rate. The generating rack of the cutter is generated by predicting and solving the meshing condition with the cutting edge. Accordingly, the cutter body is produced by simulating the meshing kinematics with the generating rack. Subsequently, the tool path is adjusted by adding the additional motions for the machining axes within the inner closed loop to reuse the cutter with different shrinkage rates. The changing range of the shrinkage rate during cutter reutilization is determined by applying the outer closed loop. The numerical examples verify the effectiveness and practicality of the proposed method. © The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2025. (52 refs)
Main heading: Shrinkage
Controlled terms: Electric discharge machining - Gear cutters - Gear cutting - Gear manufacture - Gears - Milling (machining) - Molds
Uncontrolled terms: Cutter adaptability - Cutter modification - Gear electrode - Gear mold - Milling process - Motion modification - Power - Power skiving - Robust approaches - Shrinkage rates
Classification Code: 214 Materials Science - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 604.1 Metal Cutting - 604.2 Machining Operations - 913.4 Manufacturing
Funding Details: Number: T2024-TĐ-029, Acronym: HUST, Sponsor: Trường Đại học Bách Khoa Hà Nội; Number: -, Acronym: HUST, Sponsor: Trường Đại học Bách Khoa Hà Nội;
Funding text: This research is funded by Hanoi University of Science and Technology (HUST) under project number T2024-T\u0110-029.This research was supported by the Hanoi University of Science and Technology (HUST) in Vietnam, project number T2024-T\u0110-029.
Database: Compendex
Data Provider: Engineering Village

14. Optimization of tool design and cutting angles in face gear power skiving

Zhengyang, Han (1); Chuang, Jiang (1, 2); Jing, Deng (1); Xiaozhong, Deng (1); Longlong, Geng (1)
Source: *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, v 48, n 2, February 2026; **ISSN:** 16785878, **E-ISSN:** 18063691; **DOI:** [10.1007/s40430-025-06083-x](https://doi.org/10.1007/s40430-025-06083-x); **Article number:** 110; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) School of Mechatronics Engineering, Henan University of Science and Technology, 48 Xiyuan Rd, Luoyang, China (2) Longmen Laboratory, 48 Xiyuan Rd, Luoyang, China
Abstract: Face gear transmission has the advantages of a compact structure, smooth transmission, and insensitivity to installation errors. The method of machining face gears by power skiving is a recent innovation that has been introduced in recent years. To solve the interference problem in the machining of face gear surfaces, This paper presents a cutting angle control approach to predict cutting interference conditions. Initially, the principle of power skiving is studied, and both a precise mathematical model of the power skiving cutter and a kinematics model of gear machining are established. Subsequently, the formation of the rake angle and the clearance angle is analyzed. The changing trend of the cutting angle is investigated. The problem of a negative clearance angle has been identified as prone to occurring during the machining of face gears by power skiving, potentially causing interference with the tooth surface. By improving the geometric structure of the power skiving cutter, the problem of side interference during gear machining is avoided. Ultimately, the accuracy of the proposed method is validated through the application of simulation machining technology. This research results can provide a tool design reference for processing face gears by power skiving technology. © The Author(s), under exclusive licence to The Brazilian Society of Mechanical Sciences and Engineering 2025. (23 refs)
Main heading: Gear cutting
Controlled terms: Gear cutters - Gears - Optimization - Structural design - Structure (composition)
Uncontrolled terms: Clearance angle - Cutting angles - Face gears - Gear machining - Machining interference - Optimisations - Power - Power skiving - Tool cutting - Tool designs
Classification Code: 214 Materials Science - 408 Structural Design - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 604.1 Metal Cutting - 1201.7 Optimization Techniques
Funding Details: Number: 52505060,52175049, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: 252300421543, Acronym: -, Sponsor: Natural Science Foundation of Henan Province; Number: 25A460012, Acronym: -, Sponsor: Key Scientific Research Project of Colleges and Universities in Henan Province; Number: LMQYTSKT024, Acronym: -, Sponsor: -; Number: 242102220084, Acronym: -, Sponsor: Henan Provincial Science and Technology Research Project;
Funding text: This work was supported by Frontier Exploration Project of Longmen Laboratory (No. LMQYTSKT024), the National Natural Science Foundation of China (No. 52175049, No. 52505060), the Natural Science Foundation of Henan Provence (No. 252300421543), the Key Scientific Research Project of Colleges in Henan Province (No. 25A460012), and the Henan Provincial Science and Technology Research Project (No. 242102220084).
Database: Compendex
Data Provider: Engineering Village

15. [Numerical and experimental study on surface topography of spur gear generated by double-roller gear ultrasonic rolling]()

Shi, Zhengyu (1); Shao, Wen (1); Tang, Jinyuan (1); Shi, Yu (1); Lv, Liangliang (1); Chen, Jiling (1); Feng, Guoxi (1)
Source: *Surface Topography: Metrology and Properties*, v 13, n 1, March 31, 2025; **E-ISSN:** 2051672X; **DOI:** [10.1088/2051-672X/adb5a4](https://doi.org/10.1088/2051-672X/adb5a4); **Article number:** 015028; **Publisher:** Institute of Physics
Author affiliation: (1) State Key Laboratory of Precision Manufacturing for Extreme Service Performance, College of Mechanical and Electrical Engineering, Central South University, Hunan, Changsha; 410083, China
Abstract: Compared with shot peening, the Double-roller Gear Ultrasonic Rolling (DGUR) process not only improves gear fatigue properties but also effectively reduces surface roughness. However, there is a lack of surface topography modeling methods for this process. Based on the Hertzian contact theory, this paper introduces a numerical model for the DGUR process that incorporates initial residual stress and the surface topography of the sample gear. Subsequently, DGUR experiments were conducted with four different processing parameters. The experimental and simulated results are consistent for both gear surface topography and two-dimensional gear face profiles, and the relative errors of 3D roughness parameters Sa and Sq were less than 5%, confirming the model's validity. Based on this model, we investigated the relationship between the DGUR process and the Sa, Sq parameters. The experimental outcomes indicated that the DGUR treatment considerably improved the gear tooth surface roughness, decreasing Sa from an initial 0.497 μm to 0.144 μm and Sq from 0.595 μm to 0.203 μm, thereby significantly improving gear tooth surface roughness. © 2025 IOP Publishing Ltd. All rights, including for text and data mining, AI training, and similar technologies, are reserved. (54 refs)
Main heading: Rollers (machine components)
Controlled terms: Digital elevation model - Gear teeth - Gear trains - Rollers (roadbuilding machinery) - Shot peening - Spur gears - Ultrasonic applications - Ultrasonic machine tools - Wiener filtering
Uncontrolled terms: Double-roller gear ultrasonic rolling - Fatigue properties - Gaussian filtering - Gear tooth surface - Initial residual stress - Initial surface topography - Numerical and experimental study - Roller gears - Rolling process - Shot-peening

Classification Code: 201.9 Metals Corrosion and Protection; Metal Plating - 208 Coatings, Surfaces, Finishes, Films and Deposition - 405.1 Construction Equipment - 406.2 Roads and Streets - 601.2 Machine Components - 603 Machine Tools - 661 Automotive Engines and Related Equipment - 753.2 Ultrasonic Devices - 753.3 Ultrasonic Applications - 1106.2 Data Handling and Data Processing - 1106.3 Digital Signal Processing - 1106.3.1 Image Processing
Funding Details:
Funding text: The authors gratefully acknowledge the support of Basic product innovation Program of China (No. DEDPCL).
Database: Compendex
Data Provider: Engineering Village

16. [Multi-objective optimization of grinding process parameters for improving gear machining precision]

You, Tong-Fei (1, 2); Han, Jiang (1, 2); Tian, Xiao-Qing (1, 2); Tang, Jian-Ping (1, 2); Lu, Yi-Guo (1, 2); Li, Guang-Hui (1, 2); Xia, Lian (1, 2)
Source: *Journal of Central South University*, v 32, n 2, p 538-551, February 2025; **ISSN:** 20952899, **E-ISSN:** 22275223; **DOI:** 10.1007/s11771-025-5877-7; **Publisher:** Central South University
Author affiliation: (1) School of Mechanical Engineering, Hefei University of Technology, Hefei; 230009, China (2) Anhui Engineering Laboratory of Intelligent CNC Technology and Equipment, Hefei; 230009, China
Abstract: The gears of new energy vehicles are required to withstand higher rotational speeds and greater loads, which puts forward higher precision essentials for gear manufacturing. However, machining process parameters can cause changes in cutting force/heat, resulting in affecting gear machining precision. Therefore, this paper studies the effect of different process parameters on gear machining precision. A multi-objective optimization model is established for the relationship between process parameters and tooth surface deviations, tooth profile deviations, and tooth lead deviations through the cutting speed, feed rate, and cutting depth of the worm wheel gear grinding machine. The response surface method (RSM) is used for experimental design, and the corresponding experimental results and optimal process parameters are obtained. Subsequently, gray relational analysis-principal component analysis (GRA-PCA), particle swarm optimization (PSO), and genetic algorithm-particle swarm optimization (GA-PSO) methods are used to analyze the experimental results and obtain different optimal process parameters. The results show that optimal process parameters obtained by the GRA-PCA, PSO, and GA-PSO methods improve the gear machining precision. Moreover, the gear machining precision obtained by GA-PSO is superior to other methods. © Central South University 2025. (39 refs)
Main heading: Grinding machines
Controlled terms: Gear cutters - Gear cutting - Gear cutting machines - Gear manufacture - Gear teeth - Grinding (machining) - Grinding wheels - Particle swarm optimization (PSO) - Precision engineering - Worm gears
Uncontrolled terms: Gear grinding machines - Gear machining - Gear machining precision - Machining precision - Machining process parameters - Multi-objectives optimization - Optimal process - Process parameters - Worm wheel gear grinding machine - Worm wheels
Classification Code: 601.2 Machine Components - 603 Machine Tools - 604.1 Metal Cutting - 604.2 Machining Operations - 901 Engineering Profession - 942.2.3 Abrasive Devices and Processes - 1106 Computer Software, Data Handling and Applications - 1201.7 Optimization Techniques
Funding Details: Number: 2023ZY01050, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China;
Funding text: Foundation item: Projects(U22B2084, 52275483, 52075142) supported by the National Natural Science Foundation of China; Project (2023ZY01050) supported by the Ministry of Industry and Information Technology High Quality Development, China
Database: Compendex
Data Provider: Engineering Village

17. [Hard Gear Skiving with High-Performance Tools - An Innovative Technology for Future Drivetrains]

Hilligardt, Andreas (1); Leonhardt, Christoph (1); Zimmer, Maximilian (1)
Source: *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*, p 291-309, 2025, *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*; **ISBN-13:** 9781643532035; **Conference:** American Gear Manufacturers Association Fall Technical Meeting, FTM 2025, October 22, 2025 - October 24, 2025; **Publisher:** AGMA American Gear Manufacturers Association
Author affiliation: (1) Reishauer AG, Switzerland
Abstract: Due to the increasing demand for drivetrains with even higher power densities, high efficiency and low noise emissions, new gearbox concepts with planetary gear sets are increasingly being developed. Internal gears with a high load capacity and geometric accuracy in a thin-walled design are required for these concepts. These requirements can be met in particular by hard fine machined, case- or induction-hardened gears. However, the high hardening distortions of thin-

walled components create major challenges for hard fine machining, meaning that there is currently no economical hard fine machining process available for internal gears. In the last 15 years, gear skiving has established itself as one of the most important processes for the production of internal gears in green machining. However, attempts to use the process in hard fine machining have failed due to the limited tool life that can be achieved with tungsten carbide tools and the resulting quickly insufficient workpiece quality. This paper introduces a novel PCBN tool system for the high-quality, economical hard finishing of internal gears. The tool system is complemented by a highly specialized hard skiving machine. Application examples demonstrate how this technology machines internal gears to a quality of ISO class 5 or better, achieving tool lives exceeding 2000 workpieces per resharpening. (23 refs)

Main heading: Tungsten carbide

Controlled terms: Carbide cutting tools - Finishing - Gear manufacture - Gear trains - Gears - Hardening - Thin walled structures

Uncontrolled terms: Gear skiving - High-low - High-performance tools - High-power-density - Higher efficiency - Innovative technology - Internal gear - Tool life - Tool systems - Workpiece

Classification Code: 201.7.1 Heat Treatment Processes - 202.3 Chromium, Manganese, Molybdenum, Tantalum, Tungsten, Vanadium and Alloys - 208.1 Coating Techniques - 408.1 Structural Members and Shapes - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 603.1 Machine Tool Accessories - 605.1 Small Tools, Powered - 661 Automotive Engines and Related Equipment - 804.2 Inorganic Compounds

Database: Compendex

Data Provider: Engineering Village

18. Identification of pivotal thermal errors in worm gear grinding machine affecting gear machining accuracy

Li, Guolong (1); Wang, Long (1); Li, Zheyu (1, 2); Xu, Kai (3)

Source: *International Journal of Advanced Manufacturing Technology*, v 141, n 9-10, p 4837-4858, December 2025; **ISSN:** 02683768, **E-ISSN:** 14333015; **DOI:** 10.1007/s00170-025-16900-1; **Publisher:** Springer Science and Business Media Deutschland GmbH

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Abstract: Thermal error is the primary factor affecting the accuracy of gear grinding machines. To improve gear grinding accuracy, it is critical to determine the effect of thermal errors on gear tooth surface errors and identify the pivotal thermal errors. In the paper, a pivotal thermal error identification method combining the thermal error-tooth surface error model and improved Sobol sensitivity analysis is proposed. Firstly, the worm wheel tooth surface model is established using the conjugate surface envelope theory, and the thermal error-tooth surface error model is constructed based on the principle of conjugate grinding. Then, the improved Sobol method is applied to quantify the error sensitivity under different temperature states, thereby identifying the pivotal thermal errors that affect the gear tooth surface accuracy. Finally, thermal error measurement experiments are conducted under various working conditions to determine the variation ranges of different thermal errors. The validity of these results is verified through numerical modification and simulation analysis of the pivotal thermal errors. The results demonstrate that compensating for pivotal thermal errors reduces the maximum, average, and root mean square values of the gear tooth surface error by over 70%, confirming the accuracy of the identification method. (35 refs)

Main heading: Sensitivity analysis

Controlled terms: Errors - Gear teeth - Grinding (machining) - Grinding wheels - Metal drawing - Thermal modeling - Worm gears

Uncontrolled terms: Error identification - Gear grinding machines - Improved sobol method - Pivotal error identification - Sobol method - Surface error - Teeth surface - Thermal error - Tooth surface error - Worm gear grinding machine

Classification Code: 201.5.2 Metal Forming - 601.2 Machine Components - 604.2 Machining Operations - 731.1.1 Error Handling - 942.2.3 Abrasive Devices and Processes - 1201 Mathematics - 1201.12 Modeling and Simulation

Database: Compendex

Data Provider: Engineering Village

19. Simulation and analysis of dynamic cutting load for gear skiving method considering different cutting phases

Xu, Zhonghai (1, 2); Sun, Jicheng (3); Wang, Peng (1, 2); Wu, Zhiwen (1, 2); Tesfa, Ephrem Bekele (1, 2)

Source: *International Journal of Advanced Manufacturing Technology*, 2025; **ISSN:** 02683768, **E-ISSN:** 14333015; **DOI:** [10.1007/s00170-025-16094-6](10.1007/s00170-025-16094-6); **Publisher:** Springer Science and Business Media Deutschland GmbH, Article in Press
Author affiliation: (1) College of Mechanical & Energy Engineering, Beijing University of Technology, Beijing; 100124, China (2) Beijing Engineering Research Center of Precision Measurement Technology and Instruments, Beijing University of Technology, Beijing; 100124, China (3) Chongqing Gearbox Co., Ltd (CQ-Gearbox), Chongqing; 402263, China
Abstract: Accurately predicting the cutting load in gear skiving is crucial for optimizing cutting parameters, extending tool life, improving gear tooth surface quality. An analysis framework for dynamic cutting loads was proposed and the finite element analysis (FEA) model was also created to analyze time-varying characteristics of gear skiving cutting loads during the cut-in, stable cutting, and cut-out phases. Based on numerical simulations, the quantitative relationships between cutting parameters and dynamic cutting loads, including cutting force and torque, cutting temperature, and cutting edge stress, have been explored. The simulation results indicate that with changes in axial cutting position, the cutting force and torque rise during the cut-in phase, remain constant during stable cutting, and gradually decrease to zero in the cut-out phase. With rotation speed increasing from 500 to 1200 r/min, the tool cutting force and torque decrease, but the rate of decrease slows when the tool rotation speed reaches 800 r/min; the cutting temperature on the tool's rake face exhibits a decrease-increase–decrease trend, while the cutting edge stress gradually decreases. The tool cutting force and torque rise by 30.6% for every 0.1 mm/r increase in axial feed speed and by 12.6% for every 0.2 mm increase in radial depth of cut, and both the cutting temperature and cutting edge stress are positively correlated with feed speed and depth of cut. The proposed cutting load analysis framework and simulation results for gear skiving can be applied for further optimization of cutting parameters. © The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2025. (27 refs)
Main heading: Torque
Controlled terms: Cutting tools - Gear cutting - Gears - Loads (forces) - Rotation - Turning
Uncontrolled terms: Cutting forces - Cutting load - Cutting parameters - Cutting torque - Dynamic cutting - Dynamic cutting load - Finite element analyse - Force and torques - Gear skiving - Skiving tool
Classification Code: 408 Structural Design - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 603.1 Machine Tool Accessories - 604.1 Metal Cutting - 604.2 Machining Operations - 1301.1.1 Mechanics - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Funding Details: Number: 2022YFB3402902, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China; Number: -, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China;
Funding text: This work was supported by National Key R&D Program of China (2022YFB3402902).
Database: Compendex
Data Provider: Engineering Village

20. Generation of internal spiral bevel gears by gear skiving method

Wang, Peng (1, 2); Bekele Tesfa, Ephrem (1, 2); Lin, Jiachun (1, 2); Shi, Zhaoyao (1, 2)
Source: *Forschung im Ingenieurwesen/Engineering Research*, v 89, n 1, December 2025; **ISSN:** 00157899, **E-ISSN:** 14340860; **DOI:** [10.1007/s10010-025-00900-4](10.1007/s10010-025-00900-4); **Article number:** 129; **Publisher:** Springer Vieweg
Author affiliation: (1) College of Mechanical & Energy Engineering, Beijing University of Technology, Beijing; 100124, China (2) Beijing Engineering Research Center of Precision Measurement Technology and Instruments, Beijing University of Technology, Beijing; 100124, China
Abstract: This paper presents an innovative gear skiving technique for the efficient manufacturing of internal spiral bevel gears. The widespread adoption of these gears, critical components in nutation reducers used in aerospace, robotics, and precision machinery, has been limited by significant machining challenges. Current methods, including universal tool five-axis milling and face milling, are constrained by low efficiency and high susceptibility to tool interference. To overcome these obstacles, this study introduces a novel skiving tool design and motion control strategy that offers both high precision and efficiency. The proposed method's effectiveness is confirmed through detailed mathematical modeling, and validation via virtual machining simulation using VERICUT software, which demonstrates exceptional accuracy, effectively eliminating errors such as gouging and excess material. The results highlight the potential of this approach to revolutionize the production of internal spiral bevel gears, offering a promising solution for industries requiring high-performance gear systems. This work paves the way for further advancements in gear manufacturing technologies. © Der/die Autor(en), exklusiv lizenziert an Springer-Verlag GmbH Deutschland, ein Teil von Springer Nature 2025. (32 refs)
Main heading: Bevel gears
Controlled terms: Computer software - Efficiency - Gear manufacture - Milling (machining) - Motion control
Uncontrolled terms: 'current - Control strategies - Critical component - Face-milling - Five-axis milling - Gear skiving - Precision machinery - Spiral bevel gears - Tool designs - Tools motions
Classification Code: 601.2 Machine Components - 604.2 Machining Operations - 731.3 Specific Variables Control - 913.1 Production Engineering - 1106.9 Computer Software

Funding Details: Number: 2022YFB3402902, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China; Number: -, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China;
Funding text: This work was supported by National Key R&D Program of China (2022YFB3402902).
Database: Compendex
Data Provider: Engineering Village

21. A new mathematical model for the product family design of the skiving tools of spur face gears

Tang, Zhongwei (1); Zhou, Yuansheng (1, 2); Mo, Shuai (3); Tang, Jinyuan (1, 2); Du, Zichang (1); Zhang, Wuji (1); He, Haiyu (1)
Source: *Mechanism and Machine Theory*, v 217, December 2025; **ISSN:** 0094114X; **DOI:** 10.1016/j.mechmachtheory.2025.106232; **Article number:** 106232; **Publisher:** Elsevier Ltd
Author affiliation: (1) College of Mechanical and Electrical Engineering, Central South University, Changsha; 410083, China (2) State Key Laboratory of Precision Manufacturing for Extreme Service Performance, Central South University, Changsha; 410083, China (3) School of Mechanical Engineering, Guangxi University, Nanning; 530004, China
Abstract: Power skiving is increasingly used in face gear manufacturing while the existing tools are limited to the face gears with specific parameters (module, pressure angle, and tooth number), which reduces flexibility and increases costs. This paper proposes a product family design method for skiving tools aimed at spur face gears. First, a mathematical model of the tooth surface is established, along with an error evaluation framework. Then, an error compensation method is introduced for a specific gear design, and errors are analyzed when using a dedicated tool to machine the face gears with different parameters. Results show that variations in tooth number cause minor errors, while differences in module and pressure angle lead to significant inaccuracies. A product family design approach is proposed to enable one tool to machine multiple gears accurately. Validated through simulations and experiments, the method achieves high precision for gear families with small variations in module and pressure angle. This work offers practical value and theoretical support for developing skiving tool libraries. © 2025 (37 refs)
Main heading: Product design
Controlled terms: Error compensation - Gear manufacture - Spur gears
Uncontrolled terms: Face gears - Gear manufacturing - New mathematical model - Power - Power skiving - Pressure angles - Product family design - Tool designs - Tool library - Tooth number
Classification Code: 601.2 Machine Components - 731.1.1 Error Handling - 904 Design - 913.6 Product Development; Concurrent Engineering
Funding Details: Number: 2023CXQD050, Acronym: CSU, Sponsor: Central South University; Number: -, Acronym: CSU, Sponsor: Central South University; Number: 52575084, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: CX20230255, Acronym: -, Sponsor: Fundamental Research Funds for Central Universities of the Central South University; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for Central Universities of the Central South University; Number: 2025JK2020, Acronym: -, Sponsor: Science and Technology Program of Hunan Province; Number: -, Acronym: -, Sponsor: Science and Technology Program of Hunan Province; Number: 2024YFB3410402, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China; Number: -, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China;
Funding text: The authors express sincere gratitude for the financial support received from the following sources: the National Key R&D Program of China (Grant No. 2024YFB3410402), The science and technology innovation Program of Hunan Province (Grant No. 2025JK2020), the National Natural Science Foundation of China (Grant No. 52575084), the Central South University Innovation-Driven Research Program (Project No. 2023CXQD050), and the Fundamental Research Funds for the Central Universities of Central South University (Grant No. CX20230255).
Database: Compendex
Data Provider: Engineering Village

22. A novel robust distributed mass-damping vibration absorber for spiral bevel gear face-hobbing chatter mitigation

Yu, Jianwu (1); Huang, Kaifeng (2); Qian, Jun (3); Shang, Zhentao (1); Fu, Chunming (2); Tan, Min (1, 4)
Source: *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, v 48, n 4, March 2026; **ISSN:** 16785878, **E-ISSN:** 18063691; **DOI:** 10.1007/s40430-025-06209-1; **Article number:** 282; **Publisher:** Springer Science and Business Media Deutschland GmbH
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Abstract: It is challenging to suppress chatter in face-hobbing gear machining, because it involves very complex spatial kinematic and time-varying dynamic characteristics compared to other machining techniques. This study presents a novel reconfigurable distributed-mass-damping dynamic vibration absorber (DMDVA) with excellent robustness for chatter suppression in face-hobbing gear machining. Unlike traditional tuned mass dampers (TMDs) with fixed setups, the proposed DMDVA introduces three key innovations: (1) a modular design that allows for adjustable mass distribution and damping topology through spatial reconfiguration of functional units; (2) a frequency-adaptive mechanism tailored for the changing dynamics in hypoid gear cutting; and (3) an integrated tuning framework based on differential evolution that considers machine-tool-workpiece interactions. Systematic comparison of compliance characteristics across multiple layouts shows that the optimal DMDVA configuration achieves a 42% wider adequate bandwidth and 68% higher damping efficiency than conventional TMDs. Experimental and numerical results on gear cutting machines demonstrate significant performance improvements: an 88.92% reduction in chatter amplitude (compared to 56.41% with TMD), and tooth flank normal deviation decreased from 1.7190 to 1.5164 μm on convex surfaces and from 0.5757 to 0.4722 μm on concave surfaces. The reconfigurable topology allows dynamic adjustment of natural frequency over a broad range, effectively addressing variations in process parameters during complex tooth flank machining. These contributions provide a systematic and adaptive approach for precise vibration control in multi-axis gear manufacturing systems. © The Author(s), under exclusive licence to The Brazilian Society of Mechanical Sciences and Engineering 2025. (43 refs)
Main heading: Optimization
Controlled terms: Adaptive control systems - Bevel gears - Damping - Gear cutting - Gear cutting machines - Gear manufacture - Gear teeth - Topology - Vibration control - Vibrations (mechanical)
Uncontrolled terms: Chatter mitigation - Dynamic vibration absorber - Face hobbing - Gear machining - Hypoid gears - Mass-damping - Optimisations - Reconfigurable - Tooth flank - Tuned mass dampers
Classification Code: 601.2 Machine Components - 603 Machine Tools - 604.1 Metal Cutting - 731.1 Control Systems - 731.3 Specific Variables Control - 1201.2 Calculus and Analysis - 1201.7 Optimization Techniques - 1201.14 Geometry and Topology - 1301.1.1 Mechanics
Funding Details: Number: 2023GK2091,2023ZK1050, Acronym: -, Sponsor: -; Number: 52205508, Acronym: NNSF, Sponsor: National Natural Science Foundation of China; Number: 2023JJ30147,2025JJ60370, Acronym: -, Sponsor: Natural Science Foundation of Hunan Province; Number: 24C0891, Acronym: -, Sponsor: -;
Funding text: This research was supported by the National Natural Science Foundation of China (Grant No. 52205508), Natural Science Foundation of Hunan Province (Grant No. 2025JJ60370, 2023JJ30147), Key R&D Projects in Hunan Province (Grant No. 2023GK2091, 2023ZK1050), and Projects of Hunan Provincial Department of Education (Grant No. 24C0891).The funding was provided by National Natural Science Foundation of China, Grant No.: 52205508 and Natural Science Foundation of Hunan Province Grant Nos.: 2025JJ60370 and 2023JJ30147.
Database: Compendex
Data Provider: Engineering Village

23. Experimental and multiscale simulation analysis of the lubricant penetration in gear skiving (*Open Access*)

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Source: *Production Engineering*, v 19, n 6, p 1373-1394, December 2025; **ISSN:** 09446524, **E-ISSN:** 18637353; **DOI:** 10.1007/s11740-025-01374-7; **Publisher:** Springer Science and Business Media Deutschland GmbH
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Abstract: Cooling lubricants play essential roles in machining processes, namely cooling and lubricating contact surfaces, and facilitating the removal of chips that could compromise surface quality. A key question is how well the lubricant penetrates the cutting zone in complex interrupted cutting operations, such as gear skiving. This study tackles the challenge of analyzing the behavior of cooling lubricants across different scales by employing a combined experimental and multiscale simulation approach. The overall fluid flow is modeled using smoothed particle hydrodynamics, while chip formation is simulated with finite element methods. The cavitation behavior of the lubricant within the cutting wedge is examined using the Reynolds equation, and the tool's indentation is investigated through molecular dynamics simulations. Finite element simulations are validated against experimental data from gear skiving tests using AISI 4140 steel, showing an average deviation of 6.6% in the maximum force values. Smoothed particle hydrodynamics simulations predict that the cooling lubricant can reach the meshing zone between the tool and the workpiece. For validation purposes, typical global flow characteristics from the simulation are compared with high-speed camera images, exhibiting good agreement. In typical gear skiving conditions, Reynolds calculations indicate that significant cavitation occurs, resulting in a substantial portion of the contact area remaining dry. We investigate the conditions that can help reduce cavitation. Molecular dynamics

simulations reveal that nanocavities on the tool's surface can improve the transport of lubricant molecules to the contact area. © The Author(s) 2025. (70 refs)
Main heading: Cavitation
Controlled terms: Cooling - Cutting tools - Finite element method - Flow of fluids - Gear cutting - Gears - High speed cameras - Hydrodynamics - Lubricants - Reynolds equation
Uncontrolled terms: Condition - Contact areas - Cooling lubricants - Dynamics simulation - Experimental simulations - Gear skiving - Multi-scale simulation - Multiscale modeling - Reynolds - Smoothed particle hydrodynamics
Classification Code: 301.1 Fluid Flow - 301.1.1 Liquid Dynamics - 301.2 Hydrodynamics - 302.2 Heat Transfer - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 603.1 Machine Tool Accessories - 604.1 Metal Cutting - 606.1 Lubricants - 742.2 Photographic and Video Equipment - 801.3 Physical Chemistry - 1201.2 Calculus and Analysis - 1201.9 Numerical Methods
Funding Details: Number: -, Acronym: MWK, Sponsor: Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg; Number: -, Acronym: BMBF, Sponsor: Bundesministerium für Bildung und Forschung; Number: 439954775, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft; Number: -, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft;
Funding text: The research was generously funded by the DFG (\u201CDeutsche Forschungsgemeinschaft\u201D) under the project \u201CFluSimPro\u201D (439954775). The authors gratefully acknowledge the computing time provided on the high-performance computer HoreKa by the National High-Performance Computing Center at KIT (NHR@KIT). This center is jointly supported by the Federal Ministry of Education and Research and the Ministry of Science, Research and the Arts of Baden-W\u00FCrttemberg, as part of the National High-Performance Computing (NHR) joint funding program (https://www.nhr-verein.de/en/our-partners). HoreKa is partly funded by the German Research Foundation (DFG).
Open Access type(s): All Open Access, Hybrid Gold, Green
Database: Compendex
Data Provider: Engineering Village

24. Determination of Gear Skiving Tool Life Using an Image-Based Wear Detection System (*Open Access*)

Ogura, Ichiro (1); Furukawa, Yoshiyuki (1); Ikeno, Kazuhiro (2); Nonaka, Hirofumi (2)
Source: *International Journal of Automation Technology*, v 19, n 5, p 801-810, 2025; **ISSN:** 18817629, **E-ISSN:** 18838022; **DOI:** 10.20965/ijat.2025.p0801; **Publisher:** Fuji Technology Press
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Abstract: Gear skiving is a high-precision cutting technology that is particularly well-suited for machining internal gears. It is essential to evaluate tool wear on the machine in a timely manner to accurately estimate tool life. Existing research focuses on the development of an evaluation system that estimates wear and breakage through image-based observation. This study outlines the system configuration and presents an image processing method for extracting tool geometry. However, the flank surface reflection interfered with the extraction of the rake face ridge during bottom-up observation, where a reflector was placed behind the tool. To resolve this, a new contour-extraction method was employed. This method involves installing a blue or other colored reflector, illuminating the adjacent surface with diffusely reflected light, capturing an image of the tool bottom illuminated with white light, and applying RGB color decomposition. An index value that comprehensively evaluates the difference between the tool profile before and after each machining operation is also proposed. Additionally, a corresponding procedure is established to identify tool wear or chipping by comparing the index value to a threshold value that is determined based on its relationship to the actual amount of wear. The experimental results demonstrate that the index value increases progressively with tool wear advancement, validating the effectiveness of the proposed method. However, owing to image focus, wear detection can become unreliable, making it a critical consideration in image-based wear detection methodologies. © Fuji Technology Press Ltd. (18 refs)
Main heading: Cutting tools
Controlled terms: Extraction - Feature extraction - Gears - Image processing - Reflection - Wear of materials
Uncontrolled terms: Gear skiving - High precision cuttings - Image detection - Image-based - Index values - On machine measurement - Tool life - Tool wear - Wear detection - Wear detection systems
Classification Code: 214 Materials Science - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 603.1 Machine Tool Accessories - 802.3 Chemical Operations - 1101.2 Machine Learning - 1106.3.1 Image Processing - 1301.3 Optics
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

25. Precision prediction of tooth surface roughness in dry hobbing using limited sample data: An approach with potential for enhancing gear surface quality

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Source: *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, v 239, n 19, p 7861-7868, October 2025; **ISSN:** 09544062, **E-ISSN:** 20412983; **DOI:** 10.1177/09544062251353395; **Publisher:** SAGE Publications Ltd
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Abstract: Tooth surface roughness serves as one of the critical characterization indices for evaluating machining quality in dry hobbing. In this research, a precision prediction method with limited sample data is proposed for predicting tooth surface roughness in dry hobbing. Firstly, based on the envelope forming characteristics of dry hobbing, the formation mechanism of tooth surface roughness and its influence on gear transmission performance are clarified by analyzing the cutting vibrations and machine tool error mechanism. Secondly, a prediction model based on Support Vector Machine (SVM) is developed for tooth surface roughness in dry hobbing. In this SVM-based model, the model parameters (C, Ε, and γ) are determined through a hybrid optimization strategy combining grid search and random search. Finally, experimental tests on a representative helical gear with large helix angles, shallow tooth depths, and a large number of teeth were conducted to verify the proposed method. The results demonstrate a relative error of less than 7% between measured and predicted values, which validates the feasibility and reliability of the prediction method. Sensitivity analysis further reveals that tooth surface roughness value is negatively dependent on spindle speed and positively dependent on feed speed. This study thereby provides theoretical support for the optimal control of tooth surface roughness in dry hobbing. © IMechE 2025 (18 refs)
Main heading: Forecasting
Controlled terms: Cutting tools - Gear teeth - Green manufacturing - Helical gears - Machine tools - Optimal control systems - Support vector machines - Surface properties - Vibrations (mechanical)
Uncontrolled terms: Dry hobbing - Green manufacturing - Machine-learning - Machining quality - Precision prediction - Prediction methods - Sample data - Support vectors machine - Teeth surface - Tooth surface roughness
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 601.2 Machine Components - 603 Machine Tools - 603.1 Machine Tool Accessories - 731.1 Control Systems - 1101.2 Machine Learning - 1201 Mathematics - 1202 Statistical Methods - 1301.1.1 Mechanics - 1301.1.2 Physical Properties of Gases, Liquids and Solids - 1501 Sustainability
Funding Details: Number: 51905059,52105533, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: KJZD-K202300801, Acronym: CQMEC, Sponsor: Chongqing Municipal Education Commission; Number: 2021XM2020, Acronym: -, Sponsor: -;
Funding text: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the National Natural Science Foundation of China (Grant No. 51905059, 52105533), the key project of science and technology research program of Chongqing Municipal Education Commission (Grant No. KJZD-K202300801), and the Special Funding for Postdoctoral Research Projects in Chongqing (Grant No. 2021XM2020).
Database: Compendex
Data Provider: Engineering Village