Vibration

1-Dynamic model and vibration of rack vehicle on curve line

By Chen, ZW (Chen, Zhaowei) [1] ; Zhou, WH (Zhou, Wenhao) [1] ; Kuang, HL (Kuang, Honglin) [1] ; Chen, ZG (Chen, Zaigang) [2] ; Yang, JZ (Yang, Jizhong) [3] ; Chen, ZH (Chen, Zhihui) [3] ; Chen, F (Chen, Feng) [3] (provided by Clarivate) Source VEHICLE SYSTEM DYNAMICS DOI 10.1080/00423114.2025.2494835 Early Access APR 2025 Indexed 2025-04-27 Document Type Article; Early Access

Abstract

When rack vehicles traverse curved track sections, severe dynamic interactions between the gears and the rack, as well as between the wheel and rail, may lead to gear-rack disengagement or derailment, posing a safety risk. To address this, a coupled dynamics model of rack vehicles and track on curved sections is developed, based on gear system dynamics and vehicle-track coupling theory. The model is validated and used to investigate dynamic responses of rack vehicles on curved tracks, with a focus on gear-rack engagement dynamics. The study also examines how different curve radii influence vibration patterns. Results show that vehicle vibrations and dynamic meshing behavior are more severe on curved sections compared to straight ones. Specifically, the lateral acceleration of the vehicle body and the lateral force between the wheel and rail increase by 32.3% and 40%, respectively. During curve negotiation, lateral vibrations dominate over vertical ones, with gear offset reaching 1.323 mm. The primary frequencies of vehicle body acceleration and lateral force range from 1 to 3 Hz, while the frequencies for vertical and longitudinal gear acceleration vibrations range from 29 to 60 Hz. Additionally, vehicle body acceleration, derailment coefficient, and gear-rack meshing vibrations increase as the curve radius decreases.

Keywords

Author Keywords

Rack railwayvehicle dynamicscurve trackgear dynamicsgear-rack meshingoperation safety

Keywords Plus

RAILWAY VEHICLETRACKSTABILITYBRIDGE

Vibration

2-Vibration Performance of Composite Doubly Curved Shells Embedded With Damping Layer

By Zhai, YC (Zhai, Yanchun) [1] ; Li, SC (Li, Shichen) [2] ; Zhang, XX (Zhang, Xiaoxue) [1] (provided by Clarivate) **Source INTERNATIONAL JOURNAL OF STRUCTURAL STABILITY AND DYNAMICS DOI 10.1142/S0219455426502652 Early Access APR 2025 Indexed 2025-05-09 Document Type Article; Early Access**

Abstract

This paper presents an analysis of the vibration performance of composite shells with doubly-curved shapes embedded with a damping layer. First, the geometric equation and governing equation of composite sandwich doubly curved shells (CSDCSs) are deduced using the first-order shear shell theory and Hamilton's principle. Subsequently, the Navier solution is applied to solve the deduced governing equation of CSDCSs, and the findings obtained by ANSYS are used to validate the validity and accuracy of the solutions. Finally, this paper graphically provides the vibration performance of CSDCSs with the structural as well as the physical parameters, as follows: With the change of the thickness ratio of the upper and lower layers, the frequency of hyperbolic shell decreases and then increases, while the loss factor increases and then decreases. As the aspect ratio rises, the frequency and loss factor of the spherical shell gradually decrease; the frequency of the parabolic shell shows a trend of gradually decreasing, while the loss factor shows a trend of increasing. Increasing the length-to-radius ratio, the loss factor decreases significantly, but the frequency only decreases slightly. When the shear coefficient takes a value greater than a certain value, CSDCSs can obtain both a better structural stiffness and a larger loss factor.

Keywords
Author Keywords
Dynamic propertydoubly curved shellscomposite sandwich structurevibration frequencyloss factor

Keywords Plus
3-LAYER

Vibration

3-Nonlinear vibration of rotor-bearing system considering base-motion and bearing-misalignment

By Guan, H (Guan, Hong) [1] ; Ma, H (Ma, Hui) [1] , [2] ; Chen, X (Chen, Xi) [3] ; Mu, QQ (Mu, Qinqin) [4] ; Zeng, Y (Zeng, Yao) [5] ; Chen, YY (Chen, Yanyan) [5] ; Wen, BC (Wen, Bangchun) [1] ; Guo, XM (Guo, Xumin) [1] , [2] (provided by Clarivate) Source MECHANISM AND MACHINE THEORY Volume 206 DOI 10.1016/j.mechmachtheory.2025.105933 Article Number 105933 Published APR 2025 Early Access JAN 2025 Indexed 2025-02-07 Document Type Article

Abstract

The rotor system may be subjected to base motion excitation in addition to unbalanced excitation. Moreover, bearing loads can be simultaneously influenced by the base motion and bearing misalignment caused by assembly errors, potentially causing excessive axial load. To study the vibration characteristics of rotors and the contact characteristics of bearings, a new bearing contact force model of the misaligned angular contact ball bearing is proposed and the proposed bearing model is verified by the measured vibration acceleration responses. Incorporating both base motions and bearing misalignment, a dynamic model of a rotor-bearing system is established. The findings reveal that as the rotating speed of the base increases, the amplitude of the variable compliance vibration frequency of the bearing gradually increases because the base motion intensifies the variable compliance vibration of the bearing and some harmonic frequencies and combined frequencies can be observed. Additionally, base motion significantly amplifies the axial force of the bearing, with the axial load rising by approximately 28 times compared to the system without base motion excitation. Both the base motion and bearing misalignment can change the contact zone for the bearing and base motion can cause the ball and raceway to always maintain contact.

Keywords
Author Keywords
Rotor-bearing systemBearing assembly errorBearing contact characteristicsNonlinear vibrationBase motion

Keywords Plus
DYNAMIC-BEHAVIORANGULAR MISALIGNMENTCRACKED ROTORLOAD

Vibration

4-Customized quasi-zero-stiffness metamaterials for ultra-low frequency broadband vibration isolation

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By Liu, J (Liu, Ji) [1] ; Wang, YH (Wang, Yanhui) [1] , [2] ; Yang, SQ (Yang, Shaoqiong) [1] , [2] ; Sun, TS (Sun, Tongshuai) [1] , [2] ; Yang, M (Yang, Ming) [1] , [2] ; Niu, WD (Niu, Wendong) [1] , [2] (provided by Clarivate) **Source INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES Volume 269 DOI 10.1016/j.ijmecsci.2024.108958 Article Number 108958 Published MAY 1 2024 Early Access JAN 2024 Indexed 2024-03-08 Document Type Article**

Abstract

Quasi-zero-stiffness (QZS) metamaterials play an important role in ultra-low frequency vibration mitigation. In this study, a customized QZS metamaterial is proposed to isolate ultra-low frequency broadband vibration and its isolation performance is verified. A representative unit cell (RUC) that satisfies both optimal QZS performance and minimum size is designed for the metamaterial and optimized by matching the parameters of positive stiffness heart-shaped beam with the properties of negative stiffness cosine beam. Then, a new composite structure with multiple RUCs is designed by matching the optimal mass block for each RUC to meet the vibration isolation requirements of ultra-low frequency and broadband. The transmissibility test is performed, and the isolator made of the metamaterial is then integrated into an underwater glider to test the vibration isolation performance. The results show that the proposed QZS metamaterial can isolate broadband vibrations of 3.2 to 60 Hz and the isolator can attenuate the vibration signals of gliders to the background noise in air and water. Therefore, the customized metamaterial can be used in the engineering case of ultra-low frequency broadband vibration isolation and the design method of the metamaterial can be used for reference by other equipment.

Keywords
Author Keywords
Quasi-zero-stiffnessMetamaterialUltra-low frequencyBroadbandVibration isolation

Keywords Plus
NONLINEAR ISOLATORTURBULENCEREDUCTIONTRANSMISSIBILITYPERFORMANCEVEHICLESYSTEMPROBEBEAMSEA

Vibration

5-A digital twin methodology for vibration-based monitoring and prediction of gear wear

By Feng, K (Feng, Ke) [1] , [2] ; Xiao, HL (Xiao, Huili) [1] , [2] ; Zhang, JC (Zhang, Jiachang) [1] , [2] ; Ni, Q (Ni, Qing) [3] (provided by Clarivate) Source WEAR Volume 571 DOI 10.1016/j.wear.2025.205806 Article Number 205806 Published JUN 15 2025 Early Access JUN 2025 Indexed 2025-06-20 Document Type Article

Abstract

The process of gear wear is a complex phenomenon, and multiple effects will lead to non-uniform wear propagation rates in the tooth profile alone. As a result, current model-based methods cannot produce features that account for non-uniform wear propagation rates, leading to an inaccurate representation of the actual tooth profile. This limitation negatively impacts the accuracy of predicting gear wear progression. This paper proposes a digital twin methodology for monitoring and predicting gear wear to overcome this challenge. More specifically, in the proposed digital twin methodology, the geographical distribution of the wear coefficient is introduced with the utilization of a series of scale coefficients and a shape function, and then feed the generated wear coefficient into the well-known Archard wear model to indicate the non-uniform wear propagation rate alone the tooth profile. Even though the actual tooth profile can be structured with the introduced geographical distribution, the wear coefficient varies throughout the gear wear process. To achieve accurate predictions of gear wear, it is essential to update the wear coefficient timely as the wear progresses. Thus, a "grey box" approach is used to estimate the wear coefficient, updating the scale coefficients using measurements obtained from the physical systems. The gear wear process can be effectively monitored by continuously updating the gear wear model. This approach allows for accurately predicting the remaining useful life at any given time. The paper illustrates the ability and effectiveness of the proposed digital twin methodology in wear progradation prediction using measurements from a laboratory gear rig.

Keywords

Author Keywords

Gear wearDigital twinWear monitoringWear coefficientWear progradation prediction

Keywords Plus

SPUR GEAR

Vibration

6-Vibration control of vehicle ISD suspension based on the fractional-order SH-GH stragety

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By Shen, YJ (Shen, Yujie) [1] ; Li, JY (Li, Jinyuan) [1] ; Huang, RN (Huang, Rongnan) [1] ; Yang, XF (Yang, Xiaofeng) [2] ; Chen, JJ (Chen, Junjie) [3] ; Chen, L (Chen, Long) [1] ; Li, M (Li, Ming) [4] (provided by Clarivate) **Source MECHANICAL SYSTEMS AND SIGNAL PROCESSING Volume 234 DOI 10.1016/j.ymssp.2025.112880 Article Number 112880 Published JUL 1 2025 Early Access MAY 2025 Indexed 2025-06-02 Document Type Article**

Abstract

To further explore the beneficial effects of vehicle ISD (inerter-spring-damper) suspension, an optimal design approach grounded in the fractional-order SH-GH (skyhook-groundhook hybrid) control strategy is put forward in this paper. First, by incorporating fractional-order theory, the ideal SH-GH ISD suspension structure, comprising both integer-order and fractional-order elements, is derived. After obtaining key parameters using the improved simulated annealing optimization algorithm, simulation results indicate that the S2 (Fractional-order) outperforms others in the SH-GH ISD suspension structures. Subsequently, a dynamics model for the actual S2 (Fractional-order) 1/4 vehicle suspension is developed and designated as the reference model. The controllable ISD suspension (Fractional-order) incorporating a mechatronic inerter is chosen as the controlled model, and a model reference adaptive controller is devised to accurately track the reference model. Finally, a specialized suspension test bench is employed to evaluate the performance of the controllable ISD suspension system. Under sinusoidal road input, the controllable ISD suspension (Fractional-order) demonstrates a reduction in the RMS values of both vehicle body acceleration and dynamic tire load across both low-frequency and high-frequency bands. Under random road input, the controllable ISD suspension (Fractional-order) demonstrates a significant reduction in the RMS value of vehicle body acceleration when compared to passive suspension. The experimental results outperform those of controllable ISD suspension (Integer-order) under both sinusoidal road input and random road input conditions. The results indicate that fractional-order SH-GH control can further enhance the vibration suppression capability of the vehicle ISD suspension.

Keywords

Author Keywords

Vehicle ISD suspensionMechatronic inerterFractional-order theorySkyhook-groundhook hybrid control

Keywords Plus

SEMIACTIVE CONTROLACTIVE SUSPENSIONMECHANICAL NETWORKSGROUND-HOOKDESIGNIMPROVEMENTSTABILITYINERTERSAFETYDYNAMICS

Vibration

7-Research on vertical vibration characteristics of rolling mill based on magnetorheological fluid damper absorber

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By He, DP (He, Dongping) [1] , [2] ; Xu, HD (Xu, Huidong) [1] , [2] ; Wang, YP (Wang, Yiping) [1] , [2] ; Wang, M (Wang, Ming) [1] , [2] ; Duan, ZH (Duan, Ziheng) [1] , [2] ; Yang, N (Yang, Nan) [1] , [2] ; Wang, T (Wang, Tao) [1] , [2] (provided by Clarivate) **Source MECHANICAL SYSTEMS AND SIGNAL PROCESSING Volume 224 DOI 10.1016/j.ymssp.2024.112203 Article Number 112203 Published FEB 1 2025 Early Access DEC 2024 Indexed 2025-02-13 Document Type Article**

Abstract

The study of rolling mill vibration theory has always been a scientific frontier in the field of rolling forming, which is very important to the quality of sheet metal and the stable operation of equipment. A magnetorheological fluid damper absorber is designed to control the nonlinear vertical vibration of rolling mill. Considering the fractional order and delay factors in the control effect of magnetorheological fluid, the fractional order delay nonlinear vertical vibration equation with magnetorheological damping damper is established. The amplitude-frequency characteristic equations of the main resonance and sub-resonance of the system are solved by multi-scale method. The effects of stiffness coefficient, damping coefficient, time delay, fractional order, and exciting force on the vibration characteristics of roller system are analyzed by comparing the amplitude-frequency curve, time-domain curve and phase diagram. The transition set of the steady-state response of the system and the corresponding bifurcation topology structure are analyzed by using the singularity theory. A magnetorheological fluid damper absorber platform of rolling mill is built based on modern test technology, and the influence laws of the control threshold, control current, type of magnetorheological fluid and reduction rate are analyzed. The correctness and feasibility of the design of the magnetorheological fluid damper absorber are verified, which provided theoretical guidance and technical support for the nonlinear dynamic analysis and stability control of the rolling mill.

Keywords
Author Keywords
Rolling millNonlinear vertical vibrationMagnetorheological fluid damper absorberAmplitude-frequency characteristicsVibration reduction control

Keywords Plus
DYNAMIC-MODELCHATTERSUSPENSIONSYSTEM

Vibration

8-Vibration Suppression of the Vehicle Mechatronic ISD Suspension Using the Fractional-Order Biquadratic Electrical Network

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By Shen, YJ (Shen, Yujie) [1] ; Li, ZW (Li, Zhaowei) [1] ; Tian, X (Tian, Xiang) [1] , [2] ; Ji, K (Ji, Kai) [1] ; Yang, XF (Yang, Xiaofeng) [3] (provided by Clarivate) **Source FRACTAL AND FRACTIONAL Volume 9 Issue 2 DOI 10.3390/fractalfract9020106 Article Number 106 Published FEB 2025 Indexed 2025-03-05 Document Type Article**

Abstract

In order to break the bottleneck of the integer-order transfer function in vehicle ISD (inerter-spring-damper) suspension design, a positive real synthesis design method of vehicle mechatronic ISD suspension based on the fractional-order biquadratic transfer function is proposed. The emergence of the fractional-order components disrupts the equivalence relationship between the passivity of components and the positive realness of integer-order transfer functions in traditional networks. In this paper, the positive real condition of the fractional-order biquadratic transfer function is given. Then, a quarter dynamic model of the vehicle mechatronic ISD suspension is established, and the parameters of the fractional-order biquadratic transfer function and vehicle suspension are obtained by an NSGA-II multi-objective genetic algorithm. Moreover, the structure of the external circuit and the parameters of the electrical components are obtained by the fractional-order passive network synthesis theory. The simulation results show that under the condition of random road input and vehicle speed of 20 m/s, the root-mean-square (RMS) value of the vehicle body acceleration and the dynamic tire load of the fractional-order ISD suspension are reduced by 7.98% and 18.75% compared with the traditional passive suspension, while under the same condition, the integer-order ISD suspension can only reduce by 5.34% and 16.07%, respectively. The results show that employing a fractional-order biquadratic electrical network in the vehicle mechatronic ISD suspension enhances vibration isolation performance compared with the suspension using an integer-order biquadratic electrical network.

Keywords

Author Keywords

vehicle suspensionmechatronic inerterpositive real synthesisfractional-order biquadratic transfer function

Keywords Plus

MULTIOBJECTIVE OPTIMIZATIONMECHANICAL NETWORKSSERIESEXCITATIONELEMENTSDESIGNMOTOR

Vibration

9-Analysis of vortex-induced vibration in flexible risers using a physically-meaningful wake-oscillator model

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By Yang, QS (Yang, Qingshan) [1] ; Zeng, XR (Zeng, Xiaorong) [1] ; Guo, KP (Guo, Kunpeng) [1] ; Cao, SY (Cao, Shuyang) [2] ; Wei, K (Wei, Kai) [3] ; Shan, WS (Shan, Wenshan) [1] ; Tamura, Y (Tamura, Yukio) [1] (provided by Clarivate) Source ENGINEERING STRUCTURES Volume 325 DOI 10.1016/j.engstruct.2024.119415 Article Number 119415 Published FEB 15 2025 Early Access DEC 2024 Indexed 2025-01-05 Document Type Article

Abstract

Flexible riser is prone to vortex-induced vibration (VIV), which can cause fatigue problems, making it essential to accurately estimate the VIV of the riser. The empirical wake-oscillator model is frequently used for VIV analysis, while the accuracy of the predicted response is not satisfactory in some cases, mainly due to its reliance on empirical parameters. To address these limitations, this study employs the wake-oscillator model developed by Tamura and Matsui, which provides a more explicit physical interpretation. Firstly, a set of interrelated partial differential equation is derived by integrating the wake-oscillator equations that characterize the flow with the structural motion equation that represent the riser's movement. The effectiveness of the proposed method is validated by comparing the predicted outcomes (the displacement, dominant mode, and dominant frequency) with field and tank experiments. Additionally, space-time evolutions and spectral analysis were performed, and the energy conversion between the riser and the flow was examined to comprehend the physical mechanism of VIV of riser. Based on this, it was found that VIV of riser simultaneously exhibits traveling wave and standing wave characteristics. And there were also both mono-frequency and multi-frequency phenomena. Overall, the physically-meaningful model can accurately simulate the CF response of flexible riser, providing essential references for estimating its fatigue life, design, and operation of flexible risers.

Keywords

Author Keywords

Flexible riserVortex-induced vibrationWake-oscillator modelCentre different methodCross-flow response

Keywords Plus

FLOWVIVPREDICTIONCYLINDERUNIFORMWAVES

Vibration

10-Vibration reduction study of a simplified floating raft system by installing connecting nonlinear spring-mass systems

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By Mi, XH (Mi, Xiaohong) [1] , [2] ; Zhao, YH (Zhao, Yuhao) [2] ; Zhan, QC (Zhan, Qingchuan) [2] ; Chen, MF (Chen, Mingfei) [1] (provided by Clarivate) Source THIN-WALLED STRUCTURES Volume 210 DOI 10.1016/j.tws.2025.113015 Article Number 113015 Published MAY 2025 Early Access JAN 2025 Indexed 2025-02-13 Document Type Article

Abstract

In marine engineering, some floating raft systems typically can be simplified as coupling plate structures in analyzing their vibration characteristics due to their structural characteristics, where they contain additional installation space between each sub-structure. Nonlinearities studied in the existing study can be designed as coupling elements to connect each sub-structure of the floating raft systems, which may play a positive influence on the vibration control of the floating raft systems. Against this background, this work proposes a theoretical vibration model of a simplified floating raft system (SFRS) attached to connecting nonlinear spring-mass systems (CNSMSs). Based on the correct results, vibration responses of SFRS attached to CNSMSs are studied. According to the numerical analysis, CNSMSs present multi-frequency vibration restraining characteristics, where the vibration of each subplate can be concurrently restrained by reasonably using CNSMS. Reasonable parameters of CNSMS are good for the vibration restraining of SFRS under resonance regions. Unreasonable parameters motivate complicated responses of SFRS. Furthermore, the vibration of each subplate can be concurrently restrained by reasonably using CNSMS. The introduction of CNSMSs provides a possible way to restrain the vibration of SFRS.

Keywords
Author Keywords
Nonlinear behaviorFloating raft systemsVibration suppressionNonlinear system

Keywords Plus
STEADY-STATE DYNAMICSAXIALLY MOVING BEAMRECTANGULAR-PLATESENERGY SINKTRANSVERSAL VIBRATIONSLOADS

Vibration

11-A sound-vibration physical-information fusion constraint-guided deep learning method for rolling bearing fault diagnosis

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By You, KS (You, Keshun) [1] ; Wang, PZ (Wang, Puzhou) [1] , [2] ; Huang, P (Huang, Peng) [1] ; Gu, YK (Gu, Yingkui) [1] (provided by Clarivate) **Source RELIABILITY ENGINEERING & SYSTEM SAFETY Volume 253 DOI 10.1016/j.ress.2024.110556 Article Number 110556 Published JAN 2025 Early Access OCT 2024 Indexed 2024-11-06 Document Type Article**

Abstract

Although current deep learning models for bearing fault diagnosis have achieved excellent accuracy, the lack of constraint-guided learning of the physical mechanisms of real bearing failures and a physically scientific training paradigm leads to low interpretability and unreliability of intelligent fault diagnosis models. In this study, a sound-vibration physical-information fusion constraint-guided (PFCG) deep learning (DL) method is proposed, aiming at weighted fusion of sound and vibration multi-physical information into a deep learning model, to guide the DL model to learn more realistic physical laws of bearing failure. Firstly, a 15-degree-of-freedom nonlinear dynamics model of multi-stage degraded bearing failure mechanism with sound-vibration response is developed, which considers the evolutionary mechanism of bearing failure from healthy state to different stages, and utilizes a particle filtering algorithm for dynamic calibration of hidden parameters. Moreover, a lightweight DL fault diagnosis model is designed to realize the deep interaction between the physical model and the DL model through the weighted fusion of the cross-entropy loss function, physical consistency loss and uncertainty loss. Moreover, the superior diagnostic performance of the proposed sound and vibration PFCG-DL model is verified by comparing the performance fluctuations and parameter attributes of different DL benchmark models before and after being guided by physical information fusion constraints (PFCG). Eventually, the proposed PFCGTransformer model achieves a diagnostic accuracy of 99.45% while keeping the number of parameters at only 0.62M, which significantly improves the accuracy and reduces the computational complexity by 81.5% compared to the CAME-Transformer model's 3.24 M number of parameters and 95.00% diagnostic accuracy. In addition, the test time of PFCG-Transformer is reduced to 1.02 s, which is 60.2% less than CAME-Transformer, demonstrating higher computational efficiency and real-time performance. Importantly, in terms of interpretability, the engineering interpretability and credibility of the models are further improved by visualizing the feature learning results of the vibration modal and multimodal fusion models and the sensitivity analyses of the sound-vibration response models with internal and external physical hyperparameters. Therefore, this study proposes a physical information-guided deep learning method with strong interpretability and superior performance, which provides an important reference for further research and application in the field of bearing fault diagnosis.

Keywords

Author Keywords

Sound-vibrationPhysical-information fusion constraint-guidedDeep learningEngineering interpretabilityBearing fault diagnosis

Keywords Plus

NETWORKS

Vibration

12-Free vibration analysis of Bi-Directional Functionally Graded Beams using a simple and efficient finite element model

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By Belabed, Z (Belabed, Zakaria) [1] , [2] ; Tounsi, A (Tounsi, Abdeldjebbar) [2] , [3] ; Bousahla, AA (Bousahla, Abdelmoumen Anis) [4] ; Tounsi, A (Tounsi, Abdelouahed) [5] , [6] ; Bourada, M (Bourada, Mohamed) [2] ; Al-Osta, MA (Al-Osta, Mohammed A.) [6] , [7] (provided by Clarivate) **Source STRUCTURAL ENGINEERING AND MECHANICS Volume 90 Issue 3 Page 233-252 DOI 10.12989/sem.2024.90.3.233 Published MAY 10 2024 Indexed 2024-06-29 Document Type Article**

Abstract

This research explores a new finite element model for the free vibration analysis of bi-directional functionally graded (BDFG) beams. The model is based on an efficient higher -order shear deformation beam theory that incorporates a trigonometric warping function for both transverse shear deformation and stress to guarantee traction -free boundary conditions without the necessity of shear correction factors. The proposed two -node beam element has three degrees of freedom per node, and the inter -element continuity is retained using both C1 and C0 continuities for kinematics variables. In addition, the mechanical properties of the (BDFG) beam vary gradually and smoothly in both the in -plane and out -of -plane beam's directions according to an exponential power -law distribution. The highly elevated performance of the developed model is shown by comparing it to conceptual frameworks and solution procedures. Detailed numerical investigations are also conducted to examine the impact of boundary conditions, the bi-directional gradient indices, and the slenderness ratio on the free vibration response of BDFG beams. The suggested finite element beam model is an excellent potential tool for the design and the mechanical behavior estimation of BDFG structures.

Keywords

Author Keywords

bi-directional functionally graded beamexponential power-lawfinite element formulationfree vibrationhigher-order shear deformation theory

Keywords Plus

BERNOULLI NANO-BEAMSBENDING ANALYSISBUCKLING ANALYSISFG BEAMSELASTICITYSTABILITY

Vibration

13-Nonlinear free vibrations of a nanocomposite micropipes conveying laminar flow subjected to thermal ambient: Employing invariant manifold approach

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By Zhang, PJ (Zhang, Peijun) [1] , [2] ; Shao, WC (Shao, Wenchen) [1] ; Arvin, H (Arvin, Hadi) [3] , [4] ; Chen, W (Chen, Wen) [1] ; Wu, WJ (Wu, Wenjing) [1] (provided by Clarivate) **Source JOURNAL OF FLUIDS AND STRUCTURES Volume 135 DOI 10.1016/j.jfluidstructs.2025.104311 Article Number 104311 Published JUN 2025 Early Access JUN 2025 Indexed 2025-04-04 Document Type Article**

Abstract

This research presents, for the first time, essential insights into the free vibrations of a composite micropipe enriched by means of graphene sheets (a GRC micropipe) conveying laminar flow subjected to a thermal ambient, preparing precious discernment for designers and engineers. The study develops the governing equations in the framework of the Euler-Bernoulli beam theory, the modified couple stress theory (MCST), von-Karman nonlinear relations for strains, and revised Halpin-Tsai relationships. Taking the advantage of invariant manifold procedure the two-degrees-of-freedom (DOFs) discretized governing equations, coupled gyroscopically, are reduced efficiently to one nonlinear governing equation with inertial nonlinearity that coping with it is considerably simpler. Leveraging the method of multiple scales (MMS) the nonlinear natural frequency, along with the accompanying nonlinearity constant is disclosed. It is underscored that the contribution of layer stacking on the vibrational behavior of GRC micropipes carrying laminar flow is substantially highlighted when the GRC micropipe is subjected to a thermal medium. It is observed that although it is expected to have a larger fundamental linear natural frequency for an FGV GRC micropie, at low temperatures UD GRC micropipe has the largest one for thin micropipes. It is shown that the hardening behavior of the first mode of the GRC micropipe is alleviated regarding the small scale factor while it is intensified regarding the flow profile effect. In sum imposing both factors relieves the first mode hardening behavior.

Keywords

Author Keywords

Micropipe conveying flowInvariant manifoldLaminar flowGraphene sheet scattering prototypeThermal ambient

Keywords Plus

FLUIDSTABILITYPIPESBEAMS

Vibration

14-Interval riccati equation-based and non-probabilistic dynamic reliability-constrained multi-objective optimal vibration control with multi-source uncertainties

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By Yang, C (Yang, Chen) [1] (provided by Clarivate) Source JOURNAL OF SOUND AND VIBRATION Volume 595 DOI 10.1016/j.jsv.2024.118742 Article Number 118742 Published JAN 20 2025 Early Access OCT 2024 Indexed 2024-10-23 Document Type Article

Abstract

Structural vibration control is used to ensure the safety of structures in service and has become an active research area in the past few years. In this study, uncertainties in structural dynamics are considered to propose an interval linear quadratic regulator (LQR) method based on an interval Riccati equation. Multi-objective optimization with non-probabilistic dynamic reliability as a constraint is performed to design an optimal uncertain vibration control system. To alleviate the difficulty of quantifying the probabilistic uncertainty and accurately characterize uncertainty information for small samples, multi-source uncertainties are regarded as interval parameters. The bounds on these uncertainties are determined, and the deterministic and uncertain parts of an interval state-space equation for vibration control are then formulated using an expanded-order matrix and the interval analysis method. Next, the interval perturbation method with a matrix series is used to develop a novel solution method for the linear inhomogeneous time-invariant equation in the interval state-space equation for the vibration control system and is used to accurately predict the interval bounds of the state responses. The conventional LQR method from modern control theory is used to propose a novel optimal control method based on a novel interval Riccati equation using the Lyapunov equation and interval uncertainty propagation. The proposed interval control method can be used to estimate the uncertain bounds of the controlled gain and cost function. A non-probabilistic dynamic reliability model is established to evaluate the reliability index of the system, which can overcome the limitations of the large computational cost of determining the probabilistic reliability. The deterministic controlled cost and uncertain states are considered as two optimization objectives with the proposed reliability constraint. The resulting constrained multi-objective optimal vibration control problem is designed and solved using c-DPEA. A flowchart is presented as a clear overview of the uncertain vibration control method, and the effectiveness of the proposed method is validated using two numerical examples. Different optimal control designs are obtained using different reliability constraints for quantitatively analyzing the safety of the control system.

Keywords
Author Keywords
interval Riccati equationoptimal vibration controlinterval state-space equationmulti-objective optimizationnon-probabilistic dynamic reliabilitymulti-source uncertainties

Keywords Plus
SYSTEMSOPTIMIZATIONALGORITHMMODEL

Vibration

15-Integrated uncertain optimal design strategy for truss configuration and attitude-vibration control in rigid-flexible coupling structure with interval uncertainties

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By Yang, C (Yang, Chen) [1] ; Wang, QS (Wang, Qingshuang) [2] ; Lu, WZ (Lu, Wanze) [2] ; Li, YY (Li, Yuanyuan) [3] (provided by Clarivate) **Source NONLINEAR DYNAMICS DOI 10.1007/s11071-024-10291-w Early Access OCT 2024 Indexed 2024-10-17 Document Type Article; Early Access**

Abstract

By simultaneously considering the supported truss configuration optimization and optimal attitude-vibration control in rigid-flexible coupling (RFC) structure, this study proposes a novel integrated uncertain optimal structure-control design strategy with interval uncertainties. Based on the principle of energy equivalence, the flexible support truss of the RFC structure is simplified using an equivalent beam model, which can significantly reduce the degree of freedom of the model and improve design efficiency on the premise of satisfying the analysis accuracy of the static and dynamic characteristics of the complete truss structure. The Lagrangian method is applied to establish an RFC structure model including a central rigid body, equivalent flexible truss and free end mass. Given the difficulty of quantifying the multi-source uncertainty encountered by actual RFC structures, the structural optimization and control system design in this study considers them as interval uncertainty. As long as the uncertainty bounds are known, the uncertainty propagation in the integrated design strategy can be quantified using interval dimension-wise analysis. The time-independent interval reliability-based frequency constraint and time-dependent interval reliability-based dynamic response constraint are both constituted for the proposed integrated uncertain optimal design strategy, which is solved using an advanced multi-objective optimization algorithm. One numerical example is applied to verify the proposed method. An optimum integrated design layout with a lightweight truss configuration and a low energy consumption control system is obtained.

Keywords

Author Keywords

Rigid-flexible coupling structureEquivalent beam modelUncertain optimal attitude-vibration controlTruss configuration optimizationInterval dimension-wise analysisIntegrated uncertain optimal design strategy

Keywords Plus

OPTIMIZATION