Volume 33, Issue 1, Page 129-136, Research Note

• Received 10 May 2015; received in revised form 13 December 2015; accepted 1 March 2016.

Abstract

In the present study, a comprehensive thermodynamic modeling and optimization of CGAM problem is presented. The CGAM problem refers to a cogeneration plant which delivers 30 MW of electricity and 14kg/s of saturated steam at 20 bar. The installation consists of a gas turbine followed by an air preheater that uses part of the thermal energy of the gases leaving the turbine, and a heat-recovery steam generator in which the required steam is produced. This system is composed of air compressor, combustion chamber (CC), Air Preheater, Gas Turbine (GT), and a Heat Recovery Heat Exchanger. In this paper, at the first stage, each part of the system is modeled using thermodynamic laws; and next, with by applying economic functions, the optimization of this problem is performed. For optimization, objective functions includes the total cost rate of the system product. The environmental conditions are defined as T0 = 298.15K and P0 = 1.013 bar. The fuel for the total plant is natural gas (taken as methane) with a lower heating value (LHV) which is equal to 50000 kJ/kg. And then, solve the problem which is formulated as a set covering problem by Genetic algorithm and PSO algorithm is solved. In the end of this article, we compare these solving approaches (Genetic and PSO algorithms) to know which of them are working efficiently. The design parameters of this cycle are compressor pressure ratio (r_{AC}), compressor isentropic efficiency (η_{AC}), GT isentropic efficiency (η_{GT}) , CC inlet temperature (T_3), and turbine inlet temperature (T_4). After reviewing the results of the two algorithms, it is showed that both algorithms which to optimize the results are almost identical. However, the PSO algorithm is simple to implement and more flexible in programmingand convergence rate than compared to the capability of Genetic algorithm is capable. The results show that the PSO algorithm is more efficient than Genetic algorithm in solvinge CGAM problem.

Key Words: PSO algorithm, genetic algorithm, optimization, CGAM problem.

AN INVESTIGATION ON THE EFFECT OF GRAPHENE NANO-PLATE ON PERFORMANCE OF A SHAPE-MEMORY-POLYMER BASED NANOCOMPOSITE

M. Baghani(corresponding author)
baghani@ut.ac.ir
M. Baniassadi
m.baniassadi@ut.ac.ir
School of Mechanical Engineering
University of Tehran

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 137-145, Research Note

• Received 16 January 2016; received in revised form 20 April 2016; accepted 21 June 2016.

Abstract

Shape memory polymers are a class of multi-phase smart materials which have the ability to return from a deformed state (temporary or fixed shape) to their original (or permanent) shape, called as shape memory effect, (or recovery) under different thermo mechanical cycles, e.g., fixed strain stress recovery and fixed stress strain recovery. Due to their unique behavior, shape memory polymers have many applications in industry areas. Shape memory polymers have been researched, developed, and utilized in a wide range of applications such as advanced technologies in the aerospace, medical and oil exploration industries. Moreover, shape memory polymers have a promising future for application in sensors, actuators and smart devices. However, applications of shape memory polymers are restricted by their low strength. Different techniques are employed to eliminate such restrictions. Among them, addition of micro and/or nano-particles is a common practice. In this study, a numerical method, based on 3D finite element method, is introduced to investigate the effect of nanoparticles on mechanical properties (e.g., the mechanical strength) and performance of shape memory polymer nano-composites. The non-linear behavior of shape memory polymers is described through employing a recently proposed visco-hyper-elastic constitutive model, and the nano-composite is simulated in the framework of the nonlinear finite element method. Effects of different volume fractions and aspect ratios of the nanoparticles are investigated, and the results are presented in the form of stress strain temperature diagrams. According to the produced results, increasing the volume fraction and/or aspect ratio increases the generated elastic stress and the recovered stress. In addition, adding up to 3 percent of nano-particle volume fraction and applying strains up to 20 percent would not disrupt the performance of the material, while remarkably enforce the shape memory polymer based nano-composite.

Key Words: Shape memory polymer nanocompos- viscoelastic modeling, finite element method, graphene nanoplat.

is based on traditional safe-life design methodology that uses special S-N curves obtained from specimens containing some defects (flaws). Damage tolerance requires that the structures retain, after a partial failure, the capability to withstand the limit load. Fault tolerance is a new damage tolerance design method which is based on equivalent initial flaw-sized concept.
Since 1989, the Airworthiness Regulation evolved towards the application of Damage Tolerance principles to rotorcraft. This change forced the helicopter industries to review their design methodologies and to face new problems, linked with fracture mechanics applications to their typical structures.
In this paper, various approaches to helicopter fatigue design are reviewed, and the advantages and disadvantages of each method are discussed. Then, different methods of helicopter fatigue design are compared. At the end, other aspects of helicopter fatigue design, such as influence of material on helicopter fatigue design, fatigue design of helicopter components against impact loads, and conducting tests in relation to the helicopter fatigue design are all discussed.

Key Words: Helicopter fatigue, fatigue design, helicopter fatigue life, helicopter fatigue approaches.

INVERSE KINEMATICS AND MOTION PLANNING OF A REDUNDANT MANIPULATOR ROBOT IN AN UNKNOWN ENVIRONMENT USING FUZZY CONTROL

M. Karimi(corresponding author)
karimi_mh@yahoo.com
A. Dadsetan
amin.dadsetan7@gmail.com
Faculty of Mechanical Engineering
Bu Ali Sina University, Hamedan

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 121-127, Research Note

- Received 6 May 2015; received in revised form 6 December 2015; accepted 8 February 2016.

Abstract
In this paper, a novel technique is presented for inverse kinematics and motion planning of a redundant manipulator robot in an environment with unknown obstacles using a fuzzy controlling is presented. Kinematic redundancy occurs when a manipulator possesses more degrees of freedom than the minimum number required for executing a given task. Redundancy enhances the manipulator dexterity and flexibility which allows the redundant robot to move faster and safer in the environment without colliding with obstacles. In order to avoid colliding with obstacles, a high degree of freedom robot was used. Due to high degree of freedom, inverse kinematics of redundant robots is very difficult, thus a general approach to motion planning of a redundant manipulator robot is very practical and valuable. It was inspired that a human arm is capable of avoiding colliding obstacles. Therefore, in this paper, direct control of end effector position of manipulator using a multi- behavior fuzzy controller, inspired by behavior of human arm, makes a practical method to the navigation of redundant manipulator robots. In this method, the control of every link is independent from the degree of freedom of robot; the number of input and output signals are constant. Fuzzy controller system used in this research is a combination of three fuzzy controllers, which deals with a separate behavior of redundant robot. The main objective is still to avoid the obstacles and flexion and extension of arm. The final behavior of redundant robot is a combination of these behaviors. For illustration, some simulation results of redundant planar manipulator moving in an unknown environment is presented. Results were prepared by a Simulink model containing fuzzy control subsystems, sensor, actuators, and obstacles. The simulation and experimental results of three and six link planar manipulators in environment with one obstacle and without obstacle show a good and promising performance of the robot.

Key Words: Motion planning, redundant robot, fuzzy control, unknown environment.

COMPARISON OF PARTICLE SWARM OPTIMIZATION AND GENETIC ALGORITHM FOR OPTIMIZATION OF CGAM PROBLEM

M. Karimi
karimi_mh@yahoo.com
B. Ahrar Yazdi(corresponding author)
b.ahrar92@basu.ac.ir
Dept. of Mechanical Engineering
Bu-Ali Sina University, Hamedan
B. Ahrar Yazdi
behnam.ahrar@yahoo.com
Dept. of Mechanical Engineering
Science and Research Branch
Islamic Azad University, Arak

Sharif Mechanical Engineering Journal

HARDWARE IMPLEMENTATION OF NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS ON FPGA

F. Farhani Baghlani(corresponding author)
f.farhani@irost.ir
Dept. of Mechanical Engineering
IROST
A. Ebrahimi Chamgordani
ebrahimi_a@ae.sharif.edu
Dept. of Aerospace Engineering
Sharif University of Technology
A. Nikravan Shalmani
nikravan@irost.ir
Dept. of Mechanical Engineering
IROST

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 93-99, Original Article

- Received 5 March 2016; received in revised form 2 July 2016; accepted 19 July 2016.

Abstract

Nowadays, CPUs and GPUs are used in computations pertaining to numerical solution of differential equations. However, the fixed hardware architecture of CPUs and GPUs makes it difficult to optimally implement many numerical solution algorithms. In recent years, a new method, based on hardware implementation of equations using Field Programmable Gate Array (FPGA), has been given much attention. The unique feature of this approach is the ability to vary the hardware architecture on the basis of the solution algorithm, which results in increased solution speed and a reduction in power consumption. This methodology, in which hardware can vary from one architecture to another for computing purpose is named Reconfigurable Computing (RC). RC can be used to solve a lot of problems such as FEM, FVM with structured or unstructured mesh. In this research, typical problems, such as mass-spring systems and wave equations, have been considered, and hardware implementation on FPGA has been used to solve the resulting differential equations. For modeling these systems, we used the software and hardware which is accessible to us, so we used a domestic FPGA board and MatLab and Xilinx ISE software products. Based on the results, advantages and challenges for hardware implementation of differential equations have been presented. Results for a single element mass-spring system show a comparable solution speed for CPU and FPGA implementation. However, with an increase in the number of elements of the mass-spring system, for example, to 6, the FPGA hardware implementation overtakes CPU and the speed of FPGA becomes almost 8 times that of CPU. Moreover, results of the solution of wave equations show that the speed with FPGA implementation is 3.6 times that of CPU. Therefore, for higher numbers of computational elements, results show the superior process speeds attainable with hardware implementation of equations using FPGA compared to the software implementation on CPU.

Key Words: Reconfigurable computing, solution speed up, PDE, ODE.

DIFFERENT APPROACHES TO FATIGUE DESIGN OF COMPONENTS OF A HELICOPTER

A.R. Shahani(corresponding author)
shahani@kntu.ac.ir
S. Mohammadi
mec.mohammadi@gmail.com
Dept. of Mechanical Engineering
K.N. Toosi University

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 101-120, Rview Article

- Received 15 October 2013; received in revised form 21 June 2014; accepted 30 June 2014.

Abstract

Fatigue design of helicopter components has proven to be a difficult and challenging task. The purpose of the fatigue evaluation of helicopter components, especially the main rotor blade, is to show that catastrophic failure expectation during its service life due to fatigue is completely gone; in addition, occurrence of Non-catastrophic cracking remains low enough so that the economic use of the helicopter structure can be achieved. The fatigue design methodology, most commonly applied by the helicopter community, was based on the Safe-Life philosophy. In spite of safety and the overall success in helicopter applications, this method does not account for any component strength that deviates from the strength distribution assumption made during the fatigue substantiation process. In recent years, due to low efficiency of Safe-Life method, using other fatigue life analysis methods, such as flaw tolerance, damage tolerance, and fault tolerance, have been felt to be more necessary.

The Flaw Tolerant Safe-Life or Enhanced Safe-Life method provides component management requirements based on the assumption of the existence of flaws in the component's critical areas. This approach is adopted only in the helicopter community. Flaw Tolerant method

using the appropriate changing in the structure of a linear damper which results the damping coefficient of the proposed NDVD damper varies respect to the displacement and the velocity of damper piston. To this end, a solid cone shaped part is assembled in the interior region of the damper cylinder, which causes the fluid moves between the solid cone shaped part and inside the existing orifice on the piston. In fact, the movement of the piston results in changing the size of the gap where the fluid passes and the damping coefficient is consequently varied. In order to obtain more accurate modeling in the vibration analysis, the effect of momentum variation is also applied in the advised NDVD damper. The effect of momentum variation on the motion of a vibratory system equipped with a nonlinear displacement-velocity-dependent (NDVD) damper is elaborated and also compared with the previously published papers. In this paper, the governing equation of a mass-spring system equipped with the NDVD damper as the vibratory system is derived for three cases of free, forced and resonance vibration problems and solved by the numerical fourth-order Runge-Kutta method. The displacement profile, velocity profile, damping force and the force transmitted to the base of the system are evaluated for a mass-spring system equipped with the NDVD damper. In addition, these results for three cases of free, forced and resonance vibration problems are compared with the results obtained from the system equipped with a linear damper as well as the nonlinear displacement-dependent (NDD) damper presented in the previous works. The simulation results confirm that the recommended NDVD damper has much better performance in reducing of vibration in the system compared to the linear and NDD dampers.

Key Words: Free vibration; forced vibration; resonance vibration; nonlinear displacement-velocity-dependent damper; law of conservation of momentum.

THE STRUCTURE INTERACTION MODELING OF FLUID FLOW PATTERNS IN THE DIAPHRAGM PUMP

H. Bakhshayesh(corresponding author)
hbakhshayesh@shahroodut.ac.ir
A. Sarreshtehdari
sarreshtehdari@shahroodut.ac.ir
H. Fekri
fekri@nigc-khrz.ir
Dept. of Mechanical Engineering
Shahrood University of Technology

Sharif Mechanical Engineering Journal

Volume 33, Issue 1, Page 83-91, Original Article

- Received 16 January 2016; received in revised form 23 May 2016; accepted 8 June 2016.

Abstract

Diaphragm pumps are positive displacement pumps which have many applications in the petrochemical, and gas industries. As an example, Infusion pumps can be mentioned which are highly regarded in the gas industry due to the good resistance against chemical fluids. Since the diaphragm pumps are composed of various mechanical parts, some of which, such as the diaphragm, are in direct contact with the fluid, many different causes of mechanical damage are reported from some consumer companies such as Gas Company for this purpose, finding a model similar to the actual model is very useful. One of these pumps' design and manufacturing methods is using commercial codes for simulation rather sophisticated and expensive laboratory methods. Since the fluid in the pump is transmitted by a diaphragm motion, the concept called the fluid structure interaction is defined due to the problems related to simulations of fluid structure interaction, animated network simulation, and geometry of the pumps, limited deal of efforts has been done in the past for numerical analysis of these pumps. Today, with significant progress made in the development of computational systems and commercial codes, a good platform for the simulation of such problems is created. There are several methods for simulating fluid structure interaction problems; one-way method is selected for this simulation due to the small deformation of the diaphragm and flow fields in front of other aspects of the model pump. In order to reduce the size of the pump dimensional model calculations, this pump is simulated using ANSYS CFX commercial code. We have generated a model that could well show some parameters of this type of pump, and so, a more efficient model can be produced by reduced construction costs via future studies. One of the results of the presented method, is introducing one-way fluid structure interaction method as a suitable modeling method. The other results worthy of being mentioned are the study on the velocity and pressure fields, the effects of functional parameters such as engine speed and displacement diaphragm pump on stream, and other outcomes that are fully addressed in a season. In order to validate the model the boundary conditions of a real sample fluid injection pump, odorant in city gas company, is used; that after comparing the amount of output in terms of displacement diaphragm with the information contained in the pump catalog, in the worst case, error rate turns out to be 10%, and an average error is about 5%.

Key Words: Diaphragm pump, fluid structure interaction, ansys CFX.

of the second language academic words via the flexible proposed learning modes led to better vocabulary retention over time. The findings indicated that the students recognized more vocabulary for the recall test, given one month after the end of the training period. However, the results suggested that those received online instruction via computer-supported learning recalled vocabulary better when compared to their counterparts. The usability and convenience of the flexible proposed technology-enhanced learning modes support an overall positive response from university students. To conclude, technologies in use for English vocabulary learning promote long-term retention of vocabulary. It is, therefore, suggested that teacher education and training in the area of technology in use for second language vocabulary learning requires further research.

Key Words: Mobile learning, computer learning, dictionary-based learning, english vocabulary learning.

VIBRATIONAL ANALYSIS OF FUNCTIONALLY-GRADED MICRO-ROTORS WITH MASS ECCENTRICITY BASED ON THE COUPLE STRESS THEORY

M. Hashemi
mehdihashemi@mech.sharif.ir
M. Asghari(corresponding author)
asghari@sharif.edu
Dept. of Mechanical Engineering
Sharif University of Technology

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 63-71, Original Article

- Received 11 November 2015; received in revised form 12 March 2016; accepted 12 April 2016.

Abstract
In this paper, flexural vibration behavior of functionally graded micro-rotors with a mass eccentricity is investigated on the basis of the modified couple stress theory. The modified couple stress theory is a non-classical one which is capable to take into account the small-scale effects on micro-scale elements and structures with just one higher-order or non-classical material property. It should be noted that it has been experimentally verified that the classical continuum theory fails to properly simulate the mechanical behavior of small-scale flexible structures. The micro-rotor is composed of a flexible shaft and a disk at its middle. Here, the disk is assumed to have a mass eccentricity, which causes forced vibrations. Additionally, the shaft of the micro-rotor is assumed to be made of a functionally graded (FG) material with varying properties in the radial direction. In derivation of the formulation, both gyroscopic effects and rotary inertia are included. By setting the non-classical material property to zero, the formulation is reduced to the classical continuum formulation. Governing equations of motion of the micro-rotor in lateral motions as well as the general form of boundary conditions are derived with the aid of the Hamilton's principle. These equations are transformed into a partial differential equation utilizing complex functions. Next, based on the Galerkin method with two-mode truncation, analytical expressions for vibration characteristics of the micro-rotor, including first two natural frequencies in both forward and backward whirl motions, are obtained for the simply-supported cases. Moreover, the amplitude of the forced vibration of the micro-rotor in steady state condition is determined. The forced vibration is due to the mass eccentricity of the disk. With these analytical results in hand, it is an opportunity to evaluate the effect of non-classical material property on the vibrational characteristics of micro-rotors. These non-classical effects have been numerically investigated in an example provided.

Key Words: Micro-rotor, functionally graded materials, couple stress theory, free and forced vibration, eccentricity.

MODELING AND VIBRATION PERFORMANCE ANALYSIS OF A NONLINEAR DISPLACEMENT-VELOCITY-DEPENDENT DAMPER CONSIDERING THE EFFECT OF MOMENTUM VARIATION OF FLUID AT PISTON ORIFICE

R. Moalef Shahri
r.moalef@yahoo.com
J. Jahanpour(corresponding author)
jahanpourfr@mshdiau.ac.ir
Dept. of Mechanical Engineering
Mashhad Branch, Islamic Azad University

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 73-82, Original Article

- Received 16 December 2015; received in revised form 26 June 2016; accepted 19 July 2016.

Abstract
In this paper, vibration performance analysis of a nonlinear displacement-velocity-dependent (NDVD) damper is presented. The proposed NDVD damper is constructed

A. Sadough Vanini
sadough@aut.ac.ir
Dept. of Mechanical Engineering
Amirkabir University of Technology
N. Kordani (corresponding author)
naser.kordani@gmail.com
Dept. of Mechanical Engineering
University of Mazandaran
Gh. Eskafi
eskafi54@yahoo.com
Dept. of Mechanical Engineering
University of Kashan

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 49-54, Original Article

- Received 8 November 2015; received in revised form 29 December 2015; accepted 16 January 2016.

Abstract

Fluids can be divided into several classifications in terms of their viscosity behavior with relation to shear rate. One of these classes is the Newtonian fb02uids, which exhibit a constant viscosity with the increase of shear rate. The main feature of Shear Thickening Fluid)STF(exhibits an increased viscosity with the increase of shear rate. The shear thickening phenomenon occurs in most of the concentrated colloidal suspensions containing hard solid particles in fluid. The behavior of continuous phase has a significant impact on the properties of the STF. Due to the appearance of OH bonds on the surface of silica particles and also the appearance of this type of bond in the polyethylene glycol, the formation of hydrogen bonds. In this paper, glass fiber reinforced shear thickening fluid and shear thickening fluid with clay nanoparticles under quasi-static tests is investigated. A shear thickening fluid was prepared successfully and rheological behavior was was investigated. One of the disadvantages of shear thickening fluid (STF) is high concentration. To prepare shear thickening fluid polyethylene glycol as a base fluid and the silica nanoparticles is added slowly to the fluid. After to create shear thickening fluid clay nano particles are added to the fluid. Glass fabrics were soaked in STF/ethanol (1:3) solution to prepare STF-glass fabric composite and STF- nanoclay-glass composite. For better immersion of fibers, at first STF is diluted in ethanol, and then the fibers are left there in for a specified period in order to impregnate all fibers with the fluid. The composite's sensitivity to the impact will be reduced through ethanol combining with the fluid and its elimination. After this stage, to eliminate the ethanol in the sample, it is heated at a temperature range of $60-70^0C$. Quasi-static resistant tests were carried out on three modes the neat glass fabrics and STF- glass fabric and STF-nanoclay glass fabrics composites. The current study clearly displays a significant enhancement in penetration resistance of glass fabric impregnated with STF-nanoclay.

Key Words: Shear thickening fluid, rheological property, glass fabrics, nanosilica, nanoclay.

INVESTIGATION OF THE PROPER WAY TO FACILITATE LONG-TERM RETENTION OF VOCABULARY: COMPUTER-ASSISTED, MOBILE-BASED, OR DICTIONARY INVOLVEMENT LEARNING

M. Alemi(corresponding author)
minooalemi2000@yahoo.com
Dept. of Humanities
Islamic Azad University, west- Tehran Branch
R. Pashmforoosh
r.pashmforoosh@gmail.com
Dept. of Foreign Languages
Kharazmi University

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 55-61, Original Article

- Received 8 November 2015; received in revised form 14 February 2016; accepted 12 March 2016.

Abstract

With the rapid development of ubiquitous learning, the emerging technologies contribute significantly to English language learning. An increasing number of studies began to discover the effects of computer and mobile language learning on the second language areas and skills. With each language area, the relevant technologies are embedded in the context of English pedagogy to facilitate the efficiency of learning. However, to date, it seems that no research has been conducted to examine the effectiveness of dynamic methods of English vocabulary learning. To shed light on the pre-existed pedagogical values of computer and mobile language learning for the second language vocabulary, the study pursued the purpose of investigating the effectiveness of diverse teaching methods of computer-assisted, mobile-based, and dictionary-use on students' long-term retention of 330 words of Coxhead's (2000) academic word list. To this end, 264 freshman university students were randomly distributed into four groups and received new academic words either on paper or through computer and SMS. After learning the words of each sublist, periodical tests were given from the proposed system for the learned vocabulary to test whether students have learned the new English vocabulary over time. The findings of the current research revealed that the regular distribution

theories used because of existence one material length scale. Although Eringen's nonlocal elasticity is the popular theory to simulate mechanical behavior of carbon nano-structures, its microstructure-dependent constitutive model does not allow the construction of the energy functional. Hence, this article is aimed at investigating the utilization of modified couple stress theory and Aifantis's theory to estimate natural frequencies of simply-supported single-layered graphene sheets. For this purpose, it is tried to estimate material length scale of theories by point-by-point matching between available first natural frequency of graphene sheets determined by molecular dynamic method and the obtained data. According to the results, modified couple stress theory cannot be used unless one substitutes square of length scale parameter with a minus value in stain energy equation or adds the gradient velocity to the kinetic energy equation by a new material length scale. The former leads to a non-positive definite strain energy function, and the later makes a gradient elasticity theory with two material length scales. Aifantis's theory is more applicable than modified couple stress theory in this situation. It is also seen that the higher order natural frequencies, estimated by different gradient elasticity theories and, material length scale of which is fixed by using molecular dynamic data, are different, although this difference decreases with an increase in side-length of square nanoplate. It can be concluded that chirality, side-length of nano-plate, and the used gradient elasticity theory affect the material length scales, as well.

Key Words: Free vibration of graphene sheet, chirality, aifantis's theory, couple stress theory.

COMPARISON OF DIFFERENT THEORIES OF PREDICTING FATIGUE FAILURE OF NOTCHED CK45 CYLINDRICAL SPECIMENS

J. Amirian(corresponding author)
j.amirian@me.iut.ac.ir
Dept. of Mechanical Engineering
Isfahan University of Technology
M. Shirani
mehdi.shirani@cc.iut.ac.ir
Subsea Research and Development Center
Isfahan University of Technology

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 37-47, Original Article

- Received 28 October 2015; received in revised form 6 February 2016; accepted 27 February 2016.

Abstract

Typically, fatigue failure of a component happens at a notch where the stress level rises because of the stress concentration effect. Notch is usually defined as a geometric discontinuity. Notch may be introduced either by design or by the manufacturing process. A hole in a component is an example of a design notch. Material and fabrication defects, such as weld defects, inclusions, casting defects, or machining marks, are notches which are introduced due to the manufacturing process. A variety of methods are available to predict fatigue failure of notched specimens. The purpose of the present investigation is to rank such methods according to their predictive capability. Tensile tests were conducted on CK45 steel specimens and mechanical properties and stress-strain curve were obtained. Rotating bending fatigue tests were performed at room temperature on smooth and notched cylindrical specimens, and S-N curves were obtained. To better investigate the notch-size effect on fatigue life of the cylindrical specimens, two different notch geometries were used. Based on the obtained experimental S-N curve for smooth specimens, fatigue strength reduction factor or fatigue life for notched specimens were predicted by Neuber, Peterson, maximum stress, critical distance (Point method, Line method, Area method) and weakest-link (Area method, Volume method) theories and comparison of experimental results were considered. The predictions by maximum stress and stress gradient methods were conservative, which is some consolation to engineering designers; nevertheless, the errors were high. Neuber, Peterson and critical distance methods are based on stress gradient in notch root radius and predictions by these methods were not accurate. Also, Peterson, Neuber and Stress gradient methods are not consistent with finite element results. The predicted fatigue strength reduction factors by weakest-link methods were the closest to the experimental results. Finally, the weakest-link theory is recommended in terms of predictive capability, availability of the required materials data, and the compatibility with FEA stresses to predict fatigue strength factor among the studied methods in this research.

Key Words: Notch, fatigue life, fatigue failure, CK45 steel.

EXPERIMENTAL ANALYSIS OF PENETRATION INTO WOVEN FABRIC TARGET IMPREGNATED WITH SHEAR THICKENING FLUID WITH CLAY NANOPARTICLES

E. Balali
balali@aut.ac.ir

are derived and using harmonic balance method, capture region is defined. Numerical results are provided to assess the validity of obtained solutions. Then a free rotating unbalanced disk is added to the system. Using harmonic balance method and numerical solutions, effect of the added free unbalanced disk on the capture range is discussed. Numerical results are provided for different unbalanced added discs and different initial conditions. Obtained results show that the added unbalanced mass can improve the system capability to narrow the capture region and escape it.

Key Words: Unbalanced rotor, resonant capture, added unbalanced disk.

OPTIMUM DESIGN, FABRICATION, AND TEST OF A RADIAL FLOW COMPRESSOR VOLUTE

M. Mojaddam(corresponding author)
m_mojaddam@sbu.ac.ir
Dept. of Mechanical and Energy Engineering
Shahid Beheshti University
A. Hajilouy Benisi
hajilouy@shrif.ir
Dept. of Mechanical Engineering
Sharif University of Technology

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 17-28, Original Article

- Received 1 September 2015; received in revised form 27 January 2016; accepted 6 March 2016.

Abstract

Volute is one of the main components in radial flow compressors where the working fluid is collected and delivered to the compressor downstream pipelines. Volute design has direct and strong effects on the compressor performance and its stable operating range. This component causes distorted pressure fields in upstream flow passages which can lead to mechanical forces on the impeller. In the current research, based on the fundamental concepts of volute design, a new approach for volute design is considered and the effective parameters on volute performance are recognized. Using computational fluid dynamic (CFD) tools, the optimum values of effective parameters which lead to an increase in volute pressure ratio and static pressure recovery coefficient as well as decreasing the total pressure loss coefficient and the net radial force are explored.

Considering the exit cone and the tongue area geometry design criteria, the models are numerically evaluated at the design point and off-design conditions to select the optimum model for fabrication and testing. The new volute is installed at a compressor test rig and the compressor characteristic curves are obtained. At the design point, area variation by 40% results in 14% variation in static pressure recovery factor and 18% variation in total pressure loss coefficient, however, it leads to increase the net radial force on impeller up to 100%. Experimental results, which are used for numerical model verification, show that the compressor pressure ratio and the isentropic efficiency are increased by 2.5% and 1.9% at 70,000rpm respectively.

Key Words: Radial flow compressor, volute, tongue area, static pressure recovery, isentropic efficiency, free vortex, non-uniform circumferential pressure.

FREE VIBRATION OF SINGLE-LAYERED GRAPHENE SHEETS BASED ON DIFFERENT GRADIENT ELASTICITY THEORIES

S. Ziaee
ziaee@yu.ac.ir
Dept. of Mechanical Engineering
School of Eng., Yasouj University

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 29-36, Original Article

- Received 19 September 2015; received in revised form 15 December 2015; accepted 12 April 2016.

Abstract

The unique electrical and mechanical properties of carbon nano-structures make them desired materials with a wide range of applicability. Hence, the study of their mechanical behavior is an important topic which has attracted a great deal of attention. Graphene, a two-dimensional carbon nano-structures with an one-atom thickness, exhibits so wonderful electrical, mechanical, thermal and optical properties which make it suitable to use in micro-/nano-electromechanical system such as nano-scale electromechanical resonators, vibrational behavior of which affects their functionality.

The importance of incorporating the size effect on continuum mechanics to simulate the mechanical behavior of nano-structures is well-known. To this end, different higher-order continuum mechanics that contain additional material constants have been developed. However, the recognition of an efficient non-classical theory with respect to nano-materials is a challenging process. Modified couple stress theory, Eringen's nonlocal elasticity, and Aifantis's theory are some of non-classical

Abstracts of Papers in English

ANALYTICAL STUDY OF RESONANT CAPTURE IN ROTATING UNBALANCED SYSTEMS AND EFFECT OF A FREE UNBALANCED DISK ON SYSTEM BEHAVIOR

S. Farhadi
s.farhadi@uok.ac.ir
Dept. of Mechanical Engineering
University of Kurdistan, Sanandaj

Sharif Mechanical Engineering Journal
Volume 33, Issue 1, Page 3-15, Original Article

- Received 11 April 2015; received in revised form 26 December 2015; accepted 16 January 2016.

Abstract

Vibration problems in rotating machines can be extremely frustrating and may lead to great damages, reduced reliability, and unpleasant side-effects. Unbalanced rotating masses are a main source of machine vibrations. In an unbalanced rotating system with elastic supports, mass center displacements induce an oscillatory force into the support and cause base vibrations. On the other hand, base vibrations introduce an oscillatory torque to the rotor and cause velocity oscillations. In this way, a reciprocal action forms a complex set of nonlinear equations which depend on actuating torque, giving a wide range of harmonic, periodic and chaotic solutions. Close to the system natural frequency, base's high amplitude vibrations result in considerable power waste and prevent rotor acceleration. In such a case, system may suffer power shortage and remain in resonance. This phenomenon is named resonant capture.

In this article, it is proposed to interrupt capture mechanism by adding a free unbalanced mass to the system. It is predicted that system base vibrations force the added mass to rotate or vibrate, and the reacting forces will affect the base motions. This may delay the capture mechanism and provide enough time for the system to accelerate and escape the capture region.

To evaluate the efficiency of the proposed method, an unbalanced rotating system with elastic supports is considered. The nonlinear governing equations of motion