International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 06, June 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

VIBRATION ANALYSIS OF FGM CYLINDRICAL SHELL: A STATE-OF-THE-ART-REVIEW

Ashish kumar Jain

PG Student,Department of mechanical engineering,

University College of Engineering Kota (Rajasthan)(India)

ABSTRACT

This paper is a review of the various approachesconsidered to study theStatic and dynamic behavior of Functionally Graded Material (FGM) cylindrical shell. The approximate and close formapproach are well thought-out. The review is carried out vibration characteristics of FGMcylindrical shell predicted usingvarious theories offered by many researchers without considering the detailedmathematical inference of various approaches. The variation of materialparameters through the shell thickness and boundary conditions on the behavior of FGMcylindrical shell are discussed.Theaim of this paper is to serve the benefits of researchers and engineers alreadyIntricate in the analysis and design of FGM structures.

Keyword:*Functionally graded material, Vibration, FEM, Thermal effect.*

I. INTRODUCTION

Structure component is used many different material compositions to optimize details of structure of loading condition. Local stress concentration is reduced by quick transition to material constants. Due to high stiffness to weight ratio of composite materials and structure are used in field of advanced engineering.

Japan scientist was obtained functionally graded material since 1980. Functionally graded materials are recovering mechanical and thermal parameters of structure components under high temperature conditions. Phase distribution variation is reproduced in their volume fraction.The variation on phase volume fractions is completely through the thickness of the structure.

The FGMs structure components are difficult to analysis compare to homogeneous structure components due to spatial variation in material constants [1]. Many applications of cylindrical shells are established in engineering application and industry field. They are generally used as load bearing structures of aircraft, building and ships. However, last seventeen years most of research work were published.

II.VIBRATION ANALYSIS

Various approaches have been considered for the vibration analysis of FGM cylindrical shell is further classified into two approaches: approximate approaches and Close form approaches.

2.1 Approximate approaches

To achieved the approximate method few techniques have been used by various researchers.

2.1.1 Finite Element Method (FEM)

Various researchers studied the dynamic analysis of FGMs cylindrical shell using FEM.

Using finite element formulation Reddy J.N. and Chin C.D. [2] examined dynamic response of FGMs cylindrical shell. Governing equations were derived using first-order shear deformation theory. Material constants were varied according to power law distribution.

Loy C.T. et al. [3] examined dimensionless frequency of FGMs cylindrical shell using Rayleigh-Ritz method. The investigation were based on Love's shell theory. Material constants are presumed to be dependent on temperature and varied according to power law distribution through thickness direction.

Pradhan S.C. et al. [4] studied vibration characteristics of FGMs cylindrical shell using Rayleigh-Ritz method. The investigation were based on Love's shell theory. Material constants are temperature dependent and varied according to power law distribution in radial direction.

Bhangale K. Rajesh and Ganesan N. [5] studied vibration analysis of simply supported FGMs cylindrical shell under magneto-electro-elastic effect using finite element method. Material constants were varied in shell thickness followed by power-law distribution.

Navazi H.M. et al. [6] examined natural frequencies of simply supported FGMs cylindrical shell under thermal effect using Galerkin's method. Governing equations were derived using Love's shell theory. Material constants dependent on temperature and varied according to power law distribution in radial direction.

Zhao et al. [7] presented static and dynamic analysis of FGMs cylindrical shell using finite element method. The investigation were based on sander's shear deformation theory. Material constants were varied according to power law distribution in thickness direction.

Using finite element method Santos H. [8] studied vibration analysis of FGMs cylindrical shell. The investigation were based on 3D-elastic theory. Material constants were varied according to power law distribution in the thickness direction.

NaeemMN et al. [9] examined dimensionless frequency of FGMs cylindrical shell using Ritz method. Sanders and Budiansky's thin shell theory was used in this studied. Material constants were varied in shell thickness followed by power law distribution.

Asgari M and Akhlaghi M [10] investigated frequency analysis of simply-supported 2DFGMs cylindrical shell using finite element method. Governing equations were based on 3D elastic theory. Material constants were varied according to power law in radially and axially direction.

Arshad Hussain Shahid et al. [11] examined non-dimension frequency of bi-layered FGMs cylindrical shell using Rayleigh-Ritz method. Governing equations were based on Love's thin shell theory. Material constants were varied from shell thickness according to power-law distribution.

Pandey Shashank et al. [12] examined natural frequencies of FGMs sandwich shell under thermal and non-thermal effect using finite element method. Material constants are dependent on temperature and varied according to Mori–Tanaka and Voigt's rule of mixture in radial direction. The temperature distribution are non-linear in thickness direction. This analysis is done by using thin shell theory.

2.1.2 Differential Quadrature Method (DQM)

Yang J. et al. [13] examined static and dynamic analysis of FGMs cylindrical panel under thermal environment using DQM. Reddy's higher order deformation theory was used to obtained the governing equation. Material constants are presumed to be dependent on temperature and varied according to power law distribution through thickness direction.

Zhi-yuan Cao and Hua-ning Wang [14] investigated frequency parameters of FGMs cylindrical shell with holes using numerical method. Governing equations were based on Hamilton's principle. Material constants were varied according to power law distribution in thickness direction.

The natural frequencies of three layers FGMs cylindrical shell was reported byBatraR.C. [15] using Flugge's shell theory. Material constants were varied according to power law distribution in thickness direction.

Malekzadeh P. et al. [16] proposed natural frequencies of rotating FGMs cylindrical shells under thermal effect using DQM. Material constants are temperature dependent and varied according to power law in thickness direction. The analysis based on first order shear deformation theory. Governing equation were derived using Hamilton's principle.

NevesA.M.A. et al. [17] investigated vibration response of FGMs cylindrical shell using higher-order deformation theory. Governing equations were based on principle of virtual work. Material constants were varied according to power law distribution in thickness direction.

EbrahimiM.J. et al. [18] examined non-dimensionless frequency of 2DFGMs cylindrical shell using differential quadrature and integral quadrature method. Governing equations were based on Love's shell theory. Material constants were varied according to power law in radially and axially direction.

Dimensionless frequency of 2D axisymmetric FGMs cylindrical shell was presented by Najafizadeh M.M. et al. [19] using DQM. Governing equation were derived by Euler`s equation and Hamilton`s principle. Material constants were varied according to power law in axially and radially direction.

Foroutan M. et al. [20] examined frequency analysis of FGMs cylindrical shell using mesh less method. Material constants were varied according to power law distribution in radial direction.

2.1.3 Perturbation Method and Taylor Series Method

Ng T.Y. et al. [21] proposed vibration analysis of FGMs cylindrical shell under harmonic axial loading using Bolotin's method. Governing equations were based on Donnell's shell theory. Material constants were varied according to power law distribution.

2.2 Closed form approaches

2.2.1 Method of Separation of Variables

JinGuoyong et al. [22] examined natural frequencies of FGMs cylindrical shell using Haar wavelet method. The investigation were based on first-order deformation theory. Material constants were varied according to power law in thickness direction.

2.2.2 Finite Fourier Transformation

KadoliRavikiran et al. [23] proposed natural frequencies of clamped-clamped FGMs cylindrical shell under thermal effect using Fourier series expansion method. The investigation was followed by First order deformation theory. Material constants were assume to power law variation through shell.

Ansari R. and Darvizeh M. [24] examined dynamic performance of FGMs cylindrical shell using Stoke's Fourier transformation under different boundary conditions. The theoretical formulation was obtained using first order deformation shell theory. Material constants are temperature dependent and assumed to vary through shell thickness according to power law, exponential law and sigmoid law.

III. CONCLUSION

This review is reported on modern advances in approximate approaches and Close form approachesfor the vibration analysis of FGM cylindrical shell. Most of theapproaches considered for the analysis of FGM cylindrical shell are the additions of the relatedapproaches used for isotropic cylindrical shell. The important role of material parameters to obtained response of FGM cylindrical shell.

IV. ACKNOWLEDGMENT

My sincere thanks are due to Mr. Pankaj Sharma for their advice and guidance on various theoretical aspects of the subject during my course.

REFERENCE

[1] Victor Birman and Larry W. Byrd, Modeling and Analysis of functionally graded materials and structures, Applied Mechanics Reviews, 60, 2007, 195-216.

[2] Reddy J.N. et al., Thermo mechanical analysis of functionally graded cylinders and plates, Journal of Thermal Stresses, 21, 1998, 593-626

[3] Loy C.T. et al., Vibration of functionally graded cylindrical shells, International Journal of Mechanical Sciences, 41, 1999, 309-324.

[4] Pradhan S.C. et al., Vibration characteristics of functionally graded cylindrical shell under various boundary conditions, Applied Acousics, 61, 2000, 111-129.

[5] BhangaleK.Rajesh and Ganesan N., Free vibration studies of simply supported non-homogeneous functionally graded magneto-electro-elastic finite cylindrical shells, Journal of Sound and Vibration, 288, 2005, 412–422.

[6] Navazi H.M. et al., Free vibration analysis of functionally graded cylindrical shell including thermal effects, Thin-walled structure, 45, 2007, 591-599.

[7] Zhao X. et al., Thermo elastic and vibration analysis of functionally graded cylindrical shell, International journal of mechanical science, 51, 2009, 694-707.

[8] Santos H. et al., A semi-analytical finite element model for the analysis of cylindrical shells made of functionally graded materials, Composite Structures, 91, 2009, 427–432.

[9] Naeem MN et al., The Ritz formulation applied to the study of the vibration frequency characteristics of functionally graded circular cylindrical shells, MechanicalEngineering Science, 224, 2010, 1545-1548.

[10] Asgari M.et al., Natural frequency analysis of 2D-FGM thick hollow cylinder based on three-dimensional elasticity equations, EuropeanJournalofMechanicsand Solids, 30, 2011, 72-81.

[11] Arshad Hussain Shahidet al., Vibration analysis of bi-layered FGM cylindrical shells, Arch ApplMech, 81, 2011, 319–343.

[12] Pandey Shashank et al., A layer wise finite element formulation for free vibration analysis of functionally graded sandwich shells", Composite Structures, 133, 2015, 438-450.

[13] Yang J.et al., Free vibration and parametric resonance of shear deformable functionally graded cylindrical panels, Journal of Sound and Vibration, 261, 2003, 871–893.

[14] Zhi-yuan Cao and Hua-ning Wang "Free vibration of FGM cylindrical shells with holes under various boundary condition", Journal of Sound and Vibration (2007), vol. 306, pp. 227–237.

[15] BatraR.C., Free vibration of three-layer circular cylindrical shells with functionally graded middle layer, Mechanics Research Communication, 37, 2010, 577-580.

[16] Malekzadeh P. et al., Free vibration analysis of rotating functionally graded cylindrical shells in thermal environment, Composite Structures, 94, 2012, 2971–2981.

[17] NevesA.M.A. et al., Free vibration analysis of functionally graded shells by a higher-order shear deformation theory and radial basis functions collocation, accounting for through-the-thickness deformations, European Journal of Mechanics A/Solids, 37, 2013, 24-34.

[18] EbrahimiM.J. et al., Free vibration analysis of two-dimensional functionally graded cylindrical shells, Applied Mathematical Modeling, 38, 2014, 308–324.

[19] Najafizadeh M.M. et al., Free Vibration Analysis of two-dimensional Functionally Graded Axisymmetric Cylindrical Shell on Winkler- Pasternak elastic Foundation by First-order Shear Deformation Theory and using Navier-Differential Quadrature solution methods, Appl. Math. Modelling, 2015.

[20] Foroutan M. et al., Analysis of free vibration of functionally graded material cylinders by Hermitian collocation mesh less method, Australian Journal of MechanicalEngineering, 46, 2015, 507.

[21] Ng T.Y. et al., Dynamic stability analysis of functionally graded cylindrical shells under periodic axial loading, International Journal of Solids and Structures, 38, 2001, 1295-1309.

[22] JinGuoyong et al., The Haar wavelet method for free vibration analysis of functionally graded cylindrical shells based on the shear deformation theory, Composite Structures, 108, 2013, 435–448.

[23] KadoliRavikiran et al., Buckling and free vibration analysis of functionally graded cylindrical shells subjected to a temperature-specified boundary condition, Journal ofSound and Vibration, 289, 2006, 450–480.

[24] Ansari R. et al., Prediction of dynamic behavior of FGMs shells under arbitrary boundary conditions, Composite Structures, 85, 2008, 284–292.