Non-linear design and control optimization of composite laminated doubly curved shell

Author(s):
Youssif, YG (Youssif, Y. G.)
E-mail: Y_G_Youssif4l@yahoo.com
Mansoura Univ, Dept Math, Fac Sci, Mansoura 35516, Egypt

Abstract
Multiobjective design and control optimization of composite laminated non-linear doubly curved shell with various boundary conditions is presented to minimize the dynamic response. The control objective aims at dissipating the elastic energy of the composite laminated shell with the minimum possible expenditure of control energy using a closed-loop distributed force. The layer thicknesses and fiber orientations are taken as design variables. The objectives of the optimization problem are formulated based on a shear deformation theory including the von-Karmen non-linear effect for various cases of boundary conditions. The non-linear control problem is solved iteratively until an appropriate convergence criterion is satisfied based on Liapunov-Bellman theory. Liapunov function is taken as a sum of positive definite functions with different degrees. Comparative examples for three-layer symmetric and four-layer antisymmetric cylindrical laminated shell are given for various cases of edges conditions. Graphical study is carried out to assess the accuracy of results obtained due to the successive iterations. The influences of the boundary conditions, orthotropy ratio, shear deformation on the cylindrical laminated shell optimal design are elucidated.

Published in : COMPOSITE STRUCTURES Volume: 88 Issue: 3 Pages: 468-480
DOI: 10.1016/j.compstruct.2008.05.020 Published: MAY 2009

References:

- [1]
- J.N. Yang, T.T. Soong
- Recent advances in active control of civil engineering structures
- J Probabilistic Eng Mech, 3 (1988), pp. 179–188
- [2]
- R.K. Miller, S.F. Marsi, T.J. Dehganyer, T.K. Caughey
- Active vibration control of large civil structures
- ASCE J Eng Mech, 114 (1988), pp. 1542–1570
- [3]
- N.S. Khot
- Structure/control optimization to improve the dynamic response of space structures
- Comput Mech, 3 (1988), pp. 179–186
- [4]
- R.V. Grandhi
- Structural and control optimization of space structures
- Comput Struct, 31 (1989), pp. 139–150
- [5]
- S.S. Rao, V.B. Venkayya, N.S. Khot
- Game theory approach for the integrated design of structures and controls
- AIAA J, 26 (1988), pp. 463–469
- [6]
- G. Duvaut, G. Terrel, F. Léné, V.E. Verijenko

- Optimization of fiber reinforced composites
- Compos Struct, 48 (1–3) (2000), pp. 83–89
- [7]
- A. Muc, Z. Krawiec
- Design of composite plates under cyclic loading
- Compos Struct, 48 (1-3) (2000), pp. 139–144
- [8]
- P.E. O'Donoghue, S.N. Atluri
- Control of dynamic response of a continuum model of a large space structure
- Comput Struct, 23 (1986), pp. 199–209
- [9]
- J.M. Sloss, I.S. Sadek, J.C. Bruch Jr., S. Adali
- Optimal vibration control of laminated cross-ply cylindrical panels
- Math Eng Ind, 2 (3) (1989), pp. 169–188
- [10]
- I.S. Sadek, J.M. Sloss, S. Adali, J.C. Bruch Jr.
- Integrated design and control of laminated hybrid plates with dynamic response and buckling objectives
- J Sound Vib, 163 (1) (1993), pp. 57–66
- [11]
- M.A. Langthjem, Y. Sugiyama
- Optimum design of cantilevered columns under the combined of conservative and non-conservative loads Part II: the damped case
- Comput Struct, 74 (2000), pp. 399–408
- [12]
- S. Adali, I.S. Sadek, J.M. Sloss, J.C. Bruch Jr.
- Distributed control of layered orthotropic plates with damping
- Optimal Control Appl Methods, 9 (1988), pp. 1–17
- [13]
- I.S. Sadek, J.M. Sloss, J.C. Bruch Jr., S. Adali
- Structural control to minimize the dynamic response of Mindlin–Timoshenko plates
- J Franklin Inst, 324 (1987), pp. 97–112
- [14]
- J.C. Bruch, S. Adali, J.M. Sloss, I.S. Sadek
- Optimal design and control of cross-ply laminate for maximum frequency and minimum dynamic response
- Comput Struct, 37 (1990), pp. 87–94

[15]

- R.S. Esfandiari, J.M. Sloss, J.C. Bruch Jr.
- Passive optimal control of an antisymmetric angle-ply laminate
- J Optim Theory Appl, 66 (2) (1990), pp. 227–242
- [16]
- C.W. Kim, W. Hwang, H.C. Park, K.S. Han
- Stacking sequence optimization of laminated plates
- Compos Struct, 39 (2003), pp. 267–278
- [17]
- Y.G. Youssif, M.N.M. Allam, A.E. Alamir

- Optimal stabilization of a compressed elastic shallow shell
- J Egypt Math Soc, 6 (2) (1998), pp. 233–244
- [18]
- Y.G. Youssif
- The influence of the in-plane compression on the stability of a vibrating cylindrical shell
- J Egypt Math Soc, 7 (2) (1999), pp. 279–290
- [19]
- M.E. Fares, Y.G. Youssif, A.E. Alamir
- Optimal design and control of composite laminated plates with various boundary conditions using various plate theories
- Compos Struct, 56 (2002), pp. 1–12
- [20]
- M.E. Fares, Y.G. Youssif, A.E. Alamir
- Minimization of the dynamic response of composite laminated doubly curved shells using design and control optimization
- Compos Struct, 59 (2003), pp. 369–383
- [21]
- M.E. Fares, Y.G. Youssif, A.E. Alamir
- Design and control optimization of composite laminated truncated conical shells for minimum dynamic response including transverse shear deformation
- Compos Struct, 64 (2004), pp. 139–150
- [22]
- C.A. Conceicfl'ao Ant onio
- Optimisation of geometrically non-linear composite structures based on load–displacement control
- Compos Struct, 46 (1999), pp. 345–356
- [23]
- Y.G. Youssif, M.E. Fares, M.A. Hafiz
- Optimal control of the dynamic response of anisotropic plate with various boundary conditions
- Mech Res Commun, 28 (5) (2001), pp. 525–534
- [24]
- I.S. Sadek, J.M. Sloss, S. Adali, J.C. Bruch Jr.
- Integrated design and control of laminated hybrid plates with dynamic response and buckling objectives
- J Sound Vib, 163 (1) (1993), pp. 57–66
- [25]
- J.N. Reddy
- On the generalization of displacement based laminate theories
- Appl Mech Rev, 42 (11) (1989), pp. 213–222
- [26]
- J.N. Reddy
- Mechanics of composite materials and structures, Theory and analysisCRC Press, Florida (1997)
- [27]
- M.E. Fares, Y.G. Youssif
- A refined equivalent single layer model of geometrically non-linear doubly curved layered shells using mixed variational approach
- Int J Non-linear Mech, 36 (1) (2001), pp. 117–124

- [28]
- M.S. Gabralyan, N.N. Krasoviskii
- About stabilization of mechanical system problem
- PMM, 28 (1964)
- [29]
- M.S. Gabralyan
- About stabilization of mechanical systems under continuous forces
- YGU, Yervan, 2 (1975), pp. 47–56
- [30]
- A.M. Letov
- Analytical design of controllers
- Aftamateka Telemchanika, 21 (4–6) (1960) 1961;22(4)
- [31]
- H. Benaroya
- Mechanical vibration analysis, uncertainities and control
- Prentice-Hall, Englewood Cliffs, NJ (1998)

Non-linear design and control optimization of composite laminated plates with buckling and postbuckling objectives

Author(s):

Youssif, YG (Youssif, Y. G.)

E-mail: Y_G_Youssif4l@yahoo.com

Fares, ME (Fares, M. E)

Elshoraky, AE (Elshoraky, A. E.)

Mansoura Univ, Dept Math, Fac Sci, Mansoura 35516, Egypt

Abstract

Multiobjective design and control optimization of composite laminated plates is presented to minimize the postbuckling dynamic response and maximize the buckling load. The control objective aims at dissipating the postbuckling elastic energy of the laminate with the minimum possible expenditure of control energy using a closed-loop distributed force. The layer thicknesses and fiber orientations are taken as design variables. The objectives of the optimization problem are formulated based on a shear deformation theory including the von-Karman non-linear effect for various cases of boundary conditions. The non-linear control problem is solved iteratively until an appropriate convergence criterion is satisfied based on Liapunov-Bellman theory. Liapunov function is taken as a sum of positive definite functions with different degrees. Comparative examples for three-layer symmetric and four-layer antisymmetric laminates are given for various cases of edges conditions. Graphical study is carried out to assess the accuracy of results obtained due to the successive iterations. The influences of the boundary conditions, orthotropy ratio, shear deformation, aspect ratio on the laminate optimal design are elucidated.

Published in : INTERNATIONAL JOURNAL OF NON-LINEAR MECHANICS Volume: 41 Issue: 6-7 Pages: 807-824 DOI: 10.1016/j.ijnonlinmec.2006.05.003 Published: JUL-SEP 2006

References:

- [1]
- J.M. Sloss, I.S. Sadek, J.C. Bruch Jr., S. Adali
- Optimal vibration control of laminated cross-ply cylindrical panels
- Math. Eng. Ind., 2 (3) (1989), pp. 169–188
- [2]
- J.N. Yang, T.T. Soong
- Recent advances in active control of civil engineering structures
- J. Probab. Eng. Mech., 3 (1988), pp. 179–188
- [3]
- R.S. Esfandiari, J.M. Sloss, J.C. Bruch Jr.
- Passive optimal control of an antisymmetric angle-ply laminate
- J. Optim. Theory Appl., 66 (2) (1990), pp. 227–242
- [4]
- R.K. Miller, S.F. Marsi, T.J. Dehganyer, T.K. Caughey
- Active vibration control of large civil structures
- ASCE J. Eng. Mech., 114 (1988), pp. 1542–1570
- [5]
- Y.S. Lee, Y.W. Lee, M.S. Yang, B.S. Park
- Optimal design of thick laminated composite plates for maximum thermal buckling load
- J. Therm. Stresses, 22 (3) (1999), pp. 259–273
- [6]
- C.W. Kim, W. Hwang, H.C. Park, K.S. Han