

Yaghoobi, Hessameddin; Yaghoobi, Pooria

Buckling analysis of sandwich plates with FGM face sheets resting on elastic foundation with various boundary conditions: an analytical approach. (English) Zbl 1293.74135

Meccanica 48, No. 8, 2019-2035 (2013).

Summary: This paper presents an analytical investigation on the buckling analysis of symmetric sandwich plates with functionally graded material (FGM) face sheets resting on an elastic foundation based on the first-order shear deformation plate theory (FSDT) and subjected to mechanical, thermal and thermo-mechanical loads. The material properties of FGM face sheets are assumed to be graded in the thickness direction according to a simple power law distribution in terms of the volume fractions of the constituents. The core layer is still homogeneous and made of an isotropic material. An analytical approach is used to reduce the governing equations of stability and then solved using an analytical solution which is named as power series Frobenius method for symmetric sandwich plates with six different boundary conditions. A detailed numerical study is carried out to examine the influence of the plate aspect ratio, side-to-thickness ratio, loading type, sandwich plate type, volume fraction index, elastic foundation coefficients and boundary conditions on the buckling response of FGM sandwich plates. This has not been done before and serves to fill the gap of knowledge in this area.

MSC:

[74G60](#) Bifurcation and buckling

[74K20](#) Plates

[74E30](#) Composite and mixture properties

[74G10](#) Analytic approximation of solutions (perturbation methods, asymptotic methods, series, etc.) of equilibrium problems in solid mechanics

Cited in **5** Documents

Keywords:

buckling analysis; sandwich plate; functionally graded material; elastic foundation; various boundary conditions; analytical approach

Full Text: [DOI](#)

References:

- [1] Zenkour, AM, A comprehensive analysis of functionally graded sandwich plates: part 1. deflection and stresses, *Int J Solids Struct*, 42, 5224-5242, (2005) · [Zbl 1119.74471](#) · [doi:10.1016/j.ijsolstr.2005.02.015](#)
- [2] Zenkour, AM, A comprehensive analysis of functionally graded sandwich plates: part 2. buckling and free vibration, *Int J Solids Struct*, 42, 5243-5258, (2005) · [Zbl 1119.74472](#) · [doi:10.1016/j.ijsolstr.2005.02.016](#)
- [3] Zenkour, AM; Alghamdi, NA, Thermoelastic bending analysis of functionally graded sandwich plates, *J Mater Sci*, 43, 2574-2589, (2008) · [doi:10.1007/s10853-008-2476-6](#)
- [4] Zenkour, AM; Alghamdi, NA, Bending analysis of functionally graded sandwich plates under the effect of mechanical and thermal loads, *Mech Adv Mat Struct*, 17, 419-432, (2010) · [doi:10.1080/15376494.2010.483323](#)
- [5] Zenkour, AM; Alghamdi, NA, Thermomechanical bending response of functionally graded nonsymmetric sandwich plates, *J Sandw Struct Mater*, 12, 7-46, (2010) · [doi:10.1177/1099636209102264](#)
- [6] Zenkour, AM; Sobhy, M, Thermal buckling of various types of FGM sandwich plates, *Compos Struct*, 93, 93-102, (2010) · [doi:10.1016/j.compstruct.2010.06.012](#)
- [7] Hadji, L; Atmane, HA; Tounsi, A; Mechab, I; Adda Bedia, EA, Free vibration of functionally graded sandwich plates using four variable refined plate theory, *Appl Math Mech*, 32, 925-942, (2011) · [Zbl 1237.76061](#) · [doi:10.1007/s10483-011-1470-9](#)
- [8] El Meiche, N; Tounsi, A; Ziane, N; Mechab, I; Adda Bedia, EA, A new hyperbolic shear deformation theory for buckling and vibration of functionally graded sandwich plate, *Int J Mech Sci*, 53, 237-247, (2011) · [doi:10.1016/j.ijmecsci.2011.01.004](#)
- [9] Houari, MSA; Benyoucef, S; Mechab, I; Tounsi, A; Adda Bedia, EA, Two variable refined plate theory for thermoelastic bending analysis of functionally graded sandwich plates, *J Therm Stresses*, 34, 315-334, (2011) · [doi:10.1080/01495739.2010.550806](#)
- [10] Abdelaziz, HH; Atmane, HA; Mechab, I; Boumia, L; Tounsi, A; Adda Bedia, EA, Static analysis of functionally graded sandwich plates using an efficient and simple refined theory, *Chin J Aeronaut*, 24, 434-448, (2011) · [doi:10.1016/S1000-9361\(11\)60051-4](#)

- [11] Merdaci, S; Tounsi, A; Houari, MSA; Mechab, I; Hebali, H; Benyoucef, S, Two new refined shear displacement models for functionally graded sandwich plates, *Arch Appl Mech*, 81, 1507-1522, (2011) · [Zbl 1271.74285](#) · [doi:10.1007/s00419-010-0497-5](#)
- [12] Bourada, M; Tounsi, A; Houari, MSA; Adda Bedia, EA, A new four-variable refined plate theory for thermal buckling analysis of functionally graded sandwich plates, *J Sandw Struct Mater*, 14, 5-33, (2012) · [doi:10.1177/1099636211426386](#)
- [13] Natarajan, S; Ganapathi, M, Bending and vibration of functionally graded material sandwich plates using an accurate theory, *Finite Elem Anal Des*, 57, 32-42, (2012) · [doi:10.1016/j.finel.2012.03.006](#)
- [14] Khalili, SMR; Mohammadi, Y, Free vibration analysis of sandwich plates with functionally graded face sheets and temperature-dependent material properties: a new approach, *Eur J Mech A, Solids*, 35, 61-74, (2012) · [Zbl 1349.74173](#) · [doi:10.1016/j.euromechsol.2012.01.003](#)
- [15] Neves, AMA; Ferreira, AJM; Carrera, E; Cinefra, M; Jorge, RMN; Soares, CMM, Static analysis of functionally graded sandwich plates according to a hyperbolic theory considering zig-zag and warping effects, *Adv Eng Softw*, 52, 30-43, (2012) · [doi:10.1016/j.advengsoft.2012.05.005](#)
- [16] Neves, AMA; Ferreira, AJM; Carrera, E; Cinefra, M; Jorge, RMN; Soares, CMM, Buckling analysis of sandwich plates with functionally graded skins using a new quasi-3D hyperbolic sine shear deformation theory and collocation with radial basis functions, *Z Angew Math Mech*, 92, 749-766, (2012) · [Zbl 1348.74129](#) · [doi:10.1002/zamm.201100186](#)
- [17] Neves, AMA; Ferreira, AJM; Carrera, E; Cinefra, M; Roque, CMC; Jorge, RMN; Soares, CMM, Static, free vibration and buckling analysis of isotropic and sandwich functionally graded plates using a quasi-3D higher-order shear deformation theory and a meshless technique, *Composites, Part B*, 44, 657-674, (2013) · [doi:10.1016/j.compositesb.2012.01.089](#)
- [18] Tounsi A, Houari M, Benyoucef S, Adda Bedia EA (2012, in press) A refined trigonometric shear deformation theory for thermoelastic bending of functionally graded sandwich plates. *Aerosp Sci Technol*. [doi:10.1016/j.ast.2011.11.009](#)
- [19] Hamidi A, Zidi M, Houari MSA, Tounsi A (2012, in press) A new four variable refined plate theory for bending response of functionally graded sandwich plates under thermomechanical loading. *Composites, Part B*. [doi:10.1016/j.compositesb.2012.03.021](#)
- [20] Kiani, Y; Bagherizadeh, E; Eslami, MR, Thermal and mechanical buckling of sandwich plates with FGM face sheets resting on the Pasternak elastic foundation, *Proceedings of the institution of mechanical engineers, part C, J Mech Eng Sci*, 226, 32-41, (2011) · [doi:10.1177/0954406211413657](#)
- [21] Wang, ZX; Shen, HS, Nonlinear analysis of sandwich plates with FGM face sheets resting on elastic foundations, *Compos Struct*, 93, 2521-2532, (2011) · [doi:10.1016/j.compstruct.2011.04.014](#)
- [22] Kiani, Y; Eslami, MR, Thermal buckling and post-buckling response of imperfect temperature-dependent sandwich FGM plates resting on elastic foundation, *Arch Appl Mech*, 82, 891-905, (2012) · [Zbl 1293.74123](#) · [doi:10.1007/s00419-011-0599-8](#)
- [23] Akbarzadeh, AH; Abbasi, M; Hosseini zad, SK; Eslami, MR, Dynamic analysis of functionally graded plates using the hybrid Fourier-Laplace transform under thermomechanical loading, *Meccanica*, 46, 1373-1392, (2011) · [Zbl 1271.74278](#) · [doi:10.1007/s11012-010-9397-6](#)
- [24] Bachir Bouiadjra, M; Houari, MSA; Tounsi, A, Thermal buckling of functionally graded plates according to a four-variable refined plate theory, *J Therm Stresses*, 35, 677-694, (2012) · [doi:10.1080/01495739.2012.688665](#)
- [25] Fekrar, A; El Meiche, N; Bessaim, A; Tounsi, A; Adda Bedia, EA, Buckling analysis of functionally graded hybrid composite plates using a new four variable refined plate theory, *Steel Compos Struct*, 13, 91-107, (2012) · [doi:10.12989/scs.2012.13.1.091](#)
- [26] Fahsi, B; Kaci, A; Tounsi, A; Adda Bedia, EA, A four variable refined plate theory for nonlinear cylindrical bending analysis of functionally graded plates under thermomechanical loadings, *J Mech Sci Technol*, 26, 4073-4079, (2012) · [Zbl 1252.80014](#) · [doi:10.1007/s12206-012-0907-4](#)
- [27] Mena, R; Tounsi, A; Mouaici, F; Mechab, I; Zidi, M; Adda Bedia, EA, Analytical solutions for static shear correction factor of functionally graded rectangular beams, *Mech Adv Mat Struct*, 19, 641-652, (2012) · [doi:10.1080/15376494.2011.581409](#)
- [28] Malekzadeh, P; Golbahar Haghighi, MR; Alibeygi Beni, A, Buckling analysis of functionally graded arbitrary straight-sided quadrilateral plates on elastic foundations, *Meccanica*, 47, 321-333, (2012) · [Zbl 1293.74124](#) · [doi:10.1007/s11012-011-9436-y](#)
- [29] Boudarba B, Houari MSA, Tounsi A (2013) Thermomechanical bending response of FGM thick plates resting on Winkler-Pasternak elastic foundations. *Steel and Composite Structures* 14(1)
- [30] Zenkour, AM; Sobhy, M, Thermal buckling of functionally graded plates resting on elastic foundations using the trigonometric theory, *J Therm Stresses*, 34, 1119-1138, (2011) · [doi:10.1080/01495739.2011.606017](#)
- [31] Wylie CR, Barrett LC (1951) *Advanced engineering mathematics*. McGraw-Hill, New York
- [32] Meyers, CA; Hyer, MW, Thermal buckling and postbuckling of symmetrically laminated composite plates, *J Therm Stresses*, 14, 519-540, (1991) · [doi:10.1080/01495739108927083](#)
- [33] Duc, ND; Tung, HV, Mechanical and thermal postbuckling of higher order shear deformable functionally graded plates on elastic foundations, *Compos Struct*, 93, 2874-2881, (2011) · [doi:10.1016/j.compstruct.2011.05.017](#)
- [34] Yaghoobi, H; Fereidoon, A; Shahsiah, R, Thermal buckling of axially functionally graded thin cylindrical shell, *J Therm Stresses*, 34, 1250-1270, (2011) · [doi:10.1080/01495739.2011.616795](#)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.