15th INTERNATIONAL CONFERENCE
Dynamical Systems — Theory and Applications
December 2-5, 2019. Lodz, POLAND.

DSTA 2019

paper id: VIB74

Thermoelastic large amplitude vibration of bi-material beams

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Abstract: The main goal of this work is to develop an accurate numerical approach to study the geometrical nonlinear vibration of bi-material beams under the combined action of mechanical and thermal loads. Under considerations are beams subjected to dynamic mechanical loading and different thermal condition: elevated temperature, heat flux, convective heating/cooling. The governing equations of coupled vibration of the bi-material beam are deduced. The geometrically nonlinear version of the Timoshenko beam theory is used to describe the theoretical model of the problem. The equations of beam motion are transformed in coupled ordinary differential equations by using normal modes of the beam. The equation of the heat propagation is discretized by the finite difference method. The coupling terms of the mechanical and thermal equations are taken into account. The second approach used to study the problem is the creation of a 3D finite element model of the thermoelastic vibration of the beam. The finite element program ANSYS is used for the analytical model validation. The influence of the difference of the mechanical and thermal properties of the beams on the response of structure is studied in details. It is shown that the temperature condition can lead to buckling of the beam. The effects of the geometrical nonlinear terms and the heat condition on the buckling and post buckling vibration and on the frequency response functions are studied as well.

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