Influence of the Functionally Graded Material of Three-Layered Annular Plate on Dynamic Response under Thermal Loading

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Presented problem draws attention to the dynamic responses of three-layered, annular plates subjected to constant or time-dependent temperature fields. Using the functionally graded material on the plate outer layers the new composite structure was built, whose dynamic behaviours are some new cognition. The temperature field model in combination with the material and geometrical parameters create a multiparameter problem. Detailed analysis can show plate reactions, whose meaning can be used in practical applications of such composite plates in for example: aerospace industry, mechanical and nuclear engineering, civil engineering or miniature mechanical systems.

The three-layered annular plate is composed of the thin FGM facings and thicker foam core. The plate is loaded thermally with the temperature difference between plate edges: inner and outer. The thermal environment is defined by the temperatures T_i and T_o in the area of plate hole and outer perimeter, respectively. The temperature field is axisymmetric and flat. There is no heat exchange between plate surfaces. The support system of the examined plates is in the form of both edges slideably clamped. Time-dependent thermal loads is formulated as follows:

$$\Delta T = at, \tag{1}$$

where ΔT is the temperature difference, t is the time, a is the rate of temperature loading growth.

The radial changes of the FGM facing material are smooth presented by the following power function:

$$VV = \left(\frac{r_i}{r_i - r_o} + \frac{r}{r_o - r_i} \right)^n, \tag{2}$$

where VV is the rate of material variation in the radial direction, r_i and r_o are the inner and outer plate radii, r is the plate radius, and n is the power-law exponent. The material parameters of the facings are calculated according to the following equation:

$$W = W1 + VV\left(W2 - W1\right), \tag{3}$$

where $W1$ and $W2$ are the values of the material parameters, W is the value of the facing material parameters at the plate point determined by the radius r. The facings are composed of two materials located at the plate edges. Between the edges, the facings' material parameters vary according to the selected power-law exponent n. Solution procedure uses two numerical methods: finite difference method in author's programme and finite element method in Abaqus system. The solution process is presented in works [1,2] in detail.

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[1] D. Pawlus, *International Journal of Structural Stability and Dynamics* **20**(12), (35 pages), 2020. https://doi.org/10.1142/S0219455420501394

[2] D. Pawlus, *Materials* **19**, 256, 2026. https://doi.org/10.3390/ma19020256