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Optimizing Volume Fraction Variation Profile of Bidirectional Functionally Graded Circular Plate under Mechanical Loading to Minimize Its Stresses

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Abstract : Considering that application of functionally graded material is increasing in most industries, it seems necessary to present a methodology for designing optimal profile of structures such as plate under mechanical loading which is highly consumed in industries. Therefore, volume fraction variation profile of functionally graded circular plate which has been considered two-directional is optimized so that stress of structure is minimized. For this purpose, equilibrium equations of two-directional functionally graded circular plate are solved by applying semi analytical-numerical method under mechanical loading and support conditions. By solving equilibrium equations, deflections and stresses are obtained in terms of control variables of volume fraction variation profile. As a result, the problem formula can be defined as an optimization problem by aiming at minimization of critical von-mises stress under constraints of deflections, stress and a physical constraint relating to structure of material. Then, the related problem can be solved with help of one of the metaheuristic algorithms such as genetic algorithm. Results of optimization for the applied model under constraints and loadings and boundary conditions show that functionally graded plate should be graded only in radial direction and there is no need for volume fraction variation of the constituent particles in thickness direction. For validating results, optimal values of the obtained design variables are graphically evaluated.

Keywords : two-directional functionally graded material, single objective optimization, semi analytical-numerical solution, genetic algorithm, graphical solution with contour
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