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Buckling and Postbuckling of Elastoplastic FGM Plates under Inplane loads

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Abstract: Elastoplastic buckling behaviors of rectangular plates made from functionally graded materials (FGMs) are investigated in this paper. The elastoplastic material properties are assumed to vary smoothly through the thickness of the plates. The three dimensional material constitutive relation of FGMs is found by introducing the material homogenization method, named Tamura-Tomota-Ozawa(TTO) model, into J_2 deformation theory or J_2 flow theory. The uniform strain hypothesis helps to simplify the prebuckling state and derive the analytical expression of the position of the material elastoplastic interface. The buckling governing equations and the buckling critical condition of the structures are formulated under the framework of the classical plate theory. An iterative algorithm is designed to obtain the elastoplastic buckling critical load, a converging result between the prebuckling and the buckling critical internal forces. ABAQUS simulation well verifies the present theoretical predictions from J_2 flow theory, and is resorted to investigate the postbuckling behaviors of FGM plates. Discussions are addressed for the effects of the constituent distribution, the material plastic flow, the preloaded states of the plates, and the regions of buckling types are plotted as well.

Keywords: functionally graded materials; plates; buckling; postbuckling; elastoplasticity.

1. Introductions

Functionally graded materials (FGMs) are inhomogeneous material composed by ceramic and metallic constituents [1]. The combination of ceramic heat-resistance with metallic crack-resistance enables their excellent thermal-mechanical performances. Meanwhile, the continuous mixing ratio of the constituents in the space highlights their potential applications in designation and optimization of their structures. As ideal thermal barrier materials, FGMs were initially used in coating of space shuttle and container of nuclear reactor to cope with thermal stress. Nowadays, FGMs tend to be used to achieve some required functions in

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