IMPROVED LOCAL BUCKLING SOLUTION FOR ELASTICALLY RESTRAINED COMPOSITE ORTHOTROPIC PLATES

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In this paper, improved explicit analysis of local buckling of rectangular orthotropic composite plates with various elastic restrained edge boundary conditions and subjected to uniform in-plane axial action is presented. A generic formulation of elastically restrained orthotropic plates is first presented. A variational formulation of the Ritz method is used to establish an eigenvalue problem, and explicit solutions of plate local buckling coefficients in term of the rotational restraint stiffness (k) are obtained by using a unique shape function of combining the simply support ($k = 0$) and clamped ($k = \infty$) boundary condition effect. The generic and explicit formulations are then simplified to two specific cases of elastic restrained orthotropic plates: (1) ones with elastic restraints along the loaded edges (i.e., rotationally restrained along both the loaded edges (L-RR)) and (2) the others with elastic restraints along unloaded edges (i.e., rotationally restrained along both the unloaded edges (U-RR)). The explicit local buckling formulas of rotationally restrained plates of both the cases are validated with the exact transcendental solutions and finite element numerical modeling.

Several simple and common cases of the plate buckling solutions are derived from the generic solution, and they are consistent with the ones in the existing literature, thus further demonstrating the validity of the present solution. The present explicit formulation can be applied effectively to determine the local buckling capacities of composite plates with elastic restraints along either the loaded or the unloaded edges and can be further used to predict the local buckling strength of honeycomb sandwich structures and thin-walled FRP structural shapes. The explicitness of the local buckling formulas developed in this study could greatly simplify the design procedures and assist the practicing engineers in design analysis and optimization of composite structures.

Keywords: Local buckling; Explicit design; Composite structures; Discrete plate analysis; the Ritz formulation; variational formulation; Orthotropic plates.