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An analytical solution for axisymmetric buckling of annular plates based on perturbation technique

Saeed Abolghasemi[1], Hamidreza Eipakchi[2] and Mahmoud Shariati[3]

Abstract

This article investigates the axisymmetric buckling of annular plates under in-plane loading applied at the inner and outer boundaries. The first order shear deformation theory is used to represent the displacement field and the governing equations are derived from the principle of virtual work. Unlike the circular plate in which the prebuckling stress components are constant, for an annulus, these stress components are functions of the radial distance from the plate center. As a consequence, the resulting eigenproblem, which is in the form of coupled differential equations with variable coefficients, does not have a closed form solution. In this article, an asymptotic approximation based on the perturbation technique is introduced to solve this problem. A parametric analysis is performed and the effects of different combinations of boundary conditions at the inner and outer edges, load ratios, inner to outer radius ratios and thicknesses are investigated. The obtained results are in a good agreement with the numerical data and also with the other references.

Keywords:

Annular plate, Buckling load, Perturbation technique, Analytical solution, In-plane loading.

Introduction

The stability analysis of circular and annular plates has wide applications in various engineering fields such as ships and aerospace structures. Different approximate methods have been presented for vibration and buckling analysis of these plates, e.g the Ritz method, the finite element (FE) and the differential quadrature (DQ) method.

Majumdar [1] presented an analytical solution for buckling of an annular plate with clamped outer edge and free inner edge. The plate was modeled by the classical plate theory (CPT). Ramaiah and Vijayakumar [2] used the Ritz method with simple polynomials as admissible functions to investigate the buckling of annular plates under uniform compression. The buckling and vibration of annular plates with variable thicknesses was investigated by Gupta and

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