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Axial buckling of perforated plates reinforced with strips and middle tubes

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Highlights

- Perforated plates with similar dimensions as perfect ones have smaller buckling axial load.
- Buckling load decreases with increasing the hole size.
- In plates with known radius of the hole, application of reinforcing strips would increase strength of the buckling.
- Increasing the strip width linearly increases the buckling load.
- Attaching a tube within the holed plate increases the buckling load.

Abstract
Global buckling of perforated plates reinforced with circumferential strip or short tube is investigated. Effects of the hole radius, width of the strip, thickness and radius of the tube and boundary conditions are studied numerically and experimentally. Axial buckling loads of the holed plates decrease versus the hole radius. By using the strip or tube, the buckling strength increases significantly. In some cases, the stiffened plate has buckling load greater than the perfect plate. Numerical studies showed that the increasing restraints at the boundaries increase the buckling strength in any case and geometry of the plate.
Keywords: buckling load, reinforced plates, circular hole, compressive loading.

1. Introduction

Thin plates are among the widely implemented components in construction of various structures as ships and aero planes. When a plate is subjected to compressive loading, examining the buckling becomes important. Investigating the mechanical behavior of the plates and determining their buckling forces in different cases including the type of loadings, support conditions and plate geometry have been conducted by many researchers[1-4]. Perry [5] has studied on the buckling of elliptical plates by solving their corresponding nonlinear static problem. Buckling of the rectangular plates subjected to different cases of non-uniform loadings such as concentrated, local and sinusoidal loadings are studied by Jana and Bhaskar [6], [7]. They utilizing a numbers of Airy stress functions based on the principle of superposition to solving the problem of pre-buckling to determine the in-plane stress field of the plate. Then by applying the Galerkin method, they studied the buckling based on the classical theory for different loading cases. Bert and Devarakonda [8] investigated the buckling of rectangular plates with simple boundary conditions at the edges which were subjected to a sinusoidal loading. Chen and Liew [9] investigated the effects of three types of concentrated loading, local uniform and parabolic shaped loading on the buckling load of functionally graded composite plates. The formulation of the problem is based on the meshless method and approximation of displacement fields based on the radial basis functions. Roberts and Azizian [10] examined resistance to buckling of the square plates with the central hole against the uniaxial and biaxial compressive loads and also shear loads. Komur [11] investigated resistance to buckling of the square plates with the elliptical shaped hole. Also, Komur and Sonmez [12] studied the buckling behavior of the rectangular plates with a hole under partial edge loadings. Paik presented an empirical relationship for calculation of the collapse load of the square plates with the hole under edge shear load [13], axial compressive loads along short edges [14] and combined biaxial and shear loads [15] with simple support conditions at both sides. Ghannadpour et al. [16] investigated the buckling load of cross-ply laminated composite plates include elliptical or circular holes. Effects of the hole size, its shape, plate aspect ratio and different boundary conditions were determined. Moen and Schafer [17] determined the elastic buckling loads of the plates with