10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

The Effect of Biaxial Loading on the Buckling of Simply Supported Thick Rectangular Plates

Bahram Navayi-Neya[1], Abdollah Moslemi[2], Elham Alizade[3]

1- Associate Professor, Babol Noshirvani University of Technology, Babol, Iran
2- Ph.D. Student in Structural Engineering, Babol Noshirvani University of Technology, Babol, Iran
3- M.Sc. of Structural Engineering, Babol Noshirvani University of Technology, Babol, Iran

a.moslemi.v@gmail.com

Abstract

By increasing the thickness of plates, the effects of shear strains are more pronounced and implementing the thin-walled structure theories, which neglect the shear deformations, yield a high inaccuracy. On the other side, including the shear deformations in analyses, makes the process so difficult and in exact solutions somehow impossible to solve. Buckling analysis of structures is generally intricate, and for plates, even thin plates, finding buckling loads are probed by researchers. So it’s clear that buckling analysis of thick plates especially in biaxially loaded plates by exact methods would be noteworthy, which is presented in this paper. Herein by implementing an efficient exact method, the effect of biaxial loading on the thick isotropic rectangular plates is considered. This is done by analyzing several cases of plates with different aspect ratios, different thickness ratios, and under the various combinations of uni- or biaxial loadings.
Keywords: Thick Plates, Buckling analysis, Biaxial Loading, Exact solution

1. INTRODUCTION

It is well known that neglecting the transverse shear deformation will lead to an overestimate for the buckling load in comparison with more accurate methods. Reissner [1] proposed a simple plate theory, which takes the shear deformation into account for bending analysis. This theory was afterwards extended to vibrating plates including the rotary inertia by Mindlin [2], plate buckling by Herrmann and Armenakas [3] and also by and Robertson [4]. In these plate theories, the stress distribution through the plate thickness is simply assumed to be constant. Thus, these theories use a shear correction factor to adjust the shear stress distribution in order to compensate the error.

Srinivas and Rao [5] developed a 3-D linear, small deformation solution for the bending, vibration and buckling of simply supported thick orthotropic rectangular plates and laminates in theory of elasticity point of view. They assumed that the displacements u, v and w to be produced by trigonometric functions of x and y multiplied by an unknown function of z. Matsunaga [6] just treated the out of plane buckling problems of plates subjected to in-plane stress, however, he considered the in-plane and out-of-plane buckling of thick plates subjected to in-plane load in [7 and 8] in which he clarified the applicability and reliability of the 2-D higher order theory through static boundary-value problems for an extremely thick plate.

The exact solutions for plate’s problems, especially buckling ones are difficult to be achieved. Because of this, some numerical methods like finite stripe, finite element, and other approximate methods are so common in this field. Dawe and Roufaeil [9] studied buckling of rectangular Mindlin plates employing two related methods; Rayleight-Ritz method and its piece-wise form, the finite strip method. The applied membrane load can involve biaxial normal stress plus shear stress. By using the finite strip method, Plank and Wittrick [10] have offered a simple relation to relate the vibration and buckling problems. Benson and Hinton [11] and also Hinton [12] have solved the buckling of moderately thick plates with two simply supported opposite edges using the finite strip method considering the curvature terms; but their method is limited to the cases in which the strips are simply supported and have normal stresses at two edges. By employing the spline strip method, Mizusawa [13] analyzed the buckling problem of Mindlin plates with the thickness tapering linearly in one direction.

Analysis of biaxially loaded plates, give some new results about buckling that makes these problems so different from the problems of uniaxially loaded plates. Wittrick [14] obtained the exact 3-D solution for eigenvalue problem for buckling of rectangular plates subjected to biaxial compression. Bui et al. [15]