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On the simple and mixed first-order theories for plates resting on elastic foundations

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Abstract This article investigates the bending response of an orthotropic rectangular plate resting on two-parameter elastic foundations. Analytical solutions for deflection and stresses are developed by means of the simple and mixed first-order shear deformation plate theories. The present mixed plate theory accounts for variable transverse shear stress distributions through the thickness and does not require a shear correction factor. The governing equations that include the interaction between the plate and the foundations are obtained. Numerical results are presented to demonstrate the behavior of the system. The results are compared with those obtained in the literature using three-dimensional elasticity theory or higher-order shear deformation plate theory to check the accuracy of the simple and mixed first-order shear deformation theories.

1 Introduction

A plate on an elastic foundation belongs to the problem of mutual action between two media. Early research adopted single-parameter Winkler's model to simulate the foundation. It considered that the displacement on a foundation surface is limited only on the loaded domain, which conflicts with the practical response situation. In some of the analyzes of the plates on elastic foundations, a single-parameter K_1 is used to describe the foundation behavior [1]. In this model, it is assumed that there is a proportional interaction between the external forces and the deflection of the applied point in the foundation. A two-parameter elastic foundation model can reflect the practical deformation of a foundation, so it is widely accepted by investigators.

Plates supported by elastic foundations are commonly encountered technical problems in many engineering applications. The studies of plates resting on elastic foundations have attracted the attention of many researchers [2–5]. Some other researchers have modeled the foundations with two parameters. One of these models is

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