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Free Vibration Analysis of Isotropic Plates by Alternative Hierarchical Finite Element Method Based on Reddy's C1 HSDT

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Abstract

This paper presents the free vibration analysis of isotropic thick rectangular plates, based on higher order shear deformation theory (HSDT). The plate theory ensures a zero shear-stress condition at the top and bottom surfaces of the plate, and do not requires a shear correction factor. The model requires inter-element C1 continuity for the transverse displacement. To overcome this hindrance, a new hierarchical p-element with six degrees of freedom per node is developed and used to find natural frequencies of thick plates. Convergence studies and comparison have been carried out for with different boundaries conditions. It is shown that the present element enables rapid convergence.

Keywords: Free vibration; Thick isotropic plates; hierarchical finite element method; third order C1 HSDT.

1. Introduction

Thick plates are extensively used in many fields of engineering, including aerospace, civil structures, hydraulic structures, etc. For plates analysis different theories exists, the classical plates theory (CPT) is adopted for thin plates, where the effect of shear deformation is neglected [1]. The Reissner. Mindlin plate theory is used for moderately thick plates, known as the first order shear deformation theory (FSDT), in which the effect of shear deformation is considered by using a proper choice of a shear correction factor which depend on loading and boundary conditions [2]. The simplifying assumptions made in CPT and FSDT are reflected by the high percentage errors in the results of thick plates analysis. For these plates, higher-order shear deformation theories (HSDT) are required. The HSDT ensure a zero shear-stress condition on the top and bottom surfaces of the plate, and do not require a shear correction factor, which is a major feature of these theories.

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