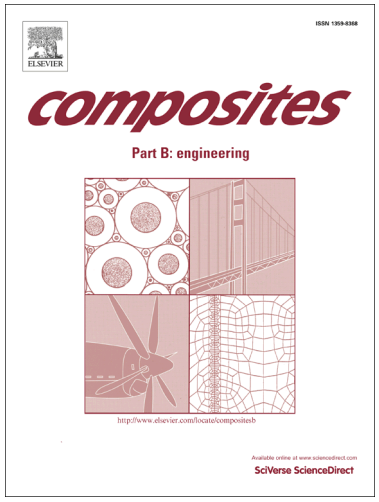

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PII: S1359-8368(14)00189-9
DOI: http://dx.doi.org/10.1016/j.compositesb.2014.04.033
Reference: JCOMB 3018

To appear in: *Composites: Part B*

Received Date: 4 April 2014
Revised Date: 24 April 2014
Accepted Date: 28 April 2014

Please cite this article as: Attallah, K.M.Z., Yu, M., Ye, J.Q., Three-Dimensional State Space Spline Finite Strip Analysis of Angle-plied Laminates, *Composites: Part B* (2014), doi: http://dx.doi.org/10.1016/j.compositesb.2014.04.033

Three-Dimensional State Space Spline Finite Strip Analysis of Angle-plied Laminates

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Abstract

In this paper, a combined spline finite strip and state space approach is introduced to obtain three-dimensional solutions of laminated composite plates with general boundary conditions. Spline and linear polynomial functions are used, respectively, as the shape functions in the longitudinal and transverse directions of the strips. The variations of the displacements and stresses through the thickness of a strip are calculated through solving differential equations in the form of the state space equations. This method allows the displacements and stresses to be computed simultaneously at all nodes along the nodal lines. In comparison with three dimensional finite element solutions, the current method guarantees the continuity of all the displacements and through-thickness stresses across all interfaces of material layer and, therefore, provides more reliable and accurate results. It can also reduce the computational effort when compared with the traditional three-dimensional finite element and finite strip methods.

Keywords: A: Laminates; Plates, B: Anisotropy; Interface, C: Computational modelling; Finite element analysis (FEA).

1. Introduction

The semi-analytical finite strip method was regarded as a very efficient method for the analysis of prismatic orthotropic structures under distributed loading. This was conducted by combining polynomial and trigonometric functions for the displacement field. However, the method has difficulties in dealing with concentrated forces, multi-spans, complex boundary conditions, etc. The adopted trigonometric functions also limited its applications to angle-ply laminates due to the coupling between tension and bending.

In order to overcome these difficulties, a mathematical tool known as B-spline was used to approximate the displacements along the longitudinal direction, i.e. to form a spline finite strip. Spline functions (Bojanov, et al, 1993) were proposed as it was considered that the specially structured functions can approximate both displacements and stresses accurately and satisfy complex boundary

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