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A GLOBAL-LOCAL MODEL FOR THE ANALYSIS OF LAMINATED COMPOSITE PLATES

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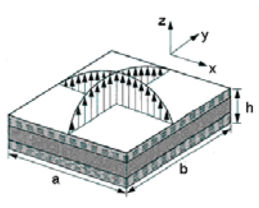
ABSTRACT

The objective of this work is to propose a finite element model for the stress analysis of laminated composite plates. The model combines the numerical efficiency of the First Order Shear Deformation Theory (FSDT) and the accuracy of the Full Layerwise Laminate Theory (FLLT) [1,2,3,4]. Additionally, in order to obtain the stress field with a higher order of accuracy than that naturally obtained from the finite element approximation, a stress recovery strategy is accounted[5,5].

The principal advantages of the Equivalent-Single Layer (ESL) laminate theories, as the FSDT theory, are the simplicity and the low computational cost. Nevertheless, they are of limited value in modelling primary critical structural components, mainly, due to their inability to describe, with suitable precision, the state of stress and strain at the ply or at fiber/matrix interface, a mandatory issue in assessing the localized regions of potential damage initiation. Thus, the analysis of primary composite structures may be modelled by using a layerwise laminate theory that contains full 3-D kinematics and constitutive relations [1,2].

When the structure is composed by both primary and secondary components, the adoption only of Finite Elements based on FLLT theory may produce a ineffective numerical model, because of the great numbers of involved variables. Trying to solve these problems with maximum accuracy and minimal computational cost, Robbins and Reddy[1,3] proposed a multiple model by connecting together, in the same computational domain, the ESL and FLLT elements. In the present work, the proposed element is also based on this strategy, but differs from them by the kind of interpolation adopted and by the inclusion of the stress recovery to improve the final result.

Numerical studies are conducted by considering various lamination arrangements, external loads and boundary conditions. For instance, the accuracy of the proposed model is noticeable on the stress distributions at critical points of the plate, as shown on figure 1.



Load: $q(x,y) = q_0 .\text{sen}\left(\frac{\pi x}{a}\right).\text{sen}\left(\frac{\pi y}{b}\right)$

Geometrical Parameters:

$a = b$ $a = 4h$

Material properties:

E_{11}=25 *MPa* $E_{22} = E_{33}$ = *1MPa*

$G_{12} = G_{13}$ = *0.5MPa* G_{23} = *0.2MPa*

$\nu_1 = \nu_2 = \nu_3 = 0{,}25$

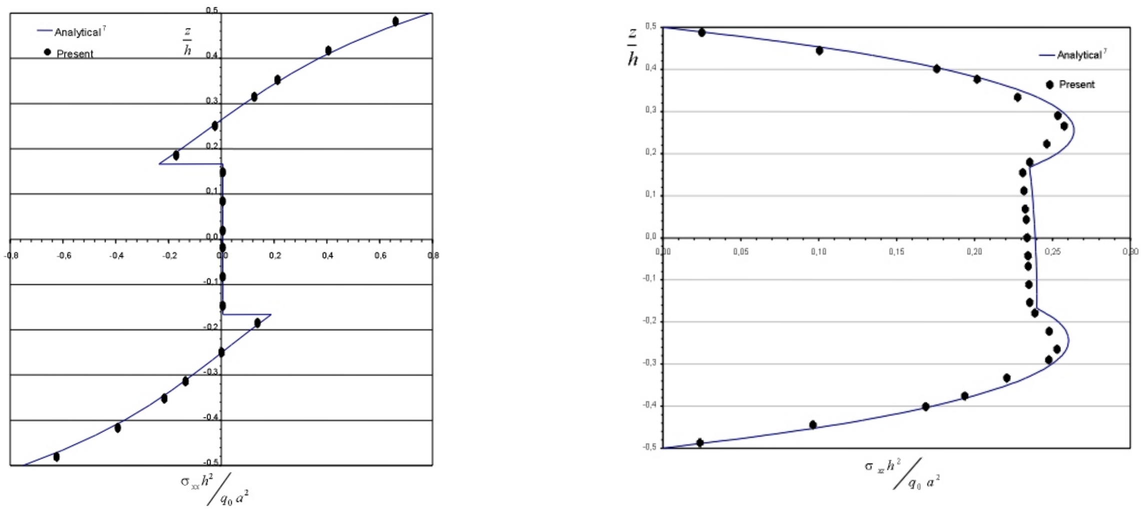


Figure.1 - Simply supported [0^0, 90^0,0^0] plate under sinusoidal load [2,4,7].
σ_{xx} at the central point and and σ_{xz} near the edge orthogonal to the x-axis.

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