MULTILAYER THEORY FOR DELAMINATION STRESSES IN SEMICIRCULAR LAMINATED COMPOSITE CURVED BARS

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Composites laminates are widely used in both civil and military aircraft structures and gases cylinders leading to weight saving. However, study of the behaviour of such materials has shown that they are more damage sensitive than metallic material especially to delamination due to edge effect or low velocity impact [1]. In order to improve the performance of composite structures, advances must be made in the prediction of delamination growth and the evaluation of residual strength. The aim of this paper is to extend a delamination model valid for the plate in small displacement [2] or large displacement [3] to the case of curved structures as shells. Two kinds of approach are commonly used to study delamination growth, (i) the damage mechanics approach in which the interface enclosing the delamination is modelled by a damageable material Delamination is obtained when the damage variable reaches its maximum value [4 - 6] and (ii) the fracture mechanics approach which the present work is part.

There are two classes of problems on the construction of bundles of different models and the development of methods for solving problems of strength, stability and dynamics of thin layered structures with structural defects. The first of these are problems of fracture mechanics, the second class of problems related to the issues the study of stress-strain state of structures with the local bundles.

In such an approach, the de1amination characteristic is the stress intensity factors [7 - 9] and more generally the local energy release rate computed using either the virtual closure technique [9]. In most engineering applications, laminated composite structures have certain curvatures (for example, curved panels and curved beams). If the curved composite structure is .subjected to bending that tends to flatten the composite structure, tensile stresses can be generated in the thickness direction of the composites. Also, shear stresses could be induced if the bending is not a "pure" bending. Under normal operations, if the above type of bending occurs cyclically, open-mode delaminations or shear-mode delaminations could nucleate at the sites of peak interlaminar tensile stresses or at the sites of peak interlaminar shear stresses. Continuation of these bending cycling will cause the delamination zones to grow in size and ultimately cause the composite structures to lose their structural integrity (loss of stiffness and strength) due to excessive delaminations. The type of delamination failure (open mode or shear mode) depends on which The classical anisotropic elasticity theory was used to construct multilayer theory for the calculation of the stress and deformation fields induced in the multilayered composite semicircular curved bar subjected to end forces and end moments by using program Mathcad 14.

The radial location and intensity of the open mode delamination stress were calculated and were compared with the results obtained from the anisotropic continuum theory and ANSYS method. The multilayer theory gave more accurate type of interlaminar strength (tensile or shear) is reached first.
The MATH-CAD 14 method were used to perform similar delamination analysis of the multilayered semicircular composite curved bar subjected to end forces and end moments. The resulting predictions of locations and intensities of peak radial stresses are compared with the results of the anisotropic continuum theory presented in reference [7].

The classical anisotropic elasticity theory was used to construct multilayer theory for the calculation of the stress and deformation fields induced in the multilayered composite semicircular curved bar subjected to end forces and end moments by using program Mathcad 14.

The radial location and intensity of the open mode delamination stress were calculated and were compared with the results obtained from the anisotropic continuum theory and ANSYS method. The multilayer theory gave more accurate prediction of the location and intensity of the open mode delamination stress than those calculated from the anisotropic continuum theory.

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