Asociación Argentina
de Mecánica Computacional

Mecánica Computacional Vol XXXVII, págs. 1561-1561 (resumen)
A. Cardona, L. Garelli, J.M. Gimenez, P.A. Kler, S. Márquez Damián, M.A. Storti (Eds.)
Santa Fe, 5-7 Noviembre 2019

A FINITE ELEMENT-BASED MODEL TO COMPUTE THERMAL EXPANSION COEFFICIENTS OF CROSS-PLY LAMINATES WITH RANDOMLY SPACED CRACKS

Néstor D. Barulich[a,b], Luis A. Godoy[a,c] and Patricia M. Dardati[b]

[a]*Instituto de Estudios Avanzados en Ingeniería y Tecnología, IDIT, CONICET-Universidad Nacional de Córdoba, Av. Vélez Sársfield 1611, Córdoba, Argentina. nbarulich@frc.utn.edu.ar, lgodoy@com.uncor.edu, http://www.inv.idit.efn.uncor.edu*

[b]*Grupo de Investigación y Desarrollo en Mecánica Aplicada, GIDMA, Facultad Regional Córdoba, Universidad Tecnológica Nacional. Maestro M. Lopez esq. Cruz Roja Argentina, Córdoba, Argentina. pdardati@gmail.com, http://www.frc.utn.edu.ar*

[c]*Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Av. Vélez Sársfield 1611, Córdoba, Argentina. http://www.portal.efn.uncor.edu/*

Keywords: Cross-ply laminates, Finite Elements, Transverse matrix cracks, Thermal expansion.

Abstract. Fiber Reinforced Composite (FRC) laminates subjected to membrane and bending loads suffer an early damage mode called transverse cracking or matrix cracks in which cracks appear in some laminae spanning the lamina thickness. This damage mode seldom produces the laminate final failure but, under higher loads, it induces catastrophic failure modes such as delamination or fiber breakage. It has been shown in the literature that transverse cracking reduces the laminate stiffness and Coefficients of Thermal Expansion (CTE). It was also shown that these laminate properties are key aspects in predicting delamination and fiber breakage onset under mechanical and thermal loads. Most studies found in literature focused on uniformly spaced transverse cracks but experiments show that cracks are always randomly spaced. This work presents a numerical model with two scales to predict the laminate CTE with randomly spaced transverse cracks. In a smaller scale, often called meso-scale, a portion of the laminate is represented together with transverse cracks. This domain is called Representative Volume Element (RVE) and it is modeled using a two-dimensional Finite Element model. The larger scale, called macro-scale, considers a classic laminated plate model (Kirchhoff plate model). These scales are related by the periodic boundary conditions and the Hill-Mandel principle. After mesh convergence studies, the model was verified with numerical data taken from the literature for the membrane CTE's. Parametric studies on the influence of the Laminate Staking Sequences (LSS), the random crack location, the transverse crack density, and the material properties in cross-ply laminates are presented. It was found that the membrane and bending CTE's of cross-ply laminates with randomly spaced cracks appears always above the values for a uniformly cracked laminate. This model will provide benchmark results for more simplified models.