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ASSESSMENT OF COHESIVE LAW EXTRAPOLATION PROCEDURE OF ADHESIVELY BONDED JOINTS UNDER DIFFERENT ENVIRONMENTAL CONDITIONS.

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ABSTRACT

Recently, a compliance-based data reduction method has been proposed that allows the determination of the energy release rate J and the relative crack tip displacement Δ in both mode I and mode II [1,2] as a function of the equivalent crack advance.

The method based on beam theory assumes that all effects associated with damage development are included in the equivalent crack length obtained from the compliance variation.

Analytical expressions have been derived for the flexibility C, the relative displacement at the crack tip Δ and the J-Integral, all of which are a function of the elastic properties of the adherends, the test configuration, the cross-sectional dimensions of the specimens, the applied load and the equivalent crack length (a_e).

By rewriting the expressions of C, the Δ and the J-Integral as multiplication of separate functions, new factored expressions are defined with respect to the applied load and the adhesive and adherend thicknesses, of the flexibility (C_{0i}), the J-Integral (J_{0i}) and the crack tip displacement (Δ_{0i}) for each fracture mode.

Assuming that all damage-associated effects are included in the equivalent crack length, and according to the polynomial expressions of J_{0i}, C_{0i} and Δ_{0i} with respect to it, invariant relations between J_{0i}- C_{0i} and Δ_{0i}-C_{0i} are obtained for any given adhesive-adherend thickness ratio of a given material system and test configuration in both mode I and mode II.

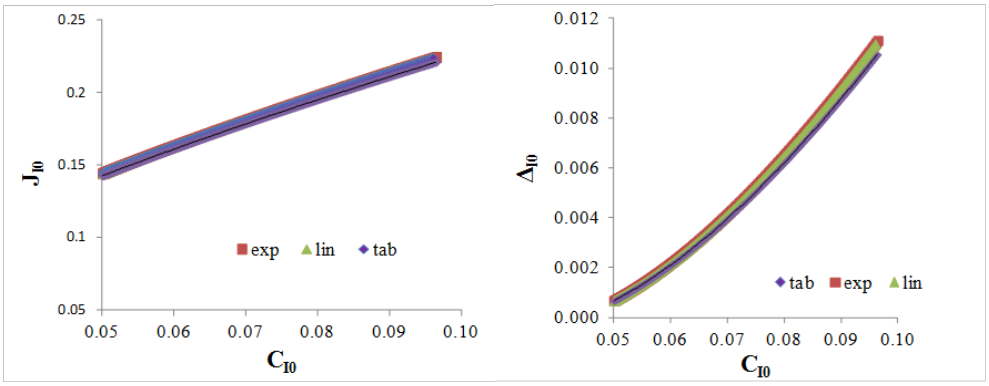

Figure 1: J_{0I}-C_{0I} y Δ_{0I}-C_{0I} invariant curves in mode I.

If the invariant curves are calibrated for a given material system and test configuration, then it would be possible to extrapolate the J and Δ, and consequently, the cohesive law for different adhesive-adherend thicknesses of the same material system and test configuration by processing only with the load-displacement curve in both mode I and mode II.

The present work evaluates the validity of the extrapolation method using the master curves determined under laboratory conditions to determine the properties of adhesive bonds under different environmental conditions.

REFERENCES

[1] A. Arrese, A. Boyano, J. de Gracia, F. Mujika A novel procedure to determine the cohesive law in DCB tests. *Composites Science and Technology*, 2017, **152**, p. 76- 84. https://doi.org/10.1016/j.compscitech.2017.09.012

[2] A. Arrese, N. Insausti, F. Mujika, M. Perez-Galmés, J. Renart, A novel experimental procedure to determine the cohesive law in ENF tests *Composites Science and Technology*, 2019, **170**, p. 42–50. https://doi.org/10.1016/j.compscitech.2018.11.031