SELECTION OF THE MOST SUITABLE CZM CONDITIONS IN THE FINITE ELEMENT STRENGTH PREDICTION OF ADHESIVE JOINTS

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ABSTRACT

The adhesively-bonding technique is widely used in the industry to join components. Strength prediction of these joints with Cohesive Zone Models (CZM) coupled to Finite Element (FE) analyses is one of the most widespread methods, which allows simulation of crack propagation in the adhesive layer. The present study addresses this issue, and more specifically the influence of the damage law shape used to simulate the adhesive layer behaviour in the FE model of single-lap adhesive joints. This procedure enabled an estimation of the damage law influence on the strength prediction under different material conditions. It was showed that the predicted strength of joints with ductile adhesives is highly dependent on the CZM shape, and that the trapezoidal CZM is the best approximation. Conversely, brittle adhesives are accurately modelled disregarding the damage law shape.

KEYWORDS: Bonded joints, Finite Element Method, Adhesives, Cohesive zone models, Strength prediction.

REFERENCES

[1] **Lee M.J., Cho T.M., Kim W.S., Lee B.C., Lee J.J.**, *Determination of cohesive parameters for a mixed-mode cohesive zone model*, International Journal of Adhesion & Adhesives, vol. 30, pp. 322-328, 2010.
[2] **Wooley G.R., Carver D.R.**, *Stress concentration factors for bonded lap joint*, Journal of Aircraft, vol. 8, pp. 817-820, 1971.
[3] **Tsai M.Y., Morton J.**, *An evaluation of analytical and numerical solutions to the single-lap joint*, International Journal of Solids and Structures, vol. 31, pp. 2537-2563, 1994.
[4] **da Silva L.F.M., Campilho R.D.S.G.**, *Advances in Numerical Modelling of Adhesive Joints*, Heidelberg: Springer, 2011.
[5] **Blackman B.R.K., Brunner A.J., Williams J.G.**, *Mode II fracture testing of composites: a new look at an old problem*, Engineering Fracture Mechanics,vol. 73, pp. 2443-2455, 2006.
[6] **Campilho R.D.S.G., de Moura M.F.S.F., Pinto A.M.G., Morais J.J.L., Domingues J.J.M.S.**, *Modelling the tensile fracture behaviour of CFRP scarf repairs*, Composites Part B – Engineering, vol. 40, pp. 149-157, 2009.
[7] **Pandya K.C., Williams J.G.**, *Measurement of cohesive zone parameters in tough polyethylene*, Polymer Engineering Science, vol. 40 pp. 1765-1776, 2000.
[8] **Carlberger T., Stigh U.**, *Influence of layer thickness on cohesive properties of an epoxy-based adhesive – an experimental study*, The Journal of Adhesion, vol. 86, pp. 814-833, 2010.
[9] **Liljedahl C.D.M., Crocombe A.D., Wahab M.A., Ashcroft I.A.**, *Damage modelling of adhesively bonded joints*, International Journal of Fracture, vol. 141, pp. 147-161, 2006.
[10] **Pinto A.M.G., Magalhães A.G., Campilho R.D.S.G., de Moura M.F.S.F., Baptista A.P.M.**, *Single-lap joints of similar and dissimilar adherends bonded with an acrylic adhesive*, The Journal of Adhesion, vol. 85, pp. 351-376, 2009.
[11] **Xie D., Salvi A.G., Sun C., Waas A.M., Caliskan A.**, *Discrete cohesive zone model to simulate static fracture in 2D triaxially braided carbon fiber composites*, Journal of Composite Materials, vol. 40, pp. 2025-2046, 2006.
[12] **Campilho R.D.S.G., de Moura M.F.S.F., Domingues J.J.M.S.**, *Modelling single and double-lap repairs on composite materials*, Composites Science & Technology, vol. 65, 1948-1958, 2005.
[13] **da Silva L.F.M., da Silva R.A.M., Chousal J.A.G., Pinto A.M.G.**, *Alternative methods to measure the adhesive shear displacement in the thick adherend shear test*, Journal of Adhesion Science and Technology, vol. 22,pp. 15-29, 2008.
[14] **Campilho R.D.S.G., de Moura M.F.S.F., D.A. Ramantani, Morais J.J.L., Domingues J.J.M.S.**, *Buckling behaviour of carbon-epoxy adhesively-bonded scarf repairs*, Journal of Adhesion Science and Technology, vol. 23, pp. 1493-1513, 2009.
[15] *** Abaqus® HTML Documentation, DassaultSystemes, 2009.