Universita` di Brescia - DICATAM
Aula RIUNIONI, 10 giugno 2015, ore 14:00

STATISTICAL ANALYSIS FOR INTERFACE FRACTURE AND DELAMINATION FAILURE OF COMPOSITES

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Abstract

A methodology for measuring the interface fracture toughness of a crack between two isotropic, homogeneous materials and a delamination between two laminae of unidirectional composite materials of differing directions is presented. Four cases are considered. Two isotropic material pairs are described: glass/epoxy and two ceramic clays. Similar studies are presented for two cross-ply laminates: 00/900 and +450/−450.

The Brazilian disk specimen was used to carry out mixed mode fracture tests. The load and crack or delamination length at fracture were measured and used in a finite element analysis to determine the displacement field. An interaction energy or M-integral was used to determine the stress intensity factors at failure. These in turn were employed to obtain the critical interface energy release rate Gic and one phase angles ψ in two dimensions or two phase angles ψ and ϕ in three dimensions which measure the mode mixity. For the M-integral and for each interface crack or delamination, the first term of the asymptotic solution of the field quantities is required. For two isotropic materials, these solutions are well known. For the laminates described here, they were determined by the Stroh and Lekhnitskii formalisms. A failure criterion determined from first principles is presented. The values of Gic and ψ in two dimensions or ψ and ϕ in three dimensions are used to specify the criterion for each material pair. A statistical analysis is presented. Two approaches are taken; one uses the t-statistic to predict a 10% probability of failure; the second uses a standard normal variate to predict a 10% failure probability with 95% confidence.

Acknowledgements

Prof. Banks-Sills is currently Visiting Professor at the University of Brescia, sponsored by the hosting institution on a specific grant.

Short Bio

Leslie Banks-Sills is an Emeritus Professor at Tel Aviv University. She serves on the editorial boards of Engineering Fracture Mechanics, International Journal of Fracture, International Journal of Structural Integrity and Strain. She has consulted for various organizations in Israel, as well as for NASA, regarding problems of fracture in structures.

Professor Banks-Sills completed a B.A. degree in mathematics at Queens College of the City University of New York in 1965, an M.Sc. degree in engineering mechanics from the University of Michigan in 1973 and a Ph.D. degree in engineering from Harvard University in 1977. After carrying out post-doctoral studies at Brown University, she joined the Faculty of Engineering at Tel Aviv University in 1979. From 1993 through 1997, and again from 2001 through 2005, she served as Chairman of the Department of Mechanics, Materials and Structures. She is Director of the Dreszer Fracture Mechanics Laboratory at Tel Aviv University. She was a visiting scientist at Wright Patterson Air Force Base in the U.S. and the Research Center in Karlsruhe, Germany. The prestigious Mary Shepard B. Upson Visiting Professorship at Cornell University was awarded to her in 1997. Since 2001, she is an Adjunct Professor in the School of Civil and Environmental Engineering at Cornell University. She held the Lise Meitner Chair at Lund University, Sweden, from July, 2006 until December, 2006. Between 2009 and 2012, she was a Guest Professor in the Division of Solid Mechanics at Lund University. She was a Fellow of the Japan Society for the Promotion of Science at Kyoto University in 2009-2010. In the spring of 2015, she will be a Visiting Professor at Brescia University in Italy.

She received the Teaching Excellence Award in Mechanical Engineering, Tel Aviv University (1995-1996) and the Teaching Excellence Award, Faculty of Engineering, Tel Aviv University (1998-1999). She was elected as an Honorary Fellow of the International Congress of Fracture in 2005 and served on the Executive Board of this organization. The Technion in Haifa awarded her the Hanin Prize for her contributions to aeronautical engineering in 2006. She is the recipient of the 2006 Honorary Membership to ESIS (European Society of Structural Integrity) for her outstanding original technical contributions to fracture mechanics and good service to the international fracture mechanics community. She was elected as a Fellow of the American Academy of Mechanics in 2008, a Fellow of the Japan Society for the Promotion of Science (2009-2010), a member of the European Academy of Sciences and Arts in 2012 and she received an Honorary Doctorate from Lund University in 2014. In 2006, she was elected one of two Vice Presidents of ESIS and is currently the President (2010-2018). In addition, she is a Vice President of EURASEM (European Society of Experimental Mechanics) since 2008.

Her research interests include the use of analytical, numerical and experimental methods to treat fracture problems which include homogeneous materials, bonds, interfaces and composites. In particular, recently she and her group have been examining the propagation of cracks in piezoelectric materials, delaminations in cross-ply and woven composites and the effect of carbon nano-tubes in polymer materials.

She has participated in over 90 international conferences and been on the scientific committees of many of them. She has guided over 45 Master, Ph.D. and post-doctoral students many of whom hold key positions in academia and industry. She has published over 100 papers in international journals and edited the book Advances in Mathematical Modeling and Experimental Methods for Materials and Structures, The Jacob Aboudi Volume, Springer, The Netherlands (2010) with Dr. Rivka Gilat.

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