



Adhesively Bonded Joints:

Testing, Analysis, and Design

W.S. Johnson, *editor*



STP 981

STP 981

***ADHESIVELY BONDED
JOINTS: TESTING,
ANALYSIS, AND DESIGN***

W. S. Johnson, editor



ASTM
1916 Race Street
Philadelphia, PA 19103

Library of Congress Cataloging-in-Publication Data

Adhesively bonded joints: testing, analysis, and design/W.S. Johnson, editor.

(ASTM special technical publication; 981)

"The International Symposium on Adhesively Bonded Joints: Testing, Analysis, and Design was held in Baltimore, Maryland, on 10-12 September 1986. The event was sponsored by ASTM Committee D-14 on Adhesives"—Foreword.

"ASTM publication code number (PCN) 04-981000-25."

Includes bibliographies and index.

ISBN 0-8031-0993-8

1. Adhesive joints—Testing—Congresses. I. Johnson, W. S. (W. Steven) II. International Symposium on Adhesively Bonded Joints: Testing, Analysis, and Design (1986: Baltimore, Md.) III. ASTM Committee D-14 on Adhesives. IV. Series.

TA492.A3A34 1988

88-6912

668'.3-dc19

CIP

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1988

NOTE

The Society is not responsible, as a body,
for the statements and opinions
advanced in this publication.

Peer Review Policy

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM.

Foreword

The International Symposium on Adhesively Bonded Joints: Testing, Analysis, and Design was held in Baltimore, Maryland, on 10-12 September 1986. The event was sponsored by ASTM Committee D-14 on Adhesives. W. S. Johnson, NASA Langley Research Center, served as symposium chairman and has edited this publication.

Contents

| | |
|---------------------|----------|
| Introduction | 1 |
|---------------------|----------|

MECHANICAL TESTING

| | |
|--|-----------|
| Effect of Removing Eccentricity from Button Tensile Adhesion Tests—G. P. ANDERSON, S. CHANDAPETA, AND K. L. DEVRIES | 5 |
| An Examination of Mixed-Mode Debonding in the Blister Test—K. M. LIECHTI AND E. C. HANSON | 13 |
| A Uniform Pure Shear Testing Specimen for Adhesive Characterization—V. WEISSBERG AND M. ARCAN | 28 |
| Mechanical Behavior Assessment of Epoxy Adhesive in the Double-Lap Joint—Y. GILIBERT, M. L. L. KLEIN, AND A. RIGOLOT | 39 |
| Determination and Verification of Elastic Parameters for Adhesives—D. JANGBLAD, P. GRADIN, AND T. STENSTRÖM | 54 |
| Chevron-Notched Specimens for Measuring Adhesive Fracture Toughness—J. SPINGARN | 69 |
| Development of Alternative Techniques for Measuring the Fracture Toughness of Rubber-to-Metal Bonds in Harsh Environments—D. A. DILLARD, K. M. LIECHTI, D. R. LEFEBVRE, C. LIN, J. S. THORNTON, AND H. F. BRINSON | 83 |
| A Test Specimen with Constant Stress Intensity Factor—H. L. GROTH | 98 |

STRESS ANALYSIS


| | |
|--|------------|
| Deformations and Strains in a Thick Adherend Lap Joint—D. POST, R. CZARNEK, J. D. WOOD, AND D. JOH | 107 |
| Factors Influencing Elastic Stresses in Double Cantilever Beam Specimens—J. H. CREWS, JR., K. N. SHIVAKUMAR, AND I. S. RAJU | 119 |
| Special Mixed Finite Elements for Interfacial Stress Analysis of Adhesively Bonded Joints—S. AIVAZZADEH, M. BICHARA, A. GHAZAL, AND G. VERCHERY | 133 |
| Determination of Stress Distribution in Double-Lap Joints, Matched Asymptotic Expansions and Conformal Mapping—Y. GILIBERT AND A. RIGOLOT | 145 |

FAILURE MECHANISMS

| | |
|--|-----|
| A Comparison of Pure Mode I and Mixed Mode I-III Cracking of an Adhesive Containing an Open Knit Cloth Carrier—E. J. RIPLING, P. B. CROSLY, AND W. S. JOHNSON | 163 |
| Application of Fracture Mechanics and Acoustic Emission to the Characterization of Adhesively Bonded Joints Tested in Mode I Opening—E. ZIANE AND C. CODDET | 183 |
| Debonding Characteristics of Adhesively Bonded Woven Kevlar Composites—S. MALL AND W. S. JOHNSON | 194 |

DESIGN AND DURABILITY

| | |
|---|-----|
| Effect of Adhesive Debond on Stress-Intensity Factors in Bonded Composite Panels—C. A. BIGELOW | 209 |
| Static Strength of Bolted and Adhesively Bonded Joints for Steel Structures—P. ALBRECHT AND A. H. SAHLI | 229 |
| Understanding Effects of Adhesive Ductility and Bondline Geometry on Tube-and-Socket Joint Performance—J. M. MILLER, J. L. HAMMILL, AND K. E. LUYK | 252 |
| Stress Analysis Concepts for Adhesive Bonding of Aircraft Primary Structure—R. B. KRIEGER, JR. | 264 |
| Environmental Effects on Fracture of Adhesively Bonded Joints—R. A. JURF | 276 |
| Environmental Durability of Adhesively Bonded Joints—L. R. PITRONE AND S. R. BROWN | 289 |
| Summary | 305 |
| Author Index | 309 |
| Subject Index | 311 |



ISBN 0-8031-0993-8