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(continued after index)

Weili Cheng and Iain Finnie

Residual Stress Measurement and the Slitting Method

 Springer

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Series Preface

Mechanical engineering, and engineering discipline born of the needs of the industrial revolution, is once again asked to do its substantial share in the call for industrial renewal. The general call is urgent as we face profound issues of productivity and competitiveness that require engineering solutions, among others. The Mechanical Engineering Series is a series featuring graduate texts and research monographs intended to address the need for information in contemporary areas of mechanical engineering.

The series is conceived as a comprehensive one that covers a broad range of concentrations important to mechanical engineering graduate education and research. We are fortunate to have a distinguished roster of consulting editors, each an expert in one of the areas of concentration. The names of the consulting editors are listed on page vi of this volume. The areas of concentration are applied mechanics, biomechanics, computational mechanics, dynamic systems and control, energetics, mechanics of materials, processing, thermal science, and tribology.

To
Weihsun and Joan

Preface

The early development of the slitting method is closely related to the work in Fracture Mechanics. G. Irwin's strain energy release rate is the foundation for computation of the crack compliance functions. H. F. Bueckner's principle for crack growth leads to the superposition principle for the release of the residual stresses. R. J. Hartrenft and G. G. Sih's, and G. Chell's expressions of K_I for shallow and deep cracks lead to an expression of K_I that works for both cases. The body force method introduced by H. Nisitani and his colleagues is a very useful tool for computing the compliance functions for a cut of finite width for near-surface measurements. The inherent-strain method developed by Y. Ueda and his colleagues has inspired the use of initial strains to approximate the residual stresses in the slitting method and the single-slice method.

The method of measuring residual stresses by a cut of progressively increasing depth was first tried in 1971 by S. Vaidyanathan and I. Finnie, who estimated the residual stress from a variation of K_I obtained by a photoelastic technique. It was not until fourteen years later that the method was extended by W. Cheng and I. Finnie in 1985 to measure residual stresses from a strain variation. In the years that followed a number of researchers around the world carried out similar measurements: D. Ritchie and R. H. Leggatt in 1987, T. Frett in 1987, C. N. Reid in 1988, and K. J. Kang, J. H. Song and Y. Y. Earmme in 1989.

Part of our early work was supported by Joe Gilman and Raj Pathania of EPRI and Wayne Kroenke of Bettis Laboratory. We appreciate the significant contribution of Mike Prime, who chairs the ASTM E.28.13.02 Task Group, and all Task Group members, Mike Hill, Gary Schajer, Yung Fan, Hans Schindler, and Can Aydiner, who have devoted their time to working towards a standard for the slitting method.

Our thanks also go to Öktam Vardar, Marco Gremaud, Glen Stevick, Ron Streit and Robert Ritchie for their contributions, friendship, and help over the years.

Fremont, California
Berkeley, California

Weili Cheng
Iain Finnie
June 2006

Contents

1	Introduction to Residual Stresses	1
1.1	What are residual stresses?	1
1.2	Influence of Residual Stresses	2
1.3	Mechanical Methods for Residual Stress Measurement	4
1.4	About This Book	7
2	Elements of Measurement Using the Slitting Method	9
2.1	Linear Elasticity and Superposition Principle	9
2.2	Expressions for Approximation of Residual Stresses	11
2.3	Experimental Procedures	17
3	The Body Force Approach for Near-Surface Measurement .	19
3.1	Introduction	19
3.2	Analysis	20
3.3	Results	25
3.4	Comparison of Cuts with Circular Bottom and Flat Bottom . .	29
3.5	Discussion	30
4	The LEFM Approach for Through-Thickness Measurement	33
4.1	Introduction	33
4.2	An Edge-Cracked Beam	33
4.2.1	Normal Stress on Crack Faces	33
4.2.2	Shear Stresses on Crack Faces	40
4.3	An Edge-Cracked Circular Body	42
4.4	A Thin-Walled Cylinder With a Circumferential Crack	45
4.5	A Ring With a Radial Crack	49
4.6	Discussion	51
5	The FEM Approach for Through-Thickness Measurement	53
5.1	Introduction	53
5.2	General Consideration in Finite Element Mesh	53

5.3	Typical Geometries Analyzed by the FEM	59
5.3.1	An Edge-Crack at a T-Joint Weld or a Fillet Weld	59
5.3.2	A Slot of Finite Width in a Thin Specimen	61
5.3.3	The Use of 2-D FEM for 3-D Problems	64
5.4	Discussion	68
6	Estimation of Residual Stresses	69
6.1	Introduction	69
6.2	Approximation Using a Power Series	73
6.2.1	Least Squares Fit for Stress Estimation	73
6.2.2	Properties of Compliance Matrices	75
6.3	Approximation Using Polynomial Series	76
6.3.1	Series for Through/Partial-Through-Thickness Measurement	78
6.3.2	Weighted LSF for Through-Thickness Measurement	80
6.4	Approximation Using Strip-Loads	82
6.4.1	Error Analysis	84
6.4.2	Discussion	87
6.5	Overlapping-Piecewise Functions for Near-Surface Measurement	88
6.5.1	Influence of Error on Overlapping-Piecewise Functions	93
6.6	Configurations Analyzed by the Compliance Method	98
6.7	Conclusion	102
7	Measurement of Through-Thickness Residual Stress	103
7.1	Introduction	103
7.2	A Case Study: Through-Thickness Residual Stress in a Beam	103
7.3	Dominant Variation in Stress Estimation	108
7.4	Error in Through-Thickness Measurement	111
7.5	Conclusion	115
8	Measurement of Axisymmetric Residual Stresses	117
8.1	Measurement Using Two Axial Cuts	117
8.1.1	Introduction	117
8.1.2	Analysis of Axisymmetric Residual Stresses in Plane Strain	118
8.1.3	Determination of the Axial Residual Stress in a Water-Quenched Cylinder	121
8.1.4	Discussion	122
8.2	The Single-Slice Approach for Axisymmetric Stresses	122
8.2.1	Introduction	122
8.2.2	Estimation of the Axial Residual Stress	123
8.2.3	The Choice of the Functions $S_i(r)$	126
8.2.4	Determination of the Hoop and Radial Stresses in Plane Strain	127
8.2.5	Plane Strain and the Choice of the Slice Thickness	128

8.2.6	An Additional Experimental Feature	130
8.2.7	Experimental Validation	131
8.2.8	Discussion	133
9	Estimation Using Initial Strains	135
9.1	Introduction	135
9.2	Initial Strain Approach for the Crack Compliance Method: Axial Stress in a Beam	138
9.3	Initial Strains Approach for the Single-Slice Method: Axial Stress in a Rod	140
9.4	Experimental Validation	143
9.5	Application: Residual Stress in a Pyrolytic Carbon Coated Graphite Leaflet	146
9.6	Discussion	151
10	Residual Stresses and Fracture Mechanics	153
10.1	Introduction	153
10.2	Influence of Residual Stress on Fracture Strength of Glass . . .	153
10.3	Surface Compressive Residual Stresses and Surface Flaw Detection	155
10.4	Measurement of Stress Intensity Factors Using the Slitting Method	159
10.5	Discussion	163
A	K_I and K_{II} Solutions for an Edge-Cracked Beam	165
A.1	An Expression for K_I	165
A.2	An Expression for K_{II}	166
B	Stresses Due to Point Forces	167
C	C Subroutines for the Calculation of Polynomial Series	169
C.1	Chebyshev Polynomials	169
C.2	Legendre Polynomials	172
C.3	Jacobi Polynomials	174
D	K_I Solution for an Edge-Cracked Disk	177
D.1	Analysis	177
D.2	Results	180
E	Stress Variation With the Location of the Virtual Forces on a Disk	183
F	Nonuniform Strain over a Gage Length	185

G C++ Programs for the Calculation of Eq. (10.24)	189
G.1 PointF Class Header – Listing of PointF.h	189
G.2 Code for Class Definition – Listing of PointF.cpp	190
G.3 Sample Code for Usage of Class PointF	194
References	197
Index	205