# Table of Contents

| List of Symbols | viii  |
| Foreword by G. R. Irwin | xvi  |
| Preface - Third Edition | xvii |
| Preface - Second Edition | xviii |
| Preface - First Edition | xix  |
| Acknowledgments to the First Edition | xx   |

## Part I

### Introductory Information

- Introduction 2
- Crack-Tip Stress Fields for Linear-Elastic Bodies 2
- Alternate Expressions for Crack-Tip Elastic Fields 6
- Slender Notches and Stress Concentrations from Stress Intensity Factors 8
- Energy Rate Analysis of Crack Extension 11
- Relationships between $G$ and $K$ 12
- Superposition of $G$ and $K$ Results 13
- Meaning of Plane Stress and Plane Strain for Fracture Mechanics Purposes 14
- Effects of Small Scale Yielding on Linear-Elastic Fracture Mechanics 16
- Introduction to Stress Function Methods 17
- Additivity of Crack Stress Fields and $K$ Values 22
- Boundary Collocation Method 23
- Successive Boundary Stress Correction Method 24
- $K$ Estimates from Finite Element Methods 25
- Additional Remarks for Part I 26
  - A. Unified Formulation for In-Plane Two-Dimensional Problems 26
  - B. On Completeness of Westergaard Single-Function Method for Analysis of Cracks 27
  - C. Effect of Surface Interference of Partly Closed Cracks 31

## Part II

### Stress Analysis Results for Common Test Specimen Configurations

- The Center Cracked Test Specimen 40
- The Double Edge Notch Test Specimen 46
- The Single Edge Notch Test Specimen 52
- The Pure Bending Specimen 55
- The Three-Point Bend Test Specimen 58
- The Compact Tension Test Specimen 61
- The Round (Disk-Shaped) Compact Specimen 64
- The Arc-Shaped (C-Shaped) Specimen 65
- Other Common Specimen Configurations 66
- Electrical Potential Calibration 80
Part III
Two-Dimensional Stress Solutions for Various Configurations with Cracks

A. Cracks Along a Single Line
- A Semi-Infinite Crack in an Infinite Plane 82 (3.1–3.12)
- Two (Opposing) Semi-Infinite Cracks in an Infinite Plane 96 (4.1–4.16a)
- A Finite Crack in an Infinite Plane 124 (5.1–5.22a)
- Multiple Cracks in an Infinite Plane 165 (6.1–6.5)
- A Periodic Array of Cracks in an Infinite Plane 170 (7.1–7.11)
- An Edge Crack in a Semi-Infinite Plane 193 (8.1–8.18)
- A Semi-Infinite Crack (Leaving a Finite Ligament) in a Semi-Infinite Plane 219 (9.1–9.6a)
- Finite Crack(s) in a Semi-Infinite Plane 227 (10.1–10.4)
- An Internal and Edge Crack(s) in a Finite Width Strip or in a Rectangular and Circular Regions 232 (11.1–11.15)

B. Parallel Cracks
- Parallel Semi-Infinite Cracks in an Infinite Plane 247 (12.1–12.6)
- Opposing Parallel Semi-Infinite Cracks in an Infinite Plane 253 (13.1–13.3)
- Finite Parallel Cracks in an Infinite Plane 256 (14.1–14.7)
- Parallel Edge Cracks in a Semi-Infinite Plane 264 (15.1–15.2)
- A Semi-Infinite Crack Parallel to Edges of an Infinite Strip 266 (16.1–16.6)
- A Finite Crack Parallel to Edges of an Infinite Strip 272 (17.1–17.13)
- Transverse Crack(s) in an Infinite or a Finite Strip 285 (18.1–18.4)

C. Cracks and Holes or Notches
- Crack(s) Emanating from a Hole or a Notch in an Infinite, a Semi-Infinite or a Finite Plane 289 (19.1–19.17)
- Crack(s) at a Juncture of a Strip and a Semi-Infinite Plane 306 (19.18–19.19)
- A Finite Crack Near Hole(s) in an Infinite Plane 308 (20.1–20.6)

D. Curved, Angled, Branched, or Radiating Cracks
- Curved, Angled, Branched, or Radiating Crack(s) in an Infinite Plane 314 (21.1–21.17)

E. Cracks in Reinforced Plates
- Finite Crack(s) in an Infinite Plane with Reinforced Regions 331 (22.1–22.2)

Part IV
Three-Dimensional Cracked Configurations

- A Semi-Infinite Crack in an Infinite Body 334 (23.1–23.8)
- An Embedded Circular Crack in an Infinite Body 342 (24.1–24.26)
- An External Circular Crack (a Circular Net Section) or a Circular Ring (an Annular) Crack in an Infinite Body 369 (25.1–25.10)
- An Elliptical Crack or Net Section and a Parabolic Crack in an Infinite Body 384 (26.1–26.6)
- An External Circular Crack in a Round Bar 390 (27.1–27.3)
- An Internal Circular Crack in a Round Bar 396 (27.4–27.6)
- An Internal Circumferential Crack in a Thick-Walled Cylinder 402 (27.7–27.8a)
- An External Circumferential Crack in a Thick-Walled Cylinder 406 (27.9–27.10a)
- A Half-Circular Surface Crack in a Semi-Infinite Body 410 (28.1–28.2)
- A Quarter-Circular Corner Crack in a Quarter-Infinite Body 412 (28.3–28.5)

Part V
Crack(s) in a Rod or a Plate by Energy Rate Analysis

- Bending, Shearing, and Tension/Compression 415
### Table of Contents

**Part VI**  
**Strip Yield Model Solutions**  
- Introduction to Strip Yield Model Analysis 432 (30.1–30.2)  
- Additional Notes on Strip Yield Models 433 (30.2)  
- Two-Dimensional Problems of Strip Yielding from Crack(s) 434 (30.3–30.25)  
- Two-Dimensional Problems of Strip Yielding from a Hole with or without Crack(s) 457 (31.1–31.5)  
- Three-Dimensional Strip Yielding Solutions 462 (32.1–32.6)

**Part VII**  
**Crack(s) in a Shell**  
- A Circumferential Crack in a Cylindrical Shell 470 (33.1–33.6)  
- Multiple Circumferential Cracks in a Cylindrical Shell 479 (34.1–34.4a)  
- A Longitudinal Crack in a Cylindrical Shell 485 (35.1)  
- A Crack in a Spherical Shell 486 (36.1)

**Appendices**  
- A. Compliance Calibration Methods 487 (A.1–A.6)  
- B. A Method for Computing Certain Displacements Relevant to Crack Problems 493 (B.1–B.4)  
- C. The Weight Function Method for Determining Stress Intensity Factors 497 (C.1–C.16)  
- D. Anisotropic Linear-Elastic Crack-Tip Stress Fields 513 (D.1–D.2)  
- E. Stress Intensity Factors for Cracks in a Plate Subjected to Pinching Loads 515 (E.1–E.14)  
- F. Cracks in Residual Stress Fields 529 (F.1–F.17)  
- G. Westergaard Stress Functions for Dislocations and Cracks 547 (G.1–G.33)  
- H. The Plastic Zone Instability Concept Applied to Analysis of Pressure Vessel Failure 581 (H.1–H.11)  
- I. Approximations and Engineering Estimates of Stress Intensity Factors 593 (I.1–I.18)  
- J. Rice's $J$-Integral as an Analytical Tool in Stress Analysis 611 (J.1–J.12)  
- K. Elasto–Plastic Pure Shear Stress–Strain Analysis (Mode III) 623 (K.1–K.12)  
- L. Table of Complete Elliptic Integrals 635 (L.1–L.2)  
- M. Table and Properties of Gamma Function 637 (M.1–M.3)

**References**  
- 641 (R.1–R.21)  
**Reference Index**  
- 663  
**Subject Index**  
- 667  
**Free Software (SmartCrack-Lite)**  
- 676  
**Software Guide**  
- 677