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Residual Stress

Measurement by Diffraction and Interpretation

With 160 Figures and 31 Tables

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Preface

As industries find that the market for their goods and services is often as closely connected to their quality as to their price, they become more interested in inspection and quality control. Non-destructive testing is one aspect of this topic; the subject of this book is a sub-field of this domain. The techniques for measuring residual stresses have a long history for a technological subject. Yet, in the last decade or so there has been renewed and vigorous interest, and, as a result of this, there has been considerable progress in our understanding and in our methods. It seemed a proper time to bring the new material together in an organized form suitable for a course or for self-teaching, hence this book.

After an initial introduction to the qualitative ideas concerning the origin, role, and measurement of residual stresses, we follow with chapters on classical elasticity and the relatively new subject of microplasticity. These are primarily introductory or review in nature, and the reader will find it important to consider further the quoted references if he is to be involved in a continuing basis in this area. There follows a chapter on diffraction theory, and then we fuse these subjects with a chapter on diffraction techniques for measuring stresses and strains which at present is our most general tool for non-destructive evaluation in this area. In Chap. 6 we explore how to evaluate errors in such a measurement, a topic almost as important as the stress itself and certainly vital in automating the measurement. Practical examples are described in Chap. 7 and means for measuring the strain distribution, in Chap. 8, in contrast to the measurement of average values described in the earlier chapters.

The Appendices include solutions to the problems given at the end of some of the chapters, Fourier analysis, and sources of useful data.

We emphasize diffraction because in our opinion it is the most well understood and reliable tool available for the measurement of stresses. Of course our own background in diffraction colors our opinion, but we hope this book will reveal to the reader why we feel this way.

Dr. M. James provided Appendices E and F, and Mr. W. P. Evans supplied many practical examples for Chap. 7. Both gave us helpful comments on the manuscript.

Both authors thank our many co-workers in this field, Drs. R. Marion, M. James, H. Dölle, W. Schlosberg, Prof. Jai Wen Ho, Mrs. Rui Mai Zhong, Messrs. T. Devine, W. Evans, and P. Rudnik. The two of us have enjoyed (most of the time) working together over the past five years on research in this field and on this book. One of us (I. C. N.) especially acknowledges the support of his family.

I. C. Noyan
J. B. Cohen

Evanston, IL, April 1987

Dedication

We dedicate this book to the U.S. Office of Naval Research and particularly to Dr. Bruce MacDonald of this office. His foresight led us into this field and his helpful encouragement and support led us along many interesting avenues of research on residual stresses.

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