

A S M E H A N D B O O K

Metals Engineering Design

Edited by OSCAR J. HORGER

Chief Engineer, Railway Division, The Timken Roller Bearing Company

Sponsored by

*the Metals Engineering Handbook Managing Committee
of The American Society of Mechanical Engineers*

28 JUN 1982



SECOND EDITION

McGRAW-HILL BOOK COMPANY

New York San Francisco Toronto London Sydney

**ASME HANDBOOK
METALS ENGINEERING—DESIGN**

Copyright © 1965 by The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York 10017, New York. All Rights Reserved.

Copyright 1953 by The American Society of Mechanical Engineers. All Rights Reserved. Printed in the United States of America. This book, or parts thereof, may not be reproduced in any form without permission of the copyright owner. *Library of Congress Catalog Card Number: 63-13133*

6789-MAMM-7654321

CONTENTS

<i>Foreword to the Second Edition</i>	v
<i>Foreword to the First Edition</i>	vii
<i>Preface</i>	xi

PART ONE Selection of Materials

by William P. Achbach	3
-----------------------	---

PART TWO Mechanical Properties of Metals in Design

1. Significance of Mechanical-properties Data <i>William P. Achbach</i>	11
2. Temperature Consideration in Design	
2.1 High-temperature Considerations in Design	20
2.1.1 Power Plants <i>H. D. Emmert and Robert Matters</i>	20
2.1.2 Petroleum Heaters <i>M. W. Barnes</i>	33
2.1.3 Internal Combustion Engines <i>Thomas E. Eagan</i>	37
2.1.4 Gas Turbines <i>Howard R. Voorhees</i>	44
2.1.5 Rocket Engines <i>R. F. Bagge, J. W. Campbell, and F. J. Darms, Jr.</i>	54
2.2 A Review of Engineering Approaches to Brittle Fracture Design <i>J. D. Lubahn</i>	71
2.3 Thermal Stresses <i>Bruno A. Boley and Jerome H. Weiner</i>	106
3. Plasticity Considerations in Design	
3.1 Stress and Strain in the Plastic Region <i>Evan A. Davis</i>	123
3.2 Anelasticity <i>Clarence Zener and A. C. Hagg</i>	133
4. Residual Stresses <i>Oscar J. Horger</i>	135
5. Vibration Considerations in Design <i>Nils O. Myklestad</i>	156
6. Plates and Shells <i>William A. Nash</i>	174
7. Fatigue Characteristics in Design	
7.1 Types of Stress <i>Herbert F. Moore</i>	190
7.2 Stress Range <i>Thomas J. Dolan</i>	192
7.3 Method of Testing <i>Thomas J. Dolan</i>	199
7.4 Mechanical Properties <i>Thomas J. Dolan</i>	208
7.5 Surface Finish <i>B. C. Hanley and Thomas J. Dolan</i>	215
7.6 Grooves, Fillets, Oil Holes, and Keyways <i>R. E. Peterson</i>	226
7.7 Overstressing and Understressing in Fatigue <i>H. T. Corten</i>	231
7.8 Statistical Methods in Fatigue <i>Alfred M. Freudenthal</i>	242
8. Fatigue Considerations Resulting from Processing	
8.1 Grain Flow <i>R. L. Templin, E. C. Hartmann, and F. M. Howell</i>	249
8.2 Shot Peening <i>John C. Straub</i>	258
8.3 Cold Working <i>Oscar J. Horger</i>	264
8.4 Decarburization <i>Oscar J. Horger</i>	278
8.5 Case Carburizing <i>R. L. Mattson and G. H. Robinson</i>	284
8.6 Nitriding <i>Carl F. Floe</i>	291
8.7 Metallic Coatings <i>R. R. Moore</i>	295
8.8 Flame Strengthening <i>J. H. Zimmermann</i>	319
8.9 Riveted Structural Joints <i>W. H. Munse and W. M. Wilson</i>	322
8.10 Bolted Structural Joints <i>W. H. Munse</i>	326
8.11 Bolted Joints <i>W. C. Stewart</i>	328
8.12 Welded Structural Joints <i>W. H. Munse and W. M. Wilson</i>	335
8.13 Press- and Shrink-fitted Assembly <i>Oscar J. Horger</i>	340
9. Bearing, Friction, Wear, and Lubrication Considerations in Design <i>H. W. Gillett and revised by C. M. Allen, S. L. Cosgrove, and J. C. Bell</i>	355
10. Shock and Impact Considerations in Design <i>Irwin Vigness and W. P. Welch</i>	365

PART THREE Other Physical Properties Affecting Design

1. Corrosion		
1.1 Mechanical Factors Influencing Corrosion	<i>H. R. Copson</i>	38
1.2 Fretting Corrosion and Fatigue	<i>George Sachs and Oscar J. Horger</i>	39
2. Radiation Properties	<i>R. G. Berggren</i>	40
3. Electrical Properties	<i>P. H. Estes and A. E. Kettner</i>	41

PART FOUR Nondestructive Testing

1. Magnetic-particle Inspection	<i>C. E. Betz</i>	44
2. Ultrasonic Testing and Inspection	<i>John C. Smack</i>	45
3. X-ray Examination	<i>R. M. Landis</i>	46
4. Electrical Methods	<i>G. R. Greenslade and W. J. Eisenbeis</i>	47
5. Core-loss Principle	<i>P. E. Cavanagh and R. T. Cavanagh</i>	48
6. Magnetic and Electromagnetic Methods	<i>G. R. Greenslade and W. J. Eisenbeis</i>	48

PART FIVE Design Considerations

1. Design Practice	<i>Charles Lipson and G. C. Noll</i>	497
2. Design Theory		
2.1 Elements of Theory of Elasticity	<i>S. Timoshenko and Joseph Marin</i>	506
2.2 Theories of Failure	<i>Joseph Marin</i>	517
2.3 Working Stresses	<i>Joseph Marin</i>	527
3. Experimental Design		
3.1 Strain Gages—Principally Electric Type	<i>Peter K. Stein</i>	532
3.2 Strain Gages—Other than Electric Type	<i>C. O. Dohrenwend</i>	546
3.3 Ceramic Brittle Coatings	<i>Joseph Baranowski</i>	551
3.4 Photoelasticity	<i>Max M. Frocht</i>	554
3.5 Stress Analysis with the Photoelastic Coating Technique	<i>Felix Zandman</i>	570
3.6 Statistical Design of Experiments	<i>W. J. Youden</i>	583
3.7 Radioactive Isotopes	<i>Robert S. Rochlin</i>	586
4. Surface-finish Requirements in Design	<i>James A. Broadston</i>	593

Index

607