

Contents

1	Introduction	1
	Concluding Remarks	5
	References	9
2	Characteristic Service Stresses	13
2.1	Stress-Time Functions	13
2.2	Causes of Stress	19
2.3	Deterministic and Stochastic Stress-Time Functions	22
2.4	Special Events and Misuse	28
	References	30
3	Description of the Counting Methods	31
3.1	Basic Principles	31
3.1.1	Classes	31
3.1.2	Range of Restoration and Class Width	32
3.2	Standards	34
3.3	One-Parameter Counting Methods	34
3.3.1	Peak Counting	34
3.3.2	Level-Crossing Counting	36
3.3.3	Range Counting	38
3.3.4	Range-Pair Counting	39
3.4	Two-Parameter Counting Methods	41
3.4.1	Range-Mean Counting	41
3.4.2	Transition Counting	42
3.4.3	Range-Pair-Mean Counting	44
3.4.4	Rainflow Counting	46
	References	51
4	Load Spectra and Matrices	55
4.1	Description of Load Spectra	56
4.2	Extrapolation	62

4.2.1	Analytical Extrapolation with the Shape Parameter . . .	64
4.2.2	Statistical Extrapolation for Stationary Processes . . .	66
4.3	Derivation of Spectra from Matrices	69
4.3.1	Transition Matrix	69
4.3.2	Rainflow Matrix	74
4.4	Standardised Load Sequences and Spectra	79
	References	82
5	Comparison of the Counting Methods for Exemplary Load Time Functions	85
5.1	Load-Time Functions Selected for the Investigation	85
5.2	Random Load with an Irregularity Factor $I = 0.99$	85
5.3	Random Load with an Irregularity Factor $I = 0.7$	86
5.4	Step Function with Superimposed Damped Load-Time Function	86
5.5	Superimposed Sinusoidal-Sinusoidal Load-Time Function . . .	91
	References	91
6	Multiaxial Loads and Stresses	93
6.1	Definition of Terms	93
6.2	Measuring and Recording Technology	94
6.2.1	Calibrated Strain-Gauge Measuring Points	94
6.2.2	x-y Strain Gauge or Multiple Strain Gauge	94
6.3	Counting of Multiaxial Load-Time Functions	95
6.4	Counting of Multiaxial Local Stress States	96
	References	97
7	Time-at-Level and Level-Distribution Counting	99
7.1	One-Parameter Methods	99
7.1.1	Time-at-Level Counting	99
7.1.2	Relative Level-Distribution Counting	101
7.2	Two-Parameter Methods	103
7.2.1	Two-Parameter Time-at-Level Counting	103
7.2.2	Relative Two-Parameter Level-Distribution Counting	105
	References	106
8	Application of the Counting Methods	107
8.1	Criteria for the Selection of a Counting Method	107
8.2	Recommendations	109
8.2.1	Graphical Representation	109
8.2.2	Practical Experience	109
	References	110

- 9 Analytical Fatigue-Life Estimate 113**
 - 9.1 Palmgren-Miner Rule 115
 - 9.1.1 Consideration of the Mean Stress and Stress Ratio . . . 117
 - 9.2 Modifications of the Palmgren-Miner Rule 118
 - 9.3 Comparison Between Calculation and Experiment 120
 - 9.3.1 Results 125
 - 9.4 Relative Palmgren-Miner Rule 127
 - References 128

- 10 Design and Dimensioning Load Spectra 131**
 - 10.1 Determination of Representative Load Spectra 132
 - 10.1.1 Definition of the Relevant Measuring Frequency 132
 - 10.1.2 Recommendations for the Generation of Measuring Spectra 133
 - 10.1.3 Determination of the Necessary Duration of Measurement 135
 - 10.1.4 Recommendations for the Evaluation of Comprehensive Measurements Under Operational Conditions 137
 - 10.2 Example for the Generation of Design and Dimensioning Spectra 138
 - 10.3 Different Procedures for Load Assumptions 139
 - References 140

- 11 Safety Aspects 143**
 - 11.1 Designing and Dimensioning of Structural Components 143
 - 11.2 Safety Concept 148
 - 11.3 Reliability Concept 149
 - 11.4 Scatter of the Strength 156
 - 11.5 Scatter of the Stress 160
 - 11.6 Safety and Engineering 165
 - 11.6.1 Calculation or Test, or Both 165
 - 11.6.2 Cases of Damage Analysis 166
 - 11.6.3 Comparison of the Concepts 169
 - 11.6.4 Differences in the Scope of Application 175
 - 11.6.5 Safety-Relevant Measures 176
 - References 181

- 12 Load Assumptions in Various Special Fields 185**
 - 12.1 Load Assumption in Technical Rules and Standards 185
 - 12.2 Examples in Various Fields 186
 - 12.2.1 Example: Cranes 186
 - 12.2.2 Example: Rail Vehicles 187
 - 12.2.3 Example: Bicycles 191
 - 12.2.4 Example: Automobile 192
 - References 203

**13 Supplementary References to Publications on Load Assumptions
in Various Specialised Fields 205**

13.1 General Machine Construction 205

13.2 Plant Engineering 206

13.3 Wind Turbines 207

13.4 Motor Vehicles 209

13.5 Railway Vehicles 214

13.6 Aircraft Construction and Space Travel 215

13.7 Naval and Offshore Construction 216

13.8 Construction Machines and Agricultural Machines 216

13.9 Sporting Equipment 217

13.10 Reliability 217

13.11 Books with Special Emphasis on Load Assumptions 218

13.12 Symposia and Conferences 219

References 219

Index 221