

Contents

Preface

vii

1. ANALYSIS OF STRESS

1-11

- 1.1 Definition of Stresses 1
- 1.2 Stress Notation 2
- 1.3 The State of Stress at a Point 3
- 1.4 Stress on an Arbitrary Plane 3
- 1.5 Transformation Equations for Stresses 4
- 1.6 Principal Stresses 6
- 1.7 Octahedral Stresses 7
- 1.8 Hydrostatic and Pure Shear States 8
- 1.9 Equations of Equilibrium 8
- 1.10 Equations of Equilibrium in Cylindrical Coordinate 9
- 1.11 Summary 11
- References 11

2. ANALYSIS OF STRAIN

12-22

- 2.1 Introduction 12
- 2.2 The Displacement Field 12
- 2.3 Strain Components 13
- 2.4 Strains in Terms of Displacement Field 15
- 2.5 Compatibility Conditions 16
- 2.6 The State of Strain at a Point 17
- 2.7 Transformation Equations for Strain 17
- 2.8 Principal Axes and Principal Strains 19
- 2.9 Plane Strain State 20
- 2.10 Summary 21
- Analytical Problems 21
- References 22

3. GENERALIZED HOOKE'S LAW

23-29

- 3.1 Introduction 23
- 3.2 Hooke's Law for Isotropic Materials 24
- 3.3 Nonisothermal Hooke's Law 24
- 3.4 Hooke's Law for Orthotropic Materials 25
- 3.5 Summary 27
- Analytical Problems 27
- References 29

4. THEORIES OF FAILURE	30–35
4.1 Introduction	30
4.2 The Maximum Normal Stress Theory	30
4.3 The Maximum Normal Strain Theory	31
4.4 The Maximum Shear Stress Theory	32
4.5 The Strain Energy Theories	33
4.6 The Internal Friction Theory	35
4.7 Summary	36
Analytical Problems	37
References	38
5. BASIC EQUATIONS OF SOLID MECHANICS	39–55
5.1 Introduction	39
5.2 Plane Stress Problems	40
5.3 Plane Strain Problems	43
5.4 Axisymmetric Problems	44
5.5 Three Dimensional Problems	46
5.6 Torsion of Bars	47
5.7 Variational Methods	51
5.8 The Finite Element Method	52
5.9 Summary	53
Analytical Problems	54
References	55
6. PLANE STRESS AND PLAIN STRAIN PROBLEMS	56–80
6.1 Cantilever Plate	56
6.2 Simply Supported Rectangular Plate	58
6.3 Punch Press Frame	59
6.4 Aero Engine Compressor Disk	62
6.5 Thermal Stress in a Solid Circular Disk	64
6.6 Tapered Skew Cantilever Plate	67
6.7 Stress Concentration Around a Notch	69
6.8 Long Hollow Cylinder Subjected to Radial Temperature Variation	71
6.9 Concrete Dam	73
6.10 Welded Joints	75
7. AXISYMMETRIC PROBLEMS	81–102
7.1 Stress Concentration Factor: Spherical Cavity in a Cylinder	81
7.2 Rotating Hollow Cylinder with a Shrink Fitted Annular Disk	84
7.3 Aero Engine Compressor Rotor	87
7.4 Cylinder with a Fillet	89
7.5 High Pressure Cylinders	91
7.6 Cylinder with Torispherical End Closures	93
7.7 Welded Flywheel	95

- 7.8 Missile Component 97
- 7.9 Bolted Connection in a Pipe 99
- 7.10 Hemispherical Cap 101

8. THREE DIMENSIONAL PROBLEMS

103–124

- 8.1 Curved Cantilever Beam 103
- 8.2 Helical Coil Spring 107
- 8.3 Stress Concentration Around a Hole 108
- 8.4 Prismatic Bar with a Triangular Cross-section 112
- 8.5 Machine Tool Spring 113
- 8.6 Automobile Suspension Arm 116
- 8.7 'A' Machine Frame (A Carbon Steel 'C' Frame) 117
- 8.8 Bell Crank Lever 119
- 8.9 A Utility Hook 121
- 8.10 A Welded Frame 123

9. TORSION OF BARS

125–154

- 9.1 Torsion of a Prismatic Bar of Elliptical Cross-section 125
- 9.2 Torsion of a Prismatic Bar of Square Cross-section 127
- 9.3 Torsion of Tapered Bar with Varying Cross-section 130
- 9.4 Torsion of a Tube with a Complex Cross-section 133
- 9.5 Coupled Bending and Torsion of Slit Tube 135
- 9.6 Torsion of a Stepped Bar with a Fillet 135
- 9.7 Torsion of a Hollow Stepped Bar with a Fillet 141
- 9.8 Torsion of a Prismatic Bar with Cross-section 144
- 9.9 Coupled Bending and Torsion of a Prismatic Bar with Cross-section 146
- 9.10 Helical Conical Spring 1 149
- 9.11 Helical Conical Spring 2 152

Index

155–158