

Contents

1	Method of Singular Integral Equations in Application to Problems of the Theory of Elasticity	1
1.1	Basic Relationships of the Plane Theory of Elasticity	2
1.1.1	Basic Equations	2
1.1.2	Complex Representation of General Solution for Equations of Plane Theory of Elasticity	5
1.2	System of Curvilinear Cracks in Elastic Plane	8
1.2.1	Selected Information Concerning the Theory of Analytical Functions	8
1.2.2	Single Curvilinear Crack	12
1.2.3	System of Curvilinear Cracks	16
1.3	System of Curvilinear Holes and Cracks in Elastic Body	18
1.3.1	Multiply Connected Region with Holes	18
1.3.2	Multiply Connected Region with Holes and Cracks	21
1.4	Numerical Solution of Singular Integral Equations Using Quadrature Method	24
1.4.1	Quadrature Formulas	24
1.4.2	Integral Equation on an Open Contour	33
1.4.3	Integral Equation on a Closed Contour	43
	References	51
2	Stress Distribution in Elastic Plane with a Semi-infinite Notch	57
2.1	Methods for Stress Analysis in Notched Bodies	57
2.2	Eigensolutions of Elasticity Theory Plane Problem for Wedge	60
2.2.1	Characteristic Equations	60
2.2.2	Stress Intensity Factors in V-Notch Tip	63
2.2.3	Constructing General Solution Using Eigenfunctions	68

2.3	Semi-infinite Curvilinear Notches in Elastic Plane	70
2.3.1	Parabolic Notch	70
2.3.2	Hyperbolic Notch	75
2.3.3	Curvilinear Notch of Special Shape.	78
2.4	Rounded V-Notch Under Symmetrical Loading	82
2.4.1	Problem Definition and Reduction to Singular Integral Equation	82
2.4.2	Symmetrical Stress Distribution in Plane with Rounded V-Notch	88
2.5	Rounded V-Notch Under Mixed Loading	92
2.5.1	Antisymmetric Stress Distribution	92
2.5.2	Complex-Stressed State	98
	References.	102
3	Elastic Plane with Semi-infinite Notch and Cracks.	113
3.1	Elastic Wedge with Edge Crack at Notch Tip	113
3.1.1	Solutions Obtained Using Wiener–Hopf Method.	114
3.1.2	Approximate Closed-Form Solution for Symmetrical Loading.	118
3.2	Edge Crack System in Semi-infinite Rounded V-Notch Tip	123
3.2.1	Reduction of Problem to Singular Integral Equations.	123
3.2.2	Numerical Solution of Singular Integral Equations	125
3.3	Symmetrical Edge Crack in Rounded V-Notch Tip	128
3.4	Two Symmetrical Edge Cracks in Rounded V-Notch Tip	130
	References.	134
4	Deformation Fracture Criterion for Bodies with Notches.	137
4.1	Fracture Criteria for Notched Solid Bodies.	137
4.2	Model of Plasticity Bands in Fracture Mechanics.	140
4.2.1	Plane Stress State	141
4.2.2	Plane Strain State	145
4.3	Infinite Wedge with Plasticity Bands	149
4.3.1	Plane Stress State	150
4.3.2	Plane Strain State	154
4.4	Plasticity Band Near Rounded V-Notch	158
4.5	Two Plasticity Bands Near Rounded V-Notch	163
	References.	170
5	Stress Concentration Near Hole in Elastic Plane	181
5.1	Elliptical Hole.	181
5.1.1	Stress Concentration Near Elliptical Hole	182
5.1.2	Limit Transition to Parabolic Notch	184
5.1.3	Stress Distribution Around Notch Tip	186

5.2	Oval Hole	191
5.2.1	Stress Concentration Near Narrow Slot	191
5.2.2	Stress Concentration Near Oval Hole	196
5.2.3	Limit Transition to Two-Tip Lens-Like Hole	197
5.3	Rhombic Hole	201
5.3.1	Stress Concentration Near Rhombic Hole	201
5.3.2	Stress Concentration Near Square Hole with Rounded Vertices	204
5.4	Rectangular Hole	207
5.4.1	Stress Concentration Near Rectangular Hole with Rounded Vertices	207
5.4.2	Stress Intensity Factors in Vertices of Rectangular Hole	211
5.4.3	Semi-infinite Rectangular Notch	212
5.5	Elastic Plane with Circular Hole and Edge U-Notches	214
5.5.1	First Basic Problem for Plane with Circular Hole	214
5.5.2	Cracks in Elastic Plane with Circular Hole	214
5.5.3	Edge U-Notch in Plane with Circular Hole	216
5.5.4	Elastic Plane with Circular Hole and Two Edge U-Notches	219
	References	220
6	Periodic System of Closely Spaced Holes in Elastic Plane	227
6.1	Integral Equation of the Problem	228
6.2	System of Elliptical Holes	232
6.3	System of Narrow Slots	234
6.4	Systems of Rhombic or Oval Holes	236
6.5	Bilateral Rounded Notch	239
6.5.1	Bilateral Hyperbolic Notch	239
6.5.2	Bilateral Parabolic Notch	240
6.5.3	Bilateral U-Notch	242
6.5.4	Bilateral Rounded V-Notch	243
6.6	Bilateral Sharp V-Notch	245
	References	247
7	Edge Notches in Elastic Half-Plane	249
7.1	Edge Notch	249
7.1.1	Edge Notch in the Shape of Circular Segment	249
7.1.2	Semi-elliptical Notch	251
7.1.3	Rounded V-Notch	251
7.1.4	Sharp V-Notch	256
7.2	Edge Notch with Cracks	259
7.2.1	Edge Semi-elliptical Notch with Crack	260
7.2.2	Edge V-Notch with Crack Growing from Its Tip	262

7.2.3	Edge Rectangular Notch with Crack Growing from Its Tip.	263
7.3	Periodic Elasticity Theory Problem for Half-Plane with Curvilinear Boundary	264
7.3.1	Singular Integral Equation for Plane with Periodic System of Curvilinear Cuts	265
7.3.2	Singular Integral Equation for Periodic Boundary Value Problem of Half-Plane with Curvilinear Boundary.	266
7.3.3	Numerical Solution for Half-Plane with Sinusoidal Boundary.	268
7.4	Periodic System of Edge V-Notches.	271
7.4.1	Rounded V-Notches	271
7.4.2	Sharp V-Notches	274
	References.	275
8	Rectangular Specimens with Edge Notches	279
8.1	Rectangular Specimen with Edge V-Notch.	279
8.1.1	Tensile Specimens.	279
8.1.2	Pure Bending Specimens.	282
8.1.3	Three-Point Bending Specimens	283
8.1.4	Double-Cantilever Beam Specimen	283
8.1.5	Rectangular Specimen with Lateral V-Notch Under Antisymmetrical Loading	284
8.2	Rectangular Specimen with Two Edge V-Notches	287
8.2.1	Tensile Specimen with Symmetrical Notch	287
8.2.2	Tensile Specimen with Skew Bilateral Notch	289
8.2.3	Bending Specimen with Skew Bilateral Notch	289
8.3	Rectangular Specimen with Edge-Rounded V-Notch	291
8.3.1	Tensile Strip with Edge Semi-circular Notch.	291
8.3.2	Pure Bending of Strip with Edge Semi-circular Notch	294
8.3.3	Neuber Interpolation Formula	294
8.3.4	Pure Tensile Strip with Edge-Rounded V-Notch	295
8.3.5	Pure Bending of Strip with Edge-Rounded V-Notch.	298
8.4	Rectangular Specimen with Two Edge-Rounded Notches.	300
8.4.1	Strip with Bilateral Semi-elliptical Notch	300
8.4.2	Strip with Bilateral U-Notch	301
8.4.3	Tension of Strip with Edge-Rounded V-Notch	305
8.4.4	Interpolation Formula for Stress Intensity Factors	310
8.4.5	Pure Bending of Strip with Edge-Rounded V-Notch.	314
	References.	316

9	Disc Specimens with Notches	323
9.1	Integral Equations for Plane Elasticity Problem of Circular Region with Holes and Cracks	323
9.1.1	First Basic Problem for Circle	323
9.1.2	System of Cuts in Circular Disc	326
9.2	Disc Specimen for Studying Crack Nucleation Phenomena	329
9.2.1	Disc Specimen with Edge U-Notch	330
9.2.2	Disc with Edge U-Notch and Crack Growing from its Tip	337
9.3	Compression of Disc Specimens with Rhombic Hole	338
9.4	Compression of Disc Specimens with Narrow Slot	343
9.5	Ring-Shaped Specimen with Inner U-Notches	344
	References	345
10	Antiplane Deformation of Elastic Bodies with Notches and Cracks	349
10.1	Method of Singular Integral Equation in Antiplane Problems of Elasticity Theory	349
10.1.1	Basic Relationships of Elasticity Theory for Longitudinal Shear	349
10.1.2	System of Cuts in Infinite Elastic Medium	351
10.1.3	Numerical Solution of Singular Integral Equations for Problems with Longitudinal Shear Cracks	353
10.1.4	System of Holes in Finite Elastic Body	355
10.1.5	Numerical Solution of Singular Integral Equations in Antiplane Problems for Multiply Connected Regions with Holes	357
10.2	Stress Distribution in Elastic Plane with Semi-infinite Notch	358
10.2.1	Eigensolution to Elasticity Theory Antiplane Problem for Wedge	358
10.2.2	Parabolic Notch	360
10.2.3	Hyperbolic Notch	361
10.2.4	Semi-infinite Rounded V-Notch	362
10.3	Longitudinal Shear of Elastic Wedge with Cracks or Notches	368
10.3.1	Integral Representation of Complex Stress Potential	369
10.3.2	Wedge with Holes and/or Cracks	372
10.3.3	Crack Along Wedge Bisector	373
10.3.4	Crack Along Circular Arc	376
10.3.5	Circular Notch Near Wedge Tip	378

10.4	Longitudinal Shear of Elastoplastic Wedge.	380
10.4.1	Plastic Zone Near V-Notch	380
10.4.2	Elastic–Plastic Interaction Between V-Notch and Circular Hole Under Antiplane Strain.	381
10.4.3	Deformation Fracture Criterion	386
10.5	Stress Concentration Near Holes in Elastic Plane Under Antiplane Deformation	387
10.5.1	Elliptical Hole	387
10.5.2	Narrow Slot.	388
10.5.3	Oval Hole	392
10.5.4	Rhombic Hole.	394
10.5.5	Rectangular Hole.	396
	References.	398
11	Stress Concentration Near Notch in Anisotropic Body.	403
11.1	Basic Relationships of Elasticity Theory for Anisotropic Body.	403
11.1.1	Plane Problem of Elasticity Theory of Anisotropic Medium.	403
11.1.2	Longitudinal Shear in Anisotropic Medium.	407
11.2	Stress Distribution in Anisotropic Plane with Parabolic Notch	410
11.2.1	Symmetrical Loading.	410
11.2.2	Antisymmetrical Loading.	416
11.2.3	Antiplane Deformation	418
11.3	Singular Stress Distribution in Orthotropic Wedge	420
11.3.1	Problem Statement and General Solution.	421
11.3.2	Symmetrical Stress State	424
11.3.3	Antisymmetrical Stress State	427
11.4	Method of Singular Integral Equations in Application to Problems for Anisotropic Body	429
11.4.1	Integral Representation of Complex Stress Potentials.	429
11.4.2	Integral Equation	432
11.4.3	Limit Transition to Degenerate Material	434
11.4.4	Stress Intensity Factors	436
11.4.5	Arbitrarily Oriented Straight Crack	439
11.4.6	Parabolic Crack in Orthotropic Plane	441
11.5	Rounded V-Notch in Orthotropic Plane	444
11.5.1	Problem Definition and Reduction to Singular Integral Equation	445
11.5.2	Orthotropic Plane with Two-Sectional Kinked Crack.	452
	References.	455

12	Stress Concentration Near Notches in Quasi-Orthotropic Body . . .	459
12.1	Basic Relationships of Elasticity Theory Plane Problem for Quasi-Orthotropic Body	459
12.2	Singular Stress Distribution in Quasi-Orthotropic Wedge	463
12.2.1	Problem Statement and General Solution.	463
12.2.2	Symmetrical Stress State	465
12.2.3	Antisymmetrical Stress State	467
12.3	Stress Distribution in Elastic Quasi-Orthotropic Plane with Elliptical Hole or Parabolic Notch	469
12.3.1	Symmetrical Loading.	469
12.3.2	Antisymmetrical Loading.	475
12.4	Method of Singular Integral Equations in Application to Problems for Quasi-Orthotropic Body	479
12.4.1	Integral Equation of Plane Elasticity Theory Problem for Quasi-Orthotropic Plane Containing Curvilinear Cracks.	479
12.4.2	Stress Distribution Around Crack Tip	482
12.4.3	Arbitrarily Oriented Straight Crack in Quasi-Orthotropic Plane	483
12.4.4	Crack Along a Parabolic Arc.	485
12.5	Relationship Between Stress Concentration and Stress Intensity Factors in Sharp or Rounded V-Notches in Quasi-Orthotropic Plane	486
12.5.1	Rounded V-Notch	486
12.5.2	Quasi-Orthotropic Plane with Two-Sectional Kinked Crack	492
	References.	496

Stress Concentration at Notches

Savruk, M.P.; Kazberuk, A.

2017, XVIII, 498 p. 207 illus., Hardcover

ISBN: 978-3-319-44554-0