Subject Index

A

ADINA computer program, 619

Aircraft structures
fatigue cracks
in fastener holes, 45

Alloys
aluminum, 45, 281, 467
iron, 328
nickel-base, 167
steel, 214, 238, 281, 381, 467
HSLA, 131
HY-80, 45, 578
manganese aluminum, 597
manganese chromium, 149, 597
manganese silicon, 597
titanium, 281, 392
tungsten, 554
uranium, 554

Aluminum alloys
6061-T651, 281
7075-T651, 45, 467
7075-T7351, 281

Angle, crack opening, 453

ANSYS finite element code, 242

Arc-shaped tension specimen, 27, 106

Arrest, crack (see also Propagation, crack)
in aluminum alloy, 467
table, 476
in welded HY-80 steel, 451

ASTM Standards
A 289: 150
D 638: 494
E 23: 579
E 208: 579
E 399: 27, 107, 214, 239, 253, 310, 566, 579
E 647: 387
E 813: 294, 319, 328

Axial flaws
in steel pipelines, 632
in zirconium pressure tubes, 308

B

Beam specimen, 239

Bending specimen (see also Three-point bend specimen) 27, 102, 197

British Standard BS 5762(1979): 214

Burst pressures
experimental versus theoretical values, table, 612
nuclear reactor vessels, 597

C

CANABC computer program, 356
Cathodic charging, 135

Central Electricity Generating Board
R6 analysis
stress prediction in pipelines
initiation loading, table, 644
maximum loading, table, 644

Charpy transition tests
in carbon steel, 238
in pipelines, table, 635
in pressure vessels, 598
Charpy V-notch specimens, 281, 582
ASTM Standard E 23: 582
Clip gage displacement (see Displacement, crack opening)
Closure, crack, 350, 361, 381
COD (see Displacement, crack opening)
Compact tension specimens
  boundary collation analysis, 113
  displacement of crack opening zirconium pressure tube, 308
  elastoplastic analysis, 251
  equations for displacement, 27
  Hutchinson-Rice-Rosengren analysis, 197, 409
HY-80 steel, 579
Inconel 718, 168
Conic section
  edge crack shape approximation, 95
Corrosion
  in generator end rings, 149
  in HSLA steel, 131
Crack
  axial, 183, 308, 632
  beam specimen, 238
  center, 239
  ductile tearing, 238
  hole corner, 45, 65
  nozzle corner, 45, 65
  rapid tearing, 431
  rectangular, 521
  ring segment, 106, 149
  semi-elliptical, 521, 617
  single edge on panel, 197
  single edge on strip, 95
  small type, 347, 361
  stationary, 409
  straight, 535
  surface, 521
  triangular, 521
  twin, 521
Crack advancement (see Propagation, crack)
Crack front
  in aluminum alloys, 474
  profile, 535
  straight versus curved, 251, 544
  and stress distribution, 251, 617
Crack initiation (see Initiation, crack)
Crack interaction, 521
Crack length
  as function of crack opening displacement
  arc tension specimens, table, 42
  compact tension specimens, table, 41
Crack opening displacement (see Displacement, crack opening)
Critical load assessment method, 183
CTOA (see Angle, crack opening)
CTOD (see Displacement, crack opening)

D
Disk-shaped tension specimen, 27
Displacement, crack opening
  in aluminum alloys, 467
  in bending specimens, 33, 197
    load-line displacement, table, 37
  in cast iron alloy, 328
  in compact specimens, 113, 197, 251, 308
    table, 38
  constant amplitude loading, table, 388
  in disk-shaped tension specimen, table, 38
  in ductile steel pipelines, 632
  equations for standard specimens, 27
  as function of crack length
    arc tension specimens, table, 42
    compact tension specimens, table, 41
  initiation loading, table, 640
  maximum loading, table, 640
  in pressure vessels, 214, 308, 597, 617
    table, 600
  in ring segments, 106
in side-grooved specimens, table, 268
single edge on panel, 197
single edge on strip, 95
in steels, 214, 361, 381, 409, 431, 617
three-point bend specimens, 27, 214
load-line displacement, table, 37
in zirconium pressure tubes, 308
Ductile/brittle transition
steel, 569
Ductile tearing, 238
Dugdale model, 113, 361, 431

E
Elastoplastic fracture analysis
of aluminum, 281
of cast iron alloys, 328
of pipelines, 632
of pressure vessels, 214, 597, 617
of projectiles, 554
of steels, 281, 293, 381, 409, 431, 451, 632
three-dimensional specimens, 251
of titanium alloy, 281
of zirconium, 308
Electric generators
rotor end rings, 149
Electron microscope, 328, 367, 493
Energy release rate, 535, 617
Equations
Barson-Rolle-Novak, 246
boundary collocation, 106, 113
Bowie, 75
Budansky and Hutchinson, 365
Buekner, 95
Castigilliano, 28
Clark, 262
crack length as function of displacement
standard specimens, 27
displacement as function of crack length
standard specimens, 27
Eigenfunction, 197
Gauss-Chebyscher, 7
Hutchinson-Rice-Rosengren, 204, 409, 617
eigenmodes, 197
Keer and Freedman, 97
Kiefner, 648
Liu, 45
Neuber's rule, 352
Newman and Raju, 45, 75
Paris, 28, 46, 606, 651
Park, 551
Rice, 86, 95, 382, 412
Shah, 45
Stallybrass, 97
Walker, 48
Westergaard, 67
Explosions
effect on welded steel, 451

F
Fastener hole, 45
Fatigue crack propagation, 27, 45, 131, 347, 361, 381
ASTM Standard E 399: 27
ASTM Standard E 647: 387
ASTM Standard E 813: 387
and cyclic J relation, 381
and creep interaction
nickel superalloy, 167
in side-grooved compact tension specimens, 251
and surface roughness, 392
Finite element analysis
bending specimen model, 197
compact tension model, 197, 409
line spring model, 521
projectile model, 554
three-dimensional model, 238, 251, 535, 617
three-point bend model, 214, 451
Flaw growth (see Propagation, crack)
Fractography
- of steel, illus., 136, 140, 141
Fracture (see Crack)
Fracture toughness (see Resistance, crack)
Frozen stress analysis, 504

G
Glass fiber
- as plastic reinforcement, 493

H
Hoop stress
- in pressure vessels, 612
Hot rolling
- austenitic steel plate, 293
- HSLA steel, 133
Hydrogen
- in 18Mn-4Cr steel, 149
- and steel mechanical properties, table, 137
Hysteresis loop, 385

I
Inclusion in smooth steel plate, 376
Inconel 718 (see Nickel-base superalloy)
Infinite strip, 7
Initiation, crack (see also Resistance, crack)
- in electric generator end rings, 149
- in HY-80 steel, 451, 569
- in pressure vessels, 274
- in steel end rings
  hydrogen environment, table, 158
Instability point, crack, 183
Iron alloys
- GGG-4 (nodular), 328
- S-45 (ductile), 328
Isochromatics, 65, 431
- steel, illus., 441, 443, 444

J

J-Δa curves, 308
J-R curves
- aluminum alloys, 281
- austenitic stainless steel, table, 300
- center-cracked panel, 183
- pressure vessel, 183
- steel, A723, 281
- titanium alloy, 281

J-integrals
- aluminum alloys, 281
  table, 289
- biaxial load, table, 92
- cast iron alloy, 328
- critical load assessment method, 183
- ductile materials, 197
- effect of fatigue cycling, 381
  table, 289
- titanium alloys, 281
  table, 289
- zirconium pressure tube, 308

K
Kiefner analyses
- stress predictions, pipelines, table, 648

L
Launch simulation tests
- tungsten alloy, 554
- uranium alloy, 554
LEFM (see Linear elastic analysis)
Ligament activity
- in aluminum alloys, 467
- in pressure vessels, 617
Linear elastic analysis
ASTM Standard E 399 specimens, 27
bending specimen, 27
boundary collocation method, 106, 113
in edge-cracked strip, 95
in infinite strip, 7
in plate with through crack, 535
theory development, 7, 27, 45, 65, 95
in thick shell/plate, 521
Line spring model, 521

Literature review
ductile/brittle transition of steel, 569
stress intensity factor analysis
corner cracks at holes, 45

Load-drop method (see also Unloading)
aluminum alloys, 281
steel alloys, 281
titanium alloys, 281

Loading
biaxial, 65, 89
blast, 451
concentrated force, 113
constant amplitude, 45, 381, 392
table, 387
cyclic, 113, 167, 293, 361
dynamic, 409, 431, 451
inertialless, 409
instability point determination, 183
maximum in pipelines, 632
monotonic, 113, 472
pin-type, 113, 310
projectile launch simulation, illus., 560
and small crack behavior, illus., 370
three-point radial, 106
triangular waveform, 170
uniform pressure, 24, 113
unsymmetric triangular waveform, 170
Long-rod penetrator, 554
Lug root stress, 554

M
Microcracks
in thermoplastics, illus., 498, 499

Microstructure
heat-treated steel, illus., 305
heat-treated steel, table, 579
iron alloy, illus., 332, 338, 339
titanium alloy, 402
Widmanstätten, 398
Moiré interferometry, 504

N
Nickel-base superalloy, 167
Nil ductility temperature
specimen, 569
test, 598
Nonlinear fractures, 597
Nuclear reactors, 183, 308, 597

O
Optical analysis techniques
Cranz-Schardin camera, 436
electron microscopy, 493
interferometry, 504
Oxygen, interstitial
in titanium alloys, 392

P
Paris tearing instability analysis
in pipelines, 651
Pearlite
cast iron alloys, 328
Penalty function, 197
Photoelasticity, 431, 504
Pipelines, 521
API 5LX, 56, 632
Plastic deformation, 113, 347, 386
Plastic hinge formation, 233
Plastics
  glass fiber reinforced, 493
  polyamide, 66, 493
  polymeric material, 504
  polymethyl methacrylate, 45
tensile properties
  ASTM Standard D 638: 494
Plastic zones, 214, 349, 409, 431
Polariscope, 436
POLO-FINITE structural mechanics system, 219
Power-hardening material, 197
Power law analysis
  of pressure vessels, 617
  of stationary cracks, 409
Pressure vessels, 183, 214, 308, 521, 597, 617
  K values, table, 605
Profile, crack front (see Crack front)
Projectile, cannon-launched, 554
Propagation, crack (see also Fatigue crack propagation)
  in blunt- and sharp-notched plates, 361
  in center-cracked panel, 183
  crack-shape predictions
    for aluminum, table, 60
    for polymethyl methacrylate, table, 59
  in generator end rings, 149, 167
  in nickel-base superalloys, 167
  in nuclear reactor pressure vessels, 183
  in polymeric materials, 45, 493, 504
  in side-grooved compact tension specimens, 251
  in steel, 281, 409
    austenitic, 293
    HY-80, 451, 578
    hydrogenated, 131
    polycarbonate, 431
  stainless, 293
    in three-dimensional specimen, 251
  R
Radius, notch root, 392
Residual stress, 247, 434, 451
Resistance, crack
  aluminum, titanium, and steel alloys, table, 291
  ASTM Standard E 813: 328
  in austenitic stainless steel, 293
  in ductile steel pipeline, 632
  in HY-80 steel plates, 451
  in iron alloys, 328
    table, 343
  in normalized/as-rolled steel, 238
  in titanium alloys, 392
  in zirconium pressure tubes, 308
Ring segment
  external cracking, 106
  hydrogen-assisted cracking, 149
S
SEM (see Electron microscope)
Similitude parameters, 347
Slip (see Plastic deformation)
Steel
  A36: 238
  A131: 214
  A508: 214
  A516: 214, 238
  A517: 214
  A533: 214, 381, 467
  A723: 281
  AISI 1018: 467
  AISI 4340: 453
  austenitic stainless, 293
  in bridges, 569
  high-carbon, 361
  HSLA, 131
hydrogenated, 131, 149
HY-80 alloy, 451, 578
manganese aluminum alloys, 597
manganese chromium alloys, 149, 597
manganese silicon alloys, 597
microstructure of, 579
pipeline, 632
polycarbonate, 431
1020: 361
1070: 361
welded, 451, 597
Strain hardening
  of austenitic stainless steel, 293
Strain-rate effects (see Loading)
Stress (see Loading; Residual stress; Stress intensity factor analysis)
Stress intensity factor analysis
  correlations of four solutions
    aluminum, table, 57, 61
    polymethyl methacrylate, table, 59, 61
  edge-cracked strip, 95
HSLA steel, 131
inappropriate use of, 347
infinite strip, 7
nondimensionalized
  biaxial loading of hole crack, table, 71, 76, 77
  normal/shear components, 17
plates, 361, 551
polymeric materials, 504
polymethyl methacrylate, 45
pressure vessel tests, 597, 617
projectiles, 554
ring segment, 106
standard specimens, 27
thick shells, 521
titanium alloys, 392
uranium projectiles, table, 557
Stress ratios
  7075-T651 aluminum, table, 51
Strip yield model (see Dugdale model)
Surface roughness
  crack initiation
    titanium alloys, 392
T
Tearing instability theory
  crack propagation, table, 193, 195
Temperature
  lowered
    effect on cast iron, 328
    effect on nickel alloy, 167
    effect on pipelines, 635
    effect on steel, 113, 569
    effect on steel, table, 143, 241
    effect on uranium alloy, table, 558
  elevated
    effect on polymeric material, 504
    effect on pressure vessels, 597
    effect on steel, table, 293, 580, 584
Tensile tests
  ductile cast iron alloys, 328
tungsten alloy, table, 565
Three-dimensional fractures
  finite element analysis, 535
Three-point bend specimens, 37, 214, 453
  initiation/maximum loading, table, 636
  $K$ values, table, 605
  $R$-curve data, 636
  radial loading, 106
Thermoplastic composite (see Plastics)
Titanium alloys
  Ti-6Al-4V, 281, 392
Tubular products, 106
Tungsten alloys, 554
Tunneling effects
  and crack propagation, 251
<table>
<thead>
<tr>
<th>U</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloading (see also Loading)</td>
<td>Weight function (see Loading)</td>
</tr>
<tr>
<td>compliance method, 281, 308</td>
<td>Weldments</td>
</tr>
<tr>
<td>and crack behavior, 167, 349</td>
<td>HY-80 steel, 451</td>
</tr>
<tr>
<td>table, 316</td>
<td></td>
</tr>
<tr>
<td>Uranium alloys, 554</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex (see Crack front)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zirconium, 308</td>
</tr>
</tbody>
</table>