Subject index

adhesion between elastic bodies, 125–9
Amonton’s law of friction, 204, 212
in rolling contact, 244, 265
anisotropic materials, 134–5
axi-symmetrical elastic stresses, 76–80

ball-bearings
headstock slip in, 268–70
spin in, 8–9
ball and socket, 117
Bauchinger effect, 184
bearing area, 407
belt
creep of, 245–7
model for tyre, 283
boundary element method, 55
brittle materials
ring cracks in, 94, 125, 178

calendering, 312–28
camber thrust, 267, 280
cast iron in contact with steel, 110
Cauchy principal value of integrals, 27, 30, 424
cavity model of indentation, 173–6
circular region of elastic half-space
axi-symmetrical tractions on, 76–80
cylic loading of, 125
general pressure on, 63
Hertz pressure on, 60–3, 93–4
Hertz traction on, 74–5
sub-surface shear stress, 62, 99
torsional loading of, 80–2
uniform normal displacement of, 59–60
uniform pressure on, 56–9
uniform tangential displacement of, 71–4
cold rolling, 326–8
complementary energy, 151

creep, 220, 356
effect of roughness on, 422–3
conductance, 415
cone
elastic contact of, 114
impact by, 353
plastic indentation by, 168–9
conforming contacts, 1, 114–18
ball and socket, 117
torsional method, 144–9
pin joint, 116
rolling, 268–70
contact resonance see resonance
cornering force (tyre), 277–8, 282
corrugation, 350
creep (material), 186
linear, 191
non-linear, 196, 200
creep (rolling), 242
between strip and rollers, 315
coefficient (creepage), 255, 259, 431
effect of roughness on, 423
doing belt on pulley, 245–6
experiments, 251, 266
linear theory of, 257–9
of pneumatic tyres, 279
of railway wheel, 264–5, 268
strip theory of, 261–3
creep compliance function, 185
curvature
equivalent radius of, 85, 97
principal radius of, 85–7
radius of, 85–7
relative radius of, 85–7, 97
cylic loading, 224–31
cylindrical bodies
compression of, 130–1
contact of, 99–104, 129–34
end effects in, 132
Subject index

onset of yield in, 155  
profile for uniform loading of, 134  
sub-surface stresses in, 134  
cylinder, contact on flat ends of, 111  
damping, vibration, 230  
Deborah number, 304, 306, 310  
dimensional analysis of contact, 89–90  
disc machine, 8  
distortivity, 380, 385, 387, 390  
Dundur’s theorem, 381  
Duralumin  
bail rolling on steel, 251  
in contact with steel, 110  
edge of contact, stresses at, 25–6, 37, 39, 107–11, 214, 248  
elastic constants, 110  
difference of in rolling contact, 246–51, 315–16  
difference of in static contact, 110, 119–25, 207–9  
plane strain modulus, 89, 110  
elastic foundation model  
in elastic rolling, 274–7  
in normal contact, 104–6  
in viscoelastic rolling, 303–6  
elastic-plastic indentation, 171–84  
penetration in, 179–80  
pile-up at edge of, 178  
unloading of, 179–84  
elastic-plastic rolling contact, 286–98  
elastohydrodynamic lubrication, 331–9  
elliptical region of elastic half-space  
general pressure on, 63, 67–8  
general traction on, 76  
Hertz pressure on, 65–7, 95–9  
Hertz traction on, 75  
sub-surface shear stress, 67, 99  
torsional loading of, 82–3  
uniform normal displacement of, 64  
uniform tangential displacement of, 71  
et effects in rollers, 132–4  
equivalent radius of curvature, 85, 97  
exponential roughness, 413–15  
finite-element method, 55, 172  
force at surface of half-space  
dynamic (‘step’), 344–5  
harmonic, 345–6  
high speed travelling, 370–2  
non-linear material, 196–8  
normal line, 14–17  
normal point, 50–3  
tangential line, 17–18  
forces at point of contact, 4–5  
frame of reference, 1–3  
fretting (fatigue), 26, 230  
functional filtering, 410, 421  
Gaussian roughness, 407–8, 410, 413  
gears, involute, 6, 129  
gelatine sphere, adhesion of, 128  
glass  
in contact with steel, 110  
stress waves in, 358–9  
granular material, 231  
grinding, surfaces produced by, 397  
hardness, 90, 157  
Vickers’, 177  
heat source  
continuous point, 376, 381  
instantaneous line, 376  
instantaneous point, 375–6  
moving, 377–80, 382–3  
‘Heathcote slip’, 251, 269  
Hertz theory, 90–104  
basic assumptions of, 91–2  
cylindrical bodies (2-D) for, 99–104  
effect of roughness on, 419–20  
general profiles for, 95–9  
limitations of, 99  
solids of revolution for, 92–5  
summary of formulae, 427–8  
hot rolling, 322–6  
hydrodynamic lubrication, 328–31  
hysteresis, elastic  
in contact resonance, 350  
in normal contact, 181  
in rolling contact, 284–5  
in tangential contact, 227, 229  
impact  
collinear elastic, 351–5  
high speed, 366  
hypervelocity, 367  
longitudinal, 341–2, 359–60  
oblique elastic, 355–8  
plastic, 361–6  
time of, 353, 365  
viscoelastic, 196, 368–9  
impedance, 346  
imperfect contact, 389–90  
inhomogeneous materials, 134–6  
interference fringes (optical), 86, 90  
junction growth, 235  
Kelvin solid, 193  
layer, elastic, 136–42  
line force on half-space  
high-speed travelling, 370–2
Subject index

non-linear elastic, 196–8
normal, elastic, 14–17
tangential, elastic, 17–18
lubrication
of elastic cylinders (elastohydrodynamic), 331–3
of rigid cylinders, 329–31
variable viscosity, 333–9
Maxwell material, 186–7, 191, 194–6, 369
microslip between rollers and strip, 314
cyclic loading, in, 224–31
due to dissimilar materials, 121
elastic wedge, 110
flat punch, circular planform, 80
flat punch (2-D), 40
‘Heathcote slip’, 269
oblique impact, in, 356
‘Reynolds’ slip’, 247, 250
rolling contact, in, 242, 245, 248–50, 253–6, 260–4
tangential loading, in, 211, 217–24
torsional loading, in, 232–3
non-conforming contacts, 1
anisotropic materials with, 135
geometry of, 84–7, 425–6
non-linear creep (material), 196, 200
non-linear elasticity, 196
line contact with, 198
point contact with, 199
numerical methods, 144–52
oblique loading, 221–4
oscillating forces, 224–31, 345–9
Péclet number, 378–9
perex
in contact with steel, 110
radial cracks in, 178
photoelasticity, 22, 99, 103, 112
in rolling contact, 262
‘pile-up’ at edge of indentation, 178–9, 200, 362
pin joint, 117–18, 141
plane strain modulus, 89, 110
plastic yield, onset of, 153–7
in cylinders in contact, 154
in general profiles, 155
in impact, 361
in rolling contact, 286–7
in sliding contact, 206–7
in solids of revolution, 154
in strip between rollers, 318–20
in wedge and cone, 155–6
plasticity index, 416
plates, contact with, 143
ploughing, 237–41
pneumatic tyres see tyres
point force on elastic half-space
dynamic (step), 344–5
harmonic, 345–6
normal, 50–3
tangential, 68–70
polygonal region of elastic half-space
non-uniform pressure on, 55–6
uniform pressure on, 53–5
potential functions of Boussinesq and
Cerruti, 45–50
for normal point force, 50
for pressure on elliptical area, 63–5, 98
for tangential point force, 68
principal value (Cauchy) of integrals, 27, 30, 424
profilometer, 406
punch
flat, circular planform, 59–60, 71–4, 80–2
flat, elliptical planform, 64, 74, 82–3
flat (2-D), 35–42
non-linear materials, indentation by, 198–9
plastic indentation by, 168–9
polynomial profile (2-D), 30–2
stresses at the edge of, 108
thermoelastic contact by, 390
railway wheel/rail, 264–5
random rough surfaces
characteristics of, 406
contact of, 411–23
exponential height distribution of, 413–5
Gaussian height distribution of, 407–8, 410, 413
real area of contact, 397, 400–6, 414–15
receptance, 346
functions, 347
receding contact, 141–2
rectangular elastic block
in contact with cylinder, 131
in contact with plane, 111
rectangular region, pressure applied to, 54–5
relaxation function, 185, 303–4
residual stresses
in normal contact, 183–4
in rolling contact, 295
resonance, contact, 349–51, 357
restitution, coefficient of, 362–5, 369
revolution, solids of, 87, 92–5
Reynolds’ equation, 329
Reynolds’ slip, 250
rigid perfectly-plastic material
see slip-line fields
<table>
<thead>
<tr>
<th>Subject index</th>
<th>451</th>
</tr>
</thead>
<tbody>
<tr>
<td>ring cracks in brittle solids, 94, 125, 178</td>
<td>slip see microslip</td>
</tr>
<tr>
<td>roller bearings, 129</td>
<td>slip-line field, 157-60</td>
</tr>
<tr>
<td>end effects in, 132-4</td>
<td>extension into rigid zone of, 170-1</td>
</tr>
<tr>
<td>rollers (rolls)</td>
<td>for core indentation, 168-9</td>
</tr>
<tr>
<td>elastic contact of, 129-34</td>
<td>for hot rolling of metals, 324-6</td>
</tr>
<tr>
<td>elastic strip between (calendering), 312-8</td>
<td>for indentation by sphere, 170-1</td>
</tr>
<tr>
<td>lubrication of, 328-39</td>
<td>for plastic wedge, 165-8</td>
</tr>
<tr>
<td>plastic strip between (rolling), 320-8</td>
<td>for rolling contact of rigid cylinder, 295-302</td>
</tr>
<tr>
<td>rolling</td>
<td>for serrated surface, 404</td>
</tr>
<tr>
<td>ball in conforming groove, 268-70</td>
<td>for wedge indentation, 160-5</td>
</tr>
<tr>
<td>cumulative plastic flow in, 292-5</td>
<td>spin</td>
</tr>
<tr>
<td>definition of, 3</td>
<td>in ball-bearings, 8-10</td>
</tr>
<tr>
<td>elastic foundation model of, 274-7</td>
<td>definition of, 4</td>
</tr>
<tr>
<td>free, 5, 242, 246</td>
<td>in pneumatic tyres, 279</td>
</tr>
<tr>
<td>of metal strip, 320-8</td>
<td>in rolling, 242</td>
</tr>
<tr>
<td>supersonic (supersismic), 372-3</td>
<td>spin moment, 5, 10, 233</td>
</tr>
<tr>
<td>tractive, 242, 252-68</td>
<td>spin parameter, 244</td>
</tr>
<tr>
<td>transient, 270-4</td>
<td>spin pole, 259</td>
</tr>
<tr>
<td>viscoelastic bodies of, 302-6</td>
<td>strain, representative, 176, 199</td>
</tr>
<tr>
<td>with spin, 242, 256-68</td>
<td>stress intensity factor, 129, 401</td>
</tr>
<tr>
<td>rolling creep see creep</td>
<td>stress waves, 340-3</td>
</tr>
<tr>
<td>rolling friction (resistance), 306-11</td>
<td>dilatational, 343</td>
</tr>
<tr>
<td>due to elastic hysteresis, 285, 309</td>
<td>distortional (shear), 343</td>
</tr>
<tr>
<td>due to Heathcote slip, 269, 307</td>
<td>in elastic impact, 354, 358</td>
</tr>
<tr>
<td>due to Reynolds' slip, 250, 307</td>
<td>head (S-P), 345</td>
</tr>
<tr>
<td>due to surface roughness, 311</td>
<td>longitudinal, 343</td>
</tr>
<tr>
<td>due to traction and spin, 208</td>
<td>Rayleigh, 343</td>
</tr>
<tr>
<td>with elastic-plastic materials, 294, 309</td>
<td>supersonic (supersismic), 372</td>
</tr>
<tr>
<td>with rigid-plastic materials, 299-301, 309</td>
<td>transverse, 343</td>
</tr>
<tr>
<td>with viscoelastic materials, 304-5, 310</td>
<td>velocities of, 343</td>
</tr>
<tr>
<td>rolling moment, 5, 250, 269, 285, 305</td>
<td>strip between rollers, 312-27</td>
</tr>
<tr>
<td>roughness parameter, 419</td>
<td>onset of plastic flow in, 318-20</td>
</tr>
<tr>
<td>rubber in contact with steel, 110</td>
<td>plastic reduction in, 320-7</td>
</tr>
<tr>
<td>in rolling contact, 286</td>
<td>sub-surface shear stress, 62, 67, 94, 99,</td>
</tr>
<tr>
<td>sampling interval, 408-11, 421</td>
<td>102, 114, 399, 420-1</td>
</tr>
<tr>
<td>self-aligning torque (tyre), 278, 282</td>
<td>sub-surface stresses</td>
</tr>
<tr>
<td>self-similarity, 119, 121, 161</td>
<td>circular contact region, 57, 60, 62, 94</td>
</tr>
<tr>
<td>separation</td>
<td>contact of cylinders, 103, 429-30</td>
</tr>
<tr>
<td>adhesive force as a function of, 125</td>
<td>elliptical contact region, 66-7, 99</td>
</tr>
<tr>
<td>rough surfaces of, 412-13</td>
<td>sliding contact, 205, 209-10, 429-30</td>
</tr>
<tr>
<td>shakedown, 286, 288</td>
<td>table of values, 429-30</td>
</tr>
<tr>
<td>limit in line contact, 289</td>
<td>supersensitive see supersonic</td>
</tr>
<tr>
<td>limit in point contact, 291</td>
<td>supersonic (supersismic), 355, 369</td>
</tr>
<tr>
<td>with kinematic hardening, 292</td>
<td>surface energy, 125</td>
</tr>
<tr>
<td>shells, contact with, 144</td>
<td>surface loading (plane strain)</td>
</tr>
<tr>
<td>shot-peening, 183, 398</td>
<td>axial traction, 42-4</td>
</tr>
<tr>
<td>sidleslip (tyres), 281</td>
<td>displacements specified, 28-33</td>
</tr>
<tr>
<td>singular integral equations, 29</td>
<td>distributed tractions, 18-21</td>
</tr>
<tr>
<td>singular pressure element, 150-1</td>
<td>line forces, 14-18</td>
</tr>
<tr>
<td>sliding</td>
<td>triangular distributions, 26-8</td>
</tr>
<tr>
<td>cylinder, 204-9</td>
<td>uniform normal pressure, 21-4</td>
</tr>
<tr>
<td>definition of, 3</td>
<td>uniform tangential traction, 24-6</td>
</tr>
<tr>
<td>sphere, 209-10</td>
<td>surface loading (3-D)</td>
</tr>
<tr>
<td>supersensitive (supersismic), 372-3</td>
<td>axi-symmetric, 76-80</td>
</tr>
<tr>
<td>thermoelastic effects due to, 391-6</td>
<td>Hertz pressure, 60-3, 65-7</td>
</tr>
<tr>
<td>sliding contact, 202-10</td>
<td>non-uniform pressure, 55-6, 63, 67-8</td>
</tr>
<tr>
<td>normal point force, 50-3</td>
<td></td>
</tr>
</tbody>
</table>

© Cambridge University Press www.cambridge.org
Subject index

potential functions, 45–9
tangential point force, 68–70
tangential tractions, 70–6
torsional, 80–3
uniform normal displacement, 59–60, 64
uniform pressure, 53–5, 56–9
uniform tangential displacement, 71–4

tangential loading
cyclic, 221–31
elastic, 210–31
plastic, 233–41

temperature in half-space, 375–80
continuous point source, due to, 376
distributed sources, due to, 376–7
instantaneous line source, due to, 376
instantaneous point source, due to,
375–6
moving source, due to, 377–80
thermal rectification, 390
thermoelastic distortion, 380–95
contact at different temperatures, due to,
383–90
Dundurs’ theorem, 381
moving heat source, due to, 382–3
point source, due to, 381
transient, 395–6
uniform heating, due to, 381–2
uniform temperature, due to, 382
thermoelastic instability, 391–96
torsional contact, 231–3
transient rolling contact, 270–4
oscillating tractive force, due to, 274
starting from rest, 272
travelling loads, 369–72

---
tungsten carbide in contact with steel, 110
turning, surfaces produced by, 398
tyres (pneumatic), 277
textile in contact, 299
sidetrip and spin, 279
unloading
of an elastic contact, 125, 224–6
of an elastic-plastic contact, 181–4
of a viscoelastic contact, 193–4
variations, 147, 151
Vickers pyramid hardness, 177
viscoelastic material, 184–7
viscoelasticity, 187–196
in normal contact, 187–196
in rolling contact, 302–6
waves
elastic see stress waves
plastic, 238
wavy surfaces
one-dimensional contact of, 398–402
plastic deformation of, 403–6
thermoelastic contact of, 390, 391–4
two-dimensional contact of, 402–3
wear, 224, 240
wedge
elastic contact of, 111–14
plastic deformation of, 165–8
plastic indentation by, 160–5
plastic shear of, 234–7
Williams, Landen and Ferry shift factor, 310

yield see plastic yield