adhesion between elastic bodies, 125-9	compliance, 220, 356
Amonton's law of friction, 204, 212	effect of roughness on, 422-3
in rolling contact, 244, 265	conductance, 415
anisotropic materials, 134-5	cone
axi-symmetrical elastic stresses, 76-80	elastic contact of, 114
	impact by, 353
ball-bearings	plastic indentation by, 168-9
Heathcote slip in, 268-70	conforming contacts, 1, 114–18
spin in, 8–9	ball and socket, 117
ball and socket, 117	numerical method, 144-9
Bauchinger effect, 184	pin joint, 116
bearing area, 407	rolling, 268–70
belt	contact resonance see resonance
creep of, 245-7	cornering force (tyre), 277-8, 282
model for tyre, 283	corrugation, 350
boundary element method, 55	creep (material), 186
brittle materials	linear, 191
ring cracks in, 94, 125, 178	non-linear, 196, 200
	creep (rolling), 242
	between strip and rollers, 315
calendering, 312–28	coefficient (creepage), 255, 259, 431
camber thrust, 267, 280	effect of roughness on, 423
cast iron in contact with steel, 110	of elastic belt on pulley, 245-6
Cauchy principal value of integrals, 27, 30,	experiments, 251, 266
424	linear theory of, 257-9
cavity model of indentation, 173-6	of pneumatic tyres, 279
circular region of elastic half-space	of railway wheel, 264-5, 268
axi-symmetrical tractions on, 76-80	strip theory of, 261-3
cyclic loading of, 125	creep compliance function, 185
general pressure on, 63	curvature
Hertz pressure on, 60-3, 93-4	equivalent radius of, 85, 97
Hertz traction on, 74-5	principal radius of, 85-7
sub-surface shear stress, 62, 99	radius of, 85-7
torsional loading of, 80-2	relative radius of, 85-7, 97
uniform normal displacement of, 59-60	cyclic loading, 224-31
uniform pressure on, 56-9	cylindrical bodies
uniform tangential displacement of, 71-4	compression of, 130-1
cold rolling, 326–8	contact of, 99-104, 129-34
complementary energy, 151	end effects in, 132

onset of yield in, 155	fretting (fatigue), 26, 230
profile for uniform loading of, 134	functional filtering, 410, 421
sub-surface stresses in, 134	
cylinder, contact on flat ends of, 111	Gaussian roughness, 407-8, 410, 413
	gears, involute, 6, 129
damping, vibration, 230	gelatine sphere, adhesion of, 128
Deborah number, 304, 306, 310	glass
dimensional analysis of contact, 89-90	in contact with steel, 110
disc machine, 8	stress waves in, 358-9
distortivity, 380, 385, 387, 390	granular material, 231
Dundur's theorem, 381 Duralumin	grinding, surfaces produced by, 397
ball rolling on steel, 251	hardness, 90, 157
in contact with steel, 110	Vickers', 177
in contact with steel, 110	heat source
edge of contact, stresses at, 25-6, 37, 39,	continuous point, 376, 381
107-11, 214, 248	instantaneous line, 376
elastic constants, 110	instantaneous point, 375-6
difference of in rolling contact, 246-51,	moving, 377-80, 382-3
315-16	'Heathcote slip', 251, 269
difference of in static contact, 110,	Hertz theory, 90–104
119-25, 207-9	basic assumptions of, 91-2
plane strain modulus, 89, 110	cylindrical bodies (2-D) for, 99-104
elastic foundation model	effect of roughness on, 419–20
in elastic rolling, 274-7	general profiles for, 95-9
in normal contact, 104-6	limitations of, 99
in viscoelastic rolling, 303-6	solids of revolution for, 92-5
elastic-plastic indentation, 171-84	summary of formulae, 427-8
penetration in, 179-80	hot rolling, 322-6
pile-up at edge of, 178	hydrodynamic lubrication, 328-31
unloading of, 179-84	hysteresis, elastic
elastic-plastic rolling contact, 286–98	in contact resonance, 350
elastohydrodynamic lubrication, 331-9	in normal contact, 181
elliptical region of elastic half-space	in rolling contact, 284-5
general pressure on, 63, 67-8	in tangential contact, 227, 229
general traction on, 76	
Hertz pressure on, 65-7, 95-9	impact
Hertz traction on, 75	collinear elastic, 351-5
sub-surface shear stress, 67, 99	high speed, 366
torsional loading of, 82-3	hypervelocity, 367
uniform normal displacement of, 64	longitudinal, 341-2, 359-60
uniform tangential displacement of, 71	oblique elastic, 355-8
end effects in rollers, 132-4	plastic, 361-6
equivalent radius of curvature, 85, 97	time of, 353, 365
exponential roughness, 413-15	viscoelastic, 196, 368-9
finite element mothed 55, 172	impedance, 346
finite-element method, 55, 172	imperfect contact, 389-90
force at surface of half-space	inhomogeneous materials, 134-6
dynamic ('step'), 344–5 harmonic, 345–6	interference fringes (optical), 86, 90
high speed travelling, 370-2	junction growth, 235
non-linear material, 196-8	junction growth, 255
normal line, 14-17	Valvin solid 102
normal point, 50–3	Kelvin solid, 193
tangential line, 17–18	layer, elastic, 136-42
forces at point of contact, 4-5	line force on half-space
frame of reference, 1-3	high-speed travelling, 370-2
manic or reference, 1-2	night-speed dayeding, 3/0-2

non-linear elastic, 196-8	ploughing, 237-41
normal, elastic, 14-17	pneumatic tyres see tyres
tangential, elastic, 17–18	point force on elastic half-space
lubrication	dynamic ('step'), 344-5
of elastic cylinders (elastohydrodynamic),	harmonic, 345-6
331-3 of rigid cylinders, 329-31	normal, 50–3 tangential, 68–70
variable viscosity, 333-9	polygonal region of elastic half-space
variable viscosity, 555-9	non-uniform pressure on, 55-6
Maxwell material, 186-7, 191, 194-6, 369	uniform pressure on, 53-5
microslip	potential functions of Boussinesq and
between rollers and strip, 314	Cerruti, 45–50
cyclic loading, in, 224-31	for normal point force, 50
due to dissimilar materials, 121	for pressure on elliptical area, 63-5, 98
elastic wedge, 110	for tangential point force, 68
flat punch, circular planform, 80	principal value (Cauchy) of integrals, 27,
flat punch (2-D), 40	30, 424
'Heathcote slip', 269	profilometer, 406
oblique impact, in, 356	punch
'Reynolds' slip', 247, 250	flat, circular planform, 59-60, 71-4,
rolling contact, in, 242, 245, 248-50,	80-2
253-6, 260-4	flat, elliptical planform, 64, 74, 82-3
tangential loading, in, 211, 217-24	flat (2-D), 35-42
torsional loading, in, 232-3	non-linear materials, indentation by, 198–9
non-conforming contacts, 1	plastic indentation by, 168-9
anisotropic materials with, 135	polynomial profile (2-D), 30-2
geometry of, 84-7, 425-6	stresses at the edge of, 108
non-linear creep (material), 196, 200	thermoelastic contact by, 390
non-linear elasticity, 196	
line contact with, 198	railway wheel/rail, 264-5
point contact with, 199	random rough surfaces
numerical methods, 144-52	characteristics of, 406
111 1 11 001 1	contact of, 411-23
oblique loading, 221-4	exponential height distribution of,
oscillating forces, 224-31, 345-9	413-5 Gaussian height distribution of, 407-8,
Paglat number 279 0	410, 413
Peclet number, 378-9	real area of contact, 397, 400-6, 414-15
in contact with steel, 110	receptance, 346
radial cracks in, 178	functions, 347
photoelasticity, 22, 99, 103, 112	receding contact, 141-2
in rolling contact, 265	rectangular elastic block
'pile-up' at edge of indentation, 178-9,	in contact with cylinder, 131
200, 362	in contact with plane, 111
pin joint, 117-18, 141	rectangular region, pressure applied to,
plane strain modulus, 89, 110	54-5
plastic yield, onset of, 153-7	relaxation function, 185, 303-4
in cylinders in contact, 154	residual stresses
in general profiles, 155	in normal contact, 183-4
in impact, 361	in rolling contact, 295
in rolling contact, 286–7	resonance, contact, 349-51, 357
in sliding contact, 206-7	restitution, coefficient of, 362-5, 369
in solids of revolution, 154	revolution, solids of, 87, 92-5
in strip between rollers, 318-20	Reynolds' equation, 329
in wedge and cone, 155-6	Reynolds' slip, 250
plasticity index, 416	rigid-perfectly-plastic material
plates, contact with, 143	see slip-line fields

ring cracks in brittle solids, 94, 125, 178	slip see microslip
roller bearings, 129	slip-line field, 157–60
end effects in, 132-4	extension into rigid zone of, 170-1
rollers (rolls)	for cone indentation, 168-9
elastic contact of, 129-34	for hot rolling of metals, 324-6
elastic strip between (calendering),	for indentation by sphere, 170-1
312-8	for plastic wedge, 165-8 for rolling contact of rigid cylinder,
lubrication of, 328–39	295–302
plastic strip between (rolling), 320-8 rolling	for serrated surface, 404
ball in conforming groove, 268-70	for wedge indentation, 160-5
cumulative plastic flow in, 292-5	spin
definition of, 3	in ball-bearings, 8-10
elastic foundation model of, 274-7	definition of, 4
free, 5, 242, 246	in pneumatic tyres, 279
of metal strip, 320-8	in rolling, 242
supersonic (superseismic), 372-3	spin moment, 5, 10, 233
tractive, 242, 252-68	spin parameter, 244
transient, 270-4	spin pole, 259
viscoelastic bodies of, 302-6	strain, representative, 176, 199
with spin, 242, 256–68	stress intensity factor, 129, 401
rolling creep see creep	stress waves, 340-3
rolling friction (resistance), 306-11	dilatational, 343
due to elastic hysteresis, 285, 309	distortional (shear), 343 in elastic impact, 354, 358
due to Heathcote slip, 269, 307	head (S-P), 345
due to Reynolds' slip, 250, 307	longitudinal, 343
due to surface roughness, 311 due to traction and spin, 308	Rayleigh, 343
with elastic-plastic materials, 294, 309	supersonic (superseismic), 372
with rigid-plastic materials, 294, 309	transverse, 343
with viscoelastic materials, 304-5, 310	velocities of, 343
rolling moment, 5, 250, 269, 285, 305	strip between rollers, 312-27
roughness parameter, 419	onset of plastic flow in, 318-20
rubber in contact with steel, 110	plastic reduction in, 320-7
in rolling contact, 286	sub-surface shear stress, 62, 67, 94, 99,
	102, 114, 399, 420-1
sampling interval, 408–11, 421	sub-surface stresses
self-aligning torque (tyre), 278, 282	circular contact region, 57, 60, 62, 94
self-similarity, 119, 121, 161	contact of cylinders, 103, 429–30
separation	elliptical contact region, 66-7, 99
adhesive force as a function of, 125	sliding contact, 205, 209–10, 429–30
rough surfaces of, 412-13 shakedown, 286, 288	table of values, 429-30 superseismic see supersonic
limit in line contact, 289	supersonic (superseismic), 355, 369
limit in point contact, 291	surface energy, 125
with kinematic hardening, 292	surface loading (plane strain)
shells, contact with, 144	axial traction, 42-4
shot-peening, 183, 398	displacements specified, 28-35
sideslip (tyres), 281	distributed tractions, 18-21
singular integral equations, 29	line forces, 14-18
singular pressure element, 150–1	triangular distributions, 26-8
sliding	uniform normal pressure, 21-4
cylinder, 204-9	uniform tangential traction, 24-6
definition of, 3	surface loading (3-D)
sphere, 209-10	axi-symmetric, 76–80
supersonic (superseismic), 372-3	Hertz pressure, 60-3, 65-7 non-uniform pressure, 55-6, 63, 67-8
thermoelastic effects due to, 391-6	non-uniform pressure, 55-6, 63, 67-8 normal point force, 50-3
sliding contact, 202-10	normal point force, 30-3

potential functions, 45-9 tungsten carbide in contact with steel, 110 turning, surfaces produced by, 398 tangential point force, 68-70 tangential tractions, 70-6 tyres (pneumatic), 277 torsional, 80-3 creep in free rolling, 279 uniform normal displacement, 59-60, 64 sideslip and spin, 279 uniform pressure, 53-5, 56-9 uniform tangential displacement, 71-4 unloading of an elastic contact, 125, 224-6 tangential loading of an elastic-plastic contact, 181-4 cyclic, 221-31 of a viscoelastic contact, 193-4 elastic, 210-31 plastic, 233-41 variational methods, 147, 151 temperature in half-space, 375-80 Vickers pyramid hardness, 177 continuous point source, due to, 376 viscoelastic material, 184-7 distributed sources, due to, 376-7 in normal contact, 187-196 instantaneous line source, due to, 376 in rolling contact, 302-6 instantaneous point source, due to, 375-6 waves moving source, due to, 377-80 elastic see stress waves thermal rectification, 390 plastic, 238 thermoelastic distortion, 380-95 wavy surfaces contact at different temperatures, due to, one-dimensional contact of, 398-402 383-90 plastic deformation of, 403-6 Dundurs' theorem, 381 thermoelastic contact of, 390, 391-4 moving heat source, due to, 382-3 two-dimensional contact of, 402-3 point source, due to, 381 wear, 234, 240 transient, 395-6 wedge uniform heating, due to, 381-2 elastic contact of, 111-14 uniform temperature, due to, 382 plastic deformation of, 165-8 thermoelastic instability, 391-96 plastic indentation by, 160-5 torsional contact, 231-3 plastic shear of, 234-7 transient rolling contact, 270-4 Williams, Landen and Ferry shift factor, 310 oscillating tractive force, due to, 274 starting from rest, 272 yield see plastic yield travelling loads, 369-72