

Index

- accident protection 397
- accidental loadings 53–4
- accuracy *see* tolerances
- acid pickling 1037
- acoustics 214
- added elements, metallurgy 224–5
- aerodynamics 128–31
- air leakage index 36
- air-drying paints 1041
- amplified moments 14–15
- analysis methods
 - area moments 310–11
 - beams 325–41, 606–12
 - bearing piles 879
 - bending 297–9
 - bolts 676–80
 - elastic 289–93, 347–8, 606–8
 - finite element 316–24, 368–71
 - foundations 827–31
 - fracture mechanics 268–71
 - graphs 349–52
 - line elements 289–302
 - manual 286–324
 - moment–rotation behaviour 380–1
 - orthotropic decks 915
 - plane frames 342–52
 - plastic 300–2, 347, 348, 351–2, 608–9
 - skeletal structures 303–16
 - space frames 186
 - towers and masts 174–5
 - trusses 550–2
 - Vierendeel girders 557–8
 - weld groups 704–6, 707
- anchors 397, 480–1
- angles
 - dimensions/property tables 1203–7
 - floor beams 1298–9
 - struts 420, 423
 - web cleats 729–33, 738–44
- annealing 232
- applied metallurgy 222–46
 - chemical composition 223–6
 - fabrication 239–45
 - heat treatment 226–33
 - manufacture 233–7
 - selection criteria 245–6
 - service performance 239–45
- approximate methods 365–7
- arc plasma cutting 959
- arc welding 241
- arches 131–3, 207
- architectural design aims 44
- area moments method, *see also* second moments . . .
- area moments theorem 310–11
- articulation 146–7
- ASB *see* asymmetric beams
- assemblies, bearings 856–9
- asymmetric beams (ASB) 1195–6
- atmospheric corrosion rates 1034
- atria 204–19
- austenite 227, 232
- axial
 - capacity 873–5
 - compressive forces 750
 - forces 1059
 - loads 289–90, 299–300, 384–8, 652–9
- b/t* width-to-thickness ratios 373–81, 1222–3
- back marks, bolts 676
- bainite 229
- 'balloon' constructions 204, 205
- barrel vaults 179–82
- base
 - heave 894–6
 - motion response 360
 - resistance 874–5, 877
 - stability 894–6
- baseplates 822–7
- 'bath tubs', box girders 138–40
- beams
 - analysis 325–41
 - asymmetric 1195–6
 - atria 207, 208
 - beam connections 738–47
 - bearing plates 827, 828, 829
 - bending elastic limit 294–9
 - bracing 448–52
 - bridges 161–4
 - built-in 1087–93
 - cold-formed sections 454–7
 - columns
 - connections 721–3, 729–38

- constructions 11–12, 16–18
 - cross-sections 522–3
 - design 533–40
 - loading 511–22
 - portal frames 525–31
- composite 601–50
 - analysis 606–12
 - continuous 609–12, 637–50
 - design 612–27, 629–50
 - economy 601–3
 - shear connections 605, 613–22
 - spans 603–4, 605–6
 - supported 629–1
- continuous 332–5
 - cross-sections 433–6
 - design 436–48, 452–4, 462–9
 - elastic critical load 450
 - end plates 929, 930
 - Eurocodes 1059, 1063–4
 - fabrication economy 950
 - fire resistance 1017–19, 1023, 1296–9, 1302
 - flanges 763–4
 - industrial steelwork 108–9
 - lateral bracing 448–9
 - loaded in-plane plates 720
 - moment capacity 433–7
 - multi-storey buildings 60–6
 - plastic analysis 300–1
 - restricted depth 452–4
 - serviceability limit state 494
 - single-storey buildings 16–18
 - supported 325, 328–32, 335–9, 1079–86
 - types 431–3
 - ultimate limit state 485–94
 - universal
 - bridges 161–4
 - castellated 1208–13
 - dimensions/property tables 1150, 1155, 1166–71, 1214–17
 - fire-resistance 1302
 - web openings 457–60
 - web tension 761–2
- bearings 843–59, 866
 - assemblies 856–9
 - bolt design 681
 - capacity 882–5
 - column splices 749–53, 754–5
 - column web compression 762–3
 - curved structures 858–9
 - materials 845–8
 - piles 867–85, 1150, 1178–80
 - pressure 820–2
 - stiffeners 478–94, 714–15
 - tolerances 924–8, 940, 946
 - types 849–53
 - use 853–6
- bedding 833–4
- bending
 - analysis 297–9
 - fabrication 962–3
 - plate girders 492–3
 - resistances 582–3
 - strengths 1224–5
 - tension members 388–91
- bending moments (BM)
 - axial loads 656–8, 659
 - beams 325–41
 - design theory 1077–114
 - Eurocodes 1059
 - plane frames 342–52
- bicycle wheel roofs 191
- bimetallic corrosion 1032
- blast
 - cleaning 1036–7
 - loadings 120–13
 - primers 1041–4
- block-filled columns 1288–90
- BM *see* bending moments
- board fire protection 1024, 1284–5
- boiler houses 95–6
- bolts 671–83, 1046
 - anchorage 830–1
 - capacities 683, 1160–4, 1242–65
 - close-tolerance 957
 - data 1160–2, 1236–65
 - design 680–3, 1160–2
 - erection site practices 981–3
 - erection tolerances 937–9, 941
 - Eurocodes 1061
 - fabrication 953–4, 955–8
 - failure 760–1
 - forces 827–30
 - geometry 673–6
 - holding-down systems 832–3
 - preloaded 671–3, 681, 957, 1162
 - standards 1319–20
 - strengths 680–3
 - tolerances 937–9, 941
 - types 671–3, 937–8, 956–7
- box
 - columns 110–12
 - girders 1006–8
 - sections 935–6
 - sheet piles 870, 1276
- braced-bay frames 71–2, 74–5
- bracings
 - barrel vaults 181
 - beams 448–52
 - bridges 152–3, 449–52
 - compression/moments 531
 - crane safety 1008
 - industrial steelwork 112–13
 - multi-storey buildings 71–5
 - towers and masts 169, 171
- bracket stiffeners 715
- bridges 124–68
 - bracing 449–52
 - cables 395–7
 - continuous 157–8

- deck bearings 856–9
- design 148–64, 166–8
- plate girders 483–95
- roads 568–76
- spans 124–7
- stability/articulation 146–7
- steel grades 145–6
- suspension 128–31, 148–9, 187–8
- traffic loading 144–5
- trusses 543–4, 546–7
- type selection 127–43
- Vierendeel girders 568–76
- British Standards 1311–21
 - BS 4395, bolts 671–3
 - BS 5400
 - axial tension 387–8, 391, 392–3
 - bridges 143, 164
 - composite columns 655, 656, 657
 - compressive resistance 510
 - fatigue 269
 - fracture 254
 - plate girders 485–95
 - slender sections 407
 - weld 691
 - BS 5493, corrosion 1035
 - BS 5588, atria 215
 - BS 5606, tolerance 920–1
 - BS 5950
 - bending strengths 1224–5
 - bolts 673–4, 683
 - composite columns 660
 - composite deck slabs 586–8
 - compressive strengths 1228–35
 - cross-sections 381
 - deflections 1220
 - design strengths 1221
 - element design 1220–35
 - fire protection 1014–16
 - fracture 254
 - in-plane stability 13
 - lateral bracing 448–9
 - plate girders 473–83
 - slender sections 404, 407
 - struts 404, 1227
 - tension members 384–7, 389–92
 - tolerance 919
 - welds 689, 708
 - width-to-thickness ratios 1222–3
- BS 6399, external gravity loads 8–11
- BS 7448, fracture 255
- BS 7608, fatigue 269
- BS 7910, fracture mechanics 255–6
- BS 8100, towers and masts 173–4
- BS 8110, composite columns 659
- BS EN 1011-2, welds/welding 690
- buckling
 - beams 442–5
 - column web compression 763
 - columns/struts 404, 411–13
 - local 373–82, 1149–50
 - parameters 1152–3
 - plate girder 488, 489, 501–3
 - resistance 714
- buildings
 - envelope tolerances 922, 939–40
 - finishes 48–52
 - log books 37–8
 - multi-storey 42–93
 - plate girders 471–3
 - regulations 35–8, 1013–16
 - services integration 48–52
 - single-storey 1–40
 - towers and masts 175–8
 - trusses 541–2, 545–6
 - types 1–2
- built-in beams 327
- built-up struts 420–3
- burning, fabrication 958–9
- butt welds 695–6
- cable-stayed beams 187–9
- cable-stayed bridges 131–2, 148, 150
- cables
 - mathematics 189, 191–6
 - structures 186–97
 - tension members 395–7
 - towers and masts 198
- cambering 962–3
- cantilevers
 - design theory 1077–8
 - erection 996, 997
 - plastic failure 339–41
 - propped 325–41, 1094–101
- cased strut methods 654
- castellated beams 62–3, 1208–13
- castellated sections 1151
- casting 234–5, 1317
- catenary loaded vertically 193, 194
- CCT *see* continuous cooling transformation diagrams
- ceiling voids 49–50
- cellular beam sections 62–3
- cement manufacturing plants 98
- cementite 226–7
- channel struts 420, 423
- Charpy V-notch test 238, 251–2, 255–8
- chemical composition 223–6
- chemical-resistant paints 1041
- chemistry, corrosion 1030–2
- ‘chord and joint’ space frames 182–5
- circular arc loaded radially 193
- circular hollow sections 1181–2, 1187–9, 1304
- claddings 1–4, 34–40, 209–11
- Clapeyron’s Theorem 326–7, 332–5
- classification
 - connections 724–5
 - cross-sections 381, 402–8, 433–6, 525
 - paints 1040
- clay soils 821
- cleaning 1036–7

- cleats 729–33, 738–44
- client briefs 44
- closed stringers 913–14
- CNC *see* Computer Numerically Controlled
- coatings
 - cladding 4
 - corrosion 1039–44, 1052, 1309
 - tension members 397
 - weather-resistant steels 1046
- Codes of Practice 9–10, 114–18, 143
- cohesionless soils 821–2, 877
- cohesive soils 876–7, 897–8
- cold cracking 243, 244–5
- cold rolled thin gauge sections 1315–16
- cold sawing 960
- cold-formed sections 454–7, 986, 1187–94
- columns
 - atria 208
 - buckling 373, 375, 404, 411–13, 763
 - composite 651–70, 1066–7
 - crane safety 1006
 - cross sections 402–3
 - dimensions tables 1150
 - economy 424
 - effective lengths 412–20
 - fabrication economy 950
 - fire-resistance 1018–20, 1288–92, 1300–3
 - flange 373, 375
 - industrial steelwork 109–10, 111, 112
 - multi-storey buildings 58–60, 92
 - single-storey buildings 11–12, 16–18
 - slender webs 406–8
 - splices 747, 749–55, 769–75
 - stability 527–9
 - struts 402–30
 - universal 1172–4, 1218–19, 1303
 - web 761–3
 - see also* beams
- combi-piles 871–2
- combined loadings 511–18
- commercial buildings 279–81, 282–4
- compactness 373
- composite
 - beams *see* beams
 - columns 651–70
 - deck construction 136–40, 148, 152
 - deck slabs *see* deck slabs
 - floor trusses 64–5
 - panels 39–40
 - plate girders 155–61
 - slabs 1019–20
- composition
 - cables 395
 - paints 1039–4
- compound struts 420–3
- compression
 - bending 513–18
 - effective lengths 553–4
 - Eurocodes 1058
 - joint tolerances 928
 - moments 413–18, 511–40, 762–4
- compressive loads 402–30
- compressive strengths 1228–35
- computer analysis 286–324
- Computer Numerically Controlled (CNC)
 - fabrication 5, 952–3
- concrete
 - bearings 848
 - composite deck slabs 580
 - filled columns 658–60, 1290–2
- connections
 - baseplates 822–7
 - bolts 1236–65
 - classifications 724–5
 - composite beams 605, 613–22
 - continuous 724, 728
 - definitions 725–8
 - design 721–815, 1236–73
 - Eurocode 1059, 1064
 - fabrication economy 953
 - industrial steelwork 110–12
 - loaded in-plane plates 717–18
 - moments 753–66
 - plate elements 711–20
 - prying forces 716–17
 - simple 729–55, 769–75
 - stiffeners 711–20, 826–7
 - structural steelwork 75–6
 - trusses 547–50
 - Vierendeel girders 558–9
 - weather-resistant steels 1046
 - welds 1266–73
- constant-amplitude loading 266–7
- construction
 - building services integration 55–8
 - cable 197–8
 - composite deck slabs 577–8, 581–2, 592
 - fire-resistance data 1282–307
 - residential 199–204
 - standards 1317
 - sustainability 275–84
 - see also* erection
- contact bearings 924–8, 940, 946
- continuous beams 332–5, 609–12, 637–50
- continuous bridges 157–8
- continuous cooling transformation diagrams (CCT) 229–30, 232
- continuous frames 71, 72–3
- conversion coefficients 342–4
- conveyors 99–100, 966–7
- cored wire welding 699–700
- cores 112–13
- corrosion 1030–52
 - coatings 1320
 - environment effects 1033–4
 - fabrication economy 954–5
 - metallic coatings 1037–9, 1052
 - paints 1039–44, 1052, 1309

- piles 901–3
- prevention and coatings 1320
- processes 1030–3
- protection 393–4, 396, 1035–52
- rates 1032–4
- resistance 686, 1308–10
- surfaces 1035–7, 1051–2
- treatment specification 1047–51
- weather-resistance 1045–7
- Corus Corrosion Protection Guides 1051
- cost issues, atria 54, 214, 692–7, 948–55
- cracks
 - composite beams 626–7
 - growth 268–70
 - opening modes 251–2
 - tip opening displacement 255, 258–9
- cranes, mobile 989–92
- cranes/cranage 11–12
 - erection 988–1001
 - fabrication workshops 964–6
 - layout 99, 997
 - safety 997–9, 1001–11
 - slinging/lifting 999–1001
 - special structures 1011
 - types 989–94
- crevice corrosion 1032
- cropping 959–60
- cross centres 676
- cross-sections
 - beams 433–6, 471–3
 - buckling 373–82
 - classification 381, 402–8, 525
 - columns/struts 402–8, 433–6
 - compression/bending 525
 - compression/moments 522–3
 - moment–rotation behaviour 375–81
 - plate girders 471–3
- curved structures 153–5, 858–9
- cutting techniques 239–40, 958–63
- cycles to failure 262–5
- cyclic stress range 262–5
- cylindrical bearings 852
- damping 357–8, 367–8
- decks
 - erection 985–6
 - metal 67–70, 1292–5
 - orthotropic 913–15
 - shapes 620–2
 - slabs, composite 577–600
 - concretes 580
 - condition 583–6
 - construction 577–8, 581–2, 592
 - design 581–90, 591, 594–600
 - diaphragm action 591–2
 - fire resistance 590–1, 592
 - floors 580–1
 - profiles 578–9
 - types 578–9
- deep metal deck floors 69–70
- defects 236–7, 969
- deflections
 - beams 437–9
 - BS limits 1220
 - composite beams 624–6
 - design theory 1077–101
 - steel plate floors 911
- deformation methods 893–4
- degree of indeterminacy 308
- delivery, steelwork 974–5
- delta ferrite 227
- deposition rates 693
- design procedures
 - beams 436–48
 - columns/struts 103–4
 - compression/bending 523–5
 - moment–rotation behaviour 380–1
 - portal frames 525–31
 - standards 1311–12
 - strengths 692–7, 706–9, 1221
 - theory 1077–147
- detailing 197–8, 211–12, 1150–1, 1310
- deviations *see* tolerances
- diamond trusses 544–6
- diaphragm action 591–2
- dimensions
 - property tables 1148–60, 1166–219
 - welds/welding 686
- disc/pot bearings 852
- displacement functions 317–18
- distortion 702
- distributed dynamic parameters 361–7
- dome structures 179–85
- double angle web cleats 729–33, 738–44
- double shell roof construction 38–9
- draped cables 187
- drawing process 239–40
- drilling 239–40
- driving piles 884–900
- driving stresses 884–5
- ductility 248–52, 294–9, 727
- durability 686, 901–3
- Durbar plates 906, 907
- dynamic modelling techniques 370–1
- dynamic stress wave analysis 884
- dynamic systems
 - bearing piles 884
 - behaviour 354–61
 - distributed parameters 361–7
 - dynamic behaviour 354–61
 - dynamic testing 371
 - equilibrium 355–6, 361–2
 - finite element analysis 368–71
 - formulae 884
- eccentricity 392–3
- economy
 - columns/struts 423–4

- composite beams 601–3
- cross-section 381–2
- fabrication 948–55
- sustainability/construction 275–6
- trusses 554
- edge preparation standards 687–8
- effective area method 823–6
- effective breadths 612–13
- effective lengths 412–20, 553–4, 703–4
- effective throats 702–3
- elastic
 - analysis 289–93, 347–8, 606–8
 - critical loads 450
 - critical stress 490–2
 - limit 294–9
 - modulus 1017, 1151–2
 - plastic fracture mechanics 255–7
 - properties 1071
- elastomers 847–50
- electric overhead travelling cranes 964–6
- electrochemical corrosion 1030–2
- electrodes 1061
- element design
 - analysis 287–8
 - bolts 1160–2
 - dimensions/property tables 1166–219
 - extracts from BS 5950 1220–35
 - materials 1148
 - references 1163–5
 - section dimensions 1148–59
 - tolerances 1148
 - trusses 547–9, 552–4
 - welds 1163
- elements, applied metallurgy 224–5
- elevators 923
- embedment depths 891
- embodied energy 277, 279–81
- EN 1990 conformity with Eurocodes 1054–5
- encasement 654–60, 921
- encastré beams 327
- end anchorage 478–81
- end connection eccentricity 392–3
- end panels 478–81
- end-plates
 - beam-to-beam connections 741–2, 744–6
 - beam-to-column connections 731–6
 - moment connections 755–9
 - tolerances 929, 930
- end/edge distances 674–6
- energy
 - embodied 277, 279–81
 - meters 37–8
 - operational 281–4
 - strain 316–17, 319–24
- engineering properties 237–9
- ENV 1090-1, tolerance 920
- ENV 1994, composite columns 660
- environment
 - atria 218–19
 - corrosion 1033–4
 - protective treatment specification 1049–50
 - standards 1321
 - steel piles 899–900
 - structural form choice 46
 - sustainability/construction 276–81
 - towers and masts loadings 171–4
- equal angles 1203, 1206
- equal span continuous beams 1102–4
- equilibrium
 - dynamic 355–6, 361–2
 - phase diagrams 226–7
 - static 287
- equivalent loading intensity 116
- equivalent slenderness coefficient 1157–8
- erection 971–1011
 - atria 212–13
 - cranes/cranage 988–1001
 - design 973–4
 - method statement 972–3
 - planning 973–7
 - poles 996, 998
 - quality control 986–8
 - shear connectors 985–6
 - site fabrication 983–5
 - site practices 977–83
 - standards 1313, 1317
 - steel decking 985–6
 - tension members 394–5
 - tolerances 919, 923–4, 929–46
- Eurocodes 1053–68
 - EC3 design 1055–61
 - EC3 plate/stiffener elements 711
 - EC4 design 1061–7
 - EN 1990 conformity 1054–5
 - fire resistance 1020–2
- European standards 1072–6, 1311–21
- examinations, welding 1318–19
- external firewalls 40
- external gravity loads 8–9
- external walls 53
- fabric reinforced bearings 849
- fabrication 948–69
 - applied metallurgy 239–45
 - bearings 852
 - bolts 953–4, 955–8
 - building services 54–5
 - corrective action 969
 - cutting 958–63
 - economy 948–55
 - erection sites 983–5
 - handling 963–7
 - plate girders 63–4
 - production design 952–5
 - quality 967–8
 - routing 963–7
 - standards 1313
 - tension members 394–5
 - tolerances 919, 921–9, 931–6
 - welding 954, 955

- facades 217
- fasteners 674–6, 1319–20
- fatigue 261–73, 393–4, 494–5
 - loadings 100–1
- ferrite 227–9
- fillet welds 694–5, 706–9, 1270–3
- film-formation 1039–4
- fin plates 736–8, 742–8, 776–95
- financial design aims 44
- finishes 211–12
- finite element analysis 316–24, 368–71
- Fink trusses 541–7
- fire
 - engineering method 214–17, 591, 1027–8
 - protection 1013–28
 - resistance 1017–22, 1300–3
 - composite deck slabs 590–1, 592
 - concrete composite columns 659–60
 - construction data 1282–307
 - standards 1320
 - safe design 1022–3
 - structural performance 1016–23
 - testing 1025–7
- firewalls 40
- fittings, cables 196–7, 198
- fixed bases 822–3
- fixed beams 327, 329–32, 335–9
- fixings
 - bearings/joints 853–4, 860
 - see also* bolts
- flame cutting 958–9
- flanges
 - bridges 156–8, 160, 166
 - compression 763–4
 - dimensions/property tables 1150, 1197–202
 - load dispersion 711–13
 - moment connections 760
 - plastic moduli 1127
 - plate girders 473–4, 484, 499–500
 - second moments of area 1116–17
 - section properties 1156–7
 - slenderness 376–7
- flare towers 171, 173
- flatness 926
- flexibility 305–8
- flexible end-plates 731–6, 741–2, 744–6
- flexural buckling 404, 411–12, 413
- floors 906–13
 - building services integration 49–52
 - composite deck slabs 580–1
 - fire-resistance 1298–9
 - industrial steelwork 105–7
 - loadings 47–8
 - multi-storey buildings 49–52, 60–71, 78
 - open-grid 911–13
 - plate data 1280–1
 - steel plate 906–13
- force units 1149
- forces
 - horizontal 12–13, 85–9
 - prying 716–17
 - shear 325–41, 750–1, 1115
 - sway 7–8, 23
 - towers and masts 175–8
 - wind 85
- forging 234–5, 1317
- forming process 239–40
- formulae
 - bearing piles 884
 - rigid frames 342–6, 1130–47
- foundations
 - analysis methods 827–31
 - design 818–20, 835–41
 - holding-down systems 831–42
 - standards 1313–14
 - steelwork connections 822–7
 - structural form choice 46–7
 - sub-soil bearing pressure 820–2
 - tolerances 941
 - types 816–18
- fracture 248–61
 - brittle 248–52
 - ductile 248–52
 - mechanics 268–71
 - safe design 260–1
 - testing 257–60
 - toughness 253–4, 258–9
- frames
 - Eurocodes 1059–60
 - formulae 342–6, 1130–47
 - plane frames 342–52
 - primary 5–7
 - robustness 93
 - space frames 176–86
 - U-frame bridges 449–52
 - wind-moment frames 71, 72–3
- free body diagrams 303–4
- free vibration 356–8, 630
- fresh-water immersion corrosion rates 1034
- friction 874–7
 - grip bolts 671–3, 681, 957, 1162
- Frodingham piles 886–7, 1275, 1277
- full contact bearings 924–8, 940, 946
- full strength connections 725
- fully restrained beams 445–7
- fully threaded bolts 673
- fusion welding 241
- galvanizing 1037–8
- gantry girders 483
- generic paint types 1041, 1042, 1309
- geometry
 - bolts 673–6
 - plane sections 1124–6
 - welds/welding 702–4
- girders
 - bridges 134–43, 155–61
 - crane safety 1006–8
 - fabrication economy 955
 - multi-storey buildings 63–4, 65

- see also* plates
 glazing systems 209–11
 global analysis 485
 goliath cranes 964–6
 gouging 961
 gradient loading 518–22
 grain size changes 226–30
 granular soils 895–6, 897
 graph analysis 349–52
 gravity loads 8–9, 11, 101–3
 grid structures 179–82
 grinding 271–2
 grips 682–3
 gross section properties 1166–219
 ground pressure 818–20
 group effect, piles 880–1
 grouting 833
 gussets 718–20, 826–7
 guyed towers 171, 172, 174–5
 gyration radius 1151
- H-piles 1279
 hammer peening 271–2
 hand signals, crane safety 1002
 handling techniques 99–100, 963–7
 hanger supports 108–9
 harmonics 356–60
 haunches 27–8
 heat treatments 226–33
 high modulus piles 871, 1277–8
 high strength friction grip (HSFG) bolts 671–3,
 681, 957, 1162
 high-rise buildings *see* multi-storey buildings
 high-yield steel 845–6
 highway bridges 136–40, 144, 148, 152
 Hinge method 893, 894
 hinges, plastic 25–6, 297–9, 335–9
 holding primers 1041–4
 holding-down systems 831–42, 981–2
 holes
 bolts 673–4
 forming 957–8
 loaded in-plane plates 717–18
 hollow columns 1290–2
 hollow sections 1158–60, 1181–94, 1304–6
 horizontal forces 12–13, 85–9
 hot cracking 243–5
 hot-dip galvanizing 1037–8
 hot-finished hollow sections 1181–6
 housing 279, 281–2
 Howe trusses 541–4
 HSFG *see* high strength friction grip
 hydraulic failures 894–6
 hydrogen induced cracking 243, 244–5
- I-sections 1307
 impact response 360
 impact toughness 689–90
 imposed loading 910–11
 in-plane stability 13–16
- indeterminate frames 345–6
 industrial
 buildings 950
 corrosion rates 1034
 steelwork 94–123
 influence lines 1105–14, 1115
 inspection techniques 968–9, 1049
 installation 854–6, 881–5, 898–900
 Instantaneous Centre method 676, 678–80
 insulation 34–40
 insulation standards 36–7
 integration of services 48–52
 interaction, compression/moments 413–18
 interface management 976
 intermediate bridge supports 152
 internal gravity loads 11
 internal/external joints 860
 international rubber hardness (IRHD) 847
 intumescent coatings 1024–5, 1286–7
 IRHD *see* international rubber hardness
 ISO 1071-2, tolerance 920
 isothermal transformation diagrams 228–9
- J-integral 255, 258–9
 joints 860–6
 composite 1067
 lap 928
 lengths design 682–3
 movement 842, 862–4
 trusses 21–3
 type standards 687–8
 joists 1155–6, 1175–7
- K-braces 74
 K-trusses 544–6
 knuckle bearings 851
- lamellar tearing 243, 244–5
 laminated bearings 849–50
 laminations 236
 lap joints 928
 Larssen piles 886–7, 1274, 1278
 lateral
 bracing 448–9
 load resistance 878–80, 892–3
 loadings 118–19
 restrained universal beams 462–9
 stiffness 53
 torsional buckling 442–5, 488, 489
- lattices
 fabrication 951–2
 girders 955
 grids 179, 180
 towers 169–70, 174
- leaf bearings 851–2
 LEFM *see* linear elastic fracture mechanics
 level supports 328–30
 levelling 977–80
 lift shafts 923
 lifting equipment 964–6, 996–7

- see also* cranes/cranage
- light steel construction 197–204
- limit state design 887–8
- line elements 287–302
- linear elastic analysis 347–8
- linear elastic fracture mechanics (LEFM) 252–4
- linear thermal expansion coefficient 1071
- linings 977–80
- loaded in-plane plates 717–18
- loadings
 - bearing piles 873
 - bridges 144–5
 - building services integration 53–4
 - capacity 882–4, 892–3
 - compression/moments 511–18
 - fatigue 262, 266–7
 - industrial steelwork 114–22
 - moment gradients 518–22
 - multi-storey buildings 47–8, 79–85
 - orthotropic decks 915
 - plastic analysis 301–2
 - single-storey buildings 8–13
 - standards 1311
 - steel plate floors 907–11
 - towers and masts 171–4
- loads
 - cable 193–4
 - carrying stiffeners 482
 - dispersion 711–13
 - dynamic behaviour 354
 - extension relationship 189, 191–2
 - factors 299, 911
 - generation 865–6
 - paths 101–5
 - resistance 878–81, 892–3
 - reversal effects 547
 - slip curves 613–14
 - towers and masts 175–8
 - transfer 873–5
 - trusses 547, 552–3
- local bearing 714–15
- log books 37–8
- longitudinal shear transfer 622–3

- MAG welding 698–9
- maintenance, atria 213–14
- mansard trusses 541–4
- manual metal arc (MMA) welding 693, 697–8
- manufacture 233–7, 919
- marine corrosion rates 1034
- martensite 229
- mass/force units 1149
- masses 1149
- masts 169–78
- materials
 - bearings 845–8
 - element design 1148
 - grades 953
 - resistance 1057–8, 1062–3
 - single-storey buildings 37
 - strength 486
 - testing 257–60
- mathematical modelling 286–7
- mechanical bearings 850–3
- mechanical tests 237–9
- mechanics analysis 268–71
- member compression/moments 511–40
- member tolerances 921
- membranes 318–22
- MERO system 182, 184
- metal decks 67–70, 1292–5
- metal properties 694
- metallic coatings 1037–9, 1052
- metallurgy 222–46
- method statement, erection 972–3
- microstructures 226–31
- microwave towers 169, 170
- MIG/MAG welding 698–9
- mild steel bearings 845–6
- Miner's rule 266–7
- mobility, non-mobile cranes 993
- modelling 286–7, 370–1
- modes of vibration 362–4
- modular construction units 201, 202–4
- modular ratio 612–13
- modular towers 171, 172
- moduli
 - elastic 1017, 1151–2
 - plastic 1154–7, 1159–60
 - torsion constant 1159
 - Young's 191–2, 1071
- moments
 - capacity 433–7
 - compression/moments 511–40
 - connection 753–66
 - distribution method 312–13, 314
 - gradient loading 518–22
 - resistance 474–5, 478, 500
 - rotation behaviour 375–81
 - second 1116–23, 1151
 - shear interaction 437, 438
- monosymmetry index 1157–8
- multi-prop walls piles 893–4
- multi-storey buildings
 - bracings 71–5
 - choice of form 46–58
 - columns 58–60
 - design 44–6, 53–4, 78–93
 - fabrication economy 951–5
 - floors 49–52, 60–71
 - steel frame advantages 42–3
 - structure 58–76

- National Structural Steelwork Specifications (NSSS) 701, 920
- natural frequency 362–4, 365–7
- natural resources 277
- NCR *see* Non-Conformance Reports
- NHF *see* notional horizontal forces
- NODUS system 182, 184

- noise 899–900
- nominally pinned connections 727
- Non-Conformance Reports (NCR) 987–8
- non-metallic inclusions 225–6
- non-mobile cranes 993–4, 995, 996
- non-preloaded bolts 671, 681, 1161–2
- notation xxiii–xxviii
- notched beams 720
- notional horizontal forces (NHF) 12–13, 86–9
- NSSS *see* National Structural Steelwork Specifications
- nuclear fuel processing plants 98
- nuts *see* bolts

- off-loading steelwork 974–5
- on site sub-assemblies 975–6
- open stringers 914–15
- open-grid floors 911–13
- operational energy 281–4
- orthotropic decks/plates 302–3, 913–15
- outriggers 176, 178
- outstand 714
- overall design concept influences 44–6
- overall unit weights 159, 161
- oxide layer formation 1045–6

- P-Delta effects 15–16
- P-Y curves 87
- packing 682–3
- paints 1039–44, 1046, 1052, 1309
- panels 200, 201–2, 203
- parallel flange channels 1150, 1156–7, 1197–202
- parallel-bar cables 396
- parallel-wire cables 396
- partial shear connections 618–20
- partial strength connections 726
- pearlite 227, 230
- pedestrian bridges 140–3
- peening 271–2
- petrochemical plants 98–9
- phase (equilibrium) diagrams 226–7
- phosphor bronze bearings 847
- pier girders 168
- piles 867–903
 - bearing 867–85
 - box sheet data 1276
 - corrosion 901–3
 - data 1274–9
 - design 872–81, 887–98
 - dimensions/property tables 1150, 1178–80
 - driving 884–900
 - durability 901–3
 - Frodingham 886–7, 1275, 1277
 - group effect 880–1
 - H type 1279
 - high modulus data 1277–8
 - installation 881–5, 898–900
 - Larssen 1274, 1278
 - loading capacity 882–4, 892–3
 - sheet 885–98
 - standards 1313–14
 - types 868–72, 886–7
 - universal bearings 868–9, 1178–80
 - uses 867–8, 885
- pinned bases 822–3
- pitting corrosion 1032
- plane frame analysis 342–52
- plane section geometry 1124–6
- plane structures 288
- planning, erection 973–7
- plastic
 - analysis
 - composite beams 608–9, 611
 - line elements 300–2
 - portal frames 347, 348, 351–2
 - collapse theorems 299
 - deformation 248–52
 - failure 335–41
 - hinges 25–6, 297–9, 335–9
 - moduli 1127–9, 1154–7, 1159–60, 1170–1
- plated structures 288
- plates
 - analysis 302–3
 - bending 322–4
 - element connections 711–20
 - floors 906–13
 - girders 470–510
 - bridges 155–61
 - buckling 488, 489, 501–3
 - crane safety 1006–8
 - cross-sections 471–3, 483, 485
 - elastic critical stress 490–2
 - multi-storey buildings 63–4
 - tolerances 933–5
 - Vierendeel 557–76
 - second moments of area 1118–21
 - thickness recommendations 471–3
- platform constructions 204, 205
- plumbing 977–80
- Poisson's Ratio 1071
- polar inertia 676–80, 704–7
- polytetrafluoroethylene (PTFE) bearings 846–7, 852
- portal frames
 - analysis 346–52
 - atria 208, 209
 - bridges 133–4
 - compression/moments 525–31
 - fabrication economy 950
 - single-storey buildings 16, 24–9
- positional tolerance 929–37
- Pounder's plate theory 907–8
- power law 268
- power station structures 95–7
- Pratt trusses 541–4
- pre-delivery fire protection 1024–5
- precast floor systems 70–1
- prefabrication 200–3, 1041–4
- pressure 818–22, 888–90
- prestressed cable structures 194–5

- primary beams 108–9
- primary frames 5–7
- primers 1041–4
- principle of superposition 287
- process plant steelwork 97–9, 115–18
- procurement 213
- production designs, fabrication 952–5
- productivity, welds/welding 701
- profiled metal decks 1292–5
- programming erection 974
- progress schedules 55–6
- property units 1149
- proportions, plate girders 471–3
- propped cantilevers 325–41, 1094–101
- protection techniques 1013–28, 1035–52
- protective treatment specification 1047–51
- prying forces 716–17
- PTFE *see* polytetrafluoroethylene
- pure bending 290–2
- purlins 5–6, 9–457

- quality
 - assurance standards 1321
 - control 237–9, 986–8
 - fabrication 967–8
 - welds/welding 686–92, 701
- quenching 232

- radius of circular arc 193
- radius of gyration 1151
- rafter stability 530–31
- railway bridges 140, 141, 144–5
- rapid fracture 248–61
- rates, corrosion 1032–4
- re-using materials 278
- reactions
 - bending moments 1102–4
 - chemical 1030–2
 - influence lines 1115
- rectangles, plastic moduli 1128–9
- rectangular plates 1118–21
- rectangular sections 1185–6, 1192–4, 1305–6
- recycling 278–9
- reduction, sustainability 278
- reheat cracking 243, 244–5
- reinforced concrete walls 71–2, 73–4
- residential construction 197–204
- residual stress 271, 272, 410
- resistances
 - base 874–5, 877
 - bending 582–3
 - compressive 409–11
 - corrosion 686, 1308–10
 - loads 652–9, 878–81, 892–3
 - moments 474–5, 478, 500, 759–62
 - shear 475–94, 613–22
 - sway 7–8, 23
 - weather 861–2, 1045–7
- response calculations 364–5
- response types, interactions 513–18

- restrained universal beams 462–9
- restricted depth 452–4
- retaining walls 891
- rigid
 - connections 726
 - frame formulae 342–6, 1130–47
 - jointed Vierendeel girders 557–76
 - plastic analysis 297–9
- risk assessments, crane safety 1003–6
- robustness 122
- rocker mechanical bearings 850
- rocks 878
- rod tension members 197
- rolled
 - beams 161–4, 535–40
 - columns 410, 425–6, 429–30, 533–4
 - component tolerances 931–2
- roller mechanical bearings 850
- rolling steel 232, 235–6
- roofs 217, 545–67
- rotation-moment behaviour 375–81
- routing 963–7
- rubber pad bearings 849

- S–N curves 262–5
- safety
 - cranes 997–9, 1001–11
 - workforce 1001–6
- sandy soils 821–2
- sawing process 960
- sea-water immersion corrosion rates 1034
- second moments of area 1116–23, 1151
- second-order analysis 15–16
- secondary beams 108–9
- secondary elements 4–5
- sections
 - element design 1148–59
 - fabrication economy 953
 - gross properties 1166–219
 - properties 1151–60
 - standards 1315–16
- seismic loading 98
- selection criteria
 - applied metallurgy 245–6
 - bearings 843–8
 - bridges 127–43
 - cross-sections 471–3, 522–3
 - portal frames 349–52
 - trusses 547–9
- semi-continuous connections 728
- semi-rigid connections 726–7
- service performance 239–45
- serviceability
 - bearing piles 875
 - composite deck slabs 588–90
 - limit state 494
 - tension members 393–4
 - towers and masts 175
- settlement 875
- shading 218

- shaft friction 874–5, 876–7
- shallow metal deck floors 67–9
- shape factor 296
- shape limitations 486–8
- shaping techniques 958–61
- shear 1077–101
 - beams 437, 438, 441–2
 - bolts 676–82
 - buckling 474–8, 501–3
 - connections 605, 613–22, 985–6
 - elastic analysis 292–3
 - Eurocodes 1064–5
 - fabrication 959–60
 - forces 325–41, 750–1, 1115
 - line elements 299–300
 - moments 623–4, 765
 - plastic analysis 300–1
 - resistance 475–94, 613–22
 - transfer 622–3
 - walls 71–2, 73–4
 - welding 704–6, 707
- sheet piles 885–98, 1274–9
- sheet standards 1315–16
- shelf angle floor beams 1298–9
- shims 940, 946
- shock transmission units 859
- shop bolting 956
- shop-primers 1041–4
- shrinkage 626–7
- siderails 31–4
- sign conventions 345
- signals, crane safety 1002
- simple connections 729–55, 769–75
- simple harmonic motion 356–8
- simply-supported beams 325
- single skin trapezoidal roofing 38
- single-storey buildings 1–40
 - beams 16–18
 - claddings 1–4, 34–40
 - columns 11–12, 16–18
 - loadings 8–13
 - portal frames 16, 24–9
 - roofing 38
 - stressed skin designs 29–31
 - truss and stanchion 18–23
- sinking supports 327–8
- site fabrication 983–5
- site practices 977–83
- skeletal structures 287–8, 303–16
- slabs 1065–6, 1292–5
 - see also* decks
- slender
 - columns/struts 407–8
 - webs 406–8
- slenderness
 - coefficient 1157–8
 - composite columns 655
 - cross-sections 373, 376–7
 - struts 403–4
- Slimdek beams 69–70, 1296–7
- slinging 999–1001
- slope-deflection method 311–12
- smoke control 214–17, 219
 - see also* fire
- smoothness 925, 928
- snow loads 8
- social impacts 276
- soils 879–80, 888–90, 1034
- solidification cracking 243–5
- Space Deck System 183, 185
- space structures 179–86, 288
- spacings 674–6
- span-to-depth ratios 471, 473, 483–4, 603–4
- spans 124–31, 166–8, 483, 605–6
- specifications, applied metallurgy 246
- spherical bearings 852
- splices 153, 747–55, 769–75, 1007–8
- spray coatings 1038–9
- sprayed fire protection 1023–4, 1282–3
- square hollow sections 1183–4, 1190–1, 1306
- squareness 926–7
- stability
 - bridges 146–7
 - compression/moments 527–30
 - Eurocodes 1059–60
 - portal frame analysis 348
 - retaining walls 891
 - towers and masts 176–8
- stacking plants 99–100
- stainless steels 846, 1317
- stanchions 18–23
- standards
 - European 1053–68, 1072–6
 - fire protection 1013–16
 - piles design 872
 - tolerances 919–21
 - welds/welding 686–92
- standing beam systems 38
- static equilibrium 287
- static test loading 882–4
- statically indeterminate structures 308–9
- statutory constraints 45
- steady-state response 358–60
- steel bridges 485–95
- steel grades 145–6, 688–9
- steel plate floors 906–13
- steel product standards 1315
- steel selection standards 688–9
- steel strengths 1016–17
- steel weights 168
- steelmaking 233–4
- steelwork connections 822–7
- ‘stick-build’ construction 199–201, 202
- stiff bearing lengths 711
- stiff walls 112–13
- stiffened bases 826–7
- stiffened bending resistances 582–3
- stiffeners
 - elements 711–20
 - end posts 478–80

- moment connections 765–6
- plate girders 472–3, 504–9
- shear resistance 478–83, 493–4
- stiffness
 - building services integration 53
 - finite element analysis 316, 319–24
 - plate analysis 302–3
 - skeletal structure analysis 305–8
 - welds/welding 686
- stockyard cranes 994
- straight structure bearings 856–8
- straightening 962–3
- strain 267–8, 316–24, 626–7
- strengths, bolts 680–3
- stress
 - bearing piles 884–5
 - concentration factors 394
 - cycles 266–7
 - distributions 376–8
 - intensity factor 252–4, 268–70
 - plate analysis 302–3
 - strain curves 284, 387
 - wave analysis 884
 - welding procedures 241–3
- stressed skin designs 29–31
- stringers 913–15
- strip bearings 849
- structural forms
 - atria 206–9
 - bolts 956–7
 - cable structures 187–9
 - choice 46–58
 - cross-section 373–82
 - design 13–40
 - joints 860
 - space frames 179–82
 - towers and masts 169–71
- structural standards 1314
- structural steelwork 94–123
- structural tees 1214–19
- structure
 - alignment 976–7
 - bearings 854
 - fire performance 1016–23
 - industrial steelwork 101–14
 - multi-storey buildings 58–76
 - single-storey buildings 1–8
- struts 403–24
 - buckling 404, 411–12, 413
 - columns 402–30
 - cross sections 404–6, 407–8
 - curves 409–11, 1227
 - economy 423–4
 - effective lengths 414–20
 - special types 420–3
- stub girders 65
- sub-assembly erection 975–6
- sub-soil bearing pressure 820–2
- submerged arc welding 700
- substitutions, welding standards 689–90
- substrate cladding 3
- superposition principle 287
- supporting standards, Eurocodes 1060–1
- surfaces
 - preparation 961–2, 1035–7
 - protection 1051–2
 - stressed cable structures 189
- surveys 976–7
- sustainability 275–84
- sway
 - checks 14
 - force resistance 7–8, 23
 - load paths 103–5
- symbols, welding standards 687–8
- symmetrical loads 342–4
- tables
 - cross-sections 381
 - dimensions/property 1148–60, 1166–219
- tapered beams 50–1, 63–4
- technical design aims 43–4
- tee struts 420, 423
- tee-stubs 759–60
- temperature
 - composite beams 626–7
 - crane safety 1008–9
 - movements 146
 - steel strengths 1016–17
 - time relationships 1025–6
- tempering 233
- temporary primers 1041–4
- temporary supports 896–7, 1009–11
- tensile resistance 387–8
- tension
 - bolt design 681–2
 - column splices 750
 - field theory 490–2
 - members
 - axially loaded 384–8
 - bending 388–91
 - cable structures 197
 - cables 395–7
 - corrosion 393–4
 - design 399–401
 - end connection eccentricity 392–3
 - erection 394–5
 - fabrication 394–5
 - fatigue 393–4
 - serviceability 393–4
 - stress concentration factors 394
 - types 383
 - moment connections 759–62
- Terzaghi's method 821
- Test Certificates 237–9
- tests
 - fire 1025–7
 - fracture 257–60
 - mechanical 237–9
 - standards 1318–19

- thermal expansion coefficient 1071
- thermal (metal) spray coatings 1038–9
- thermal movement 121–2
- thickness, welding standards 689–90
- thin film intumescent coatings 1286–7
- thin gauge sections/sheets 1315–16
- three moments theorem 326–7, 332–5
- tied portals 16, 29
- tightening methods, bolts 673
- time-temperature relationships 1025–6
- time-varying load response 361
- tolerances 917–47
 - bolts 937–9, 941
 - building envelope 922, 939–40
 - classes 917–18
 - compression joints 928
 - definitions 917, 918
 - deviation 929–37, 941–4
 - element design 1148
 - erection 923–4, 929–46, 981
 - fabrication 919, 921–9, 931–6
 - implications 921–3
 - internal accuracy 939
 - lap joints 928
 - member sizes 921
 - setting out 929–37
 - standards 919–21
 - steel piles 898–9
 - types 919
- tool cleaning 1036
- torsion 439–45, 1153–4, 1158–9
 - buckling 411–12, 488
- towers 169–78, 993–6
- traceability 968
- traffic loadings 144–5
- transformation diagrams 228–30, 232
- transmission towers 169–70, 174, 996, 998
- transportation 955
- transverse shear 1064–5
- transverse stiffeners 481–2
- treatment plants 98
- trusses 541–76
 - atria 207
 - bridges 134, 135, 543–4, 546–7
 - buildings 541–2, 545–6
 - cable 189, 190
 - fabrication economy 955
 - load reversal effects 547
 - multi-storey buildings 64–5
 - roofs 545–67
 - selection criteria 547–50, 552–4
 - single-storey buildings 18–23
 - stanchions 18–23
 - types 541–5
 - Vierendeel girders 557–76
 - see also* columns
- tubular piles 869
- turbine halls 96–7
- two-way cable nets 195–6
- U* values 35–6
- U-frame bridges 449–52
- ultimate limit state 485–94
- undamped free vibration 356–7
- unequal angles 1204–5, 1207
- uniform distributed loadings 907–9
- unit areas 1122–3
- unit load method 313–16
- unit weights 159, 161
- universal bearing piles 868–9, 1178–80
- universal columns 1172–4, 1218–19, 1303
- uplift bearings 853
- variable-amplitude loading 266–7
- vehicle assembly plants 98
- ventilation 218–19
- vertical
 - load resistance 880–1, 892
 - settlement 875
 - shear resistance 587
- viaducts 126–7
- vibration
 - composite beams 626
 - dynamic behaviour 356–8, 362–4
 - industrial steelwork 117
 - modes 362–4
 - pile driving 899–900
- Vierendeel girders 557–76
- walls 52–3, 112–13, 941
- warping constant 1153–4
- Warren trusses 541–4
- washers *see* bolts
- water pressures 890
- weather proofing 17–18, 29–31, 34–40
- weather-resistance 861–2, 1045–7
- weathering steel 146
- webs
 - beams 440–2
 - bridges 156–8, 160–1, 166
 - cleats 729–33, 738–44, 795–815
 - infilled columns 1300–1
 - openings 457–60, 477–8
 - plate girders 473–4, 484–5, 500
 - stiffeners 481–3
 - stress patterns 378–9
 - susceptibility 474–8
- wedging action 859
- weight, welding 686
- weldable primers 1041–4
- welded box columns 427–8
- welds/welding 685–709
 - analysis methods 704–6, 707
 - applied metallurgy 240–5
 - cost reduction 692–7
 - data 1163, 1266–73
 - design strength 692–7, 706–9
 - element design 1163

fabrication 954, 955
geometry 271–2, 702–4
positions 693–4
processes 697–702
quality 686–92, 701
standards 686–92, 1317–19
toe remelting 271–2
types 687–8, 694–6, 708
weather-resistant steels 1046
wet blasting 1036–7
wide plate test 260
width-to-thickness ratios 1222–3

wind
 bracing systems 17–18
 crane safety 1008–9
 forces 85
 loads 9–11, 83–91, 119–20, 173
 moment frames 71, 72–3
workforce safety 1001–6

yield strengths 689–90
Young's Modulus 191–2, 1071

Zed sections 5, 31–2, 457