

Index

A

- Abutment 7
 - Accelerator 48, 61, 63–65, 77
 - alkali-containing 64
 - alkali-free 64
 - hydration time 65
 - liquid 65
 - (in) powder form 65
 - water glass 64
 - ADECCO-RS tunnelling method 182–188
 - Adit 5 f.
 - Agricola, Georg 1
 - Air bubble 298
 - Air ducts 415 f.
 - calculation 417–419
 - Coanda duct 419
 - folding duct 415
 - hooped duct 415
 - operating costs 421 f.
 - shaft duct 415
 - spiral duct 415
 - steel duct 415
 - swirl duct 415
 - Air flow velocity 409
 - Aldehydes, threshold 410
 - Altstadt Tunnel Arnsberg 171
 - blasting pattern with cut made by roadheader 266
 - Anchor *see also* Bolt and Rock bolt
 - adhesive anchor 40
 - concrete anchor 37–39
 - corrosion protection 40
 - double wedge anchor 37
 - dowel action 40
 - expanding wedge anchor 37
 - failure load 35
 - failure strain 34
 - fibre anchor 187
 - FM anchor 37
 - friction tube anchor 40 f.
 - fully bonded anchor 35
 - grouted anchor 34
 - rammed 39
 - self-drilling 39
 - technical data 34
 - GRP anchor 42
 - load-bearing capacity 34
 - long-term anchor 44
 - mortar anchor 37–39
 - mortar filled anchor 37
 - installation 38
 - permanent anchor 29
 - retightening 32
 - sliding anchor 44
 - slotted wedge anchor 37
 - SN anchor 37
 - split-set anchor 43
 - steel tube anchor 43
 - strand anchor 29, 34, 44
 - Swellex anchor 40 f.
 - synthetic resin 39 f.
 - timber anchor bars 43
 - tunnel anchor 29
 - types 36–44
 - special 43 f.
 - (with) unbonded length 35 f.
 - unstressed anchor 36
 - yielding anchor 44
 - force-deflection diagram 44
 - Anchor clamp 15 f.
 - Anchor force
 - check 32
 - determination 33
 - (in the) rock mass 33
 - Anchor length 32 f.
 - Anchor shaft 37
 - Anchor spacing 32 f.
 - Arch forms 15 f.
 - AT casing system 27
 - Auger boring 386, 393–395
 - application 394
 - direction correction 395
 - working sequence 393
 - Austrian tunnelling method 145, 154–161
 - new Austrian tunnelling method (NATM) 145, 154–161, 183
 - newer Austrian tunnelling method 154 f.
 - newest Austrian tunnelling method 154
 - old Austrian tunnelling method 154
- ## B
- Backfilling 7, 145 f.
 - Belgian tunnelling method 148–151
 - machinery applications 149
 - modern applications 150
 - working sequences 150
 - Belt conveyance 257
 - Bench 7
 - Bench excavation 148
 - Bentonite 164
 - Bentonite suspension 302, 307

Blast box 218 f.
 Blast hole diameter 229
 Blasting 168, 189, 211–243, 279
 – blast hole diameter 229
 – burden 228
 – – initial cut 228
 – – stoping blast 228
 – cartridge diameter 229
 – charge determination 228–231
 – confinement 228
 – drilling pattern 232–235
 – effects on the surroundings 267–278
 – – gas emission 275–278
 – – vibration *see there*
 – firing pattern 232–235
 – gases 277
 – historical development 1–4
 – hole spacing 229–231
 – mucking *see also there* 243–265
 – round depth 229
 – round length 229
 – smooth 234
 – success 241 f.
 – technology aspects 241–243
 – terms 228–231
 – time calculation 239–241
 – – charge loading 239
 – – detonation connection 240
 – – detonation checking 240
 – – detonator wire connection 240
 – – firing circuit connection 240
 – – firing circuit checking 240
 – – stemming 239
 – – total time 240 f.
 Blasting cap 212–214
 Blasting lead wire 218
 Blasting machine 217
 – testing instruments 217
 Blasting pattern 350
 – (with) cut made by roadheader 266
 Blowout 315 f.
 Bodex system 27
 Bolt *see also* Anchor and Rock bolt
 – head 35
 – plate 35
 – shaft 33–35
 Box-type crusher 302
 Breaker 301
 – box breaker 301
 – grab breaker 301 f.
 – jaw breaker 301
 – types 302
 Brunel, Sir Marc Isambard 4, 163
 Bunker train 255
 Burden 228
 – initial cut 228
 – stoping blast 228

C

California switch 256
 Carbon dioxide, threshold 410
 Carbon monoxide, threshold 410
 Cartridge
 – detonator cartridge 236 f.
 – diameter 229
 – – small 235
 – primer cartridge 236 f.
 Cast concrete 111–124
 – after-treatment 123 f.
 – concreting 114 f.
 – crack formation 118
 – formwork 111–114
 – – stopend 113
 – joint details 120
 – stripping times 119
 Cavern 5 f.
 Cement 61 f.
 – unpressurised 35
 Cement cartridge 38
 – construction 38
 – mode of functioning 38
 Central trench 149
 Centrifuge 304 f.
 Chain conveyor 353, 358
 – central 359
 Chamber 5 f.
 Channel Tunnel 1 f., 166, 343
 Charleroi Tunnel 148
 Cherry picker 256
 Clay suspension 295, 307
 Coal mining in Germany 4
 Coanda duct 419
 Cologne support 21 f.
 Compressed air 176
 Compressed air regulations (DLV) 293
 Compressed air work
 – air loss 293
 – application limits 293 f.
 – lock layouts 294
 Concrete 45–143
 – cast concrete *see there*
 – extruded concrete 120–122
 – shotcrete *see there*
 – steel fibre concrete *see there*
 – steel fibre shotcrete *see there*
 – waterproof concrete 115 f.
 Concrete pump 55
 Confinement 228
 Connection wire 218
 Construction method 6
 Construction process 6
 Contour cutting process 364
 Contour hole 234
 Core 7
 Core tunnelling method *see also* German tunnelling
 method 151–153, 167
 – (with) side headings 173, 175 f.

- Corrosion protection
 - anchor 40
 - sewer tunnel 136–142
 - Cross-section
 - description of the parts 7
 - division 167, 171
 - small 379–408
 - Crossbeam tunnelling method *see* Austrian tunnelling method
 - Crown 7
 - Crown arch 7
 - Crown beam 161
 - Crown filling 11, 119 f., 145
 - Crown heading 7
 - driving 178
 - Crown pilot heading 170–173
 - Crown support with spiles 24
 - Cut 232–234
 - angled cut 232
 - burn cut 233
 - conical cut 232
 - Coromant cut 234
 - fan cut 233
 - parallel cut 233
 - – (with) large diameter hole 233
 - spiral cut 233 f.
 - wedge cut 232 f.
 - Cutter attachment 361
 - Cutting
 - degressive 356
 - progressive 356
 - Cutting boom 353
 - combination with an open shield 361
 - Cutting head 292, 354
 - construction 357
 - cooling 357
 - dust reduction 357
 - (with) internal flushing water system 359
 - longitudinal 355 f.
 - rotating at right angles to the boom axis 355
 - transverse 356
 - Cutting wheel 299
 - Cyclone 303–305
- D**
- Deduster
 - capacity 424
 - dry deduster 416
 - (in a) tunnel boring machine 423
 - wet deduster 416 f.
 - Deformation slot 154, 173
 - Delay connector 221
 - Dense flow conveyance 54
 - Descriptions 4–7
 - Detcord 220 f.
 - Detonation
 - electrical 215–217, 238
 - electronic 219, 238 f.
 - non-electrical 219
 - non-electronic 239
 - set off from the drill 226
 - systems 215–221
 - unintended 222
 - Detonation cord 220 f., 223
 - (as) charge 235
 - Detonator 211 f., 215–221
 - delay 215 f.
 - electrical 212 f., 215 f.
 - electronic 213, 218
 - instantaneous 215 f.
 - non-electrical 212 f., 219
 - non-explosive 212
 - selection 242
 - Diesel motor emissions 419
 - threshold 410
 - Dilatation tube element 174
 - DLV *see* Compressed air regulations
 - Drainage 7
 - Drainage trench 7
 - Drift 5 f.
 - Drillability 208–211
 - classification 210
 - influences 209
 - Drill and blast tunnelling 189–284
 - automation 278–284
 - backup system 284
 - blasting *see there*
 - combinations
 - – (with) full-face machines 266 f.
 - – (with) mechanised tunnelling processes 265–267
 - – (with) roadheaders 265 f.
 - drilling *see there*
 - electronics control 280
 - historical development 189–191
 - logistics 280
 - mechanisation 278–284
 - – emphasis 279 f.
 - minimum profile 416
 - mucking *see also there* 243–265, 282–284
 - support 279 f.
 - tunnelling logistic 282–284
 - Drill bit 200–206
 - adapters 201–203
 - connecting sleeves 202
 - construction types 204
 - consumption 211
 - drill rod 203 f.
 - drill shaft 201
 - forms 204
 - (with) hard metal cutters 200
 - monobloc drills 203
 - wear 206 f.
 - – classification 207
 - Drill feed with directional laser 282
 - Drilling 191–211, 279
 - anchor drilling 191
 - costs 210 f.
 - directional 396, 399 f.
 - enlargement drilling 205

- flushing drilling 205 f.
- geotechnical drilling 191
- hammer drilling 192, 201, 386, 395
- historical development 1–4
- percussion drilling principle 194
- probe drilling 191
- process 192
- relief drilling 191
- rotary drilling 192
- rotary hammer drilling 192
- rotational boring 201
- rotational hammer drilling 201
- sequence, documentation 199
- shot hole drilling 191
- speed 211
- Drilling boom 196–200
 - movements 198
 - working range 197
- Drilling jumbo 198–200
 - computer-assisted 280–282
- Drilling pattern 232–235
- Drilling performance 192, 207–210, 282
- Drills 192–200
 - air leg 195
 - drill feed 195 f.
 - drilling boom *see there*
 - drilling jumbo *see there*
 - drilling rig 198–200
 - feed mechanism 195
 - hammer drill *see there*
 - stoper drill 196
 - working platform 198
- Dry-mix machine 50
- Dry-mix process 49–52, 55, 57–59, 71 f.
- Ducts *see* Air ducts
- Dust binder 66
- Dust bulkhead effect 423
- Dust concentration 409
- Dust control with a roadheader 359
- Dust curtain 359
- Dust extraction 410, 423
- Dust reduction 107
- Dust settlement 410
- Dust shield 423
- Dust suppression 413
- Dust with quartz content, threshold 410

E

- Earth pressure calculation, kinematic method 314
- Earth pressure shield 306–310
 - (to) actively control the support pressure 310
 - agitator provision 308
 - application 307–309
 - conditions 308
 - foam use 310
 - functional principle 306 f.
 - section 306
 - soil conditioning process 307–309
 - tunnel boring machines 336–338
- Elastomer gasket 134

- Elbe Tunnel 2, 372–374
 - Hydroschild 299
 - vertical alignment 373
- Emulsion blasting agents 214 f.
- English tunnelling method 154, 161
- Enlargement 342–344, 352
 - (of a) pilot tunnel 350
- Euerwang Tunnel
 - emergency support 13
 - spiles 24
- Eupalinos Tunnel 2
- Evolutiv seal 134
- Excavation
 - blasting *see there*
 - full-face excavation 147, 167, 183
 - mechanical 168
 - partial-face excavation 148, 167
 - pipe jacking 383–385
 - (by a) roadheader 355–359
- Excavator 244–251, 289
 - construction 244 f.
 - hydraulic excavator 244 f., 292
 - – conventional 245
 - – (for) deep digging 245
 - overhead loading excavator 245 f.
 - tunnel excavator *see there*
 - tunnel loading machines 246 f.
- Explosives 211–215
 - ammonium saltpetre explosives
 - gelatin 213
 - powder-form 213 f.
 - charge loading 235–239
 - classification 222
 - compatibility 222
 - costs 241
 - dangers 221
 - – accident dangers 222 f., 225 f.
 - – health dangers 222, 225
 - – precautionary measures 223
 - – protection measures 226–228
 - emulsion blasting agents 214 f.
 - exothermic reaction 211
 - firedamp 226
 - firing sequence 235
 - fumes 225
 - handling 241
 - health aspects 241
 - history 190
 - labelling 222
 - magazine 223 f.
 - – intermediate 224
 - (in) muck heaps 226
 - packaging regulations 221
 - risks
 - – accident risks 224 f.
 - – health risks 224
 - – precautionary measures 225
 - safety blasting explosives 215
 - selection 241
 - storage on site 222

- transport
- – on site 224 f.
- – to the site 221

F

- Face 7
 - without support 292
- Face support 152, 164, 187, 299
 - compressed air support 288, 293 f., 299
 - – air demand 320 f.
 - – air escape 321
 - earth pressure support 288, 299, 306–310
 - mechanical support 288, 292
 - methods 287
 - natural support 288
 - slurry support 288, 294–305
- Fan 414 f.
 - axial fan 414 f.
 - centrifugal fan 414
 - flushing fan 424
 - radial fan 414
- Filter cake 298
- Fine dust concentration 76 f., 110, 276
- Fine dust development 77, 277
- Firedamp 226
- Firing circuit tester 217
- Firing pattern 232–235
- Fly ash 68 f.
- Folding duct 415
- Folding formwork unit 112
- Foot support 17
 - examples 17
 - structural detail 17
- Foot thickening 170
- Forepoling 14
- Formwork
 - reusable 121 f.
 - window 114
- Frame set timbering 13
- Frankfurter Kreuz Tunnel, jet gout screen
 - application 28
- Fresh air 409
- Freudenstein Tunnel 339 f.
- Full-face excavation 147, 167, 183
- Full-face machine 266 f., 362, 364
- Full-round formwork unit 111 f.
- Fume, composition 275 f.

G

- Galgenberg Tunnel 174
- Gallery 5 f.
- Gas concentration 409
- Gas emission 275–278
- Gauge 255
- Gelatin ammonium saltpetre explosives 213
- General Blumenthal mine 179 f.
- German tunnelling method 151–153
 - excavation sequence 152
 - newer applications 152
 - pipe screen 153 f.

- Gildehof Tunnel 153
- Gotthard base tunnel 2 f., 339, 344 f.
- Gotthard rail tunnel 2 f., 148
- Gotthard road tunnel 2 f.
- Grashopper 256
- Gripper TBM 323–325, 330, 334, 346
 - advance rates 333
 - categorisation 324
 - (with) thrust cylinders 328
- Ground displacement processes 386–392
 - steerable processes 390–392
- Ground freezing 21, 28, 150, 176 f.
- Ground improvement 183, 186
- Ground pressure 307
 - critical increase 12
 - high 13, 145
- Ground removal processes 386, 392–395
- Ground water pressure 292
- Grout screen 21, 25–28
 - application 27
- Grouting 150, 176–178, 186
- Guided boring with reamer 386, 389 f.
- Guided processes 395–400
 - directional drilling 396, 399 f.
 - microtunnelling *see there*
 - pilot boring 396, 398 f.
- Gumpoldskirchner Tunnel 154

H

- Hammer drilling 386, 395
- Hammer drills
 - hydraulic hammer drill 193–195
 - hydraulic rotary hammer drill 192 f.
 - pneumatic hammer drill 193 f.
- Head protection 147
- Himmelberg Tunnel 168 f., 175 f.
- Hole spacing 229–231
- Hölzern Tunnel 153
- Hönebacher Tunnel 149
- Hooped duct 415
- Hydraulic hammer drill 193–195
- Hydraulic rotary hammer drill 192 f.
- Hydrojet shield 295, 300–302
 - sticking 301
 - support circuit 301
 - transport medium circuit 301
- Hydroshield 164, 295, 297–299, 302
 - application 298
 - cutting wheel 299
 - filter cake 298
 - support pressure control 298

I

- Ignition, electronic 218
- Impact crusher 302
- Impact mole 386–389
 - controlling 389
 - piercing head 388
 - principle 388
 - section 388
 - steerable 392

- Injection tube 25
 - self-drilling 25
- Inner lining 45 f.
 - minimum reinforcement 115 f.
 - unreinforced 117
 - (of) waterproof concrete 116
- Installations 6
- Invert 7
- Invert closing 150, 152
- Invert heading 7, 152, 155
- Invert vault 7
- Investigation tunnel 338–341
 - cross-section 338
 - examples 334–353
- Irlahüll Tunnel 71
 - grout screen application 27
- Isolation 7
- Italian tunnelling method 161 f.
 - new Italian tunnelling method 167, 182–188

J

- Jacking station 381
 - intermediate station 383, 401 f.
 - main station 381, 384, 401
- Jaw crusher 302
- Jerusalem water supply tunnel 2
- Jet grout screen 25–28
 - application 28

K

- Kandertal investigation tunnel 345–348
 - geological findings 348
 - gripper TBM 346
 - invert segment installation 347
- Kiesberg Tunnel 152
- Königsdorfer Tunnel 151
- Krieger Tunnel 111
- Kunz support system 150, 155

L

- Lagging sheet 22 f.
- Landeck Tunnel 425
- Landrücken Tunnel 2, 71, 169
- Lattice arch 173 f.
- Lattice beam 19–21
 - sprayed-in 20
- Lefortovo Tunnel 372, 375–377
 - vertical alignment 375
- Lining 6
 - final 7, 111
 - masonry 154
 - permanent 154
 - Semmering rail tunnel 154
- Lining formwork unit 111
- Loader 247–251
 - chain loader 357
 - front loader 247
 - Häggloader 250 f.
 - lobster claw loader 357, 359

- overhead loader 247, 249
 - – output 264 f.
- side-tipping loader 247, 249
- slewing bucket loader 247
- (with) special bucket types 248–250
- specialised machines 250 f.
- swing loader 249 f.
- tracked loader 248
- underground loader 247 f.
- wheeled loader 247 f.
 - – long-term output 261–263
- Loading machine 244–251
 - capacity determination 257–259
 - excavator *see there*
 - loader *see there*
 - loading device 244
 - loading system 244
 - number of cycles 258
 - requirements 244
 - types 244
 - utilisation 259
- Loading ramp 353
- Locomotive 252 f.
- Long beam timbering 161
- Longitudinal beam 154
- Longitudinal section
 - description of the parts 7
- Longitudinal tunnelling method *see* English tunnelling method
- Lötschberg Tunnel 2, 339, 346

M

- MAK values 409
- Malpas Tunnel 2
- Manned processes 380–385
 - pipe jacking *see there*
- Mechanised tunnelling 285–378
- Microsilica 69
- Microtunnelling 396–398
 - machines 397
 - mucking 396
 - principle 396
 - steering 397
- Milchbruck Tunnel 341
- Mini-Fullfacer 364
- Mixshield 299 f.
- Mont Blanc road tunnel 2, 147
- Mont Cenis rail tunnel 2, 148, 165
- Mortar 45
 - synthetic 35
- Muck pile 7
- Mucking 243–265, 282–284
 - belt conveyance 257
 - capacity determination 257–259
 - further developments 165
 - (in an) investigation tunnel 264 f.
 - loading machines *see there*
 - mechanisation 282
 - microtunnelling 396
 - muck conveyance 251–259

- pipe jacking 383–385
- rail-borne operation 252–259
- (in) shield tunnelling 290
- tracked operation 251
- trackless operation 251 f.
- tracks 255–257
 - California switch 256
 - cherry picker 256
 - gauge 255
 - grasshopper 256
 - passing tracks 255 f.
 - sliding floor 256 f.
 - traverser 256
- (in a) transport tunnel 261–264
- transport vehicles 252–255
 - bunker train 255
 - locomotive 252 f.
 - output 260
 - rotating tipper 254
 - transport chaines 260–265
 - transport wagon 253–255
- (with) tunnel boring machines 331

N

- NATM *see* New Austrian tunnelling method
- New Austrian tunnelling method (NATM) 145, 154–161, 173
- New DB line Hannover–Würzburg 111, 117, 166
- New DB line Nuremberg–Ingolstadt 339
- Newer Austrian tunnelling method 154 f.
- Newest Austrian tunnelling method 154
- New Italian tunnelling method 167, 182–188
- New rail line Bologna–Florence 184–188
- Nitrous gases, threshold 410
- Non-steerable processes 386–395
- Nordstern mine 178 f.
- Nozzle angle 78 f., 83
- Nozzle distance 78 f., 82–85
- Nozzle guidance
 - automatic 85 f.
 - manual 85 f.
- Nozzle movement 78
- Nozzle pointing 78, 80

O

- Oberau Tunnel 154
- Obstruction removal 295, 298
- Old Austrian tunnelling method 154
- Opening 7
- Operational method 6
- Outer lining 45 f.
- Overbreak 359
- Oxygen concentration 409

P

- Packing tunnelling method *see* Italian tunnelling method
- Pantex 3-chord PS beam 20
- Partial-face cutting unit 289
- Partial-face excavation 148, 167

- Partial-face machine 362, 364
- Passing track 255 f.
- Pattern bolting 30, 32 f.
- Permissible values at the workplace 409
- Picks
 - arrangement, roadheader 357
 - round-shafted 357 f.
 - selection 357
- Pilot boring 398 f.
- Pilot tunnel 339, 341 f., 349–353
- Piora fault investigation tunnel 344 f.
- Pipe bursting 386, 390
- Pipe jacking *see also* Pipe ramming 380–385
 - advantages 381
 - application 382 f.
 - disadvantages 381
 - excavation 383–385
 - loading 402 f.
 - from the installation process 402 f.
 - from the location in the ground 402
 - maximum possible permissible weight 383
 - maximum possible pipe diameter 383
 - mucking 383–385
 - overcut 383
 - pipe material 385
 - resistance reduction 383
 - steering head 382
 - steering shield 381 f.
 - target precision 381
 - technical success 381
 - working sequence 383
- Pipe pulling 386, 390 f.
- Pipe ramming *see also* Pipe jacking
 - (with) closed end 386, 389
 - (with) expansion cone 386, 395
 - (with) open end 386, 392
 - steel pipe leading edges 392
- Pipe screen 25–28, 153 f., 176
 - grouted, production 27
 - without grouting 27
- Pipeline 5 f.
- Piston pump 54
- Plasticizer 63, 65 f.
- Plug conveyance 54
- Pneumatic hammer drill 193 f.
- Polymer suspension 307
- Portal 7
- Pouilly Tunnel 151
- Powder-form ammonium saltpetre explosives 213 f.
- Pressure chamber machine 50, 52
- Product pipe 402–408
 - extruded 408
 - insertion 407 f.
 - jacking 408
- Propellants 211
- Prosper 10 shaft inset 180 f.
- Pyrotechnic material 211

Q

- Quick fuse 220 f.

R

Rafter tunnelling method *see* Austrian tunnelling method

Raimeux Tunnel 340

Ramming head 39

Reinforcement 19, 115, 117

– lapping 19

– nominal

– – disadvantages 118 f.

– – inner lining 115 f.

Rennsteig Tunnel 2

Resulting cloud 412

Retarder 67

Ring closure 12, 162

Ring construction 155

Roadheader 166, 265 f., 353–366

– additional equipment 361

– advantages 362

– application 354

– – economic limits 355

– apron 357

– basic principle 353–355

– classification 354

– construction 353 f., 360 f.

– conveyance 357 f.

– cutter attachment 361

– directional control 359 f.

– disadvantages 362

– dust control 359

– functionality 353

– loading 357 f.

– (with) longitudinal cutting head 356

– picks arrangement 357

– process diagram 360

– profile control 359 f.

– rock excavation 355–359

– selection criteria 362 f.

– system diagram 353

– (with) transverse cutting head 356

– variations 361 f.

– ventilation 359, 425

Rock bolt *see also* Anchor and Bolt 7, 12, 16, 29–44, 106

– arrangement 31

– expanding 36

– load-bearing behaviour 33–36

– mode of action 29–32

– single 29 f.

Rock bolting 173

Rock classes 167

Rock deformation 146

Rock mass contact 14, 18, 145

Rock mass load-bearing capacity 32

Rock mass load-bearing ring 12, 30

Rock mass loosening 152, 156

Rock nail 29

Rotary drill, hydraulic 190 f.

Rotating tipper 254

Rotor hose pump 54

Rotor machine 50

Round depth 7, 229

Round length 30, 229

Ržihá, Franz 1

S

Safety blasting explosives 215

Schulwald Tunnel 2, 170–173

Scraper 236

Scraper conveyor 358

Sealing wall freezing 177

Segment 124–136, 290

– arrangement 130 f.

– cam and socket system 132

– cast iron segment 126 f.

– – flange sealing 127

– – permissible stresses 126

– – profile shapes 127

– – safety factors 126

– cast steel segment 125 f.

– – flange sealing 127

– circumferential joint 131 f.

– curve ring 130

– dimensional tolerances 135

– erector 135

– fixing systems 132 f.

– gaskets 133 f.

– geometrical shapes 130 f.

– installation in the shield 290 f.

– Kaubit strip 131

– lining installation 135

– profile shapes 128 f.

– radial joint 131

– – taper 135

– reinforced concrete segment 127–129

– – production 134 f.

– ring erector 135 f.

– sealing systems 132 f.

– segment ring, layout 130

– single-layer construction 128

– steel segment 124 f.

– transport 290 f.

– two-layer construction 128

Seikan Tunnel 2, 339

Semmering rail tunnel 151

Separation plant 295

– centrifuge 304 f.

– coarse sieve 303

– costs 303

– cut-off 304

– functional diagram 303

– oscillating dewaterer 303, 305

– sieve band process 305

Settlement 18, 22, 25, 105, 155

Sewer Hamburg-Nord 122

Sewer pipe

– flow velocity 404

– loading 402–407

– – biological actions 406 f.

– – chemical actions 405 f.

– – from the installation process 402 f.

- from the internal water pressure 403
- from the location in the ground 402
- mechanical actions 403–405
- thermal actions 403
- service life 405
- Sewer tunnel
 - corrosion protection
 - active 136 f.
 - passive 137–142
 - lining 136–142
 - sealing of joints 139–142
- Shaft 5 f.
 - drive shaft 381
 - reception shaft 381, 398, 401
 - thrust shaft 398, 400 f.
- Shaft duct 415
- Shaft insets 179–181
 - General Blumenthal mine 179 f.
 - Prosper 10 shaft inset 180 f.
 - single-layer construction 179 f.
 - two-layer construction 180 f.
- Shear failure hypothesis 160
- Shield
 - blade shield 311–313
 - blind shield 306
 - earth pressure shield *see there*
 - hand shield 289
 - Hydrojet shield *see there*
 - Hydroschild *see there*
 - mechanical shield
 - (with) full-face excavation 289
 - (with) partial-face excavation 289
 - Mixshield 299 f.
 - open shield 292
 - combination with a cutting boom 361
 - slurry shield *see there*
 - steering shield 381 f.
 - systems 289
 - Thixshield *see there*
- Shield blade 317
- Shield drives, classic 163 f.
- Shield handbook 371 f.
- Shield machine 286–321
 - basic principle 287–291
 - categories 286
 - (with) full-face excavation 286
 - historical development 4
 - (with) partial-face excavation 286
- Shield skin friction force 317
- Shield tail, air escape 293
- Shield tunnelling 286–321
 - blade shields 311–313
 - blade tunnelling 311
 - calculations
 - air demand for compressed support 320 f.
 - (of) face stability 313–315
 - (of) safety against breakup 315 f.
 - (of) safety against blowout 315 f.
 - (of) thrust force 316–320
 - development 163
 - face support method 287
 - hydraulic soil transport 300–302
 - hydraulic transport 302–305
 - mucking 290
 - settlement behaviour 291
 - settlement causes 291
 - soil excavation 287–289
 - soil separation 302–305
 - support installation 290 f.
 - transport 290
 - hydraulic 290
 - verification calculations 313–321
- Shock tube starting device 220
- Shotcrete 12, 18 f., 30, 45–111, 150
 - additives 68–70
 - admixtures 62–68
 - limit quantities 63
 - aggregate 60 f.
 - binders 62
 - hydration 62
 - types 62
 - calculation methods 87–89
 - cement 61 f.
 - compression strength 61
 - dangers 107 f.
 - dry-mix process 49–52, 55, 57–59, 71 f.
 - dust development 72
 - influences 76, 84 f.
 - dust exposure 110
 - dust protection 107–109
 - dust reduction 107–109
 - early strength 48, 101
 - Elastic Modulus 88
 - equipment 49–59
 - fine dust concentration 76 f.
 - handling 49–59
 - manipulators 91 f.
 - advantages 91
 - material behaviour 87–89
 - materials technology influences 72–77
 - (in) mining 178–181
 - shaft insets *see there*
 - tunnel support 178 f.
 - mixing 60–71
 - examples 70
 - noise problem 108
 - permissible value 108
 - process categorisation 10
 - process technology 49–59
 - influences 72, 77–86
 - production 61
 - quality 72
 - control 89 f.
 - criteria 87
 - influences 73 f., 79–81
 - rebound behaviour 72
 - influences 74–76, 81–84
 - recipes 60–71
 - robot 93–96
 - functional mode 96
 - starting position 98
 - Rombold spraying system 51

- spraying machines 52
- – technical data 56
- – types 50, 53
- spraying processes 49
- Spritzmobil 51
- steel fibre shotcrete *see there*
- (as) support material 146, 182
- technology mechanisation 91–99
- test rig 94, 98 f.
- W/C ratio 73–76
- wet-mix process 52–55, 57–59, 71–73
- work capacity 101
- working joint 20 f.
- working safety 106–111
- work under compressed air 110 f.
- Shotcrete process 167
- Shotcrete tunnelling 167–188
 - core tunnelling method *see there*
 - further developments 182
 - (with) longitudinal shots 173 f.
 - special processes 176–178
 - – compressed air 176
 - – ground freezing 176 f.
 - – grouting 176–178
 - top heading *see there*
 - (with) tunnel boring machines 338–353
- Side heading 7
- Silica dust 69 f.
- Silo coefficient 314
- Simplon Tunnel 162
- Sinnberg Tunnel 117
- Skin friction 392
- Sliding floor 256 f.
- Slipforming 122
- Slow fuse 212 f.
- Slurry shield 164, 294–297
 - support pressure control 296
 - tunnel boring machines 336
- Soil conditioning 307, 310
- Soil excavation 287
- Sommeiller drill 189
- Spile 21, 23 f.
 - bored 24
 - crown support 24
 - driven 24
 - rammed 24
 - rammed injection 25
- Spiral duct 415
- Spraying nozzle 55 f.
- Springline heading 7
- Springline joint 7
- Stabiliser 63, 66 f.
- Stadtbahn Bensberg 71
- Stadtbahn Dortmund
 - full-round formwork unit 112
 - lagging sheets 23
 - steel arches 18
- Stadtbahn Duisburg, crown heading driving 178
- Stadtbahn Duisburg-Duisern, Mixshield 300
- Stadtbahn Essen, vault freezing 177
- Stadtbahn Mülheim, mortar filling behind steel sheets 22
- Starting point 7
- Start pistol 220
- Steel arch 145, 173
 - expanding 18
- Steel concrete 121
- Steel duct 415
- Steel fibre concrete 100–106, 146
 - construction material properties 100 f.
 - early strength 101
 - Moment-Normal force test rig 102 f.
 - properties 102
 - testing methods 102
 - testing procedure 101–103
 - work capacity 101
- Steel fibre-reinforced shotcrete 20
- Steel fibre shotcrete
 - cost-effectiveness 104–106
 - processing 103 f.
 - spraying, special features 59
- Steel lagging sheet 21–23
- Steel pipe leading edges 392
- Steel plate 21–23
- Steel rib 14–19
 - installation 16–19
 - profile forms 15
 - sprayed filling 19
- Steel sheet, mortar filling behind 22
- Stemming 242
- Stope hole 234
- Submerged wall 298
- Subway tunnel San Francisco 124
- Sulfur dioxide, threshold 410
- Superplasticizer 65 f.
- Support 9–143, 145, 147, 149
 - advance 184
 - advance measures 21–29
 - bond 11
 - (in) coal mining 178 f.
 - deformability 10 f.
 - description of the parts 7
 - final 111
 - foot support *see there*
 - (of the) ground 288
 - lattice beam *see there*
 - materials
 - – action of 9–12
 - – deformability 9
 - – stiffness 9
 - permanent 6, 19, 45
 - segment temporary 113
 - semi-stiff 167
 - single-layer construction 46–48
 - soft in bending 167 f.
 - steel ribs *see there*
 - stiff 10 f., 167
 - temporary 6 f., 11, 19, 45, 111, 115, 148
 - timbering *see there*
 - time of installation 11 f.

- traditional 22
- two-layer construction 46 f.
- Support pressure control 310
- Swirl duct 415
- Synthetic dispersions 67 f.

T

- Tauern Tunnel 1, 142
- TBM *see* Tunnel boring machine
- Terms 4–7
- Thames Tunnel 4, 163 f.
- Thin flow conveyance 53
- Thixshield 164, 295, 297
 - longitudinal section 297
- Thrust force 316–320
- Timber frame 22
- Timbering 12–14
 - (as) emergency support 13
 - frame set timbering 13 f.
 - lagging 14
 - shoring 14
 - trussed timbering 14
- Top heading 7, 149, 155, 168–175
 - crown pilot heading with crown beam 170–173
 - shotcrete tunnelling method 168
 - – (with) longitudinal shots 173 f.
 - underpinning method 168–170
- Top heading vault 175
- Track 255–257
- Transport chaines 260–265
- Transport machine, capacity determination 257–259
- Transport vehicle, output 260
- Transport wagon 253–255
- Traverser 256
- Trenchless construction process 379 f.
- Trestle timbering 161
- Trestle tunnelling method *see* English tunnelling method
- Triebitzer Tunnel 151
- Tronquoi, Galerie de 2
- Tronquoy Tunnel 151
- Trussed timbering 14
- TSM *see* Roadheader
- Tube spile 21
- Tunnel advance portal (TVP) 360
- Tunnel boring machine (TBM) 165, 286, 322–338
 - acceptance 370
 - – check 366–378
 - basic principles 322–326
 - boring system 327 f.
 - bracing system 328–331
 - categorisation 322
 - (with) cutterhead shield 325, 327
 - cutter types 327
 - data check 372
 - deduster 423
 - design 367 f.
 - double shield TBM 325
 - (with) earth pressure shield 336–338
 - – closed mode 336
 - – open mode 336
 - – transition mode 337 f.
 - functional test 372
 - gripper bracing 329
 - gripper TBM *see there*
 - (in) hard rock 322–338
 - historical development 4
 - (with) hood 324
 - machine specification 369 f.
 - machine systems 324
 - mucking 331
 - obstruction analysis 368 f.
 - open TBM 324
 - (with) partial shield 324
 - risk contain 367
 - (for) shotcrete tunnelling 338–353
 - single shield TBM 325
 - (with) slurry shield 336
 - suitability check 366–378
 - support system 332–335
 - system groups 323
 - telescopic shield TBM 325
 - thrust system 328–331
 - tunnel reaming machine 326
 - ventilation 335, 423 f.
 - working areas 334
 - working sequence 330
- Tunnel driving 6
- Tunnel driving machine 165
- Tunnel excavator 245, 364–366
 - application conditions 364 f.
 - construction features 365
 - special forms 365 f.
- Tunnelling
 - blade tunnelling 311
 - historical development 1–4
 - mechanised tunnelling 285–378
 - shield tunnelling *see there*
- Tunnelling machine
 - application 285
 - categories 285 f.
 - classic 164–166
 - development 164
 - functional principle 285
 - shield machine *see there*
 - tunnel boring machine *see there*
- Tunnelling methods
 - ADECCO-RS tunnelling method 182–188
 - Austrian tunnelling method *see there*
 - Belgian tunnelling method *see there*
 - bench excavation 148
 - classic methods 145–166
 - core tunnelling method *see also* German tunnelling method 151–153, 167
 - cross beam tunnelling method *see* Austrian tunnelling method
 - English tunnelling method 154, 161

- full-face excavation 147, 167, 183
- further developments 145–166
- German tunnelling method *see there*
- Italian tunnelling method *see there*
- longitudinal tunnelling method *see* English tunnelling method
- packing tunnelling method *see* Italian tunnelling method
- partial-face excavation 148, 167
- rafter tunnelling method *see* Austrian tunnelling method
- shield drives, classic 163 f.
- trestle tunnelling method *see* English tunnelling method
- underpinning tunnelling method *see also* Belgian tunnelling method 155, 167
- upraise tunnelling method *see* Austrian tunnelling method
- Tunnels, historical overview 2
- TVP *see* Tunnel advance portal

U

- Underpinning 152, 172 f.
- Underpinning tunnelling method *see also* Belgian tunnelling method 155, 167
- Unmanned processes 385–395
 - ground displacement processes 386–392
 - ground removal processes 386, 392–395
 - non-steerable processes 386–395
- Upraise tunnelling method *see* Austrian tunnelling method
- Uznaberg Tunnel 341, 349–353
 - cross-section with location of the pilot tunnel 349
 - enlargement of the pilot tunnel 350

V

- Vault, self-load-bearing 31
- Vault formwork unit 111
- Vault freezing 177
- Ventilation 409–425
 - automatic 425
 - combined ventilation 413
 - costs 417–422
 - design 417–422
 - extraction ventilation 412
 - materials 414–417
 - natural ventilation 411
 - positive pressure ventilation 411 f.

- regulation in Germany 409
- reversible ventilation 412 f.
- roadheader 359, 425
- supply ventilation 411
- systems 411–414
 - operation 420 f.
 - operation costs 421 f.
 - recirculation systems 413 f., 419 f.
 - special systems 423 f.
- tunnel boring machines 335, 423 f.
- Vereina Tunnel 71, 284
- Vibration 267–275
 - detonation sequence 269
 - evaluation
 - (in) Austria 273–275
 - (in) Germany 273
 - (in) Switzerland 271 f.
 - (with) extended detonation delay 270
 - reduction 275

W

- Waste water, water properties 405 f.
- Water and bentonit suspension 295
- Water glass as accelerator 64
- Water holding at the face 288
- Water pressure 307
 - internal 403
- Waterproof concrete 115 f.
- Waterproofing 7, 118
- W/C ratio 73–76
- Wear 354
- Westtangente Tunnel Bochum 3, 170
- Wet-mix machine 53
- Wet-mix process 52–55, 57–59, 71–73
- Wilson, Charles 4
- Working joint, shotcrete 20 f.
- Working safety 91, 106–111
- Worm conveyance pump 54
- Worm pump machine 50

Y

- Yielding elements 142 f.
 - arrangement 142
 - key developments 142
 - types 142 f.
 - working curves 143

Z

- Zürich-Thalwil rail tunnel 342