INDEX

Note: Page numbers followed by "n" indicate notes.

A-weighted sound level, 129 Abbreviated Injury Scale (AIS), 310 Acceleration, 143 resistance to, 143-144 Access, 253 Accessibility, 6, 8, 20, 33, 48, 174, 261 Accuracy, 256 Acoustics, 114 frequency analysis, 116–117 practical measurement quantities, 118 - 120sound levels and decibels, 114-116 sound travel. 117-118 Active safety role, 154 Active crossing, 301 Activity-based modelling technique, 14 Aerodynamic noise, 125 Agent-based modelling technique, 14 Airborne transmission, 125–126 'Alimentation par Sol' system (APS system), 175 Amsterdam train collision, 306 Anthropomorphic test devices (ATDs), 307 Anxiety, 30 Appraisal, 16-17 Approach behaviour, 27, 29-30 Approach locking, 231 Appropriateness of trackbed design method, 84 Apps, 246 Articulated train sets, 165–168 Artificial intelligence (AI), 241 Asphalted track systems, 62 Assessment methods, 312–313 Assets, 326

Association Européenne pour l'Interopérabilité Ferroviaire (AEIF), 156 Association of Community Rail Partnerships (ACoRP) (see Community Rail Network) Association of Train Operating Companies (ATOC), 307 Attention, 43 Attractive, 33 Automatic route setting (ARS), 237 Automatic train operation (ATO), 245 Automatic train protection (ATP), 225, 233, 246 classification of, 233-234 European Train Control System, 234 Automation technologies, 237-238, 240 Availability, 249 Averch-Johnson effect, 273 Avoidance behaviour, 27, 29-30 Axle counter, 228 Ballast, 99, 101, 106, 123, 196

Ballasted track systems, 62–65 Big data analytics, 240, 251 Black, Asian and Minority Ethnic (BAME), 242 Block systems, 227 fixed, 227–229 moving, 229 Borrowings, 284, 289–291 Braking system, 121 British Rail modernisation programme, 267 British Transport Act, 287 Broad-based community engagement, 45 Building information modelling (BIM), 255 Built largely as elevated (*see* 'Skytrain' system) Bus alternative, 178–179 Business continuity, 260

Cab signalling block systems, 227–229 cab signalling with fixed block sections, 225-226 cab signalling with moving block, 226-227 train control by, 225 Cab structure analysis model, 165 Cairo Metro, 185 Cant deficiency, 67-68, 139 equilibrium, 67 Capacity, 203-217 Capital grants, 284 Capital investment, 182 Car body validation, 164 Carbon emissions, 42 Care, 130 Careful planning, 10 Cast-iron brake blocks, 121 Central Station Leiden, 34 Central Station Rotterdam, 34 Centralised control, 236-237 Centre for Research into Energy **Demand Solutions** (CREDS), 44 Chiselling, 272 Civil engineering, 266 Clapham Junction rail accident, 307 Classic household location models, 181 Clear strategy, 287 Climate crisis, 43 'Climate emergency', 43 Cloud communications, 248 Cloud computing, 240 Cloud providers, 248 Coil springs, 141 Collative dimensions. 28

Comfort, 22–23 experience, 28 Commercial freedoms, 282 Common safety indicators (CSIs), 296 Communications. 248 communications-based train control. 245 research. 45 **Communications Based Train Control** (CBTC), 171 Community engagement, 43-46 Community rail, 42-43 exploring community rail's position and power to influence sustainability, 46-54 future development and lines of inquiry, 54-56 partnership, 328 postscript, 56-57 reviewing research, 43-46 Community Rail Network, 42, 53 Commuter vehicles, 153 Competition and Markets Authority (CMA), 273 Computable general equilibrium modelling (CGE modelling), 198 Computer simulation, 312 Computer-aided engineering tools, 255 Computers development, 240 Concrete sleepers, 64 Conflicting routes, 231-232 'Connected commuter', 246 Conrail. 278n1 Contact patch, 135-137, 146 Continuously welded rail (CWR), 64 Contract plan, 287 Corrugation, 121, 142–143 Cost, 13, 193 controlling, 15-16 of urban rail construction, 12 Cost-benefit analysis (CBA), 16, 300 Covid-19 crisis, 260 Crash management system (CMS), 309 Crash process model (CPM), 154-155

Crash safety, 311, 314 Crash scenarios category CI vehicles, 158 design cases, 164-165 like-to-like impact at 36 km/h with 40 mm vertical offset, 159 like to like impact, 158-159 train against 80t UIC Standard Wagon Impact, 159-160 train against level crossing object impact, 160 train against small object impact, 160 - 164Crash simulations, 306 Crashworthiness, 153 CPM, 154-155 crash scenarios category CI vehicles, 158-165 design for structural crashworthiness, 156 European Standards and Regulations, 156–158 role of active and passive safety, 154 'Creep control', 138 Creep forces, 139 Critical timing, 256 Critical velocity, 95-96 Cronbach's alpha, 32 Curve squeal, 123–125 Curving behaviour, 138-139 Customer buy-in, 249-250 customer-centric railway, 262 experience, 13 facing technologies, 249-250 needs, 21-23 Cutting, 93 Cyber-physical systems, 241 Cybersecurity, 250 Damping, 141 'DART' system, 172 Data analytics, 241, 250-251

challenges, 251-253

SE, 258-260

simulation and modelling, 253-256 transformational leadership, 256-258 Data management, 253 Data transmission, 234 'De-politicalisation', 287 Debt, 289-291 Decarbonisation, 240 Deceleration rate, 164 Decibel (dB), 114-115, 118 Deep-seated rotational failure, 99 Deficit funding, 286 Demand. 6 side factors, 12 Den Haag Holland Spoor Station, 33 Department for Transport (DfT), 46, 55, 270 **Community Rail Development** Strategy, 47 Depreciation, 284–285 Derailment, 142 Design methodology, 314 validation, 320 Design, Build, Finance, Operate scheme (DBFO scheme), 277 Determinants of injury severity, 309 Diesel multiple unit (DMU), 145 Digital inspection tools, 247–248 Digital railway, 240 addressing challenges, 261-262 data analytics, 250-253 digital technologies, 243-250 digitalisation for sustainability, 241-243 elements of, 243 Digital revolution, 240 Digital signaling, 245 Digital technologies, 243-244 challenges, 249 command and control, 245-246 communications, 248 cybersecurity, 250 identifying and incorporating technologies, 249

interoperability, 250 mobility, 246-247 obsolescence management, 249 reliability and availability, 249-250 staff buy-in, 250 supply chain, 247-248 supply chain sustainability, 249 technologies radar for horizon scanning, 245 'Digital twin', 253-254 Digitalisation, 240 for sustainability, 241-243 'Direct demand' models, 14 Displacements, 99 Diversity, 258 Drainage, 96 Driverless operation, 177 Dutch Safety Board (DSB), 306 Earth embankments, 92 Earthworks, 92, 106 embankment and cutting, 93 management, repair and stabilisation methods, 106 - 108modern earthworks design and construction, 93-96 modern problems with old earthworks, 99-106 old earthwork construction, 96-98 Economic benefits, 8, 15, 197, 286 Economic sustainability, 12 controlling costs, 15-16 other sources of revenue and economic benefits, 15 predicting demand, 12-15 Economic sustainability, 2 Effects of railways on urban structure, 180 - 182Electrical engineering, 266 Embankment, 93 Emotions, 28 Enabling actions, 287 End-tipping gave embankments, 98

Energy absorption, 154, 158, 163, 311 components, 165 concept for articulated vehicles, 167 device prior to crushing, 167 post crush, 168 Energy consumption for urban railways, 149-150 Engineering principles, 326 Environmental impact of HSR, 195 Environmental noise limits and noise mapping, 127-128 Environmental quality, 27 Environmental sustainability, 2, 9, 12 assessing risk and resilience, 12 choosing route, 9-11 whole-life impact assessment, 11 Environmental variables, 22 Equality, 258 Equations of motion, 145 Equilibrium cant, 67 Equity, issues of, 183–184 Equivalent continuous sound level $(L_{eq}), 119$ European Association for Railway Interoperability (see Association Européenne pour l'Interopérabilité Ferroviaire (AEIF)) European Commission (EC), 308 European Committee for Standardisation (CEN), 156, 308 European Rail Agency (ERA), 312 European Rail Community, 308 European Rail Traffic Management System (ERT MS), 154-155, 234, 246 European Shift2Rail programme, 243 European Standards and Regulations, 156 - 158European Train Control System (ETCS), 234-235, 246 Level 1, 236 Level 2, 236 Level 3, 236

European Union (EU), 187 European Union Agency for Railways (EUAR), 296 Excessive plastic deformation, 86 Excitement. 30 Experience, 22–23 Factor analyses, 32 Failure, 182 modes of. 99 Fast and slow area, 24 Fatalities at level crossings, 301–302 Fatigue, wear and, 142–143 Feelable vibration, 129 Finance, 327 Financial appraisal, 16 Financial sustainability, 182-183, 281, 282-283 Financially sustainable railway, 291 capital grants/borrowings/ investment requirements, 284 financial sustainability, 282–283 long-term financing, 289–291 operating costs and depreciation, 284 - 285operating grant and subsidies, 284 operating revenue, 283 railway financial outgoings and sources of revenue, 282 short-term financing, 285-289 short/medium and long term, 285 5G radio technology, 234, 248 Fixed block sections, cab signalling with, 225-226 Flank protection, 232-233 Fostering innovation, 260 Fouling material, 65 Frequency analysis, 116–117 Friction coefficient, 138 Future Rail Mobile Communication System (FRMCS), 234 Future Traffic Regulation Optimisation programme (FuTRO programme), 214

G44 sleeper, 64 General Data Protection Regulation (GDPR), 253 Generic procedures, 11 Geometrical constraints, 69 Geotextiles, 107 Global System for Mobile Communications-Railway (GSM-R), 234, 248 Gradual subgrade failure, 86 Great Britain, 271 Greathead Shield method, 174 Ground vibration, 114, 129 Ground-borne noise and vibration, 128 - 130Halo effect. 28 Hatfield train accident (2000), 270 Head injury criteria (HIC), 319 Hedonic tone. 28 Hertz theory, 135 High Speed 2 (HS2), 93, 208 High-level output specification (HLOS), 270 High-plasticity clays, 94 High-speed networks, 241 High-speed rail (HSR), 152, 187–188 benefit, 196-199 high-speed line system development, 188-192 sustainability of, 193-199 technical characteristics, 192-193 temporal tipping points, 199–200 High-speed railway, 93 High-speed train route, 62 High-speed vehicles, 152-153 Historical development, 206 HSR-COMET project, 25 Human bio-modelling and testing, 309 - 310Human error, 299 Hunting, 135, 139, 142 Hyperbolic discounting, 17 Impact noise, 123

Impact noise, 123 Impact object shape, 318 Impact object stiffness, 319 Impact velocity, 317-318 In situ geology, 94-95 Inclusion, 258 Income distribution, issues of, 183-184 Industry 4. 0, 240 247 sustainability functions of, 241 Inertial measurement units (IMUs), 79 Infrastructure provision, 303 Injury criteria, 309-310 Injury severity, determinants of, 309 Intelligent train control and monitoring systems, 155 Intensity, 117-118 Interchanges, layout of, 23-27 Interior passive safety assessment methods. 312-313 description of feasible standard and rationale behind requirements, 311–312 designing to requirement, 313 determinants of injury severity, 309 impact object shape, 318 impact object stiffness, 319 impact velocity, 317-318 injury criteria and use of human bio-modelling and testing, 309-310 minimising passenger injury, 317 need for passive safety requirement, 307-309 occupant containment, 313-316 passenger injury, 316 effect of seat and feature locations. 319 effect of seat pitch and height, 316 validation of design, 320 Interlocking principles, 229 conflicting routes, 231-232 flank protection, 232-233 interlocking routes, 229-230 overlaps, 233 route locking, 230-231 International Council on Systems Engineering (INCOSE), 259 International Energy Agency (IEA), 149 International Railway Journal (IRJ), 209–210 International Railway Union (UIC), 188 Internet of things (IoT), 240, 241 Interoperability, 250 Inverted U-curve, 28 and psychological reversal, 29 Investment, 289–291 requirements, 284 Japanese National Railways (JNR), 271 Journey time economic benefits of reduced, 197 end-to-end, 9

incremental, 199 rail, 13 reducing, 8 Jubilee Line Extension (JLE), 180

Key performance indicators, 150 Kinematic oscillation, 134 Klingel motion, 134

L'Autorail Grande Capacité (AGC), 164 Laminated rubber-metal springs, 141 Land use transport interaction (LUTI), 197 Land-use patterns, 12-13 Layout of interchanges, 23-27 Learning curve for quality improvement, 32 Leiden Central Station, 34 Level crossings, fatalities at, 301–302 Li and Selig's method, 86 Life cycle analysis, 11 Lineside signals, train control by, 222-225 London Underground, 97, 107, 171, 176, 180, 182, 205, 274-275 Long-Term Evolution-Railway (LTE-R), 248 Long-term financing, 289-291

Machine learning (ML), 241 Management dimensions, 30 Management plan, 287 Manchester Metrolink, 274 Market-led proposals (MLPs), 277 'Market-led' approach, 216 Mass Transit Railway (MTR), 205 Matlab. 87n1 Matrix management, 267-268 Maximum contact pressure, 135 Measuring quality, 79 Mechanical engineering, 266 Mechanised railway systems, 1 **MERLIN** project, 150 Metal coil springs, 141 'Metro' systems, 172 Mitigation measure for curve squeal, 124 Mobility as a Service offering, 328 Modal integration, 209 Modal shift, 48, 53, 183, 199, 209-211, 213, 216, 240, 241, 327 Model sharing, 256 Modern earthworks critical velocity, 95-96 design and construction, 93 drainage and vegetation, 96 earthworks settlement and heave, 94-95 introduction, 93-94 slope stability, 94 Modern locomotives, 92 Modern problems with old earthworks, 99-106 Modern sleepers, 64 Modes of failure, 99 Monitoring and evaluation, 17 Monte Carlo simulation, 11 Motion equations of, 145 resistance to, 143-144 Moving and staying, 24 Moving block, 227 Multidisciplinary-engineered system, 259 Multidivisional structure, 269

National-level ticketing, 328 Network Rail (NR), 270, 291 in United Kingdom, 103 New measurement train (NMT), 75 Noise, 113 acoustics, 114-120 aerodynamic noise, 125 curve squeal, 123-125 ground-borne noise and vibration, 128 - 130impact noise, 123 limits and mapping, 126–128 other sources of noise, 125 railway noise sources, 120 rolling noise, 120-123 sustained exposure, 113-114 vehicle interior noise, 125-126 Noise barriers and window insulation, 128 Noise Insulation Regulations, 127 Noise limits on individual trains, 126-127 'Non-user benefits', 7 Normal contact, 135–137 Notified Body (NoBo), 151 Obsolescence management, 249 Occupant kinematics, 310 Occupant Protection and Egress in Rail Systems (OPERAS), 312 Office of Passenger Rail Franchising (OPRAF), 269 Office of Rail and Road (ORR), 206, 250, 269 Old earthwork construction, 96-98 modern problems with, 99 overview, 99-100 transitions onto bridge structures, 106ultimate failure, 101-104 vegetation and serviceability issues, 104 - 105One-size-fits-all solution. 328 Openness, 261

Operating costs, 284–285 Operational Philosophy (OP), 214 'Opposing locking', 232 Optimal arousal theory, 28 Optimism bias, 290 Organisational reform, 285-289 Origin-destination matrix (OD matrix), 14 **OSIRIS** project, 150 Overall sustainability, 16-17 Overcrowding, 272 Overhead line electrification (OLE), 99 Overlaps, 233 Ownership, 253, 273–275 Pandemic, 13, 45, 211–212, 277–278 Paratelic state, 29 Paris Metro, 173, 177, 178, 185n2 Passenger injury, 316 minimising, 317 Passenger rolling stock, 150 articulated train sets, 165-168 crashworthiness, 153-165 high-speed vehicles, 152-153 materials, 168 rail vehicle taxonomy, 151-152 regional and commuter vehicles, 153 Passenger train service operations, 278 Passengers in excess of capacity (PIXC), 272 Passive safety design, 306 requirement, 307-309 role, 154 'Passive' crossing, 301 Pattern of railway fatalities, 296-297 network, 207 Pay as you go (PAYG), 172 People, 31 Permanent Way Institution (PWI), 69

People, 31 Permanent Way Institution (PWI Persons with restricted mobility (PRM), 272, 307 Physical barriers, 10 Place, 31 Planning, 75–79 economic sustainability, 12-16 environmental sustainability, 9-12 overall sustainability, 16-17 social sustainability, 6-9 system and route planning for sustainable railway system, 5-6Plastic Bodyform, 312–313 'Plug-and-play' approach, 249 Politics, 285-289 Post-occupancy evaluation, 25–26 Power supply and energy, 174–176 Practical measurement quantities, 118 - 120Preferred noise criterion (PNC), 129 Primary collision, 309 'Prime user' model, 288 Privatisation, 268, 274 initial privatised structure, 270 Processes, 31 'Production-led' approach, 216 Profitability, 2 Progressive shear failure, 86 Public control, 272 Public performance measure (PPM), 272 Public service obligations (PSOs), 282 contract payments, 286 Public-private partnerships (PPPs), 274 Pyramid of customer needs, 21-23

Quality learning curve for quality improvement, 32 measurement, 79 Quality dimensions in order of importance, 23 of service, 31 Quality of transport interchanges, 21–23 Quantitative regression analyses, 21 Radio Block Centre (RBC), 229, 246

Radio Block Centre (RBC), 229, 246 Radio-based data transmission, 234 Rail corrugation, 142

Rail dampers, 122 Rail deflection, 70 Rail Delivery Group (RDG), 44 Rail inclination, 134 Rail roughness, 121 Rail safety, 303-304 appraisal of railway safety measures, 300-301 fatalities at level crossings, 301-302 pattern of railway fatalities, 296-297 personal fatalities, 302 rail restructuring and rail safety, 303-304 train accidents, 297-300 trespassers and suicides, 302-303 Rail Safety and Standards Board (RSSB), 245, 273, 307–308 Rail Technical Strategy (RTS), 241 Rail traffic management technologies, 236 automation technologies, 237-238 centralised control, 236-237 Rail-specific regression modelling approach, 14 Railway network development, 2 in United Kingdom, 96–97 Railway profiles, 134-135 Railway station and interchange design experience work, 27-31 focus on passenger, 20-21 layout of interchanges, 23-27 measuring all relevant quality aspects, 32-36 quality of transport interchanges, 21 - 23Railway track system ballasted track systems, 63-65 locations of enhanced deterioration, 80 maintenance, 75 other, 81-82 planning, 75–79 principles of performance, 62-63

railway track performance, 69-75 S&C, 81 tamping, 79-80 track geometry, 65-69 trackbed design, 82-86 transitions, 81 Railway(s), 266 accident, 296 changing emphasis, 208-210 evaluation, 17 financial sustainability, 281 historical development, 206-208 interior passive safety, 306 owners and promoters, 2 pattern of railway fatalities, 296-297 purpose of, 6-8 restructuring, 303-304 sustainable capacity provision, 211-215 sustainable timetabling, 215–217 system technology, 306 transformation, 57 vehicle taxonomy, 151-152 Railways Act, 269, 270, 272 Rapid drawdown effect, 101 Rayleigh wave speed velocity, 95 Regenerative braking, 172, 176, 214 Regional vehicles, 153 Regulation, 285–289 Regulation of Railways Act 1889, 272 - 273Relaxation. 30 Reliability, 22, 249-250 Renewable energy, 327 'Renewable' power solutions, 2 Repair, 106-108 Resilience, 12 Resilient, 262 'Resource-led' approach, 217 Responsive, 261–262 Retail Price Index (RPI), 272 Rete Ferroviaria Italiana (RFI), 62 Revenue, 12, 15, 210, 216–217, 282 - 285Reversal theory, 29–30

Ride comfort, 139–142 Risk assessment, 12 Rolling contact fatigue (RCF), 121, 134 Rolling noise, 120–123 Rolling stock leasing companies (ROSCOs), 269 Rolling stock technical categorisation system, 151 Root mean square (rms), 114 Rotterdam Central Station, modernisation of, 34-36 Route choice, 9–11 Route locking, 230-231 Route planners, 10 Route planning for sustainable railway system, 5-6 RSSB Data Sandbox⁺ project, 251 Safe train separation, 222 SafeInteriors project, 308-309, 310, 321 Safety integrity levels (SILs), 249 Safety-critical information, 303 Satellite communication, 248 Seasonal shrink-swell movements, 104 Seat systems, 320, 321 Secondary collisions, 309 Self-selective protective points, 232 Service environment, 31 Serviceability issues, vegetation and, 104-105

Shallow translational failure, 99 Sheet pile walls, 108 Shift2Rail, 243, 248 Short-term financing, 285-289 Signalling ATP, 233-236 interlocking principles, 229-233 rail traffic management technologies, 236-238 steel rail system, 221-222 train control principles, 222-229 Signalling and telecommunications (S&T), 266 Simulation and modelling, 253–256 challenges, 256 critical timing, 256

model sharing, 256 validation and accuracy, 256 Skills gap, 258 'Skytrain' system, 174 Slab tracks, 62 Sleeper, 65 selection, 64 used in United Kingdom, 64 Slope stability, 94 Smart energy management, 150 Smartrail 4.0, 242 Social distancing, 277 Social inclusion, 8-9, 46, 48, 52, 207 Social psychology, 45 Social safety, 22 Social sustainability, 2, 6 integration with broader policy and planning, 8-9 purpose of railway, 6-8 Social sustainability of railways, 2 Social value, 46, 53-54, 56 Soft rail pads, 122 Sound exposure level (SEL), 120 Sound level meter, 118 Sound pressure level (SPL), 114-115 Spatial wayfinding, 24 Specific Targeted Research Projects (STReP), 308 Speed, 22 Speed dependence of noise level, 125 Spring, 141 Stabilisation methods, 106-108 Staff, 31 Staff buy-in, 250 Stand-alone DAS, 246 Standard deviation (SD), 77-78 Station adoption/friends, 53 Station choice models, 12 Station Experience Monitor (SEM), 32 Steel rail system, 221 Stimulus-Organism-Response Model, 28 Straight curved plain line, 65-69 Strategic Rail Authority (SRA), 270 Structural crashworthiness, design for. 156

Structures for urban railways, 180-182 Sub-national transport bodies (SNTBs), 277 Suicides. 302-303 Supply chain, 247–248 sustainability, 249 Supply side factors, 13 Suspension levels of, 140 primary, 129, 140-141 secondary, 140-141 vehicle, 140-141, 146 wheel and bogie, 191 Sustainability, 1-2, 6, 42, 150, 182, 325 achieving sustainable development, 53 - 54aiding access to sustainable, healthy travel, 48-51 creating more inclusive railway, 51 - 53DfT's Community Rail Development Strategy, 47 digitalisation for, 241-243 effect on urban structure and, 180 - 182exploring community rail's position and power to influence, 46 financial. 182-183 functions of Industry 4.0, 241 growing grassroots movement, 46 of HSR, 193-199 railways and, 204-206 social, 6-9 supply chain, 249 voicing local needs and opportunities, 47-48 Sustainable capacity provision, 211-215 Sustainable development, 1 achieving, 53-54 Sustainable railway organisation, 266-271 ownership, 273-275 regulation, 271-273 route planning for, 5-6 system, 2-3

Sustainable timetabling, 215–217 Sustainable transport, 42-43 Sustainable travel, 7, 48, 50, 51 Sustainable urban railways broader role of urban rail systems, 179 - 182bus alternative, 178-179 CBTC, 171 financial and economic issues, 182 financial sustainability, 182-183 issues of equity and income distribution, 183–184 power supply and energy, 174-176 signalling and control, 176–177 structures, 173-174 system capacity, 177-178 track. 172-173 'Sweat the assets' approach, 212 Switches and crossings (S&C), 63, 81 System planning, 17 for sustainable railway system, 5-6 Systemic risks, 12 Systems engineering (SE), 243, 258 challenges, 260 fostering innovation, 260 INCOSE, 259

'Taktfahrplan', 216–217 Tamping, 79-870 Tangential contact, 137-138 Taxonomy, 152, 276 Technical recommendation (TecRec), 308 Technical requirements document (TRD), 152 Technical specifications for interoperability (TSI), 126, 151-152, 187, 250, 272, 307 environmental noise limits and noise mapping, 127-128 noise barriers and window insulation, 128 noise limits on individual trains. 126-127 Technological development, 174 Telic state, 29

10-point scale, 30, 32-33 TGV Haute-Picardie, 285 Theory of rolling contact, 137 Three management dimensions, 30-31 Three-dimensional environments (3D environments), 255 Threshold injury, 310 Timetabling, 206, 215 sustainable, 215-217 Top-down governance, 328 Track circuit, 228 Track decay rate, 122, 127 Track design, 173 Track geometry, 65 quality, 79 straight or uniformly curved plain line. 65-68 transition curves, 68 vertical curves, 68-69 Track maintenance, 75-80 Track performance, 69–75 Track recording vehicle, 75 Trackbed design, 82 design principles, 85 evaluating appropriateness of, 84 general, 82-83 Trackbed load, 70-71 Tractive effort, 92, 143 Traditional transport modelling, 199 Traffic management system (TMS), 242 Train accidents, 296 Train against 80t UIC Standard Wagon Impact, 159-160 Train against level crossing object impact, 160 Train against small object impact, 160 - 164Train control and monitoring systems (TCMS), 155 Train control, 222 by cab signaling, 225-227 by lineside signals, 222-225 Train journey, 30 Train operating companies (TOCs), 270

Train performance calculations, 143 equations of motion, 145 resistance to motion and other accelerations, 143–144 tractive force, 143 worked example, 145 'Train protection', 300 Train resistance, 143–144 Train simulators, 255 Trans-European Network (TEN), 152 Transformational leadership, 256-258 challenges, 258 equality, diversity and inclusion, 258 Transit-oriented development, 7 Transition curves, 68 Transitions, 81 Transport Decarbonisation Plan, 56 Transport interchanges, quality of, 21 - 23Trespassers, 302-303 Trip end model, 13-14 Trip rate model, 13-14 Tunnel boring machines (TBMs), 174 TWINS model, 121

UK Digital Railway, 242 UK Rail Research and Innovation Network (UKRRIN), 252 UK Transport Industry Skills Strategy, 258 Ultimate failure, 101-104 Ultra-high-frequency radio identification tags, 247 Under sleeper pad (USP), 65 Under-track crossing (UTX), 81-82 Underfunding, 288–289 Uniformly curved plain line, 65-69 Union des Industries Ferroviaires Européennes (UNIFE), 156 Union of European Railway Industries (see Union des Industries Ferroviaires Européennes (UNIFE)) Union of Railways (UIC), 240 United Nations Sustainable Development Goals, 328

Urban rail systems, 179–182 Urban railways, 172-173 broader role of urban rail systems, 179 - 182bus alternative, 178-179 CBTC, 171 financial and economic issues, 182 financial sustainability, 182-183 issues of equity and income distribution. 183-184 power supply and energy, 174-176 signalling and control, 176-177 structures, 173-174 system capacity, 177-178 track, 172-173 Validation, 256 of design, 320 'Value-added' services, 13 Valuing people, 262 Vegetation, 96 and serviceability issues, 104-105 Vehicle dynamics, 133-134 consequences of vehicle-track interaction, 142-143 curving behaviour, 138–139 normal contact, 135-137 ride comfort, 139 tangential contact, 137-138 train performance calculations, 143-145 wheel and rail profiles, 134-135 Vehicle interior noise, 125-126 Vehicle safety, 151 Vehicle-track interaction, 133-134, 142 - 143

Vertical curves, 68-69 Viareggio accident, 298 Vibration environment, 139-140 ground-borne noise and, 128-130 velocity, 115 Vignole, 63 Virtual integration, 270 Visual intrusion, 175 Voicing local needs and opportunities, 47-48 Volume, variety, velocity, veracity and value (5Vs), 252 Volunteering, 46, 52–53, 56 Warming climate, 43 Wayfinding process, 24 Wear and fatigue, 142-143 WebTAG, 16, 197 Well-functioning intermodal station, 24 Wheel, 134–135 Wheel damping treatments, 124 Wheel-Rail Interface, 66 Whole-life impact assessment, 11 Wi-Fi, 248 Wider Economic Impacts (WEIs), 180 Williams–Shapps Plan, 278 Window insulation, noise barriers and, 128 Workplace, noise in, 113 World Wide Web, 240 Yiwu-London route, 241

Zero carbon transport system, 2