Index

A
AADT (Annual Average Daily Traffic), 253–257, 263
AASHO Road Test, 120–121, 123, 133
AASHTO:
  flexible pavement design procedure, 120–132
  geometric design guidelines, 57–58, 69, 71–72, 86
  recommended deceleration rate, 40–43
  rigid pavement design procedure, 133–142
Access point frequency adjustment:
  for multilane highways, 237
  for two-lane highways, 243–244
Actuated control, 273–276, 298, 315, 317
Aerodynamic resistance, 11–15, 19, 31, 37, 41, 51
Aggregates, see Pavement
Aggregation of decision-making units, 346
Air density, 13–14, 25, 51
All-red time, 272, 281, 296–297, 334
Analysis flow rate:
  for freeways, 222
  for multilane highways, 237
  for signalized intersections, 315, 320–321
  for two-lane highways, 244, 246, 247, 211244
Antilock braking systems, 32, 34–35
Arrivals:
  deterministic, 176, 182, 189–190
  exponential, 182, 189, 191
  Poisson, 176, 179, 180, 182, 189,
  random, 176, 189, 316–318
  time-varying, 189, 290
  uniform, 176, 181, 182, 189,306,315,318
Asphaltic cement, 117–118
Asphaltic concrete, 118, 129
Autonomous Vehicles 8, 10, 11, 198, 371
Available tractive effort, 12, 18–19, 21, 23–26, 51
Average length of queue, 189, 191, 193, 204
Average passenger car speed, 228
Average time waiting in queue, 189, 191, 193, 204
Average time waiting in system, 189, 191, 193, 204
Average travel speed (ATS):
  adjustment for the percentage of no-passing zones, 245–248, 250, 263
  defined, 242
  formula for, 246
B
Base conditions (for highway capacity computations):
  defined, 215
  for freeways, 218, 223, 228
  for multilane highways, 235
  for two-lane highways, 241
Base layer, 118–120, 129
Basic freeway segment:
  defined, 216
  analysis of, 216–231
Beam action, 132–133
Bottlenecks, analysis of, 195–196
Breakpoint, 217, 232
Braking:
  antilock systems, 35
  distance, 39, 42, 70
  efficiency, 3437, 41, 51
  force ratio, 32
  forces, 30–35
Bus passenger-car equivalency (PCE) factors,
  224–228, 246
C
California bearing ratio (CBR), 128, 138, 159
Capacity:
  defined, 173, 174, 211–215, 359–361
  for freeways, 216–218
  for multilane highways, 233–236
  for signalized intersections, 282, 315
  for two-lane highways, 241, 250
Central angle, 92, 94, 109
Centripetal force, 88–89, 109
Change interval, 272, 296
Circular curve, 90
Clearance interval, 272, 280, 296–297
Coefficient of:
  drag, 13–15, 30
  road adhesion, 19-20, 29–30, 32, 34–35, 39, 41, 51
  rolling resistance, 11–12, 15–17, 19, 30–31, 36, 51
  side friction, 88–89, 109
Compound curve, 90
Concrete modulus of rupture, 134, 159
Contraction joint, 119, 133, 150
Crest vertical curve:
  minimum length of, 70–73
  passing sight distance and design of, 82–84
  sight distance on, 70–71
  stopping sight distance and design of, 70–73
Critical flow ratio, 289–290, 292–293
Curve radius, 91, 93
Curves, see Horizontal curve or Vertical curve
Cycle length:
  defined, 272–273, 277
  minimum, 292-293
  optimal, 293
Deceleration:
  for stopping sight distance, 40, 69
  for yellow time calculation, 296
Degree of curve, 92
Delay:
  aggregation, 318, 320
  average, 301
  initial queue, 318
  maximum, 301
  random, 316–317
  total, 301
  uniform, 318
Demographic trends, 6
Density (of traffic):
  at capacity, 217, 232
  calculation of, 169–170
  defined, 166, 169
  relationship to flow, 173–174
  relationship to speed, 170–172
Departure channels, 182, 192
Departures:
  deterministic, 182, 189, 196
  exponential, 182, 189, 191, 192
  time-varying, 189, 306
  random, 176, 191
  uniform, 176, 189
Design hour volume, 255–256, 263
Design-lane axle loads, 142–143
Design speed, 69
Design traffic volumes, 253–254
Deterministic:
  arrivals, 146, 152, 159
  departures, 146, 152, 159
Dilemma zone, 296–297, 334
Directional design hour volume, 256
Directional distribution of traffic, 247, 256, 263
Drainage coefficient, 129, 134–135, 159
Drive axle slippage, 24, 51
Driver population adjustment, 244
Driver’s eye height, see Height of driver’s eye
Drivetrain efficiency, 24, 51
Dual-ring signal control, 276–278, 283, 290
Effective green time, 281–282, 294–295, 300, 334
Effective red time, 281–282, 300, 334
Engine-generated tractive effort, 21, 24, 30, 51
Equilibration, 343–345, 350
Equilibrium problem, 360
Equivalent single-axle load (ESAL), 122, 134
Exponential:
  arrivals, 182, 189
  departures, 189, 181
  distribution, 180–182, 182
External distance, 92
Fatalities, 5
First-in-first-out (FIFO), 182, 301
Flexible pavement:
  defined, 117–118
  design equation, 120–128
  structural-layer coefficients, 129
  see also Pavement
  see also Rigid pavement
Flow, of traffic:
  defined, 166–167
  relationship to density, 173–174
  relationship to speed, 174–175
  see also Analysis flow rate
Flow-density model, 173–174
Forecasting vehicle traffic, 341–345
Free-flow speed (FFS):
  defined, 171–172
  for freeways, 221
  for multilane highways, 235–236
  for two-lane highways, 243
Freeway, see Basic freeway segment
Fuel efficiency, 29–30
Fully actuated signal control, 273–274, 276
Gear reductions, 24
Grade:
  average, 224
  final, 60
  initial, 60
Grade adjustment (for two-lane highways), 244
Grade resistance, 11–12, 17
Gravity model, 376
Green time, 272, 275, 281
H
Harmonic mean of speed, 168
Headlight angle, 74–76
Headlight height, 74–76
Headway, 166–167
Heavy-vehicle adjustment factor, 222–228, 244–246
Height of driver’s eye, 58, 71, 76, 82, 85, 94, 109
Height of roadway object, 58, 71, 76, 82, 85, 94, 109
Highway:
capital investment, 6
fatalities, 5
performance functions, 360
safety, 4–5
see also Performance functions
(for travel time)
Horizontal curve:
alignment, 88
centripetal force on, 88, 89
combined with vertical curve, 96
degree of curve, 92
external distance, 92
length, 92–94
middle ordinate, 92, 94
\(PC\), 92
\(PI\), 92
\(PT\),
radius, 88–95
side frictional force on, 88
sight distance on, 83–84
stopping sight distance and design of, 94–95
superelevation on, 88–91
tangent length, 92
types of, 90
Hourly volume, 216

I
Infrastructure, 1, 3, 5–8
Intelligent transportation systems (ITS), 7
Interchange density adjustment (for freeways), 221–222
International Roughness Index (IRI), see Pavement
Interstate highway system, 6–7

J
Jam density, 171–172

K
\(K\)-factor, 256
\(K\)-value, 66, 73, 76, 84, 256

L
Lane groups, 270, 287–288
Lane width adjustment:
for freeways, 221
for multilane highways, 236
for two-lane highways, 243–244
Last-in-first-out (LIFO), 182
Lateral clearance adjustment:
for freeways, 221–221
for multilane highways, 236
Least squares regression, 347, 382–384
Length:
of horizontal curve, 88–90
of vertical curve, 59
Level-of-service:
defined, 211–214
for freeways, 228
for multilane highways, 237
for signalized intersections, 320–321
for two-lane highways, 250
Level terrain:
defined, 223
passenger-car equivalency (PCE) values for,
223–224, 245, 263
Linear performance function (for travel time), 359–360
Load transfer coefficient, 134–135
Logit model:
applications, 353–354
methodological approach, 352–353
LOS, see Level of service
Lost time, 280–281

M
Mass factor:
acceleration, 25
braking, 35, 41
Mathematical programming, 366–368
Maximum:
braking force, 30–31
flow rate, 173, 215, 216, 279
likelihood estimation, 350–354, 384–386
service flow rate, 216
tractive effort, 18–19, 24
Median type adjustment (for multilane highways), 235, 237
Middle ordinate, see Horizontal curve
Mode and destination choice, 352–354, 376
Modulus of:
estility, 132, 133, 138, 159
subgrade reaction, 134, 138, 159
Mountainous terrain, 96, 228, 245
Multilane highway:
    analysis of, 231–238
    defined, 231

N
Negative exponential distribution, 180
Nonlinear performance function, 359–360

O
Offsets, 64–65
Object height, see Height of roadway object
Optimal:
    brake force proportioning, 30–35
    traffic signal timing, 292, 314–315
Overall standard deviation, 122, 123, 128, 134, 159

P
Passenger-car equivalency (PCE) factors:
    buses, 223–224, 228, 245, 263
    recreational vehicles, 223, 245–246, 263
    trucks, 223, 245–246, 263
Passing sight distance:
    for crest vertical curve, 70–71
    for horizontal curve, 94
Pavement:
    aggregates, 118–119
    cracking 119–121, 123, 133, 149, 151
    failure, 118, 120, 121, 133, 134, 150, 151
    faulting, 133, 150, 151
    friction number, 148–149
    International roughness index (IRI), 147–149
    mechanistic-empirical pavement design
        performance, 120, 147
    punchouts, 150
    reliability, 122, 128, 134
    rut depth, 147, 149
    serviceability, 121–123, 133, 134
    see also Flexible pavement
    see also Rigid pavement
Peak-hour factor, 222–223, 245, 263
Pedestrian green/crossing time, 298
Percent time spent following (PTSF):
    adjustment for the combined effect of the
        directional distribution of traffic and the
        percentage of no-passing zones, 246–249
    defined, 242
    formula for, 247
Perception/reaction time:
    for stopping sight distance, 42–43, 68–69
    for yellow time calculation, 296
Performance functions (for travel time), 360–361,
    366, 372–373
Permitted movement, 273
Plan view, 58–59
Point of curve (PC), 92
Point of intersection (PI), 92
Point of tangent (PT), 92
Point of vertical curve (PVC), 60
Point of vertical intersection (PVI), 60
Point of vertical tangent (PVT), 60
Poisson:
    arrivals, 176, 179–182, 189, 317
    distribution, 176, 179–182, 189, 317
    models, 351, 385–386
    regression, 351, 386–386
Portland cement concrete (PCC), 119, 132, 133–135
Present serviceability index (PSI), 121–123, 128,
    134, 147
Pretimed signal control, 273–274, 317
Private vehicles, 4
Probabilistic choice model, 353
Profile view, 58–59
Progression quality, 307–308, 311
Protected movement, 272

Q
Queuing:
    arrival pattern, 181–182
    departure channels, 182, 192–193
    departure/service pattern, 182
Queuing models:
    D/D/1, 182
    M/D/l, 189
    M/M/l, 191
    M/M/N, 192–193

R
Radius (of horizontal curve), 88–93
Random:
    arrivals, 176, 189, 316–317
    departures, 176, 191
Recreational vehicle passenger-car equivalency
    (PCE) factors, 223–224, 228, 245, 263
Red time, 272, 281–282
Reliability, see Pavement
Resistance:
    aerodynamic, 11–15, 19, 29–31, 37, 41
    grade, 11–12, 17
    rolling, 11–12, 15–16
Reverse curve, 90
Rigid pavement:
    beam action, 133
    contraction joint, 119, 133
    defined, 119
deflections, 119, 133
design equation, 133
stresses, 119, 133
see also Pavement
see also Flexible pavement
Rolling resistance, 11–12, 15–16
Rolling terrain, defined, 224
passenger-car equivalency (PCE) values for, 223–224, 228, 245, 263
Route choice, 343, 345, 359–361, 367, 368, 373, 376, 377

S
Sag vertical curve:
  minimum length of, 75
  sight distance on, 75
  stopping sight distance and design of, 75–82
  underpass sight distance and design of, 85–87
Saturation flow rate:
  adjusted, 280
  base, 279
  defined, 279
  maximum, 279
Segmentation of trips by type, 347
Semi-actuated signal control, 273
Serviceability, see Pavement
Service flow rate, 218–219
Service measure:
  defined, 216
  for freeways, 218, 228
  for multilane highways, 235, 237
  for signalized intersections, 269, 274
  for two-lane highways, 242, 246
Shoulder width adjustment (for two-lane highways), 244
Side frictional force, 88
Sight distance, see Crest vertical curve, Horizontal curve, or Sag vertical curve
Signal coordination, 269, 307–315
Signalized intersection analysis:
  average delay, 301, 318
  $D/D/1$ queuing, 300–306
  filtering/metering adjustment, 317
  lane groups, 287–288
  random delay, 316–317
  signal controller mode delay adjustment, 318
  total delay, 301
  uniform delay, 318
Signalized intersection control:
  dual-ring signal control, 276–278
  permitted movement, 273
  phasing, 272
  pretimed, 273
  protected movement, 272
  semi-actuated, 273
Signalized intersection timing:
  all-red time, 280, 281, 296–297
  cycle length, see Cycle length
  effective green time, 281–282
  effective red time, 281–282
  extended green, 275
  gap-out, 275
  green time, 272, 275–276, 281, 294–295
  initial green time, 275
  lost time, 280–282, 289–290
  maximum green time, 274–275
  minimum cycle length, 292–293
  minimum green time, 275, 296
  max-out, 275
  optimal cycle length, 293
  optimal signal timing, 314–315
  pedestrian green/crossing time, 298–299
  red time, 272, 281–282
  yellow time, 272, 281, 296
Single-unit truck, see Truck passenger-car equivalency (PCE) factors
Soil-bearing capacity, 117
Soil resilient modulus, 122, 128, 159
Space-mean speed, 137–138, 140 167–168 170, 172, 174, 204
Spacing, see Vehicle
Speed:
  at capacity, 173–174
  average passenger car, 217, 219, 228, 232, 233
  design, 68
  free flow, see Free-flow speed (FFS)
  harmonic mean, 168
  relationship to density, 171–172
  relationship to flow, 174
  space-mean, 167–168, 172
  time-mean, 167
Speed-density model, 171–172
Speed-flow model, 174
Spiral curve, 90
Split phasing, defined, 283
Stationing (for highways), 58–59
Stopping distance:
  practical, 39–40
  theoretical, 37–38
Stopping sight distance:
  defined, 69
  for crest vertical curves, see Crest vertical curve
for horizontal curves, see Horizontal curve
for sag vertical curves, see Sag vertical curve
Structural-layer coefficients, 128–129
Structural number, 121–123, 128, 133, 134
Subbase, 119–120, 128–129
Subgrade, 118–120, 128
Superelevation, 89–90
System optimal route choice, 367–368

T
TAZ, see Traffic analysis zone
Tangent length, 92
Temporal:
  aggregation, 347
  decisions, 343–344
  distribution of traffic, 212, 216, 254–256
Terminal serviceability index (TSI), 121, 23, 134
Terrain, see Level terrain, Rolling terrain,
  Mountainous terrain
Time-mean speed, 167, 204
Timing stage, 272, 283, 289, 290
Torque, 21–24
Tractive effort:
  available, 12, 18–19, 25
  defined, 11
  engine-generated, 21–24
  maximum, 18–19, 24
Tractor-trailer truck, see Truck passenger-car equivalency (PCE) factors
Traffic:
  analysis zone (TAZ), 373–374
  control, see Signalized intersection control
density, see Density
design volumes, 253–256
equilibrium, 359–361
flow, see Flow
forecasting, 343–345
forecasting methodology in practice, 372–376
intensity, 189, 192, 193, 289, 316
speed, see Speed
volume, see Volume
Travel time:
  free-flow, 359–360
  route, 359-361
Traveler decisions, 343–345
Trip generation, 346–347, 294–295, 318
Trip-generation models:
  linear, 347
  Poisson, 350–351
Truck passenger-car equivalency (PCE) factors, 223–224, 228, 245, 263
Two-lane highway:
  defined, 241
  analysis of, 241–250
U
Underpass sight distance, 85–86
Uniform:
  arrivals, 176, 182, 189, 300, 304, 306
departures, 182, 189, 300
User equilibrium route choice:
  mathematical program, 366–367
  theory of, 361–362
Utility:
  function, 352–353
  maximization, 352
V
Vehicle:
  acceleration, 11–12, 25–26, 29
  arrival rate, 179, 182
  braking, see Braking
cornering, 88
deceleration, see Deceleration
departure/service rate, 182
detection, 273–275
drag coefficient, 13–14, 30
frontal area, 13
fuel efficiency, 29–30
headway, 166–167
occupancy, 4
power, 12–13, 22
spacing, 169–170
technologies, 5, 8
torque, 22–23
tractive effort, see Tractive effort
Vertical curve:
  alignment, 59–60
  combined with horizontal curve, 85
elevation (parabolic) formula, 60–61
  high point, formula for, 66
  low point, formula for, 66
  measurement of length on, 58–60
  offsets, 65–66
  PVC, 60
  PVI, 60
  PVT, 60
  rate of change of slope, 60–61
see also Crest vertical curve, Sag vertical curve
Volume:
  design hour, 255
  directional design hour, 256
  highest annual hourly, 254–256
  peak hour, 212, 216, 222
Volume/capacity ratio, 216, 232, 292–293

W
Wardrop’s rule, 361
Warrants (for signal installation), 269
Webster’s optimal cycle length formula, see Cycle length

Y
Yellow time, 272, 281, 296
Young’s modulus, 138

Z
z-statistic, 122, 134