**INDEX**

**A**
- Accessibility regulations, 286
- Accessible facilities, International Building Code, 286–290
dwelling and sleeping units, 289–290
elevators, 287–288
means of egress, 288–289, 292
parking, 340–341
toilet facilities, 202
wheelchair spaces in assembly seating, 296
- Accessible (barrier-free) facilities, National Building Code of Canada, 290–292
elevators, 291
means of egress, 292
parking, 341
toilet facilities, 204
wheelchair spaces in assembly seating, 296
- Access lanes, parking, 347, 357
- Accessory occupancies, International Building Code, 375
- Active dampers, structural, 53
- ADA, see Accessibility regulations
- Adjacent spaces, exiting through, 270
- Air conditioning systems, see Heating and cooling systems
- Air handling equipment, sizing spaces for, 218–219
- Air and water heating and cooling systems, large building, 164, 178–179
- Aisles:
  - accessible parking, 340–341
  - assembly space, 293–295
  - means of egress, 269
  - parking, 345–346
- All-air heating and cooling systems, large building, 164, 174–177
- All-water heating and cooling systems, large building, 164, 180–183
- Ambient space illumination, and daylighting, 182
- Americans with Disabilities Act, see Accessibility regulations
- Angled parking, 345–347
- Architectural sitecast concrete, 109
- Area of refuge, see Refuge area
- Assembly space:
  - egress, 293–295
  - wheelchair seating requirements, 296
- Atriums, 379
  - and daylighting, 147
- Automated parking, 337
  - and egress ways, 270, 277, 297, 304
- Barrier-free facilities, see Accessible facilities
- Base isolation, structural, 52
- Boilers:
  - large building, 186
  - small building, hydronic, 182, 250–251
  - small building, multifuel, 251
- Boiler rooms, 186
  - and vertical distribution shafts, 196
  - sizing, 218–217
- Braced core structures, 50
- Braced frames, 39–41
  - column and beam system, 44
  - column and slab system, 46
tall building, 50–51
  - precast concrete, 127, 128
  - wall and slab system, 42
- Brick Masonry, see Masonry structural systems
- Building codes, see Codes, building
- Building core, see Core, building
- Building massing, see Massing, building
- Building Services, see Services, building
- Cast-in-place concrete, see Concrete, sitecast
- CAV, see Constant air volume
- Ceilings, suspended, and horizontal distribution of services in large buildings, 212–215
- Ceiling height:
  - and daylighting, 148, 156–157
  - and distribution of services for large buildings, 212–215
- Central vs. local heating and cooling systems:
  - large building, 163
  - small building, 246
- Chilled beams, 178–179
- Chilled water plant, 187, 196
  - sizing, 218–217
- Chimney, 186, 198, 204, 243, 244, 246, 249, 251, 259. See also Solar chimney, Reverse chimney
- Codes, building, 5
  - accessibility, see Accessibility regulations, Accessible facilities
- Construction Types, 23, 376, 377, 382–390
- emergency bedroom and basement egress, 297, 298
- firefighter access, 297, 298
- height and area limitations of buildings, 5, 372–373
- height and area tables, International Building Code, 382–447
- height and area tables, National Building Code of Canada, 448–477
- high building requirements, 297, 298, 382
- mixed-occupancy buildings, 374–377
-occupancies, International Building Code, 6–12
-occupancies, National Building Code of Canada, 13–17
- residential one- and two-family and townhouse requirements, International Building Code, 436
- and structural system selection, 23
tall building requirements, 297, 298, 382
- small building requirements, National Building Code of Canada, 298
toilet fixture requirements, 202–205
underground building requirements, 297–298
zoning ordinances and land use regulations, 5
- Column and beam structural systems, 44–45
- Column locations, parking facilities, 35, 360, 362, 364, 366
- Column and slab structural systems, 46–47
- Combustible Construction, see Construction Types
- Common path of egress travel, International Building Code, 272
- Communications systems and closets, see Telecommunications rooms and closets
- Compact car parking stalls, 357
- Concrete, precast, 127
  - beams and girders, 132–133
  - columns, 129–130
  - parking structures, 354
  - single and double tees, 136–137
  - slabs, 134–135
  - wall panels, 130–131
INDEX

Concrete, sitecast, 109
architectural, 109
beams and girders, 114–115
columns, 110–111, 120, 121, 122, 123, 125
joist bands, 114, 118, 119
one-way joists, 118–119
one-way solid slab, 116–117
parking structures, 394
slab bands, 114, 116, 117
two-way flat plate, 120–121
two-way flat slab, 122–123
two-way joists, 124–125
waffle slab, 124–125
walls, 112–113
Concrete masonry, see Masonry structural systems
Concrete structural systems, 109, 127
tall building, 52
and masonry structures, 81
Constant air volume (CAV) heating and cooling systems, 176–177
packaged equipment, 192
Construction Types, 382–390
3½-Hour Noncombustible, 387
1-Hour Combustible, 390
1-Hour Noncombustible, 387
2-Hour Noncombustible, 386–387
3-Hour Noncombustible, 386
Heavy Timber, 388–390
Light Wood Frame, 390
Mill, 388–389
Ordinary, 388
and structural system selection, 23
Unprotected Combustible, 390
Unprotected Noncombustible, 388
Control rooms, large building, 195
Convector heating systems:
electric baseboard, 285
hydronic, 182, 250–251
cooling towers, 187, 197, 216, 217
Core, building, 196–198
component checklist, 212
in tall building structures, 48, 50–51
and lateral stability in building structures, 39
Corridors, 269, 273. See also Exit access accessible or barrier-free, 286, 287, 291
dead end, 273–274
International Building Code, 306–307
National Building Code of Canada, 312–313
and distance between exits, 271
sizing, 303–304
International Building Code, 306–309
National Building Code of Canada, 312–315
small building, National Building Code of Canada, 298
and travel distance, 272
Damping mechanisms, structural, 52–53
Daylighting design, 142
building interior configuration, 148
building siting and shape, 146–147
and design development, 147
and energy conservation, 149
illuminance levels, recommended, 152
path of the sun, 144
sidelighting, 147, 153–155
sizing systems, 154–157
sky cover, 143
sky dome obstruction, 145
and solar heating, 149
toplighting, 147, 156–157
Dead end corridors, 273–274
Dedicated outdoor air system, 165
and active chilled beams, 178
and fan coil terminals, 180
and hydronic radiant heating and cooling, 183
Diagrid structures, 51
Diffusers for heating and cooling systems, 211, 214, 215
Direct exit, 279
Direct vent space heaters, 258
Distance between exits, 271
DOAS, see Dedicated outdoor air system
Doors, means of egress, 275
accessible, 287, 291
exit stairway, 279–280
revolving, 275
sizing, 303–304
International Building Code, 306–309
National Building Code of Canada, 311–315
Double-threaded helix parking structures, 349–350
sizing, 362–363
Drinking fountains, 202, 203, 204
Ductless split package units, 184
Ductwork. See also risers, ducts:
active chilled beams system, 178–179
and central heating and cooling systems, 163–164, 246
constant air volume system, 176–177
and daylighting, 148
fan-coil terminal system, 180
and fan rooms, 191
horizontal distribution, 211–214
sizing, 218–219
and packaged central heating and cooling equipment, 192–193
small building active solar system, 252
small building forced air system, 247–249
small building packaged evaporative cooler, 253
variable air volume system, 174–175
vertical distribution, 196–198
E
Earthquake design, see Lateral stability, structural
Egress, see Means of egress
Ejector pit, see Sewage ejector pit
Electrical closets, 188, 189, 196
sizing, 199
Electrical systems:
distribution rooms and closets, see electrical closets
emergency and standby power, 190
horizontal distribution, 212–215
risers, see risers, electrical
small building, 263
switchgear, 189
transformers and transformer vaults, 188–189
uninterruptable power, 190
Electric baseboard convectors, 255
Electric fan-forced unit heaters, 256
Electric heating, see Heating, electric
Elevators, 207–209
accessible or barrier-free, 287–288, 291
electric traction, 209
firefighter service, 297, 299
hydraulic, 208
machine room-less, 208–209
machine rooms, 208–209
means of egress, 282, 297
number required, 207
occupant evacuation, 297
parking facility, 352
pits, 209
sizing, 207
Elevator lobbies, 207
area of refuge, 289
fire service elevator, 297
and underground building smoke compartments, 298
Emergency electrical power, 190
Emergency escape doors and windows, 297, 298
Enclosed parking structures, 337
ventilation, 281
Energy conservation:
and daylighting, 149
and passive heating and cooling design, 223–224
selection of large building heating and cooling systems, 163, 164, 165, 168, 172–173
selection of small building heating and cooling systems, 242, 244–245
Energy recovery in heating and cooling systems, 165, 175, 177, 178
Equipment spaces for large buildings, 186–195
Escalators, 209
and means of egress, 284
Evaporative cooling:
packaged, 283
passive, 237–238
INDEX

Exhaust fans, 190, 196
and fan-coil terminal systems, 180
Exits, 269, 277–284. See also means of egress
assembly occupancy, 293
balancing the capacity of, 277, 297, 304
distance between, 271
direct, 279
emergency egress doors and windows, 297, 298
exterior, 282
high-rise building, 297
horizontal, 283–284
number required:
International Building Code, 277
National Building Code of Canada, 278
passageways, 284
stairways, see Exit stairways
width, 303–304:
International Building Code, 306–309
National Building Code of Canada, 312–315
Exit access, 269, 270–276. See also means of egress
assembly occupancy, 293–295
balancing the capacity of, 270, 304
common path of egress travel, 272, 306
corridors, 273
dead end corridors, 273–274
International Building Code, 306–307
National Building Code of Canada, 312–313
distance between, 271–272
doors, 275
exterior, 276
number required, 270
International Building Code, 306
National Building Code of Canada, 312
open stairways and ramps, 274
through adjacent spaces, 270
tunnel distance, 271–272
International Building Code, 305–306
National Building Code of Canada, 312
width, 303–304
International Building Code, 305–309
National Building Code of Canada, 311–315
Exit discharge, 269, 285. See also means of egress
Lobbies and vestibules, 285
Exit passageways, 284
Exit stairways, 279–281, 318
accessible, 288–289
and areas of refuge, 288–289
circular stairs, 319
curved stairs, 319
design tables, see Exit stairway design tables
enclosure requirements, 280–281
exterior, 282
fire escapes, 282
in high-rise buildings, 297
open, see exit access, open stairways and ramps
proportioning, 318
smokeproof, 281
spiral stairs, 320
width, 303–304
National Building Code of Canada, 312–313, 315
winding stairs, 319
Exit stairway design tables, 321
1-flight stair, 322–323
2-flight stair, 324–325
3-flight stair, 326–327
4-flight stair, 328–329
donut stair, 330–331
Exposed vs. concealed building services, 215
Exterior exit, 282
Exterior exit access, 276
Exterior exit stairs, 282
Exterior wall fire-resistance requirements, 381
F
Fans, exhaust, see Exhaust fans
Fan-coil terminals, 180
Fan-forced unit heaters, electric, 256
Fan rooms, 190–192, 200
and the building core, 196, 198
sizing, 218–219
Fire areas and fire compartments, 380
Fire escapes, 282
Fire hose cabinets, 206
Fire extinguishers, 206
Firefighter access:
International Building Code, 297
National Building Code of Canada, 298
Fire separation distance, International Building Code, 381
Fire sprinklers:
in building code height and area tables, 372
International Building Code, 392
National Building Code of Canada, 448
other building code requirements:
380
in fire areas and compartments, 380
in floor openings, atriums, and interconnected floor spaces: 379
and means of egress, see Fire sprinklers and means of egress piping, within ceiling-floor assembly, 211
pumps, 195
residential class (NFPA 13R), 206
in height and area tables, 422–423, 432–439
siamese connection, 206
small building, 262
standpipes, 206
Fire sprinklers and means of egress: accessible egress:
International Building Code, 288, 298
National Building Code of Canada, 292
assembly area egress travel, 298
corridors, 273
dimensional requirements of egress system components:
International Building Code, 306–307
National Building Code of Canada, 312–313
distance between exits, 271
emergency escape doors and windows, National Building Code of Canada, 298
lobbies and vestibules, 288
open stairways and ramps, International Building Code, 274
single exit buildings and floors, 277–278
smokeproof enclosures, 281
Fire walls, 381
Floor to floor height in large buildings: and choice of heating and cooling systems, 172–173, 178
and choice of structural system, 24, 28–29, 46
and fan room location, 191
and horizontal distribution of services, 211–214
Floor openings, code requirements, 379
Forced air heating and cooling, small buildings, 247–249. See also, Air-water and all-air heating and cooling systems, large building
Fuels for heating and cooling systems: large building, 163–164
small building, 246
Furnace:
large building constant air volume heating system, 176
small building forced air heating and cooling, 247–249
small building multifuel, 249
small building wall, 258
G
Gas service, large buildings, 163
Gas service, small buildings, 246
Geothermal exchange, for heating and cooling systems, 179, 183
Grilles, for heating and cooling systems, 215
Ground source heat pump, for heating and cooling systems, see Geothermal exchange
INDEX

and vertical load resisting systems, 42–47
Means of egress, 269
acceptable or barrier-free, 288–289, 292
assembled space, 293–295
balancing the capacity of, 270, 277, 297, 304
distance between exits, 271
elevator, occupant evacuation, 297
emergency egress doors and windows, 297, 298
exits, 277–284
exit access, 270–276
exit discharge, 285
exit stairways, 279–281, 318–331
high-rise or tall building, 297, 298–299
small building, National Building Code of Canada, 298
and sprinkler requirements, see Sprinkler systems and means of egress requirements, width, 293–294
National Building Code of Canada, 312–313, 315
Means of egress, single
exit access, 270
International Building Code, 306
from a floor or building, 277
and mezzanines, 274
and open stairways, 274
from a room or space (common path of egress travel), 272
National Building Code of Canada, 312
from a floor or building, 278
and mezzanines, 378
from a room or space, 272
Residential Occupancy, 270
Mechanical systems, large building, see Heating and cooling systems, large building
Mechanical systems, small building, see Heating and cooling systems, small building
Mechanics, 378
Mill Construction, 81
building code Construction Type, 383, 388–390
Mixed-occupancy buildings, building code requirements, 374–377
design with structured parking, 353
Mixed-use buildings, see mixed-occupancy buildings
Model building codes, 5
Multi-bay parking structures, 350
sizing, 366–367
Multifuel boiler, see Boilers, small building, multifuel
Multifuel furnace, see Furnace, Small building multifuel
Mixed-occupancy buildings, 374–377
N
National Building Code of Canada, 5. See also Codes, building
Natural illumination, see Daylighting design
Natural ventilation cooling, 231–233
NBCC, see National Building Code of Canada
90-degree parking, 346
Noncombustible Construction, see Construction Types
O
Occupancy classifications, building code, 5
height and area table indexes, 372–373
International Building Code, 6–12
National Building Code of Canada, 13–17
Occupant load, and means of egress width, 303–304
International Building Code, 305–309
National Building Code of Canada, 311–319
Occupant load, and plumbing fixture requirements, 202
International Building Code, 202–203
National Building Code of Canada, 204–208
One-way parking facility traffic flow, 346–346
with double-threaded helix circulation, 349, 363
with multi-bay parking, 367
with surface parking, 359
Open exit access stairs, International Building Code, 274. See also unenclosed egress stairways, National Building Code of Canada and travel distance, 272
Open parking structures, 337. See also Parking
exit stairways, 274
structural system selection, 354
ventilation, 351
Operations and maintenance rooms, large building, 195
Ordinary Construction, 81
building code Construction Type, 383, 388s
Overhangs, exterior, and daylighting, 149, 153
and passive heating and cooling design, 224, 228
P
Packaged central heating and cooling equipment, 192–194, 249
sizing, 216–217
Packaged evaporative cooler, 237, 253
Packaged terminal heating and cooling units, 194, 254
Parking:
acceptable or barrier-free, 340–341
capacity, 338
circulation basics, 345–346
enclosed, 337, 351
facility types, 337
and land use, 337, 338, 347–348
levels of service, 339–339
mixed-occupancy buildings, special code exceptions:
International Building Code, 376
National Building Code of Canada, 377
open, 337, 347, 354
pedestrian circulation, within structured facilities, 351–352
sizing of facilities, 357–367
stall sizes, 357
structural systems, 353–354
structured parking design, 349–352
structured parking height and area limits:
International Building Code, 442–445
National Building Code of Canada, 474–477
surface parking design, 347–348
sustainability, 337, 346–347
ventilation, 337, 351
Passive heating and cooling, see Heating and cooling systems, passive
Path of the sun, 144, 230
Pervious paving, parking, 347, 348
Pipe risers, see risers, pipe
Platform Frame Construction, 57, 58–65
building code Construction Type, 383, 390
Plumbing systems, small building, 260–262
Plumbing walls:
large building, 196, 201
small building, 260–261
Posttensioning, sitecast concrete, 109
beams and girders, 115
one-way joists, 119
one-way solid slab, 117
two-way flat plate, 121
two-way flat slab, 123
waffle slab, 125
Precast concrete, see Concrete, precast
R
Radiant heating, electric, 257
Radiant heating, hydronic, 183, 250–251
Raised access floor, 212, 213. See also underfloor air distribution.
Ramps, 318
acceptable or barrier-free:
International Building Code, 287, 288, 289
National Building Code of Canada, 291, 292
part of egress, 269, 274
track distance, International Building Code, 272
width, per occupant load:
International Building Code, 308
INDEX

National Building Code of Canada, 314
parking, see Ramps, parking proportioning, 318
Ramps, parking, 357
accessible, 340, 341
double-threaded helix, 349
express ramps, in multi-bay facilities, 350
single-threaded helix, 349
speed ramps, in split level facilities, 349
References, bibliographic, 487–488
Reflecting surfaces, and daylighting:
References, bibliographic, 487–488

Ramps, parking, 357
accessible, 340, 341
double-threaded helix, 349
express ramps, in multi-bay facilities, 350
single-threaded helix, 349
speed ramps, in split level facilities, 349

Services, building:
exposed in small buildings, 263
large building horizontal distribution, 211–215
large building vertical distribution, 196–210
small building, 240, 246, 260–263
Sewage disposal:
large building, 194, 196
small building, 261
Sewage ejector pit, 194
Shafts, 196–198, 210
elevator, 207, 208, 209
fire-resistance rating requirements, 382–385
Shear walls, 39–41
column and beam system, 44
column and slab system, 46, 47
heavy timber, 57
light wood frame construction, 57
precast concrete structural system, 127
tall building, 50, 51, 52
sitecast concrete, 112
wall and slab system, 42
Siamese connection, 208
Sidelighting, daylighting, 147, 153–155
sizing, 154–155
and solar heating, 149
and toplighting combined, 156
Sills, reflective, daylighting, 154
Single means of egress, see Means of egress, single
Single-threaded helix parking structures, 349, 350
sizing, 360–361
Sitecast concrete, see Concrete, sitecast
Sky cover, and daylighting, 143
Sky dome obstruction, and daylighting, 145
Skylights, 147, 256–257
Slenderness, of tall buildings, see Tall buildings, slenderness
Small car parking stalls, 357
Smoke control:
International Building Code:
accessible egress refuge areas, 288–289
Assemble Occupancy, 293
atrium, 379
high-rise buildings, 297
mixed-occupancy buildings, 374, 375
underground buildings, 298
floor opening, 379
horizontal exit refuge areas, 283
National Building Code of Canada:
accessible egress refuge areas, 292
high building smoke control, 299
interconnected floors space, 379
and shafts, 196
Solar chimney, 232
Solar heating:
active, 262

and daylighting, 159
passive, 228–230
Span ranges for structural systems, 31
Split level parking structures, 349
sizing, 364–365
Sprinkler systems, see Fire sprinklers
Stairways, see Exit stairways
Standby electrical power, 190
Standpipes, 206
Steel structural systems, see Lightweight steel systems, Structural steel systems
Stormwater retention, surface parking, 347–348
Stoves, heating, 259
Structural systems:
basic configurations, 42–47
building code selection criteria, 23
daylighting considerations, 148
design criteria, 24–29
lateral stability, 39–41
live load ranges, 32–33
masonry, 81
parking facility, 383–384
practical span ranges, 31
precast concrete, 127
sitecast concrete, 109
steel, 93
tall building, 48–53
typical choices for various building types, 34–35
wood, 87
Structural steel systems, 93
beams and girders, 104–105
columns, 98–99
decking, floor and roof, 100–101
hollow tube steel columns, 102–103
Noncombustible Construction Types, 386–388
open-web joists, 106
parking structures, 354
selecting stabilizing elements, 41
single-story rigid frames, 107
tall building, 82
trusses, 108
Structured parking, see Parking
Sun, path of, 146, 230
Surface parking, see Parking
Suspended ceilings, see Ceilings, suspended
Sustainability:
daylight design, 142, 149
selection of heating and cooling systems for large buildings, 168, 172–173
selection of heating and cooling systems for small buildings, 241, 244–245
and parking land consumption, 337
passive heating and cooling design, 223–224
and surface parking design, 347–348
Switchgear, electrical, 189

S
Services, building:
exposed in large buildings, 215
INDEX

T
Tall buildings:
  building code requirements, 297, 298, 382
  height limits, practical 51
  service cores, 196–198, 210
  slenderness, 51
  structural systems, 48–53
  wood, 57, 388
Task illumination, and daylighting, 152
Telecommunications rooms and closets:
  large building, 194, 196, 199
  small building, 263
Thermal mass cooling, 234–236
Through-the-wall heating and cooling units, 184, 254
Timber, see Wood structural systems
Toilet facilities:
  and building core, 196, 198
  National Building Code of Canada:
    accessible, 204
    minimum fixture counts, 204, 205
  large building, 201
  small building, 261
Toplighting, daylighting, 156–157
  and building shape, 147
Transformers and vaults, electrical, 188–189
Travel distance, means of egress, 271–272. See also exit access, travel distance
Tube structures, 51
Tuned mass dampers, structural, 53
Two-way traffic flow, parking facility, 345–346
  with single-threaded helix circulation, 349
  with split level circulation, 349
  with surface parking, 347
U
UFAD, see underfloor air distribution
Underfloor air distribution (UFAD), 175, 177, 213
Unenclosed egress stairways, National Building Code of Canada, 274.
  See also open exit access stairs, International Building Code
Uninterruptable power supply (UPS), 190
  Units of conversion, 485
  UPS, see Uninterruptable power supply
V
Variable air volume (VAV) heating and cooling systems, 174–175
Variable refrigerant flow (VRF) split package units, 194
VAV, see variable air volume heating and cooling systems
Ventilation, parking facility, 337, 351
Vertical clearance, parking facilities, 357
Vertical distribution of services, large building, 196–210
Vestibules, exiting discharge, 285
Viscous dampers, exiting discharge, 285
VRG, see variable refrigerant flow split package units
W
Wall furnaces, 258
Wall and slab structural systems, 42–43
Waste compactors, 194
Waste piping, small building, 260–261
  Water pumps:
    large building, 195
  small building, 260
Water quality, and surface parking, 347–348
Water supply, small building, 260
Wheelchair access, see Accessible facilities
Windows, for emergency escape, 297, 298
Window height and area, and daylighting, 148, 153–155
Wood structural systems, 57
  beams, 70–71
  columns, 66–67
  cross-laminated timber, 74–75
  decking, 68–69
  floor joists, 60–61
  glue laminated arches, 78–79
  glue laminated beams, 72–73
  Heavy Timber Construction, 57, 81, 383, 388–390
  mass timber, 57
  Light Wood Frame Construction, 57, 383, 390
  Mill Construction, 57, 81, 383, 388–390
  Ordinary Construction, 57, 81, 383, 388
  Platform Frame Construction, 57, 383, 390
  roof rafters, 62–63
  stud walls, 58–59
  tall wood structures, 57, 388
  trusses—heavy, 76–77
  trusses—light, 64–65
Workrooms, operations and maintenance, large building, 195
Z
Zoning large building heating and cooling systems, 163
Zoning ordinances, 5