

---

# INDEX

---

- Abutment, 291
- ACI (American Concrete Institute),  
2, 8  
Code, 2
- Accuracy of computations, 5
- Admixture, 18
- Aggregates, concrete, 15, 16
- Air-entraining cement, 18
- Anchorage, 142
- Approximate analysis of structures, 78  
design factors for concrete beams,  
157, 376
- Approximate design of tied concrete  
columns, 195
- Areas of:  
slab reinforcement, 119  
steel reinforcing bars, 25
- ASCE (American Society of Civil  
Engineers), 2  
ASCE 2002, 2
- Balanced reinforcement, strength  
design, 91
- Balanced section, 91
- Bars, reinforcing, *see* Reinforcement
- Basement wall, 226
- Beams:  
analysis of, 63, 88  
balanced section, 91  
bending in, 64  
cantilever, 67  
concentrated load, 67, 69  
concrete, 88  
continuous, 69

- Beams (*Continued*)
- deflection, 122
  - depth, 122, 165
  - diagrams, typical loadings, 67, 69
  - doubly-reinforced, 102, 110
  - effective depth of concrete beam, 90
  - fixed-end, 66
  - indeterminate, 69, 78, 155
  - internal resisting moment, 88
  - investigation of, 63, 69, 90, 155
  - joists, 167
  - moment capacity, 89
  - moment diagram, 67
  - moment in, 67
  - multiple span, 68
  - neutral axis, 89
  - reactions, 67
  - rectangular stress block, 90
  - resisting moment in, 88
  - restrained, 66
  - shape of, 163
  - shear diagram, 67
  - shear in, 104, 126
  - simple, 66
  - statically indeterminate, 69, 78, 155
  - strength design of, 90
  - stresses in, 89
  - T-beam, 102, 104
  - tabular data for, 67
  - types of, 66
  - under-reinforced, 93
  - width, concrete, 96, 164
  - with compression reinforcement, 102, 110
- Bearing:
- on concrete wall, 223
  - on pedestal, 265
  - wall, 184, 223
- Bending:
- action in beams, 88
  - in concrete beams, 88
  - of reinforcement, 58, 146
  - resistance, 88
- Bending moment, in beam, 88
- diagrams, 67
- Bent, column and beam, 80, 211, 388
- Bond stress, 142
- Bracing of framed structures, 214
- Building code requirements, 301
- Building construction, choice of, 296
- Caissons, 273
- Cantilever:
- beam, 66
  - retaining wall, 281, 323
  - rigid frame, 72
- Captive column, 220
- Cast-in-place concrete, 11
- Cement, 15
- Choice of building construction, 296
- CMU (concrete masonry unit), 48, 207, 231, 348, 353, 368
- Cold joint, 51
- Columns:
- combined axial load and moment, 187
  - design of, 194
  - eccentrically loaded, 195
  - footing for, 249, 257
  - general requirements, 186
  - interaction, axial load plus moment, 187
  - investigation, 63
  - multistory, 151, 192, 383
  - P-delta effect, 79, 188
  - pedestal for, 259
  - rectangular, 198
  - reinforced concrete, 182
  - round, concrete, 184, 202
  - shape, 189
  - slenderness, 204
  - spiral, concrete, 184
  - tied, concrete, 184, 195
- Combined axial force and moment, 187

- Composite construction, 176
- Compression:
  - in columns, 180
  - reinforcement in concrete beams, 110
- Compression elements, 206
  - columns, 180
  - combined compression and bending, 187
  - confined material, 182
  - containment of, 182
  - cracked section, 188
  - interaction, 187
  - P-delta effect, 79, 188
  - vertical, 206
- Computations, 5
- Concrete:
  - finishing, 36
  - forms for, 11, 35
  - heavyweight, 31
  - insulating, 32
  - lightweight, 31
  - masonry, 48, 207
  - mix, 30
  - precast, 11, 42
  - prestressed, 2, 26
  - superstrength, 32
  - weight, 17
- Construction joint, 51
- Containment, 182
- Continuous action of:
  - beams, 69, 374
  - slabs, 156, 374
- Conversion factors for units, 5
- Core bracing, 366
- Cost of construction, 313
- Cover, of reinforcement, 24
- Cracked section, 188
- Cracks, 55
- Creep, 20
- CRSI (Concrete Reinforcing Steel Institute), 9, 99
- Cutting, of site, 235
- Dead load, of building construction, 298
- Deep foundations, 270
  - caisson, 273
  - pier, 273
  - pile, 272
- Deflection, of concrete beams and slabs, 122
- Design methods, 62, 86
  - strength, 62, 86
- Development:
  - in columns, 151
  - length for reinforcement, 142, 150
  - of resisting moment, concrete beam, 88
- Diaphragm, horizontal, 360, 337
- Doubly reinforced beams, 102, 110
- Dowels, in footings, 151, 250
- Drift, 308
- Dual bracing, 217
- Ductility, 23
- Earthquake, also *see* Seismic, 309
- Eccentric load:
  - on column, 195
  - on footing, 285
- Economics of building construction, 313
- Effective:
  - width of column in bearing wall, 223
  - width of concrete T-beam flange, 104
- Elastic stress-strain response, 88
- Equivalent eccentric load, 195
- Factored load, 310
- Fiber-reinforced concrete, 18, 26
- Fill, on site, 235
- Fire resistance, 17, 21
- Fixed end beam, 67
- Flat-spanning systems, 154, 374, 398
- Flat slab, 174, 398

- Flexure, in beams, 88
- Floor-ceiling space, in multilevel buildings, 165
- Footings:
  - column, 249, 257
  - moment-resistive, 285
  - wall, 240, 243
- Foundations, 233
  - column footing, 249, 257
  - deep, 270
  - design, 356, 396
  - design criteria, 237
  - framed floor on grade, 280, 324
  - grade beam, 266
  - moment-resistive, 285
  - pedestal, 184, 205, 259
  - retaining wall, 281
  - selection, 235
  - shallow bearing, 238
  - site design, 235
  - site exploration, 234
  - soil conditions, 235
  - for stud walls, 238
  - wall, 240, 266
  - wall footing, 240, 243
- Framed floor on grade, 280, 324
- Frames:
  - cantilever, 72
  - indeterminate, 78, 387
  - investigation of, 72
  - moment-resisting, 72, 387
  - rigid, 72, 210
- Grade of reinforcing bars, 22
- Grade beam, 266
- Heavyweight concrete, 31
- Hook in concrete, 146
  - equivalent development length of, 146
- Horizontal:
  - diaphragm, 337, 360
  - reinforcement in walls, 222
- Indeterminate structures, 69, 78, 374, 387
- Inelastic behavior, 23, 89
- Installation of reinforcement, 41, 380
- Insulating concrete, 32
- Interaction:
  - of building systems, 313
  - of compression and bending in columns, 187
- Internal forces:
  - in beams, 87
  - in rigid frames, 72
- Internal resisting moment, 87
- Investigation of:
  - basement wall, 226
  - beams, 64, 87
  - bearing wall, 223
  - columns, 63
  - footings, 240, 249
  - frames, 72, 388
  - retaining wall, 281
  - slabs, 117, 156
- Joist construction:
  - one-way, 167
  - two-way (waffle), 169
- Lapped splice, 149
- Lateral:
  - bracing of buildings, 366, 371, 387
  - load, 306, 329, 359
- Lateral resistive structures:
  - horizontal diaphragm, 337, 360
  - moment-resistive frame, 366, 387
  - perimeter:
    - bent, 366, 387
    - shear wall, 366
  - rigid frame, 388
  - shear wall, 366, 371
  - types of, 366
- Lightweight concrete, 31
- Limit state (failure), 83

- Live load:
  - element factor,  $K_{LL}$ , 303
  - for floors, 303
  - reduction, 305, 377
  - for roofs, 304
- Load:
  - building code, 301
  - combinations, 310
  - dead (DL), 298
  - design, 84, 298
  - determination, 310, 326
  - earthquake, 309
  - eccentric, 195
  - equivalent eccentric, 195
  - factored, 310
  - floor, live, 305
  - lateral, 306, 329, 359, 371
  - live, 303
  - periphery, 310
  - roof, 304
  - seismic, 309
  - service, 61
  - wind, 306, 333, 391
- Load sharing, 215
- LRFD (load and resistance factor design), 63, 83
- Masonry, concrete (CMU), 48, 207, 348, 353, 368
  - wall, 231, 348, 353, 368
- Materials, weight of, 299
- Measurement, units of, 3
- Metric units, 4
- MIA (Masonry Institute of America), 9
- Mill construction, 348
- Minimum:
  - depth of concrete beam, 122
  - dimensions for concrete members, 53, 122, 164
  - reinforcement, 24, 56, 98
  - size of concrete members, 53, 122, 164
  - thickness of concrete slab, 122
  - width of concrete beams, 164
- Mix, concrete, 30
- Mixed frame and wall systems, 214
- Modulus, of elasticity,  $E$ , 19
  - ratio (of elasticity), 19
- Moment:
  - in beams, 64
  - diagram for beam, 67, 69
  - internal bending moment, 88
  - overturning, 287, 308, 337
  - restoring, 287, 337
  - stabilizing, 337
- Moment-resisting frame, 72, 210, 388
- Moment-resistive foundation, 308
- Multistory rigid frame, 388
- Neutral axis, 89
- Nomenclature, 6
- Notation, standard, 6
- One-way slab, 117, 156
- Overturning moment, 308
  - on retaining wall, 287
  - on shear wall, 337
- Paving slab, 277
- PCA (Portland Cement Association), 9
- PCI (Prestressed Concrete Institute), 9
- P-delta effect, 79, 188
- Pedestal, concrete, 184, 205, 259
- Perimeter bracing, *see* Peripheral
- Peripheral:
  - area, 310
  - bracing, 389
  - load, 310
  - rigid frame, 389
  - shear in concrete footing, 253
- Periphery, load, 310
- Permanent set, 23
- Pier, 205, 273
- Pile, 272
- Portland cement, 10, 15
- Precast concrete, 11, 177, 230

- Prestressed Concrete, 2, 26
- Pressure:
  - in soils, 237
  - wind, 307
- Properties of:
  - balanced sections, 91
  - reinforcing bars, 23
- Proportional stiffness of:
  - column/beam bents, 213
  - individual bent members, 218
  - shear walls, 371
- Punching shear, 253
- Rectangular:
  - beam in concrete, 88
  - column, 145
  - footing, 258
  - stress block, strength method, 90
- Reduction of live load, 304, 305, 377
- Reference Sources, 8, 419
- Reinforced concrete, 2, 11
  - general requirements, 50
  - investigation, 59
  - practical considerations, 51
- Reinforcement, 22
  - anchorage of, 24
  - areas of, in slabs, 119
  - balanced, 91
  - bars, 22, 25
  - bending of, 58, 146
  - for columns, 184
  - compressive, 102, 110
  - cover for in concrete, 24, 57
  - development of, 104, 142
  - fiber, 18, 26
  - general requirements, 56
  - grade of, 23
  - hook, 146
  - installation, 41, 380
  - masonry, 209
  - minimum, 24, 56, 98
  - properties of, 23
  - shrinkage, 57
  - spaced, areas, 119
  - spacing of, 24, 57, 119
  - splice, 149
  - standard bars, 25
  - strength of, 23
  - temperature, 57
- Resistance factor, 85
- Resisting moment in beams, 88
- Restoring moment, 287, 337
- Retaining wall, 281
  - cantilever, 281, 323
  - overturn, 287
- Rigid frame, 1
  - approximate analysis, 78
  - cantilever, 72
  - concrete, 191
  - determinate, 72
  - indeterminate, 80, 387
  - for lateral force resistance, 388
  - multi story, 210, 388
  - single span, bent, 80
  - three-dimensional, 212
  - two-dimensional, 211, 388
- Roof load, live, 304
- Round columns, concrete, 184, 202
- Safe load tables for:
  - beams, 99
  - columns, 195
  - column footings, 257
  - wall footings, 243
- Segregation, 34
- Seismic effects, 309
- Service load, 61
- Set, permanent, 23
- Shallow bearing foundations, 238
- Shear:
  - beam, 67, 69, 126
  - diagram for beam, 67, 69
  - peripheral, 253
  - punching, 253
  - reinforcement, 127
- Shear in:
  - beams, 67, 69, 126
  - column footing, 249

- concrete beams, 126
- concrete structures, 125
- footings, 244, 249
- Shear reinforcement, 127
- Shear wall, 230, 329, 354, 371
  - overturn, 337
- Shop drawings, 41
- Shrinkage reinforcement, 59
- Sidesway of rigid frame, 79
- Site:
  - design, 235
  - development, 320
  - exploration, 234
- Sitecast concrete, 11, 35, 101
- Slab and beam structure, 155, 374
- Slabs:
  - flat, 174, 398
  - on grade, framed, 318
  - one-way spanning, 117, 156
  - paving, 277
  - reinforcement for, 119
  - thickness of, minimum, 165, 319
  - two-way spanning, 173
- Slenderness of columns, 204
- Slump test, 40
- Soil:
  - conditions, 235
  - pressure, 237
  - presumptive design values, 238
- Spaced reinforcement, area of, 119
- Spacing of:
  - bars in concrete, 24, 57, 119
  - stirrups, 135
- Specified compressive strength of
  - concrete, ( $f'_c$ ), 19
- Spiral column, concrete, 184
- Splices in reinforcement, 149
- Stability of:
  - retaining wall, 281
  - shear wall, 337
- Stabilizing moment of building
  - weight, 337
- Standard notation, 6
- Standards for structural design, 2, 8
- Statically indeterminate:
  - beams, 69, 78, 155, 374
  - frames, 78, 387
- Steel:
  - ductility of, 23
  - reinforcing bars, 25
  - yield strength of, 23
- Stiffness:
  - proportional, 371
  - relative, 19
- Stirrups, 127
  - spacing of, 135
- Strength:
  - of concrete, 19
  - design method, 62, 86
  - reduction factor, 85
  - ultimate, 23
  - yield, 23
- Stress:
  - in beams, 89
  - bearing, 223, 265
  - bending, 89
  - bond, 142
  - flexural, 89
  - inelastic, 23, 89
  - method, design, 62
  - in soils, 235
  - yield, 23
- Stress-strain:
  - diagram, 23
  - ductility, 23
  - modulus of elasticity,  $E$ , 19
  - proportional limit, 19
  - yield stress, 23
- Structural:
  - alternatives, 366
  - analysis, 5
  - computations, 5
  - concrete, 10, 14, 34, 59
  - design, 2, 84, 297
  - investigation, 59
  - planning, 312
  - safety, 49
  - subbase for pavement, 279

- Superstrength concrete, 32
- Symbols, 6
- T-beams, concrete, 102, 104
- Temperature reinforcement, 59
- Tests, 40
- Tied concrete column, 184
  - approximate design, 195
- Tilt-up wall, 178, 340
- Tributary area, 306 (*see also* Peripheral area)
- Two-way spanning structures, 169, 174
- UBC (Uniform Building Code), 2
- Ultimate strength design, 62, 86
- Underbalanced section, 93
- Under-reinforced concrete beam, 93
- Units, of measurement, 3, 4
  - conversion, 5
- Uplift, 308
- U. S. units, 3
- Vertical reinforcement in walls, 222
- Waffle construction, 169, 344
- Wall:
  - basement, 226
  - bearing, 223
  - footing, 240, 243
  - foundation, 240, 266
  - grade beam, 240, 266
  - masonry, 231, 348, 353, 368
  - precast concrete, 230
  - retaining, 281
  - shear, 230, 329, 354, 371
  - sitecast, 221
  - tilt-up, 178, 340
- Water-cement ratio, 30
- Water tightness of concrete, 21
- Weight of:
  - building construction, 299
  - concrete, 17
- Wind, 306
  - basic wind speed, 306
  - building code requirements for, 307
  - design wind pressure, 307
  - load determination, 306, 333, 371
  - overturning moment, 308
  - pressure variation with height
    - above ground, 371
  - uplift, 308
- Workability of wet concrete, 20
- Working stress method, 62
- Yield, strength, 23
  - stress, 23







