

## INDEX

Abutments and retaining walls .....	11-19	parapets .....	13-15
..... See Earth Pressure, 11-19		post-tensioning .....	5-23
backfill .....	11-7	railings .....	13-15
bearing resistance .....	11-21	seismic design .....	14-85
conventional walls and abutments .....	11-20	tension tie .....	5-93
drainage .....	11-35	Anchored walls .....	11-44
dynamic load allowance .....	3-34	anchor pullout capacity .....	11-47
expansion and contraction joints .....	11-21	anchor stressing and testing .....	11-54
extreme event limit state .....	11-18	anchors .....	11-47, 11-50
general considerations .....	11-19	bearing resistance .....	11-46
integral abutments .....	11-20	construction and installation .....	11-54
loading .....	11-19	corrosion protection .....	11-54
movement and stability .....	11-21	drainage .....	11-55
overturning .....	11-24	dynamic load allowance .....	3-34
passive resistance .....	11-24	earth pressure .....	3-133
protection .....	2-4	facing .....	11-52
reinforcement .....	11-20	loading .....	11-45
safety against structural failure .....	11-25	movement and stability .....	11-45
seismic design .....	11-25	passive resistance .....	11-50
sliding .....	11-24	safety against soil failure .....	11-46
subsurface erosion .....	11-24	safety against structural failure .....	11-50
transitions .....	10-32	seismic design .....	11-53
wingwalls .....	11-20	vertical wall elements .....	11-52
Aeroelastic instability		Anchors .....	5-256
aeroelastic phenomena .....	3-59	Angles	
control of dynamic responses .....	3-60	floorbeam/stringer end connection .....	6-285
wind tunnel tests .....	3-60	shelf .....	6-285
Alkali-silica reactive aggregates .....	5-264	thickness of metal .....	6-285
Aluminum		Annual frequency of collapse	
camber .....	See Camber	geometric probability .....	3-166
coefficient of thermal expansion .....	7-6	probability of aberrancy .....	3-163
culverts .....	12-8	probability of collapse .....	3-167
effective area .....	7-39	vessel frequency distribution .....	3-162
fracture .....	7-24	Approximate methods of analysis	
local buckling .....	7-48	beam-slab bridges .....	4-29
minimum thickness .....	7-34	decks .....	4-22
net section .....	7-39	effective flange width .....	4-54
nondestructive testing .....	7-32	effective length factor .....	4-49
orthotropic decks .....	See Orthotropic aluminum	equivalent strip widths for slab-type bridges .....	4-48
decks		moment magnification .....	4-14, 4-16
shear and torsion .....	7-56	seismic lateral load distribution .....	4-62
slenderness ratios .....	7-32	truss and arch bridges .....	4-49
tensile resistance .....	7-35	Arches	
unit weight .....	3-21	arch ribs .....	5-247
welding procedures and requirements .....	7-31	effective length factor .....	4-16
Anchor bolts		minimum reinforcement .....	5-248
bearings .....	14-84	moment magnification .....	4-16
elastomeric bearings .....	3-109	splices .....	6-304
deck joints .....	14-18	steel, diaphragms .....	6-79
seismic design .....	14-85	Backfill .....	See Abutments and retaining walls
Anchorage		Barriers	
anchored walls .....	11-45	anchorage .....	3-109
bearings .....	14-84	seismic forces .....	3-109
deck joints .....	14-18	Basic requirements of structural dynamics	
design live loads .....	13-11	damping .....	4-78
footings .....	10-54	distribution of masses .....	4-77
geometry .....	13-11	natural frequencies .....	4-78

stiffness .....	4-78	rock .....	10-83
Beam ledges		semiempirical procedures .....	10-68
design for bearing .....	5-112	spread footings .....	10-69, 10-70
design for flexure and horizontal force .....	5-108	Bicycles	
design for punching shear .....	5-108	deck joint provisions .....	14-17
design for shear .....	5-107	railing .....	13-9, 13-11
design of hanger reinforcement .....	5-110	Bolted connections .....	6-285
Beam-slab bridges		bearing-type connections .....	6-286, 6-288
moment and shear .....	4-35	eccentric .....	6-285
special loads with other traffic .....	4-47	edge distance .....	6-290
Bearing area		end distance .....	6-290
brackets .....	5-105	holes .....	6-288
concrete .....	5-54	maximum pitch for stitch bolts .....	6-289
fasteners .....	6-295	maximum spacing for sealing bolts .....	6-289
post-tensioning anchorage .....	5-113	minimum number of bolts .....	6-285
Bearing plates .....	See Bearings	minimum spacing and clear distance .....	6-289
Bearing stiffeners .....	6-208	minimum weld .....	6-285
axial resistance .....	6-209	nuts .....	6-84
bearing resistance .....	6-209	slip-critical connections .....	6-285, 6-288
effective section .....	6-209	washers .....	6-84, 6-287
projecting width .....	6-208	Bolted splices	
steel .....	6-370	compression members .....	6-304
Bearing-type connections .....	6-286	fillers .....	6-311
Bearings .....		flange splices .....	6-308
<i>See</i> Disc bearings, Elastomeric bearings, Pot		flexural members .....	6-304
bearings, <i>and</i> Railing		tension members .....	6-304
anchor bolts .....	14-84	web splices .....	6-305
anchorage .....	14-84	Bolts	
applicability .....	14-41	bearing resistance .....	6-286, 6-295
bearing plates .....	5-67, 5-113	combined tension and shear .....	6-297
bronze or copper alloy sliding surfaces .....	14-77	effective bearing area .....	6-295
characteristics .....	14-37	fatigue resistance .....	6-296
curved sliding surfaces .....	14-50	gauge .....	6-95, 6-289
design criteria .....	14-41	materials .....	8-21
disc bearings .....	14-78	minimum number in a connection .....	6-285
elastomeric bearings .....	14-57, 14-68	prying action .....	6-296
fabrication, installation, testing and shipping		shear resistance .....	6-286, 6-290, 6-303
.....	14-41	size .....	6-288
force effects resulting from restraint of movement		slip resistance .....	6-291
at the bearing .....	14-38	tensile resistance .....	6-286, 6-296, 6-303
guides and restraints .....	14-80	Box girders	
horizontal force and movement .....	14-38	analysis .....	4-36
launching bearings .....	5-242	effective flange width .....	4-59
load plates .....	14-83	live load distribution factors .....	4-36
metal rocker and roller bearings .....	14-43	wind bracing .....	4-62
moment .....	14-39	wind load distribution .....	4-62
movements and loads .....	14-6	Bracing .....	
other bearing systems .....	14-82	<i>See</i> Diaphragms and cross-frames, <i>and</i> Lateral	
pot bearings .....	14-52	bracing	
PTFE sliding surfaces .....	14-45	box sections .....	4-62
seismic provisions for bearings .....	14-41	connections .....	6-61, 6-286
special design provisions .....	14-43	glued laminated timber girders .....	8-37
suitability .....	14-37	portal bracing .....	8-37
tapered plates .....	14-84	sawn wood beams .....	8-36
uplift .....	14-36, 14-80	slenderness ratio .....	6-96, 6-109
Bearing resistance		sway bracing .....	8-37

- temporary ..... 4-62, 5-210, 6-71
- trusses ..... 6-83
- wood trusses ..... 8-37
- Brackets and corbels
  - alternative to strut-and-tie model ..... 5-105
- Braking force ..... 3-35
- Bridge scour ..... *See* Scour
- Bridge site arrangement
  - traffic safety ..... 2-4
- Bridge testing ..... 4-90
- Bronze or copper alloy sliding surfaces
  - clearances and mating surfaces ..... 14-78
  - coefficient of friction ..... 14-78
  - limit on load ..... 14-78
  - materials ..... 14-77
- Built-up members
  - noncomposite sections ..... 6-121
  - perforated plates ..... 6-96, 6-122
  - steel tension members ..... 6-96
- Bundled reinforcement
  - development length ..... 5-183
  - number of bars in a bundle ..... 5-171
  - splices ..... 5-190
  - termination ..... 5-171
  - ties ..... 5-173
- Buoyancy ..... 3-44
- Buried structures
  - bearing resistance and stability ..... 12-19
  - corner backfill for metal pipe arches ..... 12-20
  - corrosive and abrasive conditions ..... 12-24
  - differential settlement of backfill ..... 12-15
  - embankment installations ..... 12-21
  - end treatment ..... 12-23
  - flexibility limits and construction stiffness ..... 12-13
  - flexible culverts constructed on skew ..... 12-23
  - footing settlement ..... 12-15
  - hydraulic design ..... 12-20
  - loading ..... 12-14
  - minimum soil cover ..... 12-21
  - minimum spacing of pipe ..... 12-22
  - safety against soil failure ..... 12-19
  - scour ..... 12-20
  - service limit state ..... 12-15
  - settlement ..... 12-15
  - soil envelope ..... 12-20
  - tolerable movement ..... 12-15
  - trench installations ..... 12-20
  - unbalanced loading ..... 12-16
  - uplift ..... 12-19
- Cables
  - bridge strand ..... 6-35
  - bright wire ..... 6-35
  - epoxy-coated wire ..... 6-35
  - galvanized wire ..... 6-35
  - modulus of elasticity ..... 4-74
- Caissons ..... *See* Drilled shafts
- Camber
  - aluminum structures ..... 7-31
  - concrete structures ..... 5-44, 5-121, 5-141, 5-242
  - glued laminated timber girders ..... 8-37
  - steel structures ..... 6-65
  - stress laminated decks ..... 8-37
  - wood structures ..... 8-12
  - wood trusses ..... 8-37
- Cantilever retaining walls ..... 11-36
  - corrosion protection ..... 11-44
  - drainage ..... 11-44
  - earth pressure ..... 3-128
  - facing ..... 11-38
  - loading ..... 11-36
  - movement ..... 11-36
  - overall stability ..... 11-36
  - safety against structural failure ..... 11-38
  - seismic design ..... 11-39
  - soil failure ..... 11-36
  - vertical wall elements ..... 11-38
- Cantilever slabs
  - cantilever length ..... 3-28
  - design ..... 3-28, 4-23, 9-9, 13-4, 13-5
  - reinforcement, concrete boxes ..... 5-223
  - strip width ..... 4-24
  - thickness ..... 13-9
  - wheel load position ..... 3-28
- Cast metal
  - cast iron ..... 6-34
  - cast steel and ductile iron ..... 6-34
  - malleable castings ..... 6-34
- Cast-in-place box culverts and arches
  - cast-in-place structures ..... 12-73
  - concentrated loads ..... 12-71
  - construction and installation ..... 12-74
  - design moment for box culverts ..... 12-73
  - distribution of concentrated loads in skewed box culverts ..... 12-72
  - embankment and trench conditions ..... 12-69
  - loads and live load distribution ..... 12-68
  - minimum cover for precast box structures ..... 12-74
  - minimum reinforcement ..... 12-73
  - other installations ..... 12-71
  - precast box structures ..... 12-73
  - safety against structural failure ..... 12-73
  - service limit state ..... 12-72
  - soil structure interaction ..... 12-69
- Cast-in-place girders and box and T-beams
  - bottom flange ..... 5-223
  - bottom slab reinforcement in box girders ..... 5-224
  - deck slab reinforcement in T-beams/box girders ..... 5-223
  - effective flange width ..... 4-55
  - flange and web thickness ..... 5-223
  - reinforcement ..... 5-223
  - top flange ..... 5-223

web.....	5-223	Compression flange proportions.....	6-368
Cast-in-place piles .....	<i>See</i> Concrete piles	Compression members	
Cast-in-place voided slab superstructures		concrete.....	5-45, 5-48
compressive zones in negative moment area.....	5-207	hollow rectangular compression members.....	5-51
cross-section dimensions.....	5-206	steel.....	6-99
drainage of voids.....	5-208	steel composite members.....	6-128
general design requirements.....	5-207	steel noncomposite members.....	6-109
minimum number of bearings.....	5-207	wood.....	8-33
solid end sections.....	5-207	Compressive resistance	
Centrifugal forces.....	3-34	concrete.....	5-48
Charpy V-notch test		steel.....	6-99
temperature zones.....	6-64	steel composite members.....	6-128
Clearances.....	2-5	steel noncomposite members.....	6-109
drilled shafts.....	10-129	wood.....	8-33
highway horizontal.....	2-6	Concrete	
highway vertical.....	2-5	air-entrained.....	5-260, 5-263
navigational.....	2-5	bearing resistance.....	5-30, 5-53, 5-252
pedestrian bridges.....	2-6	bearings.....	5-242
piles.....	10-87	box girders.....	<i>See</i> Concrete box girders
railroad overpass.....	2-6	camber.....	<i>See</i> Camber
Coefficient of thermal expansion		coefficient of thermal expansion.....	5-17
aluminum.....	7-6	combined force effects.....	5-49, 5-55
concrete.....	5-17	compressive strength.....	5-15
steel.....	6-30	cover.....	5-167, 5-265, 9-14
wood.....	9-30	creep.....	5-17
Combination railing.....	13-12	culverts.....	<i>See</i> Concrete culverts
design live loads.....	13-12	deck slabs.....	<i>See</i> Concrete slabs
geometry.....	13-12	extreme event limit state.....	5-32, 5-33, 5-291
Combined force effects		formwork.....	<i>See</i> Concrete formwork
concrete.....	5-49, 5-55	modulus of elasticity.....	5-20, 5-291
steel.....	6-99, 6-129, 6-245	modulus of rupture.....	5-20
wood.....	8-35	piles.....	<i>See</i> Concrete piles
Compact sections		Poisson's ratio.....	5-20
nominal flexural resistance.....	6-178, 6-231	properties.....	5-15
Composite box girders ....	4-36, <i>See also</i> Box girders	shrinkage.....	5-19
bracing.....	6-80	slabs.....	<i>See</i> Concrete slabs
design conditions.....	6-215	stress limits.....	<i>See</i> Concrete stress limits
diaphragms.....	6-76, 6-78	strut-and-tie method.....	5-85
fatigue.....	6-215	tensile strength.....	5-21
lateral bracing.....	6-80	T-beams.....	<i>See</i> Concrete T-beams
live load distribution factors.....	4-36	Concrete box girders	
wind effects.....	4-62	effective flange width.....	4-59
Composite sections		effective flange width.....	4-55
concrete deck stresses.....	6-138	live load distribution factors.....	4-36
concrete-encased shapes.....	6-130, 6-278	Concrete culverts	
concrete-filled tubes.....	6-130, 6-279	bottom slab.....	5-210
modular ratio.....	6-138	confinement reinforcement.....	5-147
sequence of loading.....	6-137	dimensions, minimum.....	5-210
steel.....	6-128	distribution reinforcement.....	5-206
Compression chords		dynamic load allowance.....	3-34
continuity.....	6-315	seismic effects.....	3-69
lateral bracing.....	6-83	top slab.....	5-210
splices.....	6-304	web thickness.....	5-210
Compression flange flexural resistance.....	6-183	Concrete deck slabs.....	<i>See</i> Concrete slabs
lateral torsional buckling resistance.....	6-186, 6-361	Concrete formwork.....	<i>See</i> Stay-in-place formwork
local buckling resistance.....	6-185, 6-360	bedding of panels.....	9-14

- creep and shrinkage control ..... 9-14
- depth ..... 9-13
- reinforcement ..... 9-13
- Concrete piles
  - anchorage ..... 5-196, 5-253
  - cast-in-place piles ..... 5-255
  - embedment ..... 5-196, 5-253
  - end region ..... 5-198
  - pile dimensions ..... 5-256
  - precast prestressed piles ..... 5-254
  - precast reinforced piles ..... 5-254
  - reinforcement ..... 5-197, 5-205
  - reinforcing steel ..... 5-256
  - seismic requirements ..... 5-205
  - shells for cast-in-place piles ..... 5-256
  - spacing of transverse reinforcement ..... 5-256
  - splices ..... 5-254
  - structural resistance ..... 10-123
  - tensile stresses, precast piles ..... 5-125
  - tolerance ..... 5-249
  - uplift ..... 5-197
- Concrete slabs ..... 9-7
  - abrasion ..... 5-167
  - application of empirical design ..... 9-9
  - composite action ..... 9-7
  - concrete cover ..... 5-167
  - design conditions ..... 9-10
  - design of cantilever slabs ..... 9-8
  - distribution reinforcement ..... 5-206
  - edge support ..... 5-205, 9-8
  - effective length ..... 9-9
  - effective width ..... 6-139
  - empirical design ..... 9-8
  - minimum depth and cover ..... 9-7
  - precast deck slabs on girders ..... 9-14
  - reinforcement ..... 5-206, 9-11
  - segmental construction ..... 9-15
  - shear ..... 5-58
  - skewed bridges ..... 4-49
  - skewed decks ..... 9-7, 9-12
  - slab bridges ..... 5-205
  - stay-in-place formwork ..... 9-12
  - stay-in-place formwork ..... 9-13
  - top slab, box girders ..... 9-15
  - traditional design ..... 9-12
  - uplift and slip of deck slabs ..... 7-32
- Concrete stress limits
  - service stresses ..... 5-125
  - stress limits for concrete ..... 5-123, 5-291
  - temporary stresses before losses ..... 5-123
- Concrete T-beams
  - negative moment reinforcement ..... 5-57
- Concrete-filled tubes
  - circular tubes ..... 6-283
  - rectangular tubes ..... 6-283
- Cone Penetration Test ..... 10-82
- Connections ..... 6-284
  - See Bolted connections, Splices, and Welded connections*
  - block shear rupture resistance ..... 6-302
  - bolted connections ..... 6-285
  - rigid frame connections ..... 6-313
  - splices ..... 6-304
  - welded connections ..... 6-298
- Connectors
  - lacing bars ..... 6-96, 6-130
  - tie plates ..... 6-96, 6-130
- Constructibility
  - dead load deflections ..... 6-167
  - deck placement ..... 6-163
  - flexure ..... 6-160, 6-224
  - shear ..... 6-226
- Continuously braced compression flanges ..... 6-356
- Continuously braced tension flanges ..... 6-356
- Corrosion
  - prestressing systems, concrete ..... 5-23, 5-265
  - steel structures ..... 6-71
- Constructibility
  - design objectives ..... 2-14
- Continuous spans loading ..... 3-28
- Corrosion
  - bearings ..... 14-49
  - MSE facing ..... 11-61
  - piles ..... 10-125
- Corrosion protection ..... 14-85
  - alternative coating ..... 8-23
  - metallic coating ..... 8-23
- Corrugated metal decks
  - composite action ..... 9-29
  - distribution of wheel loads ..... 9-29
- Cover plates ..... 6-214
  - end requirements ..... 6-214
- CPT ..... *See Cone Penetration Test*
- cohesionless soils ..... 10-115
- Creep effect ..... 5-17, 5-122
- Cross-section proportion limits
  - flange proportions ..... 6-222
  - web proportions ..... 6-222
- Culverts
  - additional provisions for culverts ..... 5-248
  - aluminum ..... 12-8
  - design for flexure ..... 5-248
  - design for shear in slabs of box culverts ..... 5-248
  - location, length, and waterway area ..... 2-23
  - seismic effects ..... 3-69
- Curbs and sidewalks ..... *See Sidewalks*
  - end treatment of separation railing ..... 13-13
  - sidewalks ..... 13-13
- Curved structures
  - deck joints ..... 14-15
  - deflections ..... 2-12

single girder superstructures .....	4-18	isotropic plate model .....	4-68
Curved tendons		live loads .....	3-28
effects of curved tendons .....	5-150	live load effects on grids .....	4-27
in-plane force effects .....	5-151	longitudinal edges .....	4-25
out-of-plane force effects .....	5-155	orthotropic plate model .....	4-68
Dead loads		stay-in-place formwork .....	9-5
load factors .....	3-17, 5-229	traditional design .....	9-12
unit weight of materials .....	3-21	transverse edges .....	4-25
Deck analysis		unfilled composite grids .....	9-18
loading .....	9-6	Deep beams .....	5-224
methods of analysis .....	9-6	Deflection	
Deck joints		concrete .....	5-44
adjustment .....	14-19	criteria .....	2-11
anchors .....	14-18	span-to-depth ratios .....	2-13
armor .....	14-18	Deformations	
bolts .....	14-18	axial deformation .....	5-45
bridging plates .....	14-17	concrete .....	5-43
closed joints .....	14-20	steel .....	6-168
compression and cellular seals .....	14-21	Deformed bars and deformed wire in tension	
design requirements .....	14-16	tension development length .....	5-180
fabrication .....	14-18	Deformed bars in compression	
field splices .....	14-19	compressive development length .....	5-183
geometry .....	14-14	modification factors .....	5-183
installation .....	14-19	Depth of the web in compression	
joint seals .....	14-21	at plastic moment .....	6-407
location of joints .....	14-15	in the elastic range .....	6-406
maintenance .....	14-14	Design lane load .....	3-25
materials .....	14-14	Design lanes	
modular bridge joint systems .....	14-22	width .....	3-22
movements during construction .....	14-16	Design objectives	
number of joints .....	14-15	bridge aesthetics .....	2-15
open joints .....	14-20	constructibility .....	2-14
plank seals .....	14-22	economy .....	2-15
poured seals .....	14-21	safety .....	2-7
protection .....	14-17	serviceability .....	2-8
requirements .....	14-12	Design philosophy .....	1-3
selection .....	14-15	ductility .....	1-5
sheet and strip seals .....	14-22	limit states .....	1-3
structural design .....	14-13	operational importance .....	1-7
temporary supports .....	14-19	redundancy .....	1-6
waterproofed joints .....	14-20	Design tandem .....	3-25
Deck overhang design .....	9-9, 13-25	Design truck .....	3-24
decks supporting concrete parapet railings ..	13-25	Development of reinforcement	
decks supporting post-and-beam railings .....	13-26	basic requirements .....	5-176
design cases .....	13-25	bonded strand .....	5-143
resistance to punching shear .....	13-27	bundled bars .....	5-183
stay-in-place formwork .....	9-5	deformed bars and deformed wire in tension.	
Decks .... See Deck joints, and Deck overhang design		.....	5-180, 5-291
applicability .....	4-23	development by mechanical anchorages .....	5-189
concrete appurtenances .....	9-5	flexural reinforcement .....	5-177
deck drainage .....	9-4	modification factors .....	5-181, 5-183, 5-185
distribution of wheel loads .....	4-26	prestressing strand .....	5-143
edge supports .....	9-5	shear reinforcement .....	5-187
empirical design .....	9-8	standard hooks in tension .....	5-184
inelastic analysis .....	4-29	welded wire fabric .....	5-187
interface action .....	9-4	Diaphragms and cross-frames	



- aluminum structures..... 7-34
- concrete structures ..... 5-243
- steel arches..... 6-79
- steel box girders ..... 6-76
- steel I-girders ..... 6-72
- steel structures ..... 6-71
- steel trusses ..... 6-79, 6-316
- Disc bearings ..... *See* Bearings
  - elastomeric disc ..... 14-79
  - materials ..... 14-79
  - shear resisting mechanism ..... 14-80
  - steel plates..... 14-80
  - suitability ..... 14-37
- Discretely braced compression flanges ..... 6-354
- Discretely braced tension flanges ..... 6-355
- Distortion-induced fatigue
  - lateral connection plates ..... 6-61
  - orthotropic decks ..... 6-61, 9-29
- Distribution of load
  - cantilever slabs ..... 4-24
  - concrete slabs..... 4-24
  - exterior beams..... 4-39, 4-44
  - interior beams ..... 4-35, 4-36, 4-38, 4-42
  - skewed bridges ..... 4-40, 4-46
  - steel grid flooring..... 4-24
  - transverse floorbeams ..... 4-41
  - trusses ..... 4-49
  - wheel loads through earth fills..... 3-25
  - wood flooring ..... 4-23
- Dowels
  - concrete columns ..... 5-253
  - concrete interface..... 5-204
  - pile anchorage..... 5-196, 5-253
  - wood decks ..... 9-32, 9-38
- Downdrag ..... 10-101, 10-102, 10-131, 10-136
  - determination of pile loads ..... 10-88
  - settlement due to ..... 10-95
- Drainage
  - sound barrier ..... 15-2, 15-10
  - spandrel fill ..... 5-248
- Drilled shafts ..... 10-128
  - battered shafts ..... 10-130
  - buckling ..... 10-150
  - clearance ..... 10-129
  - combined side and tip resistance ..... 10-145
  - definition..... 10-2
  - design of ..... 10-33
  - diameter ..... 10-129
  - embedment into cap..... 10-129
  - enlarged bases..... 10-129, 10-151
  - estimation of resistance in IGMs ..... 10-146
  - estimation of resistance in rock ..... 10-143
  - group resistance ..... 10-147
  - group resistance in cohesionless soil ..... 10-148
  - group resistance in cohesive soil ..... 10-148
  - group resistance in strong soil overlying weak soil..... 10-149
  - horizontal movement ..... 10-135
  - horizontal resistance ..... 10-150
  - lateral stability ..... 10-150
  - reinforcement..... 10-150
  - resistance in cohesive Soils..... 10-138
  - service limit state design..... 10-132
  - settlement..... 10-132
  - shaft resistance..... 10-130
  - side resistance ..... 10-144
  - spacing ..... 10-129
  - strength limit state ..... 10-48
  - structural resistance ..... 10-150
  - tip resistance ..... 10-140, 10-142, 10-145
  - transverse reinforcement..... 10-151
- Driven piles
  - design of ..... 10-33
- Ductility ..... 1-5
- Ductility requirements
  - reinforcing bars..... 5-22
- Ducts
  - bundling ..... 5-148
  - curvature, minimum..... 5-23
  - ducts at deviation saddles ..... 5-24
  - grouting..... 5-24, 5-150, 5-236
  - materials ..... 5-23
  - size of ducts ..... 5-24
  - spacing..... 5-148
- Durability
  - concrete cover ..... 5-167, 5-265
  - materials ..... 2-8
  - self-protecting measures ..... 2-8
- Dynamic analysis ..... 4-77
  - analysis for collision loads..... 4-89
  - analysis for earthquake loads..... 4-80
  - basic requirements ..... 4-77
  - inelastic dynamic responses..... 4-79
- Dynamic load allowance ..... 3-33
  - buried components..... 3-34
  - deck joints..... 3-33
  - wood components ..... 3-34
- Earth loads
  - sound barrier ..... 15-5
  - steel tunnel liner plate ..... 12-90
- Earth pressure ..... 3-116
  - active..... 3-120
  - anchored walls ..... 3-133
  - at-rest ..... 3-119
  - buried structures ..... 12-14
  - cantilevered walls ..... 3-128
  - compaction..... 3-117
  - downdrag ..... 3-151
  - effect of earthquake ..... 3-118
  - equivalent-fluid method..... 3-126
  - lateral earth pressure ..... 3-118

modular walls.....	3-138	liquefaction design requirements .....	10-34
MSE walls.....	3-136	load combinations .....	3-10, 3-17
passive.....	3-123	prestressing steel .....	5-123
presence of water .....	3-117	railing .....	13-5
reduction due to earth pressure .....	3-151	sound barrier .....	15-3
surcharge loads.....	3-142	steel structures.....	6-37
Earthquake effects .....	<i>See</i> Seismic loads	wood structures .....	8-31
Economy		Extreme limit states .....	10-51
alternative plans .....	2-15	Eyebars	
Edge distance .....	6-290	factored resistance.....	6-96
Edge supports, slabs.....	5-205, 9-5, 9-8, 9-17	packing.....	6-97
Effective area		proportions .....	6-96
aluminum .....	7-39	Fasteners .....	<i>See</i> Bolts, and Connectors
perforated plates.....	6-315	countersunk .....	6-295
welds .....	6-300	Fatigue	
Effective flange width		distortion-induced .....	6-60
box girders .....	4-59	load-induced.....	6-38
cast-in-place multicell superstructures.....	4-59	Fatigue and fracture limit state .....	1-4, 9-5
orthotropic steel decks .....	4-59	aluminum structures.....	7-8
segmental box beams and CIP box beams .....	4-55	concrete structures .....	5-33
Effective length		decks .....	9-19, 9-29
slabs .....	9-10	elastomeric bearings.....	14-65
span .....	7-32	load combinations .....	3-17
Effective plastic moment .....	6-373	modular bridge joint systems .....	14-29
all other interior-pier sections .....	6-374	prestressing steel .....	5-28
interior-pier sections .....	6-373	reinforcing bars .....	5-27
Effective width		steel structures.....	6-36
concrete slabs.....	6-139	welded or mechanical rebar splices.....	5-28
orthotropic decks.....	9-28	Fatigue design	
Elastic dynamic responses		cycles .....	6-57
wind-induced vibration .....	4-79	deck joints .....	14-6
Elastomeric bearings.....	<i>See</i> Bearings	elastomeric bearings.....	14-65
anchorage .....	3-109	metal grid decks .....	9-19
combined compression and rotation.....	14-65	orthotropic decks.....	9-28
compressive deflection.....	14-61, 14-72	steel webs.....	6-215
compressive stress.....	14-60, 14-71	Fatigue load .....	3-30
design method A .....	14-68	approximate methods .....	3-32
design method B .....	14-57	frequency .....	3-31
movements and loads.....	14-11	load distribution for fatigue.....	3-32
Elastomeric pads.....	<i>See</i> Elastomeric bearings	refined methods.....	3-32
Emergency responder access to sound barriers....	15-2	FHWA Gates Formula .....	10-105
End distance.....	6-290	Filled and partially filled grid decks	
End requirements		design requirements .....	9-18
bolted ends .....	6-215	fatigue and fracture limit state .....	9-18
welded ends.....	6-215	Fillet-welded connections	
Engineering News formula .....	10-106	effective throat .....	6-300
Erosion control.....	11-20	size of weld .....	6-300
Expansion .....	<i>See</i> Coefficient of thermal expansion	Flange-strength reduction factors	
Expansion devices for sound barriers .....	15-4	hybrid factor.....	6-150
Exterior stringers		web load-shedding factor .....	6-151
capacity .....	4-32	Flexibility limits and construction stiffness	
distribution factors .....	4-39, 4-44	corrugated metal pipe and structural plate	
Extreme event limit state .....	1-5, 9-6, 10-33	structures .....	12-13
abutments, piers, and walls .....	11-18	spiral rib metal pipe and pipe arches.....	12-13
concrete structures .....	5-32, 5-33, 5-291	steel tunnel liner plate .....	12-14
drilled shafts.....	10-124	thermoplastic pipe.....	12-14



- Flexural members
  - concrete.....5-37, 5-40
  - steel..... 6-229, 6-230, 6-370
  - wood ..... 8-31
- Flexural resistance
  - composite members ..... 6-278
  - noncomposite steel members ..... 6-248
  - steel.....6-244, 6-372
  - wood ..... 8-31
- Footings ..... 5-249
  - critical section for flexure ..... 5-250
  - development of reinforcement ..... 5-252
  - distribution of moment reinforcement ..... 5-250
  - loads and reactions..... 5-249
  - moment in footings ..... 5-250
  - reactions..... 12-47
  - resistance factors..... 5-250
  - shear in slabs and footings ..... 5-58, 5-251
  - stepped ..... 5-249
  - transfer of force at base of column ..... 5-252
- Foundation design
  - seismic design forces ..... 3-111
- Foundation investigation ..... 2-7
  - topographic studies ..... 2-7
- Free-standing abutments..... 11-144
  - design for displacement ..... 11-146
- Friction
  - angle for dissimilar materials..... 3-123
  - coefficient ..... 14-48, 14-78
- Friction forces..... 3-158
  - forces ..... 5-242
  - post-tensioning tendons ..... 5-132
- General zone ..... 5-158
  - blister and rib reinforcement..... 5-166
  - design methods ..... 5-159
  - design principles ..... 5-160
  - deviation saddles..... 5-167
  - diaphragms..... 5-166
  - intermediate anchorages ..... 5-164
  - multiple slab anchorages..... 5-119
  - responsibilities ..... 5-159
  - special anchorage devices..... 5-164
  - tie-backs..... 5-164
- Geometry
  - large deflection theory ..... 4-13
  - small deflection theory ..... 4-12
- Geophysical tests
  - soil and rock..... 10-12
- Glued laminated decks
  - deck tie-downs ..... 9-31
  - interconnected decks..... 9-31
  - noninterconnected decks..... 9-32
  - thermal expansion ..... 9-30
- Glued laminated timber ..... *See* Wood
  - bracing ..... 8-37
  - camber ..... 8-37
  - dimensions ..... 8-13
  - marking ..... 8-12
- Groove-welded connections
  - complete penetration..... 6-299
  - partial penetration ..... 6-299
- Grout
  - joints ..... 5-208
  - prestressing ducts ..... 5-24, 5-150, 5-236
- Guides and restraints
  - attachment of low-friction material ..... 14-82
  - contact stress..... 14-82
  - design basis..... 14-81
  - design loads ..... 14-81
  - geometric requirements ..... 14-81
  - load location ..... 14-81
  - materials ..... 14-81
- Gusset plates.....6-303, 6-314
- Gravel
  - unit weight ..... 3-21
- Gravity loads
  - design vehicular live load ..... 3-23
  - fatigue load ..... 3-30
  - pedestrian loads ..... 3-32
  - rail transit load ..... 3-32
- Groundwater
  - effects and buoyancy ..... 10-100
- Ground-mounted sound barriers..... 15-4
- Grout
  - joints ..... 9-15
- High load multirotational (HLMR) bearings .... 14-12
  - curved sliding surface bearings..... 14-12
  - disc bearings ..... 14-12
  - pot bearings..... 14-12
- Holes..... 6-288
  - bolted connections ..... 6-288
  - chains ..... 6-95
  - long-slotted holes..... 6-288
  - oversize holes ..... 6-288
  - pin holes..... 6-97, 6-98
  - short-slotted holes ..... 6-288
  - size ..... 6-288
  - type ..... 6-288
- Hollow rectangular compression members
  - hoops..... 5-176
  - rectangular stress block limitations..... 5-52
  - spacing of reinforcement ..... 5-175
  - splices ..... 5-176
  - ties..... 5-175
  - wall slenderness ratio..... 5-51
- Hooks and bends
  - basic hook development length..... 5-184
  - hooked-bar tie requirements ..... 5-185
  - minimum bend diameters ..... 5-170
  - modification factors ..... 5-185
  - seismic hooks..... 5-170
  - standard hooks ..... 5-169

Horizontal wind pressure		bundled bars.....	5-190
wind pressure on structures.....	3-52	non-contact splices.....	5-190
wind pressure on vehicles.....	3-58	spiral reinforcement.....	5-173
Hydraulic analysis		Large deflection theory	
approaches.....	2-22	approximate methods.....	4-14
bridge foundations.....	2-20	moment magnification.....	4-14
bridge waterway.....	2-20	refined methods.....	4-16
stream stability.....	2-19	Lateral bracing..... <i>See</i> Bracing, and Diaphragms and	
Hydrology and hydraulics.....	2-17	cross-frames	
drainage.....	2-23	steel.....	6-369
hydraulic analysis.....	2-19	straight I-sections.....	6-80
hydrologic analysis.....	2-18	trusses.....	6-83
site data.....	2-18	Lateral clearance	
Ice loads.....	3-61	sound barrier.....	15-2
adhesion.....	3-66	Lateral-torsional buckling (LTB).....	6-408
combination of forces.....	3-65	resistance.....	6-186
crushing and flexing.....	3-63	Lightweight concrete..... <i>See</i> Concrete	
dynamic ice forces on piers.....	3-62	development length.....	5-181
effective ice strength.....	3-62	development length.....	5-185
hanging dams and ice jams.....	3-66	resistance factors.....	5-30
ice and snow load.....	3-68	shear resistance.....	5-204
slender and flexible piers.....	3-66	shear resistance.....	5-105
small streams.....	3-64	unit weight.....	3-21
static ice loads on piers.....	3-66	Limit states..... <i>See</i> Extreme event limit state,	
Idealization..... <i>See</i> Mathematical modeling		Fatigue and fracture limit state, Service limit	
IGMs.....	10-135	state, and Strength limit state	
Impact..... <i>See</i> Dynamic load allowance		resistance factors.....	10-29
Inelastic dynamic responses		sound barriers.....	15-3
plastic hinges and yield lines.....	4-80	Live loads..... <i>See</i> Distribution of load	
Influence of plan geometry		application.....	3-28
curved structures.....	4-17	bicycle loads.....	3-33
plan aspect ratio.....	4-17	braking force.....	3-35
Instantaneous losses		centrifugal forces.....	3-34
anchorage set.....	5-130	continuous spans loading.....	3-28
elastic shortening.....	5-134	deck overhang load.....	3-30
friction.....	5-130	decks and box culverts.....	3-29
posttensioned members.....	5-130, 5-133	design lane load.....	3-25
pretensioned members.....	5-130, 5-132	design tandem.....	3-25
Interconnected decks		design truck.....	3-24
panels parallel to traffic.....	9-31	dynamic load allowance.....	3-33
panels perpendicular to traffic.....	9-31	gravity loads.....	3-22
Interior beams		live load deflection.....	3-29
distribution factors.....	4-35, 4-36, 4-38, 4-42	multiple presence.....	3-22
Intermediate Geo Materials..... <i>See</i> IGMs		tire contact area.....	3-25
Interaction systems..... <i>See</i> Culverts		vehicular collision force.....	3-37
Keys		Load factors.....	3-9
construction joints.....	5-209	abutments, piers, and walls.....	11-11
precast decks.....	5-208, 9-14	buried structures.....	12-11
segmental bridges.....	5-240, 5-244	combinations.....	3-9, 3-17
Laboratory tests		construction loads.....	3-19, 5-229
geophysical tests.....	10-12	definition.....	1-4
in-situ tests.....	10-11	jacking.....	3-20
rock tests.....	10-11	post-tensioning.....	3-20
soil tests.....	10-11	Load-induced fatigue	
Lacing bars.....	6-96, 6-130	application.....	6-38, 7-10, 7-11, 7-12
Lap splices.....	5-190	design criteria.....	6-39

- detail categories ..... 6-40
- fatigue resistance ..... 6-56
- Loads ..... 10-55
- Local zone ..... 5-158
  - bearing resistance ..... 5-113
  - dimensions of local zone ..... 5-112
  - responsibilities ..... 5-159
  - special anchorage devices ..... 5-114
- Location features
  - bridge site arrangement ..... 2-4
  - environment ..... 2-6
  - route location ..... 2-3
- Long-span structural plate structures ..... 12-28
  - acceptable special features ..... 12-31
  - backfill protection ..... 12-38
  - balanced support ..... 12-37
  - construction and installation ..... 12-34, 12-39
  - continuous longitudinal stiffeners ..... 12-31
  - cross-section ..... 12-30
  - cut-off (toe) walls ..... 12-38
  - end treatment design ..... 12-35
  - footing design ..... 12-33
  - footing reactions in arch structures ..... 12-32
  - foundation design ..... 12-31
  - hydraulic protection ..... 12-37
  - hydraulic uplift ..... 12-38
  - mechanical and chemical requirements ..... 12-31
  - reinforcing ribs ..... 12-30, 12-31
  - relieving slabs ..... 12-38
  - safety against structural failure ..... 12-29
  - scour ..... 12-38
  - seam strength ..... 12-31
  - section properties ..... 12-30
  - service limit state ..... 12-29
  - service requirements ..... 12-34
  - settlement limits ..... 12-31
  - shape control ..... 12-31
  - soil envelope design ..... 12-33
  - standard shell end types ..... 12-35
  - thrust ..... 12-31
  - wall area ..... 12-31
- Longitudinal stiffeners
  - moment of inertia and radius of gyration ..... 6-213
  - projecting width ..... 6-212
- Long-slotted holes ..... 6-288
- Loss of prestress
  - approximate lump sum estimate ..... 5-135
  - creep losses ..... 5-139
  - instantaneous losses ..... 5-130
  - losses for deflection calculations ..... 5-141
  - refined estimate ..... 5-136
  - relaxation losses ..... 5-141
  - shrinkage losses ..... 5-137
  - total prestress loss ..... 5-129
- Maintenance access to sound barriers ..... *See*
  - Emergency responder and maintenance access to sound barriers
- Materials ..... 6-30
  - aluminum and plate structures ..... 12-8
  - aluminum sheet, plate, and shapes ..... 7-6
  - bolts, nuts, and washers ..... 6-32
  - bronze or copper alloy sliding surfaces ..... 14-77
  - cables ..... 6-35
  - cement ..... 5-16
  - concrete ..... 5-15, 12-8
  - disc bearings ..... 14-79
  - elastomer ..... 14-58, 14-70
  - glued laminated timber ..... 8-12
  - metal fasteners and hardware ..... 8-21
  - pins, rollers, and rockers ..... 6-32
  - pot bearings ..... 14-52
  - precast concrete pipe ..... 12-8
  - precast concrete structures ..... 12-8
  - preservative treatment ..... 8-23
  - prestressing steel ..... 5-22
  - PTFE sliding surface ..... 14-45
  - reinforcing steel ..... 5-22
  - sawn lumber ..... 8-6
  - stainless steel ..... 6-34
  - steel pipe and structural plate structures ..... 12-8
  - steel reinforcement ..... 12-8
  - structural steels ..... 6-30
  - stud shear connectors ..... 6-33
  - thermoplastic pipe ..... 12-9
  - weld metal ..... 6-34
- Mathematical modeling ..... 4-11
  - equivalent members ..... 4-17
  - geometry ..... 4-12
  - modeling boundary conditions ..... 4-16
  - structural material behavior ..... 4-11
- Mechanically stabilized earth walls... *See* MSE walls
- Metal decks ..... 9-15
  - analysis ..... 4-27
  - corrugated metal decks ..... 9-29
  - limit states ..... 9-25
  - metal grid decks ..... 9-16, 9-17, 9-18
  - orthotropic aluminum decks ..... 9-28
  - orthotropic steel decks ..... 9-20
  - superposition of local and global effects ..... 9-25
- Metal fasteners and hardware
  - corrosion protection ..... 8-23
  - drift pins and bolts ..... 8-22
  - fasteners ..... 8-21
  - minimum requirements ..... 8-21
  - nails and spikes ..... 8-22
  - prestressing bars ..... 8-22
  - shear plate connectors ..... 8-22
  - spike grids ..... 8-22
  - split ring connectors ..... 8-22
  - toothed metal plate connectors ..... 8-22

Metal pipe, pipe arch, and arch structures		Modular bridge joint systems (MBJS)	
construction and installation .....	12-28	design stress range .....	14-31
handling and installation .....	12-27	distribution of wheel loads .....	14-27
resistance to buckling .....	12-26	fatigue limit state design requirements .....	14-29
safety against structural failure .....	12-24	loads and load factors .....	14-25
seam resistance .....	12-27	performance requirements .....	14-24
section properties .....	12-25	strength limit state design requirements .....	14-28
smooth lined pipe .....	12-27	testing and calculation requirements .....	14-25
stiffeners .....	12-28	Modular ratio	
thrust .....	12-25	long-term .....	6-138
wall resistance .....	12-26	short-term .....	6-138
Methods of analysis .....	<i>See Dynamic analysis,</i>	Modulus of elasticity	
Mathematical modeling, <i>and</i> static analysis		cables .....	4-74
Micropiles .....	10-152	concrete .....	5-20, 5-291
axial compressive resistance .....	10-159	prestressing steel .....	5-23
axial tension resistance .....	10-161	reinforcing steel .....	5-22
battered .....	10-153	steel .....	6-30
corrosion and deterioration .....	10-163	wood piles .....	8-21
definition .....	10-2	Moment redistribution	
design of .....	10-33	approximate procedure .....	4-75
design requirements .....	10-153	concrete .....	5-43
determination of loads .....	10-153	refined method .....	4-75
downdrag .....	10-153, 10-155	steel .....	6-371, 6-372, 6-373
estimation of grout-to-ground bond resistance		Mononobe–Okabe analysis .....	11-144
.....	10-156	MSE walls .....	11-55
estimation of tip resistance in rock .....	10-157	abutments .....	11-112
extreme event limit state .....	10-163	bearing resistance .....	11-66
ground water table and buoyancy .....	10-155	boundary between active and resistant zones	
groups in cohesionless soil .....	10-154	.....	11-79
groups in cohesive soil .....	10-154	concentrated dead loads .....	11-106
grout-to-steel bond .....	10-163	corrosion issues for MSE facing .....	11-61
horizontal foundation movement .....	10-154	design life considerations .....	11-88
lateral squeeze .....	10-154	design tensile resistance .....	11-93
load test .....	10-158	drainage .....	11-106
nearby structures .....	10-154	dynamic load allowance .....	3-34
nominal axial compression resistance of single		earth pressure .....	3-136
.....	10-155	external stability .....	11-97
nominal horizontal resistance of single and		facing .....	11-60
groups .....	10-159	facing reinforcement connections .....	11-103
nominal uplift resistance of a single micropile		geosynthetic reinforcements .....	11-90, 11-94, 11-95
.....	10-158	hydrostatic pressures .....	11-110
nominal uplift resistance of groups .....	10-158	internal stability .....	3-137, 11-99
plunge length transfer load .....	10-162	lateral displacement .....	11-62
resistance of groups in compression .....	10-158	loading .....	11-61, 11-64, 11-68
scour .....	10-155	minimum front face embedment .....	11-59
service limit state design .....	10-154	minimum length of soil reinforcement .....	11-58
settlement .....	10-154	obstructions in the reinforced soil zone .....	11-111
settlement due to downdrag .....	10-154	overall stability .....	11-66
spacing, clearance, embedment .....	10-153	overturning .....	11-66
strength limit state design .....	10-154	reinforcement/facing connection design .....	11-94
strength limit states .....	10-50	reinforcement pullout .....	11-79, 11-81
structural resistance .....	10-159	reinforcement strength .....	11-84
through embankment fill .....	10-153	safety against soil failure .....	11-64
tolerable movements .....	10-154	safety against structural failure .....	11-68
types .....	10-152	seismic design .....	11-97
uplift .....	10-153	settlement .....	11-61

- sliding ..... 11-65
- special loading conditions..... 11-106
- steel reinforcements ..... 11-88, 11-93, 11-94
- structure dimensions ..... 11-57
- subsurface erosion ..... 11-106
- traffic loads and barriers ..... 11-109
- Multiple presence of live load ..... 3-22
- Multispan bridges
  - general ..... 4-81
  - multimode spectral method..... 4-84
  - selection of method..... 4-80
  - single-mode methods of analysis ..... 4-81
  - single-mode spectral method ..... 4-81
  - uniform load method..... 4-83
- Noncompact sections
  - nominal flexural resistance ..... 6-181, 6-232
- Noncomposite sections
  - built-up members ..... 6-121
  - channels, angles, tees, and bars..... 6-269
  - circular tubes..... 6-253
  - I- and H-shaped members ..... 6-248
- Nondestructive testing
  - aluminum ..... 7-32
- Nordlund/Thurman Method..... 10-110
- Operational importance ..... 1-7
- Orthotropic aluminum decks
  - approximate analysis ..... 9-28
  - limit states ..... 9-28
- Orthotropic deck superstructures ..... 6-323
  - effective width of deck ..... 6-325
  - superposition of global and local effects ..... 6-325
- Orthotropic decks.....*See* Orthotropic aluminum decks, *and* Orthotropic steel decks
- Orthotropic steel decks
  - design..... 9-25
  - detailing requirements ..... 9-26
  - wearing surface..... 9-20
  - wheel load distribution ..... 9-20
- Oversize holes ..... 6-288
- Painting
  - box sections ..... 6-215
  - slip-critical joints ..... 6-293
- Parapets ..... *See* Railing
- Pedestrian loads ..... 3-32
- Pedestrian railing ..... 8-23, 13-9
  - design live loads ..... 13-10
  - geometry ..... 13-9
- Perforated plates
  - effective area..... 6-315
- Permanent loads ..... 3-21
  - dead loads ..... 3-21
  - earth loads..... 3-21
- Piers ..... 11-35
  - barge collision force ..... 3-173
  - collision walls ..... 11-35
  - facing ..... 11-36
  - load effects in piers ..... 11-35
  - protection ..... 2-4, 2-5, 3-176, 11-35
  - reinforcement spacings ..... 5-203
  - scour ..... 11-36
  - seismic design..... 3-107, 5-197
  - ship collision force..... 3-170
- Pile bents ..... *See* Piles
- pile tolerance..... 5-249
- Pile foundations
  - nominal lateral resistance ..... 10-122
- Pile structural resistance
  - buckling ..... 10-123
  - lateral stability ..... 10-123
- Piles
  - $\alpha$ -Method ..... 10-107
  - $\beta$ -Method ..... 10-108
  - $\lambda$ -Method ..... 10-109
  - batter ..... 10-87
  - definition..... 10-2
  - design requirements ..... 10-88
  - determination of loads ..... 10-88
  - determination of nominal bearing resistance ..... 10-102
  - downdrag ..... 10-88
  - drivability analysis..... 10-127
  - driven ..... 10-86
  - driven to hard rock..... 10-96
  - driven to soft rock..... 10-96
  - dynamic testing..... 10-104
  - embedment into cap..... 10-87
  - groups in cohesive soil..... 10-92
  - horizontal foundation movement ..... 10-93
  - lateral squeeze..... 10-95
  - length estimates for contract documents..... 10-97
  - minimum penetration..... 10-126
  - nearby structures..... 10-89
  - nominal axial resistance change after driving ..... 10-99
  - nominal bearing resistance..... 10-126
  - Nordlund/Thurman Method in cohesionless soils ..... 10-110
  - probe ..... 10-128
  - resistance of groups in compression ..... 10-118
  - service limit state design..... 10-89
  - settlement..... 10-90
  - settlement due to downdrag ..... 10-95
  - spacing ..... 10-87
  - static analysis..... 10-106
  - static load test ..... 10-103
  - strength limit state design ..... 10-95
  - structural resistance ..... 10-123
  - tip resistance in cohesive soils ..... 10-110
  - tolerable movements ..... 10-90
  - uplift due to expansive soils..... 10-89
  - uplift resistance of groups..... 10-120
  - uplift resistance of single ..... 10-119

wave equation analysis.....	10-105	lifting devices.....	5-211
Pin-connected plates		preservice conditions .....	5-210
packing.....	6-98	Precast deck bridges	
pin plates.....	6-97	cast-in-place closure joints .....	5-209
proportions .....	6-98	design .....	5-209
Pins		longitudinal construction joints .....	5-209
holes.....	6-97, 6-98	longitudinally post-tensioned precast decks.....	9-15
length .....	6-84	post-tensioning .....	5-209
location.....	6-83	shear transfer joints .....	5-208
materials.....	6-32	shear-flexure transfer joints .....	5-208
minimum size pin for eyebars .....	6-84	structural overlay .....	5-209
resistance.....	6-83	transversely joined precast decks .....	9-14
Pipes .....	<i>See also</i> Culverts	Precast prestressed piles	
flexibility factor .....	12-13	concrete quality .....	5-255
Plank decks .....	<i>See</i> Wood decks and deck systems	pile dimensions .....	5-254
Plastic		reinforcement .....	5-255
polyethylene pipes (PE) .....	12-9	Precast RC three-sided structures .....	12-93
polyvinyl chloride (PVC).....	12-9	concrete.....	12-93
Plastic moment.....	6-401	concrete cover for reinforcement .....	12-93
Point bearing piles		crack control.....	12-95
on rock .....	10-96	deflection .....	12-95
Poisson's Ratio		design.....	12-93
intact rock .....	10-28	footing design.....	12-95
Polytetrafluorethylene sliding surfaces.....		geometric properties.....	12-93
.....	<i>See</i> PTFE sliding surfaces	materials.....	12-93
Portal and sway bracing		minimum reinforcement.....	12-95
deck truss spans.....	6-316	reinforcement .....	12-93
through-truss spans .....	6-316	resistance factors.....	12-95
Post-tensioned anchorage zones		scour.....	12-95
anchorage and couplers .....	5-23	shear transfer in joints .....	12-94
bursting forces.....	5-118	span length .....	12-94
compressive stresses .....	5-117	structural backfill .....	12-95
design of local zones .....	5-112	Precast reinforced piles	
design of the general zone.....	5-159	pile dimensions .....	5-254
edge tension forces.....	5-119	reinforcing steel .....	5-254
limitations of application .....	5-115	Prefabricated modular walls .....	<i>See</i> Earth pressure
Pot bearings .....	<i>See</i> Bearings	abutments .....	11-117
elastomeric disc.....	14-54	bearing resistance.....	11-115
geometric requirements.....	14-52	drainage.....	11-118
materials.....	14-52	dynamic load allowance.....	3-34
piston.....	14-56	earth pressure .....	3-138
pot .....	14-55	limitations .....	11-114
sealing rings .....	14-54	loading .....	11-114
suitability .....	14-37	module members.....	11-116
reinforcement .....	14-76	movement at the service limit state .....	11-114
rotation .....	14-74	overall stability.....	11-116
seismic provisions.....	14-67	overturning.....	11-115
shape factor .....	14-57, 14-72	passive resistance and sliding .....	11-116
shear deformation.....	14-64, 14-74	safety against soil failure.....	11-115
shear modulus .....	14-58, 14-70	safety against structural failure .....	11-116
stability.....	14-66, 14-76	seismic design .....	11-117
suitability .....	14-37	sliding.....	11-115
Precast beams		subsurface erosion.....	11-116
concrete strength.....	5-211	Preservative treatment for wood	
detail design .....	5-211	fire retardant treatment.....	8-24
extreme dimensions .....	5-210	inspection and marking .....	8-24



- requirement for treatment ..... 8-23
- treatment chemicals ..... 8-23
- Prestressed concrete..... *See* Prestressing steel
- buckling ..... 5-121
- concrete cover ..... 9-14
- construction load, formwork ..... 9-13
- crack control ..... 5-121
- curved tendons ..... 5-23
- design concrete strengths ..... 5-121
- eccentric prestressing ..... 5-48
- prestress losses ..... 5-129
- reinforcement limits ..... 5-198
- section properties ..... 5-121
- service stresses ..... 5-125
- stress limitations for prestressing steel ..... 5-122
- stresses due to imposed deformation ..... 5-122
- tendon confinement ..... 5-147
- tendons with angle points or curves ..... 5-121
- Prestressing steel
  - concrete cover ..... 9-14
  - corrosion protection ..... 5-260, 5-265
  - materials ..... 5-22
  - modulus of elasticity ..... 5-23
  - stress at nominal flexural resistance ..... 5-37
- Pretensioned anchorage zones
  - confinement reinforcement ..... 5-147
  - factored bursting resistance ..... 5-146
- Probability of aberrancy
  - approximate method ..... 3-163
  - statistical method ..... 3-163
- Protective coatings ..... 5-265
- Provisional ducts and anchorages
  - bridges with internal ducts ..... 5-236
  - provision for future dead load or deflection
    - adjustment ..... 5-236
- Provisions for structure types ..... 5-228
  - arches ..... 5-247
  - beams and girders ..... 5-210
  - segmental construction ..... 5-224
  - slab superstructures ..... 5-205
- PTFE sliding surfaces ..... 14-45
  - attachment ..... 14-49
  - coefficient of friction ..... 14-48
  - contact pressure ..... 14-47
  - dimples ..... 14-45
  - filler ..... 14-45
  - mating surface ..... 14-46, 14-49
  - minimum thickness ..... 14-46
  - PTFE surface ..... 14-45
  - stainless steel mating surfaces ..... 14-47
- PVC pipes..... *See* Plastic
- Railing .....
  - See* Bicycle railing, Combination railing, Pedestrian railing, *and* Traffic railing
- Railing design
  - anchorages ..... 13-17
  - application of previously tested systems ..... 13-8
  - approach railings ..... 13-6
  - end treatment ..... 13-6
  - geometry ..... 13-15
  - height of traffic parapet or railing ..... 13-9
  - materials ..... 13-4
  - new systems ..... 13-9
  - protection of users ..... 2-4
  - test specimens ..... 13-20
- Railroad
  - rail transit load ..... 3-32
  - rails, dead load weight ..... 3-21
- Redundancy ..... 1-6
- Rectangular stress block limitations
  - approximate method ..... 5-52
  - refined method ..... 5-52
- Refined method ..... 6-374
  - nominal moment-rotation curves ..... 6-376
- Refined methods of analysis
  - arch bridges ..... 4-73
  - beam-slab bridges ..... 4-69
  - cable-stayed bridges ..... 4-73
  - cellular and box bridges ..... 4-72
  - decks ..... 4-67
  - general ..... 4-67
  - suspension bridges ..... 4-74
  - truss bridges ..... 4-72
- Reinforced concrete pipe ..... 12-49
  - bearing resistance ..... 12-64
  - bedding factor ..... 12-64
  - circumferential reinforcement ..... 12-57
  - concrete cover ..... 12-61
  - construction and installation ..... 12-68
  - crack width control ..... 12-59
  - development of quadrant mat reinforcement ..... 12-66
  - direct design method ..... 12-55
  - flexural resistance ..... 12-57
  - indirect design method ..... 12-64
  - live loads ..... 12-54
  - loading ..... 12-50
  - loads and pressure distribution ..... 12-55
  - maximum reinforcement without stirrups ..... 12-58
  - minimum reinforcement ..... 12-58
  - pipe fluid weight ..... 12-54
  - pipe ring analysis ..... 12-57
  - process and material factors ..... 12-57
  - safety against structural failure ..... 12-55
  - service limit state ..... 12-54
  - shear resistance ..... 12-61, 12-62
  - standard installations ..... 12-50
  - stirrup anchorage ..... 12-63
  - stirrup embedment ..... 12-64
- Reinforcement ..... *See* Spacing of reinforcement
  - anchorage ..... 5-188
  - closed stirrups ..... 5-189
  - compression members ..... 5-46

corrosion protection .....	5-260	load test .....	10-83
crack control .....	5-55	mass deformation .....	10-26
development length .....	5-183	mass strength .....	10-21
distribution, slabs .....	5-206	semiempirical procedures .....	10-83
external tendon supports .....	5-156	sound barrier .....	15-8
footings .....	5-250	Rocker bearings	
hollow rectangular compression members .....	5-175	alignment .....	14-43
hooks and bends .....	5-169	contact stresses .....	14-44
limits .....	5-197, 5-256	geometric requirements .....	14-44
materials .....	5-22	materials .....	6-32
modulus of elasticity .....	5-22	suitability .....	14-37
posttensioned anchorage zones .....	5-156	Roller bearings	
pretensioned anchorage zones .....	5-146	alignment .....	14-43
seismic requirements .....	5-197	contact stresses .....	14-44
shrinkage and temperature .....	5-174	geometric requirements .....	14-44
spacing of reinforcement .....	5-171	materials .....	6-32
spacing, longitudinal reinforcement ....	5-57, 5-97, 5-171, 5-224	minimum diameter .....	6-32
spacing, transverse reinforcement ....	5-63, 5-172, 5-173, 5-197, 5-201, 5-202, 5-205, 5-235, 5-255, 5-256	suitability .....	14-37
special applications .....	5-22	Route location .....	2-3
spirals and ties .....	5-50	waterway and floodplain crossings .....	2-3
tendon confinement .....	5-149	Sawn lumber .....	<i>See Wood</i>
transverse reinforcement .....	5-61, 5-62, 5-63, 5-172, 5-174	base resistance .....	8-7
Reinforcing steel .....	<i>See Reinforcement</i>	bracing .....	8-36
Relieving slabs .....	12-38, 12-48	modulus of elasticity .....	8-7
Resistance factors .....	10-40	moisture content .....	8-7
abutments, piers, and walls .....	11-15	Scour .....	2-21, 10-51, 10-100, 11-36
aluminum structures .....	7-8	buried structures .....	12-20
buried structures .....	12-11	change in foundations .....	3-46
concrete structures .....	5-198	long-span structural plate structures .....	12-38
driven piles .....	10-47	micropiles .....	10-155
geotechnical resistance of axially loaded micropiles .....	10-51	piers .....	11-36
geotechnical resistance of drilled shafts .....	10-50	precast RC three-sided structures .....	12-93
seismic zones 3 and 4 .....	5-32	water loads .....	3-46
steel .....	6-36	Sealing rings	
structural resistance of axially loaded micropiles .....	10-51	rings with circular cross-sections .....	14-55
wood structures .....	8-31	rings with rectangular cross-sections .....	14-55
Retaining walls ...	<i>See Abutments and retaining walls</i>	Section transitions .....	6-369
Rigid frame connections		Sectional design model	
webs .....	6-313	combined shear and torsion .....	5-77
Roadway		determination of $\beta$ and $\theta$ .....	5-69
width .....	3-22, 13-12	longitudinal reinforcement .....	5-75
Roadway drainage		nominal shear resistance .....	5-67, 5-232
design storm .....	2-23	sections near supports .....	5-66
discharge from deck drains .....	2-24	Segmental bridge analysis .....	5-225
drainage of structures .....	2-24	analysis of the final structural system .....	5-225
type, size and number of drains .....	2-23	construction analysis .....	5-225
Rock properties		erection analysis .....	4-65
analytic method .....	10-83	final structural system .....	4-65
erodibility .....	10-29	longitudinal analysis .....	4-64
informational needs .....	10-8	strut-and-tie models .....	4-64
		transverse analysis .....	4-64
		Segmental bridge design	
		alternative construction methods .....	5-245
		cantilever construction .....	5-241
		construction loads .....	5-226, 5-227, 5-230
		creep and shrinkage .....	5-230

deck joints.....	9-15	multispan bridges.....	4-80
design.....	5-226	single-span bridges .....	4-80
design details .....	5-243	Seismic zone 1.....	3-109
design of construction equipment.....	5-244	Seismic zone 2.....	3-111
details for cast-in-place construction .....	5-241	Seismic zones 3 and 4	
details for precast construction .....	5-240	column and pile bent design forces.....	3-114
effective flange width .....	4-64	foundation design forces.....	3-114
force effects due to construction tolerances.....	5-242	inelastic hinging forces.....	3-112
incrementally launched construction .....	5-242	modified design forces.....	3-112
launching bearing .....	5-242	pier design forces.....	3-114
launching tendons .....	5-244	piers with two or more columns .....	3-113
length of top flange cantilever .....	5-238	single columns and piers.....	3-112
loads.....	5-226	Service limit states .....	1-4, 9-5, 10-29, 10-40, 12-10
minimum flange thickness.....	5-237	abutments, piers, and walls.....	11-8
minimum web thickness .....	5-237	aluminum structures.....	7-8
overall cross-section dimensions .....	5-238	concrete structures .....	5-26, 5-33
post-tensioning.....	5-236	construction load combinations .....	5-229
prestress losses.....	5-231	decks .....	9-28
provisional ducts and anchorages .....	5-235	elastomeric bearings .....	14-65
resistance factors.....	5-230	load combinations.....	3-9, 3-17
seismic design.....	5-239	prestressing steel.....	5-122
span-by-span construction .....	5-242	sound barrier .....	15-3
substructures .....	5-247	steel structures .....	6-35
tensile stresses at joint locations.....	5-125, 5-127	wood structures.....	8-30
thermal effects during construction .....	5-230	Service limit state design	
types of segmental bridges.....	5-239	micropiles .....	10-154
Segmental bridge substructures		piles.....	10-89
construction load combinations .....	5-247	spread footings.....	10-54
longitudinal pier reinforcement .....	5-247	Serviceability	
Seismic design		deformations .....	2-10
acceleration coefficient.....	3-70	durability.....	2-8
column connections .....	5-203	inspectability.....	2-9
concrete columns .....	5-196, 5-197	maintainability .....	2-9
confinement length .....	5-204	rideability.....	2-9
construction joints.....	5-204	utilities .....	2-9
elastomeric bearings .....	14-67	widening .....	2-14
hold-down devices.....	3-115	Settlement.....	12-15
importance categories .....	3-106	force effects .....	3-158
lateral load distribution .....	4-62	foundations .....	15-3
longitudinal restrainers .....	3-115	group.....	10-135
seismic performance zones .....	3-107	long-span structural plate structures .....	12-31
soil liquefaction .....	3-69	MSE walls.....	11-61
temporary bridges/stage construction .....	3-115	single-drilled shaft .....	10-132
volumetric ratio for confinement .....	5-205	Settlement Analyses .....	10-55
wall-type piers .....	5-203	Shaft load tests.....	10-147
Seismic loads		Shaft loads	
combination of seismic force effects .....	3-108	determination of.....	10-131
design forces .....	3-109	Shear and torsion	
direction.....	3-108	aluminum .....	7-56
orthogonal forces .....	3-108	brackets.....	5-104
response modification factors .....	3-107	concrete.....	5-58, 5-64, 5-67
seismic zone 1.....	3-109	corbels.....	5-104
seismic zone 2.....	3-111	interface shear transfer—shear friction.....	5-79
seismic zones 3 and 4 .....	3-111	longitudinal reinforcement.....	5-78
Seismic requirements		prestressed concrete .....	5-67
minimum displacement requirements .....	4-87	reinforcement, seismic design.....	5-197

skewed bridges.....	4-49	deformation.....	10-18
slabs and footings.....	5-251	determination .....	11-7, 12-6
steel .....	6-369	drained strength of cohesive soils .....	10-16
torsional resistance.....	5-77	drained strength of granular soils.....	10-16
transfer and development lengths.....	5-61	envelope backfill soils.....	12-7
transverse reinforcement.....	5-77	foundation soils.....	12-7
Shear connectors.....	6-197	informational needs.....	10-8
cover and penetration.....	6-199	laboratory tests.....	10-11
design force.....	9-4	semiempirical procedures .....	10-81
fatigue resistance.....	6-199	sound barrier .....	15-8
nominal shear force.....	9-4	strength.....	10-15
permanent load contraflexure.....	6-200	subsurface exploration .....	10-8
pitch .....	6-197	undrained strength of cohesive soils .....	10-15
strength limit state.....	6-201	unit weight .....	3-21
studs.....	6-33	Soil–structure interaction systems .....	<i>See Culverts</i>
transverse spacing .....	6-199	Solid web arches.....	6-325
types.....	6-197	Sound barrier	
Shear keys.....	<i>See Keys</i>	corrosion protection .....	15-10
Shear resistance		definition.....	15-1
concrete.....	5-67	drainage.....	15-10
concrete-encased shapes .....	6-283	earth loads .....	15-5
concrete-filled tubes.....	6-283	extreme event limit state .....	15-3
prestressed concrete .....	5-67	foundation design.....	15-8
steel .....	6-245	functional requirements.....	15-1
wood.....	8-33	ground-mounted.....	15-4
Ship collision force.....	<i>See Vessel collision</i>	limit states and resistance factors.....	15-3
Shock transmission unit (STU).....		movement and stability at the service limit state .....	15-9
.....	4-5, 4-87, 14-3, 14-43	seismic design .....	15-10
Short-slotted holes .....	6-288	structure-mounted .....	15-4
Shrinkage.....	5-19	vehicular collision forces .....	15-6
Sidewalks		wind load.....	15-5
curb height .....	13-12, 13-13	Sound barrier installation	
railing.....	13-5, 13-9, 13-10	on existing bridges .....	15-5
thickness of plank decks .....	9-29	Spacing of reinforcement	
Skewed bridges		bundled bars.....	5-171
deck joints .....	14-15, 14-21	cast-in-place concrete.....	5-171
live load distribution .....	4-40, 4-46, 4-49	couplers in posttensioning tendons .....	5-149
skewed decks .....	9-12, 9-32, 9-34	curved posttensioning ducts.....	5-149
Slab bridges .....	5-280	maximum spacing of prestressing tendons and .....	
Slab superstructures		ducts in slabs .....	5-142
cast-in-place solid slab superstructures.....	5-205	maximum spacing of reinforcing bars.....	5-172
cast-in-place voided slab superstructures.....	5-206	minimum spacing of reinforcing bars .....	5-171
precast deck bridges.....	5-208	multilayers .....	5-171
Slabs .....	<i>See Concrete slabs</i>	post-tensioning ducts not curved in the horizontal .....	5-148, 5-149
Slenderness effects and limits		plane.....	5-171
concrete.....	5-47	precast concrete.....	5-171
ice load, piers .....	3-61	pretensioning strand.....	5-142
Slenderness ratios .....	<i>See Aluminum and Steel</i>	splices.....	5-171
Slip-critical connections .....	6-285	Spike laminated decks	
Soil bearing resistance		deck tie-downs .....	9-38
plate load tests.....	10-82	panel decks.....	9-38
two-layered soil system in drained loading..	10-81	Splices.....	
two-layered soil system in undrained loading .....	10-79	<i>See Bolted splices, Splices of bar reinforcement, and Splices of welded wire fabric</i>	
Soil liquefaction.....	4-11	bar reinforcement.....	5-190
Soil properties			

- bolted splices ..... 6-304
- reinforcement, deck slabs ..... 9-14
- welded splices ..... 6-312
- welded wire fabric ..... 5-194
- Splices of bar reinforcement.....*See* Lap splices
- bars in compression ..... 5-192
- detailing ..... 5-190
- end-bearing splices ..... 5-193
- lap splices ..... 5-190
- lap splices in compression ..... 5-192
- lap splices in tension ..... 5-191
- mechanical connections ..... 5-191
- mechanical/welded splices in compression.. 5-193
- mechanical/welded splices in tension ..... 5-192
- reinforcement in tension ..... 5-191
- tension tie members ..... 5-192
- welded splices ..... 5-191
- Splices of welded wire fabric
- deformed wire in tension ..... 5-194
- smooth wire in tension ..... 5-194
- Spread footings..... 10-52
- bearing depth ..... 10-52
- bearing resistance at the service limit state.. 10-67
- bearing stress distributions..... 10-53
- design of ..... 10-32
- effective footing dimensions..... 10-53
- groundwater and ..... 10-54
- nearby structures and ..... 10-54
- safety against geotechnical failure at the strength limit state..... 15-9
- service limit state design..... 10-54
- settlement of footings on cohesionless soils 10-56
- settlement of footings on cohesive soils ..... 10-62
- settlement on rock..... 10-66
- tolerable movements..... 10-54
- SPT .....*See* Standard Penetration Test
- cohesionless soils ..... 10-115
- St. Venant torsion
- aluminum ..... 7-52
- Stainless steel ..... 6-34
- Standard Penetration Test..... 10-82
- Static analysis .....*See* Approximate methods of analysis, *and* Refined methods of analysis
- analysis for temperature gradient..... 4-75
- approximate methods..... 4-22
- influence of plan geometry ..... 4-17
- moment redistribution..... 4-74
- refined methods of analysis ..... 4-67
- stability ..... 4-75
- Static load test ..... 10-103
- Stay-in-place formwork..... *See* Concrete formwork
- concrete formwork..... 9-13
- deck overhangs ..... 9-5
- steel formwork..... 9-13
- Steel
- bearing stiffeners ..... 6-370
- box-section flexural members..... *See* Steel box-section flexural members
- camber ..... *See* Camber
- closed voids in structures ..... 6-221
- coefficient of thermal expansion..... 6-30
- combined force effects..... 6-99, 6-129, 6-245
- dimension and detail requirements .....*See* Steel dimension and detail requirements
- extreme event limit state ..... 6-37
- fracture ..... 6-146
- I-girders ..... *See* Steel I-section flexural members
- I-section flexural members .....*See* Steel I-section flexural members
- I-section proportioning .....*See* Steel I-section proportioning
- modulus of elasticity ..... 6-30
- net section ..... 6-86
- orthotropic decks ..... *See* Decks *and* Orthotropic steel decks
- piles..... *See* Steel piles
- slenderness ratios ..... 6-108
- spiral rib pipes ..... 12-107
- tension members .....*See* Steel tension members
- thickness of metal ..... 6-31, 6-285
- tunnel liner plate .....*See* Steel tunnel liner plate
- web crippling ..... 6-411
- Steel box-section flexural members ..... 6-215
- access and drainage..... 6-221
- access holes..... 6-76, 6-221
- bearings..... 6-220
- compact sections..... 6-231
- constructibility ..... 6-223
- cross-section proportion limits..... 6-222
- fatigue and fracture limit state ..... 6-227
- flange-to-web connections ..... 6-221
- flexural resistance of compression flange..... 6-233, 6-235
- flexural resistance of tension flange .6-234, 6-238
- flexural resistance—negative flexure ..... 6-233
- flexural resistance—positive flexure ..... 6-231
- live load distribution factor..... 6-222
- noncompact sections ..... 6-231
- painting..... 6-221, 6-223
- service limit state ..... 6-226
- shear connectors ..... 6-239
- shear resistance ..... 6-238
- stiffeners ..... 6-240
- strength limit state ..... 6-229
- stress determinations..... 6-217
- Steel dimension and detail requirements ..... 6-65
- dead load camber ..... 6-65
- diaphragms and cross-frames..... 6-71
- effective length of span..... 6-65
- lateral bracing ..... 6-79
- minimum thickness of steel ..... 6-71
- pins ..... 6-83

Steel I-girders .. <i>See</i> Steel I-section flexural members	safety against structural failure .....	12-91
Steel I-section flexural members .....	seam strength .....	12-91
compact sections .....	section properties .....	12-91
composite sections .....	wall area .....	12-91
composite sections in negative flexure and	Stiffened webs	
noncomposite .....	end panels .....	6-196
composite sections in positive flexure .....	nominal resistance .....	6-194
constructibility .....	Stiffeners..... <i>See</i> Longitudinal stiffeners and	
cover plates .....	Transverse intermediate stiffeners	
ductility requirement .....	bearing stiffeners.....	6-208
flange stresses and member bending moments	longitudinal compression-flange stiffeners ..	6-240
.....	longitudinal stiffeners .....	6-210
flange-strength reduction factors.....	rigid frame connections.....	6-314
flexural resistance .....	structural plate culverts .....	12-42
flowcharts for design.....	transverse intermediate stiffeners.....	6-204
hybrid sections .....	web stiffeners .....	6-240
minimum deck reinforcement—negative flexure	wood decks .....	9-31, 9-38
.....	Stirrups..... <i>See</i> Transverse reinforcement	
net section fracture .....	Stream pressure	
noncompact sections .....	lateral .....	3-45
noncomposite sections .....	longitudinal .....	3-44
service limit state .....	Strength limit state .....	1-4, 9-6, 10-32, 10-40, 12-10
shear connectors.....	abutments, piers, and walls .....	11-9
steel I-section proportioning .....	aluminum structures.....	7-8
stiffeners.....	concrete structures .....	5-29, 5-33, 5-291
stiffness .....	drilled shafts.....	10-33, 10-48
strength limit state.....	driven piles.....	10-33, 10-42
variable web depth members.....	flexure .....	6-174, 6-229
web bend-buckling resistance .....	load combinations .....	3-17
wind effect on flanges .....	micropiles.....	10-33
Steel I-section proportioning	modular bridge joint systems .....	14-28
flange proportions .....	prestressing steel .....	5-123
web proportions .....	railing.....	13-5
Steel orthotropic decks.....	resistance factors.....	6-36
..... <i>See</i> Decks and Orthotropic steel decks	shear connectors.....	6-178, 6-231
Steel piles.....	sound barrier .....	15-3
axial compression.....	spread footings .....	10-32, 10-42
buckling .....	stability.....	5-32
combined axial compression and flexure ....	steel structures.....	6-244, 6-284
compressive resistance.....	wood structures .....	8-30
maximum permissible driving stresses .....	Strength limit state design.....	10-136
structural resistance.....	micropiles.....	10-154
Steel tension members .....	piles.....	10-95
built-up members .....	spread footings .....	10-69
eyebars .....	Stress laminated decks... <i>See</i> Decks and Wood decks	
limiting slenderness ratio .....	and deck systems	
net area.....	camber.....	8-37
pin-connected plates.....	deck tie-downs .....	9-33
tensile resistance .....	holes in laminations .....	9-33
Steel tunnel liner plate	nailing .....	9-33
buckling .....	staggered butt joints .....	9-33
construction stiffness .....	stressing .....	9-33
earth loads .....	thermal expansion .....	9-30
grouting pressure.....	Stressing	
live loads.....	corrosion protection .....	9-37
loading .....	design requirements .....	9-36



- prestressing materials.....9-35
- prestressing system.....9-33
- railings.....9-37
- Structural material behavior
  - elastic behavior.....4-11
  - elastic versus inelastic behavior.....4-11
  - inelastic behavior.....4-12
- Structural plate box structures.....12-42
  - concrete relieving slabs.....12-48
  - construction and installation.....12-49
  - footing reactions.....12-47
  - geometric requirements.....12-44
  - loading.....12-43
  - movements.....12-44
  - plastic moment resistance.....12-46
  - safety against structural failure.....12-43
  - service limit state.....12-43
  - soil cover factor.....12-47
  - stiffeners.....12-42
- Structure-Mounted Sound Barriers.....15-4
- Strut-and-tie model
  - crack control reinforcement.....5-97
  - general zone.....5-98, 5-291
  - nodes.....5-100
  - struts.....5-100
  - ties.....5-101
- Substructures
  - design.....5-281, 6-379
  - frictional forces, launched girders.....5-242
  - vessel collision.....2-5
- Superimposed deformations
  - creep.....3-157
  - differential shrinkage.....3-157
  - settlement.....3-158
  - temperature gradient.....3-156
  - uniform temperature.....3-153
- Superstructure design.....5-279
- Surcharge loads
  - live load surcharge.....3-149
  - point, line and strip loads—restrained walls.....3-143
  - reduction of surcharge.....3-150
  - strip loads—flexible walls.....3-147
  - uniform surcharge.....3-143
- Temporary stresses before losses
  - compression stresses.....5-123
  - tension stresses.....5-123
- Tendon confinement
  - wobble effect in slabs.....5-150
- Tensile resistance
  - aluminum.....7-35
  - wood.....8-35
- Tension flange yielding.....6-365
- Tension members
  - concrete.....5-55
  - wood.....8-35
- Tension ties
  - anchorage of tie.....5-93
  - proportioning of tension ties.....5-93
  - strength of tie.....5-93
- Thermal forces
  - temperature gradient.....3-156
  - temperature zones.....6-64, 14-59
  - uniform temperature.....3-153
- Thermoplastic pipes.....12-74
  - flexibility limit.....12-14
- Through-girder spans.....6-314
- Tie plates.....6-96, 6-130
- Timber.....*See* Wood
- Timber floors.....*See* Wood decks and deck systems
- Timber piles.....*See* Wood piles
- Tire contact area.....3-25
- Tolerable Movements and Movement Criteria. 10-30
- Traffic lanes
  - width.....3-22
- Traffic railing.....13-5
  - design forces.....13-17
  - railing design.....13-8
  - railing system.....13-5
  - test level selection criteria.....13-6
- Traffic safety
  - geometric standards.....2-5
  - protection of structures.....2-4
  - protection of users.....2-4
  - road surfaces.....2-5
  - vessel collisions.....2-5
- Transverse intermediate stiffeners
  - moment of inertia.....6-205
  - projecting width.....6-204
- Transverse reinforcement
  - compression members.....5-172, 5-199, 5-201, 5-204
  - flexural members.....5-174
  - piles.....5-197, 5-255, 5-256
- Trusses.....6-314
  - camber.....6-315, 8-37
  - diaphragms.....6-79, 6-315
  - factored resistance.....6-323
  - gusset plates.....6-316
  - half through-trusses.....6-323
  - lateral bracing.....6-83, 8-37
  - load distribution.....4-49
  - members.....6-315
  - portal and sway bracing.....6-316, 8-37
  - secondary stresses.....6-315
  - splices.....6-304
  - working lines and gravity axes.....6-316
- Unfilled grid decks composite with reinforced concrete slabs
  - design.....9-19
  - fatigue limit state.....9-19
- Uplift
  - bearings.....14-36, 14-80
  - group resistance.....10-150

ice loads .....	3-61	Web proportions .....	6-368
load test .....	10-150	webs with longitudinal stiffeners .....	6-158, 6-222
micropiles .....	10-153	webs without longitudinal stiffeners .....	6-157, 6-222
pile anchorage .....	5-197	Welded connections .....	
resistance of a single drilled shaft .....	10-149	effective area .....	6-300
resistance of pile groups .....	10-120	factored resistance .....	6-298
resistance of single piles .....	10-119	fillet weld end returns .....	6-301
spread footings .....	10-54	minimum effective length of fillet welds .....	6-301
Vehicular collision force .....	3-37	seal welds .....	6-301
protection of structures .....	3-37	size of fillet welds .....	6-300
vehicle and railway collision with structures .....	3-44	Welded wire fabric .....	
Vehicular live load .....		bend diameter .....	5-170
multiple presence of live load .....	3-22	transverse reinforcement .....	5-62
number of design lanes .....	3-22	Welding .....	
Vertical wind pressure .....	3-58	procedures for aluminum .....	7-31
Vessel collision .....	3-158	requirements for aluminum .....	7-31
annual frequency of collapse .....	3-161	weld metal .....	6-34, 6-298
barge bow damage length .....	3-174	Widening .....	
barge collision force on pier .....	3-173	exterior beams .....	2-14
damage at the extreme limit state .....	3-174	substructure .....	2-14
design collision velocity .....	3-169	Wind load .....	
design vessel .....	3-160	aeroelastic instability .....	3-59
impact force .....	3-175	horizontal wind pressure .....	3-47
impact force, substructure design .....	3-175	minimum wind velocity for erection .....	5-241
impact force, superstructure design .....	3-176	vertical wind pressure .....	3-58
importance categories .....	3-160	Wind pressure on structures .....	3-52
owner's responsibility .....	3-160	box sections .....	4-62
protection of substructures .....	3-176	construction .....	4-62
ship bow damage length .....	3-172	I-sections .....	4-60
ship collision force on pier .....	3-170	loads from superstructures .....	3-55, 3-56
ship collision force on superstructure .....	3-172	substructure forces .....	3-56
ship collision with bow .....	3-172	Wind pressure on vehicles .....	3-58
ship collision with deck house .....	3-172	Wind-induced vibration .....	
ship collision with mast .....	3-173	design considerations .....	4-79
vessel collision energy .....	3-169	dynamic effects .....	4-79
Washers .....	6-84, 6-287	wind velocities .....	4-79
Water loads .....		Wood .....	
buoyancy .....	3-44	bracing .....	8-36
drag coefficient .....	3-45	camber .....	<i>See</i> Camber
scour .....	3-46	coefficient of thermal expansion .....	9-30
static pressure .....	3-44	combined flexure and axial loading .....	8-35
stream pressure .....	3-44	compression .....	8-33
wave load .....	3-46	extreme event limit state .....	8-33
Wearing surface .....		flexure .....	8-31
chip seal .....	9-40	glued laminated timber .....	8-12
orthotropic decks .....	9-28	piles .....	8-21
plant mix asphalt .....	9-39	preservative treatment .....	<i>See</i> Preservative treatment
unit weight .....	3-21	for wood .....	
wood decks .....	9-39	sawn lumber .....	8-6
Web bend-buckling resistance .....		shear .....	8-33
webs with longitudinal stiffeners .....	6-148	tension .....	8-35
webs without longitudinal stiffeners .....	6-147	trusses .....	8-37
Web local yielding .....	6-410	Wood decks and deck systems .....	9-29
Web plastification factors .....		deck tie-downs .....	9-39
compact web sections .....	6-356	deformation .....	9-30
noncompact web sections .....	6-358	design requirements .....	9-30

load distribution .....	9-30
plank decks .....	9-30, 9-39
shear design .....	9-30
skewed decks .....	9-31
spike laminated decks .....	9-30, 9-37
stress laminated decks.....	9-32
thermal expansion.....	9-30
wearing surfaces .....	9-31
Wood piles.....	<i>See</i> Wood
modulus of elasticity.....	8-21
resistance .....	8-21
structural resistance .....	10-123
Yield moment.....	6-405
Yield strength	
composite columns .....	6-130
fasteners, wood structures.....	8-22
prestressing steel.....	5-23
reinforcing steel .....	5-22
steel tunnel liner.....	12-92
structural steel.....	6-31
transverse reinforcement.....	5-64, 5-199