

CONTENT:

1. Introduction, references	6
2. Substructure	15
2.1 Introduction	15
2.2 Structural arrangement of abutments	16
2.3 Structural arrangement of piers	23
2.4 Structural arrangement of frame supports	26
2.5 Abutments – actions and performance	27
2.5.1 Actions on abutments	27
2.5.2 Verification of abutments	29
2.5.3 Verification of foundations	30
2.5.4 Design of the top, load-bearing parts of supports	31
2.5.4.1 Concentrated compressive forces below bearings ("partially loaded areas")	31
2.5.4.2 Transversal tensile forces below bearings	32
2.5.4.3 Horizontal tensile forces at the top (loaded) surface	33
2.6 Piers – actions and performance	36
2.6.1 Actions on piers	36
2.6.2 Verification of piers	37
3. Superstructures	40
3.1 Introduction	40
3.2 Slab structures	40
3.2.1 Structural arrangement	40
3.2.2 Performance of slab structures	44
3.2.3 Ordinary reinforcement of slabs	58
3.2.4 Design of prestressed concrete slabs	60
3.2.5 Joist-in structures	61
3.3 Beam and frame structures	63
3.3.1 Basis of structural arrangement	63
3.3.2 Frame and integral bridges	72
3.3.3 Analysis	84
3.3.3.1 Idealisation of structures – calculation models of beam and frame structures	84
3.3.3.1.1 Bar models	84
3.3.3.1.2 Shell models	89

3.3.3.1.3 Combined models – isotropic slab with bars	91
3.3.3.1.4 Combined models – orthotropic slab with bars	92
3.3.3.2 Idealisation of structure behaviour – types of analysis	93
3.3.3.2.1 Linear elastic analysis	94
3.3.3.2.2 Linear elastic analysis with limited redistribution	94
3.3.3.2.3 Plastic analysis	95
3.3.3.2.4 Non-linear analysis	96
3.3.3.2.5 Analysis of discontinuity regions (usually a “local analysis”)	98
3.3.3.2.5.1 Introduction	98
3.3.3.2.5.2 Strut and tie method (STM)	101
3.3.3.3 Verification of structures	105
3.3.3.3.1 Introduction	105
3.3.3.3.2 Serviceability limit states	105
3.3.3.3.2.1 Stress limitation	105
3.3.3.3.2.2 Crack control	106
3.3.3.3.2.3 Limitation of deformations and vibrations - - road bridges	109
3.3.3.3.2.4 Limitation of deformations and vibrations – - railway bridges	110
3.3.3.3.2.5 Limitation of deformations and vibrations - - footbridges	114
3.3.3.3.3 Ultimate limit states	114
3.3.3.3.3.1 Bending moment with or without a normal force	114
3.3.3.3.3.2 Shear	118
3.3.3.3.3.2.1 Introduction	118
3.3.3.3.3.2.2 Detailing rules for arrangement of shear reinforcement	119
3.3.3.3.3.2.3 Verification of members uncracked in bending at ultimate resistance	120
3.3.3.3.3.2.4 Verification of members cracked in bending at ultimate resistance - generally	122
3.3.3.3.3.2.5 Verification of members cracked in bending at ultimate resistance – not requiring design shear reinforcement	122
3.3.3.3.3.2.6 Verification of members cracked in bending at ultimate resistance – requiring design shear reinforcement	123
3.3.3.3.3.3 Shear between web and flanges of T-sections	126
3.3.3.3.3.4 Shear and transversal bending	127
3.3.3.3.3.5 Shear at interface between concretes cast at different times	128
3.3.3.3.3.6 Torsion	130
3.3.3.3.3.7 Punching shear	133
3.3.3.3.3.8 Fatigue	133

3.3.4 Prestressing	134
3.4 Arch and vaulted structures	153
3.4.1 Principles of structural arrangement	153
3.4.2 Vaulted structures	154
3.4.3 Arch structures	156
3.5 Cable stayed and suspension structures, stress-ribbon structures	172
3.5.1 Introduction	172
3.5.2 Cable stayed structures	172
3.5.2.1 Structural arrangement	172
3.5.2.2 Design principles	181
3.5.3 Suspension structures	186
3.5.4 Hybrid structures	187
3.5.5 Stress-ribbon structures	188
4. Technologies of construction of concrete bridges	191
4.1 Introduction	191
4.2 Structures cast-in-situ on scaffolding	191
4.2.1 Introduction	191
4.2.2 Stationary scaffoldings	193
4.2.3 Movable scaffolding systems (MSS)	194
4.2.4 Special features of design and construction of cast-in-situ structures built on scaffolding	195
4.2.4.1 Choice of the cross section and of structural arrangement	195
4.2.4.2 Subdivision of the structure into construction stages, realization	199
4.2.4.3 Pre-cambering of formwork	200
4.2.4.4 Prestressing	200
4.3 Incremental launching	201
4.4 Free cantilever method (cast-in-situ)	210
4.5 Rotation	239
4.6 Segmental structures	241
4.7 Structures built of precast beams	258
4.8 Heavy prefabrication	279