

Contents

Preface	iii
Editor's remarks	iv
1 Design of concrete structures	1
1.1 Introduction	1
1.2 Sequence of activities in the design process	1
1.2.1 Conceptual design	3
1.2.2 Preliminary design	4
1.2.3 Detailed design	6
1.3 Activities and strategies during the various stages	7
1.4 Modelling	8
References to Chapter 1	9
2 Conceptual design	11
2.1 Introduction	11
2.2 What is conceptual design?	17
2.3 How is conceptual design carried out?	19
2.4 Some good examples of conceptual design	27
2.5 Strengths and weaknesses of current structural engineering and their relationship to conceptual design	32
2.6 Final remarks	33
References to Chapter 2	33
3 Materials	35
3.1 Concrete	35
3.1.1 Introduction	35
3.1.2 Classification	35
3.1.3 Concrete composition and properties at the fresh state	37
3.1.4 The structure of concrete (Hydrated cement paste – Hardened concrete)	40
3.1.5 Strength and deformation under short term loading (Compression – Tension – Multiaxial stress states)	44

3.1.6	Effects of time upon strength and deformation (Development of strength and modulus of elasticity with time – Strength and deformation under sustained high loadings – Definitions of time-dependent deformations – Shrinkage – Creep – Fatigue)	53
3.1.7	Effects of temperature on strength and deformation (Thermal strains – Maturity – Strength, fracture and deformation properties – Shrinkage and creep)	72
3.1.8	Material properties influencing concrete durability (Transport mechanisms – Physical processes – Chemical processes)	78
3.1.9	Aspects of durability design and service life prediction	94
3.1.10	Special concretes (Self-compacting concrete – Architectural concrete – Light weight concrete – Fibre reinforced concrete – Ultra high performance concrete)	95
	References to Section 3.1	137
3.2	Reinforcement	150
3.2.1	Production of steel (Steel composition – Production process – Types of steel products)	150
3.2.2	Essential properties of reinforcing steel (European normative references for reinforcement of concrete structures – Behaviour under static loading – Behaviour at extreme temperatures – Behaviour under impact loading – Fatigue behaviour – Bond properties of reinforcing steel – Bendability – Weldability – Corrosion resistance of reinforcing steel – Thermal expansion – Influence of straightening)	162
3.2.3	Classification of reinforcing steel (CEB-FIP Model Code 1990 – European normative regulations)	179
3.2.4	Essential properties of prestressing steel (European normative references for prestressing steel for concrete structures – Behaviour under static loading – Behaviour under extreme temperatures – Fatigue behaviour – Bond properties of prestressing reinforcement – Corrosion resistance of prestressing steel – Thermal expansion)	181
3.2.5	Classification of prestressing steel (CEB-FIP Model Code 1990 – European normative regulations)	192
3.2.6	Special products with improved corrosion resistance (Galvanised reinforcement (zinc-coated reinforcement) – Epoxy- coated reinforcement – Stainless steel reinforcement)	195
3.2.7	Prestressing systems and anchorages (Anchorage systems for post-tensioned reinforcement – Stressing anchorage of pretensioned reinforcement)	199

3.2.8	Connections of reinforcing steel (Welding – Mechanical connections of reinforcing bars)	200
3.2.9	Industrialisation of reinforcement	209
	References to Section 3.2	211
3.3	Composite behaviour	213
3.3.1	Composite behaviour of uncracked state (Stress and strain of uncracked composite sections – Load level dependence of strain and stress in RC and PC sections – Time-dependence of strains and stresses in RC and PC sections – References to Section 3.3.1)	213
3.3.2	Bond behaviour and models (Bond of steel to concrete – Measurement of bond performance – Modelling of bond – References to Section 3.3.2)	225
3.3.3	Tension stiffening (Introduction – Behaviour of a centrally reinforced concrete bar subjected to imposed de-formations – Derivation of a simplified load-elongation relationship – References to Section 3.3.3)	253
3.3.4	Moment-curvature relationship	261
3.3.5	Confining action of reinforcement (Mechanism of confinement – The effect of a confining reinforcement – Complete stress-strain relationships for confined concrete – References to Section 3.3.5)	270
3.3.6	Biaxial behaviour of cracked reinforced concrete (General – Dowel action – Aggregate interlock in plain cracks in concrete – The shear friction principle – Biaxial crushing criterion for cracked reinforced concrete elements under biaxial loading – References to Section 3.3.6)	277
Annex:	List of notations (green pages)	287