
Contents

Tables xi

Notation xiii

Foreword xix

Chapter 1: Introduction 1

- 1.1 Aims of the *Manual* 1
- 1.2 The Eurocode system 1
 - 1.2.1 The rationale behind the Eurocode system 1
 - 1.2.2 Role of ECO 3
 - 1.2.3 Assumptions made in ECO 3
 - 1.2.4 Using Eurocodes at a National level 3
- 1.3 Scope of the *Manual* 5
- 1.4 General principles 8
- 1.5 Notation and terminology 9

Chapter 2: Basis of Structural Design 10

- 2.1 Scope 10
- 2.2 Common terms and definitions used in ECO and EC2 to EC9 10
- 2.3 Special terms relating to design in general 11
- 2.4 Terms relating to actions 13
- 2.5 Terms relating to material and product properties and geometrical data 16
- 2.6 Requirements 16
 - 2.6.1 Basic requirements 16
 - 2.6.2 Reliability management 18
 - 2.6.3 Design working life 18
 - 2.6.4 Durability 18
 - 2.6.5 Quality management 19
- 2.7 Principles of limit states design 19
 - 2.7.1 Limit state principles and design situations 19
 - 2.7.2 Ultimate limit states 19
 - 2.7.3 Serviceability limit states 20
- 2.8 Actions 21
 - 2.8.1 General and characteristic values of actions 21
 - 2.8.2 Characteristic value of a permanent action (G_k) 21
 - 2.8.3 Values of variable actions (Q_k) 21
 - 2.8.4 Accidental actions (A_d) 22
 - 2.8.5 Geotechnical actions 22
- 2.9 Verification by the partial factor method 22

2.10	Ultimate limit states	22
2.10.1	General	22
2.10.2	Verification of static equilibrium and resistance	26
2.10.3	Combination of actions	26
2.10.4	Partial factors for actions and combinations of actions	40
2.11	Serviceability limit states	40
2.11.1	General	40
2.11.2	Verification	41
2.11.3	Combination of actions	41
2.11.4	Vertical and horizontal deformations	43
2.11.5	Vibrations	43

Chapter 3: Densities, self-weight and imposed loads in buildings 45

3.1	Scope	45
3.2	Terms and definitions	45
3.3	Classification of actions	46
3.3.1	General	46
3.3.2	Self-weight	46
3.3.3	Imposed loads	46
3.4	Design situations	47
3.4.1	General	47
3.4.2	Permanent loads	47
3.4.3	Imposed loads	48
3.5	Specific weights of construction and stored materials	48
3.6	Self-weight of construction works	49
3.6.1	Representation of actions	49
3.6.2	Characteristic values of self-weight	50
3.7	Imposed loads on buildings	50
3.7.1	Representation of actions	50
3.7.2	Load arrangements	50
3.7.3	Characteristic values of imposed loads – residential, social, commercial and administration areas	52
3.7.4	Characteristic values of imposed loads – areas for storage and industrial activities	57
3.7.5	Characteristic values of imposed loads – garages and vehicle traffic areas (excluding bridges)	62
3.7.6	Characteristic values of imposed loads – roofs	63
3.7.7	Characteristic values of imposed loads – horizontal loads on parapets and partition walls acting as barriers	65
3.8	Vehicle barriers and parapets for car parks	65
3.8.1	General	65
3.8.2	Determination of horizontal characteristic force	65
3.8.3	Heights where forces are considered to act	67

Chapter 4: Actions on structures exposed to fire 68

4.1	Scope	68
4.2	Terms and definitions	68
4.3	Structural fire design procedure	70

- 4.3.1 Introduction 70
- 4.3.2 Design fire scenario(s) 75
- 4.3.3 Design fire 75
- 4.3.4 Temperature analysis 75
- 4.3.5 Mechanical analysis 76
- 4.4 Thermal actions for temperature analysis 77
 - 4.4.1 Introduction 77
 - 4.4.2 Nominal temperature-time curves 77
 - 4.4.3 Natural fire models 78
- 4.5 Mechanical actions for structural analysis 79
 - 4.5.1 General 79
 - 4.5.2 Actions from normal temperature design 79
 - 4.5.3 Additional actions 80
 - 4.5.4 Combination rules for actions 80

Chapter 5: Snow loads 82

- 5.1 Scope 82
- 5.2 Terms and definitions 82
- 5.3 Classification of actions 83
 - 5.3.1 General 83
 - 5.3.2 Snow loads 83
- 5.4 Design situations 84
- 5.5 Snow load on the ground 84
 - 5.5.1 Characteristic values 84
 - 5.5.2 Other representative values for snow load 85
- 5.6 Snow load on roofs 87
 - 5.6.1 Nature of the load 87
 - 5.6.2 Load arrangements 87
 - 5.6.3 Snow load on the roof 87
 - 5.6.4 Snow load shape coefficients 88
- 5.7 Local effects 95
 - 5.7.1 General 95
 - 5.7.2 Roofs where drifting occurs at projections, obstructions and parapets 95
 - 5.7.3 Snow overhanging the edge of a roof 98
 - 5.7.4 Snow loads on snow-guards and other obstacles 99
- 5.8 Bulk weight density of snow 99

Chapter 6: Wind actions 100

- 6.1 Introduction 100
- 6.2 General 100
 - 6.2.1 Scope 100
 - 6.2.2 Design assisted by testing and measurement 100
 - 6.2.3 Definitions 101
- 6.3 Design situations 101
- 6.4 Wind velocity and peak velocity pressure 102
 - 6.4.1 General 102
 - 6.4.2 Basic wind velocity 104
 - 6.4.3 Terrain roughness 107

6.4.4	Closely spaced buildings and obstacles	107
6.4.5	Simplified procedure for peak velocity pressure	108
6.4.6	Large and considerably higher neighbouring structures	111
6.5	Wind pressures and forces	113
6.5.1	General	113
6.5.2	Wind pressures on a surface	113
6.5.3	Wind forces	114
6.6	Structural factor $c_s c_d$	115
6.6.1	General	115
6.6.2	Determination of $c_s c_d$	115
6.7	Pressure and force coefficients	118
6.7.1	General	118
6.7.2	Pressure coefficients for buildings	120
6.7.3	Canopy roofs	136
6.7.4	Free-standing walls, parapets and fences	142
6.7.5	Friction coefficients	144

Chapter 7: Thermal actions 145

7.1	General	145
7.1.1	Scope	145
7.1.2	Introductory advice for using this Chapter for the design of buildings	145
7.1.3	Terms and definitions	147
7.2	Classification of actions	148
7.2.1	General	148
7.2.2	Thermal actions	148
7.3	Design situations	148
7.4	Representation of actions	149
7.5	Temperature changes in buildings	150
7.5.1	General	150
7.5.2	Determination of temperatures	151
7.5.3	Determination of temperature profiles	152

Chapter 8: Actions during execution 158

8.1	General	158
8.1.1	Scope	158
8.1.2	Introductory advice for using this Chapter for the design of buildings	159
8.1.3	Terms and definitions	159
8.2	Classification of actions	159
8.2.1	General	159
8.2.2	Actions during execution	160
8.2.3	Actions (other than construction loads) during execution stages	160
8.2.4	Construction loads	160
8.3	Design situations and limit states	163
8.3.1	General – identification of design situations	163
8.3.2	Ultimate limit states	165
8.3.3	Serviceability limit states	166
8.4	Representation of actions	167
8.4.1	General	167

- 8.4.2 Actions on structural and non-structural members during handling 168
- 8.4.3 Geotechnical actions 168
- 8.4.4 Actions due to prestressing 168
- 8.4.5 Predeformations 169
- 8.4.6 Temperature, shrinkage and hydration effects 169
- 8.4.7 Wind actions 169
- 8.4.8 Snow loads 170
- 8.4.9 Actions caused by water 170
- 8.4.10 Construction loads 170
- 8.4.11 Accidental actions 173
- 8.4.12 Horizontal actions 174

Chapter 9: Accidental actions 175

- 9.1 General 175
 - 9.1.1 Scope 175
 - 9.1.2 Introductory advice for using this Chapter for the design of buildings 175
 - 9.1.3 Terms and definitions 175
- 9.2 Classification of actions 177
 - 9.2.1 General 177
 - 9.2.2 Accidental actions 177
- 9.3 Design situations 178
 - 9.3.1 General 178
 - 9.3.2 Accidental design situations – strategies for identified accidental actions 179
 - 9.3.3 Accidental design situations – strategies for limiting the extent of localised failure 180
 - 9.3.4 Accidental design situations – use of consequence classes 181
- 9.4 Impact 182
 - 9.4.1 Field of application 182
 - 9.4.2 Representation of actions 182
 - 9.4.3 Accidental actions caused by road vehicles 183
 - 9.4.4 Accidental actions caused by forklift trucks 185
 - 9.4.5 Accidental actions caused by derailed rail traffic under or adjacent to building structures 185
 - 9.4.6 Accidental actions caused by helicopters 187
- 9.5 Internal explosions in buildings 188
 - 9.5.1 Field of application 188
 - 9.5.2 Representation of action 188
 - 9.5.3 Principles for design 188
- 9.6 Design for consequences of localised failure in buildings from an unspecified cause 189
 - 9.6.1 Scope 189
 - 9.6.2 Introduction 189
 - 9.6.3 Consequence classes of buildings 189
 - 9.6.4 Horizontal ties 191
 - 9.6.5 Vertical ties 194
 - 9.6.6 Nominal section of load-bearing wall 195
 - 9.6.7 Key elements 195

References 196

Appendix A: Design data 199

Appendix B: Supplementary advice on the characteristic value of a permanent action (G_k) and values of variable actions (Q_k) 200

- B.1 Supplementary advice on Section 2.8.2
(Characteristic value of a permanent action – G_k) 200
- B.2 Supplementary advice on Section 2.8.3
(Values of variable actions – Q_k) 201

Appendix C: Combination of actions by means of expressions 6.10, 6.10a and 6.10b in EC0 203

Appendix D: Serviceability limit state verifications: Vertical and horizontal deformations 208

- D.1 General 208
- D.2 Vertical deflections 208
- D.3 Horizontal deflections 210

Appendix E: Detailed information and worked examples for fire actions 212

- E.1 Parametric fire exposure 212
- E.2 External atmosphere temperatures 218
- E.3 Equivalent time of fire exposure 218

Appendix F: Detailed procedure for wind peak velocity pressure 223

- F.1 Introduction 223
- F.2 Mean wind velocity 224
- F.3 Roughness factor 224
- F.4 Wind turbulence 227
- F.5 Peak velocity pressure 227

Appendix G: Numerical calculation of orography factor 230

Appendix H: Photographs of terrain types as defined in EC1 Part 1-4 236

Appendix I: Amended tables of external pressure coefficients for roofs 240

- I.1 Status of tables in Appendix I 240