

---

## Contents

---

Tables	xiii
Glossary	xvii
Notation	xxv
Foreword	xxix
<b>1 Introduction</b>	<b>1</b>
1.1 Aims of the <i>Manual</i>	1
1.2 The Eurocode system	1
1.2.1 Origin and purpose	1
1.2.2 List of Eurocodes	1
1.2.3 Principles and Application Rules	2
1.2.4 National Annexes	2
1.2.5 Non contradictory complementary information	2
1.2.6 Eurocode design basis	2
1.3 Scope of the <i>Manual</i>	3
1.3.1 National scope	3
1.3.2 Structures covered	3
1.3.3 Principal subjects covered	3
1.3.4 Subjects not covered	3
1.3.5 Additional information contained in the CD	4
1.3.6 Sources of additional information	4
1.4 Contents of the <i>Manual</i>	4
1.5 Definitions	4
1.5.1 Technical terms	4
1.5.2 Axis nomenclature	5
1.6 Notation	5
<b>2 General principles</b>	<b>6</b>
2.1 Basis of design	6
2.1.1 Basic requirements	6
2.1.2 Design codes	6
2.1.3 Structural materials compliance	7
2.2 Responsibility for design	7
2.3 Building use and location	8
2.4 Design life	8
2.5 Design situations	8
2.6 Stability	8
2.7 Construction	8
2.8 Movement	9
2.8.1 Moisture movement	9
2.8.2 Thermal movement	9
2.8.3 Differential movement	10
2.8.4 Movement joints	10
2.9 Creep	10
2.10 Robustness and disproportionate collapse	10
2.10.1 Robust construction	10
2.10.2 Accidental actions	10

2.11	Fire resistance	10
2.12	Acoustic, thermal and air tightness requirements	11
2.13	Durability	11
2.14	Maintenance	12
2.15	Service class	12
	2.15.1 Effect of moisture on strength and stiffness	12
	2.15.2 Definitions of service classes	12
2.16	Load duration	12
	2.16.1 Effect of load duration on strength and stiffness	12
	2.16.2 Definitions of load duration classes	13
2.17	Factors to allow for effects of moisture and load duration	13
	2.17.1 Strength modification factor, $k_{\text{mod}}$	13
	2.17.2 Deformation modification factor, $k_{\text{def}}$	13
	2.17.3 Large sections of solid timber	15
<b>3</b>	<b>Design principles</b>	<b>16</b>
3.1	Actions	16
	3.1.1 Types of action	16
	3.1.2 Characteristic values of actions	16
	3.1.3 Design values of actions	16
	3.1.4 Action combinations	16
3.2	Limit states	18
	3.2.1 Ultimate limit states (ULS)	18
	3.2.2 Serviceability limit states (SLS)	20
	3.2.3 Creep effects in assemblies	25
	3.2.4 Use of frame analysis programs	25
	3.2.5 Floor vibration	25
3.3	Timber materials	26
	3.3.1 Structural timber materials	26
	3.3.2 Dimensions and tolerances	26
	3.3.3 Characteristic values	32
	3.3.4 Design values of strength properties	38
	3.3.5 Design values of stiffness properties	48
3.4	Protective treatments	48
	3.4.1 Decay	48
	3.4.2 Insect attack	48
	3.4.3 Preservative treatment	49
	3.4.4 Surface finishes	49
	3.4.5 Corrosion of metal parts	50
	3.4.6 Spread of flame	51
3.5	Material specifications	52
	3.5.1 Overview	52
	3.5.2 Dimensions	52
	3.5.3 Materials	53
	3.5.4 Protective treatments	53
	3.5.5 Marking	53

4	Initial design	58
4.1	Scope	58
4.2	Principles of initial design	58
4.2.1	General principles	58
4.2.2	Vertical load transfer	58
4.2.3	Horizontal load transfer	58
4.2.4	Load cases	59
4.2.5	Sizing	59
4.2.6	Outline of initial design process	62
4.3	Fire resistance	63
4.3.1	Introduction	63
4.3.2	Insulation method	63
4.3.3	Sacrificial timber method	65
4.4	Movement	65
4.5	Durability	65
4.6	Acoustic, thermal insulation and air tightness requirements	65
4.6.1	General	65
4.6.2	Acoustic	65
4.6.3	Thermal insulation	66
4.7	Densities and weights	66
4.8	Roofs	68
4.8.1	Introduction	68
4.8.2	Trussed rafter roofs	70
4.8.3	Cut roofs	70
4.8.4	Other types of roof	70
4.9	Floors	72
4.9.1	Introduction	72
4.9.2	Joists and beams	72
4.9.3	Decking	73
4.10	Walls	74
4.10.1	Columns	74
4.10.2	Timber frame walls	76
4.11	Connections	77
4.11.1	Introduction	77
4.11.2	Choosing a connection method	77
4.12	Estimating	78
4.13	Completing the design	84
4.13.1	Introduction	84
4.13.2	Checking of all information	84
4.13.3	Preparation of a list of design data	85
4.13.4	Amendment of drawings as a basis for final calculations	85
4.13.5	Final design calculations	86

5	Detailed design rules	87
5.1	General design procedure for structural members	87
5.2	Flexural members (solid rectangular sections)	87
5.2.1	Straight beams	87
5.2.2	Tapered, curved and pitched cambered glulam beams (EC5 6.4.3)	90
5.3	Members subject to axial compression (solid rectangular members)	92
5.3.1	Members subject to axial compression only (EC5 6.3.2)	92
5.3.2	Members subject to axial compression and bending about the $y$ axis only (EC5 6.2.4, 6.3.2 and 6.3.3)	93
5.3.3	Members subject to axial compression and bending about both axes (EC5 6.2.4, 6.3.2 and 6.3.3)	93
5.4	Members subject to axial tension	94
5.4.1	Members subject to axial tension only (EC5 6.1.2)	94
5.4.2	Members subject to axial tension and bending about the $y$ axis only (EC5 6.1.2 and 6.2.3)	94
5.4.3	Members subject to axial tension and bending about both axes (EC5 6.1.2 and 6.2.3)	95
5.5	Flitch beams	95
5.5.1	Introduction	95
5.5.2	Scope	95
5.5.3	Design method	96
5.5.4	Strength checks	97
5.5.5	Stability	98
5.5.6	Bolts for UDLs	98
5.5.7	Bolts for point loads	99
5.5.8	Bolts at reactions	99
5.5.9	Distances, spacings and orientation	99
5.6	Providing structural stability	99
5.7	Bracing of compression members and of beam or truss systems	99
5.8	Horizontal diaphragms	100
5.8.1	Simple solution	100
5.8.2	Eurocode 5 method	100
5.9	Vertical diaphragms	102
5.10	Fire resistance	102
5.10.1	Introduction	102
5.10.2	Protection by insulation	103
5.10.3	Calculation of reduced cross-section	104
5.10.4	Rules for the analysis of reduced cross-sections	105
5.11	Building a robust structure	106

<b>6</b>	<b>Connections</b>	<b>109</b>
6.1	Introduction	109
6.2	Dowel type connections	109
6.2.1	Introduction	109
6.2.2	Specification	109
6.2.3	Lateral load capacity of a timber connection	109
6.2.4	Design values	113
6.3	Nailed connections	117
6.3.1	Introduction	117
6.3.2	Laterally loaded nails	120
6.3.3	Axially loaded nails	123
6.4	Screwed connections	124
6.4.1	Introduction	124
6.4.2	Laterally loaded screws	126
6.4.3	Axially loaded screws	127
6.5	Bolted connections	134
6.5.1	Introduction	134
6.5.2	Laterally loaded bolts	134
6.5.3	Axially loaded bolts	135
6.6	Dowelled connections	141
6.6.1	Introduction	141
6.6.2	Laterally loaded dowels	141
6.7	Glued joints	146
6.7.1	Introduction	146
6.7.2	Design	147
6.7.3	Adhesives	148
6.8	Glued rods	151
6.8.1	Introduction	151
6.8.2	Design	151
6.9	3-dimensional nailing plates	155
6.10	Punched metal plate fasteners and nailing plates	156
6.10.1	Introduction	156
6.10.2	Punched metal plate fasteners	157
6.10.3	Nailing plates	157
6.11	Timber connectors	157
6.11.1	Introduction	157
6.11.2	Design	157
6.12	Proprietary connectors	160
6.13	Joint slip	160
6.13.1	Introduction	160
6.13.2	Slip modulus	160
6.13.3	Instantaneous slip	161
6.13.4	Final slip	161
6.13.5	Allowing for slip in frame analysis programs	161
6.14	Connections in fire	161

<b>7</b>	<b>Roofs</b>	<b>163</b>
7.1	General design requirements	163
7.1.1	Functions of a roof	163
7.1.2	Data required	163
7.1.3	Actions	164
7.1.4	Bracing	165
7.1.5	Raised tie trusses	165
7.1.6	Serviceability	165
7.2	Flat roofs	165
7.3	Trussed rafters	169
7.3.1	Introduction	169
7.3.2	Design information	169
7.3.3	Stability	170
7.3.4	Notching and drilling	170
7.4	Site built cut roofs	170
7.5	Timber trusses	173
7.6	Pyramid roofs	174
7.7	Gridshells	174
<b>8</b>	<b>Floors</b>	<b>175</b>
8.1	General design requirements	175
8.1.1	Functions of a floor	175
8.1.2	Actions	175
8.1.3	Design information	175
8.2	Types of timber floor	176
8.3	Materials	177
8.3.1	Specification	177
8.3.2	Beams	177
8.3.3	Joists	180
8.3.4	Strutting	180
8.3.5	Decking	180
8.3.6	Fixing	181
8.4	Floor design	182
8.4.1	General	182
8.4.2	Ultimate limit states	182
8.4.3	Serviceability limit states	182
8.4.4	Stairwell trimming	185
8.4.5	Built up beams	186
8.5	Fire resistance	187
8.6	Robustness	187
8.7	Acoustic and thermal requirements	188
8.7.1	Acoustic	188
8.7.2	Thermal	188
<b>9</b>	<b>Low rise open frame construction</b>	<b>189</b>
9.1	Forms of open frame construction	189
9.1.1	Scope	189
9.1.2	Construction principles	189
9.1.3	Selection of type of frame and materials	189

9.2	Design	190
9.2.1	Principles	190
9.2.2	Frame imperfections	190
9.2.3	Stability and bracing	190
9.2.4	Base connections	192
9.3	Construction details	192
9.3.1	Situations to be avoided	192
9.3.2	Base details	193
9.3.3	Pin jointing techniques	193
9.3.4	Stiff jointing techniques	194
9.4	Movement	194
<b>10</b>	<b>Platform timber frame buildings</b>	<b>195</b>
10.1	Introduction	195
10.2	Design procedure	195
10.3	Actions	195
10.3.1	Wind loads	195
10.3.2	Other actions	199
10.4	Material selection	199
10.4.1	Roofs	199
10.4.2	Floors	199
10.4.3	Walls	200
10.5	Overall stability calculations	204
10.5.1	General (EC0 6.4.1(1)(a))	204
10.5.2	Overturning	206
10.5.3	Sliding	210
10.5.4	Roof uplift	210
10.5.5	Roof sliding	211
10.6	Roof design	212
10.7	Floor design	212
10.8	Wall design	213
10.8.1	Racking resistance of timber frame walls	213
10.8.2	Racking resistance in asymmetric buildings	224
10.8.3	Alternative methods of providing racking resistance	226
10.8.4	Masonry wall ties	226
10.8.5	Design of wall studs	227
10.8.6	Design of lintels	228
10.8.7	Horizontal deflection of shear walls	228
10.9	Foundations	228
10.10	Fire resistance	229
10.11	Movement	229
10.11.1	Introduction	229
10.11.2	Moisture movement	229
10.11.3	Movement from induced stresses	229
10.11.4	Interface settlement	229
10.11.5	Masonry expansion	230
10.11.6	Differential movement	230
10.11.7	Movement joints	231

10.12 Other requirements	231
10.12.1 Acoustic	231
10.12.2 Thermal	231
10.13 Robustness of platform timber frame	231
10.14 Platform timber frame above 4 storeys	232
<b>11 Checking and specification guidance</b>	<b>233</b>
11.1 General checking requirements	233
11.1.1 Local Authority checking	233
11.1.2 General checking	233
11.2 Codes and standards	234
11.3 Material specifications	234
11.4 Protection against decay and insect attack	234
11.5 Deflection and creep	234
11.6 Trussed rafter roofs	234
11.7 Floors	235
11.8 Platform timber frame	235
11.9 Checking aids	235
<b>12 Workmanship, installation, control and maintenance</b>	<b>236</b>
12.1 General	236
12.2 Members	236
12.2.1 Condition of timber members	236
12.2.2 Moisture content	236
12.2.3 Dimensions	236
12.2.4 Modifications	237
12.2.5 Treatment of cut surfaces	237
12.3 Connections	237
12.3.1 General	237
12.3.2 Nailed connections	237
12.3.3 Screwed connections	237
12.3.4 Bolted connections	238
12.3.5 Dowelled connections	238
12.3.6 Connections made with timber connectors	238
12.3.7 Adhesively bonded joints	238
12.4 Trussed rafters	239
12.5 Storage and handling	239
12.5.1 Protection of materials and components	239
12.5.2 Handling	239
12.6 Assembly, erection and installation	239
12.6.1 General	239
12.6.2 Trussed rafters	239
12.6.3 Floors	240
12.7 Treatments	247
12.7.1 Preservative and flame retardant treatments	247
12.7.2 Anti-corrosive treatments	247
12.7.3 Decorative treatments	247

12.8	Production and site control	247
12.8.1	Control plan	247
12.8.2	Inspection	248
12.9	Maintenance	248
12.9.1	Responsibility	248
12.9.2	Tightening of bolts	248
12.9.3	Ancillary components	248
12.9.4	Structural metal-work	248
12.9.5	Other matters	248
	References	249
	Appendix A – Design values for a robust design	255
	Appendix B – Useful UK organisations	258

---

## CD Contents

---

### Part 1 Material properties

- CD1.1 Properties of solid timber strength classes
- CD1.2 Properties of strength-graded oak
- CD1.3 Properties of grade TH1 American hardwoods
- CD1.4 Properties of glued laminated softwood strength classes
- CD1.5 Properties of some common types of LVL
- CD1.6 Properties of OSB/3 and OSB/4
- CD1.7 Properties of wood particleboard (chipboard)

For material properties of plywood reference should be made to BS 5268-2 Tables 40 to 56, and to Section 3.3.3 of the Manual for conversion formulae.

### Part 2 Laterally loaded fastener spreadsheets

- CD2.1 Calculation basis for fastener spreadsheets
- CD2.2 Nailed connections
- CD2.3 Screwed connections
- CD2.4 Bolted connections
- CD2.5 Dowelled connections

### Part 3 Provision of restraint against the rotation of individual timber frame walls

### Part 4 Design values for timber connectors

### Part 5 Contact details for the manufacturers of some timber construction products

### Part 6 Contact information of sponsor organisations