

# DIN EN 1992-1-1:2025-09 (E)

## Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings, bridges and civil engineering structures

---

<b>Contents</b>		<b>Page</b>
European foreword .....		12
0 Introduction .....		14
1 Scope .....		17
1.1 Scope of EN 1992-1-1 .....		17
1.2 Assumptions.....		17
2 Normative references .....		17
3 Terms, definitions and symbols .....		19
3.1 Terms and definitions.....		19
3.2 Symbols and abbreviations.....		31
3.2.1 Latin upper case letters.....		31
3.2.2 Latin lower case letters .....		36
3.2.3 Greek letters.....		45
3.3 Symbols in Annex A.....		53
3.3.1 Latin upper case letters.....		53
3.3.2 Latin lower case letters .....		54
3.3.3 Greek lower case letters .....		54
3.4 Symbols in Annex I.....		54
3.4.1 Latin upper case letters.....		54
3.4.2 Latin lower case letters .....		54
3.4.3 Greek lower case letters .....		55
3.5 Symbols in Annex J.....		55
3.5.1 Latin upper case letters.....		55
3.5.2 Latin lower-case letters.....		56
3.5.3 Greek lower-case letters.....		57
3.6 Symbols in Annex L.....		58
3.6.1 Latin upper case letters.....		58
3.6.2 Latin lower case letters .....		58
3.6.3 Greek letters.....		59
3.7 Symbols in Annex R .....		59
3.7.1 Latin upper case letters.....		59
3.7.2 Latin lower case letters .....		60
3.7.3 Greek letters.....		60
3.8 Abbreviations .....		60
3.9 Units .....		61
3.10 Sign conventions.....		61
4 Basis of design .....		61
4.1 General rules.....		61
4.1.1 Basic requirements.....		61
4.1.2 Structural reliability and quality management.....		62
4.1.3 Design service life .....		62
4.2 Basic variables.....		62
4.2.1 Actions and time-dependent effects.....		62
4.2.2 Geometric data .....		64
4.3 Verification by the partial factor method.....		64
4.3.1 Partial factor for shrinkage action.....		64
4.3.2 Partial factors for prestress action .....		64
4.3.3 Partial factors for materials .....		65
4.4 Requirements for connection of elements to concrete members.....		65

5	Materials.....	66
5.1	Concrete.....	66
5.1.1	General.....	66
5.1.2	Properties and related conditions.....	66
5.1.3	Strength.....	67
5.1.4	Elastic deformation.....	68
5.1.5	Creep and shrinkage.....	68
5.1.6	Design assumptions.....	70
5.2	Reinforcing steel.....	72
5.2.1	General.....	72
5.2.2	Properties.....	72
5.2.3	Welding of reinforcing bars.....	73
5.2.4	Design assumptions.....	73
5.2.5	Reinforcement bar couplers.....	74
5.2.6	Headed bars for reinforcement.....	74
5.3	Prestressing steel.....	74
5.3.1	General.....	74
5.3.2	Properties.....	75
5.3.3	Design assumptions.....	76
5.4	Prestressing systems.....	77
5.4.1	General.....	77
5.4.2	Anchorage zones.....	78
6	Durability and concrete cover.....	78
6.1	General.....	78
6.2	Requirements for durability.....	78
6.3	Environmental exposure conditions.....	79
6.4	Exposure resistance classes.....	83
6.5	Concrete cover.....	84
6.5.1	Nominal cover.....	84
6.5.2	Minimum cover.....	84
6.5.3	Allowance in design for deviation in cover.....	88
7	Structural analysis.....	89
7.1	General.....	89
7.2	Structural modelling for analysis.....	89
7.2.1	Geometric imperfections.....	89
7.2.2	Idealisation of the structure.....	93
7.2.3	Geometric data.....	93
7.3	Methods of analysis.....	95
7.3.1	Linear elastic analysis.....	95
7.3.2	Linear elastic analysis with redistribution.....	96
7.3.3	Plastic analysis.....	98
7.3.4	Non-linear analysis.....	98
7.4	Second order structural analysis of members and systems with axial force.....	99
7.4.1	General.....	99
7.4.2	Creep.....	100
7.4.3	Methods of analysis.....	100
7.4.4	Compression member with biaxial bending.....	102
7.5	Lateral instability of slender beams.....	103
7.6	Prestressed members and structures.....	103
7.6.1	General.....	103
7.6.2	Prestressing force.....	104
7.6.3	Immediate losses of prestress.....	104

7.6.4	Time dependent losses of prestress .....	106
7.6.5	Effects of prestressing at ultimate limit state .....	107
8	Ultimate Limit States (ULS) .....	108
8.1	Bending with or without axial force .....	108
8.1.1	General .....	108
8.1.2	Stress distribution in the compression zones.....	110
8.1.3	Bending in slabs .....	110
8.1.4	Confined concrete .....	111
8.2	Shear .....	113
8.2.1	General verification procedure .....	113
8.2.2	Detailed verification for members without shear reinforcement.....	117
8.2.3	Members with shear reinforcement.....	121
8.2.4	In-plane shear and transverse bending .....	126
8.2.5	Shear between web and flanges.....	127
8.2.6	Shear at interfaces .....	129
8.3	Torsion and combined actions .....	134
8.3.1	General considerations for torsion .....	134
8.3.2	Internal forces due to torsion in compact or closed sections.....	134
8.3.3	Internal forces due to torsion in open sections.....	135
8.3.4	Torsional resistance of compact or closed sections .....	135
8.3.5	Design procedure for combination of actions.....	136
8.3.6	Interaction formula .....	137
8.4	Punching.....	137
8.4.1	General .....	137
8.4.2	Shear-resisting effective depth, control perimeter and shear stress.....	138
8.4.3	Punching shear resistance of slabs without shear reinforcement.....	142
8.4.4	Punching shear resistance of slabs with shear reinforcement.....	145
8.5	Design with strut-and-tie models and stress fields.....	148
8.5.1	General .....	148
8.5.2	Struts and compression fields .....	150
8.5.3	Ties .....	152
8.5.4	Nodes .....	152
8.5.5	Transfer of concentrated forces into a member .....	155
8.6	Partially loaded areas.....	157
9	Serviceability Limit States (SLS) .....	160
9.1	General .....	160
9.2	Stress limitations and crack control.....	161
9.2.1	General considerations .....	161
9.2.2	Minimum reinforcement areas to avoid yielding.....	163
9.2.3	Refined control of cracking.....	165
9.3	Deflection control.....	171
9.3.1	General consideration .....	171
9.3.2	Simplified deflection control by span/depth-ratio for buildings .....	171
9.3.3	Simplified calculation of deflections for reinforced concrete building structures	173
9.3.4	General method for deflection calculations.....	174
9.4	Vibrations.....	175
10	Fatigue .....	176
10.1	General .....	176
10.2	Combination of actions.....	176
10.3	Internal forces and stresses for fatigue verification .....	176
10.4	Simplified verification of reinforcing or prestressing steel.....	178

10.5	Simplified verification of concrete under compression.....	178
10.6	Simplified verification of concrete under shear .....	179
10.7	Simplified verification of shear at interfaces.....	179
11	Detailing of reinforcement and post-tensioning tendons .....	180
11.1	General.....	180
11.2	Spacing of bars .....	180
11.3	Permissible mandrel diameters for bent bars .....	181
11.4	Anchorage of reinforcing steel in tension and compression.....	182
11.4.1	General.....	182
11.4.2	Anchorage of straight bars.....	183
11.4.3	Anchorage of bundles .....	186
11.4.4	Anchorage of bars with bends and hooks.....	187
11.4.5	Anchorage of bars with welded transverse reinforcement .....	187
11.4.6	Anchorage of U-bar loops .....	188
11.4.7	Anchorage of headed bars in tension.....	188
11.4.8	Anchorage of bonded post-installed reinforcing steel .....	190
11.5	Laps of reinforcing steel in tension and compression and mechanical couplers ...	191
11.5.1	General.....	191
11.5.2	All types of laps .....	191
11.5.3	Laps of bundles .....	195
11.5.4	Laps using U-bar loops .....	196
11.5.5	Laps using headed bars.....	198
11.5.6	Mechanical couplers .....	200
11.5.7	Full penetration butt weld and fillet weld splices.....	200
11.6	Post-tensioning tendons.....	201
11.6.1	General.....	201
11.6.2	Minimum spacing of ducts .....	201
11.6.3	Minimum radius of curvature and straight length of tendons adjacent to anchorages .....	202
11.6.4	Anchorage, couplers and deviators of post-tensioning tendons.....	203
11.7	Deviation forces due to curved tensile and compressive chords .....	203
12	Detailing of members and particular rules .....	204
12.1	General.....	204
12.2	Minimum reinforcement rules.....	204
12.3	Beams .....	206
12.3.1	General.....	206
12.3.2	Longitudinal reinforcement.....	208
12.3.3	Shear and torsion reinforcement.....	209
12.3.4	Suspension reinforcement for indirect support.....	211
12.4	Slabs .....	211
12.4.1	General.....	211
12.4.2	Shear reinforcement .....	213
12.5	Slab-column connections and column bases.....	213
12.5.1	Punching shear reinforcement.....	213
12.5.2	Integrity reinforcement against progressive collapse of flat slabs.....	216
12.6	Columns .....	217
12.7	Walls and deep beams.....	218
12.8	Foundations .....	219
12.9	Tying systems for robustness of buildings .....	221
12.9.1	General.....	221
12.9.2	Dimensioning of ties .....	222
12.9.3	Required resistances for ties .....	222

12.10	Supports, bearings and expansion joints.....	223
13	Additional rules for precast concrete elements and structures.....	226
13.1	General.....	226
13.2	Specific requirements.....	226
13.3	Concrete.....	226
13.3.1	Strength for heat curing.....	226
13.3.2	Creep and shrinkage.....	226
13.4	Structural analysis.....	227
13.4.1	General.....	227
13.4.2	Losses of prestress during heat curing.....	227
13.5	Design and detailing of pre-tensioning tendons.....	228
13.5.1	Arrangement of tendons.....	228
13.5.2	Anchorage zones.....	229
13.5.3	Transfer of prestress.....	229
13.5.4	Anchorage of tensile force at ULS.....	230
13.5.5	Shear resistance of precast members without shear reinforcement.....	231
13.6	Floor systems for buildings.....	232
13.6.1	Distribution of loads.....	232
13.6.2	Diaphragm action.....	233
13.6.3	Tying systems for buildings.....	233
13.7	Connections and supports.....	234
13.7.1	Connections.....	234
13.7.2	Supports.....	236
13.8	Pocket foundations for buildings.....	236
13.8.1	General.....	236
13.8.2	Pocket foundations with keyed surface.....	236
13.8.3	Pocket foundations with smooth or rough surfaces.....	237
14	Plain and lightly reinforced concrete structures.....	238
14.1	General.....	238
14.2	Concrete.....	238
14.3	Structural analysis.....	238
14.4	Ultimate limit states.....	239
14.4.1	General.....	239
14.4.2	Design resistance to bending with axial force.....	239
14.4.3	Shear.....	239
14.4.4	Torsion.....	240
14.4.5	Ultimate limit states induced by structural deformation (buckling).....	240
14.5	Serviceability limit states.....	242
14.6	Detailing of members and particular rules.....	243
14.6.1	Structural members.....	243
14.6.2	Construction joints.....	243
14.6.3	Strip and pad footings.....	243
Annex A (informative)	Adjustment of partial factors for materials.....	244
A.1	Use of this annex.....	244
A.2	Scope and fields of application.....	244
A.3	General.....	244
Annex B (normative)	Time dependent behaviour of materials: strength, creep, shrinkage and elastic strain of concrete and relaxation of prestressing steel.....	251
B.1	Use of this annex.....	251

B.2	Scope and field of application.....	251
B.3	General.....	251
B.4	Development of concrete strength and stiffness with time .....	252
B.5	Basic formulae for determining the creep coefficient.....	253
B.6	Basic formulae for determining the shrinkage strain .....	256
B.7	Tests on elastic deformations, creep and shrinkage.....	258
B.8	Detailed analysis for creep at variable loading.....	259
B.9	Relaxation of prestressing steel.....	260
<b>Annex C (normative) Requirements for materials .....</b>		<b>262</b>
C.1	Use of this annex.....	262
C.2	Scope and field of application.....	262
C.3	Concrete.....	262
C.4	Reinforcing steel.....	262
C.5	Prestressing steel.....	265
C.6	Couplers.....	268
C.7	Headed bars .....	269
C.8	Post-installed reinforcing steel systems.....	269
<b>Annex D (informative) Evaluation of early-age and long-term cracking due to restraint .</b>		<b>271</b>
D.1	Use of this annex.....	271
D.2	Scope and field of application.....	271
D.3	General.....	271
D.4	Assessment of temperature history .....	272
D.5	Stress calculations .....	274
D.6	Crack width calculations .....	275
<b>Annex E (normative) Additional rules for fatigue verification .....</b>		<b>276</b>
E.1	Use of this annex.....	276
E.2	Scope and field of application.....	276
E.3	General.....	276
E.4	Verification using damage equivalent stress range.....	276
E.5	Explicit verifications using <i>Palmgren-Miner</i> Rule.....	278
<b>Annex F (informative) Safety formats for non-linear analysis.....</b>		<b>281</b>
F.1	Use of this annex.....	281
F.2	Scope and field of application.....	281
F.3	General.....	281
F.4	Partial factor method (PFM) .....	282
F.5	Global factor method (GFM).....	283

<b>F.6</b>	<b>Full probabilistic method .....</b>	<b>284</b>
<b>F.7</b>	<b>Model uncertainty .....</b>	<b>284</b>
	<b>Annex G (normative) Design of membrane-, shell- and slab elements.....</b>	<b>286</b>
<b>G.1</b>	<b>Use of this annex .....</b>	<b>286</b>
<b>G.2</b>	<b>Scope and field of application .....</b>	<b>286</b>
<b>G.3</b>	<b>Design of membrane elements in ULS .....</b>	<b>286</b>
<b>G.4</b>	<b>Design of shell- and slab elements in ULS.....</b>	<b>288</b>
<b>G.5</b>	<b>Refined control of cracking in membrane elements in SLS .....</b>	<b>291</b>
	<b>Annex H (informative) Guidance on design of concrete structures for water-tightness ....</b>	<b>293</b>
<b>H.1</b>	<b>Use of this annex .....</b>	<b>293</b>
<b>H.2</b>	<b>Scope and field of application .....</b>	<b>293</b>
<b>H.3</b>	<b>General .....</b>	<b>293</b>
<b>H.4</b>	<b>Tightness classes .....</b>	<b>293</b>
	<b>Annex I (informative) Assessment of Existing Structures.....</b>	<b>296</b>
<b>I.1</b>	<b>Use of this annex .....</b>	<b>296</b>
<b>I.2</b>	<b>Scope and field of application .....</b>	<b>296</b>
<b>I.3</b>	<b>General .....</b>	<b>296</b>
<b>I.4</b>	<b>Basis of assessment .....</b>	<b>297</b>
<b>I.5</b>	<b>Materials .....</b>	<b>299</b>
<b>I.6</b>	<b>Durability - Minimum cover for bond .....</b>	<b>301</b>
<b>I.7</b>	<b>Structural analysis .....</b>	<b>302</b>
<b>I.8</b>	<b>Ultimate Limit States (ULS).....</b>	<b>303</b>
<b>I.9</b>	<b>Serviceability Limit States (SLS) .....</b>	<b>310</b>
<b>I.10</b>	<b>Fatigue .....</b>	<b>310</b>
<b>I.11</b>	<b>Detailing of reinforcement and post-tensioning tendons .....</b>	<b>311</b>
<b>I.12</b>	<b>Detailing of members and particular rules - Minimum reinforcement rules.....</b>	<b>314</b>
	<b>Annex J (informative) Strengthening of Existing Concrete Structures with CFRP.....</b>	<b>315</b>
<b>J.1</b>	<b>Use of this annex .....</b>	<b>315</b>
<b>J.2</b>	<b>Scope and field of application .....</b>	<b>315</b>
<b>J.3</b>	<b>General .....</b>	<b>315</b>
<b>J.4</b>	<b>Basis of design .....</b>	<b>315</b>
<b>J.5</b>	<b>Materials .....</b>	<b>316</b>
<b>J.6</b>	<b>Durability .....</b>	<b>318</b>
<b>J.7</b>	<b>Structural analysis .....</b>	<b>318</b>
<b>J.8</b>	<b>Ultimate Limit States (ULS).....</b>	<b>319</b>
<b>J.9</b>	<b>Serviceability Limit States (SLS) .....</b>	<b>324</b>

J.10	Fatigue.....	325
J.11	Bond and anchorage of CFRP systems .....	326
J.12	Detailing of members and particular rules .....	332
J.13	Additional rules for precast concrete elements and structures .....	333
J.14	Lightly reinforced concrete structures .....	333
J.15	Material requirements for ABR strengthening systems .....	333
<b>Annex K (normative) Bridges.....</b>		<b>334</b>
K.1	Use of this annex.....	334
K.2	Scope and field of application.....	334
K.3	Terms, definitions and symbols.....	334
K.4	Basis of design .....	334
K.5	Materials.....	334
K.6	Durability and concrete cover.....	334
K.7	Structural analysis.....	336
K.8	Ultimate limit states (ULS).....	336
K.9	Serviceability limit states (SLS) .....	336
K.10	Fatigue verification .....	337
K.11	Detailing of reinforcement and post-tensioning tendons .....	346
K.12	Detailing of members and particular rules .....	346
K.13	Additional rules for precast concrete elements and structures .....	348
K.14	Plain and lightly reinforced concrete structures.....	349
K.15	Amendments to Annex G .....	349
<b>Annex L (informative) Steel Fibre Reinforced Concrete Structures.....</b>		<b>350</b>
L.1	Use of this annex.....	350
L.2	Scope and field of application.....	350
L.3	General.....	350
L.4	Basis of design - Partial factors for materials .....	350
L.5	Materials.....	351
L.6	Durability - Minimum cover .....	354
L.7	Structural analysis - Plastic analysis.....	354
L.8	Ultimate Limit States (ULS) .....	355
L.9	Serviceability Limit States (SLS) - Crack control.....	358
L.10	Fatigue.....	359
L.11	Detailing of reinforcement and post-tensioning tendons .....	359
L.12	Detailing of members and particular rules .....	359
L.13	Additional rules for precast concrete elements and structures .....	361

L.14	Lightly reinforced SFRC structures .....	361
L.15	Requirements for Materials: SFRC .....	362
Annex M (normative) Lightweight aggregate concrete structures .....		364
M.1	Use of this annex .....	364
M.2	Scope and field of application .....	364
M.3	General .....	364
Annex N (informative) Recycled aggregates concrete structures .....		367
N.1	Use of this annex .....	367
N.2	Scope and field of application .....	367
N.3	General .....	367
Annex O (informative) Simplified approaches for second order effects .....		370
O.1	Use of this Annex .....	370
O.2	Scope and field of application .....	370
O.3	Critical load of building structures .....	370
O.4	Critical load of isolated members .....	371
O.5	Slenderness ratio and effective length of isolated members .....	372
O.6	Slenderness criteria for isolated members .....	373
O.7	Simplified analysis of isolated members based on nominal curvature .....	373
O.8	Second order elastic method .....	376
Annex P (informative) Alternative cover approach for durability .....		378
P.1	Use of this Annex .....	378
P.2	Scope and field of application .....	378
P.3	Minimum cover .....	378
P.4	Indicative strength classes for durability .....	380
Annex Q (normative) Stainless reinforcing steel .....		381
Q.1	Use of this annex .....	381
Q.2	Scope and field of application .....	381
Q.3	General .....	381
Q.4	Minimum cover for durability .....	382
Q.5	Fatigue verification .....	383
Annex R (informative) Embedded FRP reinforcement .....		384
R.1	Use of this annex .....	384
R.2	Scope and field of application .....	384
R.3	General .....	384
R.4	Verification- Partial factors for FRP reinforcement .....	384
R.5	Materials .....	385

<b>R.6</b>	<b>Durability - Concrete cover.....</b>	<b>387</b>
<b>R.7</b>	<b>Structural analysis.....</b>	<b>387</b>
<b>R.8</b>	<b>Ultimate Limit States (ULS) .....</b>	<b>387</b>
<b>R.9</b>	<b>Serviceability Limit States (SLS) - Special rules for FRP reinforcement .....</b>	<b>389</b>
<b>R.10</b>	<b>Fatigue.....</b>	<b>390</b>
<b>R.11</b>	<b>Detailing of FRP reinforcement .....</b>	<b>390</b>
<b>R.12</b>	<b>Detailing of members and particular rules .....</b>	<b>392</b>
<b>R.13</b>	<b>Additional rules for precast concrete elements and structures .....</b>	<b>394</b>
<b>R.14</b>	<b>Lightly reinforced concrete structures .....</b>	<b>394</b>
<b>R.15</b>	<b>Material requirements for FRP reinforcement .....</b>	<b>395</b>
<b>R.16</b>	<b>Surface reinforcement for large diameter bars .....</b>	<b>395</b>
<b>Annex S (informative) Minimum reinforcement for crack control and simplified control of cracking .....</b>		<b>396</b>
<b>S.1</b>	<b>Use of this annex.....</b>	<b>396</b>
<b>S.2</b>	<b>Scope and field of application.....</b>	<b>396</b>
<b>S.3</b>	<b>Minimum reinforcement areas for crack width control .....</b>	<b>396</b>
<b>Bibliography .....</b>		<b>400</b>