

ISO 15673:2016-12 (E)

Guidelines for the simplified design of structural reinforced concrete for buildings

Contents		Page
Foreword		ix
Introduction		x
1	Scope	1
2	Normative references	1
3	Terms and definitions	2
4	Symbols and abbreviated terms	13
4.1	Symbols	13
4.2	Abbreviated terms	16
5	Design and construction procedure	17
5.1	Procedure	17
5.1.1	Step A	17
5.1.2	Step B	17
5.1.3	Step C	17
5.1.4	Step D	17
5.1.5	Step E	17
5.1.6	Step F	17
5.1.7	Step G	17
5.1.8	Step H	17
5.1.9	Step I	17
5.1.10	Step J	18
5.1.11	Step K	18
5.2	Design documentation	19
5.2.1	General	19
5.2.2	Calculation memoir	19
5.2.3	Geotechnical report	19
5.2.4	Structural drawings	19
5.2.5	Specifications	19
6	General guides	19
6.1	Limitations	19
6.1.1	Occupancy	19
6.1.2	Maximum number of stories	20
6.1.3	Maximum area per floor	20
6.1.4	Maximum story height	20
6.1.5	Maximum span length	20
6.1.6	Maximum difference in span length	20
6.1.7	Minimum number of spans	21
6.1.8	Maximum cantilever span	21
6.1.9	Maximum slope for slabs, girders, beams and joists	21
6.1.10	Maximum slope of the terrain	21
6.1.11	Distance between centre of mass and centre of rigidity	21
6.2	Limit states	21
6.3	Ultimate limit state design format	21
6.3.1	General	21
6.3.2	Required factored strength	22
6.3.3	Design strength	22

6.4	Serviceability limit state design format	22
7	Specific guides	23
7.1	Structural systems and layout	23
7.1.1	Description of the components of the structure	23
7.1.2	General programme	24
7.1.3	Structural layout	25
7.1.4	Feasibility under the guidelines	28
8	Actions (loads)	29
8.1	General	29
8.1.1	Load factors and load combinations	29
8.1.2	Mass of materials	31
8.1.3	Dead loads	31
8.1.4	Live loads	32
8.1.5	Specified snow load	32
8.1.6	Specified wind forces	32
8.1.7	Specified earthquake forces	32
8.1.8	Seismic design base shear	39
9	General reinforced concrete requirements	40
9.1	General	40
9.2	Additional requirements	40
9.3	Materials for reinforced concrete	40
9.3.1	General	40
9.3.2	Cement	40
9.3.3	Aggregates	40
9.3.4	Water	40
9.3.5	Steel reinforcement	40
9.3.6	Admixtures	41
9.3.7	Storage of materials	41
9.3.8	Minimum and maximum reinforcement bar diameter	41
9.3.9	Concrete mixture specification	42
9.3.10	Concrete cover to reinforcement	42
9.3.11	Minimum reinforcement bend diameter	43
9.3.12	Standard hook dimensions	44
9.3.13	Bar spacing and maximum aggregate size	45
9.3.14	Maximum nominal coarse aggregate size	45
9.3.15	Minimum clear spacing between parallel bars in a layer	46
9.3.16	Minimum clear spacing between parallel layers of reinforcement	46
9.3.17	Minimum clear spacing between longitudinal bars in columns	47
9.3.18	Clear spacing between parallel lap splices	48
9.3.19	Maximum flexural reinforcement spacing in solid slabs	48
9.3.20	Maximum shrinkage and temperature reinforcement spacing in solid slabs	48
9.3.21	Maximum reinforcement spacing in structural concrete walls	49
9.3.22	Special details per element type	49
9.4	Development length, lap splicing and anchorage of reinforcement	49
9.4.1	Development length	49
9.4.2	Lap splice dimensions	51
9.4.3	Minimum standard hook anchorage distance	51
9.5	Limits for longitudinal reinforcement	52
9.5.1	General	52
9.5.2	Solid slabs and footings	52
9.5.3	Girders, beams and joists	53
9.5.4	Columns	55
9.5.5	Structural concrete walls	55
9.6	Minimum amounts of transverse reinforcement	56
9.6.1	General	56
9.6.2	Slabs	56
9.6.3	Girders, beams and joists	56
9.6.4	Columns	56

9.6.5	Structural concrete walls	60
9.7	Strength of members subjected to bending moments	61
9.7.1	General	61
9.7.2	Factored bending moment at section	61
9.7.3	Minimum design bending moment strength	61
9.7.4	Design moment strength for rectangular sections with tension reinforcement only	61
9.7.5	Use of compression reinforcement in girders, beams, and joists	62
9.7.6	T-beam effect	64
9.8	Strength of members subjected to shear stresses	66
9.8.1	General	66
9.8.2	Factored shear	67
9.8.3	Design shear strength	67
9.8.4	Beam-action shear	67
9.8.5	Two-way action shear (punching shear) in solid slabs and footings	70
10	Floor systems	71
10.1	Types of floor systems	71
10.1.1	General	71
10.1.2	Slab-on-girder system	71
10.1.3	Description of the basic system	71
10.1.4	Joist systems	74
10.2	Criteria for the selection of the floor system	77
10.3	Guides for structural integrity	78
10.3.1	General	78
10.3.2	Perimeter girders in slab-and-girder and joist systems	78
10.3.3	Other beams and girders	78
10.3.4	Joists	78
10.4	One-way and two-way slabs and load path	78
10.4.1	General	78
10.4.2	One-way behaviour	78
10.4.3	Two-way behaviour	79
10.4.4	Floor system load path	79
10.5	Minimum depth for elements of the floor system	79
10.5.1	General	79
10.5.2	Solid one-way slabs supported by girders, beams, joists, or structural walls	79
10.5.3	Girders, beams and one-way joists supporting the slab	80
10.5.4	Two-way slabs supported by girders, beams, or structural concrete walls	81
10.6	Initial trial dimensions for the floor system	82
11	Solid slabs supported on girders, beams, joists or structural concrete walls	82
11.1	General	82
11.2	Design load definition	82
11.2.1	Loads to be included	82
11.2.2	Dead load and live load	82
11.2.3	Factored design loads	82
11.3	Details of reinforcement	83
11.3.1	General	83
11.3.2	Shrinkage and temperature reinforcement	83
11.3.3	Positive flexural reinforcement	83
11.3.4	Negative flexural reinforcement	84
11.3.5	Shear reinforcement	85
11.3.6	Corner reinforcement	85
11.4	Top thin solid slab that spans between joists	87
11.4.1	Dimensional guidelines	87
11.4.2	Factored bending moment	87
11.4.3	Reinforcement	87
11.4.4	Shear strength verification	88
11.4.5	Calculation of the reactions on the joists	88
11.5	Cantilevers of slabs supported on girders, beams or walls	88
11.5.1	Dimensional guidelines	88
11.5.2	Factored negative bending moment	88
11.5.3	Reinforcement	89

11.5.4	Shear verification	91
11.5.5	Calculation of reactions on the supports	92
11.6	One-way one-span solid slabs spanning between girders, beams, or structural concrete walls	92
11.6.1	Dimensional guidelines	92
11.6.2	Factored bending moment	92
11.6.3	Longitudinal flexural reinforcement	92
11.6.4	Shear verification	93
11.6.5	Calculation of the reactions on the supports	94
11.7	One-way solid slabs supported on girders, beams, or walls, with two or more spans	94
11.7.1	Dimensional guidelines	94
11.7.2	Factored bending moment	94
11.7.3	Longitudinal flexural reinforcement	95
11.7.4	Shear verification	97
11.7.5	Calculation of reactions on the supports	97
11.8	Two-way solid slabs spanning between girders, beams, or structural concrete walls	97
11.8.1	Dimensional guides	97
11.8.2	Factored flexural moment	98
11.8.3	Longitudinal flexural reinforcement	104
11.8.4	Shear verification	106
11.8.5	Calculation of the reactions on the supports	107
12	Girders, beams and joists	107
12.1	General	107
12.2	Design load definition	108
12.2.1	Loads to be included	108
12.2.2	Factored design loads	108
12.3	Details of reinforcement	109
12.3.1	General	109
12.3.2	Transverse reinforcement	109
12.3.3	Positive flexural reinforcement	110
12.3.4	Negative flexural reinforcement	111
12.3.5	Joists and beams supported on girders	115
13	Columns	123
13.1	General	123
13.2	Design load definition	123
13.2.1	Loads to be included	123
13.2.2	Dead load and live load	125
13.2.3	Factored design loads	126
13.3	Dimensional guidelines	126
13.3.1	General	126
13.3.2	Limiting section dimensions	126
13.3.3	Distance between lateral supports	127
13.3.4	Column built monolithically with wall	128
13.4	Details of reinforcement	128
13.4.1	General	128
13.4.2	Longitudinal reinforcement	128
13.4.3	Transverse reinforcement	132
13.5	Flexural design guidelines	132
13.5.1	Factored loads	132
13.5.2	Initial trial cross-section dimensions and longitudinal reinforcement	132
13.6	Shear design guidelines	133
13.6.1	Factored shear	133
13.6.2	Shear strength verification	134
13.6.3	Biaxial shear strength verification	134
13.7	Strength of members subjected to axial loads with or without flexure	134
13.7.1	General	134
13.7.2	Combined factored axial load and factored bending moment	134
13.7.3	Design strength for axial compression	135
13.7.4	Balanced strength for axial compression with flexure	135

14	Structural concrete walls	139
14.1	General	139
14.2	Design load definition	139
14.2.1	Loads to be included	139
14.2.2	Dead load and live load	142
14.2.3	Lateral design load	142
14.2.4	Factored design load	143
14.3	Dimensional guidelines	143
14.3.1	General	143
14.3.2	Limiting dimensions	143
14.4	Details of reinforcement	144
14.4.1	General	144
14.4.2	Number of curtains of reinforcement	145
14.4.3	Vertical reinforcement	145
14.4.4	Horizontal reinforcement	146
14.4.5	Structural concrete wall reinforcement in seismic zones	147
14.5	Flexural design guidelines	147
14.5.1	Required factored loads	147
14.5.2	Initial trial vertical reinforcement	147
14.5.3	Required factored moment strength verification	147
14.6	Shear guides	147
14.6.1	Factored shear	147
14.6.2	Shear strength verification	147
14.7	Calculation of reactions at the foundation	148
14.7.1	Load reaction	148
14.7.2	Moment reaction	148
15	Foundations	148
15.1	Dimensioning of the foundation elements	148
15.2	Footings	148
15.2.1	Footings supporting circular or regular polygon-shaped columns or pedestals	148
	Moment in footings	148
15.2.2	Shear in footings	149
15.2.3	Development of reinforcement in footings	149
15.2.4	Minimum footing depth	149
15.2.5	Transfer of forces at base of column, wall or reinforced pedestal	149
15.2.6	Sloped or stepped footings	150
15.2.7	Foundation mats	150
15.3	Footings on piles	150
15.4	General	150
15.4.1	Anchorage of reinforcement	150
15.4.2	Maximum axial stresses	150
15.4.3	Minimum reinforcement ratios and lengths	150
15.4.4	Foundation beams	151
15.5	Dimensional guidelines	151
15.5.1	Longitudinal reinforcement	151
15.5.2	Transverse reinforcement	151
15.5.3	Retaining walls	151
15.6	Lateral earth pressure	151
15.6.1	Types of retaining walls	152
15.6.2	Types of retaining wall failures	153
15.6.3	Static pressures on retaining walls	154
15.6.4	Seismic pressures on retaining walls	156
15.6.5	General requirements for retaining walls	160
15.6.6	Details of reinforcement	160
15.6.7	Lateral load resisting system	161
16	General	161
16.1	Specified lateral forces	162
16.2	General	162
16.2.1	Lateral forces included	162
16.2.2	Lateral force resisting structural system	162
16.3		

16.3.1	General	162
16.4	Minimum amount of structural concrete walls	163
16.4.1	General	163
16.4.2	Wall area guideline for shear strength	164
16.4.3	Wall dimensions guideline for lateral stiffness	164
16.5	Special reinforcement details for seismic zones	164
16.5.1	General	164
16.5.2	Girders of frames	164
16.5.3	Columns	167
16.5.4	Joints	172
16.5.5	Walls	175
17	Nonstructural walls	176
Annex A (informative)	Equivalent formulae for material factors	178