

DIN EN 12602:2013-10 (E)

Prefabricated reinforced components of autoclaved aerated concrete (includes Amendment A1:2013)

Contents		Page
Foreword		10
1	Scope	12
2	Normative references	12
3	Terms, definitions, symbols and abbreviations	14
3.1	Terms and definitions	14
3.2	Symbols	15
3.2.1	General symbols	15
3.2.2	Subscripts	16
3.2.3	Symbols used in this European Standard (including normative annexes, except Annex C)	16
3.3	Abbreviations	22
4	Properties and requirements of materials	22
4.1	Constituent materials of autoclaved aerated concrete	22
4.1.1	General	22
4.1.2	Release of dangerous substances	23
4.2	Autoclaved aerated concrete parameters	23
4.2.1	General	23
4.2.2	Dry density	23
4.2.3	Characteristic strength values	25
4.2.4	Compressive strength	25
4.2.5	Tensile strength and flexural strength	25
4.2.6	Stress-strain diagram	26
4.2.7	Modulus of elasticity	26
4.2.8	Poisson's ratio	26
4.2.9	Coefficient of thermal expansion	27
4.2.10	Drying shrinkage	27
4.2.11	Creep	27
4.2.12	Specific heat	28
4.2.13	Thermal conductivity	28
4.2.14	Water vapour permeability	30
4.2.15	Water tightness	30
4.3	Reinforcement	30
4.3.1	Steel	30
4.3.2	Structural reinforcement	31
4.3.3	Effective diameter of coated bars	32
4.3.4	Non-structural reinforcement	33
4.4	Bond	33
4.5	Thermal prestress	34
4.5.1	General	34
4.5.2	Declared mean initial prestrain $0m,g$	34
5	Properties and requirements of components	35
5.1	General	35
5.1.1	Mechanical resistance	35
5.1.2	Acoustic properties	35
5.1.3	Reaction to fire and resistance to fire	35
5.1.4	Design thermal resistance and design thermal conductivity	36

5.2	Technical requirements and declared properties	36
5.2.1	Dimensions and tolerances	36
5.2.2	Mass of the components	37
5.2.3	Dimensional stability	37
5.2.4	Load-bearing capacity	38
5.2.5	Deflections	38
5.2.6	Joint strength	38
5.2.7	Minimum requirements	39
5.3	Durability	41
5.3.1	General	41
5.3.2	Environmental conditions	41
5.3.3	Corrosion protection of reinforcement	42
5.3.4	Freeze and thaw resistance	43
6	Evaluation of conformity	43
6.1	Introduction	43
6.2	Initial type-testing of the component	43
6.3	Factory production control	44
6.3.1	General	44
6.3.2	Process control	44
6.3.3	Finished products	45
6.4	Initial inspection of the factory and the factory production control	45
6.4.1	Information to be supplied	45
6.4.2	Inspection	45
6.4.3	Reports	46
6.5	Surveillance, assessment and acceptance of the factory production control	46
6.5.1	Inspection tasks	46
6.5.2	Frequency of inspections	46
6.5.3	Reports	46
6.6	Actions to be taken in the event of non-conformity	46
7	Basis for design	54
7.1	Design methods	54
7.2	Limit states	54
7.3	Actions	55
8	Marking, labelling and designation	55
8.1	Standard designation	55
8.2	Production detail information	56
8.3	Additional information on accompanying documents	56
Annex A (normative) Design by calculation		57
A.1	General	57
A.2	Ultimate limit states (ULS) General design assumptions	57
A.3	Ultimate limit states (ULS): design for bending and combined bending and axial compression	59
A.3.1	Design assumptions	59
A.3.2	Stress-strain diagram for AAC	59
A.3.3	Stress-strain diagram for reinforcing steel	60
A.3.4	Minimum reinforcement	62
A.4	Shear	63
A.4.1	Shear design for components predominantly under transverse load	63
A.5	Ultimate limit states induced by structural deformation (buckling)	68
A.5.1	General	68
A.5.2	Method based on Euler formula	69
A.5.3	Modified model column method	70
A.6	Punching	76
A.6.1	General	76
A.6.2	Scope and definitions	76
A.6.3	Design method for punching shear	78
A.7	Primary torsion/combined primary torsion and shear	79

A.8	Concentrated forces	81
A.9	Serviceability limit states (SLS)	82
A.9.1	General	82
A.9.2	Limitation of stresses under serviceability conditions	82
A.9.3	Serviceability limit states of cracking	83
A.9.4	Serviceability limit states of deformation	83
A.10	Detailing of reinforcement	86
A.10.1	General	86
A.10.2	Bond	87
A.10.3	Anchorage	87
A.11	Support length	91
Annex B (normative) Design by testing		93
B.1	General	93
B.2	Safety evaluation	94
B.2.1	General	94
B.2.2	Brittle and ductile failure	94
B.3	Ultimate limit state	94
B.3.1	General	94
B.3.2	Transversely loaded components	95
B.3.3	Longitudinally loaded components	97
B.3.4	Simultaneously transversely and longitudinally loaded wall components	100
B.3.5	Anchorage	101
B.4	Serviceability limit states	103
B.4.1	Crack width control	103
B.4.2	Deformations	103
Annex C (normative) Resistance to fire design of AAC components and structures		104
C.1	General	104
C.1.1	Scope	104
C.1.2	Distinction between principles and application rules	104
C.1.3	Terms and definitions	104
C.1.4	Symbols	106
C.1.5	Units	107
C.2	Basic principles	108
C.2.1	Performance requirements	108
C.2.2	Design values of material properties	108
C.2.3	Assessment methods	108
C.3	Material properties	109
C.3.1	General	109
C.3.2	AAC	110
C.3.3	Steel	112
C.4	Structural fire design methods	113
C.4.1	General	113
C.4.2	Tabulated data	113
C.4.3	Simplified design methods	118
C.4.4	Anchorage	122
C.5	Protective layers	122
Annex CA (normative) Modulus of elasticity and maximum strain of AAC and reinforcing steel at elevated temperature		123
Annex CB (informative) Joints between AAC components satisfying resistance to fire E		126
CB.1	Floor and roof components with dry joints	126
CB.2	Floor and roof components with mortar joints	126
CB.3	Vertical and horizontal wall components with dry joints	127

CB.4 Vertical and horizontal wall components with mortar joints	127
Annex CC (normative) Temperature profiles of AAC wall, floor and roof components and AAC beams	129
CC.1 Basis of temperature profiles	129
CC.2 Temperature profiles for AAC wall, floor and roof components	129
CC.3 Temperature profiles for AAC beams	132
CC.4 Calculation assumptions	141
Annex CD (normative) Resistance to fire tabulated data for walls with mechanical impact	142
Annex D (informative) Recommended values for partial safety factors	144
D.1 General	144
D.2 Ultimate Limit States (ULS)	144
D.3 Serviceability Limit States (SLS)	146
Annex E (informative) Recommendations for the consideration of prestress in the design of prefabricated reinforced AAC components	147
E.1 Calculation of prestrain from test results	147
E.1.1 General	147
E.1.2 Symbols	148
E.1.3 Cross-section values of AAC components	149
E.1.4 Calculation of prestrain σ from steel measurement	149
E.2 Cross-sectional analysis of a AAC component in SLS if prestress is taken into account	149
E.3 Splitting forces due to prestress	150
E.4 Methods to prevent end cracks due to prestress	151
Annex F (informative) Statistical methods for quality control	152
F.1 Quality control	152
Annex G (normative) "Factory production control of stainless reinforcing steel based on at least three samples - Minimum acceptance criteria for individual values and corresponding mean values"	154
Annex ZA (informative) Provisions for the CE marking of prefabricated reinforced components of autoclaved aerated concrete under the EC Construction Product Directive	155
ZA.1 Clauses of this European Standard addressing the provisions of EC Construction Products Directive	155
ZA.2 Procedures for the attestation of conformity of products	163
ZA.2.1 Systems of attestation of conformity	163
ZA.2.2 EC Certificate and Declaration of conformity	165
ZA.3 CE marking and labelling	166
ZA.3.1 General	166
ZA.3.2 Declaration of geometrical data and material properties	167
ZA.3.3 Declaration of product properties	170
ZA.3.4 Declaration of compliance with given design specification	172

ZA.3.5 !Declaration of compliance with the manufacturers' designed specification"	173
ZA.3.6 Simplified CE-marking label with reference to a manufacturer's catalogue	176
ZA.3.7 !Example on Technical information in the CE-marking"	177
Bibliography	179
Figures Figure 1 -- Determination of dry thermal conductivity 10dry	29
Figure A.1 -- Determination of effective span l_{eff}	58
Figure A.2 -- Bi-linear stress-strain diagram for AAC in compression for cross-sectional design	60
Figure A.3 -- Design stress-strain diagram for reinforcing steel	61
Figure A.4 -- Strain diagrams in the ultimate limit state	62
Figure A.5 -- Notation for components subjected to shear	65
Figure A.6 --Structural model and possible load cases for the modified model column method	71
Figure A.7 -- Relation between curvature and strain Two curvatures (great curvature and small curvature) are presented	74
Figure A.8 -- Application of punching provisions in non-standard cases	77
Figure A.9 -- Critical perimeter around loaded areas located away from an unsupported edge	77
Figure A.10 -- Critical perimeter near an opening	78
Figure A.11 -- Critical sections near unsupported edges	78
Figure A.12 -- Idealised box section	81
Figure A.13 -- Definition of the areas to be introduced in Equation (A.39)	82
Figure A.14 -- Moment curvature relationship	86
Figure A.15 -- Effective length of transverse anchorage bars	89
Figure A.16 -- Envelope line for determining the tensile force in the longitudinal reinforcement	90
Figure A.17 -- Support length a_o	92
Figure B.1 -- Definition of shear span l_s	95
Figure B.2 -- Typical reinforcement layouts in AAC-components	96
Figure B.3 -- Diagram for determination of the column factor k	99
Figure B.4 -- N/M - interaction diagram of the cross-section representing the results of three test series 100 Figure B.5 -- Envelope line for determining the section of the actual bending moment, M_{da}	103
Figure C.1 Coefficient $k_c()$ allowing for decrease of compressive strength, f_{ck} , of AAC at elevated temperature	110
!Figure C.2"	111

!Figure C.3" - Coefficient $k_s()$ allowing for decrease of characteristic strength f_{yk} of tension and compression reinforcement	112
!Figure C.4" -- Sections of AAC components showing nominal axis distance a and nominal concrete cover c of reinforcement	114
!Figure C.5" -- Reduction of strength and cross-section for sections exposed to fire	120
!Figure C.6" -- Division of a wall, with both sides exposed to fire, into zones for use in calculation of strength reduction and a_z values	120
Figure CA.1 -- Stress-strain relationship of AAC under compression at elevated temperature	123
Figure CA.2 -- Stress-strain relationship of reinforcing steel at elevated temperature	125
Figure CB.1 -- Example of a dry joint in structures made of floor or roof components with cover (e.g. topping) preventing movement of air through the joint	126
Figure CB.2 -- Examples of mortar joints in structures made of floor or roof components	126
Figure CB.3 -- Example of dry joints with two sealing strips in structures made of horizontal wall components	127
Figure CB.4 -- Examples of thin layer mortar joints in structures made of vertical or horizontal wall components	128
Figure CC.1 -- Temperature profiles for AAC wall, floor and roof components with a dry density of 300 kg/m ³	129
Figure CC.2 -- Temperature profiles for AAC wall, floor and roof components with a dry density of 400 kg/m ³	130
Figure CC.3 -- Temperature profiles for AAC wall, floor and roof components with a dry density of 500 kg/m ³	131
Figure CC.4 -- Temperature profiles for AAC wall, floor and roof components with a dry density of 600 kg/m ³	132
Figure CC.5 -- Temperature profiles of the non exposed face of component for the determination of the criteria of the classification to fire, for a dry density of 300 and 600 kg/m ³	133
Figure CC.6 -- Temperature profiles in °C for AAC-beams ($b \times h = 150 \text{ mm} \times 200 \text{ mm}$) with a dry density of 300 kg/m ³ , exposed on three sides to standard fire	133
Figure CC.7 -- Temperature profiles in °C for AAC-beams ($b \times h = 150 \text{ mm} \times 200 \text{ mm}$) with a dry density of 400 kg/m ³ , exposed on three sides to standard fire	134
Figure CC.8 -- Temperature profiles in °C for AAC-beams ($b \times h = 150 \text{ mm} \times 200 \text{ mm}$) with a dry density of 500 kg/m ³ , exposed on three sides to standard fire	135
Figure CC.9 -- Temperature profiles in °C for AAC-beams ($b \times h = 150 \text{ mm} \times 200 \text{ mm}$) with a dry density of 600 kg/m ³ , exposed on three sides to standard fire	136
Figure CC.10 -- Temperature profiles in °C for AAC-beams ($b \times h = 300 \text{ mm} \times 400 \text{ mm}$) with a dry density of 300 kg/m ³ , exposed on three sides to standard fire	137
Figure CC.11 -- Temperature profiles in °C for AAC-beams ($b \times h = 300 \text{ mm} \times 400 \text{ mm}$) with a dry density of 400 kg/m ³ , exposed on three sides to standard fire	138
Figure CC.12 -- Temperature profiles in °C for AAC-beams ($b \times h = 300 \text{ mm} \times 400 \text{ mm}$) with a dry density of 500 kg/m ³ , exposed on three sides to standard fire	139

Figure CC.13 -- Temperature profiles in °C for AAC-beams (b x h = 300 mm x 400 mm) with a dry density of 600 kg/m ³ , exposed on three sides to standard fire	140
Figure E.1 -- Analysis of prestress by means of an assumed external force	148
Figure ZA.1 Example of CE marking with Method 1	170
Figure ZA.2 Example of CE marking with Method 2	171
Figure ZA.3a Example of CE marking with Method 3a	173
Figure ZA.3b Example of CE marking with Method 3b	175
Figure ZA.4 -- Example of simplified label	177
Tables Table 1 -- Density classes	24
Table 2a" -- Compressive strength classes for AAC	25
Table 2b Drying shrinkage classes for AAC"	27
Table 3 -- Creep classes	28
Table 4 -- Dry thermal conductivity λ_{dry} of AAC for 50 % and 90 % of production with a confidence level of = 90 % (compiled according to EN 1745)	30
Table 5a List of steel grades for stainless reinforcing steel	31
Table 5b Mandrel diameter for the bending test	32
Table 5c" -- Welding strength classes and welding strength factors k_W	32
Table 6 Bond classes"	33
Table 7 -- Prestress classes	34
Table 8 -- Dimensional tolerances of components	37
Table 9 -- Final shrinkage strains ϵ_0 for AAC components	37
Table 10 -- Thickness classes of structural components	39
Table 11 -- Exposure classes and protective measures related to environmental conditions	42
Table 12 -- Initial type-testing of the AAC components	47
Table 13 -- Testing of the finished product; AAC components for structural uses	50
Table 14 -- Testing of the finished product; AAC components for non-structural uses	53
Table A.1 -- Bond Classes	89
Table B.1 -- Design loadbearing capacity R_{cd} of components	102
Table C.1 -- Thermal conductivity of AAC (λ) at elevated temperature	111
Table C.2 -- Minimum wall thickness of non loadbearing AAC walls with a dry density between 350 kg/m ³ and 700 kg/m ³	114
Table C.3a -- Minimum wall thickness and axis distance a_{min} for separating loadbearing AAC walls. AAC dry density 350 kg/m ³ to 700 kg/m ³ and structural or non-structural reinforcement for resistance to fire REI	115

Table C.3b -- Minimum wall thickness and minimum axis distance a_{min} for non separating loadbearing AAC walls supported on at least two opposite ends of the components. AAC dry density 350 kg/m ³ to 700 kg/m ³ and structural or non-structural reinforcement for resistance to fire R	115
Table C.4 -- Minimum dimensions (height h_{min} and width b_{min}) in mm and minimum axis distance a_{min} in mm to the bottom side and to the vertical sides of AAC beams in relation to the maximum span length 116 Table C.5 -- Minimum thickness h_{min} in mm and minimum axis distance a_{min} in mm of AAC floor and roof components in relation to maximum span length	117
Table C.6 -- Reduction of the dimensions of AAC cross-section from fire exposed surfaces	122
Table CA.1 --Values for the parameters of stress-strain relationship of AAC in compression at elevated temperature	123
Table CA.2 -- Values for the parameters of stress-strain relationship of reinforcing steel at elevated temperature	124
Table CC.1	141
Table CC.2	141
Table CD.1 -- Minimum wall thickness and minimum axis distance a_{min} of AAC walls with mechanical impact supported on at least two opposite ends; AAC dry density 450 kg/m ³ to 700 kg/m ³ with structural or non structural reinforcement for resistance to fire REI-M and EI-M	142
Table CD.2 -- Minimum amount of reinforcement for AAC components used in walls with mechanical impact	143
Table D.1 -- Safety parameter for failure type	144
Table D.2 -- Safety parameter for accuracy when determining the material parameter	144
Table D.3 -- Safety parameters depending on variation	145
Table D.4 -- Partial safety factors	145
Table F.1 -- Control factor k_n as a function of samples n with a fractile value of 5 % ($p = 0,95$) and a confidence level of 0,75 (using bayesian procedures with "vague" prior distribution) and under the assumption that the safety level (Annex D) is based on a summarised variation of $VR = 0,10$	153
Table F.2-- Coefficient k_s as a function of samples n with a fractile value of 5 % ($p = 0,95$) and a confidence level 0,75 (using bayesian procedures with "vague" prior distribution)	153
Table ZA.1a -- Harmonised clauses for loadbearing wall components	156
Table ZA.1b -- Harmonised clauses for retaining wall components	157
Table ZA.1c -- Harmonised clauses for roof components	158
Table ZA.1d -- Harmonised clauses for floor components	159
Table ZA.1e -- Harmonised clauses for linear components	160
Table ZA.1f -- Harmonised clauses for non-loadbearing wall and noise barriers components	161
Table ZA.1g -- Harmonised clauses for cladding components	162

Table ZA.1h -- Harmonised clauses for small box culvert components	163
Table ZA.2a -- Systems of attestation of conformity	164
Table ZA.2b -- Assignment of evaluation of conformity tasks (for structural components) under system 2+1)	164
Table ZA.2c -- Assignment of evaluation of conformity tasks (for non structural or light structural components) under system 4 1)	165