BRITISH STANDARD

BS EN
13978-1:2005

Precast concrete products — Precast concrete garages —

Part 1: Requirements for reinforced garages monolithic or consisting of single sections with room dimensions

The European Standard EN 13978-1:2005 has the status of a British Standard

ICS 91.090; 91.100.30

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13978-1:2005.

EN 13978-1 is a candidate "harmonized" European Standard and fully takes into account the requirements of the European Commission mandate M/100, Precast Concrete Products, given under the EU Construction Products Directive (89/106/EEC), and is intended to lead to CE marking. The date of applicability of EN 13978-1 as a "harmonized" European Standard, i.e. the date after which this standard may be used for CE marking purposes, is subject to an announcement in the *Official Journal of the European Communities*.

The Commission in consultation with Member States has agreed a transition period for the co-existence of "harmonized" European Standards and their corresponding national standard(s). It is intended that this period will comprise a period, usually nine months, after the date of availability of the European Standard, during which any required changes to national regulations are to be made, followed be a further period, usually of 12 months, for the implementation of CE marking. At the end of this co-existence period, the national standard(s) will be withdrawn.

EN 13978-1 is the subject of transitional arrangements agreed under the Commission mandate. In the UK, there are no corresponding national standards of national origin.

The UK participation in its preparation was entrusted to Technical Committee B/524, Precast concrete products, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 23 May 2005

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 34, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 46040 1

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13978-1

May 2005

ICS 91.090; 91.100.30

English version

Precast concrete products - Precast concrete garages - Part 1: Requirements for reinforced garages monolithic or consisting of single sections with room dimensions

Produits préfabriqués en béton - Garages préfabriqués en béton - Partie 1 : Exigences pour garages en béton armé monolithiques ou composés d'éléments individuels de la dimension d'une pièce

Betonfertigteile - Betonfertiggaragen - Teil 1: Anforderungen an monolithische oder aus raumgroßen Einzelteilen bestehende Stahlbetongaragen

This European Standard was approved by CEN on 24 February 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Ref. No. EN 13978-1:2005: E

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The numbering of clauses is strictly related to EN 13369:2004 Common rules for precast concrete products, at least for the first three digits. When a clause of EN 13369 is not relevant or included in a more general reference of this document, its number is omitted and this may result in a gap on numbering.

Foreword

This document (EN 13978-1:2005) has been prepared by Technical Committee CEN/TC 229 “Precast concrete products”, the secretariat of which is held by AFNOR, and was examined by and agreed with a joint working party appointed by the Liaison Group CEN/TC 229-TC 250, particularly for its compatibility with structural Eurocodes.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2005, and conflicting national standards shall be withdrawn at the latest by February 2007.

This document is one of a series of product standards for precast concrete products.

For common aspects reference is made to EN 13369:2004 - *Common rules for precast products*, from which also the relevant requirements of the EN 206 - *Concrete — Part 1: Specification, performances, production and conformity* are taken.

The references to EN 13369:2004 by CEN/TC 229 product standards are intended to make them homogeneous and to avoid repetitions of similar requirements.

Eurocodes are taken as a common reference for design aspects. The installation of some structural precast concrete products is dealt with by ENV 13670-1: *Execution of concrete structures — Part 1: Common rules*, which has at the moment the status of an European prestandard. In all countries it can be accompanied by alternatives for national application and it shall not be treated as an European Standard.

The programme of standards for structural precast concrete products comprises the following standards, in some cases consisting on several parts:

— prEN 1168, *Precast concrete products — Hollow core slabs*.

— EN 12794, *Precast concrete products — Foundation piles*.

— EN 12843, *Precast concrete products — Masts and poles*.

— prEN 13747, *Precast concrete products — Floor plates for floor systems*.

— prEN 15037-1, *Precast concrete products - Beam-and-block floor systems - Part 1: Beams* .

— prEN 15037-2, *Precast concrete products - Beam-and-block floor systems - Part 2: Blocks.*

— EN 13224, *Precast concrete products — Ribbed floor elements*.

— EN 13225, *Precast concrete products — Linear structural elements*.

— prEN 14992, *Loadbearing wall and facades*.

— prEN 15258, *Retaining wall elements*.

— EN 13693, *Precast concrete products — Special roof elements*.

— prEN 14844, *Precast concrete products — Box culverts*.

— prEN 13978, *Precast concrete products — Precast concrete garages*.

— prEN 14991, *Precast concrete products — Foundation elements*.

— prEN 15050, *Precast concrete bridge elements*.

— WI00229019, *Precast concrete products — Silos*.

— prEN 14843, *Precast concrete products — Stairs*.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This document is Part 1 of the European Standard which consists of two parts:

— Part 1: "Requirements for reinforced garages monolithic or consisting of single sections with room dimensions" refers to precast concrete garages reinforced by bars or fabric;

— Part 2: "Requirements for steel fibre concrete garages" refers to precast garages produced of steel fibre concrete.

Part 1 contains 2 normative and 5 informative annexes.

Annex A (informative) contains recommendations regarding the concrete cover. Annex A is recommended for use if there are no national regulations standing in the way.

Annex B (normative) contains inspections schemes for carrying out the factory production control.

Annex C (informative) specifies simplified design rules for garages. These rules may be used if there are no national rules standing in the way. For garage boxes for basement garages, the applicability of Annex C is restricted (see C.1).

Annex D (normative) contains the initial tests to be carried out.

Annex E (informative) gives information about garage boxes for basement garages for which the resistance to parametric fire is ensured. The chosen fire load for the parametric fire represents the most unfavourable case of a burning car with regard to the energy release rate and the fire duration.

Garages dealt with in Part 1 allow smaller cover than accepted in EN 13369 and EN 1992-1-1. Hence the product is a separate class. This can be accepted due to the generally low stresses in the structure and that after 50 years of use no detrimental effects have been observed.

The evaluation of conformity given in this standard refers to the completed garages which are supplied to the market and covers all the production operations carried out in the factory.

1 Scope

This document regards precast reinforced concrete garages produced as monolithic units or as kits of single sections with room dimensions in stationary factories. These garages are intended to be erected on foundations designed by others and complying with the behaviour of the precast units. They may be free-standing, or may have backfilling behind some of the walls (earthfilled), or earth covered or built over with a parking area for cars or a second storey of precast garages. This document also applies to supplementary units, kits for double space garages and multiple parking garages as well as for garage boxes for one-storey basement garages. It does not apply to elements incorporated as a structural part of an upper structure unless they are designed according to EN 13369.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 206-1:2000, *Concrete — Part 1: Specification, performance, production and conformity*

EN 1992-1-1:2004, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1992-1-2:2005, *Eurocode 2: Design of concrete structures — Part 1-2: General rules – Structural fire design*

EN 13369:2004, *Common rules for precast concrete products*

EN 12504-1, *Testing concrete in structures — Part 1: Cored specimens – Testing, examining and testing in compression*

3 Terms and definitions

For the purposes of this document, the following terms, definitions and symbols apply. In general the term "product" refers to an element which is produced in large numbers. For general terms see Clause 3 of EN 13369:2004.

3.10 Special definitions for garages

3.10.1
precast reinforced concrete garage
monolithic or as a kit of single sections with room dimensions prefabricated garage made of reinforced concrete

3.10.2
monolithic garage
garage forming a spatial load bearing system

3.10.3
double space garage
kit of two garage boxes situated side by side which are open at every adjoining side

3.10.4
double-deck garage
kit of two garage boxes arranged in two levels one on top of the other

3.10.5
multiple parking garage
garage with increased height suitable for the installation of lifting devices for parking of several vehicles one on top of the other

3.10.6
supplementary unit
annex on a garage, e.g. as room for tools or for lengthening of the parking-space

3.10.7
free-standing garage
garage with the floor level being situated maximum 0,5 m below the surrounding soil

3.10.8
garage with earth-filled walls
garage, in which the height of surrounding soil above the floor level is between 0,5 m and the height of the wall

3.10.9
soil-covered garage
garage covered with a layer of soil

3.10.10
garage box for a basement garage
garage box foreseen as a construction member of an one-storey basement garage which is soil-covered or arranged under a building

3.10.11
tapered wall
wall with a thickness which becomes smaller either along the wall height or along the wall length

3.11 Symbols

Latin upper case letters

A	area of a cross-section
A_s	cross sectional area of reinforcement
H	garage height
L	garage length
N	axial force
T	time
W	garage width

Latin lower case letters

b	width of a cross-section
c	concrete cover
f	strength
h	height of a cross-section
t	thickness of a cross-section
u	axis distance

Greek letters

Δ	deviation

λ	slenderness
λ_{ah}	coefficient for earth pressure

Indices

a	active
c	concrete
d	design value
eq	equal
f	floor slab
fl	frame leg
h	horizontal
nom	nominal
p	principal (for dimensions)
r	roof
sp	spanning member
w	wall

4 Requirements

4.1 Material requirements

For general aspects, constituent materials of concrete, reinforcing steel, inserts and connectors the relevant clauses of EN 13369:2004, 4.1 (except 4.1.4) shall apply. In particular the ultimate tensile and tensile yield strength of steel shall be considered.

4.2 Production requirements

For concrete production, hardened concrete and structural reinforcement, the relevant clauses of EN 13369:2004 4.2 shall apply, with the following additional requirements. In particular the compressive strength of concrete shall be considered.

4.2.2 Hardened concrete

4.2.2.1 General

The potential strength shall be used. For initial test for the accelerated hardening, reference shall be made to Annex D.

4.2.2.2 Minimum strength class of concrete

The minimum strength class of the concrete as defined in EN 206-1 shall be chosen in dependence on the minimum nominal wall thickness class according to 4.3.1.2 as given in Table 1.

Table 1 — Minimum strength class of concrete in dependence on the minimum nominal wall thickness class

Class	Minimum nominal wall thickness class according to 4.3.1.2	Minimum strength class of concrete as defined in EN 206-1
1	1	C25/30, LC25/28
2	2	C30/37, LC30/33
3	3	C35/45, LC35/38

4.2.3 Structural reinforcement

For monolithic free-standing garages and those parts of monolithic garages with earth-filled walls not exposed to earth-pressure with a roof load (without self-weight of the roof) $\leq$ 4 kN/m^2, wire fabrics made of indented wire or bars ∅ 4 and ∅ 4,5 may be used. The minimum main reinforcement shall not be less than ∅ 4 with a maximum distance of the reinforcing bars of 150 mm.

For all other garages, 4.3.3.2 of EN 13369:2004 shall apply.

4.3 Finished product requirements

4.3.1 Geometrical properties

4.3.1.1 Production tolerances

EN 13369:2004 4.3.1.1 shall apply. The permitted deviation of the position of openings is ± 20 mm. The minimum cover is given in Annex A.

4.3.1.2 Minimum dimensions

The minimum nominal thickness of walls shall agree with one class given in Table 2. For massive floor plates the minimum nominal thickness shall be 70 mm. Floor plates with other designs (e.g. waffle plates) shall have at least an equal bending stiffness to a massive floor plate with minimum nominal thickness.

The thickness of the floor plate may be reduced up to 60 mm if an equal rigidity is reached by special measures (e.g. special concrete quality).

Table 2 — Minimum nominal wall thickness

Class	Minimum nominal wall thickness
1	100 [a]
2	60 [a]
3	50 [b]

[a] For tapered walls the given values apply to the mean value of the nominal wall thickness with a maximum reduction of 10 mm on the thinnest cross section.

[b] Not for tapered walls. The proof for second order effects shall be done according to 5.8.3 of EN 1992-1-1:2004.

The given minimum dimensions refer to mechanical resistance and durability of garages. If, for a required resistance to fire, larger dimensions are necessary, the larger values shall apply.

4.3.2 Surface characteristics

Annex J of EN 13369:2004 shall apply.

4.3.3 Mechanical resistance

4.3.3.1, 4.3.3.2 and 4.3.3.5 of EN 13369:2004 shall apply, with the following additional requirements.

4.3.3.1 General

In particular resistance to horizontal and vertical loads and the resistance to impact of vehicles at very low speed (accidental action) shall be considered.

For accidental action see 4.3.3.2.

For the other actions the simplified design rules given in Annex C may be used.

4.3.3.2 Mechanical resistance against accidental action

To consider the impact of vehicles with very low speed, it shall be shown by calculation that a horizontal force of 10 kN acting 0,5 m above the floor level on a door pile or on the back wall of the garage (distributed on a width of 1 m), respectively, does not affect the load bearing capacity of the garage as a whole. Local damages are permissible.

4.3.4 Resistance and reaction to fire

4.3.4.1 Resistance to fire

4.3.4.1, 4.3.4.2 and 4.3.4.3 of EN 13369:2004 shall apply.

NOTE For resistance to parametric fire, the information regarding the special features of fires in basement garages erected of garage boxes is given in Annex E.

4.3.4.2 Reaction to fire

4.3.4.4 of EN 13369:2004 shall apply.

4.3.5 Acoustic properties

For sound insulation properties 4.3.5 of EN 13369:2004 shall apply.

4.3.6 Thermal properties

No requirements.

4.3.7 Durability

4.3.7 of EN 13369:2004 shall apply. Additional information about the concrete cover is given in Annex A.

The crack width shall not exceed 0,4 mm.

4.3.8 Other requirements

4.3.8.1 Safety in handling

4.3.8.1 of EN 13369:2004 shall apply.

4.3.8.2 Protection against outside moisture and water

4.3.8.2.1 General

All parts of the garage shall be carried out in such a way that the forming of drops of penetrated water on the inner side of the garage will be prevented.

NOTE It is unavoidable that water is brought into garages by the cars (rainwater, rests of snow, thawing in the garage). Depending on the weather conditions, condensation in garages is unavoidable, too. Small moist spots are irrelevant compared with the brought in water and do not affect the serviceability of a garage for the intended use.

4.3.8.2.2 Sealing of the roof

The roof of the garage shall be provided with a roof sealing, if the water impermeability is not ensured by other measures (e.g. by water impermeable concrete).

Possible roof sealings are amongst other things:

— one or more layers of welding courses;

— liquid plastic covers.

Puddles on the roof sealing are admissible. In every case, the function of the roof drainage (e.g. of the roof gully) has to be ensured by a regular maintenance. If the roof is formed as a pan, the overflow of water over the edge of the pan in case of blockage of the roof gully is admissible, provided the extra weight on the roof is taken into account in mechanical resistance calculation.

Liquid plastic covers shall be suited for the bridging of cracks up to a width of 0,4 mm with the effect of a hydrostatic pressure of 1 kPa.

5 Test methods

5.1 Tests on concrete

5.1 of EN 13369:2004 shall apply.

5.2 Measuring of dimensions

5.2 of EN 13369:2004 shall apply.

6 Evaluation of conformity

6.1 General

6.1 of EN 13369:2004 shall apply.

6.2 Type testing

6.2.1 General

6.2.1 of EN 13369:2004 shall apply.

6.2.2 Initial type testing

6.2.2 of EN 13369:2004 shall apply with the additional rules for tests for the accelerated hardening according to Annex D (only for a new production equipment).

The tests according to Annex D may be omitted if there is a documented previous positive experience with the planned mixture of concrete, the intended thermal treatment and the moulds.

6.2.3 Further type testing

6.2.3 of EN 13369:2004 shall apply.

6.3 Factory production control

6.3 of EN 13369:2004 shall apply with the following.

For the inspection of the finished garage, Table B.1 of Annex B of this document shall be used instead of Table D.4 of EN 13369:2004.

7 Marking

Each garage shall be marked or labelled to show:

— the identification of the producer;

— the identification of the place of production;

— the production number.

In addition, for each garage a delivery note shall be added containing at least the following items:

— name of producer;

— address of the factory;

— products identity (commercial name);

— the date of casting;

— location of mounting;

— calculated mass of the unit;

— number of the product standard.

8 Technical documentation

The detailing of the element, with respect to geometrical data and complementary properties of materials and inserts, shall be given in technical documentation, which includes the construction data, such as the dimensions, the tolerances, the layout of reinforcement, the concrete cover, the expected transient and final support conditions and lifting conditions.

Annex A
(informative)

Concrete cover

A.1 Concrete cover with regard to durability for reinforcement steel

Annex A of EN 13369:2004 applies with the following rules.

With reference to the exposure classes of Table A.1 of EN 13369:2004, Table A.1 of this document gives examples of classification for surfaces of precast concrete garages. For other ambient conditions, Table A.1 of EN 13369:2004 should apply.

Table A1 — Nominal scale of ambient conditions for garage surfaces

Ambient condition according to EN 13369:2004 Annex A	Examples for garage surfaces
B	Inner wall and roof surfaces in closed basement garages
C	Soil-covered surfaces Inner wall and roof surfaces
D	Outside surfaces exposed to rain
E	Upper side of the floor plate if de-icing salt effect is to be expected

With reference to Table A.2 of EN 13369:2004, for all parts of a garage, except the door frame, the values for slab reinforcement apply.For surfaces which are not in contact with soil, the minimum cover may be reduced by 5 mm, but should not be less than 10 mm.

A.2 Alternative conditions

A.2 of Annex A of EN 13369:2004 applies.

Annex B
(normative)

Inspection of the finished garage

Table B1 — Inspection of the finished garage

	Subject	Method	Purpose	Frequency
1	Dimensions	Measuring	Conformity with 4.3.1.1 and 4.3.1.2	For the garages made with moulds with invariable dimensions: — one garage per 100 garages per mould with a minimum of one garage per mould yearly — after installation of a new mould or after major modifications For the garages made with moulds with variable dimensions: — one garage per 20 garages of the same type* with a minimum of one garage yearly per type* produced that year — first garage after an alteration of the dimensions
2	Roof sealing [a]	Visual check	No visible damage	Each garage
3		Appropriate water test	No visible leak	In case of doubt
4	Marking/labelling	Visual check	Conformity with Clause 7	Weekly
5	Storage	Visual check	No damaging or soiling on the garages	Weekly
6		Visual check	Segregation of non-conforming garages	Weekly
7	Delivery	Comparison with delivery note	Correct garage type	Each garage
8		Visual check	Correct delivery age, loading and loading documents	Each garage
9		Visual check	No visible damages of surface protection	Each garage
10		Visual check, in case of doubt measuring, e.g. with a crack magnifier	No cracks with an inadmissible width according to 4.3.7	Each garage

* "Type" means garages with the same principal dimensions and with the same cross-section dimensions.

[a] Only if part of the precast garage.

Annex C
(informative)

Simplified design rules

C.1 General

Unless stated otherwise 4.3.3 of EN 13369:2004 applies.

The C.3 and C.4 do not apply to garage boxes for basement garages.

C.2 Actions

C.2.1 General

Actions as a result of constraint or imposed deformations caused by temperature or shrinkage of the concrete need not to be taken into consideration.

C.2.2 Roof load

Two load groups are distinguished:

Load group I: Roof load including possible earth loads (without self-weight of the roof) $\leq$ 4 KN/m^2.

Load group II: Roof load including possible earth loads (without self-weight of the roof) $>$ 4 KN/m^2.

NOTE The extra weight of built up water on the roof according to 4.3.8.2.2 need not to be taken into consideration together with a snow load.

C.2.3 Floor load

For garages for light vehicles up to a total mass of 2,5 t, the floor slab should be dimensioned with a distributed load of 3,5 kN/m^2 without an increase for dynamic loads.

For garages for vehicles with a total mass > 2,5 t the actual wheel loads without an increase for dynamic loads may be used for the dimensioning. As a comparison calculation, the floor slab should be dimensioned with a distributed load of 3,5 kN/m^2 without an increase for dynamic loads. The more unfavourable loading case applies.

C.2.4 Wall load

Up to 0,5 m earth-filling of a wall, the earth pressure need not to be taken into consideration. Unless more exact information is given about the soil type, for the dimensioning of garages with earth-filled walls and soil-covered garages the values for earth loads given in Table C.1 may be used under the assumption that the terrain around the garage does not rise up to a distance of 3 m from the garage walls.

Table C.1 — Earth loads

	Non-cohesive soil	Cohesive soil
Soil density	19 kN/m^3	20 kN/m^3
Angle of internal friction	30°	22,5°
Coefficient for lateral earth pressure λ_{ah}	0,303	0,412

The filling material at the garage walls is decisive. The passive earth pressure need not to be taken in consideration.

C.3 Walls under axial compression (second order effects)

C.3.1 Assumptions for the neglect of second order effects

Second order effects may be disregarded if the following assumptions are given:

a) maximum size of the garage (length × width × height) 6 m × 3 m × 2,5 m;

b) there are no wall openings which are statically relevant (affecting more than 10% of the specific structural behaviour).

c) the garage is free-standing (see 3.10.7);

d) the roof load agrees with load group I according to C.2.2;

e) the garage is supported in place under the 4 corners;

f) for garages consisting of single sections, the transmission of horizontal forces over the joints is proved;

g) the minimum nominal wall thickness of the garage is ≥ 60 mm (see 4.3.1.2);

h) the garage has a door frame with a minimum cross-section of 80 mm × 80 mm of the frame legs and the frame spanning member.

C.3.2 Simplified proof for second order effects

For garages which fulfil the assumptions according to C.3.1 a) up to g), the proof for second order effects may be limited to a narrow wall sector width of $10 \times t_w$ (t_w = wall thickness) above the supports at the door side. For the axial force, a linear reduction from the support load at the upper side of the floor slab to the force at the edge of the roof on the width of the wall sector may be assumed.

For garages which fulfil the assumptions according to C.3.1 b) up to h), a more exact proof for the second order effect may be omitted if for the supports at the door side the additional assumption is given that the door frame legs together with a wall sector width of $\leq 10 \times t_w$ fulfil the condition

$$\lambda \leq 16 \Big/ \sqrt{N_d / (A_c \times f_{cd})}$$

with

λ slenderness ratio according to EN 1992-1-1:2004, 5.8.3.2;

N_d mean value of the design values of the axial force at the upper side of the floor slab and the force at the edge of the roof on the door frame legs and the wall sector;

Ac area of the cross-section of the door frame leg and the wall sector;

f_{cd} design value of the compression strength of the concrete according to EN 1992-1-1:2004;

t_w wall thickness.

In all other cases, the proof for second order effects shall be done according to 5.8.3 of EN 1992-1-1:2004. The variability of the axial force along the wall height may be considered in the sense of the previous paragraph in this case.

The influence of creep may be neglected in all cases.

C.4 Rules for reinforcement

For the garage walls, the rules for reinforcement for slabs according to EN 1992-1-1:2004 may be used.

According to the static demands, the sections of garages may also be reinforced with one layer reinforcement.

The minimum reinforcement for the limitation of the width of cracks is given in 4.2.3.

C.5 Serviceability limit states

The arithmetical deflections under the quasi-permanent loads should not exceed 1/150 of the span (in case of a planned camber, the deflection from the plain).

Annex D
(normative)

Initial test for the accelerated hardening

D.1 General

It shall be proved that with the intended raw materials, the chosen composition of the concrete and the chosen heat treatment method the required strength class of the concrete will be reached.

D.2 Measuring of the development of the concrete temperatures

For measuring, thermal elements shall be brought into the fresh concrete in the middle of each garage wall and the middle of the roof and/or the floor plate. The temperatures of the concrete shall be recorded at the beginning of the heating and then in intervals of an hour.

Acceleration hydration by heat treatment shall follow the rules in 4.2.1.4 of EN 13369:2004. The preheating period, temperature rise and max temperature shall be documented.

D.3 Compressive strength of drill cores

In the middle of each wall, the roof and the floor plate of a heat treated garage a drill core shall be taken at the age of standard conformity, declared by the producer. The diameter of the core should be about equal to its height. If necessary, the surfaces shall be ground plane. The compressive strength shall be tested in accordance with EN 12504-1:2000.

The test result shall fulfil the following criteria:

Mean value $f^{0}_{cm} \geq 0{,}85*(f_{ck} + 4)$; Singular value $f^{0}_{ci} \geq 0{,}85*(f_{ck} - 4)$

f_{ck} = characteristic value of the compressive strength of the required strength class.

f^{0}_{cm} = mean value of the compressive strength of all drill cores.

f^{0}_{ci} = singular value of the compressive strength of any drill core.

Annex E
(informative)

Fire resistance of garage boxes in basement garages

E.1 General

This annex gives information about the resistance to parametric fire of garage boxes against the actual fire loads in case of a burning car in one-storey basement garages, which exclusively are used for the parking of private cars. It specifies the dimensions of garage boxes in basement garages in connection with loads and minimum reinforcement boxes for those in which a sufficient fire resistance for this fire load was proved.

E.2 Fire load

The fire load of a burning car is given in Figure E.1. This fire load represents the most unfavourable case regarding the maximum energy release rate as well as regarding the fire duration.

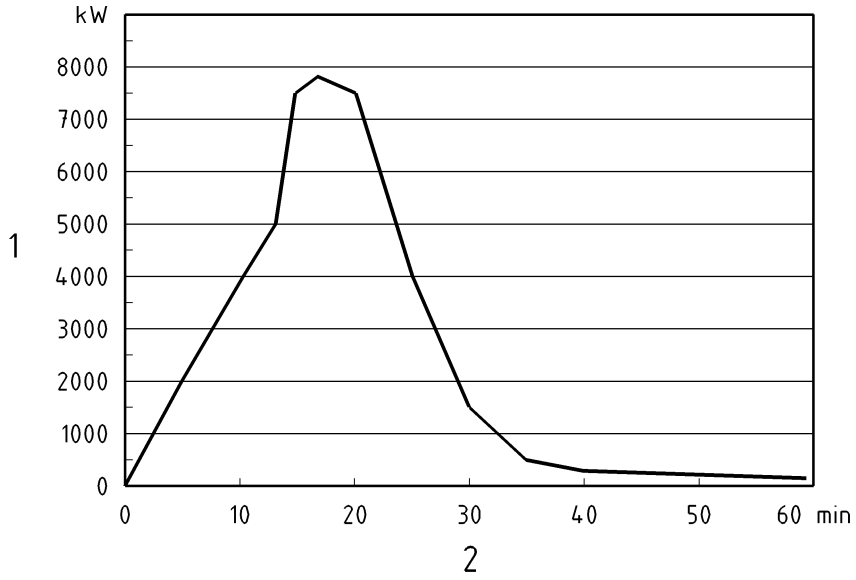

Figure E.1 — Most unfavourable energy release rate in case of a burning car

Key

1 Energy release rate Q
2 Time

E.3 Resistance to parametric fire

E.3.1 Arrangements of garage boxes in basement garages

The following information on resistance to parametric fire according to E.2 is valid for basement garages with garage boxes arranged immediately side by side as well as with garage boxes with covered free places between them.

E.3.2 Fire spread

Fire spread from one garage box into another can be excluded for garage boxes described in E.3.3.

E.3.3 Garage boxes for basement garages with proved resistance in case of fire

E.3.3.1 Garage box with door frame

For garage boxes with door frame according to Figure E.2 with the dimensions, loads and minimum reinforcements listed in Table E.1, the resistance in case of fire is ensured.

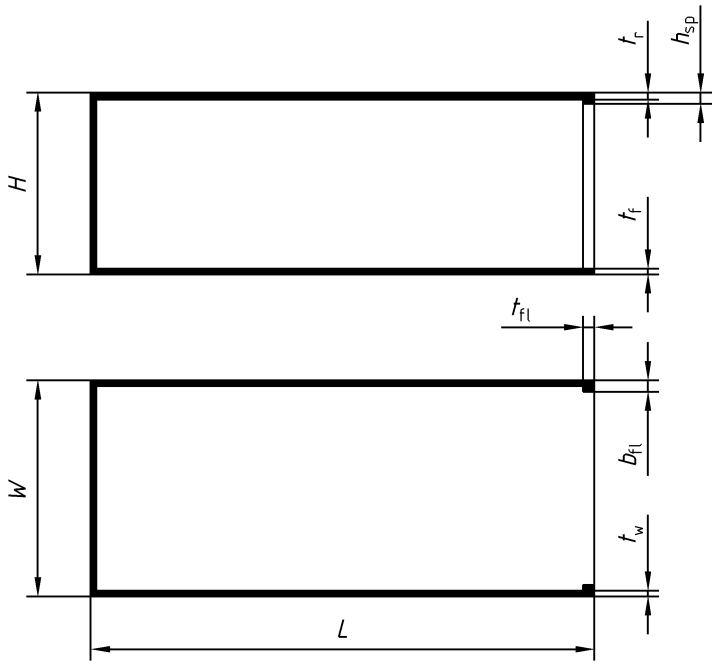

Figure E.2 — Garage box with door frame (dimensions according to Table E.1)

Table E.1 — Garage box with door frame with proved resistance in case of fire

Dimensions								
L	W	H	t_w	t_r	t_f	b_{fl}	t_{fl}	h_{sp}
≤ 7 000	≤ 3 000	≤ 2 500	≥ 80	≥ 100	≥ 70	≥ 150	≥ 150	≥ 150

Loads		
Single load door frame leg	Distributed load roof	Linear load walls
≤ 500 kN	≤ 20 kN/m^2	≤ 20 kN/m

Minimum reinforcement door frame								
Door frame leg			Frame corner door frame (up to the zero point of the moments)			span of spanning member of the door frame		
per corner	per side	design cover c	per corner	per side	design cover c	per corner	per side	design cover c
1 × ∅ 16	1 × ∅ 20	20 mm	1 × ∅ 16	----	20 mm	1 × ∅ 16	----	20 mm

Minimum reinforcement walls and roof							
walls inside		walls outside		roof inside		roof outside	
A_s mm^2/m	design cover c	A_s mm^2/m	design cover c	A_s mm^2/m	design cover c	A_s mm^2/m	design cover c
500	15 mm	200	20 mm	500	15 mm	500	20 mm
Strength class of concrete according to EN 206-1				C30/37			

E.3.3.2 Garage box without a door frame

For garage boxes without a door frame according to Figure E.3 with the dimensions, loads and minimum reinforcements listed in Table E.2, the resistance in case of fire is ensured.

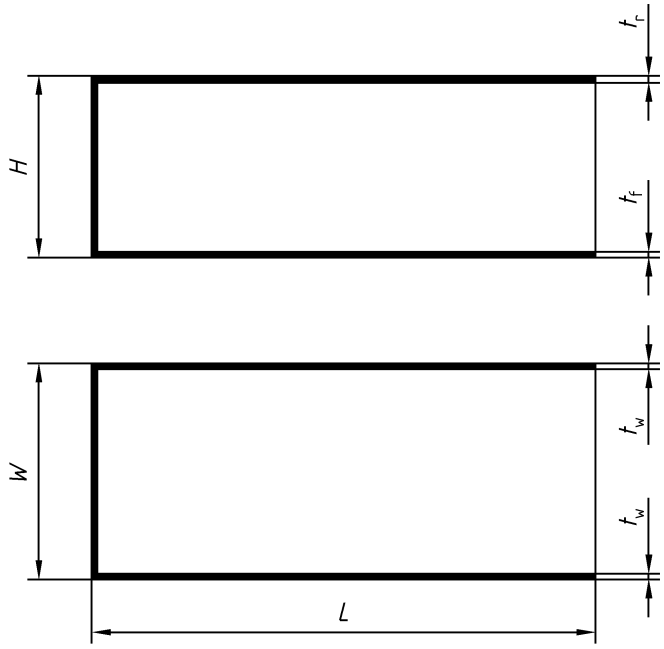

Figure E.3 — Garage box without a door frame (dimensions according to Table E.2)

Table E.2 — Garage box without a door frame with proved resistance in case of fire

Line	System A [a]								
1	Dimensions						Loads		
2	L	W	H	t_w	t_r	t_f	Single load on each wall in the door region	Distributed load roof	Linear load walls
3	≤ 7 000	≤ 3 000	≤ 2 500	≥ 80	≥ 80	≥ 80	≤ 120 kN	≤ 2 kN/m^2	≤25 kN/m
4	Minimum reinforcement walls, roof and floor slab								
5	Walls inside/ outside		Roof inside/ outside		Floor slab inside/ outside		Additional corner reinforcement in the door region		
6	A_s mm^2/m	design cover c	A_s mm^2/m	design cover c	A_s mm^2/m	design cover c	Wall/roof	Floor slab/wall	design cover c
7	159/159	15 mm	159/196	15 mm	159/196	15 mm	4 × ∅ 10 + 4 × ∅ 6	4 × ∅ 10	15 mm
8	System B [b]								
9	Dimensions						Loads		
10	L	W	H	t_w	t_r	t_f	Single load on each wall in the door region	Distributed load roof	
11	≤ 7 000	≤ 3 000	≤ 2 500	≥ 100	≥ 100	≥ 80	≤ 120 kN	≤ 20 kN/m^2	
12	Minimum reinforcement walls and roof								
13	Walls inside/ outside		Roof inside/ outside		Additional corner reinforcement in the door region				
14	A_s mm^2/m	design cover c	A_s mm^2/m	design cover c	Wall/roof	design cover c			
15	159/159	15 mm	159/196	15 mm	4 × ∅ 10 + 4 × ∅6	15 mm			
16	Strength class of concrete according to EN 206-1				C30/37				

[a] System A: Garage box with dimensions and loads according to line 3.
[b] System B: Garage box with dimensions and loads according to line 11.

E.3.4 Separation function of the garage boxes according to E.3.3

With the wall thickness of $t_w \geq 80$ mm as given in Table E.1 and Table E.2, respectively, destroying concrete spallings will be avoided so that the separation function will be ensured.

For the roof thickness of $t_r \geq 80$ mm as given in Table E.1 and Table E.2, respectively, and axis distances of the reinforcement of $a \geq 20$ mm, the separation function of the roof is ensured according to EN 1992-1-2 for an equivalent fire duration of T_{eq} = 60 min. Therefore, a fire spread in a storey above the ceiling can be excluded definitely.

Annex Y
(informative)

Choice of CE marking method

Y.1 General

The producer should choose to apply, for CE marking, one of the methods described in ZA.3, on the basis of the following conditions.

Y.2 Method 1

The declaration of geometrical data and material properties as specified in ZA.3.2 may be applied when the following condition occurs:

— off the shelf and catalogue products.

Y.3 Method 2

The declaration of product properties determined following this standard and EN Eurocodes, as specified in ZA.3.3, should be applied when the following condition occurs:

— precast product with product properties declared by the producer.

Y.4 Method 3

The declaration of compliance with a given specification as specified in ZA.3.4 may be applied when the following condition occurs:

— all other cases than Y.2 and Y.3.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under the mandate M/100 “Precast concrete products” given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the precast concrete garages covered by this annex for the intended uses indicated herein; reference shall be made to the information accompanying the CE marking.

WARNING — Other requirements and other EU Directives, not affecting the fitness for intended uses, may be applicable to the precast concrete garages falling within the scope of this standard.

NOTE 1 In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA, accessed through:http://europa.eu.int/comm/enterprise/construction/internal/dangsub/dangmain.htm.

This annex establishes the conditions for the CE marking of precast concrete garages or precast concrete supplementary units to garages used to keep cars, vans, etc. and shows the relevant clauses applicable.

This annex has the same scope as Clause 1 of this standard and is defined by Table ZA.1.

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

Table ZA.1 — Relevant clauses for precast concrete garages or supplementary units

Essential characteristics		Requirement clauses in this standard	Levels and/or class(es)	Notes and Unit
Compressive strength (of concrete)	All methods	4.2 Production requirements	None	N/mm^2
Ultimate tensile and tensile yield strength (of steel)	All methods	4.1.3 Reinforcing steel	None	N/ mm^2
Mechanical strength (by calculation)	Method 1	Information listed in ZA.3.2	None	Geometry and materials
	Method 2	4.3.3 Mechanical resistance	None	kNm, kN, kN/m
	Method 3	Design specification	None	
Resistance to fire (mechanical strength, integrity and insulation)	Method 1	Information listed in ZA.3.2	REI	Geometry and materials
	Method 2	4.3.4.1 Resistance to fire	REI	min
	Method 3	Design specification	REI	
Reaction to fire	All methods	4.3.4.2 Reaction to fire	None	Class
Resistance to impact of vehicle at very low speed	All methods	4.3.3.2 Mechanical resistance against accidental action		
Sound insulation	All methods	4.3.5 Acoustic properties	None	dB
Durability against corrosion	All methods	4.3.7 Durability	None	Ambient conditions
Durability against freeze-thaw (only for exposed applications)	All methods	4.3.7 Durability	None	Exposure classes
Detailing	All methods	4.3.1 Geometrical properties 8 Technical documentation	None	mm

Method 1 = declaration of geometrical data and material properties (see ZA.3.2).

Method 2 = declaration of the value of the product properties (see ZA.3.3).

Method 3 = declaration of compliance with given design specification (see ZA.3.4).

The producer shall select when he applies each method in accordance with Annex Y.

ZA.2 Procedure for attestation of conformity of precast concrete garages

ZA.2.1 System of attestation of conformity

The system of attestation of conformity of precast concrete garages indicated in Table ZA.1, in accordance with the Decision of the Commission 1999/94/EC of 25 January 1999 as given in Annex III of the Mandate M100 Precast concrete products, is shown for the indicated intended use and relevant levels or classes in Table ZA.2.

Table ZA.2 — System of attestation of conformity

Product	Intended use	Level(s) or class(es)	Attestation of conformity system(s)
Precast concrete garages and supplementary units	Structural	–	2+
System 2+: See Directive 89/106/EEC (CPD) Annex III.2. (ii), First possibility, including certification of the factory production control by an approved body on the basis of initial inspection of factory and of factory production control as well as of continuous surveillance, assessment and approval of factory production control.			

Table ZA.3 — Assignment of evaluation of conformity tasks for precast garages under system 2+

Tasks			Content of the tasks	Evaluation of conformity clauses to apply
Tasks for the manufacturer		Initial type testing	All characteristics of Table ZA.1 (1)	6.2
		Factory production control	Parameters related to all characteristics of Table ZA.1.	6.3
		Further testing of samples taken at the factory	— Mechanical strength; — All characteristics of Table ZA.1.	4.3.3.1 6.2.3 of EN 13369:2004
Tasks for the notified body	Certification of factory production control on the basis of:	Initial inspection of factory and of factory production control	— Compressive strength (of concrete); — Ultimate tensile and tensile yield strength; — Detailing; — Durability; — Resistance to fire REI (in case of verification by testing.	6.1.2.1 a) and 6.3 of EN 13369:2004
		Continuous surveillance, assessments and approval of factory production control	— Compressive strength (of concrete); — Ultimate tensile and tensile yield strength; — Detailing; — Durability; — Resistance to fire REI (in case of verification by testing).	6.1.2.1 b) and 6.3 of EN 13369:2004
(1) For fire resistance (when verified by testing) tests should be carried out by testing laboratory.				

The attestation of conformity of the precast garages and the supplementary units in the Table ZA.1 shall be based on the evaluation of conformity procedure indicated in Table ZA.3 resulting from application of the clauses of this or other European Standards indicated therein.

ZA.2.2 EC Certificate and Declaration of conformity

When compliance with the conditions of this Annex is achieved, and once the notified body has drawn up the certificate mentioned below, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity, which entitles the manufacturer to affix the CE marking. This declaration shall include:

— name and address of the manufacturer, or his authorised representative established in the EEA, and the place of production;

— description of the product (type, identification, use, ...), and a copy of the information accompanying the CE marking;

— provisions to which the product conforms (e.g. Annex ZA of this EN);

— particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions, etc.);

— the number of the accompanying factory production control certificate;

— name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or his authorised representative.

The declaration shall be accompanied by a factory production control certificate, drawn up by the notified body, which shall contain, in addition to the information above, the following:

— name and address of the notified body;

— the number of the factory production control certificate;

— conditions and period of validity of the certificate, where applicable;

— name of, and position held by, the person empowered to sign the certificate.

The above-mentioned declaration and the certificate shall be presented in the official language or languages of the Member State in which the product is to be used.

ZA.3 CE marking and labelling

ZA.3.1 General

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the product (or when not possible it may be on the accompanying label, the packaging or on the accompanied commercial documents e.g. a delivery note).

The following information shall be added to the CE marking symbol:

— identification number of the certification body;

— name or identifying mark and registered address of the producer;

— the last two digits of the year in which the marking is affixed;

— number of the EC factory production control certificate;

— reference to this European Standard;

— description of the product: generic name and intended use;

— information on those relevant essential characteristics taken from Table ZA.1 which are listed in the relevant Subclause ZA.3.2, ZA.3.3 or ZA.3.4;

— "No performance determined" for characteristics where this is relevant.

The "No performance determined" (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

In the following subclauses the conditions are given for the application of CE marking. Figure ZA.1 gives the simplified label to affix to the product, containing the minimum set of information and the link to the accompanying document where the other required information are given. For what concern the information on essential characteristics, some of them may be given by an unambiguous reference to:

— technical information (product catalogue) (see ZA.3.2);

— technical documentation (ZA.3.3);

— design specification (ZA.3.4).

The minimum set of information to be put directly in the affixed label or in the companying document is given in Figures ZA.2, ZA.3 and ZA.4.

ZA.3.1.1 Simplified label

In the case of simplified label the following information shall be added to the CE marking symbol:

— name or identifying mark and registered address of the producer;

— identification number of the unit (to ensure traceability);

— the last two digits of the year in which the marking is affixed;

— number of the EC factory production control certificate;

— reference to this European Standard.

The same identification number shall mark, in the accompanying documents, the information related to the unit.

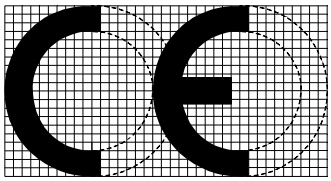	CE conformity marking consisting of the CE symbol given in Directive 93/68/EEC
AnyCo Ltd, PO Bx 21, B-1050	Name or identifying mark and registered address of the producer
45PJ76	Identification number of the unit
02	Last two digits of the year in which the marking was affixed
0123-CPD-0456	Number of the FPC certificate
EN 13978-1	Number of this European standard

Figure ZA.1 — Example of simplified label

NOTE For small elements or for product stamping reasons, the size can be reduced by removing reference to EN and/or to FPC certificate.

ZA.3.2 Declaration of geometrical data and material properties

(Method 1 to determine properties relating to essential requirements "mechanical resistance and stability" and "resistance to fire").

Figure ZA.2 gives, for a type of precast concrete garage, the model CE marking inclusive of the information needed to determine, according to design regulation valid in the place of use, the properties related to mechanical resistance and stability and resistance to fire, including aspects of durability and serviceability.

Referring to Table ZA.1 and to the information quoted in the list of ZA.3.1, the following properties shall be declared (when relevant):

— compressive strength of concrete;

— ultimate tensile strength of reinforcing steel;

— tensile yield strength of reinforcing steel;

— geometrical data (only critical dimensions);

— conditions for durability;

— possible reference to Technical Information (product catalogue) for detailing, durability and geometrical data.

CE 0123	CE conformity marking consisting of the CE symbol given in Directive 93/68/EEC Identification of the notified body
AnyCo Ltd, PO Bx 21, B-1050 02 0123-CPD-0456	Name or identifying mark and registered address of the producer Last two digits of the year in which the marking was affixed Number of the FPC certificate
EN 13978-1 Precast concrete garages Concrete: Compressive strength .....f_{ck} = xx N/mm^2 Reinforcing steel: Ultimate tensile strength .....f_{tk} = yyy N/mm^2 Tensile yield strength .....f_{yk} = zzz N/mm^2 Critical dimensions For detailing and durability see Technical Information Technical Information: Product Catalogue ABC: 2002 – Clause ii	Number and title of European Standard concerned Generic name and intended use Information on product geometry and material characteristics including detailing (to be adapted to the specific product by the producer) NOTE Critical dimensions are those necessary for calculation. Technical information (product catalogue) referred to

Figure ZA.2 — Example of CE marking with Method 1

ZA.3.3 Declaration of product properties

(Method 2 to determine properties relating to essential requirements "mechanical resistance and stability" and "resistance to fire").

For all design data, including models and parameters used in calculation, reference may be made to the technical (design) documentation.

Referring to Table ZA.1 and to the information quoted in the list of ZA.3.1, the following properties shall be declared:

— compressive strength of concrete;

— ultimate tensile strength of reinforcing steel;

— tensile yield strength of reinforcing steel;

— mechanical ultimate strength of the element (design values) with the load capacity (total loading condition);

— safety factors for concrete and steel used in calculation;

— resistance to fire R class (load bearing function);

— resistance to fire EI class (separating function): normally No Performance Determined – NPD;

— other Nationally Determined Parameters NDPs used in calculation;

— airborne sound insulation;

— conditions for durability against corrosion;

— conditions for durability against freeze-thaw (only for exposed applications);

— possible reference to Technical Documentation for geometrical data, detailing, durability, other NDPs, acoustic insulation parameters.

Figure ZA.3 gives, for a type of precast concrete garages, the model CE marking in the case in which the properties related to mechanical resistance and stability and resistance to fire are determined by means of EN Eurocodes.

The design values of the mechanical ultimate strength of the element and the resistance to fire class shall be computed using, for the Nationally Determined Parameters, either the values recommended in EN 1992-1-1 and EN 1992-1-2 or the values given in the National Annex of the EN Eurocodes applicable to the works.

CE 0123	CE conformity marking consisting of the CE symbol given in Directive 93/68/EEC
AnyCo Ltd, PO Bx 21, B-1050	Identification of the notified body Name or identifying mark and registered address of the producer
02	Last two digits of the year in which the marking was affixed
0123-CPD-0456	Number of the FPC certificate
EN 13978-1	Number and title of European Standard concerned
Precast concrete garages	Generic name and intended use
Concrete : Compressive strength .....f_{ck} = xx N/mm^2 Reinforcing steel: Ultimate tensile strength .....f_{tk} = yyy N/mm^2 Tensile yield strength .....f_{yk} = zzz N/mm^2 Mechanical ultimate strength (design value): Load capacity of the floor plate (total loading condition).....……ppp kN/m^2 or maximum vehicle mass ..... ……..ppp t Load capacity of the roof (total loading condition)..... ……ppp kN/m^2 Load capacity of the walls (only with soil backfilling) (total loading condition)..... ……ppp kN/m^2 Load capacity for accidental action (total loading condition)..... ……ppp kN/m^2 Material safety factors applied in strength calculation: For concrete ..... γ_c = z.zz For steel ..... γ_c = x.xx Resistance to fire: – Load bearing function ..... RXX for η_{fi} = 0.xx ..... RYY for η_{fi} = 0.yy ..... – Separating function ..... EI NPD	Information on product geometry and material characteristics including detailing (to be adapted to the specific product by the producer) NOTE The values of resistance to fire may be replaced by a reference to the pertinent part of the technical documentation. NOTE In case of no regulatory requirements for the intended use of the garage, the information about resistance to fire and airborne sound insulation may be replaced by: Resistance to fire.....NPD Airborne sound insulation ..... NPD
For geometrical data, detailing, durability, airborne sound insulation, possible complementary information on fire resistance and other NDPs see the technical documentation Technical documentation: Position number xxxxxx	

Figure ZA.3 — Example of CE marking with Method 2

ZA.3.4 Declaration of compliance with a given design specification

(Method 3 to determine properties relating to essential requirements "mechanical resistance and stability" and "resistance to fire").

Figure ZA.4 gives, for a type of precast concrete garage, the model CE marking in the case the product is produced according to a design specification in which the properties related to mechanical resistance and stability and resistance to fire are determined by means of design provisions applicable to the works.

Referring to Table ZA.1 and to the information and declared values quoted in the list of ZA.3.1, the following properties shall be declared:

— compressive strength of concrete;

— ultimate tensile strength of reinforcing steel;

— tensile yield strength of reinforcing steel;

— resistance to fire class.

This method applies in case of a design made with means other than EN Eurocodes.

CE 0123	CE conformity marking consisting of the CE symbol given in Directive 93/68/EEC Identification of the notified body
AnyCo Ltd, PO Bx 21, B-1050 02 0123-CPD-0456	Name or identifying mark and registered address of the producer Last two digits of the year in which the marking was affixed Number of the FPC certificate
EN 13978-1 Precast concrete garages Concrete: Compressive strength.....f_{ck} = xx N/mm^2 Reinforcing steel: Ultimate tensile strength .....f_{tk} = yyy N/mm^2 Tensile yield strength.....f_{yk} = zzz N/mm^2 For geometrical data, detailing, mechanical strength, fire resistance, airborne sound insulation and durability see the design specifications Design specification: Order code.....xxxxxx	Number and title of European Standard concerned Generic name and intended use Information on product geometry and material characteristics including detailing (to be adapted to the specific product by the producer)

Figure ZA.4 — Example of CE marking with Method 3

In addition to any specific information relating to dangerous substances, the product should be also accompanied, when and where required and in the appropriate form, by documentation listing any other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

NOTE European legislation without national derogations need not be mentioned.

Bibliography

[1] Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig Gutachtliche Stellungnahme Nr. G96075 "Zum Brandschutzkonzept für Tiefgaragen aus Garagenzellen auf der Grundlage der Muster-Garagenverordnung – GarVO –, Fassung Mai 1993; Teil I: Garagenanlagen für Einzel-Pkw.

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