SLOVENSKI STANDARD
SIST EN 1168:2005+A3:2012

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Nadomešča:
SIST EN 1168:2005+A2:2009

Montažni betonski izdelki - Votle plošče

Precast concrete products - Hollow core slabs

Betonfertigteile - Hohlplatten

Produits préfabriqués en béton - Dalles alvéolées

Ta slovenski standard je istoveten z: **EN 1168:2005+A3:2011**

ICS:

91.100.30	Beton in betonski izdelki	Concrete and concrete products

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Precast concrete products - Hollow core slabs

Produits préfabriqués en béton - Dalles alvéolées

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This European Standard was approved by CEN on 1 July 2004 and includes Amendment 1 approved by CEN on 14 January 2008, Amendment 2 approved by CEN on 4 January 2009 and Amendment 3 approved by CEN on 11 August 2011.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

The numbering of clauses is strictly related to EN 13369: 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 standard, its number is omitted and this may result in a gap on numbering.

Foreword

This document (EN 1168:2005+A3:2011) has been prepared by Technical Committee CEN/TC 229 “Precast concrete products”, the secretariat of which is held by AFNOR [A2] and was examined by and agreed with a joint working party appointed by the Liaison Group CEN/TC 229 – CEN/TC 250, particularely for its compatibility with structural Eurocodes [A2].

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of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by July 2013.

[A1] This European Standard 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. [A1]

This document includes Amendment 1 approved by CEN on 2008-01-14, Amendment 2 approved by CEN on 2009-01-04 and Amendment 3 approved by CEN on 2011-08-11.

This document supersedes [A3] EN 1168:2005+A2:2009 [A3].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [A1], [A2] [A2] and [A3] [A3].

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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 Construction Products Directives (89/106/EEC) of the European Union (EU).

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

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

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

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

[A3] Eurocodes are taken as a common reference for design aspects. The installation of some structural precast concrete products is dealt with by EN 13670. In all countries it can be accompanied by alternatives for national application. [A3]

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

— [A1] EN 1168:2005+A1 [A1], *Precast concrete products – Hollow core slabs*

— [A1] EN 12794:2005+A1 [A1], *Precast concrete products – Foundation piles*

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

— [A1] EN 13224:2004+A1 [A1], *Precast concrete products – Ribbed floor elements*

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

- EN 13693, *Precast concrete products – Special roof elements*
- [A1⟩ EN 13747 ⟨A1], *Precast concrete products – Floor plates for floor systems*
- [A1⟩ EN 13978-1, *Precast concrete products - Precast concrete garages - Part 1: Requirements for reinforced garages monolithic or consisting of single sections with room dimensions* ⟨A1]
- [A1⟩ EN 14843 ⟨A1], *Precast concrete products - Stairs*
- [A1⟩ EN 14844 ⟨A1], *Precast concrete products – Box culverts*
- [A1⟩ EN 14991 ⟨A1], *Precast concrete products – Foundation elements*
- [A1⟩ EN 14992, *Precast concrete products – Wall elements* ⟨A1]
- [A2⟩ EN 15037-1, *Precast concrete products – Beam-and-block floor systems – Part 1: Beams*
- EN 15037-2, *Precast concrete products – Beam-and-block floor systems – Part 2: Concrete blocks*
- EN 15037-3, *Precast concrete products – Beam-and-block floor systems – Part 3: Clay blocks*
- prEN 15037-4, *Precast concrete products – Beam-and-block floor systems – Part 4: Polystyrene blocks*
- prEN 15037-5, *Precast concrete products – Beam-and-block floor systems – Part 5: Lightweight blocks* ⟨A2]
- [A1⟩ EN 15258 ⟨A1], *Precast concrete products – Retaining wall elements*
- [A1⟩ EN 15050 ⟨A1], *Precast concrete products – Bridge elements*

This standard defines in Annex ZA the application methods of CE marking to products designed using the relevant EN Eurocodes (EN 1992-1-1 and EN 1992-1-2). Where, in default of applicability conditions of EN Eurocodes to the works of destination, design Provisions other than EN Eurocodes are used for mechanical strength and/or fire resistance, the conditions to affix CE marking to the product are described in ZA.3.4.

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

Introduction

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

For design rules reference is made to EN 1992-1-1. Additional complementary rules are provided where necessary.

The verification of the mechanical resistance of hollow core slabs is, at this stage of standardisation, only fully accepted by calculation; [A2] however, concrete properties adopted as input for calculation of shear resistance depend on the proper functioning of the production machine; therefore a full scale test method to confirm both the shear resistance obtained by calculation and the proper functioning of the production machine, is given in Annex J (normative). [A2]

Special rules for structures with hollow core elements are presented in annexes about load distribution (Annex C), diaphragm action (Annex D), negative moments (Annex E), shear capacity of composite members (Annex F) and design of connections (Annex H).

[A3] Special rules for pre-stressing by means of thermal pre-stressing are given in Annex K. [A3]

Because of some specialities of the product, e.g. the absence of transverse reinforcement, some complementary design rules to EN 1992-1-1 are necessary. Furthermore, research on hollow core slabs has resulted in special, widely used, design rules which are not incorporated in the design rules of EN 1992-1-1. According to subclause 1.2 of EN 1992-1-1:2004 the complementary rules given in informative annexes in this standard, comply with the relevant principles given in EN 1992-1-1.

Because of the fact that the experimental evidence is mainly based on elements with limited depth and width, this standard is applicable to elements with these limited dimensions. This limitation is not intended to prohibit the application of elements with larger sizes, but the experience is not yet wide enough to draw up standardised design rules.

1 Scope

This European Standard deals with the requirements and the basic performance criteria and specifies minimum values where appropriate for precast hollow core slabs made of prestressed or reinforced normal weight concrete according to EN 1992-1-1:2004.

This European Standard covers terminology, performance criteria, tolerances, relevant physical properties, special test methods, and special aspects of transport and erection.

Hollow core elements are used in floors, roofs, walls and similar applications. In this European Standard the material properties and other requirements for floors and roofs are dealt with; for special use in walls and other applications, see the relevant product standards for possible additional requirements.

[A3] The elements have lateral edges with a grooved profile in order to make a shear key to transfer shear through joints contiguous elements. [A3] For diaphragm action the joints have to function as horizontal shear joints.

[A3] To improve this action vertical grooves may be provided. [A3]

The elements are manufactured in factories by extrusion, slipforming or mouldcasting. [A3] Fitting slabs (narrowed slab elements) and recesses to the hollow core slabs can be made during production or afterwards. Hollow core slabs can have provisions for thermal activation, heating, cooling, sound insulation, etc. Due to these provisions, the concrete temperature remains in it's natural range. [A3]

[A3] This European Standard also deals with solid slab elements used in conjunction with hollow core slabs and manufactured by extrusion, slipforming or mouldcasting, equivalent to the manufacturing of hollow core slabs. These solid slabs have the same overall cross-section as hollow core slabs, however without hollow cores. [A3]

[A3] The application of the standard is limited for prestressed elements to a maximum depth of 500 mm and for reinforced elements to a maximum depth of 300 mm.

For both types, the maximum width without transverse reinforcement is limited to 1 200 mm and with transverse reinforcement to 2 400 mm. [A3]

The elements may be used in composite action with an in situ structural topping cast on site.

The applications considered are floors and roofs of buildings, including areas for vehicles in the category F and G of [A2] EN 1991-1-1 [A2] which are not subjected to fatigue loading. For building in seismic zones additional provisions are given in EN 1998-1.

This European Standard does not deal with complementary matters. E.g. the slabs should not be used in roofs without additional protection against water penetration.

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 1992-1-2:2004, *Eurocode 2: Design of concrete structures — Part 1-2: General rules – Structural fire design*

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

EN 12390-3, *Testing hardened concrete — Part 3: Compressive strength of test specimens*

EN 12390-4:2000, *Testing hardened concrete — Part 4: Compressive strength — Specification for testing machines*

EN 12390-6, *Testing hardened concrete — Part 6: Tensile splitting strength of test specimens*

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

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

[A1] EN 13791, *Assessment of in-situ compressive strength in structures and precast concrete components* [A1]

[A3] EN ISO 15630-3, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 3: Prestressing steel (ISO 15630-3:2010)* [A3]

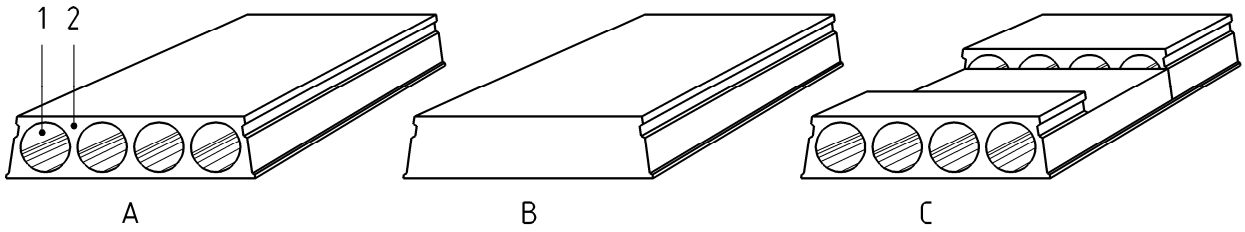
3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply. For general terms EN 13369:2004 shall apply.

3.1 Definitions

3.1.1
hollow core slab
monolithic prestressed or reinforced element with a constant overall depth divided into an upper and a lower flange, linked by vertical webs, so constituting cores as longitudinal voids the cross section of which is constant and presents one vertical symmetrical axis (see Figure 1)

[A3]



Key

A hollow core slab
B solid slab
C combined slab
1 core
2 web

Figure 1 — Types of hollow core slabs (examples) [A3]

[A3] **3.1.2**
solid slab
slab with the same overall cross-section as a hollow core slab where, during manufacturing no voids are made (Figure 1 B). This slab is manufactured in the same manner (machine, bed, …) as hollow core slabs with voids

NOTE Hollow core slabs where the voids are filled with concrete after manufacturing of the hollow core element can not be considered as a solid slab.

3.1.3
combined slab
hollow core slab that has partially a solid cross section (Figure 1 C). The depth of the cross section may vary over the length of the element

3.1.4
fitting slab
slab sawn from a standard slab with a width ≥ 250 mm with at least two webs A3

A3 **3.1.5** A3
core
longitudinal void produced by specific industrial manufacturing techniques, located with a regular pattern and the shape of which is such that the vertical loading applied on the slab is transmitted to the webs

A3 **3.1.6** A3
web
vertical concrete part between two adjacent cores (intermediate webs) or on the lateral edges of the slab (outermost webs)

A3 **3.1.7** A3
lateral joint
lateral profile on the longitudinal edges of a hollow core slab shaped so to allow grouting between two adjacent slabs

A3 **3.1.8** A3
topping
cast in situ concrete on the hollow core slab floor intended to increase its bearing capacity and so constituting a composite hollow core slab floor

A3 **3.1.9** A3
screed
cast in situ concrete or mortar layer used to level the upper face of the finished floor

A3 **3.1.10** A3
hollow core slab floor
floor made of hollow core slabs after the grouting of the joints

A3 **3.1.11** A3
composite hollow core slab floor
hollow core slab floor complemented by a cast-in-situ topping

A3 **3.1.12**
solid slab floor
floor made of solid core slabs after the grouting of the joints A3

A3 **3.1.13**
composite solid slab floor
solid slab floor complemented by a cast in situ topping A3

4 Requirements

4.1 Material requirements

Complementary to 4.1 of EN 13369:2004 the following subclauses shall apply. In particular the ultimate tensile and tensile yield strength of steel shall be considered.

4.1.1 Prestressing steel

4.1.1.1 Maximum diameter of prestressing steel

[A3] The diameter of pre-stressing steel is limited to:

— Class 1: Elements with pre-stressing steel with a maximum of 11 mm for wires and 16 mm for strands;

— Class 2: Elements with thermal pre-stressed bars with a maximum of 16 mm.

The use of pre-stressing bars is only allowed in accordance with Annex K. [A3]

4.2 Production requirements

[A2] 4.2 of EN 13369:2004 shall apply.

Proper placing and compacting of concrete by the production machine shall be verified by initial type testing according to 6.2.2.

Complementary to 4.2.3 of EN 13369:2004 4.2.1 shall apply for structural reinforcement. [A2]

4.2.1 Structural reinforcement

4.2.1.1 Processing of reinforcing steel

4.2.1.1.1 Longitudinal bars

For the distribution of the longitudinal bars the following requirements shall be fulfilled:

a) the bars shall be distributed uniformly across the width of the elements;

b) the maximum centre to centre distance between two bars shall not exceed 300 mm;

[A3]

c) in the outermost webs there shall be at least one bar, for solid slabs, the equivalent position shall be considered; [A3]

d) the clear spacing between bars shall be at least:

— horizontally : $\geq (d_g + 5\ \text{mm})$, ≥ 20 mm and $\geq \varnothing$;

— vertically : $\geq d_g$, ≥ 10 mm and $\geq \varnothing$.

4.2.1.1.2 Transversal bars

Transverse reinforcement is not required in slabs up to 1 200 mm wide. Slabs having a width greater than 1 200 mm must have transverse reinforcement designed to suit the loading requirements. The minimum transverse reinforcement shall be 5 mm diameter bars at 500 mm centres.

4.2.1.2 Tensioning and prestressing

4.2.1.2.1 Common requirements for the distribution of prestressing tendons

The following requirements shall be fulfilled:

a) the tendons shall be distributed uniformly across the width of the elements;

b) in every width of 1,20 m at least four tendons shall be applied;

c) in every element of a width greater than 0,60 m and less than 1,20 m, at least three tendons shall be applied;

d) in every element with a width of 0,60 m or less at least two tendons shall be applied;

e) the minimum clear spacing between tendons shall be:

— horizontally : $\geq (d_g + 5\ \text{mm})$, ≥ 20 mm and $\geq \varnothing$;

— vertically : $\geq d_g$, ≥ 10 mm and $\geq \varnothing$.

4.2.1.2.2 Transfer of prestress

Clause 8.10.2.2 of EN 1992-1-1:2004 shall apply:

NOTE "Good" bond conditions are obtained for extruded and slip-formed elements. For the description of "good" and "poor" bond conditions, see Figure 8.2 of EN 1992-1-1:2004.

4.3 Finished product requirements

4.3.1 Geometrical properties

4.3.1.1 Production tolerances

4.3.1.1.1 Dimensional tolerances related to structural safety

The maximum deviations, measured in accordance with 5.2, on the specified nominal dimensions shall satisfy the following requirements:

a) slab depth:

— $h \leq 150$ mm: -5 mm, $+10$ mm;

— $h \geq 250$: ± 15 mm;

— $150\ \text{mm} < h < 250\ \text{mm}$: linear interpolation may be applied;

b) nominal minimum web thickness:

— individual web (b_w): -10 mm;

— total per slab (Σb_w): -20 mm;

c) nominal minimum flange thickness (above and underneath cores):

— individual flange: -10 mm, $+15$ mm;

d) vertical position of reinforcement at tensile side:

— individual bar, strand or wire: $h \leq 200$ mm ± 10 mm;

$h \geq 250$: ± 15 mm;

200 mm < h < 250 mm: linear interpolation may be applied;

— mean value per slab: ± 7 mm;

— the requirement in this paragraph shall not conflict with subclause 4.3.1.2.3 of this standard.

〈A1〉 4.3.1.1.2 〈A1〉 Tolerances for construction purposes

The maximum deviations, unless declared otherwise by the manufacturer, shall satisfy the following:

a) slab length: ± 25 mm;

〈A3〉

b) slab width:

— general ± 5 mm;

— in case of fitting slabs ± 25 mm; 〈A3〉

c) slab width for longitudinally sawn slabs: ± 25 mm;

〈A3〉

d) length of protruding strands.

The minus deviation from the measured length of the protruding part of the protruding strand in regard to the nominal (design) value:

— 10 mm.

This value may be increased with half of the actual deviation (positive) of the measured slab length (a)). 〈A3〉

〈A1〉 4.3.1.1.3 〈A1〉 Tolerances for concrete cover

〈A1〉 The maximum deviation for concrete cover shall be Δc = -10 mm. A more stringent tolerance may be declared by the manufacturer. 〈A1〉

4.3.1.2 Minimum dimensions

Complementary to 4.3.1.2 of EN 13369:2004 next subclauses shall apply.

4.3.1.2.1 Thickness of webs and flanges

The nominal thickness specified on the drawings shall be at least the minimum thickness increased by the maximum deviation (minus tolerance) declared by the manufacturer.

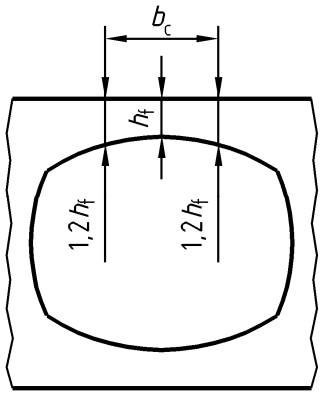
The minimum thickness shall be:

— for any web, not less than the largest of h/10, 20 mm and (d_g + 5 mm), where d_g and h are in millimetres;

— for any flange, not less than the largest value of $\sqrt{2h}$, 17 mm and ($d_g + 5$ mm), where d_g and h are in millimetres; however for the upper flange, not less than 0,25 b_c, where b_c is the width of that part of the flange in which the greatest thickness is not greater than 1,2 times the smallest thickness (see Figure 2).

Thickness of webs and flanges shall be measured in accordance with 5.2.1.1.

[A2]



[A2]

Figure 2 — Minimum thickness of upper flange

4.3.1.2.2 Minimum concrete cover and axis distances of prestressing steel

For indented wires or smooth and indented strands, the minimum concrete cover c_{min} to the nearest concrete surface and to the nearest edge of a core shall be at least:

— only with respect to the exposed face, the one determined in accordance with 4.4.1.2 of EN 1992-1-1:2004 shall apply;

— for preventing longitudinal cracking due to bursting and splitting and in the absence of specific calculations and/or tests:

[A1] a) when the nominal centre to centre distance of the strands is ≥ 3 Ø: c_{min} = 1,5 Ø;

b) when the nominal centre to centre distance of the strands is < 2,5 Ø: c_{min} = 2,5 Ø;

where Ø is the strand or wire diameter, in millimetres (in the case of different diameters, the average value shall be used for Ø).

For intermediate centre to centre distance, c_{min} may be derived by linear interpolation between the values defined in a) and b).

For ribbed wires, the concrete cover shall be increased by 1 Ø. [A1]

4.3.1.2.3 Minimum concrete cover of reinforcing steel

Clause 4.4.1.2 of EN 1992-1-1:2004 shall apply.