EUROPEAN COMMISSION
Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

Single Market Policy, Regulation and Implementation
Standards for Growth

Brussels, 14.12.2015

A Notification under Article 12 of Regulation (EU) No 1025/2012[1]

Subject matter related to

☐	Annual Union Work Programme for European standardisation (Art. 12, point a)
☐	Possible future standardisation requests to the European standardisation organisations (Art. 12, point b)
☒	Formal objections to harmonised standards (Art. 12, point c)
☐	Identifications of ICT technical specifications (Art. 12, point d)
☐	Delegated acts to modify Annexes I or III of Regulation (EU) No 1025/2012 (Art. 12, point e)

Title of the initiative

Formal Objection against EN 1168:2005+A3:2011 "Precast concrete products – hollow core slabs"

Additional information

Legislative reference(s)	Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88, 4 April 2011
EN reference(s)	EN 1168:2005 (as amended by A3:2011)
Status	
Other information	This is a formal objection launched by Germany on 14 July 2015 against EN 1168:2005 (as amended by A3:2011) the references of which have been published in the Official Journal of the European Union.

Commission contact point for this notification

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[1] OJ L 316, 14.11.2012, p. 12

Version of 14 July 2015

Member State
…

European Commission
…

Formal objection against harmonised standard
Here: Hollow core slabs

Sectoral legislation concerned	Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products (OJ L 88 of 4 April 2011, p. 5)
Objection proceedings in accordance with sectoral legislation	Art. 18 of Regulation (EU) No. 305/2011
Harmonised standard concerned	EN 1168:2005+A3:2011 Precast concrete products – hollow core slabs Intended use: floors, roofs and walls in buildings and other civil engineering works, except bridges Publication of the reference via a Commission communication in the framework of the implementation of Regulation (EU) No 305/2011 in the Official Journal of the European Union (2015/C 226/05)
Standard clauses	Objections to various standard clauses: a) Annex ZA, Table ZA.1 (Relevant clauses for hollow core slabs), in the column “Essential characteristics”: Ultimate tensile and tensile yield strength (of steel), All methods: reference to EN 13369:2004 with clauses 4.1.3 and 4.1.4 b) Annex ZA, Table ZA.1 (Relevant clauses for hollow core slabs), in the column “Essential characteristics”: Mechanical strength Method 2: clause 4.3.3 Mechanical resistance Method 3: Design specification c) Annex ZA, Table ZA.1 (Relevant clauses for hollow core slabs), column “Essential characteristics”: Resistance to fire (for load bearing capacity) d) Annex ZA, Table ZA 1 (Relevant clauses for hollow core slabs), in the column “Essential characteristics”: Detailing

All methods: clause 8

e) Annex ZA, Table ZA 1 (Relevant clauses for hollow core slabs),
in the column “Essential characteristics”:
Compressive strength (of concrete),
All methods: clause 4.2

f) Annex ZA., clause ZA.1 (Scope),
reference to clause 1
Scope, there in particular clauses 3, 6 and 7

Standardisation mandate Mandate M/100 of 7 September 1994 amended by Mandate M/100rev.1 of 22-23 May 2001

Basic requirement concerned (construction work)

Unlike in other harmonisation directives, in accordance with Art. 3 § 1 in conjunction with Annex I of Regulation (EU) No. 305/2011, the basic requirements of the sectoral legislation for construction products target not the products themselves, but construction works which are erected in the territory of the Member States from harmonised construction products or are modified and repaired with harmonised construction products.

The following basic requirements for construction works are affected by the objection in this instance:

Basic requirement No. 1 Mechanical resistance and stability in the construction and use of construction works

Durability — Satisfaction of the basic requirements for an economically reasonable working life

(cf. Annex I of Regulation (EU) No. 305/2011).

Grounds

I. Commission mandate and harmonised standard

Harmonised standard EN 1168:2005+A3:2011, as published in the Official Journal, fails to comply with the relevant mandate in several respects:

a) EN 1168 does not contain the harmonised method (calculation, test methods or others) for the determination of the ultimate tensile and tensile yield strength of reinforcing and prestressing steel as raw materials for the manufacture of hollow core slabs necessary in accordance with Art. 17 § 3 of Regulation (EU) No. 305/2011 and required in accordance with Mandate M/100 (Ch. III, No. 2 of the mandate in conjunction with Annex 2 and M/100 (5/33)).
b) The harmonised methods for the determination of mechanical strength selected in EN 1168 are inadequate to guarantee the long-term satisfaction of the basic requirements for construction works. The consideration of durability required in accordance with Ch. III, No. 6 of the Mandate is not implemented in EN 1168 in design and test methods (cf. also Ch. II, No. 2 of the Mandate).
c) Mandate M/100 requires provisions concerning resistance to fire for load bearing capacity (R), consideration being given to installation conditions. EN 1168, Annex G, Tables G.1 and G.2 however classify performance properties (“REI”) for the essential characteristic “resistance to fire” equally (that is load bearing capacity, integrity, insulation).

d) EN 1168 does not contain the harmonised methods and criteria (calculation, test methods or others) necessary in accordance with Art. 17 § 3 of Regulation (EU) No. 305/2011 and required in accordance with the mandate to assess the performance of the structural design under installation conditions (Ch. III, No. 2 of the Mandate in conjunction with Annex 2 and M/100 (5/33)).
e) EN 1168 does not contain the harmonised methods and criteria (calculation, test methods or others) to assess the performance of concrete as a raw material for the manufacture of hollow core slabs necessary in accordance with Art. 17 § 3 of Regulation (EU) No. 305/2011 and required in accordance with the mandate (Ch. III, No. 2 of the Mandate in conjunction with Annex 2 and M/100 (5/33)).
f) With the reference to clause 1 "Scope" of EN 1168:2011, Annex ZA, clause ZA.1 lists possible applications of hollow concrete slabs which are not portrayed by Mandate M/100 (5/33), Ch. III, No. 2 in conjunction with Annex 2. Furthermore, EN 1168 does not contain the design concepts and test methods necessary for the scope (walls, solid slabs, fitting slabs) that is expanded as compared to floors made of hollow concrete slabs. It is hence lacking the methods and criteria for assessing performance required in accordance with Art. 17 § 3 of Regulation (EU) No. 305/2011.

This therefore constitutes several violations of Art. 17 § 3 of Regulation (EU) No. 305/2011, as well as of Commission Mandate M/100. In detail:

re a) Ultimate tensile and tensile yield strength (of steel)

Mandate M/100 stipulates that the harmonised standard is to cover the characteristic "ultimate tensile and tensile yield strength of steel" (Ch. III, No. 2 in conjunction with Annex 2 and M/100 (5/33)) and the method (calculation, test methods or others) to verify the characteristic or a reference to a harmonised standard containing the methods for the determination of such characteristics. (Ch. III, No. 2).

Annex ZA, Table ZA.1 of EN 1168 refers to EN 13369:2004 "Common rules for precast concrete products", clause 4.1.3 for reinforcing steel and 4.1.4 for prestressing steel to characterise the characteristics "ultimate tensile and tensile yield strength of steel (reinforcing steel, prestressing steel)". Clauses 4.1.3 and 4.1.4 of EN 13369:2004 do not contain test methods or other methods for assessing the performance of the raw materials, in particular ultimate tensile and tensile yield strength.

Alternatively, reference is made there to European pre-standard prEN 10080 for reinforcing steel, and in clause 4.1.4 to pre-standard prEN 10138 for prestressing steel. These pre-standards have however currently not been harmonised (which is however required in accordance with the mandate [Ch. III, No. 2]), nor is harmonisation foreseeable. With regard to EN 10080:2005, furthermore, it is to be pointed out that a Commission Decision has been handed down on the withdrawal of the reference of this standard from the list of harmonised standards published in the Official Journal of the European Union (2006/893/EC).

EN 13369: 2004, clauses 4.1.3 and 4.1.4, referred to via EN 1168, 4.1 and 4.2, require that the prestressing steel and the concrete steel reinforcement used must satisfy the properties from EN 1992-1-1:2004 as a basis for attestation. Just as EN 13369:2004, EN 1992-1-1:2004 is a non-harmonised standard containing national regulations in clauses 3.2 "Reinforcing steel" and 3.3 "Prestressing steel". This relates amongst other things to the relaxation properties of prestressing steel, ductility and presumptions on the calculated stress-strain curve, which have design relevance for the attestation of stability. EN 1168 does not provide any harmonised methods enabling the assessment of non-harmonised concrete and prestressing steel properties on the construction product.

It must be concluded that neither harmonised definitions nor test methods are made available for the performance properties "yield strength and tensile strength (of steel)" which are to be declared in accordance with harmonised standard EN 1168. Hence, neither EN 1168 nor referenced standards make available the harmonised test methods (Ch. III, No. 2) to assess the performance properties of reinforcing steel and prestressing steel, in particular for ultimate tensile and tensile yield strength, required by Mandate M/100.

re b) Mechanical strength (shear force and bending moment capacity)

The mechanical strength of a construction product contributes towards ensuring the long-term stability of its structure. At least the limit state of the bending moment capacity and the limit state of the shear force for the hollow core slabs need to be verified in order to satisfy the basic requirement of the "mechanical resistance and stability" of the construction work. Ch. III No. 2 of Mandate M/100 stipulates that the harmonised standard must contain at least one method (calculation, tests, etc.) or a reference to a harmonised standard for the determination of these essential characteristics. Methods 2 and 3 stipulated in EN 1168, Annex ZA 1, Table ZA.1 violate this requirement stated in the mandate:

Method 2 – Statement of product characteristics

In accordance with Annex ZA, Tab. ZA. 1, EN 1168 refers for mechanical strength in Method 2 to clause 4.3.3 (Mechanical resistance) in supplementation of EN 13369:2004, 4.3.3. Item 4.3.3.2 of that standard indicates that the design values for load bearing capacity in calculational terms i) are to be calculated using the relevant expressions of Eurocode EN 1992-1-1, ii) using the additional regulations stated in the product standards, or iii) by applying the national rules applicable at the place of use.

In application of the design-relevant clauses of standard EN 1992-1-1, the attestation in method i) refers to a non-harmonised standard in which reference is to be made to the national annexes for the place of use. Calculation on the basis of EN 1992-1-1 and of national annexes leads to non-harmonised results for mechanical strength.

If performance in terms of mechanical strength is determined according to method ii), in other words in accordance with the concomitant additional rules (EN 1168, 4.3.3.1 and 4.3.3.3) referred to in the product standard, the calculated shear force is to be confirmed in full-scale tests in accordance with Annex J. The values that are calculated in accordance with EN 1168 however fail to comply with the requirements contained in Eurocode EN 1992-1-1 with the German national annex. The calculation in accordance with EN 1168 is not on the safe side, as the load bearing capacity of concrete is overstated. Unlike in Eurocode EN 1992-1-1, the durability of the concrete strength is not accounted for in the calculation method in accordance with EN 1168 (clause 4.3.3.2.2) because of the lack of the fatigue factor α_{ct}. Attempts to validate these results in accordance with Annex J.4 cannot remedy this.

The third possibility of the calculational attestation of mechanical strength (method iii) – attestation using the national rules applicable at the place of use – also constitutes a recourse to non-harmonised methods in contravention of Mandate M/100.

Summing up, the methods for the calculational attestation of mechanical strength contained in harmonised standard EN 1168 impair the precision, reliability and stability of the results, thus contravening Art. 17 § 3 of Regulation (EU) No. 305/2011, and hence the harmonised standard fails to attain the level of quality required in accordance with the mandate with regard to the satisfaction of the requirements made of construction works (Ch. II, No. 2 of the Mandate). What is more, in contravention of the mandate, the national rules applicable at the place of use and the recourse to EN 1992-1-1, which can be applied in accordance with EN 1168, do not constitute harmonised methods to determine product performance.

Methods 3a and 3b – Declaration of product compliance with a given design specification provided by the client (3a) or declaration of product compliance with a given design specification provided by the manufacturer according to the client's order (3b)

Annex ZA, Tab. ZA. 1 of harmonised standard EN 1168 provides for "Detailing" for Method 3, which is however not detailed.

The methods for determining mechanical strength according to this Method 3 remain open. The standard provides neither for test methods nor for other harmonised methods to determine performance. The requirements of the concomitant Mandate M/100 are not transposed with Methods 3a and 3b.

re c) Resistance to fire (load bearing capacity criterion)

Mandate M/100 (Ch. III, No. 2 in conjunction with Annex 2 and M/100 (5/33)) requires the

consideration of the property “resistance to fire” of hollow-core concrete slabs with regard to load bearing capacity criterion (R) under installation conditions.
The performance properties “integrity” and “insulation” (EI) are not indicated. Calculational attestation is not possible as a rule. The classification for these performance properties is contingent on detailed information being provided on the final state of the implemented construction (e.g. design of joints with connecting elements, design of openings, structural design of floors, etc.). This is not the case with the regulations provided for in EN 1168, and must furthermore be clarified and correspondingly attested in individual cases, consideration being given to all underlying conditions of the construction in its final state.

The classification of resistance to fire made possible by EN 1168, Annex G, Tab. G.1 and G.2 for “EI” (integrity and insulation) is not indicated by the mandate, and is not comprehensible or verifiable for the above reasons.

re d) Structural design

Mandate M/100 provides that the harmonised standard is to include the characteristic “structural design (conditions of use)” (Ch. III, No. 2 in conjunction with Annex 2 and M/100 (5/33)) and the relevant method (calculation, test methods or others) to verify the characteristic or a reference to a harmonised standard containing the methods for the determination of such characteristics (Ch. III, No. 2).

Annex ZA.1, Table ZA.1 of EN 1168 refers with regard to structural design to clauses 4.3.1, Geometrical properties and 8, Technical documentation. These do not however contain the methods to verify the structural design of the hollow core slabs required by the mandate.

EN 1168 also does not contain any harmonised rules as to how the effectiveness of such measures of structural design are to be assessed with regard to stability, constancy of performance and reliability.

re e) Compressive strength (of concrete), and in this context tensile strength (of concrete)

Mandate M/100 provides that the harmonised standard is to contain the characteristic “compressive strength of concrete” (Ch. III, No. 2 in conjunction with Annex 2 and M/100 (5/33)) and the method (calculation, test methods or others) to verify the characteristic or a reference to a harmonised standard containing the methods for the determination of such characteristics. (Ch. III, No. 2).

Table ZA.1 of EN 1168 refers in this regard to clause 4.2. This clause refers in turn to EN 13369:2004, clause 4.2. At 4.2.2 “Hardened concrete”, 4.2.2.1 “Strength classes”, the properties which are attributed in EN 1992-1-1, Tab. 3.1 to the concrete compressive strength classes are introduced for the design. In accordance with EN 1992-1-1, 3.1.2 (1)P, these only apply to concrete under non-harmonised concrete standard EN 206-1. For the attestation of durability at the place of use, clause 5.3 of EN 206-1 requires amongst other things an additional national standard containing national regulations on the composition of concrete. Stating compressive strength in accordance with Annex ZA of EN 1168 does not adequately describe these nationally-required properties.

It can be concluded that the non-harmonised base products with regard to which there are national regulatory derogations – prestressing reinforcement and concrete – cannot result in a harmonised construction product.

re f) Use of hollow core slabs

EN 1168, Annex ZA, clause ZA.1, states the following uses of hollow core slabs – without further technical, structural and experimental specifications – with reference to clause 1 of the standard (Scope):

- *Walls*
  Ch. III, No. 2 in conjunction with Annex 2 of Mandate M/100 does not cover walls, and hence also not the necessary characteristics which must be contained in a harmonised standard.

  In accordance with EN 1168 clause 1, paragraph 3, hollow core slabs could however also be used as walls. It adds to this with a contradiction: “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." EN 1168 however does not contain any specific references to relevant harmonised standards (cf. requirement in Ch. III, No. 2 of the Mandate) or to rules that are to be complied with.

The essential characteristics for the intended use of the hollow core slabs as roof and floor – horizontal element – of EN 1168 (Ch. III, No. 2 of the Mandate in conjunction with Annex 2 and Mandate 5) do not contain the specific performance properties attesting suitability as a wall element – vertical element. For this at least information is missing on stability criteria and tolerances of tilting. EN 1168 does not contain test methods for vertical elements.

- *Similar applications*
  In accordance with EN 1168 clause 1, paragraph 3, the elements may also be used for similar applications. There are however no specific references to corresponding harmonised standards (cf. requirement in Ch. III, No. 2 of the Mandate).
  These (undefined) purposes are neither covered by Mandate M/100 nor regulated in technical and structural terms by a harmonised product standard.

- *Solid slab elements*
  EN 1168 clause 1, paragraph 7, deals with the application of solid slab elements without any technical and structural determinations in this standard. Clause 1, Scope, specifies that solid slab elements may be manufactured using the manufacturing process for hollow core slabs. National experience however suggests that it is highly uncertain whether the adequate compaction of the concrete is achieved with slipforming or extruders for slabs without cavities. Solid slab elements are hence not to be regulated in a harmonised product standard for hollow core slabs, but are regulated amongst other things as solid slabs by EN 1992-1-1 in conjunction with national annexes.

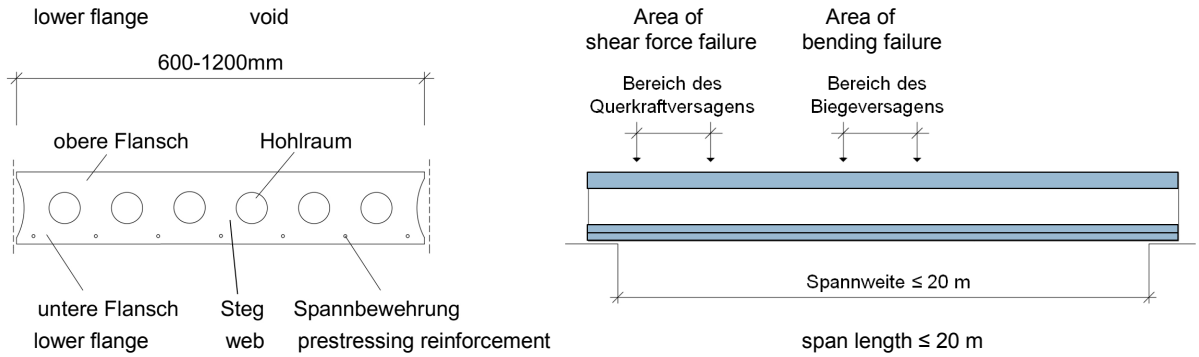
- *Fitting slabs*
  In accordance with EN 1168 clause 1, paragraph 6, fitting slabs may be made after production of the hollow core slabs. EN 1168 does not contain any technical information on cut fitting slabs. It is however important with such elements to assess the joint load capacity of the cut joint, and hence the load bearing capacity of the lower remaining slab flange, as well as the torsional strength of the slab. Recesses in these slabs should furthermore be ruled out, and the arrangement in the section of floor should be determined. A separate specification is to be drawn up because of the reduced mechanical strength.

- *Provisions for thermal activation*
  These provisions are only mentioned in the scope of EN 1168, clause 1, paragraph 6.
  EN 1168 does not contain any further technical and structural determinations for e.g. the arrangement and maximum penetration of the slabs with pipes as well as information on the size of the necessary inlet cut-outs in the slabs and their consideration in the measurement of the shear force.

Walls, similar applications, solid slab elements, fitting slabs and provisions for thermal activation are hence described as being included in the scope of EN 1168, but in some cases are not covered by the mandate (the mandate is thus exceeded). The determinations of the product characteristics, which are necessary for the applications in accordance with the mandate, are missing, as are methods to determine the characteristics or references to harmonised standards containing such methods.

II. Satisfaction of the basic requirements of construction works, damage

In accordance with EN 1168, 3.1.1, a hollow core slab is a "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" (Figure 1).



a) cross section b) long section

Figure 1: Designations on a prestressed concrete hollow slab

Prestressed reinforcement results in greater span lengths and low reinforcement percentages while providing lower weight in comparison to solid slabs (Figure 2). Prestressed concrete hollow slabs which are produced from standard concrete and prestressing reinforcement in the slab webs as a rule do not have any additional reinforcing steel and shear force reinforcement lengthwise and transversely. The transverse distribution of the loads and resistance under shear force load are therefore initially restricted with these types of slab. Hollow core slabs can be connected via the joint and ring beam design to form disks in the structure which also help brace the structure.

Figure 2: Example of prestressed concrete hollow slabs (CC BY-SA 3.0, SCHMAHL [5])

Prestressed concrete hollow slabs are used as a floor solution with higher live loads and where larger span lengths are needed (up to approx. 20 m), for instance for floors in office buildings and car parks, as well as for roofs in hall structures. They are also used for building single-family and semi-detached houses. Their use is more or less common depending on the country. Various studies permit one to conclude that at least 1 to 2 million m² of floor space are constructed from prestressed concrete hollow slabs every year in the United Kingdom. Approx. 9 million m² of floor space were constructed of prestressed concrete hollow slabs every year in the Netherlands in recent years [2], [3].

It is illustrated below that there is a risk for construction works with hollow core slabs in accordance with harmonised standard EN 1168 that basic requirement No. 1 “Mechanical resistance and stability” cannot be reliably and permanently satisfied. According to the statutory provisions in Germany, “Each structural work must be stable as a whole and in terms of its individual parts”. This is prescribed by section 12 (Stability) of the German Model Building Regulation (*Musterbauordnung*) (Notification D 2012/0598/D), which has been implemented in the *Land* Building Regulations with identical wording. Section 12 of the Model Building Regulation is the provision corresponding to basic requirement No. 1 “Mechanical resistance and stability” in accordance with Annex I of Regulation (EU) No. 305/2011.

The Building Regulations of the *Länder* furthermore provide that construction products may only be used if the requirements of the construction works are satisfied for an “appropriate period of time which is in keeping with their purpose”. This emerges from section 3 subsection (1) (General requirements) of the Model Building Regulation, which has been implemented with identical wording in the *Land* Building Regulations. This provision corresponds to the stipulations contained in Annex I of Regulation (EU) No. 305/2011, which target the satisfaction of the basic requirements “for an economically reasonable working life”. This means that construction works are as a rule to satisfy the safety requirements made of them, and hence comply with the durability rule, for a period of several decades.

a) Ultimate tensile and tensile yield strength (of prestressing steel)

The reinforcement largely determines the resistances and ductility that can be achieved under bending and shear force stress. If reliable building material properties of reinforcing and prestressing steel are not ensured, doubts must arise as to whether the level of reliability can be reached at the place of use that is stipulated regarding the load bearing capacity of a floor and of the overall structure.

In the event of failure, entire floor sections may fail without warning under bending and shear force stress (cf. Fig. 3).

Fig 3: Shear failure in a trial in case of brittle fracture (photo detail from TWOMEY [6])

b) Mechanical strength

Prestressed concrete hollow slabs as a matter of principle have the advantage vis-à-vis solid concrete slabs (solid cross-sections), which are implemented directly in accordance with design base EN 1992-1-1 and EN 1992-1-1/NA, that they are lighter in weight and that material is saved. This is used in order to achieve much greater spans while using a comparable amount of material.

Should they fail, however, the area that is suddenly and directly affected is also much larger. Solid concrete slabs (solid panels), by contrast, largely give a warning of their failure by virtue of the fact that they show considerable deformation and form cracks. Furthermore, they frequently have load-bearing reserves from storage conditions and transverse distribution of the loads. This enables people to leave hazardous areas in good time and reach safety prior to final failure.

When it comes to floors and roofs made of prestressed concrete hollow slabs within the scope regulated by EN 1168, the chances of this happening are considerably reduced. This gives rise to a considerable safety requirement with regard to mechanical strength in order to reduce the serious risk of the failure of hollow core slabs having disastrous effects.

In particular shear force resistance is problematic if the tensile strength of the concrete is overestimated since the tensile strength in EN 1992-1-1 in the national annex for the consideration of long-term impact is considerably reduced.

c) Resistance to fire (under installation conditions) (load bearing capacity criterion)

The attestation of resistance to fire serves to ensure the stability and/or the integrity of elements and constructions that are potentially exposed to fire over a certain period of exposure to fire.

The assessment is more difficult for prestressed concrete hollow slabs since the specific cross section of prestressed concrete hollow slabs makes it possible for unfavourable and high thermal loads to develop in the web when exposed to fire. The reduced transverse distribution of the loads that results from the absence of cross reinforcement contributes towards redistributions or alternative load transfer mechanisms not functioning over larger areas. What is more, the early loss of lower slab parts prior to reaching the stated fire duration can make rescue work more difficult. FELLINGER/STARK/WALRAVEN [1] already described corresponding damage scenarios for concrete hollow slabs in 2005 (Fig. 4) which were actually found to have occurred after the fire in the car park in Lloydstraat in Rotterdam (DE FEJTER/BREUNESE [4]), Fig. 5).

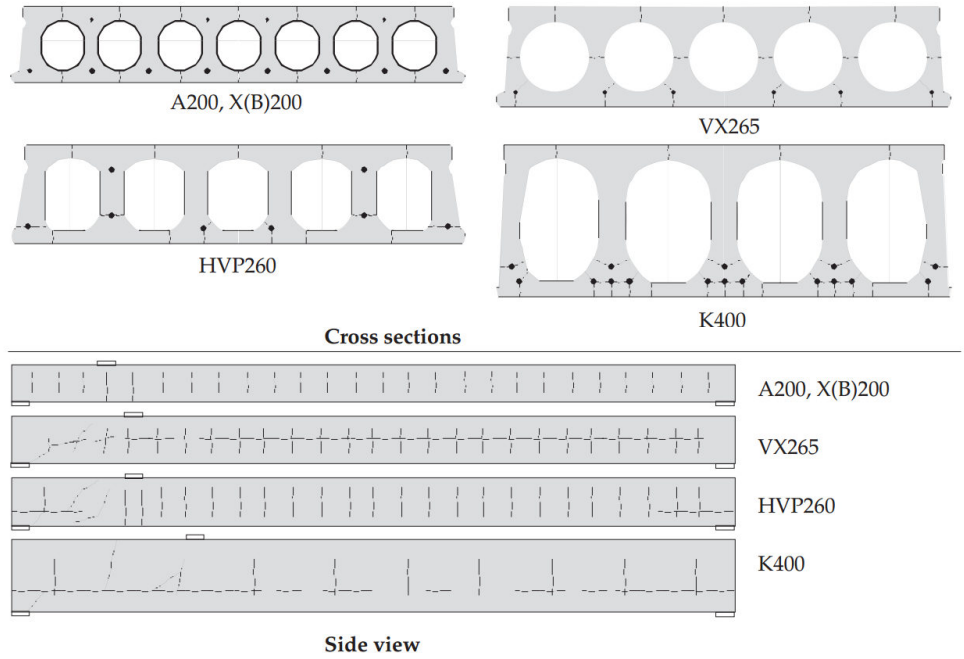


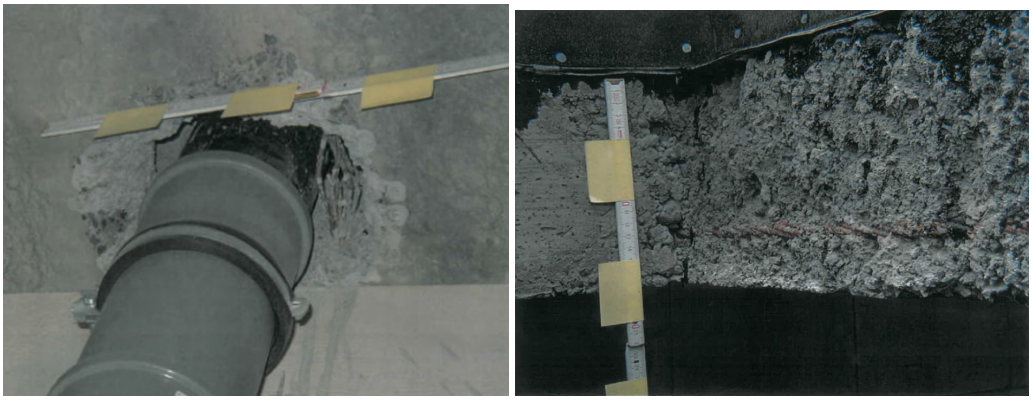
Fig. 4: Crack formation resulting from exposure to fire (Fig. 8 from FELLINGER/STARK/WALRAVEN [1])

The thermal cracks shown in Fig. 4 amongst other things considerably reduce the shear force resistance of hollow core slabs in the event of a fire. At the same time, parts of the lower slab flange may detach (Fig. 5), thus impairing the stability of the building and hindering rescue work. In the view held in Germany, the structural framework in the final state absolutely must be taken into account when attesting resistance to fire (including the criterion “R”) in order to avoid safety shortcomings.

Fig. 5: Damage occurring in the car park fire at Lloydstraat Rotterdam (Fig. 25 from DE FEJTER/BREUNESE [4])

d) Structural design

The structural design describes the arrangement of the reinforcement in the element, anchoring details, the connection to neighbouring elements in the structure, additional reinforcement, top layer and sealing requirements. The quality of the structural design guarantees the stability and robustness of the construction work throughout its useful life. Details of the structural design of the ring beam design must match the specific underlying conditions of the respective project, and are therefore virtually impossible to finally regulate and harmonise. If EN 1168 fails to define any minimum requirements and regulations for verifying the structural design, adjustment “in situ”, as in the example of Fig. 6 a), can lead not only to damage, but also to a considerable endangerment of the stability of the floor. In the case of the slab in Fig. 6 a), 20% of the prestressed reinforcement are not available to provide shear force resistance.



a) Subsequent cavity b) Poor compaction during production

Figs. 6 a) and b): Examples of poor structural design and quality

e) Compressive strength of concrete

Prestressed concrete hollow slabs are produced in extrusion or slip forming in long slabs in the prestressing bed. The customised cut that is made to produce the required length takes place via a final cut once a defined minimum compressive strength has been reached which makes it possible to anchor the prestressing reinforcement in the compound structure.

The input of the compaction forces during manufacturing is carried out here by the combined squeezing and shaking or by the slip-forming facility, and hence in derogation from the compaction methods on which Tab. 3.1 in EN 1992-1-1, referred to by EN 1168, is based.

Fig. 6 b) shows a cross section of a hollow core slab web near the reinforcement. Depending on the method used, the danger arises with concrete of the high strength classes that, in the event of a vertical load direction, the tensile strength in certain cross section zones (web) is much lower than anticipated in accordance with EN 1992-1-1. Inadequate tensile strength and compressive strength of the concrete in the web endanger the declared shear force of the entire slab, and hence the stability of floor sections and of the construction work. Small resistance samples of the concrete from the easily-accessible front sides or the upper slab flange do not offer sufficiently reliable indications with regard to the material in the critical failure areas.

III. Action at European level

The reference of harmonised standard EN 1168:2005+A3:2011 for precast concrete products – hollow core slabs in the Official Journal of the European Union should be withdrawn.

Literature and image sources

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