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Free-standing chimneys - Part 4: Brick liners - Design and execution

Freistehende Schornsteine - Teil 4: Innenrohre aus Mauerwerk - Entwurf, Bemessung und Ausführung

Cheminées indépendantes - Partie 4: Parois intérieurs en terre cuite - Planification et exécution

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Free-standing chimneys - Part 4: Brick liners - Design and execution

Cheminées indépendantes - Partie 4: Conduits intérieurs en briques de terre cuite - Conception et mise en oeuvre

Freistehende Schornsteine - Teil 4: Innenrohre aus Mauerwerk - Entwurf, Bemessung und Ausführung

This European Standard was approved by CEN on 29 April 2005.

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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.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 13084-4:2005) has been prepared by Technical Committee CEN/TC 297 “Free-standing industrial chimneys”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by February 2006, and conflicting national standards shall be withdrawn at the latest by February 2006.

This document is part 4 of a package of standards as listed below:

— EN 13084-1, Free-standing industrial chimneys - Part 1: General requirements.

— EN 13084-2, *Free-standing chimneys - Part 2: Concrete chimneys*.

— prEN 13084-4, *Free-standing chimneys - Part 4: Brick liners – Design and execution*.

— EN 13084-5, *Free-standing chimneys - Part 5: Materials for brick liners - Product specifications*.

— EN 13084-6, *Free-standing chimneys - Part 6: Steel liners - Design and execution*.

— EN 13084-7, *Free-standing chimneys – Part 7: Product specifications of cylindrical steel fabrications for use in single wall chimneys and steel liners*.

— EN 13084-8, *Free-standing chimneys – Part 8: Design and execution of mast construction with satellite components*.

Additionally applies:

— EN 1993-3-2, *Eurocode 3: Design of steel structures – Part 3-2: Towers, masts and chimneys – Chimneys*

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.

1 Scope

This European Standard specifies special requirements and performance criteria for the design and construction of lining systems made of brickwork for free-standing industrial chimneys. Current European practice favours sectional liners and the statements of the standard are mainly devoted to such solutions but are also largely applicable to base supported independent and stayed liners. This European Standard identifies requirements to ensure mechanical resistance and stability of liners in accordance with the general requirements given in EN 13084-1.

Lining systems comprise some or all of the following:

— chimney liner including duct entry;

— insulation;

— liner support;

— space between liner and concrete windshield.

Gas flow calculations to determine liner sizes are covered by EN 13084-1.

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 1052-1, *Methods of test for masonry — Part 1: Determination of compressive strength.*

EN 1052-2, *Methods of test for masonry — Part 2: Determination of flexural strength.*

EN 13084-1:2000, *Free-standing industrial chimneys — Part 1: General requirements.*

EN 13084-5:2005, *Free-standing chimneys — Part 5: Materials for brick liners — Product specifications.*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13084-1:2000 together with the following apply.

3.1.1
base supported liner
liner which is supported vertically only at the liner base

3.1.2
independent liner
base supported liner which has no other horizontal support or restraint

3.1.3
stayed liner
base supported liner which has horizontal restraints

3.1.4
sectional liner
liner which is supported vertically at a number of elevations

3.1.5
liner support
load bearing component which supports the liner

3.1.6
duct entry
part of the liner which introduces the flue gases into the liner

3.1.7
thermal gradient
temperature difference between outer and inner wall surface related to the thickness of the wall

3.1.8
thermal shock
effect on the liner of rapid changes in flue gas temperature, giving stresses. This can typically occur due to uncontrolled shutdowns, a fire or sudden by-pass of an energy conservation or flue gas desulphurisation unit

3.1.9
compensator
any systems which allows the movement of the joint in any direction maintaining its gas tightness

3.2 Symbols

The main symbols used in this document are given in Table 1.

Table 1 — Main symbols

Symbol	Denomination	Unit
Safety factor:		
γ	partial safety factor	-
Material properties:		
f	strength	N/mm^2
E	modulus of elasticity	N/mm^2
σ	stress	N/mm^2
α_T	coefficient of thermal expansion	K^{-1}
Actions:		
T	thermal effects	-
G	permanent actions	-
W	wind actions	-
a	acceleration	m/s^2
Dimensions:		
d	diameter	m
h	height	m
t	wall thickness	m
Subscripts:		
c	compression	-
t	tensile	-
y	yield	-
k	characteristic	-
M	material	-

4 Material

4.1 General

The choice of material will depend upon the service required.

4.2 Brickwork

4.2.1 General

The type of brickwork used is largely determined by the resistance to chemical attack of the bricks and mortars. In addition, when thermal shocks are expected, brick types will be selected on the basis of their resistance to spalling and other mechanical damage caused by the same.

Brickwork covered by this document consists of brick types in accordance with EN 13084-5:2005, 5.1 and mortar types in accordance with EN 13084-5:2005, 5.2

4.2.2 Thermal effects

According to the requirements as specified in EN 13084-1:2000, 5.2.3.4 the temperature effect on brickwork shall be considered particularly with regard to:

— limit temperature of the various components;

— thermal gradients through the brickwork components in steady and transient conditions;

— uniform temperature;

— expansion;

— thermal shock.

Calculations based on the maximum temperature of flue gas and the maximum expected ambient temperature shall show that all the materials are operating below their allowable temperatures.

Thermal gradients, if not limited, could cause cracks in liners especially in those made of bricks type BT1, BT2 and BT3.

Thermal shock can cause spalling and cracks on bricks type BT1, BT2 and BT3. It normally causes only shallow cracks but the thermal gradient may cause these to grow.

4.2.3 Classification and chemical attack

4.2.3.1 General

Depending on the degree of chemical attack given in EN 13084-1:2000, Table 3 the following brickwork classes may be used for the construction of chimney liners:

— brickwork class A: resistant to "very high chemical attack";

— brickwork class B: resistant to "high chemical attack";

— brickwork class C: resistant to "medium chemical attack";

— brickwork class D: resistant to "low chemical attack";

— brickwork class E: not subject to "chemical attack".

Mortar type MT3 based on Portland cement may be used only for brickwork classes D and E.

NOTE For all brickwork classes in the presence of alkalis with temperatures above 680 °C, bricks with a low true porosity (10 % maximum) are recommended.

4.2.3.2 Brickwork class A: resistant to "very high chemical attack"

This will normally consist of:

— bricks type BT1;

— mortar type MT1 (in the case of very high chemical attack due only to acids: mortar type MT2).

If abnormal temperature deviations are expected the limit in service temperature of mortars type MT1 shall be taken into account.

Brickwork class A using mortar type MT1 can also withstand alkaline condensates.

4.2.3.3 Brickwork class B: resistant to "high chemical attack"

This will normally consist of:

— bricks type BT2;

— mortar type MT2.

The use of mortar type MT2 allows its use up to 1000 °C; if thermal shocks are expected the resistance to thermal cycling of the bricks will be a factor of major importance.

Brickwork class B is not resistant to alkaline condensates.

4.2.3.4 Brickwork class C: resistant to "medium chemical attack"

This will normally consist of:

— bricks type BT3;

— mortar type MT2.

The use of mortar type MT2 allows its use up to 1000 °C; if thermal shocks are expected the resistance to thermal cycling of the bricks will be a factor of major importance.

Brickwork class C is not resistant to alkaline condensates.

4.2.3.5 Brickwork class D: resistant to "low chemical attack"

This will normally consist of:

— bricks type BT4;

— mortar type MT3.

4.2.3.6 Brickwork class E: not subjected to chemical attack

This will normally consist of:

— bricks type BT4 or BT5;

— mortar type MT3.

Brickwork class E may be used in liners that are always operating safely above the dew point.

Bricks type B5 may only be used provided that mechanical actions such as erosion or abrasion are not expected.

4.3 Insulation

Insulation may be used to reduce the thermal gradient in the liner as well as in the windshield and to reduce the heat loss of the flue gases.

The following types of insulating materials are widely available for the purpose:

— insulating bricks;

— mineral wool blankets;

— cellular glass blocks;

— vermiculite/perlite preformed blocks;

— calcium silicate blocks;

— glass wool blankets;

— ceramic fibre lancets.

Stability of insulation shall be ensured even in the case of vibrations due to possible pulsation of flue gas pressure.

5 General design requirements

5.1 General

A gas tight floor shall be provided no more than 1,0 m from the bottom of the lowest duct entry.

Adequate means shall be provided to drain acid condensate to a safe location.

5.2 Minimum wall thickness

For the determination of the minimum wall thickness of the liner see Table 2.

Table 2 — Minimum wall thickness for brick liners

	1	2	3	4
	Internal diameter, d, of liner in m	Minimum wall thickness, in mm, for		
		bricks without tongue and groove	shaped bricks with lateral tongue and groove	shaped bricks with continuous tongue and groove
1	$0 < d \leq 4{,}0$	115	100	64
2	$4{,}0 < d \leq 6{,}0$	115	100	80
3	$6{,}0 < d \leq 8{,}0$	115	100	100
4	$8{,}0 < d \leq 10{,}0$	—	120	120
5	$10{,}0 < d \leq 12{,}0$	—	140	140

5.3 Liner supports

Brick liner supports shall be designed with adequate rigidity to avoid imposing unacceptable non-uniform support reactions on the liner. In addition, in the case of multiflue chimneys, the deformation of the supporting platforms shall be such that the required clearance between the top of the liner and the upper platform is respected. Supports comprising segmental beams, supported by discrete corbels projecting from the windshield, shall be provided with torsional continuity by in-situ reinforced concrete joints or other means.