# SLOVENSKI STANDARD
# SIST EN 13084-2:2007

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**Nadomešča:**
**SIST EN 13084-2:2004**

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**Prostostoječi dimniki - 2. del: Betonski dimniki**

Free-standing chimneys - Part 2: Concrete chimneys

Freistehende Schornsteine - Teil 2: Betonschornsteine



Cheminées indépendantes - Partie 2: Cheminées en béton

**Ta slovenski standard je istoveten z: EN 13084-2:2007**



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**ICS:**

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|---|---|---|
| 91.060.40 | Dimniki, jaški, kanali | Chimneys, shafts, ducts |
| 91.100.30 | Beton in betonski izdelki | Concrete and concrete products |

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EUROPEAN STANDARD

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# EN 13084-2

May 2007

ICS 91.060.40

Supersedes EN 13084-2:2001

English Version

# Free-standing chimneys - Part 2: Concrete chimneys

Cheminées indépendantes - Partie 2: Cheminées en béton

Freistehende Schornsteine - Teil 2: Betonschornsteine

This European Standard was approved by CEN on 26 April 2007.

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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 CEN Management Centre has the same status as the official versions.

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# Foreword

This document (EN 13084-2:2007) 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of an identical text or by endorsement, at the latest by November 2007, and conflicting national standards shall be withdrawn at the latest by November 2007.

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 supersedes EN 13084-2:2001.

This European Standard is part 2 of a series of standards as listed below:

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

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

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

— EN 13084-5, *Free-standing chimneys - Part 5: Material 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 steel 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, Bulgaria, 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.

# 1 Scope

This European Standard specifies particular requirements and performance criteria for the design and construction of cast-in-situ concrete chimneys as well as prefabricated concrete chimneys. It identifies requirements to ensure the mechanical resistance and stability of concrete chimneys in accordance with the general requirements given in EN 13084-1.

As for chimneys attached to buildings the criteria given in Clause 1 of EN 13084-1:2000 apply.

Unless otherwise stated in the following clauses the basic standard for the design of concrete structures, EN 1992-1-1, applies.

# 2 Normative references

The following referenced documents are indispensable for the application of this European Standard. 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 1520:2002, *Prefabricated reinforced components of lightweight aggregate concrete with open structure*



EN 1990, *Eurocode - Basis of structural design*

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



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

EN 12446, *Chimneys - Components - Concrete outer wall elements*

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

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

# 3 Terms and definitions

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

**3.1**
**prefabricated element**
precast member of normal-weight or light-weight concrete, reinforced or not, which completely encloses the flues of chimney stacks

**3.2**
**reinforcement ducts**
route for the continuous vertical reinforcement

# 4 Materials

## 4.1 Concrete

### 4.1.1 Normal-weight concrete for cast-in-situ chimneys

The concrete strength classes given in EN 206-1 but not less than C25/30 can be used for cast-in-situ chimneys. For environmental conditions EN 206-1 applies.

NOTE Higher strength classes than C25/30 should only be used if it would be required by environmental conditions in accordance with EN 1992-1-1:2004, Table E.1N and no special provisions for corrosion protection of reinforcement and protection of concrete attack need to be taken.

### 4.1.2 Concrete for prefabricated chimneys

#### 4.1.2.1 Normal-weight concrete

See 4.1.1

#### 4.1.2.2 Light-weight aggregate concrete

The light-weight aggregate concrete for prefabricated elements shall correspond to the density-class D 1,2 or higher in accordance with Table 9 of EN 206-1:2000.



The light-weight aggregate concrete with closed structure for prefabricated elements shall correspond to the strength classes given in EN 206-1. For environmental conditions EN 206-1 applies.



NOTE Higher strength classes than LC25/28 should only be used if it would be required by environmental conditions in accordance with EN 1992-1-1:2004, Table E.1N and no special provisions for corrosion protection of reinforcement and protection of concrete attack need to be taken.



The light-weight aggregate concrete with open structure for prefabricated elements shall correspond to the strength classes given in EN 1520 but strength classes less than LAC 8 shall not be used. For environmental conditions see EN 1520: 2002, 5.8.2.

#### 4.1.2.3 Reinforcement duct infill concrete

The reinforcement duct infill concrete shall have at least the same strength class as the prefabricated elements, but not more than the next higher strength class. The flow class for consistence shall not be less than F3 in accordance with Table 6 of EN 206-1:2000 and the maximum size of aggregate shall not be greater than 8 mm.

#### 4.1.2.4 Outer wall elements

Prefabricated outer wall elements shall be in accordance with EN 12446.

## 4.2 Mortar for bedding of prefabricated elements

The mortar of bedding joints between prefabricated elements shall have the same strength class as the concrete of the prefabricated elements.

## 4.3 Reinforcing steel

For reinforcing steel the specifications given in EN 1992-1-1 apply.

## 5 Material properties

The material properties of concrete and reinforcing steel for normal temperature design shall be taken from EN 1992-1-1 or EN 1520 with the exception of the mean tensile strength of concrete, $f_{ctm}$, which shall be calculated in accordance with Equation (1). The influence of elevated temperatures on the mechanical and thermal properties of concrete and reinforcing steel shall be determined from EN 1992-1-2.

$$f_{ctm} = c_c \text{ x } c_\beta \text{ x } c_v \text{ x } c_\eta \ f_{cm}^{\ 0,67} \text{ , in N/mm}^2 \quad (1)$$

where:

$c_c$ is the concrete density factor;

$$c_c = 0,4 + 0,6\frac{\rho}{2200} \quad (1a)$$

$c_\beta$ is the concrete strength factor;

$$c_\beta = 0,45 \quad (1b)$$

$c_v$ is the predamage factor;

$$c_v = 0,85 - 0,2 \text{ x } t \quad (1c)$$



$c_\eta$ is the eccentricity factor;



$$c_\eta = \frac{0,6 + 6 \times c_t \times \eta}{1,0 + 6 \times \eta} \quad (1d)$$

$c_t$ is the wall thickness factor;

$$c_t = \frac{2,6 + 24 \times t}{1,0 + 40 \times t} \quad (1e)$$

$f_{cm}$ is the mean compressive strength of concrete;

$$f_{cm} = f_{ck} + 8 \quad \text{in Newtons per square millimetres} \quad (1f)$$

$f_{ck}$ is the characteristic compressive strength (cylinders) of concrete in Newtons per square millimetres;

$\rho$ is the density of concrete;

for normal-weight concrete:

$\rho$ = 2200 kg/m$^3$

for light-weight concrete:

$\rho$ is the design value of the density of concrete corresponding to the density class in accordance with Table 11.1 of EN 1992-1-1:2004,

$\eta$ is the eccentricity;

$$\eta = \frac{M}{N \times t} \qquad (1g)$$

$M$ is the design value of the bending moment in the cross-section concerned in Newton metres;

$N$ is the design value of the axial force in the cross-section concerned in Newtons;

$t$ is the wall thickness of the cross-section concerned in metres;

For lightweight-aggregate concrete the symbols $f_{ctm}$, $f_{cm}$ and $f_{ck}$ shall be replaced by $f_{lctm}$, $f_{lcm}$ and $f_{lck}$ respectively.

# 6 Structural design

## 6.1 Actions

Actions to be considered are given in EN 13084-1. For design values of actions and combination of actions see EN 1990.

## 6.2 Effect of actions

### 6.2.1 General

The effect of actions in both horizontal and vertical cross-sections have to be calculated taking into account moments of 2nd order.



The windshield can be treated in accordance with the beam theory being subjected to axial forces, bending moments and thermal effects.



If effects on the stability are expected, the influences from creep, shrinkage and cracking shall be taken into account.

### 6.2.2 Partial safety factors

Partial safety factors for actions shall be applied.

NOTE The values of the partial safety factors for actions in the ultimate limit state for use in a Country may be found in its National Annex.

The recommended partial safety factors for actions are:

a) permanent actions
   - unfavourable effect $\gamma_G$ = 1,35
   - favourable effect $\gamma_G$ = 1,0

b) wind actions $\gamma_W$ = 1,5

c) thermal effects $\gamma_T$ = 1,5

d) seismic actions $\gamma_E$ = 1,0

### 6.2.3 Moments of 2nd order

#### 6.2.3.1 General

For the determination of moments of 2nd order the mean values of the material properties may be used. In the concrete compression zone, the following linear material law has to be used:

$$\sigma = E_{cm} \times \varepsilon \tag{2}$$

where:

$\sigma$ is the stress;

$E_{cm}$ is the modulus of elasticity of concrete;

$\varepsilon$ is the strain.

The stiffening effect of the concrete in the tension zone may be taken into account in chimneys with continuous vertical reinforcement.

#### 6.2.3.2 Approximate method



The approximation is based on the following assumptions:

— full utilization of the cross-sections with respect to the local load carrying capacity;



— consideration of the tension stiffening effects of the concrete;

— chimney height less than 300 m;

— no consideration of deflection effects due to imperfections and rotation of the foundation;

— constant diameter and wall thickness or nearly linear reduction of one or both of them over the chimney height.

The design value of the 2nd order moment may be calculated as follows:

— for windshields with continuous vertical reinforcement:

$$M^{II}(z) = M^{I}(z) + M^{I}(0) \times \frac{(85 - 0{,}14 \times h)\alpha^2}{100} \times \left(1 + 2{,}4 \times \frac{z}{h}\right) \times \left(1 - \frac{z}{h}\right)^{2,4} \tag{3}$$

— for windshields without continuous vertical reinforcement with the value of $\alpha$ according to Equation (5) not exceeding 0,6:

$$M^{II}(z) = (1 + \kappa \times \alpha^2) \times M^{I}(z) \tag{4}$$

where:

$M^{II}(z)$ is the design value of the 2nd order bending moment at height $z$;

$M^{I}(0)$ is the design value of the 1st order bending moment at the chimney base;

$M^{I}(z)$ is the design value of the 1st order bending moment at height $z$;