SLOVENSKI STANDARD
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 13084-2:2001**

ICS:

91.060.40	Dimniki, jaški, kanali	Chimneys, shafts, ducts
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Free-standing chimneys - Part 2: Concrete chimneys

Cheminées indépendantes - Partie 2: Cheminées en béton

Freistehende Schornsteine - Teil 2: Betonschornsteine

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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by June 2002, and conflicting national standards shall be withdrawn at the latest by November 2003.

In this standard the annexes A and B are normative.

This European Standard is one 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*.

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

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

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

1 Scope

This Part of 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, ENV 1992-1-1, applies.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

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

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

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

ENV 1992-1-4:1994, *Eurocode 2: Design of concrete structures - Part 1-4: General rules - Lightweight aggregate concrete with closed structure.*

prEN 1520, *Prefabricated reinforced components of light weight aggregate concrete with open structure.*

prEN 12446, *Chimneys - Components - Concrete outer wall elements.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13084-1 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 Concrete for cast-in-situ chimneys

The concrete strength classes as given in ENV 1992-1-1 but not less than C25/30 can be used for cast-in-situ chimneys. For environmental conditions EN 206-1 applies.

4.1.2 Concrete for prefabricated chimneys

4.1.2.1 Normal-weight concrete

For prefabricated chimneys all concrete qualities given in EN 206-1 may be used. For environnemental conditions EN 206-1 applies.

4.1.2.2 Light-weight concrete

The light-weight 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 concrete for prefabricated elements shall correspond to the strength classes given in EN 206-1 or to a strength class of at least LAC 6 given in prEN 1520.

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 prEN 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 ENV 1992-1-1 apply.

5 Material properties

The material properties of concrete and reinforcing steel for normal temperature design shall be taken from ENV 1992-1-1 or ENV 1992-1-4:1994 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 ENV 1992-1-2.

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

where

c_c is the concrete density factor;

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

c_β is the concrete strength factor;

$$c_\beta = 0{,}45 \tag{1b}$$

c_v is the predamage factor;

$$c_v = 0{,}85 - 0{,}2\,t \tag{1c}$$

c_η is the eccentricity factor;

$$c_\eta = \frac{0{,}6 + 6 \cdot c_t \cdot \eta}{1{,}0 + 6 \cdot \eta} \tag{1d}$$

c_t is the wall thickness factor;

$$c_t = \frac{2{,}6 + 24 \cdot t}{1{,}0 + 40 \cdot t} \tag{1e}$$

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

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

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

ρ is the density of concrete;

for normal-weight concrete:

$\rho = 2200\ \text{kg/m}^3$

for light-weight concrete:

ρ is the design value of the density of concrete corresponding to the density class in accordance with Table 3.105 of ENV 1992-1-4:1994;

η is the eccentricity;

$$\eta = \frac{M}{N \cdot t}$$

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;

6 Structural design

6.1 General

For the structural design of concrete chimneys clause 5 of EN 13084-1:2000 has to be taken into account.

The windshield can be treated in accordance with the beam theory being subject 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 Ultimate limit state

6.2.1 Partial safety factors

The partial safety factors for actions are:

a) permanent actions

— unfavourable effect γ_G = 1,35

— favourable effect γ_G = 1,0

b) wind actions γ_W = 1,5

c) thermal effects γ_F = 1,5

d) seismic actions γ_E = 1,0

The partial safety factors for materials are:

e) concrete γ_C = 1,5

f) steel reinforcement γ_S = 1,15

6.2.2 Ultimate limit steel strain

The ultimate limit strain of steel is defined by ENV 1992-1-1.

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:

$$\sigma = E_{cm} \cdot \varepsilon \qquad (3)$$

where

σ is the stress;

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

ε 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:

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

— for windshields without continuous vertical reinforcement with the value of α according to equation (6) not exceeding 0,6:

$$M^{I}(z) = (1 + \kappa \cdot \alpha^2) \cdot M^{I}(z) \quad (5)$$

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

z is the height at the considered cross-section above the top level of the foundation

h is the height of chimney above the top level of the foundation

$$\alpha = h \cdot \sqrt{\frac{N}{E_{cm} \cdot I}} \quad (6)$$

κ = 0,5 if the horizontal joints do not open deeper than the centre of gravity

κ = 0,75 if the horizontal joints open deeper than the centre of gravity

N is the design value of the axial force at the chimney base

E_{cm} is the modulus of elasticity of concrete

I is the 2nd moment of area at the chimney base of the uncracked cross-section ignoring reinforcement

$$I = \pi \cdot d_m^3 \cdot \frac{t}{8} \quad (6a)$$