SLOVENSKI STANDARD

SIST EN 1991-1-5:2004

01-september-2004

Eurocode 1: Vplivi na konstrukcije - 1-5. del: Splošni vplivi – Toplotni vplivi

Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions

Eurocode 1: Einwirkungen auf Tragwerke - Teil 1-5: Allgemeine Einwirkungen - Temperatureinwirkungen

Eurocode 1: - Actions sur les structures - Partie 1-5: Actions générales - Actions thermiques

Ta slovenski standard je istoveten z: **EN 1991-1-5:2003**

ICS:

91.010.30 Tehniļ ni vidiki Technical aspects

SIST EN 1991-1-5:2004 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1991-1-5

November 2003

ICS 91.010.30

Supersedes ENV 1991-2-5:1997

English version

Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions

Eurocode 1: Actions sur les structures - Partie 1-5: Actions générales – Actions thermiques

This European Standard was approved by CEN on 18 September 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
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Ref. No. EN 1991-1-5:2003 E

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Foreword

This document (EN 1991-1-5) has been prepared by Technical Committee CEN/TC250 "Structural Eurocodes", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by May 2004, and conflicting national standards shall be withdrawn at the latest by March 2010.

Annexes A and B are normative. Annexes C and D are informative.

This document supersedes ENV 1991-2-5:1997.

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

Background to the Eurocode Programme

In 1975, the Commission of the European Communities decided on an action programme in the field of construction, based on article 95 of the treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonization of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980's.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to CEN through a series of mandates, in order to provide them with a future status of European Standard (EN). This links *de facto* the Eurocode with the provisions of all the Council's Directives and/or Commission's Decisions dealing with European Standards (e.g. the Council Directive 89/106/EEC on construction products - CPD - and Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of settings up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of Parts:

EN 1990	Eurocode:	Basis of Structural Design
EN 1991	Eurocode 1:	Actions on structures
EN 1992	Eurocode 2:	Design of concrete structures
EN 1993	Eurocode 3:	Design of steel structures
EN 1994	Eurocode 4:	Design of composite steel and concrete structures
EN 1995	Eurocode 5:	Design of timber structures
EN 1996	Eurocode 6:	Design of masonry structures
EN 1997	Eurocode 7:	Geotechnical design
EN 1998	Eurocode 8:	Design of structures for earthquake resistance
EN 1999	Eurocode 9:	Design of aluminium alloy structures

Eurocode standards recognize the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognize that Eurocodes serve as reference documents for the following purposes:

– as a means of providing compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 - Mechanical resistance and stability - and Essential Requirement N°2 - Safety in case of fire;

– as a basis for specifying contracts for construction works and related engineering services;

– as a framework for drawing up harmonized technical specifications for construction products (ENs and ETAs)

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents referred to in Article 12 of the CPD, although they are of a different nature from harmonized product standards. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving a full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

National Standards implementing Eurocodes

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National foreword, and may be followed by a National annex (informative).

The National annex (informative) may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, i.e.:

- values and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- country specific data (geographical, climatic, etc.), e.g. snow map,
- the procedure to be used where alternative procedures are given in the EN Eurocode.

It may also contain

- decisions on the application of informative annexes,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

Links between Eurocodes and product harmonized technical specifications (ENs and ETAs)

There is a need for consistency between the harmonized technical specifications for construction products and the technical rules for works. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

Additional information specific to EN 1991-1-5

EN 1991-1-5 gives design guidance for thermal actions arising from climatic and operational conditions on buildings and civil engineering works.

Information on thermal actions induced by fire is given in EN 1991-1-2.

EN 1991-1-5 is intended for clients, designers, contractors and relevant authorities.

EN 1991-1-5 is intended to be used with EN 1990, the other Parts of EN 1991 and EN 1992-1999 for the design of structures.

In the case of bridges, the National annexes specify whether the general non-linear or the simplified linear temperature components should be used in design calculations.

In the case of chimneys, references should be made to EN 13084-1 for thermal actions from operating processes.

National annex for EN 1991-1-5

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1991-1-5 should have a National annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1991-1-5 through clauses:

- 5.3(2) (Tables 5.1, 5.2 and 5.3)
- 6.1.1 (1)
- 6.1.2(2)
- 6.1.3.1(4)
- 6.1.3.2(1)
- 6.1.3.3(3)
- 6.1.4(3)
- 6.1.4.1(1)
- 6.1.4.2(1)
- 6.1.4.3(1)
- 6.1.4.4(1)
- 6.1.5(1)
- 6.1.6(1)
- 6.2.1(1)P
- 6.2.2(1)
- 6.2.2(2)
- 7.2.1(1)
- 7.5(3)
- 7.5(4)
- A.1(1)
- A.1(3)
- A.2(2)
- B(1) (Tables B.1, B.2 and B.3)

Section 1 General

1.1 Scope

(1) EN 1991-1-5 gives principles and rules for calculating thermal actions on buildings, bridges and other structures including their structural elements. Principles needed for cladding and other appendages of buildings are also provided.

(2) This Part describes the changes in the temperature of structural elements. Characteristic values of thermal actions are presented for use in the design of structures which are exposed to daily and seasonal climatic changes. Structures not so exposed may not need to be considered for thermal actions.

(3) Structures in which thermal actions are mainly a function of their use (e.g. cooling towers, silos, tanks, warm and cold storage facilities, hot and cold services etc) are treated in Section 7. Chimneys are treated in EN 13084-1.

1.2 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 1990:2002	Eurocode: Basis of structural design
prEN 1991-1-6	Eurocode 1: Actions on structures Part 1.6: General actions - Actions during execution
EN 13084-1	Free-standing industrial chimneys Part 1: General requirements
ISO 2394	General principles on reliability for structures
ISO 3898	Bases of design of structures - Notations. General symbols
ISO 8930	General principles on reliability for structures. List of equivalent terms

1.3 Assumptions

(1)P The general assumptions of EN 1990 also apply to this Part.

1.4 Distinction between principles and application rules

(1)P The rules in EN 1990:2002, 1.4 also apply to this Part.

1.5 Terms and definitions

For the purposes of this European Standard, the definitions given in EN 1990, ISO 2394, ISO 3898 and ISO 8930 and the following apply.

1.5.1
thermal actions
thermal actions on a structure or a structural element are those actions that arise from the changes of temperature fields within a specified time interval

1.5.2
shade air temperature
the shade air temperature is the temperature measured by thermometers placed in a white painted louvred wooden box known as a “Stevenson screen”

1.5.3
maximum shade air temperature T_{max}
value of maximum shade air temperature with an annual probability of being exceeded of 0,02 (equivalent to a mean return period of 50 years), based on the maximum hourly values recorded

1.5.4
minimum shade air temperature T_{min}
value of minimum shade air temperature with an annual probability of being exceeded of 0,02 (equivalent to a mean return period of 50 years), based on the minimum hourly values recorded

1.5.5
initial temperature T_0
the temperature of a structural element at the relevant stage of its restraint (completion)

1.5.6
cladding
the part of the building which provides a weatherproof membrane. Generally cladding will only carry self weight and/or wind actions

1.5.7
uniform temperature component
the temperature, constant over the cross section, which governs the expansion or contraction of an element or structure (for bridges this is often defined as the “effective” temperature, but the term “uniform” has been adopted in this part)

1.5.8
temperature difference component
the part of a temperature profile in a structural element representing the temperature difference between the outer face of the element and any in-depth point

1.6 Symbols

(1) For the purposes of this Part of Eurocode 1, the following symbols apply.

NOTE: The notation used is based on ISO 3898

(2) A basic list of notations is provided in EN 1990, and the additional notations below are specific to this Part.

Latin upper case letters

R	thermal resistance of structural element
R_{in}	thermal resistance at the inner surface
R_{out}	thermal resistance at the outer surface
T_{max}	maximum shade air temperature with an annual probability of being exceeded of 0,02 (equivalent to a mean return period of 50 years)
T_{min}	minimum shade air temperature with an annual probability of being exceeded of 0,02 (equivalent to a mean return period of 50 years)
$T_{max,p}$	maximum shade air temperature with an annual probability of being exceeded p (equivalent to a mean return period of 1/p)
$T_{min,p}$	minimum shade air temperature with an annual probability of being exceeded p (equivalent to a mean return period of 1/p)
$T_{e.max}$	maximum uniform bridge temperature component
$T_{e.min}$	minimum uniform bridge temperature component
T_0	initial temperature when structural element is restrained
T_{in}	air temperature of the inner environment
T_{out}	temperature of the outer environment
ΔT_1, ΔT_2, ΔT_3, ΔT_4	values of heating (cooling) temperature differences

ΔT_U uniform temperature component

$\Delta T_{N,\,exp}$ maximum expansion range of uniform bridge temperature component ($T_{e.max} \geq T_0$)

$\Delta T_{N,\,con}$ maximum contraction range of uniform bridge temperature component ($T_0 \geq T_{e.min}$)

ΔT_N overall range of uniform bridge temperature component

ΔT_M linear temperature difference component

$\Delta T_{M,heat}$ linear temperature difference component (heating)

$\Delta T_{M,cool}$ linear temperature difference component (cooling)

ΔT_E non-linear part of the temperature difference component

ΔT sum of linear temperature difference component and non-linear part of the temperature difference component

ΔT_p temperature difference between different parts of a structure given by the difference of average temperatures of these parts

Latin lower case letters

h height of the cross-section

k_1, k_2 coefficients for calculation of maximum (minimum) shade air
k_3, k_4 temperature with an annual probability of being exceeded, p, other than 0,02

k_{sur} surfacing factor for linear temperature difference component

p annual probability of maximum (minimum) shade air temperature being exceeded (equivalent to a mean return period of $1/p$ years)

u, c mode and scale parameter of annual maximum (minimum) shade air temperature distribution

Greek lower case letters

α_T coefficient of linear expansion (1/°C)

λ thermal conductivity