SLOVENSKI STANDARD
SIST EN 1999-1-3:2007

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Evrokod 9 - Projektiranje konstrukcij iz aluminijevih zlitin - 1-3. del: Konstrukcije, obļ utljive na utrujanje

Eurocode 9: Design of aluminium structures – Part 1-3: Structures susceptible to fatigue

Eurocode 9: Bemessung und Konstruktion von Aluminiumtragwerken — Teil 1-3: Ermüdungsbeanspruchte Tragwerke

Eurocode 9: Calcul des structures en aluminium — Partie 1-3: Structures sensibles a la fatigue

Ta slovenski standard je istoveten z: EN 1999-1-3:2007

ICS:

91.010.30	Tehniļ ni vidiki	Technical aspects
91.080.10	Kovinske konstrukcije	Metal structures

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1999-1-3

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English Version

Eurocode 9: Design of aluminium structures - Part 1-3: Structures susceptible to fatigue

Eurocode 9: Calcul des structures en aluminium - Partie 1-3: Structures sensibles à la fatigue

Eurocode 9: Bemessung und Konstruktion von Aluminiumtragwerken - Teil 1-3: Ermüdungsbeanspruchte Tragwerke

This European Standard was approved by CEN on 25 November 2006.

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

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Foreword

This document (EN 1999-1-3:2007) has been prepared by Technical Committee CEN/TC 250 “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of an identical text or by endorsement, at the latest by November 2007, and conflicting national standards shall be withdrawn at the latest by March 2010.

This European Standard supersedes ENV 1999-2: 1998.

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, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Background to the Eurocode programme

In 1975, the Commission of the European Community 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 harmonisation 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 1980s.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement[1)] between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links de facto the Eurocodes 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 setting up the internal market).

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

EN 1990 Eurocode 0: 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

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1) Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

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 structures

Eurocode standards recognise 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 recognise that Eurocodes serve as reference documents for the following purposes:

— As a means to prove 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 harmonised 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[2)] referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standard[3)]. 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 or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

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2) According to Art. 3.3 of the CPD, the essential requirements (ERs) shall be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for hENs and ETAGs/ETAs.

3) According to Art. 12 of the CPD the interpretative documents shall:

a) give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary;

b) indicate methods of correlating these classes or levels of requirement with the technical specifications, e.g. methods of calculation and of proof,technical rules for project design,etc.;

c) serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals. The Eurocodes, de facto, play a similar role in the field of the ER 1 and a part of ER 2.

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 for partial factors and/or classes where alternatives are given in the Eurocode;

— values to be used where a symbol only is given in the Eurocode;

— geographical and climatic data specific to the Member State, e.g. snow map;

— the procedure to be used where alternative procedures are given in the Eurocode;

— references to non-contradictory complementary information to assist the user to apply the Eurocode.

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

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works[4)]. 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 1999-1-3

EN 1999 is intended to be used with Eurocodes EN 1990 – Basis of Structural Design, EN 1991 – Actions on structures and EN 1992 to EN 1999, where aluminium structures or aluminium components are referred to.

EN 1999-1-3 is one of five parts EN 1999-1-1 to EN 1999-1-5 each addressing specific aluminium components, limit states or type of structure. EN 1999-1-3 describes the principles, requirements and rules for the structural design of aluminium components and structures subjected to fatigue actions.

Numerical values for partial factors and other reliability parameters are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and quality management applies.

National Annex for EN 1999-1-3

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 1999-1-1 should have a National Annex containing all Nationally Determined Parameters to be used for the design of aluminium structures to be constructed in the relevant country.

4) See Art.3.3 and Art.12 of the CPD, as well as clauses 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1. Construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

National choice is allowed in EN 1999-1-3 through clauses:

— 2.1 (1)

— 2.2.1 (3)

— 2.3.1 (3)

— 2.3.2 (6)

— 2.4 (1)

— 3 (1)

— 4 (2)

— 5.8.1 (1)

— 5.8.2 (1)

— 6.1.3 (1)

— 6.2.1(2)

— 6.2.1 (7)

— 6.2.1 (11)

— 6.2.4 (1)

— A.3.1 (1)

— E (5)

— E (7)

— I.2.2 (1)

— I.2.3.2 (1)

— I.2.4 (1).

1 General

1.1 Scope

1.1.1 Scope of EN 1999

(1) P EN 1999 applies to the design of buildings and civil engineering and structural works in aluminium. It complies with the principles and requirements for the safety and serviceability of structures, the basis of their design and verification that are given in EN 1990 – Basis of structural design.

(2) EN 1999 is only concerned with requirements for resistance, serviceability, durability and fire resistance of aluminium structures. Other requirements, e.g. concerning thermal or sound insulation, are not considered.

(3) EN 1999 is intended to be used in conjunction with:

— EN 1990 Basis of structural design

— EN 1991 Actions on structures

— European Standards for construction products relevant for aluminium structures

— EN 1090-1: Execution of steel structures and aluminium structures – Part 1: Conformity assessment of structural components[5)]

— EN 1090-3: Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures[6)]

(4) EN 1999 is subdivided in five parts:

EN 1999-1-1 Design of Aluminium Structures: General structural rules

EN 1999-1-2 Design of Aluminium Structures: Structural fire design

EN 1999-1-3 Design of Aluminium Structures: Structures susceptible to fatigue

EN 1999-1-4 Design of Aluminium Structures: Cold-formed structural sheeting

EN 1999-1-5 Design of Aluminium Structures: Shell structures

1.1.2 Scope of EN 1999-1-3

(1) EN 1999-1-3 gives the basis for the design of aluminium alloy structures with respect to the limit state of fracture induced by fatigue.

(2) EN 1999-1-3 gives rules for:

— Safe life design;

— damage tolerant design;

— design assisted by testing.

5) To be published

6) To be published

(3) EN 1999-1-3 is intended to be used in conjunction with EN 1090-3 “Technical requirements for the execution of aluminium structures” which contains the requirements necessary for the design assumptions to be met during execution of components and structures.

(4) EN 1999-1-3 does not cover pressurised containment vessels or pipe-work.

(5) The following subjects are dealt with in EN 1999-1-3:

Section 1: General

Section 2: Basis of design

Section 3: Materials, constituent products and connecting devices

Section 4: Durability

Section 5: Structural analysis

Section 6: Ultimate limit state of fatigue

Annex A: Basis for calculation of fatigue resistance [normative]

Annex B: Guidance on assessment by fracture mechanics [informative]

Annex C: Testing for fatigue design [informative]

Annex D: Stress analysis [informative]

Annex E: Adhesively bonded joints [informative]

Annex F: Low cycle fatigue range [informative]

Annex G: Influence of R-ratio [informative]

Annex H: Fatigue strength improvement of welds [informative]

Annex I: Castings [informative]

Annex J: Detail category tables [informative]

Annex K: Hot spot reference detail method [informative]

Bibliography

1.2 Normative references

(1) The normative references of EN 1999-1-1 apply.

1.3 Assumptions

(1) P The general assumptions of EN 1990, 1.3 apply.

(2) P The provisions of EN 1999-1-1, 1.8 apply.

(3) P The design procedures are valid only when the requirements for execution in EN 1090-3 or other equivalent requirements are complied with.

1.4 Distinction between principles and application rules

(1) P The rules in EN 1990, 1.4 apply.

1.5 Terms and definitions

1.5.1 General

(1) The rules in EN 1990, 1.5 apply.

1.5.2 Additional terms used in EN 1999-1-3

(1) For the purpose of this European Standard the following terms and definitions in addition to those defined in EN 1990 and EN 1999-1-1 apply.

1.5.2.1
fatigue
weakening of a structural part, through crack initiation and propagation caused by repeated stress fluctuations

1.5.2.2
fatigue loading
a set of typical load events described by the positions or movements of actions, their variation in intensity and their frequency and sequence of occurrence

1.5.2.3
loading event
a defined load sequence applied to the structure, which, for design purposes, is assumed to repeat at a given frequency

1.5.2.4
nominal stress
a stress in the parent material adjacent to a potential crack location, calculated in accordance with simple elastic strength of materials theory, i.e. assuming that plane sections remain plane and that all stress concentration effects are ignored

1.5.2.5
modified nominal stress
A nominal stress increased by an appropriate geometrical stress concentration factor K_{gt}, to allow only for geometric changes of cross section which have not been taken into account in the classification of a particular constructional detail

1.5.2.6
geometric stress
also known as structural stress, is the elastic stress at a point, taking into account all geometrical discontinuities, but ignoring any local singularities where the transition radius tends to zero, such as notches due to small discontinuities, e.g. weld toes, cracks, crack like features, normal machining marks etc. It is in principle the same stress parameter as the modified nominal stress, but generally evaluated by a different method

1.5.2.7
geometric stress concentration factor
the ratio between the geometric stress evaluated with the assumption of linear elastic behaviour of the material and the nominal stress

1.5.2.8
hot spot stress
the geometric stress at a specified initiation site in a particular type of geometry, such as a weld toe in an angle hollow section joint, for which the fatigue strength, expressed in terms of the hot spot stress range, is usually known

1.5.2.9
stress history
a continuous chronological record, either measured or calculated, of the stress variation at a particular point in a structure for a given period of time

1.5.2.10
stress turning point
the value of stress in a stress history where the rate of change of stress changes sign

1.5.2.12
stress peak
a turning point where the rate of change of stress changes from positive to negative

1.5.2.12
stress valley
a turning point where the rate of change of stress changes from negative to positive

1.5.2.13
constant amplitude
relating to a stress history where the stress alternates between stress peaks and stress valleys of constant values

1.5.2.14
variable amplitude
relating to any stress history containing more than one value of peak or valley stress

1.5.2.15
stress cycle

part of a constant amplitude stress history where the stress starts and finishes at the same value but, in doing so passes through one stress peak and one stress valley (in any sequence). Also, a specific part of a variable amplitude stress history as determined by a cycle counting method

1.5.2.16
cycle counting
the process of transforming a variable amplitude stress history into a spectrum of stress cycles, each with a particular stress range, e.g. the 'Reservoir' method and the 'Rain flow' method

1.5.2.17
rainflow method
particular cycle counting method of producing a stress-range spectrum from a given stress history

1.5.2.18
reservoir method
particular cycle counting method of producing a stress-range spectrum from a given stress history

1.5.2.19
stress amplitude
half the value of the stress range

1.5.2.20
stress ratio
minimum stress divided by the maximum stress in a constant amplitude stress history or a cycle derived from a variable amplitude stress history

1.5.2.21
stress intensity ratio
minimum stress intensity divided by the maximum stress intensity derived from a constant amplitude stress history or a cycle from a variable amplitude stress history

1.5.2.22
mean stress
the mean value of the algebraic sum of maximum and minimum stress values

1.5.2.23
stress range
the algebraic difference between the stress peak and the stress valley in a stress cycle

1.5.2.24
stress intensity range
the algebraic difference between the maximum stress intensity and the minimum stress intensity derived from the stress peak and the stress valley in a stress cycle

1.5.2.25
stress-range spectrum
histogram of the frequency of occurrence for all stress ranges of different magnitudes recorded or calculated for a particular load event (also known as 'stress spectrum')

1.5.2.26
design spectrum
the total of all stress-range spectra relevant to the fatigue assessment

1.5.2.27
detail category
the designation given to a particular fatigue initiation site for a given direction of stress fluctuation in order to indicate which fatigue strength curve is applicable for the fatigue assessment

1.5.2.28
endurance
the life to failure expressed in cycles, under the action of a constant amplitude stress history

1.5.2.29
fatigue strength curve
the quantitative relationship relating stress range and endurance, used for the fatigue assessment of a category of constructional detail, plotted with logarithmic axes in this standard

1.5.2.30
reference fatigue strength
the constant amplitude stress range $\Delta\sigma_c$ for a particular detail category for an endurance $N_C = 2x10^6$ cycles

1.5.2.31
constant amplitude fatigue limit
the stress range below which value all stress ranges in the design spectrum should lie for fatigue damage to be ignored

1.5.2.32
cut-off limit
limit below which stress ranges of the design spectrum may be omitted from the cumulative damage calculation

1.5.2.33
design life
the reference period of time for which a structure is required to perform safely with an acceptable probability that structural failure by fatigue cracking will not occur

1.5.2.34
safe life
the period of time for which a structure is estimated to perform safely with an acceptable probability that failure by fatigue cracking will not occur, when using the safe life design method