SLOVENSKI STANDARD
oSIST prEN 13381-4:2009

01-februar-2009

Preskusne metode za ugotavljanje prispevka k požarni odpornosti konstrukcijskih elementov - 4. del: Zaščita jeklenih elementov

Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied passive protection products to steel members

Prüfverfahren zur Bestimmung des Beitrages zum Feuerwiderstand von tragenden Bauteilen - Teil 4: Passive Brandschutzmaterialien für Stahlbauteile

Méthode d'essai pour déterminer la contribution à la résistance au feu des éléments de construction - Partie 4 : Revêtements non réactifs

Ta slovenski standard je istoveten z: **prEN 13381-4**

ICS:

13.220.50	Požarna odpornost gradbenih materialov in elementov	Fire-resistance of building materials and elements
91.080.10	Kovinske konstrukcije	Metal structures

oSIST prEN 13381-4:2009 **en,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 13381-4

December 2008

ICS 91.080.10; 13.220.50

Will supersede ENV 13381-4:2002

English Version

Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied passive protection products to steel members

Méthode d'essai pour déterminer la contribution à la résistance au feu des éléments de construction - Partie 4 : Revêtements non réactifs

Prüfverfahren zur Bestimmung des Beitrages zum Feuerwiderstand von tragenden Bauteilen - Teil 4: Passive Brandschutzmaterialien für Stahlbauteile

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 127.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CEN 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.

CEN members are the national standards bodies of 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.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. prEN 13381-4:2008: E

Contents

Page

Foreword

This document (prEN 13381-4:2008) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede ENV 13381-4:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of 89/106/EEC.

This document is one of a series of standards for evaluating the contribution to the fire resistance of structural members by applied fire protection materials. Other parts of this EN are:

Part 1: Horizontal protective membranes.

Part 2: Vertical protective membranes.

Part 3: Applied protection to concrete members.

Part 5: Applied protection to concrete/profiled sheet steel composite members.

Part 6: Applied protection to concrete filled hollow steel composite columns.

Part 7: Applied protection to timber members.

Annexes A to J are normative.

CAUTION — The attention of all persons concerned with managing and carrying out this fire resistance test, is drawn to the fact that fire testing can be hazardous and that there is a possibility that toxic and / or harmful smoke and gases can be evolved during the test. Mechanical and operational hazards can also arise during the construction of test elements or structures, their testing and the disposal of test residues.

An assessment of all potential hazards and risks to health shall be made and safety precautions shall be identified and provided. Written safety instructions shall be issued. Appropriate training shall be given to relevant personnel. Laboratory personnel shall ensure that they follow written safety instructions at all times.

The specific health and safety instructions contained within this Standard shall be followed.

1 Scope

This part of this European Standard specifies a test method for determining the contribution made by applied fire protection systems to the fire resistance of structural steel members, which can be used as beams, columns or tension members.

The evaluation is designed to cover a range of thicknesses of the applied fire protection material, a range of steel sections, characterized by their section factors, a range of design temperatures and a range of valid fire protection classification periods.

This European Standard applies to fire protection materials where the gap between the material and the flange faces of the steel member is less than 5 mm in size. Otherwise, the test methods in EN 13381-1 or EN 13381-2, as appropriate, apply.

This European Standard contains the fire test which specifies the tests which shall be carried out to determine the ability of the fire protection system to remain coherent and fixed to the steelwork, and to provide data on the thermal characteristics of the fire protection system, when exposed to the standard temperature/time curve specified in EN 1363-1.

In special circumstances, where specified in national building regulations, there can be a need to subject reactive protection material to a smouldering curve. The test for this and the special circumstances for its use are described in annex A.

The fire test methodology makes provision for the collection and presentation of data which can be used as direct input to the calculation of fire resistance of steel structural members in accordance with the procedures given in EN 1993-1-2.

This European Standard also contains the assessment which prescribes how the analysis of the test data shall be made and gives guidance on the procedures by which interpolation shall be undertaken.

The assessment procedure is used to establish:

a) on the basis of temperature data derived from testing loaded and unloaded sections, a correction factor and any practical constraints on the use of the fire protection system under fire test conditions, (the physical performance);

b) on the basis of the temperature data derived from testing short steel column sections, the thermal properties of the fire protection system, (the thermal performance).

The limits of applicability of the results of the assessment arising from the fire test are defined, together with permitted direct application of the results to different steel sections and grades and to different fire protection systems and fixings.

The results of the test and assessment obtained according to this part of EN 13381 are directly applicable to steel sections of "I" and "H" cross sectional shape. Guidance is given in annex B on the application of the data obtained from "I" and "H" steel sections to other section shapes.

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 1363-1, *Fire resistance tests — Part 1: General requirements*

EN 1363-2, *Fire resistance tests — Part 2: Alternative and additional procedures*

EN 10025, *Hot rolled products of non-alloy structural steels — Technical delivery conditions*

EN 10113, *Hot rolled products in weldable fine grade structural steels*

EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1993-1-2, *Eurocode 3: Design of steel structures — Part 1-2: General rules - Structural fire design*

ISO 8421-2, *Fire protection — Vocabulary — Part 2: Structural fire protection*

EN ISO 13943, *Fire safety — Vocabulary (ISO 13943:1999)*

3 Terms and definitions, symbols and units

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1363-1, EN ISO 13943 and ISO 8421-2, together with the following, apply:

3.1.1
steel member
element of building construction which is loadbearing and fabricated from steel

3.1.2
fire protection material
material or combination of materials applied to the surface of a steel member for the purpose of increasing its fire resistance

3.1.3
passive fire protection materials
materials which do not change their physical form on heating, providing fire protection by virtue of their physical or thermal properties. They may include materials containing water which, on heating, evaporates to produce cooling effects

3.1.4
reactive fire protection materials
materials which are specifically formulated to provide a chemical reaction upon heating such that their physical form changes and in so doing provide fire protection by thermal insulative and cooling effects

3.1.5
fire protection system
fire protection material together with a prescribed method of attachment to the steel member

3.1.6
fire protection
protection afforded to the steel member by the fire protection system such that the temperature of the steel member is limited throughout the period of exposure to fire

3.1.7
test specimen
steel test section plus the fire protection system under test. The steel test section, representative of a steel member, for the purposes of this test, comprises short steel columns, tall columns or beams

3.1.8
fire protection thickness
thickness of a single layer fire protection system or the combined thickness of all layers of a multilayer fire protection system

3.1.9
stickability
ability of a fire protection material to remain sufficiently coherent and in position for a well defined range of deformations, furnace and steel temperatures, such that its ability to provide fire protection is not significantly impaired

3.1.10
section factor

profiled
ratio of the fire exposed outer perimeter area of the steel structural member itself, per unit length, to its cross sectional volume per unit length, see Figure 1

boxed
ratio of the sum of the inside dimensions of the smallest possible rectangle or square encasement which can be measured round the steel structural member times unit length, to its volume per unit length, see Figure 1

3.1.11
design temperature
temperature of a steel structural member for structural design purposes

3.1.12
characteristic steel temperature
temperature of the steel structural member which is used for the determination of the correction factor for stickability

3.2 Symbols and units

Symbol	Unit	Description
LB		loaded beam section
UB		unloaded beam section
LC		loaded 3 metre column section
TC		unloaded Tall (2 metre) column section
SC		short column section
p		fire protection material
a		steel
f		furnace
d		thickness
ρ		density
A_m/V	m^{-1}	section factor of the unprotected steel section
A_p/V	m^{-1}	section factor of the protected steel section
A_p	m^2/m	area of the protected steel section, around the profile (profiled) or over the linear dimensions (boxed) of the steel section
A	m^2	cross sectional area of the steel section
V	m^3/m	volume of the steel section per unit length
V_p	m^3/m	volume of the fire protection material per unit length
h	mm	depth of the steel section
b	mm	flange breadth of the steel section
t_w	mm	thickness of the web of the steel section
L_{exp}	mm	length of beam specimen exposed to heating
L_{sup}	mm	length of beam specimen between supports
d_{UB}	mm	thickness of fire protection material on an unloaded beam section
d_{SC}	mm	thickness of fire protection material on an unloaded column section
d_p	mm	thickness of fire protection material concerned
$d_{p(max)}$	mm	maximum thickness of fire protection material used
$d_{p(min)}$	mm	minimum thickness of fire protection material used
$\rho_{protection}$	kg/m^3	density of fire protection material
ρ_{UB}	kg/m^3	density of fire protection material on an unloaded beam section
ρ_{SC}	kg/m^3	density of fire protection material on an unloaded column section
ρ_{LB}	kg/m^3	density of fire protection material on a loaded beam
ρ_a	kg/m^3	density of steel (normally 7850 kg/m^3)
θ_{SC}	°C	mean (or characteristic) steel temperature of a short column (see 13.2.2)
θ_{LB}	°C	characteristic steel temperature of a loaded beam
θ_{UB}	°C	characteristic steel temperature of an unloaded beam
θ_{LC}	°C	characteristic steel temperature of a loaded column
θ_{TC}	°C	characteristic steel temperature of a tall column
$\theta_{c(UB)}$	°C	corrected temperature of an unloaded beam section
θ_t	°C	average temperature of the furnace at time *t*
θ_{at}	°C	average temperature of the steel at time *t*

Symbol	Unit	Description
$\Delta\theta_t$	°C	increase of furnace temperature during the time interval Δt
$\theta_{m(SC)}$	°C	modified steel temperature of an unloaded column section
θ_D	°C	design temperature
$k(\theta)$		correction factor for temperature of an unloaded section at a temperature θ
$k(\theta_{LB})_{max}$		correction factor for temperature based on beams for a short section at a temperature θ with maximum thickness of applied fire protection material
$k(\theta_{LB})_{min}$		correction factor for temperature based on beams for a short section at a temperature θ with minimum thickness of applied fire protection material
$k(\theta)_C$		correction factor for temperature based on columns for a short section at a temperature θ with maximum thickness of applied fire protection material
$k_d(\theta)$		correction factor for temperature of a short column section at a thickness of fire protection material d and at a temperature θ
$k_d(\theta_{LB})$		correction factor for temperature based on beams for a short section at a thickness of fire protection material d and at a temperature θ
$k_d(\theta_{TC})$		correction factor for temperature based on tall columns (or loaded columns) for a short section at a thickness of fire protection material d and at a temperature θ
$k_{max}(\theta)$		correction factor for temperature of a short section at maximum thickness of fire protection material d_{max}
$k_{min}(\theta)$		correction factor for temperature of a short section at minimum thickness of fire protection material d_{min}
C_a	J/kg °C	temperature dependant specific heat of steel as defined in EN 1993-1-2
C_p	J/kg °C	temperature independant specific heat of the fire protection material
μ		ratio of heat capacity of the fire protection material to that of the steel section
t	min	time from commencement of the start of the test
t_e	min	time for an unloaded section to reach an equivalent temperature to the loaded beam at time t
Δt	min	time interval
t_D	min	time required for a short steel column section to reach the design temperature
λ_p	W/m °C	effective thermal conductivity of the fire protection material
$\lambda_{char(p)}$	W/m °C	characteristic value of effective conductivity of the fire protection material
$\lambda_{ave(p)}$	W/m °C	mean value of λ_p calculated from all the short column sections at a temperature θ_{SC}
$\lambda_{\delta(p)}$		standard deviation of λ_p calculated from all the short column sections at a temperature θ_{SC}
$C_{n(\theta)}$		constant derived for short section at temperature (θ)
K		constant applied to $\lambda_{\delta(p)}$

4 Test equipment

4.1 General

The furnace and test equipment shall conform to that specified in EN 1363-1.

4.2 Furnace

The furnace shall be designed to permit the dimensions of the test specimens to be exposed to heating, be they short columns, tall columns or beams, to be as specified in 6.2 and their installation upon or within the test furnace to be as specified in clause 7.

4.3 Loading equipment

Loading shall be applied according to EN 1363-1. The loading system shall permit loading to be applied to beams as specified in 5.2.1 and to columns as specified in 5.2.3.

5 Test conditions

5.1 General

A number of short steel, "I" or "H" test sections, protected by the fire protection system, is heated in a furnace according to the protocol given in Figures 2, 3 and 4.

Loaded and unloaded beams or columns (see Table 1) that are likewise heated provide information on the ability of the fire protection system to remain intact and adhere to the steel test sections (stickability).

The method of testing loaded beams in this part of the test method is designed to provide maximum deflection under the influence of load and heating.

It is recommended that the tests be continued until the steel temperature reaches the maximum value commensurate with application of the data, usually 750 °C.

Where several test specimens are tested simultaneously, care shall be taken that each is adequately and similarly exposed to the specified test conditions.

The procedures given in EN 1363-1 shall be followed in the performance of this test unless specific contrary instructions are given.

5.2 Support and loading conditions

5.2.1 Loaded beams

Each loaded beam test specimen shall be simply supported and allowance shall be made for free expansion and vertical deflection of the beam. The simply supported span shall be not greater than the length exposed to heating by more than 250 mm at each end.

Loading shall be uniformly and symmetrically applied at two or more locations along its length. Point loads shall be applied directly via loading spacers introduced through the cover slabs, see Figure 5. These spacers may be of any suitable material but if they are of steel or other high conductivity material, unless the contact surface at each loading point is less than or equal to 100 mm $\times$ 100 mm or 10 000 mm^2, they shall be insulated from the steel beam by a suitable insulation material.

5.2.2 Unloaded beams

Each unloaded beam test specimen shall be supported as shown in Figure 6.

5.2.3 Loaded columns

For each loaded column provision shall be made for the proper support, positioning and alignment of the column test specimen in the furnace and for ensuring uniform distribution of the loading over the ends of the specimen, see Figure 7.

The ends of the specimen shall be designed and detailed for the proper transmission of the test load from the loading platens to the specimen. The loadbearing faces at top and bottom of the column shall be parallel to each other and perpendicular to the axis of the column to avoid introduction of bending moments.

For protection of the loading equipment against heat, provision shall be made for the attachment of collars at each end of the test specimen. These shall be designed to locate the column and to provide an adequate seal with the furnace walls and shall be suitably attached and supported so that they remain effective and in position throughout the heating period.

The method adopted to provide the seal shall allow the test specimen to move within the furnace walls without significantly affecting the load transmitted from the loading rig to the specimen or the fixity at the ends of the specimen.

5.2.4 Unloaded columns

A tall column test specimen or short column section test specimens shall be supported vertically within the furnace, either installed to the soffit of the furnace cover slabs, (see Figure 8), or stood, directly or on plinths, on the furnace floor.

5.3 Loading

The loaded bem test specimens shall be subjected to a total load which represents 60 % of the design moment resistance, according to EN 1993-1-1, calculated using the nominal steel strength and the recommended boxed values given in EN 1993-1-1.

The actual load applied shall be the calculated total load less the dead weight of the beam, concrete topping and fire protection material etc.

The method of loading shall be by a system which will produce a bending moment which is uniform over at least 25 % of the span of the beam around mid-span.

The loaded column shall be subjected to an axially applied test load which represents 60 % of the design buckling resistance, according to EN 1993-1-1, calculated using the nominal steel strength and the recommended boxed values given in EN 1993-1-1.

Details of the calculation made to define the test loads shall be included in the test report.

6 Test specimens

6.1 Number of test specimens

6.1.1 General

The standard package of short steel column test sections appropriate to each assessment method, chosen to span the full range of steel section factors which are in general usage, together with section dimensions, are given in Tables 2, 3 and 4.

For both the maximum and the minimum thickness of the fire protection system, a loaded beam shall be tested to examine stickability during maximum deflection of the steel section, up to a maximum anticipated steel temperature.

For each test involving a loaded beam, an equivalent unloaded beam section shall be included and tested in the furnace at the same time.

Where the range of thicknesses for the fire protection system is such that the difference between the maximum and the minimum thickness is less than 50 % of the minimum thickness, then only a single loaded and unloaded beam or column at the maximum fire protection material thickness need to be tested.

6.1.2 Passive fire protection systems

If the assessment is to be made for both three and four sided application of the fire protection system to both beams and columns, then two loaded beams and two unloaded beams and a number of short steel column sections shall be tested, (see Figures 2, 3 and 4).

The minimum number of short steel column sections to be tested is 10. The number may be increased to 18 or 26 in order to satisfy the criteria for validity of the results from the assessment method.

If the assessment is to be confined to four sided protection of columns, the two loaded beam tests shall be replaced by two loaded column tests, one with maximum and one with minimum thickness of applied fire protection material. The two unloaded beam tests are not required.

6.1.3 Reactive fire protection systems

If the assessment is to be made for both three and four sided application of the fire protection system to beams and columns, the number of test specimens required is the same as for passive fire protection materials plus an additional test upon a single unloaded column of two metre height minimum, (named a tall column hereafter). This column shall be tested with maximum thickness of fire protection material.

If the assessment is to be confined to four sided protection of columns, the two loaded beam tests shall be replaced by two loaded column tests, one with maximum and one with minimum thickness of applied fire protection material. The two unloaded beam tests are not required. The additional tall column is not required, since adequate data would be obtained from the behaviour of the fire protection material upon the two loaded columns.

These column tests are required to provide information on stickability and the ability of the reactive fire protection material to resist slumping and flowing.