

Nederlandse voornorm

NVN-ENV 13381-4 (en)

Beproevingsmethoden voor de bepaling van de bijdrage aan brandwerendheid van draagconstructieonderdelen - Deel 4: Bescherming aangebracht op stalen constructiedelen

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

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Voorbeeld
 Preview

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Voor de in deze voornorm vermelde normatieve verwijzingen bestaan in Nederland de volgende equivalenten:

<u>vermelde norm</u>	<u>Nederlandse norm</u>	<u>titel</u>
EN 1363-1	NEN-EN 1363-1	Bepaling van de brandwerendheid - Deel 1: Algemene eisen (en)
EN 1363-2	NEN-EN 1363-2	Bepaling van de brandwerendheid - Deel 2: Alternatieve en aanvullende procedures (en)
EN 10025	NEN-EN 10025	Warmgewalste producten van ongelegeerd constructiestaal - Technische leveringsvoorwaarden (bevat wijzigingsblad A1:1993) (en,nl)
EN 10113:series	NEN-EN 10113:reeks	Warmgewalste produkten van lasbaar fijnkorrelig constructiestaal (en,nl)
ENV 1993-1-1	NVN-ENV 1993-1-1	Eurocode 3 - Ontwerp en berekening van staalconstructies - Deel 1-1: Algemene regels en regels voor gebouwen (en)
ENV 1993-1-2	NVN-ENV 1993-1-2	Eurocode 3 - Ontwerp en berekening van staalconstructies - Deel 1-2: Algemene regels - Constructieve brandveiligheid (en)
ISO 8421-2	-	-
EN ISO 13943	NEN-EN-ISO 13943	Brandveiligheid - Woordenlijst (en,fr,de)
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ISO 8421-2	-	-
EN ISO 13943	NEN-EN-ISO 13943	Brandveiligheid - Woordenlijst (en,fr,de)

ICS 13.220.50

English version

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

This European Prestandard (ENV) was approved by CEN on 1 March 2002 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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Foreword

This document ENV 13381-4:2002 has been prepared by Technical Committee CEN/TC127 "Fire safety in buildings", the secretariat of which is held by BSI.

This document has been prepared under the mandate given to CEN/TC127 by the Commission and the European Free Trade Association.

As there was little experience in carrying out these tests in Europe CEN/TC127 agreed that more experience should be built up during a prestandardization period before agreeing text as European Standards. Consequently all parts are being prepared as European Prestandards.

This European Prestandard 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 ENV 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 should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written safety instructions at all times.

The specific health and safety instructions contained within this prestandard should be followed.

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

1 Scope

This part of this European Prestandard 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 Prestandard 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 ENV 13381-1 or ENV 13381-2, as appropriate, apply.

This European Prestandard contains the fire test which specifies the tests which should 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 ENV 1993-1-2.

This European Prestandard also contains the assessment which prescribes how the analysis of the test data should be made and gives guidance on the procedures by which interpolation should 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 ENV 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 Prestandard 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 Prestandard 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.
ENV 1993-1-1	Eurocode 3: Design of steel structures Part 1-1: General rules and rules for buildings.
ENV 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 Prestandard, 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
<i>LB</i>		loaded beam section
<i>UB</i>		unloaded beam section
<i>LC</i>		loaded 3 metre column section
<i>TC</i>		unloaded Tall (2 metre) column section
<i>SC</i>		short column section
<i>p</i>		fire protection material
<i>a</i>		steel
<i>f</i>		furnace
<i>d</i>		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

A	m^2	dimensions (boxed) of the steel section
V	m^3/m	cross sectional area of the steel section
V_p	m^3/m	volume of the steel section per unit length
h	mm	volume of the fire protection material per unit length
b	mm	depth of the steel section
t_w	mm	flange breadth of the steel section
		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
$d_{\text{p(max)}}$	mm	maximum thickness of fire protection material used
$d_{\text{p(min)}}$	mm	minimum thickness of fire protection material used
$\rho_{\text{protection}}$	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 $7850 \text{ kg}/\text{m}^3$)
θ_{sc}	$^{\circ}\text{C}$	mean (or characteristic) steel temperature of a short column (see 13.2.2)
θ_{LB}	$^{\circ}\text{C}$	characteristic steel temperature of a loaded beam
θ_{UB}	$^{\circ}\text{C}$	characteristic steel temperature of an unloaded beam
θ_{LC}	$^{\circ}\text{C}$	characteristic steel temperature of a loaded column
θ_{TC}	$^{\circ}\text{C}$	characteristic steel temperature of a tall column
$\theta_{\text{c(UB)}}$	$^{\circ}\text{C}$	corrected temperature of an unloaded beam section
θ_t	$^{\circ}\text{C}$	average temperature of the furnace at time t
θ_{at}	$^{\circ}\text{C}$	average temperature of the steel at time t
$\Delta\theta_t$	$^{\circ}\text{C}$	increase of furnace temperature during the time interval Δt
$\theta_{\text{m(SC)}}$	$^{\circ}\text{C}$	modified steel temperature of an unloaded column section
θ_{D}	$^{\circ}\text{C}$	design temperature
$k(\theta)$		correction factor for temperature of an unloaded section at a temperature θ
$k(\theta_{\text{LB}})_{\text{max}}$		correction factor for temperature based on beams for a short section at a temperature θ with maximum thickness of applied fire protection material
$k(\theta_{\text{LB}})_{\text{min}}$		correction factor for temperature based on beams for a short section at a temperature θ with minimum thickness of applied fire protection material
$k(\theta)_{\text{C}}$		correction factor for temperature based on columns for a short section at a temperature θ with maximum thickness of applied fire protection material
$k_{\text{d}}(\theta)$		correction factor for temperature of a short column section at a thickness of fire protection material d and at a temperature θ
$k_{\text{d}}(\theta_{\text{LB}})$		correction factor for temperature based on beams for a short section at a thickness of fire protection material d and at a temperature θ
$k_{\text{d}}(\theta_{\text{TC}})$		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
$k_{\text{max}}(\theta)$		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 ENV 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
$\lambda_{\text{char}(p)}$	W/m °C	characteristic value of effective conductivity of the fire protection material
$\lambda_{\text{ave}(p)}$	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.

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