

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

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN 13381-4:2013 sisaldab Euroopa standardi EN 13381-4:2013 ingliskeelset teksti.	This Estonian standard EVS-EN 13381-4:2013 consists of the English text of the European standard EN 13381-4:2013.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 01.05.2013.	Date of Availability of the European standard is 01.05.2013.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 13.220.50, 91.080.10

### Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Aru 10, 10317 Tallinn, Eesti; [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

### The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:  
Aru 10, 10317 Tallinn, Estonia; [www.evs.ee](http://www.evs.ee); phone 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

English Version

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

Méthodes d'essai pour déterminer la contribution à la  
résistance au feu des éléments de construction - Partie 4 :  
Protection passive appliquée aux éléments en acier

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

This European Standard was approved by CEN on 10 February 2013.

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-CENELEC 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-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

**Management Centre: Avenue Marnix 17, B-1000 Brussels**

# Contents

Page

Foreword.....	4
1 Scope.....	6
2 Normative references.....	6
3 Terms and definitions, symbols and units.....	7
3.1 Terms and definitions.....	7
3.2 Symbols and units.....	9
4 Test equipment.....	11
4.1 General.....	11
4.2 Furnace.....	11
4.3 Loading equipment.....	11
5 Test conditions.....	11
5.1 General.....	11
5.2 Support and loading conditions.....	11
5.3 Loading.....	12
6 Test specimens.....	12
6.1 General.....	12
6.2 Size of test specimens.....	13
6.3 Construction of steel test specimens.....	13
6.4 Composition of steel sections.....	15
6.5 Properties of fire protection materials.....	15
6.6 Selection of test specimens.....	16
7 Installation of the test specimens.....	22
7.1 Loaded beam.....	22
7.2 Unloaded beams.....	22
7.3 Loaded columns.....	22
7.4 Unloaded columns.....	23
7.5 Test specimen installation patterns.....	23
7.6 Furnace load.....	23
8 Conditioning of the test specimens.....	23
9 Application of instrumentation.....	23
9.1 General.....	23
9.2 Instrumentation for measurement and control of furnace temperature.....	24
9.3 Instrumentation for measurement of steel temperatures.....	25
9.4 Instrumentation for the measurement of pressure.....	26
9.5 Instrumentation for the measurement of deformation.....	26
9.6 Instrumentation for the measurement of load.....	26
10 Test procedure.....	26
10.1 General.....	26
10.2 Furnace temperature and pressure.....	26
10.3 Application and control of load.....	27
10.4 Temperature of steelwork.....	27
10.5 Deflection.....	27
10.6 Observations.....	27
10.7 Termination of test.....	27
11 Test results.....	28
11.1 Acceptability of test results.....	28

11.2	Presentation of test results.....	29
12	Test report .....	29
13	Assessment.....	30
13.1	General .....	30
13.2	Temperature data .....	30
13.3	Correction for discrepancy in stickability and insulation performance over the thickness range tested.....	30
13.4	Assessment procedures for thermal performance.....	31
13.5	Acceptability of the assessment method used and the resulting analysis – criteria for acceptability .....	31
14	Report of the assessment.....	31
15	Limits of the applicability of the results of the assessment.....	32
Annex A	(normative) The applicability of the results of the assessment to sections other than I or H sections.....	49
A.1	Structural hollow sections - General .....	49
A.2	Boxed systems .....	49
A.3	Profiled systems.....	49
A.4	Alternative Fixing Methods for Boards (Slabs).....	50
A.5	Limitations .....	50
Annex B	(normative) Measurement of properties of fire protection materials .....	51
B.1	Introduction .....	51
B.2	Thickness of fire protection materials.....	51
B.3	Density of applied fire protection materials .....	53
B.4	Moisture content of applied fire protection materials.....	53
Annex C	(normative) Fixing of thermocouples to steel work and routing of cables.....	55
C.1	Introduction .....	55
C.2	Types of thermocouples .....	55
C.3	Fixing of thermocouples .....	55
C.4	Routing of thermocouple wires .....	55
C.5	Connection of thermocouples .....	56
C.6	Thermocouple failures .....	56
Annex D	(normative) Correction of data/Nominal thickness.....	57
D.1	Correction of data.....	57
D.2	Nominal thickness-Graphical method .....	60
Annex E	(normative) Methods of Assessment of Fire Protection System Performance .....	61
E.1	General .....	61
E.2	Graphical Approach .....	61
E.3	Differential Formula Analysis (variable $\lambda$ approach) Methodology.....	67
E.4	Differential Formula Analysis (constant $\lambda$ approach) Methodology.....	73
E.5	Numerical Regression Analysis.....	77
Annex F	.....	79
Bibliography	.....	83

## Foreword

This document (EN 13381-4:2013) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, 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 2013, and conflicting national standards shall be withdrawn at the latest by November 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes 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.

With respect to the previous version, the following changes have been made:

- A change has been made to the test method to introduce of a means allowing loaded beams to reach a deflection of  $L/30$ .
- In addition the graphical assessment method now includes a point to point method of constructing lines and a new virtual data point related to furnace temperature.

This document is compatible with EN 13381-8 and specifically deals with the testing and assessment of passive fire protection systems (sprays, renderings, mat products and boards) designed to protect structural steel.

This document is part of the EN 13381 series with the general title *Test methods for determining the contribution to the fire resistance of structural members*. Other parts of this series are:

- *Part 1: Horizontal protective membranes;*
- *Part 2: Vertical protective membranes;*
- *Part 3: Applied protection to concrete member;*
- *Part 4: Applied passive protection to steel members* (the present document);
- *Part 5: Applied protection to concrete/profile sheet steel and composite members;*
- *Part 6: Applied protection to concrete filled steel composite members;*
- *Part 7: Applied protection to timber members;*
- *Part 8: Applied reactive protection to steel members.*

**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 standard should be followed.**

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

This document is a preview generated by EVS

## 1 Scope

This European Standard specifies a test method for determining the contribution made by applied passive fire protection systems to the fire resistance of structural steel members, which can be used as beams or columns. It considers only sections without openings in the web. It is not directly applicable to structural tension members without further evaluation. Results from analysis of I or H sections are directly applicable to angles, channels and T-sections for the same section factor, whether used as individual elements or as bracing. This European Standard does not apply to solid bar or rod.

This European Standard covers fire protection systems that involve only passive materials and not to reactive fire protection materials as defined in this document.

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

This European Standard contains the fire test procedures, which specifies the tests which should be carried out to determine the ability of the fire protection system to remain coherent and attached 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.

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 and EN 1994-1-2.

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 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 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 the fire protection system.

The results of the test and assessment obtained according to this European Standard are directly applicable to steel sections of I and H cross sectional shape and hollow sections.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12467, *Fibre cement flat sheets — Product specification and test methods*

EN 13162, *Thermal insulating products for buildings — Factory made mineral wool (MW) products — Specification*

EN 823, *Thermal insulating products for building applications — Determination of thickness*



EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*

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

EN 1365-3, *Fire resistance tests for loadbearing elements — Part 3: Beams*

EN 1365-4, *Fire resistance tests for loadbearing elements — Part 4: Columns*

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*

EN 10025-1, *Hot rolled products of non-alloy structural steels — Part 1: General technical delivery conditions*

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

ISO 8421-2:1987, *Fire protection — Vocabulary — Part 2: Structural fire protection*

ETAG 018-Part 3, *Guideline for European Technical Approval of Fire Protective Products — Part 3: Renderings and rendering kits intended for fire resisting applications*

ETAG 018-Part 4, *Guideline for European Technical Approval of Fire Protective Products — Part 4: Fire protective board, slab and mat products and kits*

### 3 Terms and definitions, symbols and units

#### 3.1 Terms and definitions

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

##### 3.1.1

##### **steel member**

element of building construction which is loadbearing and fabricated from steel of the same type as is used in the testing

##### 3.1.2

##### **reactive fire protection material**

reactive 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

##### 3.1.3

##### **passive fire protection material**

materials, which do not change their physical form on heating, providing protection by virtue of their physical or thermal properties

Note 1 to entry: They may include materials containing water or endothermic materials which, on heating, produce cooling effects. These may take the form of sprayed coatings, renderings, mat products boards or slabs.

##### 3.1.4

##### **fire protection system**

fire protection material together with any supporting system including mesh reinforcement as tested and with a specific primer and/or topcoat if applicable