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Test methods for determining the contribution to the fire resistance of structural members  
- Part 2: Vertical protective membranes

Prüfverfahren zur Bestimmung des Beitrages zum Feuerwiderstand von tragenden  
Bauteilen - Teil 2: Vertikal angeordnete Brandschutzbekleidungen

Méthodes d'essai pour déterminer la contribution a la résistance au feu des éléments de  
construction - Partie 2: Membranes de protection verticales

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**ICS:**

13.220.50	Požarna odpornost gradbenih materialov in elementov	Fire-resistance of building materials and elements
91.080.01	Gradbene konstrukcije na splošno	Structures of buildings in general

**SIST ENV 13381-2:2003**

**en**

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EUROPEAN PRESTANDARD  
PRÉNORME EUROPÉENNE  
EUROPÄISCHE VORNORM

**ENV 13381-2**

July 2002

ICS 13.220.50

English version

Test methods for determining the contribution to the fire  
resistance of structural members - Part 2: Vertical protective  
membranes

Prüfverfahren zur Bestimmung des Beitrages zum  
Feuerwiderstand von tragenden Bauteilen - Teil 2: Vertikal  
angeordnete Brandschutzbekleidungen

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.

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

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## ENV 13381-2: 2002 (E)

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## Foreword

This document ENV 13381-2:2002 has been prepared by Technical Committee CEN/TC127 "Fire safety in buildings", the secretariat of which is held by BSI.

This European Prestandard has been prepared under a mandate given to CEN by the European 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 prestandardisation 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 the ENV are:

- Part 1: Horizontal protective membranes.
- Part 3: Applied protection to concrete members.
- Part 4: Applied protection to steel members.
- Part 5: Applied protection to concrete / profiled sheet steel composite members.
- Part 6: Applied protection to concrete filled hollow steel columns.
- Part 7: Applied protection to timber members.

The fire protection provided by the vertical protective membrane can be nullified by the presence of combustible materials in the cavity behind the membrane. The assessment methodology can be modified according to the quantity and position of such materials within that cavity.

Annex A is 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.

When testing concrete filled hollow steel composite columns steam release holes should be provided for the release of steam from the column, during the test, as specified in ENV 13381-6.

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 ability of a vertical protective membrane, when used as a fire resistant barrier, to contribute to the fire resistance of loadbearing vertical structural building members fabricated from steel, concrete, steel / concrete composites or timber. The method described is applicable to any type of vertical protective membrane, which can be associated with a separate bracing membrane.

The vertical protective membrane can be separate from the structural building member and be self-supporting or can be attached to the structural building member and can form part of any load bearing structure. This test method is applicable to vertical protective membranes where there is a separating gap of at least 5 mm size between the vertical protective membrane and the structural building member, otherwise alternative test methods ENV 13381-3, ENV 13381-4, ENV 13381-6 or ENV 13381-7 should be used as appropriate

This test method and assessment is not applicable to the following:

- a) all situations where the cavity behind the vertical protective membrane contains more than a specified amount of combustible materials, e.g. electrical cables and pipes, other than where timber structural members themselves are required;
- b) all situations where the cavity is to be used as a service or ventilation shaft;
- c) all situations where the vertical protective membrane acts as a bracing membrane.

This European Prestandard contains the fire test which specifies the tests which should be carried out whereby the vertical protective membrane together with the structural member to be protected is exposed to the specified fire. The fire exposure, to the standard temperature/time curve given in EN 1363-1, is applied to the side which would be exposed in practice.

The test method makes provision, through specified optional additional procedures, for the collection of data which can be used as direct input to the calculation of fire resistance according to the processes given in ENV 1992-1-2, ENV 1993-1-2, ENV 1994-1-2 and ENV 1995-1-2.

This European Prestandard also contains the assessment which provides information relative to the analysis of the test data and gives guidance for the interpretation of the results of the fire test, in terms of loadbearing capacity criteria of the protected vertical structural member.

The results of the fire test and the assessment can be applied, with certain defined provisions, to vertical structural building members which can be beams, columns or a combination of both and / or which could form part of a separating element or partition.

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 structures, membranes and fittings.

## 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 206-1	Concrete - Part 1: Specification, performance, production and conformity.
ENV 1992-1-2	Eurocode 2: Design of concrete structures Part 1-2: General rules - Structural fire design.
ENV 1993-1-2	Eurocode 3: Design of steel structures Part 1-2: General rules - Structural fire design.
ENV 1994-1-2	Eurocode 4: Design of composite steel and concrete structures Part 1-2: General rules - Structural fire design (including Technical Corrigendum 1:1995).
ENV 1995-1-2:1994	Eurocode 5: Design of timber structures Part 1-2: General rules - Structural fire design.
EN 10025	Hot rolled products of non-alloy structural steels - Technical delivery conditions.
ENV 10080	Steel for the reinforcement of concrete - Weldable ribbed reinforcing steel B 500 - Technical delivery conditions for bars, coils and welded fabric.
EN 10113	Hot rolled products in weldable fine grade structural steels.
ENV 13381-3	Test methods for determining the contribution to the fire resistance of structural members Part 3: Applied protection to concrete members.
ENV 13381-6	Test methods for determining the contribution to the fire resistance of structural members Part 6: Applied protection to concrete filled hollow steel columns.
ENV 13381-7	Test methods for determining the contribution to the fire resistance of structural members Part 7: Applied protection to timber members.
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 and the following apply.

##### 3.1.1

##### **vertical structural building member**

vertical loadbearing structural element of building construction, which may be a column, a beam or a combination of both, and / or which might form part of a separating element or partition and which is fabricated from either concrete, steel, steel/concrete composite or timber

##### 3.1.2

##### **vertical protective membrane**

material or construction which is installed in front of a vertical structural building member and which is intended to give additional fire resistance to that member

The vertical protective membrane may comprise multiple layers of materials.

##### 3.1.3

##### **structural building member test column**

test column, representing the loadbearing structural building member to be protected in practice, in front of which the vertical protective membrane test specimen is installed for the purposes of the test

##### 3.1.4

##### **vertical protective membrane test specimen**

full vertical protective membrane assembly submitted for test, including typical fixing equipment and methods and typical features such as insulating materials, light fittings, ventilation ducts

##### 3.1.5

##### **furnace closure**

fire resistant vertical construction designed to close the furnace and with the vertical protective membrane create a cavity within which the test column is placed

##### 3.1.6

##### **separating gap**

distance between the rear face of the vertical protective membrane and the closest surface of the structural building member test column

##### 3.1.7

##### **cavity**

whole void between the rear face of the vertical protective membrane and the furnace closure

##### 3.1.8

##### **fire protection**

protection afforded to the structural building member by the vertical protective membrane such that the temperature on the surface of the test column and within the cavity is limited throughout the period of exposure to fire

#### 3.2 Symbols and units

Symbol	Unit	Designation
$A_m/V$	$m^{-1}$	Section factor of unprotected steel column (see ENV 13381-4).



## 4 Test equipment

### 4.1 General

The furnace and test equipment shall be as specified in EN 1363-1.

### 4.2 Furnace

The furnace shall be designed to permit the dimensions of the test specimen to be exposed to heating to be as specified in 6.3 and its installation to be as described in clause 7.

### 4.3 Test frame

The vertical protective membrane test specimen, the test column and the furnace closure shall be mounted in a test frame which shall be designed such that it possesses sufficient stiffness appropriate to the test construction. A suitable frame for this purpose shall have head and side members constructed from steel section protected with refractory concrete having a nominal density of at least 2 000 kg/m<sup>3</sup>.

The dimensions of the test frame shall be such that the furnace closure, the test column and the vertical protective membrane test specimen, together with any supporting construction, may be installed within it (see Figure 1) and permit the size of the test construction exposed to heating to be as specified in 6.3.

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### 4.4 Supporting construction

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If the size of the vertical protective membrane test specimen is smaller than the test frame of the laboratory then the test frame opening shall be reduced in size, whilst still fulfilling the general requirements for test frames, by the following which may be provided to accommodate the test specimen:

- a) where the height is smaller, a plinth shall be provided to adjust the opening to the required size;
- b) where the overall dimensions are smaller, a supporting construction shall be built in the test frame.

If the vertical protective membrane is required in practice to be used together with any supporting construction then the test construction shall include that supporting construction, otherwise, a standard construction made of aerated concrete slabs or blocks of density  $(650 \pm 200)$  kg/m<sup>3</sup> and thickness  $(100 \pm 10)$  mm, bonded with sand / cement mortar or other fire resistant material shall be used.

### 4.5 Furnace closure

The fire resistant furnace closure is designed to close the furnace and to create, together with the vertical protective membrane test specimen, a cavity to contain the test column.

The normal furnace closure shall comprise a wall built within the test frame comprising aerated concrete slabs or blocks of density  $(650 \pm 200)$  kg/m<sup>3</sup> and thickness  $(100 \pm 10)$  mm, bonded with sand / cement mortar or other appropriate fire resistant material.

Where the vertical protective membrane is to be used on all sides of the structural building member, and where exposure to fire might be expected to occur from any side, then the furnace closure shall comprise the same vertical protective membrane system. This type of furnace closure shall be sealed into the test frame by the same method as would be used for the vertical protective membrane in use. The applicability of the result shall be restricted in this case (see 15.8).

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At the request of the sponsor, insulation material of lower insulation performance than that normally required, representing a high heat loss external or internal wall or open cavity situation (remote from the fire exposure side) may be used. The choice of such materials shall be made by the sponsor. The laboratory shall ensure that they are inserted into the test frame and all joints sealed, both within the closure and around its edges, such that leakage of gases from the cavity cannot occur. The applicability of the result shall be restricted in this case (see 15.8).

If the vertical protective membrane is to be used in a situation where it forms a ventilated cavity in which the building member it protects is situated, then the test cavity shall be ventilated in a manner representative of practice. The applicability of the result shall be restricted in this case (see 15.8).

## 5 Test conditions

### 5.1 General

A loadbearing vertical structural building member represented by an unloaded test column is protected against fire by a vertical protective membrane and subjected to the fire test defined herein. The temperature within the cavity and the surface temperature of the test column are measured throughout the test.

It is recommended that the test is continued until the mean temperature recorded by all thermocouples within the cavity, reaches the appropriate limiting temperature for the test columns used or until any individual temperature recorded within the cavity, rises to 750 °C for steel, concrete or concrete filled hollow steel columns and 500 °C for timber columns.

The procedures given in EN 1363-1 shall be followed in the performance of this test method unless otherwise stated in this European Prestandard.

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### 5.2 Support and restraint

#### 5.2.1 Standard conditions

Where the vertical protective membrane test specimen in practice is not larger than the furnace opening, the edges of the specimen shall be installed and restrained as in practice.

Where the vertical protective membrane test specimen in practice is larger than the furnace opening then it shall be installed as in practice, but with one vertical edge unrestrained and having freedom of movement, the remaining edges being restrained as in practice.

Any unrestrained edges shall be sealed with fire resistant material which shall accommodate movement of those edges and yet not restrict that movement, or allow furnace gases to leak into the cavity. The distance between the exposed face of the vertical protective membrane and the forward edge of the test frame shall be sufficient to accommodate any bowing of the membrane, without allowing furnace gases to leak into the cavity. The sponsor shall define expected bowing, where possible.

#### 5.2.2 Other support and restraint conditions

Support and restraint conditions differing from the standard conditions specified in 5.2.1 shall be described in the test report and the validity of the results restricted to that tested.

## 6 Test specimens

### 6.1 General

The structural building member to be used in the test shall be as given in 6.3 and be chosen from those standard members described in 6.4.1 and be representative of that to be used in practice. Alternatively an actual practical structural vertical building member may be used according to 6.4.2.

Vertical protective membranes would typically be board or panel type partitions or membranes, comprising timber, plaster, mineral wool or similar materials. They shall be installed in front of the test column by the procedures given in the installation manual or other written instructions provided by the sponsor. The means of connection and use of insulation between the membrane and the test frame shall be defined by the sponsor.

Where the vertical protective membrane is expected to include joints or a gap (or gaps) for design purposes or in practice these shall be included within the vertical protective membrane test specimen and be included in a manner representative of practice, in both vertical and horizontal directions.

All fixtures and fittings expected to be installed shall be included in the vertical protective membrane test specimen and the spacing of these shall be representative of practice. Such fixtures and fittings shall not be installed within the test specimen at a distance of less than 500 mm from any of its edges.

Any combustible materials required to be present in the cavity, representing the practical situation, shall be identified and their fire load density calculated.

### 6.2 Number of tests

Normally for a vertical protective membrane designed for one sided protection of a vertical structural building member only one test shall be carried out.

Where a vertical protective membrane is manufactured with elements or components of variable size or may be installed by different procedures, then a unique test shall be carried out on elements or components at maximum and minimum size and with every expected installation procedure for which the sponsor requires approval.

Where a vertical protective membrane is designed to protect two or more sides of a structural building member and the vertical protective membrane is the same on all sides then one test only shall be required. In this test the furnace closure shall be the vertical protective membrane itself as given in 4.5.

Where a vertical protective membrane is designed to protect two or more sides of a structural building member and the vertical protective membrane is not the same on all sides then unique tests shall be required for each type of membrane, with each in turn presented to the furnace. Each test result shall be treated separately for field of direct application purposes.

### 6.3 Size of test specimen

The size of the test construction and furnace aperture shall be at least 3 000 mm × 3 000 mm. The whole area of the test construction shall be exposed to the furnace conditions.

If the vertical protective membrane in practice is less than 3 000 mm × 3 000 mm then the test specimen shall be brought up to this size by the use of a supporting construction.

When the actual size is larger than can be accommodated in the furnace then a reduced size test specimen, of size not less than 3 000 mm × 3 000 mm, including representative joints in both horizontal and vertical directions, shall be used.

## 6.4 Structural building members

### 6.4.1 Standard vertical structural building members

Each test construction shall include at least two, possibly three, standard test columns, representing loadbearing vertical structural building members.

The test column or columns, chosen by the sponsor, may be steel, concrete, concrete filled hollow steel or timber according to the sponsor's wishes and the desired applicability of the test result (see Table 2). They may be tested separately or different types of columns tested together.

When timber test columns are used together with other types of column, the final termination temperature shall be that appropriate to the timber test column. Timber test columns will normally be tested separately for this reason.

Test columns shall have a height of  $(3\ 000 \pm 50)$  mm and be securely fixed vertically in the test frame at the top and bottom, with allowance for expansion.

Test columns shall be positioned:

- i) two columns used : placed symmetrically at  $1/3$  and  $2/3$  exposed width;
- ii) three columns used : placed symmetrically at  $1/4$ ,  $1/2$  and  $3/4$  exposed width;

with a clear space of  $(20 \pm 10)$  mm between the test column and the furnace closure.

The separating gap between the test columns and the vertical protective membrane shall be defined by the sponsor, be normally that to be used in practice but, however, be no less than 5 mm size.

The following structural building members upon which the test columns are based are considered to be standard for this test method.

#### a) Steel test columns

The standard steel test column shall comprise a hot rolled H profile steel column of section type HEB 140 with section depth of typically  $(140 \pm 5)$  mm. The grade of steel used shall be any structural grade (S designation) to EN 10025 or EN 10113 (excluding S185). Engineering grades (E designation) shall not be used.

Provision shall be made to minimise heat transfer from the ends of the steel column. The ends shall be protected with insulation board or similar material.

#### b) Concrete test columns

The standard concrete test column shall possess a cross section of  $150\text{ mm} \times 200\text{ mm}$ . It shall be made from normal concrete of density  $(2\ 300 \pm 150)$  kg/m<sup>3</sup>. The concrete shall be of type C20/25 or C25/30 prepared from silicious aggregates, of maximum dimension of 20 mm and portland cement according to EN 206-1. It shall contain 12 mm diameter reinforcing bars which shall be ribbed and of grade B 500 or comparable grade to ENV 10080. They shall be covered by 20 mm to 25 mm of concrete. Permitted tolerances on size of reinforcing bars are given in ENV 10080.

Other concrete grades within the strength range C20/25 to C50/60 and other non-silicious aggregates may be used, however, the applicability of the result shall be restricted according to ENV 13381-3.

The concrete column shall be prepared in a smooth surfaced framework made from steel or timber. To facilitate its release from the framework soluble oils or emulsions shall be used. The actual material used for this purpose shall be described in detail in the test report.

The consistency of the wet concrete shall be of type S3 or F3 determined in accordance with EN 206-1, to allow for good compaction and production of a smooth surface.