DRAFT FOR DEVELOPMENT

DD ENV
13381-7:2002

Test methods for determining the contribution to the fire resistance of structural members —

Part 7: Applied protection to timber members

ICS 13.220.50

British Standards

National foreword

This Draft for Development is the official English language version of ENV 13381-7:2002.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature because of insufficient experience in this area. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Comments arising from the use if this Draft for Development are requested so that UK experience can be reported to the European organization responsible for its conversion into a European Standard. A review of this publication will be initiated 2 years after its publication by the European organization so that a decision can be taken on its status at the end of its three-year life. The commencement of the review period will be notified by an announcement in *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into a European Standard, to extend the life of the prestandard or to withdraw it. Comments should be sent in writing to the Secretary of BSI Subcommittee FSH/22/12, Test procedures for protection systems, at 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

This Draft for Development, having been prepared under the direction of the Health and Environment Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 2 August 2002

Summary of pages

This document comprises a front cover, an inside front cover, the ENV title page, pages 2 to 34, an inside back cover and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 40158 8

EUROPEAN PRESTANDARD

PRÉNORME EUROPÉENNE

EUROPÄISCHE VORNORM

ENV 13381-7

July 2002

ICS 13.220.50

English version

Test methods for determining the contribution to the fire resistance of structural members - Part 7: Applied protection to timber 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.

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.

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

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

Ref. No. ENV 13381-7:2002 E

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Foreword

This document ENV 13381-7:2002 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 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.

Annexes A and C are normative. Annexes B and D are informative.

Caution

The attention of all persons concerned with managing and carrying out this fire resistance test, is drawn to 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 to be followed for determining the contribution of fire protection systems to the fire resistance of structural timber members.

Such fire protection systems include claddings, sprayed fire protection and coatings.

The method is applicable to all fire protection systems used for the protection of timber members. These can be fixed directly, totally or in part, to the timber member and can include an air gap between the fire protection system and the timber member, as an integral part of its design.

Evaluation of timber constructions protected by horizontal or vertical protective membranes are the subject of ENV 13381-1 or ENV 13381-2 respectively.

The test method is applicable to the determination of the contribution of fire protection systems to the fire resistance of loadbearing timber structural members and non-loadbearing parts of the works, including floors, roofs, walls, beams and columns. It is also applicable to timber structural members incorporating insulating materials between the timber members, e.g. between timber joists in floor constructions.

The test method and its assessment procedure is designed to permit direct application of the results to cover a range of thicknesses of the applied fire protection material.

This European Prestandard contains the fire test which specifies the test to be carried out to determine the ability of the fire protection system to delay the temperature rise throughout the timber member, to determine the ability of the fire protection system to remain coherent and fixed to the timber member and to provide data of the temperature profile throughout the timber test member, when exposed to the standard temperature/time curve according to the procedures defined herein.

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 detailed 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 timber members in accordance with the procedures given in ENV 1995-1-2.

A description of the relationship of this test method and the assessment of the results obtained therefrom to ENV 1995-1-2 and guidelines for the use of this test method in accordance with that standard are given in annex B.

This European Prestandard also contains the assessment which prescribes how the analysis of the test data should be made and gives guidance to the procedures by which interpolation should be undertaken.

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 timber constructions over the range of thicknesses of the applied fire protection system tested.

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 1365-1	Fire resistance tests for loadbearing elements - Part 1: Walls.
EN 1365-2	Fire resistance tests for loadbearing elements - Part 2: Floors and roofs.
EN 1365-3	Fire resistance tests for loadbearing elements - Part 3: Beams.
EN 1365-4	Fire resistance tests for loadbearing elements - Part 4: Columns.
ENV 1995-1-2	Eurocode 5: Design of timber structures Part 1-2: General rules - Structural fire design.
EN 338	Structural timber - Strength classes.
EN 312	Particleboards - Specifications.
ISO 8421-2	Fire protection -Vocabulary - Part 2: Structural fire protection.
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
timber structural member
element of building construction which may be loadbearing or non-loadbearing and which is mainly constructed from solid timber and/or other wood based products

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

3.1.3
passive fire protection materials
materials which do not change their physical form upon heating, provide fire protection by virtue of their physical or thermal properties. They may include materials containing water which, on heating, is removed 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 a timber structural member. The fire protection system may include multiple layers of materials and multiple combinations of materials

3.1.6
fire protection
protection afforded to the timber member by the fire protection system such that the rise of temperature of the timber and fixings is limited or delayed throughout the period of exposure to fire

3.1.7
test specimen
complete assembly of the timber test member plus the fire protection system under test. Within this test method, several timber beams representative of timber in various constructional environments in a structural building member, may be combined into a single test specimen

3.1.8
stickability
ability of a fire protection material to remain sufficiently coherent and in position for a well defined range of deformations, and furnace and test specimen surface temperatures, such that its ability to provide fire protection is not significantly impaired

3.1.9
charring depth
distance from the original surface of the timber member to the char line. The char line is the border-line between char layer and the residual cross section

3.2 Symbols and units

Symbol	Unit	Designation.
t	min	Time.
t_{pr}	min	The failure time of the fire protection system, i.e. the time when the temperature on the surface of the timber test member (interface between timber and fire protection or air gap beneath the fire protection) reaches 300 °C.
$t_{300,prot}$	min	Time at which the temperature indicated by a thermocouple placed at the interface between the timber test member and the fire protection system, or at a specified point within a protected timber test member, reaches 300 °C.
$t_{300,unprot}$	min	Time at which the temperature indicated by a thermocouple on the surface of an unprotected timber test member, or at a specified point within an unprotected timber test member, reaches 300 °C.
t_{test}	min	Time of termination of test.
d_p	mm	Thickness of the fire protection system. In the case of two or more layers of fire protection material d_p is the sum of the thicknesses.
d_{char}	mm	Charring depth.
β	mm/min	Notional charring rate from ENV 1995-1-2 excluding the effect of roundings at arrises.
β_o	mm/min	Notional charring rate from ENV 1995-1-2 including the effect of roundings at arrises.
β'	mm/min	Actual unprotected charring rate determined by testing.

β	mm/min	Actual protected charring rate determined by testing.

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 6.2 and its installation to be as specified in clause 7.

4.3 Loading equipment

Loading equipment shall conform to that specified in EN 1363-1. The loading system shall permit loading of the magnitude defined in 5.3 to be applied.

5 Test conditions

5.1 General

The tests shall be carried out as described in EN 1363-1 unless otherwise stated.

For a fire protection system to be applied to timber floors, walls, beams and columns, both floor and beam tests shall be performed according to EN 1365-2 and EN 1365-3 respectively.

For a fire protection system to be applied only to timber floors and walls, then floor tests shall be performed according to EN 1365-2.

For a fire protection system to be applied only to timber beams and columns, then beam tests shall be performed according to EN 1365-3.

This test method is written in terms of this universal application to all constructions.

Wall or column tests only may be performed (according to EN 1365-1 or EN 1365-4 respectively) but the results shall be restricted to that tested.

The EN 1365 test methods shall be slightly modified for the purposes of this test in order that the following information may be obtained and monitored:

- the behaviour of the fire protection system and its stickability;
- the temperature of the timber behind the fire protection system and the temperature throughout the depth of the timber.

5.1.1 The modified prEN 1365 large scale test

The EN 1365 test method(s) and test specimen(s) appropriate to the use of the fire protection material, specified by the sponsor, shall be followed.

The temperature performance, stickability and general behaviour of the fire protection system, under load shall be examined by incorporation into the test specimen an assembly or assemblies comprising particleboard laminate together with additional instrumentation.

5.1.2 The small scale test

Small scale tests shall be performed upon scaled down test assemblies from that given in 5.1.1.

Small scale tests shall be carried out on the same furnace as that used for the large scale tests in 5.1.1 and in horizontal orientation, unless the result is to be restricted (see 5.1).

Such tests shall be used to give correlation between protected and unprotected timber structures and to provide additional information.

5.2 Support and restraint conditions

Test specimens shall be supported according to the relevant large scale test.

5.3 Loading conditions

Loading shall be applied to full size test specimens according to the relevant large scale test.

The magnitude of the load shall be calculated, taking account of the differing strength and deformation properties induced by included particle board laminates, to be that required to give the necessary deflection according to the appropriate EN 1365 test.

The small scale test shall be performed unloaded.

6 Test specimens

6.1 Number

6.1.1 General

The appropriate test or tests to be carried out shall be as given in 5.1. For each EN 1365 test method to be used, if the fire protection material is available in more than one thickness then following shall be carried out:

a) Test result to be applicable to floors and beams according to EN 1365-2 and EN 1365-3 (and therefore to walls and columns according to 5.1).

- one large floor test at minimum thickness
- one large floor test at maximum thickness
- one large beam test at minimum thickness
- one large beam test at maximum thickness
- one small floor test at minimum thickness
- one small floor test at maximum thickness
- one unprotected small scale test.

b) Test result to be applicable only to floors according to EN 1365-2 (and therefore to walls according to 5.1).

- one large floor test at minimum thickness
- one large floor test at maximum thickness
- one small floor test at minimum thickness
- one small floor test at maximum thickness
- one unprotected small scale test.

c) Test result to be applicable only to beams according to EN 1365-3 (and therefore to columns according to 5.1).

- one large beam test at minimum thickness
- one large beam test at maximum thickness
- one small floor test at minimum thickness
- one small floor test at maximum thickness
- one unprotected small scale test.

For very restricted application to walls or columns (see 5.1) the same numbers of tests shall be carried out with walls or columns replacing floors or beams.

For each EN 1365 test method to be used, if the fire protection material is available in one thickness or if the sponsor specifies limitation to one commercially appropriate thickness only, then the two tests at maximum and minimum thickness shall be replaced by a single test at that thickness. The results of the assessment shall be restricted to that tested.

Test constructions carrying particleboard test specimens shall be built according to 6.3 and installed according to clause 7.

6.1.2 Fire protection system variations

Additional particleboard test specimens shall be tested to provide further test data for the fire protection system when it is required to consider:

- different construction and fixing variables: One particleboard specimen per variable shall be tested in both large and small scale tests at maximum fire protection thickness;

- multilayer fire protection systems: One particleboard specimen per variable shall be tested in both large and small scale tests;

- other intermediate fire protection thicknesses between maximum and minimum thickness. One small scale test per thickness variable to be considered;

- alternative and intermediate thicknesses of multiple layer combinations. One small scale test per combination and combination thickness to be considered;

- the test to the smouldering curve (see annex A). One small scale test for maximum and minimum thickness tested on the large scale.

Test constructions carrying particleboard test specimens shall be built according to 6.3

The additional particleboard specimens given in 6.1.2 may be incorporated into the tests defined in 6.1.1 or tested separately, providing the requirements of clause 7 are satisfied.

6.2 Size

6.2.1 Large scale test specimen

For each EN 1365 test method to be carried out, as given in 5.1, the size of the large scale test construction to carry the particleboard test specimen shall be that specified in that method, i.e.:

- Floors: the exposed dimensions of the floor shall be at least 4 000 mm length and 2 000 mm width according to EN 1365-2.

- Beams: the exposed length of the beam shall be at least 4 000 mm according to EN 1365-3.

- Walls: the exposed dimensions of the wall shall be as specified in EN 1365-1.

- Columns: the exposed height of the column shall be as specified in EN 1365-4.

6.2.2 Small scale test specimen

The size of the small floor test construction to carry the particleboard test specimen shall be such that its exposed length is 2 000 mm and its exposed width 1 000 mm.

6.3 Construction

6.3.1 Construction of timber test specimens

The test constructions to carry the particleboard laminate test specimens shall be made according to the EN 1365 test(s) under consideration.

6.3.1.1 Particle board laminate test specimens

Loaded large floor - A particle board laminate, comprising 10 layers of 10 mm thick particleboard, of width equal to the spacing between the floor joists and length equal to the exposed length of the floor, is rigidly fixed between and to the joists such that the deflection applied to the floor is transferred to the particleboard. This fixing is made from above by use of appropriate brackets or fixings. The lower face of the particleboard laminate shall be flush with the lower face of the joists.

Thermocouples shall be inserted between the layers as defined in 9.3.

Depending upon the width of the floor, the spacing of the joists etc, more than one particleboard test specimen may be incorporated into a test floor to permit more than one variable to be examined per furnace test, providing the limitations of 6.1.2 and clause 7 are followed. Multiple specimens shall be symmetrically distributed.

Loaded beams - The beam is covered with particleboard laminate, comprising 5 layers of 10 mm thick particleboard, applied round the beam on all exposed sides. The particleboard laminate is rigidly fixed to the beam such that the deflection applied to the beam is transferred to the particleboard.

Thermocouples shall be inserted between the layers as defined in 9.3.

An alternative construction for loaded beam testing is given in annex D.

6.3.1.2 Small scale tests

Unloaded floor test specimens: shall comprise particleboard laminates made up from 10 layers of 10 mm thick particleboard, adhesive laminated, size 2000 mm 1000 mm. Thermocouples shall be inserted between the layers as defined in 9.3.

6.3.2 Application of the fire protection materials to the timber test specimen

Fire protection systems comprising boards (or panels), for the fire protection of flat, two dimensional, timber structures shall be arranged such that boards of the largest practical size are used and that at least one longitudinal joint and one transverse joint, where applicable, are tested within the furnace.

Fire protection systems comprising boards (or panels), for the protection of beams and columns shall be arranged such that boards of the largest practical size are used and that at least one longitudinal joint, one transverse joint and one horizontal joint, where applicable, are tested within the furnace.

For multiple layer fire protection systems each layer shall be individually fixed and lateral joints staggered according to ENV 1995-1-2.

The fire protection systems shall be applied to floor, beam and small scale test specimens as in practice.

6.3.3 Insulating materials

Where the timber structure to be protected by the fire protection material or system is to be provided with additional insulating materials, within, around or adjacent to the timber members therein, then these shall be incorporated into the test assembly as used in practice.

6.4 Composition of components of test specimen

6.4.1 Timber

The timber used for manufacture of characteristic floors or beams shall be of strength classes C14 to C40 as defined in EN 338. Other grades may be used but the limits of applicability of the results of the assessment may be restricted according to 15.1.6.

6.4.2 Particle board laminate

Particle board laminate shall meet the requirements of EN 312 and be of density 700 kg/m^3 ± 10 %. Its properties shall meet those specified in EN 312-4.

When tests are performed with and without the applied fire protection, the density of the different particleboard laminates shall not differ by more than 10 % from the mean measured density of all laminates in all tests.

6.4.3 Fire protection system

The composition of the fire protection system shall be specified by the sponsor and include, at least, its expected nominal density, thickness and moisture content. For confidentiality reasons the sponsor may not wish detailed formulation or composition details to be reported in the test report. Such data shall, however, be provided and maintained in confidence in laboratory files.

6.5 Properties of test materials

The actual material properties of test specimen component materials shall be determined, according to EN 1363-1 and using appropriate product test standards, on test materials or test samples conditioned as defined in clause 8.

The actual thickness, density and moisture content of the fire protection materials shall be measured and recorded for each test specimen at the time of test, either directly upon the fire protection material or upon special test samples taken. These shall be conditioned as defined in clause 8. The procedures appropriate to different types of material are given in annex C.

The thickness of board or panel type fire protection systems should not deviate by more than 15 % of the mean value over the whole of its surface. In this case, the mean value shall be used in the assessment of the results and the limits of applicability of the assessment. If it deviates by more than 15 %, the maximum thickness recorded shall be used in the assessment.

The thickness of sprayed or coated passive or reactive type fire protection systems should not deviate by more than 20 % of the mean value over the whole of its surface. In this case, the mean value shall be used in the assessment of the results and the limits of applicability of the assessment. If it deviates by more than 20 %, the maximum thickness recorded shall be used in the assessment.

The density of the fire protection material applied to the test specimens at maximum and minimum thickness shall be recorded. The mean value of the density of the fire protection material at maximum and minimum thickness shall be used in the assessment of the results of the test, unless the difference between these is greater than 15 %, in which case the maximum density recorded shall be used.

6.6 Verification of the test specimen

An examination and verification of the test specimen for conformity to specification shall be carried out as defined in EN 1363-1.

The properties of the materials used in the preparation of the test specimen shall be measured using special samples, where necessary, as defined in 6.5 using the methods defined in annex C.

The sponsor shall verify that the fire protection material has been applied correctly and in the case of sprayed or coating materials ensure, by methods appropriate to the material, that it is of the design composition and specification.

7 Installation of the test construction

7.1 Large scale tests

Loaded floors, carrying particleboard test specimen(s), protected with the fire protection system, shall be installed onto the furnace according to EN 1365-2.

Loaded beams, covered with particleboard laminate, protected with the fire protection system, shall be installed onto the furnace according to EN 1365-3.

7.2 Small scale tests

Small scale test specimens shall be installed across the furnace aperture, in horizontal mode, in an appropriate test frame. The furnace/test assembly interface shall be sealed with non-combustible packing.
Should the ends of the test specimen be within the furnace these shall be blanked off to provide a level of fire protection equal to or greater than that given to the timber by the fire protection material.

7.3 Installation patterns

Large scale tests and/or small scale tests may be tested together on a furnace providing:

- the thickness of applied fire protection is the same (either as single or multiple layer);
- separate specimen supports are provided and a furnace closure is applied to each to permit tests to safely run for different durations without affecting the other test specimens.

Otherwise tests shall be run separately.

8 Conditioning of the test construction

The test construction and test samples taken for the determination of material properties (specified in 6.5) shall be conditioned according to EN 1363-1. Material properties shall be determined according to methods specified in annex C.

Timber shall be conditioned at 23 °C/50 % RH to give the moisture content specified in EN 1363-1. Care shall be taken to ensure that this does not change substantially between conditioning and test.

9 Application of instrumentation

9.1 General

The instrumentation for the measurement of temperature, furnace pressure and deformation shall comply with the requirements of EN 1363-1.

9.2 Instrumentation for measurement of furnace temperature

Plate thermometers of the type specified in EN 1363-1 shall be provided to measure the temperature of the furnace. They shall be uniformly distributed and positioned as specified in the appropriate large scale test(s).

9.3 Instrumentation for measurement of test specimen temperature

Thermocouples for measuring temperatures upon the exposed surface of the particleboard laminates and within the particleboard laminates, for both large and small scale tests, shall be of the double glass fibre insulated bare wire type specified in EN 1363-1 and be positioned and fixed as specified therein. Such thermocouples shall be new when used for this test.

Thermocouples shall be provided to measure test specimen temperature at temperature measurement stations at which there shall be five thermocouples for measuring particleboard temperature: one for measuring particleboard surface temperature beneath the fire protection material and one at each of the lower four interfaces between the layers of particleboard (see Figure 1).

a) Large floor test specimens

Thermocouple measuring stations shall be provided to measure test specimen temperature at the centre of each quadrant of each particleboard laminate test specimen included within the test construction, giving a total of 20 thermocouples, per particleboard test specimen.

b) Large beam test specimens

Thermocouple measuring stations shall be provided to measure test specimen temperature at $^1/_3$ and $^2/_3$ of the length of the beam on each exposed face, giving a total of 30 thermocouples per beam.

c) Small test specimens

Thermocouple measuring stations shall be provided to measure test specimen temperature at the centre of each quadrant of each particleboard laminate test specimen included within the test construction, giving a total of 20 thermocouples per particleboard test specimen.

d) Joints in the fire protection

Where joints are to be included within the fire protection system, thermocouples at 50 % of the locations shall be positioned at a minimum of 50 mm from any joint or fixing in the fire protection system and those at the other stations positioned coincident with the joint in the protection system. Such thermocouples shall be included for every type of joint expected to occur in practice.

9.4 Instrumentation for measurement of pressure

Equipment for measuring pressure within the furnace shall be provided, located and used as specified in EN 1363-1.

9.5 Instrumentation for measurement of deformation

A means of measuring the vertical deformation of the test specimen at mid-span, relative to the supports, shall be provided, located and used as specified in EN 1363-1 for large scale test specimens.

9.6 Instrumentation for measurement of applied load

Instrumentation for the measurement of applied load to loaded large scale test specimens shall be provided and used as specified in EN 1363-1.

10 Test procedure

10.1 General

Carry out checks for thermocouple consistency and establish data points for temperature as specified in EN 1363-1 before commencement of the test and procedures defined in 10.2 to 10.7.

10.2 Furnace temperature and pressure

Measure and record the furnace temperature using the thermocouples defined in 9.2 and the furnace pressure in accordance with the procedures and frequency specified in EN 1363-1.

Control the furnace temperature according to the data received from the plate thermometers to the criteria of EN 1363-1.

Control the furnace pressure to the criteria of EN 1363-1.

10.3 Application and control of load

Using the procedures of EN 1363-1 apply a constant load to a loaded large scale test specimen, of magnitude in accordance with 5.3, throughout the test period. The load shall be removed or reduced once the criteria of the appropriate floor or beam (or other test) is/are reached as defined therein.

10.4 Temperature of test specimen

Measure and record the temperature of the test specimen using the thermocouples specified in 9.3, at intervals not exceeding one minute.

10.5 Deformation

Using the procedures of EN 1363-1, for the loaded large scale test specimens, apply the load, monitor and record the deformation and/or rate of change of deformation continuously.

10.6 Observations

Wherever practical, monitor the general behaviour of the test specimen, especially the fire protection, throughout the test as described in EN 1363-1.

10.7 Termination of test

Terminate the test when the temperature indicated by all thermocouples in the particleboard laminate reaches 300 °C or when one or more of the reasons for termination specified in EN 1363-1 occurs.

11 Test results

11.1 Acceptability of test results

It is possible that within any test apparently erroneous results may occur through failure of thermocouples, abnormal behaviour of the test specimen etc. The criteria for acceptability of temperature data given in EN 1363-1 shall be observed.

11.2 Presentation of test results

The following shall be reported within the test report:

a) the results of measured dimensions and actual material properties, especially the properties of the timber and the particleboard laminate and the thickness, density and moisture contents of the fire protection and its components required according to 6.5;

b) the individual results of all furnace temperature measurements and the mean of all individual furnace temperature measurements, taken as specified in EN 1363-1, graphically presented and compared with the specified requirements and tolerances given in EN 1363-1;

c) the individual results of all furnace pressure measurements and the mean of all individual furnace pressure measurements, taken as specified in EN 1363-1, graphically presented and compared with the specified requirements and tolerances given in EN 1363-1;

d) for each particleboard test specimen, the individual results and the mean of all individual results of all temperature measurement thermocouples at the equivalent locations given in 9.3, all graphically presented. Evidence of compliance with the validity criteria of 11.1. Equivalent locations are:

   i) at the surface of the particleboard laminate beneath the fire protection material, 50 mm away from any joint in the fire protection;

   ii) at the surface of the particleboard laminate beneath the fire protection material, at a joint in the fire protection;

   iii) at the interface between each layer in the particleboard laminate, 50 mm away from any joint in the fire protection;

   iv) at the interface between each layer in the particleboard laminate, at a joint in the fire protection;

e) the individual results and the mean of all individual results of all the deformation measurements, specified in 10.5, all graphically presented. If the load is removed or reduced according to 10.3, the time at which this occurred.

   These results b) to e) may be presented as a selection of the measured data sufficient to give a history of the performance of the test specimen according to EN 1363-1.

   These results may also be prepared and printed in tabular form and/or presented upon computer diskette. In the latter case this shall be prepared in an appropriate, secure "read only" format to prevent alteration. The only legally genuine data shall be those data maintained in the laboratory files;

f) the results of observations made and the times at which they occured shall be reported.

12 Test report

The test report shall include the following statement:

"This report provides the constructional details, the test conditions, the results obtained and the interpolated data obtained when a specific form of construction was tested following the procedures of ENV 13381-7. Any deviation with respect to thickness and density of fire protection system, timber type and construction could invalidate the assessment of the test result".

In addition to the items required by EN 1363-1, the following shall also be included in the test report:

a) details of the fabrication of the test specimens. The fixing details of the fire protection system. Details of the conditioning of the test construction(s). Details of the installation of the test construction(s) onto the furnace;

b) the composition and measured properties, especially density, thickness and moisture content, of components of the test specimens which are required to be determined and their method of determination;

c) a description of significant behaviour of the test specimen observed during the test period, including observation of the time(s) and magnitude of any detachment of the fire protection material;

d) the magnitude of the load applied to the test large scale specimens as a function of time and if removed, the time at which this occurred;

e) the reason, on the basis of the criteria of 10.7 of this test method, for the termination of the test and the time elapsed when the test was terminated;

f) results of any tests carried out to the smouldering fire (slow heating curve) given in annex A.

13 Assessment

13.1 General

The assessment method details the means whereby the results of temperature measurement and observations made throughout the test are used to provide the following:

a) the relationship between particleboard laminate surface and internal temperature, time and thickness of fire protection;

b) the effectiveness of the fire protection system to delay temperature rise and the beginning of charring of the timber and the magnitude of the rate of charring material;

c) information on stickability and the behaviour of joints in the fire protection and, if required, information on the behaviour of added fixtures and fittings;

d) optional additional data on the performance of the fire protection system at alternative thicknesses than those thicknesses tested.

From the temperature data collected and reported in 11.2 and clause 12 the following shall be identified:

- the graphs of the mean of all individual temperatures for each thermocouple group or location as defined in 11.2 (d);

- the graphs of the individual temperatures giving rise to the highest individual temperature for each thermocouple group or location as defined in 11.2 d).

The mean of the mean temperature and the maximum individual temperature for each thermocouple group or location as defined in 11.2 d) ie. [(mean + maximum) / 2] shall be calculated and similarly presented as described in 11.2. These results shall be used as the characteristic temperature in the assessment under 13.2.

13.2 Assessment of failure time and charring rates

This test method examines charring rates and the advancement of the char line through both the protected and the unprotected timber structural member. For application of results see annex B.

The temperature at which charring of timber begins is generally accepted to be 300 °C. Therefore t_{pr} is the time at which the temperature of the protected timber surface reaches 300 °C.

The values of charring rates β' and β are determined for unprotected and protected test specimens as the slopes of relationships between charring depth d_{char} and time. See Figure 2.

The charring depth d_{char} is the distance of a thermocouple recording 300 °C from the surface and the corresponding time values $t_{300,unprot}$ and $t_{300,prot}$.

The ratio of β / β' is assumed to be species independent. Normally one or both relationships between charring depth and time are non-linear. Therefore the charring rates β' (actual unprotected charring rate from testing) and β (actual protected charring rate from testing- shall be taken as secant values as shown in Figure 3. The limit of application is given as t_{test}.

13.3 Preparation and use of basic data

a) From 13.2, determine the following basic data:

- [unloaded] t_{pr}, β, β' and $[\beta / \beta']$ versus time for each thickness of the fire protection system;
- [loaded] t_{pr}, β, β' and $[\beta / \beta']$ versus time for each thickness of the fire protection system.

b) Correct the data from the unloaded tests [unloaded] t_{pr}, β, β' and $[\beta / \beta']$ at each thickness of the fire protection system for the data obtained from the loaded test at all test durations according to the following:

i) the large scale test gives values of t_{pr} less than those for the small scale test.
All values of t_{pr} shall be reduced by multiplying by the correction factor

$$\left[\frac{t_{pr(large)}}{t_{pr(small)}} \right]$$

ii) the large scale test gives values of t_{pr} greater than those for the small scale test. In this case the values of t_{pr} from the small scale test shall be used without correction.

c) Apply limits for direct application for t_{pr}, β, β' and $[\beta / \beta']$.

13.4 Stickability

a) Assess the time, when, or if, the maximum temperature recorded on the exposed surface of the timber (after reaching 200 °C) is more than 50 % above the mean value of all temperatures recorded on the surface

i) for a transient period, and then returns to normal;

ii) continuously for the remainder of the test.

b) Assess the time when, or if, significant detachment of the fire protection system occurs from the recorded

observations.

The occurrence of a combination of a ii) or b) should be assessed as loss of stickability.

14 Report of the assessment

The report of the assessment shall include the following:

a) the name and address of the body providing the assessment and the date it was carried out.
Reference to the name and address of the test laboratory, the unique test reference number and report number(s);

b) the name(s) and address(es) of the sponsor(s). The name of the manufacturer of the product or products and the manufacturer or manufacturers of the test construction;

c) the generic description of the product or products, particularly the fire protection system and any component parts (where known). If unknown this shall be stated;

d) general description of the fabrication of the test specimens. The fixing details of the fire protection system. Details of the conditioning of the test construction(s) and the installation of the test construction(s) onto the furnace;

e) general description of the test specimen with drawings, including the dimensions of the test specimen and photographs and written instructions, provided by the sponsor;

f) the composition and measured properties, especially density, thickness and moisture content, of components of the test specimen which are required to be determined and their method of determination;

g) graphs of mean temperature, maximum temperature and characteristic temperature derived according to 13.1;

h) for small and large scale tests, the times $t_{300,unprot}$ and $t_{300,prot}$ at which the characteristic temperature reaches 300 °C at the surface and throughout the depth of the timber member for each of the thermocouples in each of the locations defined in 9.3, for each thickness of fire protection tested and the corresponding graphs of charring depth versus time according to 13.2;

i) the values of t_{pr}, β , β' and [β /β'] versus time for both unloaded and loaded test specimens for each thickness of the fire protection system according to 13.3;

j) the corrected data from the unloaded tests and the limits applied for unloaded t_{pr}, β , β' and [β /β'] according to 13.3;

k) the stickability performance of the fire protection material obtained from the large scale test according to 13.4.

15 Limits of applicability of the results of the assessment

15.1 Small and large scale testing in accordance with this test method

The limits of applicability of the results of the assessment arising from small and large scale testing in accordance with this test method shall be as specified in 15.1.1 to 15.1.9.

15.1.1 Thickness of fire protection material

Direct application of the test results to thicknesses less than the minimum and more than the maximum tested shall not be permitted. When one thickness only is tested direct application is not permitted.

15.1.2 Multiple layers

Where a fire protection system has been tested comprising multiple layers of fire protection material, the result shall be applicable only to that system and that number of layers and those thicknesses tested.

15.1.3 Panel or board size

For a board or panel type fire protection system, the results shall be applied to boards or panels no larger than those tested on the large scale and may be applied to boards or panels of smaller size than tested.

15.1.4 Orientation of test

For a fire protection system tested in horizontal configuration, the results may be applied to the use of the system on all horizontal and vertical surfaces. For a fire protection system tested in vertical configuration, the results may be applied only to the use of that system on vertical surfaces.

15.1.5 Fixing systems

The results of the test from a fixing system, with a particular and defined type of fixing method and fixing centres are applicable only to that fixing system tested. The results from the large scale test shall be considered dominant for this purpose.

15.1.6 Grade of timber

The results from the test of a fire protection system on a particular stress grade or strength class of timber may be applied to lower grades when used with corresponding lower applied loads. The results are not applicable to higher grades of timber than tested.

15.1.7 Timber widths or depths

The results from the test of a fire protection system applied to a timber construction, wall or floor containing studs or joists, beam or column, may be applied to similar constructions, with timber widths or depths greater than tested, together with corresponding higher loads. Noggins or herring bone strutting may be required for deeper joists. The results may not be applied to constructions with timber widths or depths less than those tested.

15.1.8 Insulation materials

The results from the test of a fire protection system applied to a timber construction in which additional insulation materials were included may not be applied to constructions where no additional insulation materials are included. The results may be applied to constructions containing similar materials of equivalent insulation or ‘K’ value.

The results from the test of a construction in which additional insulation materials were not included may not be applied to constructions containing additional insulation material.

15.1.9 Fire resistance times

The results of the tests may not be applied to fire resistance times of greater duration than that of the test carried out.

15.1.10 Fixtures and fittings

The results of tests with added fixtures and fittings, with a particular and defined type of fixture or fitting and spacing, are applicable only to those fixtures or fittings tested with a frequency of use not exceeding that tested. The results from the large scale test shall be dominant for this purpose.

15.2 Large scale testing in accordance with this test method

15.2.1 Walls and floors - type of construction

a) **Joist centres:** The results from the test of a fire protection system applied to a timber construction may be applied to constructions at centres closer than tested, together with corresponding higher loads. The results may not be applied to constructions with members at wider centres than tested.

b) **Noggins:** The results from the test of a fire protection system applied to a timber construction not containing noggins may be applied to constructions containing noggins. Results from tests carried out with noggins may not be applied to constructions without.

c) **Span:** The results from the test of a fire protection system applied to a timber construction may be applied to constructions with spans greater or less than tested provided that the resultant level of stress is no greater than tested and the maximum deflection, defined in the relevant full size fire resistance test appropriate to the type of timber structural member under consideration, is not exceeded.

d) **Load/stress:** The results from the test of a fire protection system applied to a loaded timber construction may be applied to constructions with applied load less than tested provided that the resultant level of stress is no greater than tested. It may be applied to constructions with applied load greater than tested when 15.1.7 and / or a) and c) of this clause apply provided that the resultant level of stress is no greater than tested.

e) **Floor (wall) thickness:** The results from the test of a fire protection system applied to a timber floor (wall) construction may be applied to constructions with thickness greater than tested. The results may not be applied to constructions with thickness less than tested.

f) **Floor-boarding:** Where the result has been obtained using square edged boards, the result may be applied to tongue and grooved boards. The reverse shall not be directly applicable.

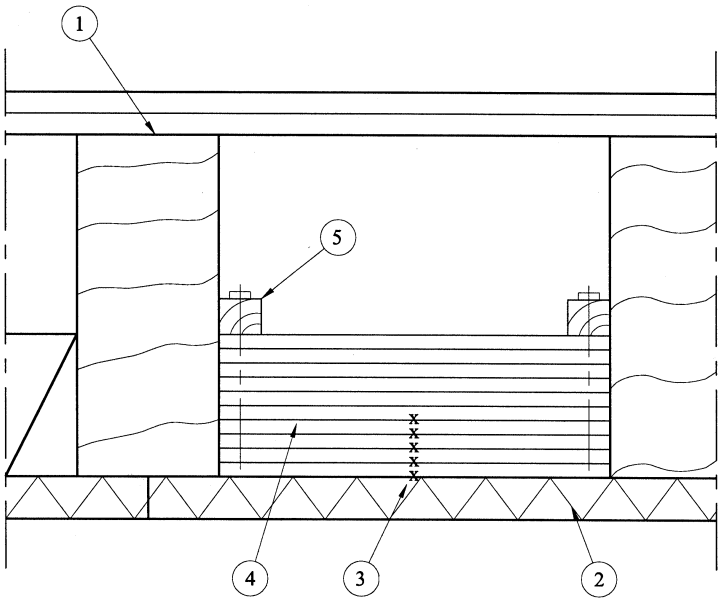
15.2.2 Beams and columns - type of construction

a) **Span or height (columns):** The results from the test of a fire protection system applied to a timber beam or column may be applied to beams or columns with spans or heights greater or less than tested provided that the resultant level of stress is no greater than tested and the maximum deflection or deformation is not exceeded.

b) **Load/stress:** The results from testing a fire protection system applied to a loaded timber beam or column may be applied to beams or columns with applied load less than tested provided that the resultant level of stress is no greater than tested. It may be applied to beams or columns with load greater than tested when 15.1.7 and/or a) of this clause apply provided that the resultant level of stress is no greater than tested.

c) **Three or four sided configuration beams and columns**
The results from testing a fire protection system on a beam or column in four sided configuration, may be applied to a three sided beam or column of similar construction.

Dimensions in millimetres



Key

1 Timber

2 Fire protection

3 Thermocouples within particleboard laminate

4 Particleboard laminate

5 Support for particleboard (floor only)

6 Load

7 Concrete

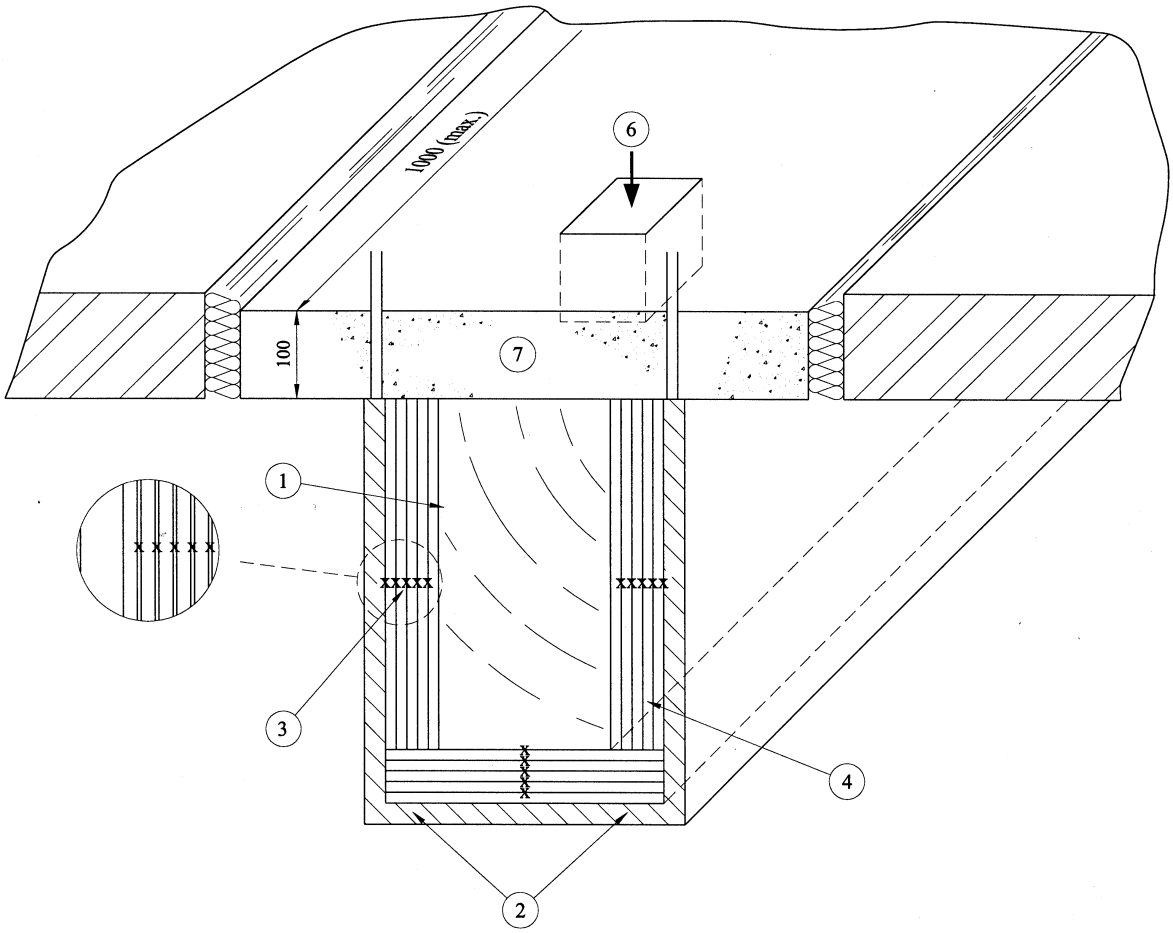
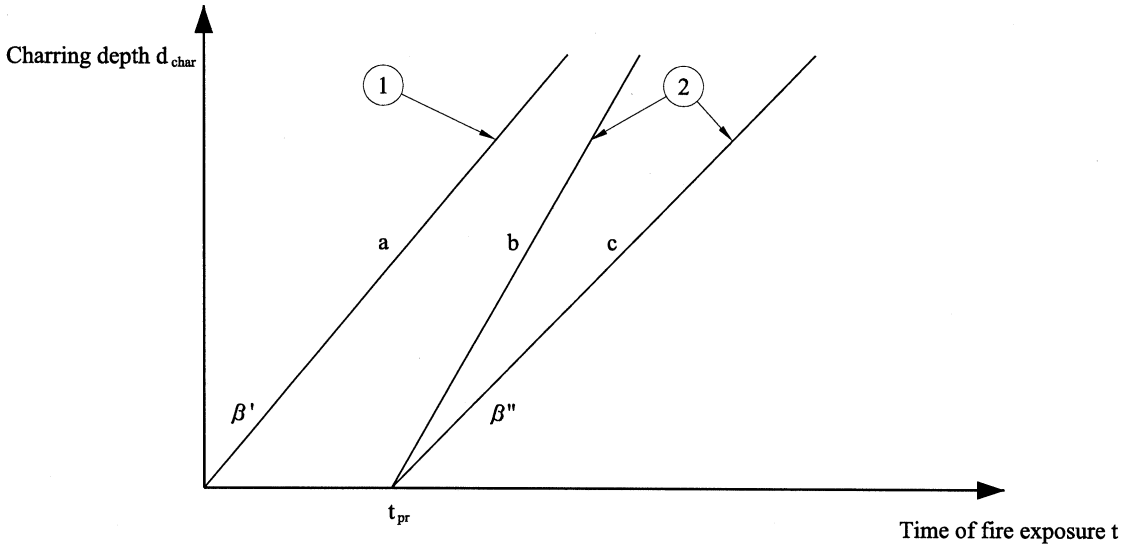
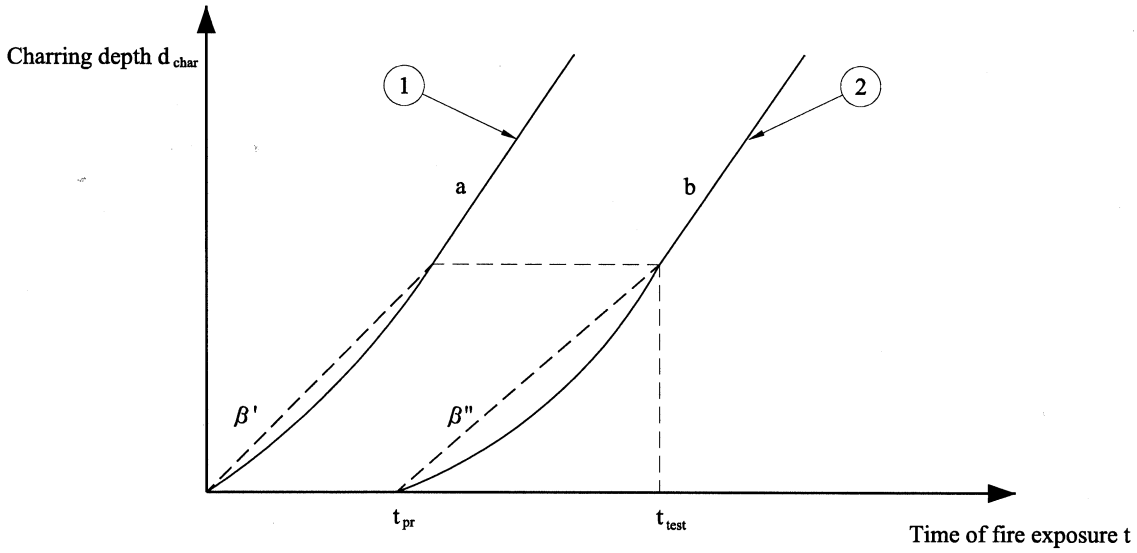


Figure 1 - Assembly of particleboard laminates and thermocouple locations



Key
1 Unprotected member
2 Protected member

Figure 2 - Illustration of charring depth versus time for unprotected (curve a) and two different casesof protected timber members (curves b and c)



Key
1 Unprotected member
2 Protected member

Figure 3 - Definition of the charring rate as the secant values and the corresponding limit of application

Annex A
(normative)

Test method to the smouldering fire or slow heating curve

A.1 Introduction

Fire protection products activated by the heat flux of the fire may be required to be subjected to a test to a smouldering curve (slow heating curve as defined in EN 1363-2), with a rate of temperature increase less than that of the standard temperature/time curve.

NOTE See Council Directive 89/106/EEC, ID No2: Safety in case of fire, 3.2.4 and 4.3.1.3.4 (b).

This exposure, applicable to reactive fire protection materials, is used only in special circumstances, where it might be expected that the performance of the product when exposed to a smouldering fire might be substantially less than when it is exposed to the standard temperature/time curve, and where such a test is specified in the national building regulations of a Member State of destination.

It is not intended to be mandatory for all fire protection materials applied to structural timber members.

A.2 Test equipment

The furnace and test equipment shall be designed to permit the test specimens to be exposed to heating as specified in A.3.

A.3 Test conditions

The test is carried out on small particle board test specimens, (see 6.1.1, 6.2 and 6.3), one for each of maximum and minimum thickness of applied reactive fire protection material.

Each member shall be similarly exposed to the smouldering curve (slow heating curve), as described in EN 1363-2. The heating protocol is shown in Figure A.1.

A.4 Test specimens

The small particleboard test specimens shall be as specified in 6.2, 6.3, 6.4 and 6.5. All test specimens shall be verified according to 6.6.

A.5 Installation of the test specimens

The test specimens shall be unloaded and shall be simply supported as specified in 5.2 and installed as specified in clause 7.

A.6 Conditioning of the test specimens

All test specimens shall be conditioned according to clause 8.

A.7 Application of instrumentation

All instrumentation for measurement of furnace temperature shall be as specified in 9.2.

All instrumentation for measurement of particleboard test specimen temperatures shall be as specified in 9.3.

All instrumentation for measurement of furnace pressure shall be as specified in 9.4.

A.8 Test procedure

Carry out checks for thermocouple consistency and establish data points for temperature as specified in EN 1363-1.

Measure, control and record the furnace temperature and pressure as specified in 10.2.

Measure and record the particleboard test specimen temperatures as specified in 10.4.

Monitor the behaviour of the test specimens throughout the test as specified in 10.6.

Terminate the test after 40 minutes or if it becomes unsafe to continue according to EN 1363-1.

A.9 Test results

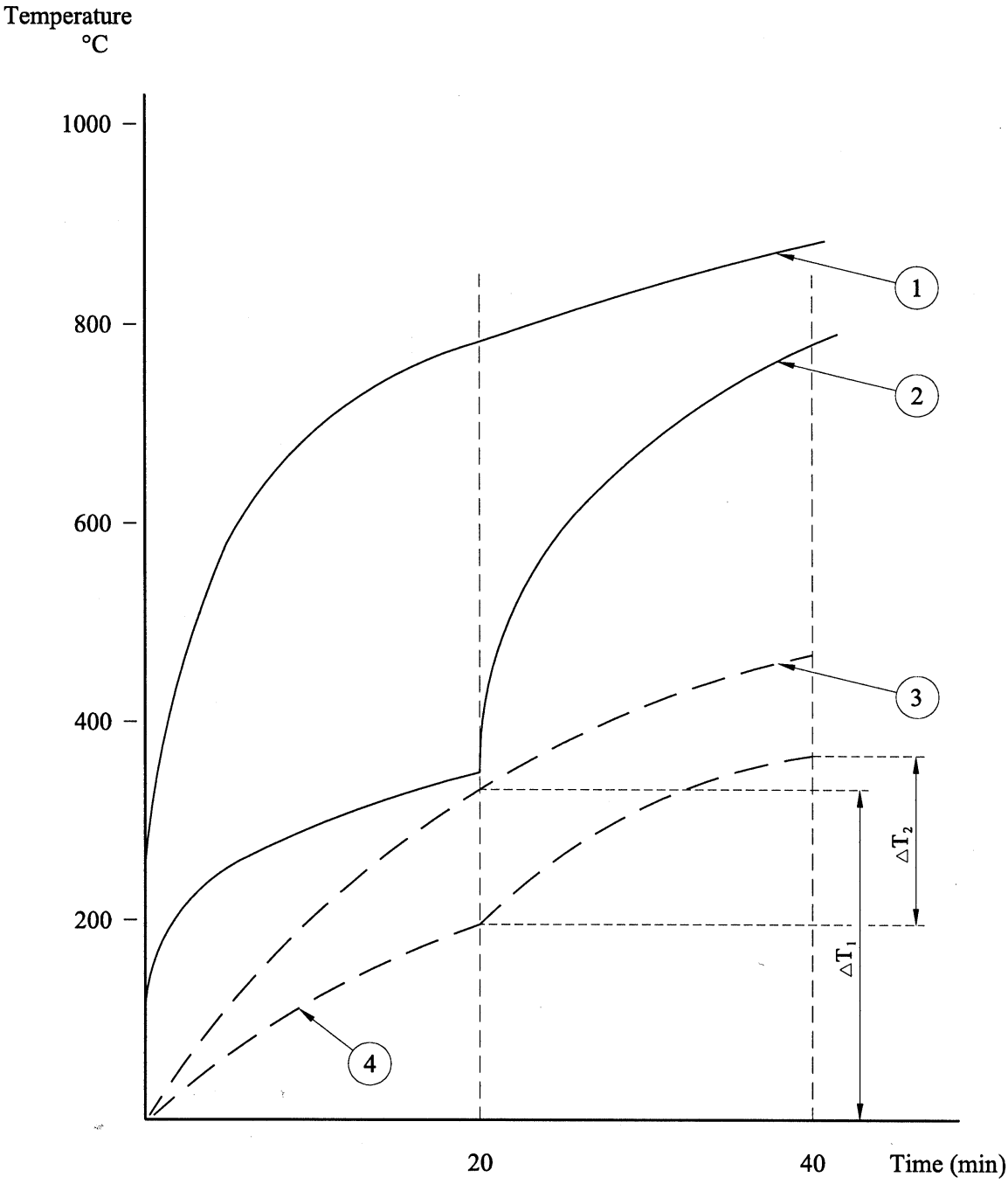
The test results shall be presented according to the principles given in clause 11.

A.10 Evaluation of the results

The characteristic temperature test data obtained for each small particleboard test specimen tested, when subjected to both the standard temperature/time curve (according to the principal test) and the smouldering curve (this test) shall be compared, at each thickness tested, each with the other.

The results from all thermocouples in each comparable location shall be examined and recorded by tabulation. The results for each comparable location shall be presented graphically, in a manner similar to that given in Figure A.1 and the performance of the fire protection material to the two fire sources compared and recorded. The values of ΔT_1 and ΔT_2 shall be measured and recorded for all comparable locations.

The results of tests carried out according to the standard temperature/time curve for the particular reactive fire protection material under test shall only be valid and applicable if $\Delta T_1 > \Delta T_2$ in each and every comparable location.



Key
1 Standard temperature/time curve
2 Smouldering (slow heating) curve
3 Test element temperature to standard temperature/time curve
4 Test element temperature to smouldering (slow heating) curve

Figure A.1 - Comparison of performance to the standard and smouldering fire curves

Annex B
(informative)

Guidelines for fire protection of timber structures according to ENV 1995-1-2 - Loadbearing function

The loadbearing capacity of timber members exposed to fire is dependent on the charring depth and the loss of strength of the residual cross section due to the influence of elevated temperature. In ENV 1995-1-2 for design by calculation charring rates are given for two cases:

a) the charring rate β_0 which is a notional value since it includes effects of the roundings due to increased charring at arrises of the cross section;

b) the charring rate β which is the value obtained from tests. This charring rate should be used only when the roundings at arrises are considered in the calculation of e.g. the section modulus of the residual cross section.

The charring depth is calculated as

$$d_{char} = \beta_0 t \qquad \text{(B1)}$$

or

$$d_{char} = \beta t \qquad \text{(B2)}$$

The reduction of strength (and stiffness) is considered by multiplying the corresponding values for normal temperature design with a modification factor $k_{mod.fi}$ for fire (see ENV 1995-1-2).

For simplicity, the charring rates given in ENV 1995-1-2 are constant. They are valid for unprotected surfaces of timber or wood-based panels.

When surfaces of timber members are covered by fire protective claddings, the charring of the members starts at the failure time t_{pr} of the cladding (see ENV 1995-1-2). In the calculation then the same charring rate is used as in the case of an unprotected surface from the beginning.

ENV 1995-1-2 does not take into account that the charring rate in the case of a fire protected timber member is different to that if it was unprotected, see Figure B1. If the fire protective cladding falls down e.g. due to the loss of stickability or the failure of fixings, the charring rate β'' of the protected member (curve b) would be greater than the charring rate β' of the corresponding unprotected member (curve a). When the fire protective cladding remains fixed to the timber member, the charring rate will be influenced by the insulation effect of the fire protective cladding (curve c).

Using t_{pr}, β' and β'' according to this standard, expressions (B1) and (B2) can be replaced by:

$$d_{char} = {}_0 k \ (t - t_{pr})$$

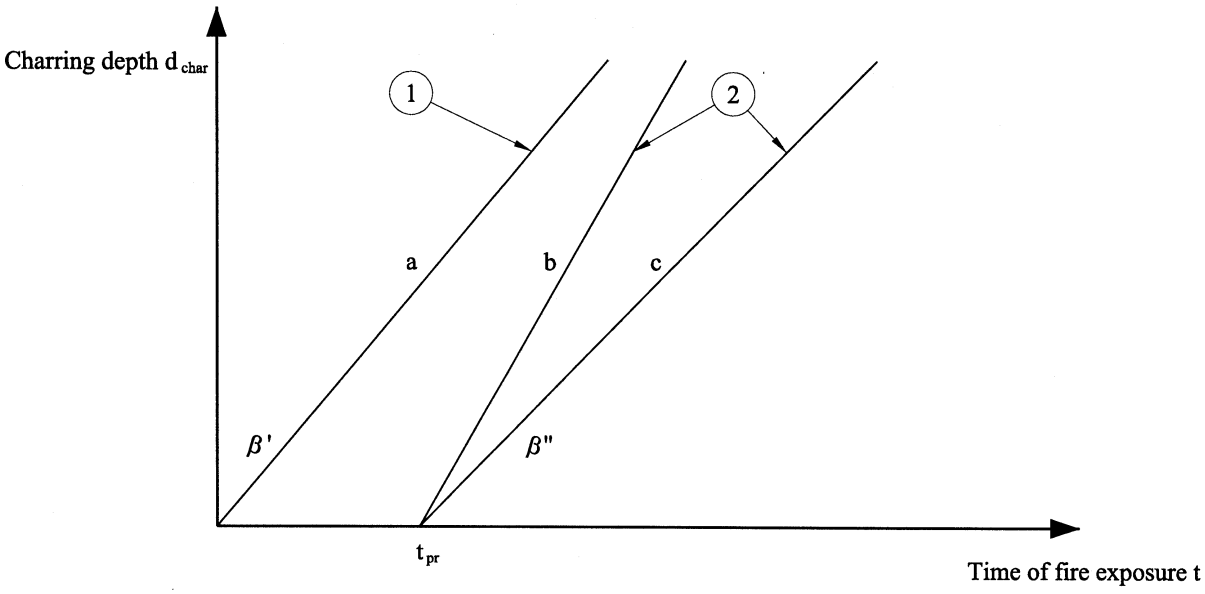
and

$$d_{char} = k \ (t - t_{pr})$$

with

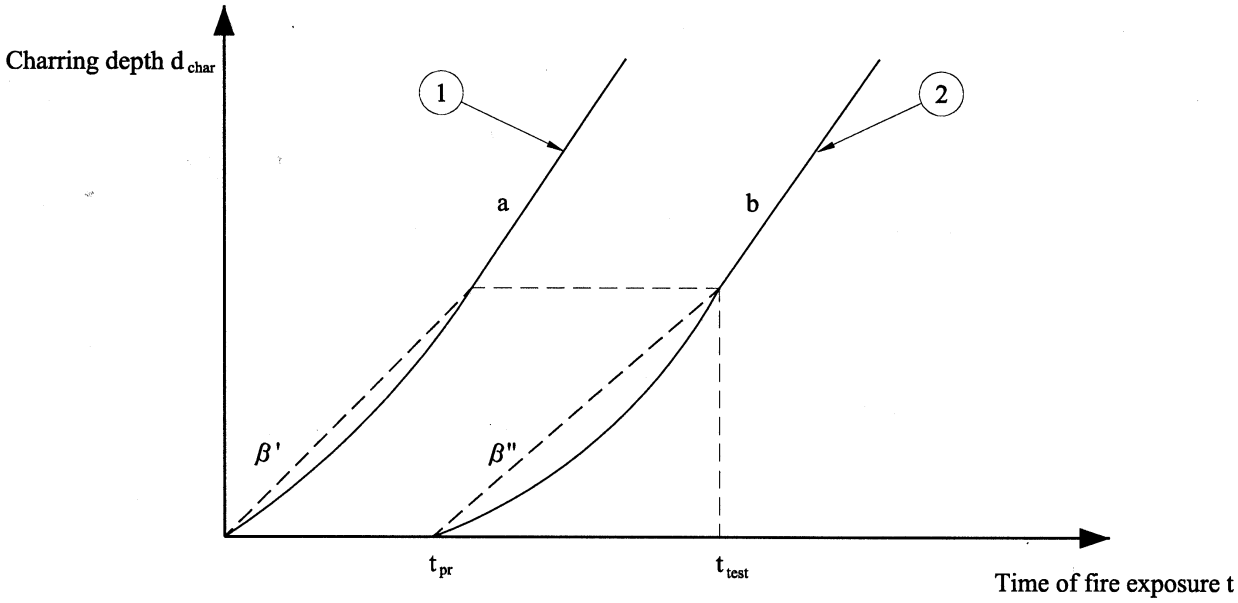
$$k = \frac{''}{}$$

When, in the case of a non-linear relationship between charring depth and time, the charring rate is determined as the secant value as shown in Figure B.2, the limit of application is given by the time.



Key
1 Unprotected member
2 Protected member

Figure B.1 - Illustration of charring depth versus time for unprotected (curve a) and two different cases of protected timber members (curves b and c)



Key
1 Unprotected member
2 Protected member

Figure B.2 - Definition of the charring rate as the secant values and the corresponding limit of application

Annex C
(normative)

Measurement of properties of fire protection materials

C.1 Introduction

Determination of the thickness, density and moisture content of fire protection materials and other materials used in this fire resistance test is important to the accurate prediction of fire protection performance from the test result. The methods used to establish these properties shall, therefore, be consistent and this section gives guidance on appropriate procedures to be used.

Any special test samples used to determine thickness, density and moisture content shall be conditioned with the fire test specimen under the conditions defined in clause 8 of this Prestandard.

Any specific product standard existing for the measurement of such properties shall be followed.

The procedures given in EN 1363-1 shall be followed together with the provisions of C.2 to C.4.

C.2 Thickness of fire protection materials

C.2.1 For board or panel fire protection materials, the nominal thickness of each material shall be measured using suitable gauges or callipers.

The measurement shall be carried out either on the actual materials during assembly of the test specimen or on a representative special test sample, the minimum linear dimensions of which shall be 300 mm 300 mm. At least nine measurements shall be made including measurements around the perimeter and over the surface of the material.

The design thickness used in the assessment shall be as defined in 6.5.

C.2.2 For sprayed passive fire protection materials, the thickness shall be measured using a 1 mm diameter probe or drill, which shall be inserted into the material at each measurement position until the tip of the probe or drill touches the surface of the building element. The probe or drill shall carry a circular steel plate of diameter 50 mm upon it, for accurate determination of the surface level.

The thickness of sprayed or coated passive or reactive fire protection material shall be measured in the proximity, between 50mm and 100 mm away from each of the thermocouples fixed to the surface of the particle board test specimen, beneath the applied fire protection system, see 9.3. They shall be regarded as the minimum number of thickness measurement points. For sprayed fire protection materials, the design thickness used in the assessment shall be as specified in 6.5.

C.2.3 For reactive fire protection coating materials applied to particleboard test specimens, the thickness shall be determined by either:

a) Fixing of at least 9 steel plates of size 50 mm 200 mm and 1 mm thickness to the particleboard test specimen, before the fire protection material is applied. The thickness of the material applied to each of these is measured;

b) Interpolation from that measured on a standard steel plate, of size 300 mm 300 mm, to which the coating is applied at the same time and by the same method as it is applied to the particleboard test specimen. Measurements shall be made at 9 points over the steel plate at least, including measurements around the perimeter and over the surface of the material.

The thickness of reactive fire protection coatings over steel plates or trays (methods a or b) shall be measured using an instrument employing either the electro-magnetic induction principle or the eddy current principle.

Reactive fire protection materials applied as coatings typically range from 0,25 mm to 4 mm thickness and the choice of instrument shall be appropriate to the thickness of coating used;

c) Measuring dry film thickness of sprayed and coated reactive materials from examination of the applied wet film, by:

i) determining mass of material applied per unit area and hence applied wet film thickness. Interpolation of this using expected mass loss/thickness loss to dry film thickness;

ii) use of wet film thickness combs to give wet film thickness. Interpolation of this using expected thickness loss to dry film thickness, making allowances for the reactive materials soaking into the particleboard.

d) Other verifiable methods proposed by the sponsor.

It is preferable that at least two of the above methods shall be used.

The design thickness used in the assessment shall be as defined in 6.5.

C.3 Density of applied fire protection materials

C.3.1 The density of each fire protection material shall be determined from measurements of mass and dimensions using the following:

For board or panel passive fire protection materials, the density can be obtained from values of mass, mean thickness (from 9 measurements) and area measured either on the actual materials during assembly or on a representative special test sample, the minimum linear dimensions of which shall be 300 mm 300 mm. The mass of the board shall be obtained using a balance having an accuracy equivalent to 0,1 % of the total mass of the sample being weighed or 0,1 g (the sample size shall be sufficient such that the minimum sample mass is 100 g) whichever is the greater.

The density of fibrous or compressible fire protection material shall be related to nominal thickness.

C.3.2 For spray applied fire protection materials, the density of the material shall be determined from samples of the material sprayed, from beneath, into two metal trays, horizontally orientated, at the same time as the fire protection system is applied to the particleboard test specimen. These two trays shall be of size 300 mm 300 mm, made from 1 mm thick steel plate. The depth of the trays shall be the same as the design thickness of the spray applied protection.

For each thickness of material, two such trays shall be prepared with the material applied to the same thickness as that applied to the particle board test specimen. One of these trays is dried to provide a reference for dry density and moisture content. The second tray shall be used to determine the density at the time of test.

The thickness of the specimen within the trays shall be determined at nine points over the surface of the trays according to:

- one at the centre;

- two along each centre to corner axis, equidistant from each other, the centre and the corner.

The arithmetic mean of all measurements made shall be used in the calculation of density.

The mass of the fire protection within the tray shall be obtained using a balance having an accuracy equivalent to 0,1 % of the total mass of the sample being weighed or 0,1 g (the sample size shall be sufficient such that the minimum mass is 100 g) whichever is the greater.

C.3.3 The design density used in the assessment shall in all cases be as defined in 6.5.

C.4 Moisture content of applied fire protection materials

C.4.1 The samples and materials used to measure moisture content shall be stored together with and under the same conditions as the test specimens. The measurement of final moisture content shall be made on the day that fire testing takes place.

C.4.2 For board or panel passive fire protection materials, special test samples shall be taken measuring minimum 300 mm 300 mm and of each thickness of the material used. They shall be weighed [initial conditioned mass, (W_1)] and then heated in a ventilated oven at (105 $\pm$ 2) °C for 24 hours, cooled and then re-weighed.

For gypsum based and similar materials, drying shall take place at (40 ± 5) °C.

Repeated weighings shall be taken until moisture equilibrium or constant mass, (W_2), as defined in EN 1363-1, is reached. The moisture content (W_1 - W_2) of the specimen shall be calculated as a percentage of its moisture equilibrium or constant mass.

C.4.3 For spray applied passive fire protection materials, the moisture content of the material shall be calculated from repeated weighing / heating / weighing of one of the sample trays referred to in C.3.2, for each thickness tested.

The sample trays shall be weighed [initial conditioned mass (W_1)], heated in a ventilated oven at (105 ± 2) °C for 24 hours, cooled and then re-weighed. Repeated weighings shall be taken until moisture equilibrium or constant mass, (W_2), as defined in EN 1363-1, is reached.

The moisture content (W_1 - W_2) of the specimen shall be calculated as a percentage of its moisture equilibrium or constant mass.

Should the product contain, or be based on, gypsum and similar materials, drying shall take place at (40 ± 5) °C.

Annex D
(informative)

Alternative construction for loaded beam test specimen

D.1 General

During laboratory trials, the construction of the loaded beam test specimen as specified in 6.3.1.1 was found to be questionable. The laboratory had, in particular, problems with definition of the cross-sectional characteristics required to calculate the applied load according to 5.3. Additionally, the specified beam construction, containing both horizontal and vertical particleboard laminates applied to a solid timber beam, was considered by the test laboratory to give rise to uncertain behaviour under load with respect to adhesion between the timber beam and the laminate, particularly that laminate applied vertically.

An alternative beam construction is proposed, which has been examined and found to be free of the above difficulties and is recommended for consideration by laboratories performing this test.

D.2 Alternative beam construction

The alternative test beam is made from horizontal laminated particleboards only without a natural timber core and without vertical orientated particleboards as prescribed in 6.3.1.1.

The alternative test beam comprises a laminate of at least 10 layers of 10 mm thick particleboard. Its width should be at least 100 mm and its length > 4 000 mm. Thermocouples are incorporated on the surface of and within the laminate according to 9.3.

D.3 Number of test specimens

It is considered that the results from use of the alternative large beam construction should provide the same information as those from the large floor test specified in 6.3.1.1.

The particleboard laminate specimen used in both alternative beam and specified floor test specimens is similar, in the first case it is unsupported and in the second it is supported between two timber joists at nominal joist spacing [see Figure 1]. The deflection applied to the laminate in both cases will be equivalent and fire exposure similar (the alternative beam being the worst case).

Additionally any interaction and transfer of deformations from the joists to the set of laminated particleboards in the space between them in the large floor test can be avoided.

The test procedure to provide data applicable to floors, beams, walls and columns (see 6.1.1 a) can therefore become:

- Large beam with minimum protection
- Large beam with maximum protection
- Small scale floor test with minimum protection
- Small scale floor test with maximum protection
- Small scale floor test without protection.

The applicability to floors (6.1.1 b)) and beams (6.1.1 c)) individually can therefore be covered by the above combination.

Fire protection system variants as tested according to 6.1.2, where no specification is made if these are beam or floor test specimens, would now only be carried out on large scale beam specimens.

D.4 Application of instrumentation: measurement of test specimen temperature

According to 9.3, thermocouples for the measurement of test specimen temperature are required to be placed at 1/3 and 2/3 beam length. As a consequence of use of the alternative large beam construction, these thermocouples can be placed at half beam width only, again at the interface between the fire protection material and the particleboard laminate and at each of the lower four interfaces between the layers of particleboard. The requirement to measure temperature within the particleboard laminate on each exposed face (two vertical and one horizontal) as prescribed in 9.3 b) is no longer necessary. Within the alternative beam construction, all such positions can be considered equivalent.

D.5 Preparation and use of data

As a consequence of use of the alternative large beam, the correction factor to be applied according to 13.3 b) (i) becomes: $(t_{pr(beam)}/t_{pr(small)})$.

D.6 Advantages of the alternative beam construction

The alternative beam construction offers the following advantages:

1) the requirement to measure temperature within the particleboard laminate on each exposed face (two vertical and one horizontal) as prescribed in 9.3 b) is no longer necessary. The number of thermocouples required is reduced to 10 from 30;

2) by considering the large beam test equivalent to the large floor test, the number of test specimens in the total test package can be reduced;

3) the alternative beam is easier to prepare in the laboratory and the instrumentation more easily incorporated.

Bibliography

ENV 13381-1 Test methods for determining the contribution to the fire resistance of structural members - Part 1: Horizontal protective membranes.

ENV 13381-2 Test methods for determining the contribution to the fire resistance of structural members - Part 2: Vertical protective membranes.

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