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Fire-resistance tests — Elements of building construction —

Part 9: Specific requirements for non-loadbearing ceiling elements

Essais de résistance au feu — Éléments de construction —

Partie 9: Exigences spécifiques relatives aux éléments non porteurs de plafond

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 834 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 834-9 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

ISO 834 consists of the following parts, under the general title *Fire-resistance tests — Elements of building construction*:

— *Part 1: General requirements*

— *Part 3: Commentary on test method and test data application*

— *Part 4: Specific requirements for loadbearing vertical separating elements*

— *Part 5: Specific requirements for loadbearing horizontal separating elements*

— *Part 6: Specific requirements for beams*

— *Part 7: Specific requirements for columns*

— *Part 8: Specific requirements for non-loadbearing vertical separating elements*

— *Part 9: Specific requirements for non-loadbearing ceiling elements*

Annex A of this part of ISO 834 is for information only.

Introduction

This part of ISO 834 contains specific requirements for fire resistance testing which are unique to the elements of building construction described as non-loadbearing elements. The requirements for these non-loadbearing elements are intended to be applied in appropriate conjunction with the detailed and general requirements contained in ISO 834-1.

Fire-resistance tests — Elements of building construction —

Part 9:
Specific requirements for non-loadbearing ceiling elements

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

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

1 Scope

This part of ISO 834 specifies test procedures for determining the fire resistance of non-loadbearing ceiling elements which possess fire resistance independent of any building element above them, when exposed to heating from below the ceiling. It is applicable to self-supporting ceilings and to ceilings suspended from, or fixed directly to, a supporting construction.

The application of this test to other untested forms of construction is acceptable when the construction complies with the direct field of application as given in this part of ISO 834 or when subjected to an extended application analysis in accordance with ISO/TR 12470[1]. Since ISO/TR 12470 gives only general guidelines, specific extended application analyses are to be performed only by persons expert in fire-resistant constructions.

This part of ISO 834 is not applicable to ceilings used as a horizontal fire barrier for the protection of a loadbearing element above, in which case performance is assessed as an integral part of the complete assembly using ISO 834-5.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 834. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 834 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this part of ISO 834, the terms, definitions, symbols and abbreviations given in ISO 834-1, the terms and definitions given in ISO 13943 and the following apply.

3.1

ceiling

non-loadbearing element of building construction designed to provide horizontal fire separation

3.2

ceiling grid

substructure or suspension system that supports the ceiling membrane

3.3

expansion device

typically, device built into the ceiling grid that allows for expansion of the grid without causing significant deformation of the ceiling

3.4

plenum

concealed space between ceiling and floor or roof, often, but not necessarily, designed to accommodate air movement

3.5

self-supporting ceiling

ceiling with span from wall to wall, without additional suspension support

3.6

services

devices penetrating the ceiling (e.g. lighting and ventilation systems) not otherwise covered by a specific fire test

3.7

span

distance between centres of support

3.8

suspended ceiling

non-loadbearing horizontal protective membrane suspended from a loadbearing horizontal separating element and its supporting framework, including hangers, services, insulating materials, and access and inspection panels

3.9

test specimen

full ceiling specimen submitted for test, including hangers, fittings, insulating materials and features such as lighting, ventilation and access and inspection panels

4 Test equipment

The test equipment employed in the conduct of this test shall consist of a furnace, restraint and support frames and instrumentation in accordance with ISO 834-1.

5 Test conditions

The heating and pressure conditions, furnace atmosphere and the restraint and boundary conditions shall be in accordance with ISO 834-1, in addition to the requirements of this part of ISO 834.

6 Test specimen preparation

6.1 Specimen design

6.1.1 Details of construction

The test specimen shall be designed to characterize the details of the construction for which the desired rating is sought, such as longitudinal and transverse jointing systems. Differently constituted forms of the same detail shall be avoided.

6.1.2 Alignment

When the longitudinal and transverse directions of the ceiling are constructed differently, and the performance of the test specimen varies depending upon the direction aligned with the longitudinal axis, the ceiling shall be designed to represent the more onerous orientation by arrangement of the more critical components parallel to the longitudinal axis. When the more onerous condition cannot be identified, two separate tests shall be performed, with the components arranged both parallel and perpendicular to the longitudinal axis.

6.1.3 Services

When ceilings incorporate services such as lighting or air handling systems, which are an integral part of the design of the ceiling, these shall be included in the test specimen or in an additional specimen and distributed as in practice.

6.2 Specimen size

The exposed dimensions of the test specimen shall be at least 4 m $\times$ 3 m, unless the construction it represents is designed to have exposed dimensions of less than 4 m $\times$ 3 m, in which case the actual exposed dimensions shall be tested. The span of the ceiling shall be in the direction of the larger dimension.

6.3 Number of test specimens

The number of test specimens shall be in accordance with this part of ISO 834 and ISO 834-1.

6.4 Specimen conditioning

At the time of the test the strength and moisture content of the test specimens shall approximate the conditions expected in normal service. This shall include any infills and jointing materials. All components and materials of the test specimen shall be conditioned in accordance with ISO 834-1. After equilibrium has been achieved the moisture content or state of cure shall be determined and recorded. Any supporting construction, including the lining to the test frame, is exempt from this requirement.

6.5 Specimen installation and restraint

6.5.1 General

6.5.1.1 Installation and fittings

The ceiling shall be installed in a manner representative of its use in practice. It shall be installed using the method and procedures recommended by the sponsor. It shall model the edges between the ceiling and walls, the joints and jointing materials to be used in practice. The test specimen shall include any appropriate fittings that are an essential part of the specimen and may influence its behaviour in test.

Where fixtures and fittings do not form an integral part of the ceiling but can be fitted subsequently in a manner that could affect the fire resistance of the ceiling, these shall be the subject of a separate full-size test.

When the ceiling design includes both longitudinal and transverse joints, the test specimen shall include both.

6.5.1.2 Profiles

IMPORTANT — Where the supporting grid of the ceiling contains a built-in expansion device, the ends of the grid supported on the perimeter angle/section shall be tightly abutted to it. This is to ensure that the expansion device in the grid is adequately tested.

Profiles bearing the various components or panels of the ceiling shall be installed without gaps, unless a gap or gaps are required for design purposes, in which case such gaps shall be representative of practice.

In situations where the effect of large gaps between the grid and the supports at the perimeter angle/support needs to be shown, this shall be investigated in a separate, additional test.

6.5.1.3 Gaps

Small gaps between the ceiling and laboratory test frame shall be sealed by a suitable resilient material that will prevent the passage of hot gases but not impose restraint at the boundaries of the ceiling.

6.5.1.4 Suspended ceilings

Suspended ceiling test specimens shall be supported across the furnace from steel beams of type IPN 140 or equivalent and a span of 4 200 mm $\pm$ 200 mm, and shall be open to the laboratory on its upper face as shown in Figure 1.

6.5.2 Restraint

The test specimen shall be mounted in a test frame or furnace to prohibit thermal elongation. There shall be no allowance made for longitudinal movement of the edges or thermal expansion in either direction, other than that provided for in the ceiling design specification. Grid members shall be tightly fitted to a test frame or furnace walls in order that the thermal expansion behaviour of grid members and expansion devices can be correctly evaluated (see 6.5.1.2). All connections with the test specimen shall reproduce normal levels of restraint. The stiffness of the supporting construction shall also reproduce normal levels of restraint.

6.5.3 Fixing

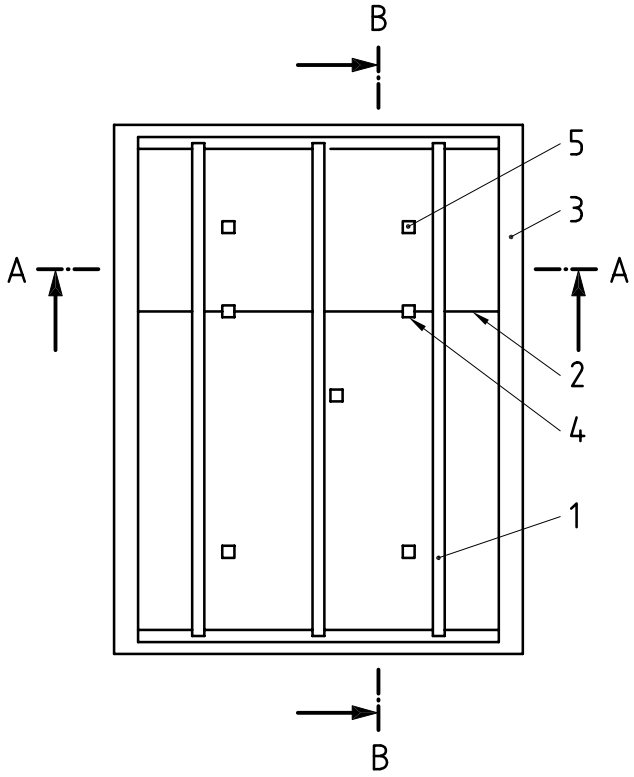
6.5.3.1 General

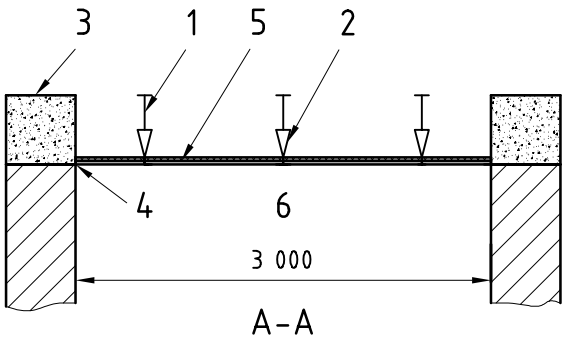
When the ceiling being tested is not smaller in any direction than in practice, it shall be tested fixed as in practice.

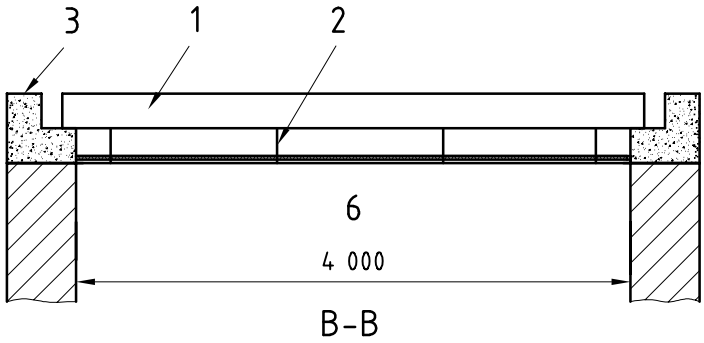
6.5.3.2 Size

When the proposed specimen is smaller than the test frame or furnace opening, a supporting construction shall be used to reduce the opening to the required dimension. (This construction is not subject to the specimen conditioning requirements when there is no contribution from it to the performance of the test specimen.) When another supporting structure is used, the design of the connection between the specimen and the supporting construction, including any fixings and materials used to make the junction, shall be as used in practice and shall be regarded as part of the test specimen. The supporting construction is to be considered part of the test frame.

Dimensions in millimetres







Key

1	Steel beams (with a span of approximately 4 200 mm ± 200 mm)
2	Suspension devices
3	Test frame of furnace
4	Perimeter support for ceiling fixed back to test frame
5	Ceiling (shown here with insulation laid above ceiling panels)
6	Furnace

Figure 1 — Ceiling exposed to fire from below — Suspended (shown) or self-supporting

6.5.3.3 Support

When the ceiling being tested is smaller in one or both directions than in practice, the following support conditions are applicable.

a) For a self-supporting ceiling, there shall be one free edge which shall be that intended in practice to be the longer span. There shall be no allowance made for longitudinal movement of the edges or thermal expansion in either direction, other than that provided for in the ceiling system.

b) For a suspended ceiling, all edges shall be fixed without any allowance for longitudinal movement of the edges or thermal expansion in either direction, other than that provided for in the ceiling system.

7 Application of instrumentation

7.1 Furnace thermocouples

7.1.1 Furnace plate thermometers shall be provided for measuring the temperature of the furnace and shall be distributed such that they give a reliable indication of the temperature across the exposed face of the test specimen. These thermometers shall be constructed and located in accordance with ISO 834-1.

7.1.2 The number of furnace thermocouples shall not be less than one for every 1,5 m^2 of exposed surface area of the test specimen. There shall be a minimum of four thermocouples for any test.

7.2 Unexposed surface thermocouples

7.2.1 Unexposed surface thermocouples shall be constructed and located in accordance with ISO 834-1.

7.2.2 When testing corrugated or ribbed ceiling constructions, the number of thermocouples on the unexposed face shall be increased to six so that there are an equal number at points of maximum and minimum ceiling thickness.

7.2.3 Thermocouples shall not be placed closer than 100 mm to any edge of the specimen.

7.2.4 Additional thermocouples shall be attached to measure the maximum temperature rise on or above the unexposed surface of the ceiling at locations where high temperature conditions are anticipated (joints, hangers, service penetrations or services, etc.).

7.2.5 When fibrous or resilient thermal insulation materials are included on the upper surface of the ceiling, thermocouples shall be placed on top of that thermal insulation material using thermocouple weights. These weights shall not reduce the thickness of the thermal insulation material by more than 10 %.

7.3 Deformation measurement

7.3.1 Zero point for the test is the deflection measured at the beginning of the test before commencement of heating and after the deflection has stabilized.

7.3.2 The vertical deflection along the longitudinal axis shall be measured at mid-span.

7.3.3 Deflection measurements shall be taken at multiple positions to determine maximum movement.

7.4 Pressure

Pressure within the furnace shall be measured in accordance with ISO 834-1.

8 Test procedure

SAFETY PRECAUTIONS — Monitoring for integrity by the cotton pad or other means and insulation by use of the roving thermocouple from above a test can be hazardous unless the risks associated with these practices are considered and appropriate precautions taken to protect operators from radiation, smoke, hot gases and from contact with the furnace flame.

The use of the roving thermocouple may not be possible for safety reasons. Operators shall not lean or reach over the test specimen to carry out observations during the test. Because of this restriction, additional surface thermocouples may be installed. Precautions shall be taken to protect operators making these observations from the effects of heat and smoke, especially if degradation of the ceiling during the test results in its partial or total collapse.

8.1 Furnace control

Measure and control the furnace temperature and pressure conditions in accordance with ISO 834-1.

8.2 Measurements and observations

Monitor the specimen for compliance with the criteria of integrity and insulation, and carry out relevant measurements and observations in accordance with ISO 834-1. For practical reasons, it is not possible to use gap gauges to evaluate integrity. Visual assessments shall be utilized instead. Monitor deflection in accordance with 7.3.3.

9 Performance criteria

The fire resistance of non-loadbearing ceilings shall be judged against the integrity and insulation criteria given in ISO 834-1, except that the gap gauge shall not be used for integrity.

10 Validity of test

The test shall be considered to be valid when it has been conducted within all of the prescribed limits of the requirements pertaining to

— test equipment,

— test conditions,

— test specimen preparation,

— instrument application, and

— test procedure,

in accordance with this part of ISO 834.

The test may also be considered for acceptance when the fire exposure conditions relating to furnace temperature, pressure and ambient temperature are in excess of the upper limits of the tolerances prescribed by this part of ISO 834.

11 Expression of results

The results of the fire resistance test shall be expressed in accordance with ISO 834-1.

12 Test report

The test report shall be in accordance with ISO 834-1.

Annex A
(informative)

Direct application of results

A.1 General

The applicability of the test results to other constructions shall be restricted to those others in which the installation of the ceiling is carried out from below.

A.2 Self-supporting ceilings

A.2.1 Size

a) For ceilings in which both length and width are less than 4 m × 3 m, and which have been tested at full size, the results may be applied to ceilings of the same or smaller size than the ceiling tested.

b) For ceilings of full size span less than 4 m but of width greater than or equal to 3 m (tested at full-size span and 3 m width), and in which the most onerous direction lies in the 4 m direction of the furnace, the results may be applied to ceilings of the same span or less than that tested. There shall be no restriction on application of the result in the width direction. The provisions with respect to most onerous configuration shall be followed in the direct application of results.

c) For ceilings of full size span greater than or equal to 4 m but of width less than 3 m (tested at 4 m span and full-size width) and in which the most onerous direction lies in the 4 m direction of the furnace, the results may be applied to ceilings up to 4,4 m long. The width is restricted to those less than or equal to that tested. The provisions with respect to most onerous configuration shall be followed in the direct application of results.

d) For ceilings in which both length and width are greater than or equal to 4 m × 3 m in practice, and which were tested at the 4 m × 3 m size, and in which the most onerous direction lies in the 4 m direction of the furnace, the results may be applied to ceilings up to 4,4 m long. There shall be no restriction on application of the result in the width direction. The provisions with respect to most onerous configuration shall be followed in the direct application of results.

A.2.2 Services

Services which may be installed are those which have been included in the test specimen, with a distribution per unit area not greater than that tested.

A.2.3 Plenum above self supporting ceilings exposed to fire from below

The test results are valid for plenum of any height.

A.3 Suspended ceilings

A.3.1 Size

Test results obtained on a 4 m × 3 m or greater test specimen may be applied to ceilings of any dimension, provided that the distance between the suspension devices is not increased and that provisions for expansion are increased accordingly.

A.3.2 Ceiling grids

The ceiling grid may incorporate locking assembly details that enhance performance by providing some continuity or load transfer capability between adjacent sections of the ceiling. The underside of the suspension system may be exposed or semi-exposed (e.g. lay-in ceiling panels) or may be fully concealed (e.g. monolithic gypsum board ceiling membrane screw attached to the suspension system from below).

A.3.3 Services

A.3.3.1 Suspension devices

Test results on ceilings containing fittings with their own suspension devices may be applied to ceilings containing such services and suspension devices provided the distribution does not exceed those tested.

A.3.3.2 Expansion devices

The result from a test on one type of expansion device may not normally be applied to an alternative device unless the alternative device has been subjected to the same test procedure.

A.3.3.3 Plenums

The test results are valid for plenums of any height.

Test results obtained on a 4 m $\times$ 3 m, or greater, test specimen, may be applied to ceilings of any dimension, provided that the distribution of the hangers, i.e. the distance between hangers, is not reduced. The span of grid elements and the load on the hanger shall not be increased.

Bibliography

[1] ISO/TR 12470, *Fire-resistance tests — Guidance on the application and extension of results*

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