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Fire-resistance tests — Elements of building construction —

Part 5: Specific requirements for loadbearing horizontal separating elements

Essais de résistance au feu — Éléments de construction —

Partie 5: Exigences spécifiques relatives aux éléments porteurs horizontaux de séparation

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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 834-5 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 horizontal separating elements*

— *Part 10: Method to determine the contribution of applied protection materials to structural metallic elements*

— *Part 11: Method to assess the contribution of applied protection materials to structural metallic 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 horizontal separating loadbearing elements. The requirements for these 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 5: Specific requirements for loadbearing horizontal separating elements

1 Scope

This part of ISO 834 specifies the procedures to be followed for determining the fire resistance of loadbearing horizontal separating elements when exposed to heating from the underside.

The test is also appropriate for the evaluation of loadbearing separating elements containing beams when it is not possible to test the floor or roof assembly in a representative manner without them. However, the data cannot be transferred directly one to the other.

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. Since ISO/TR 12470 gives only general guidelines, specific extended application analyses are to be performed only by persons expert in fire-resistant constructions.

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 834-1:1999, *Fire-resistance tests — Elements of building construction — Part 1: General requirements.*

ISO 834-6, *Fire-resistance tests — Elements of building construction — Part 6: Specific requirements for beams.*

ISO/TR 12470, *Fire resistance tests — Guidance on the application and extension of results.*

ISO/IEC 13943, *Fire safety — Vocabulary.*

3 Terms and definitions

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

3.1
beams
all horizontally oriented structural members employed in building construction and known variously as beams, joists or girders

NOTE They may be integral with or separate from the structure that they support.

3.2
exposed length
length of the specimen exposed to the heating effects of the test furnace

3.3
exposed width
width of the specimen exposed to the heating effects of the test furnace

3.4
floor
horizontal separating element of a building construction which is loadbearing

3.5
horizontal separating element
loadbearing, horizontally oriented floors and roofs which are required to act as fire separations or fire barriers, which divide buildings into fire compartments or fire zones, or which separate a building from adjoining buildings in order to resist the spread of fire to or from compartments or buildings

3.6
plenum
concealed space between a ceiling and a floor or roof, often, but not necessarily designed to accommodate air movement

3.7
roof
horizontal separating element of a building construction which is loadbearing

3.8
span
distance between the centres of support

3.8
specimen length
overall length of the test specimen

3.9
specimen width
overall width of the test specimen

3.10
suspended ceiling
non-loadbearing horizontal protective membrane that is suspended from or fixed directly to a loadbearing horizontal separating element and its supporting framework, including hangers, services (e.g. lighting and ventilation systems), insulating materials, and access and inspection panels

4 Symbols and abbreviated terms

Symbols and designations appropriate to this test are given in ISO 834-1 and as follows:

L_{exp}	Length of test specimen exposed to heating	mm
L_{sup}	Length of test specimen between the centres of supports	mm
L_{spec}	Length of test specimen	mm
W_{exp}	Width of the test specimen exposed to heating	mm
W_{sup}	The transverse span of a two-way spanning test specimen	mm
W_{spec}	Width of the test specimen	mm

5 Test equipment

Equipment employed in the conduct of this test consists of a furnace, loading equipment, restraint and support frames and instrumentation as specified in ISO 834-1.

6 Test conditions

6.1 General

The heating and pressure conditions, the furnace atmosphere and loading conditions shall conform to those specified in ISO 834-1.

6.2 Restraint and boundary conditions

Restraint and boundary conditions shall comply with the requirements given in ISO 834-1 and the requirements of this part of ISO 834.

6.3 Loading

6.3.1 All loadbearing horizontal separating elements shall be tested when subjected to loads calculated in accordance with subclause 6.3 a), b) or c) of ISO 834-1:1999, in consultation with the sponsor to produce the conditions the structure is designed to accommodate. The material properties utilized in the calculation of the load shall be clearly indicated and their source given.

6.3.2 When the proposed test specimen is smaller than the element in practice, it is important that the size of the test specimen, the type and level of loading and the support conditions be selected such that the same type of failure (for instance, a bending failure, a shear failure or a bond or an anchorage failure) will be decisive for the test specimen as for the construction it represents; i.e. the load applied during the test shall provide the same load level as the real construction. For cases in which the decisive type of failure is difficult to predict, two or more tests, individually designed to cover in total all relevant types of failure, shall be required.

6.3.3 The magnitude and the distribution of the load shall be such that the maximum moments and shear forces produced are representative of, or higher than, those expected in practice.

6.3.4 The loading system shall be capable of applying the required load uniformly distributed over the surface by weights or hydraulic jacks such that at any single application point the load is not more than 10 % of the total load. This is permitted to be exceeded when it is necessary to accommodate concentrated loading or additional loading over structural members. The contact area between the load point and the horizontal separating element surface shall be through a pad not smaller than 0,01 m^2 and no greater than 0,09 m^2 individually, and shall not exceed 16 % of the total surface area. If the plates are made of steel or of materials with a similar high conductivity, they shall be insulated from the surface of the test specimen. The loading system shall not inhibit the free movement of air above the top surface and, other than at the loading point, no part of the loading apparatus shall be closer than 60 mm from the surface.

6.3.5 The loading system shall be capable of compensating for the maximum allowable deformation of the test specimen.

6.3.6 When the floor or roof contains one or more structural beams, the additional requirements in ISO 834-6 shall apply. When the loading requirements of a horizontal assembly includes the application of an additional point or line load over a beam that is an integral part of the assembly, the loading apparatus shall be capable of applying such loads.

7 Test specimen preparation

7.1 Specimen design

The specimen shall be designed to characterize the many aspects of the construction for which the desired rating is sought. Differently constituted forms of the same detail shall be avoided.

When the test assembly includes a ceiling, the dimensions of the ceiling shall correspond with L_{exp} and W_{exp} and its performance shall be assessed as an integral part of the complete assembly and comply with the following requirements.

a) The ceiling shall be installed from below in accordance with methods and procedures given in an installation manual or provided by the sponsor and represent conditions of use.

b) The test specimen shall include the in-practice components for suspension or fixing, expansion and abutting. 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 and distributed as in practice.

c) When the ceiling design includes both longitudinal and transverse joints, the test specimen shall include both. The devices bearing the ceiling components shall be installed against each other without any gaps, unless a gap or gaps are required for design purposes. Such gaps shall be representative of practice and located within the field of the ceiling and not at its perimeter.

d) Edges between the ceiling and walls and the joints and jointing materials shall be representative of that in practice. The ceiling shall be installed to prohibit thermal elongation, with no allowance for longitudinal movement of the edges or thermal expansion in either direction other than that provided for in the ceiling system. Grid members shall be tightly fitted at the periphery to evaluate the thermal expansion behaviour of grid members and expansion devices.

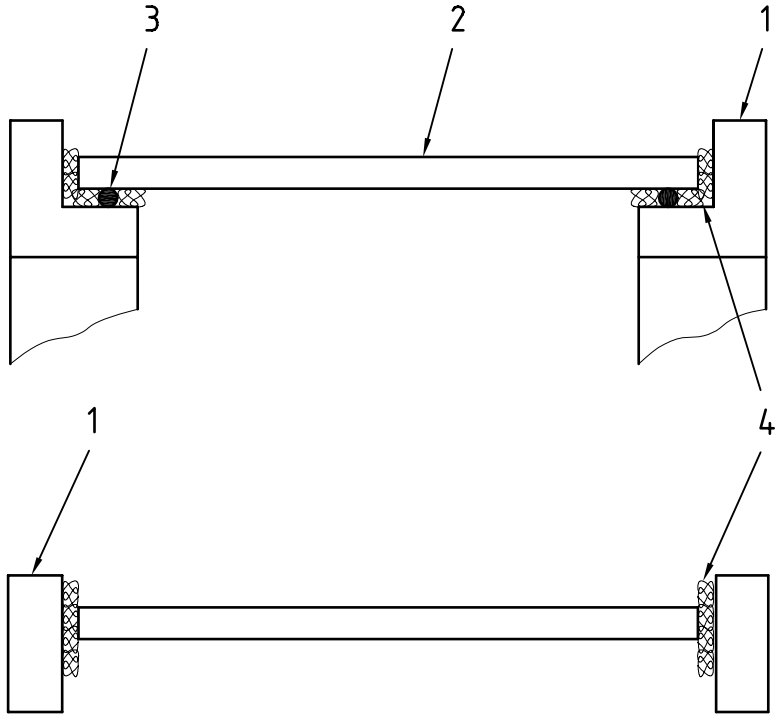
e) When the longitudinal and transverse directions of the ceiling are constructed differently, and the performance of the test specimen varies depending upon the direction aligned with the longitudinal axis, the ceiling shall be designed to represent the more onerous condition by arranging the more critical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

f) When services do not form an integral part of the ceiling but may be fitted subsequently in a manner that may affect the fire resistance of the ceiling, a separate test incorporating these services shall be required.

7.2 Specimen size

7.2.1 Floors supported on rollers

7.2.1.1 Standard conditions (floors supported on rollers) are addressed in 7.2.1.2 and 7.2.1.3. A general arrangement of a simply supported floor in the furnace is shown in Figure 1.



Key

1	Furnace	3	Roller or rod
2	Test assembly	4	Insulation

Figure 1 — Example of a simply supported test specimen

7.2.1.2 The exposed length (L_{exp}) shall not be less than 4 m. The span between supports (L_{sup}) shall be the exposed length (L_{exp}) plus up to a maximum of 100 mm at each end. The specimen length (L_{spec}) shall be the exposed length (L_{exp}) plus up to a maximum of 200 mm at each end.

7.2.1.3 The width of the test specimen (W_{spec}) shall equal the exposed width (W_{exp}) and shall not be less than 3 m. Exception: not less than 2 m for one-way spanning simply supported constructions that do not include a structural member or a ceiling.

7.2.2 Conditions in practice

7.2.2.1 Floors supported representative of conditions in practice are addressed in 7.2.2.2 through 7.2.2.5.

7.2.2.2 The exposed length (L_{exp}) shall not be less than 4 m when the exposed length of the floor in practice is longer than can be accommodated in the furnace. For constructions designed to have an exposed length in practice of less than 4 m, the actual exposed length shall be tested. The length of bearing shall not exceed that in practice. The specimen length (L_{spec}) shall be the exposed length (L_{exp}) plus up to a maximum of 200 mm at each end.

For constructions that include a restrained beam, a 4 m minimum span is inadequate because only a portion of the beam would be expected to be in bending mode, the remainder being partially supported by the restraint mechanism. Therefore, a longer span in which at least 4 m is subjected to positive bending moments shall be selected. If X % of the beam is expected to be in positive bending mode, the overall length shall be given by $L_{exp} = 4 \times 100/X$ m.

7.2.2.3 The width of the test specimen exposed to heating (W_{exp}) shall not be less than 3 m. For constructions designed to have an exposed width in practice of less than 3 m, the actual exposed width shall be tested.

7.2.2.4 For one-way spanning constructions, the transverse span (W_{sup}) shall equal the exposed width (W_{exp}).

7.2.2.5 For constructions that include structural members that span two ways, the transverse span (W_{sup}) shall be the exposed width (W_{exp}) plus up to half the length of bearing at each transverse end. The length of bearing shall be selected so that the difference between (W_{sup}) and (W_{exp}) does not exceed that in practice. The specimen width (W_{spec}) shall be the exposed width (W_{exp}) plus up to a maximum of 200 mm at each end.

7.3 Number of test specimens

The number of test specimens shall comply with the requirements given herein and in ISO 834-1.

7.4 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 includes any in-fills and jointing materials. Guidance on conditioning is given in 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.

7.5 Specimen installation and restraint

7.5.1 Loadbearing horizontal separating elements are either subjected to fire exposure while resting on roller supports (simply supported) or simulating the end conditions as in practice. When support and restraints represent in-practice conditions, those conditions shall be described in the report and the test results shall be reported as restricted.

7.5.2 Test specimens representing floors or roofs shall normally be tested on roller supports. When the end conditions are known, the test construction may be installed as in practice with smooth concrete or steel plate bearing surfaces.

7.5.3 Simply supported specimens shall be positioned to allow freedom for longitudinal movement and vertical deflection and to remove any fixity induced by frictional resistance.

7.5.4 The apparatus utilized for providing restraint to thermal expansion, axially or rotationally, shall be designed or adapted for the forces to be expected as a consequence of thermal expansion and the required restraint.

7.5.5 When a test incorporates more than one beam, each beam shall be exposed to the specified conditions and shall be loaded to act independently.

7.5.6 Any gaps at the boundaries shall be sealed with a non-restraining, non-combustible material.

7.5.7 Resilient material of adequate fire performance shall seal and protect the supports and prevent the leakage of hot gases having any influence on end conditions during the test.

7.5.8 When a specimen is smaller than the test frame opening, a supporting construction shall be used to reduce the opening to the required dimension. Supporting constructions shall not be subject to the specimen conditioning requirements unless there is likely to be a contribution from it to the performance of the test specimen. When a beam is used between the supporting construction and the separating element, the design of the connection between the separating element and the beam, including any fixings and materials 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.

7.5.9 All connections between the test specimen and supporting construction or test frame shall reproduce the normal levels of restraint. The stiffness of the supporting construction shall also sufficiently reproduce normal levels of restraint.

8 Application of instrumentation

8.1 **Furnace thermocouples** (plate thermometers)

Plate thermometers shall be provided to measure the temperature of the furnace and shall be distributed to give a reliable indication of the temperature across the exposed face of the test specimen. These plate thermometers shall be constructed and located in accordance with ISO 834-1.

The number of plate thermometers shall not be fewer than one for every 1,5 m^2 of the exposed surface area of the test specimen. There shall be a minimum of four plate thermometers for any test and each shall be oriented so that side “A” faces the floor of the furnace.

8.2 Unexposed surface thermocouples

Unexposed specimen surface thermocouples shall be constructed and located in accordance with ISO 834-1. When the floor or roof test specimen incorporates one or more loadbearing beams, specimen thermocouples shall be placed at specified locations along each beam as required in accordance with ISO 834-6 on beams.

Unexposed specimen surface thermocouples shall not be placed closer than 100 mm to any edge of the specimen.

8.3 Deformation measurement

The zero point for the test is the deflection measured after the load has been applied at the beginning of the test before commencement of heating and after the deflection has stabilized.

The vertical deflection along the longitudinal axis shall be measured at mid-span. For specimens containing beams, the deflection along the longitudinal axis of the beam shall likewise be measured at mid-span.

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

9 Test procedure

9.1 Load application

Apply and control the load to the horizontal element in accordance with ISO 834-1 and 6.3 of this part of ISO 834.

9.2 Furnace control

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

9.3 Measurements and observations

Monitor the specimen for compliance with the criteria of loadbearing capacity, integrity and insulation and make relevant measurements and observations in accordance with ISO 834-1.

10 Performance criteria

The fire resistance of loadbearing horizontal separating elements shall be judged against the loadbearing capacity, integrity and insulation criteria as specified in ISO 834-1.

11 Validity of test

The test shall be considered to be valid when it has been conducted within all of the specified limits of the requirements pertaining to: the test equipment, test conditions, test specimen preparation, instrument application and test procedure according to this part of ISO 834.

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

12 Expression of results

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

When a test has been performed on a specimen which has been subjected to a service load specified by a sponsor, which is intended for a specific application and which is less than the maximum which would be applied in consideration of a recognized structural code, the loadbearing capacity shall be qualified in the result by the term “restricted”. Full details shall be provided in the test report concerning its derivation.

13 Test report

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

Annex A
(informative)

Direct application of results

The results of a fire-resistance test are applicable to a similar untested loadbearing horizontal separating element provided that all the following are true.

a) Regarding the horizontal loadbearing element:

1) the type of construction (beam and slab) is unchanged;

2) the perimeter/area ratio of the beam is not increased;

3) the thermal inertia (expressed by $\sqrt{k\rho c}$) of the cover slab is not increased;.

4) the conductivity of any bedding material between the beam and the slab is not increased.

b) Regarding the suspended ceiling:

1) the permeability of the cover slab is not increased;

2) the thickness of any tile is not reduced;

3) the design and material used for tiles is unchanged;

4) the area of tiles is not increased and the aspects ratio of tiles is unchanged;

5) the method of fixing to the support structure is unchanged;

6) the depth of the plenum is not reduced;

7) the length of the hangers is not increased by more than X %;

8) the expansion allowance of the suspension system and of the support structure is not reduced;

9) the distance between hangers is not increased;

10) the cross-sectional area and the thermal capacity of the hangers are not reduced;

11) the ceiling is not penetrated by more services or by services of greater size than those tested;

12) no additional insulation is put in the cavity.

For specimens tested with a fire insulation, a failure of these protective non-loadbearing components can cause a failure of the whole loadbearing structural element. The protective components then normally fail under certain critical conditions which depend on the interrelated temperature and deflection states. As these interrelated states can vary for a specified element with the support conditions, a warning should be given against using a critical temperature state for such a component, derived for one support condition, for another support condition which is more decisive with regard to the deflections; for instance, to use a critical temperature state, obtained for a restrained element, for a simply supported element, otherwise unchanged.

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