



Fire-resistance tests — Contribution made by suspended ceilings to the protection of steel beams in floor and roof assemblies

Essais de résistance au feu — Contribution apportée par les plafonds suspendus à la protection des poutrelles en acier dans les ouvrages de plancher et de toiture

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0 Introduction

The tests specified in this Technical Report provide a means of determining the contribution made by suspended ceilings to the fire-resistance of load-bearing unventilated floor or roof assemblies on the basis of the length of time for which the test specimens satisfy the defined criteria when submitted to the test. In most cases these floor and roof assemblies are represented in the tests by a slab of reinforced concrete but provision is also made for some tests to be carried out using slabs of aerated concrete (see A.1.1). For information on the testing of ventilated assemblies, see A.1.2.

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The tests are based on the assumption that the fire will attack the underside of the suspended ceiling and will not attack from within the void between the ceiling and the supporting construction.

Before performing a test specified in this Technical Report, all concerned should read the commentary given in the annex. This commentary explains some of the problems of suspended ceilings in fires, explains why the tests are needed, how they were developed and how their results can be put to use.

Safety warning : So that suitable precautions may be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved during combustion of test specimens.

1 Scope and field of application

This Technical Report specifies methods of test for assessing the contribution made by suspended ceilings to the protection of steel beams forming part of horizontal unventilated floor and roof assemblies.

These tests are not intended to provide a separate fire-resistance classification for the ceiling alone. Results from these tests may be used as data for extrapolation techniques where appropriate (see the annex). These tests are not applicable to ceilings serving solely as horizontal partitions or as suspended false ceilings of the open cell or louvered types.

These test methods, which are referred to in an amendment to ISO 834, should be read in close conjunction with ISO 834. The annex explains some of the problems associated with suspended ceilings in fires and gives recommendations to assist in carrying out the tests : they are not mandatory as far as this Technical Report is concerned.

The test methods are not applicable to :

- a) ceilings which form a part of a complete floor assembly (which should be tested in accordance with ISO 834);
- b) ceilings which are required to act as horizontal partitions by themselves¹⁾;
- c) suspended false ceilings of the open cell or louvered types;
- d) ventilated roof assemblies (which should be tested in accordance with ISO 834).

2 References

ISO 834, *Fire-resistance tests — Elements of building construction*.

EURONORM 19, *Beams with parallel flanges — Dimensions*.²⁾

EURONORM 53, *Broad flanged beams with parallel sides — Dimensions*.²⁾

3 Definitions

For the purposes of this Technical Report the following definitions shall apply :

3.1 suspended ceiling : A horizontal membrane which is located at a clear distance of not less than 5 mm from the floor or roof construction beneath which it is suspended and, amongst its other functions, is intended to contribute to the fire-resistance of the floor and roof constructions beneath which it is suspended, and which does not incorporate any load-bearing member of the structure.

3.2 cavity : The whole void between the suspended ceiling and the underside of the top covering (see figure 1).

3.3 unventilated floor and roof assembly : An assembly in which the cavity between the floor or roof soffit and the suspended ceiling is entirely surrounded by barriers which have the effect of restricting the transfer of hot gases.

1) A separate test procedure for testing such structures is under consideration.

2) These Euronorms are obtainable from the Office for Official Publications of the European Communities, BP 1003, Luxembourg.

3.4 supporting construction : The horizontal load-bearing construction (steel beams and covering slabs) to which the suspended ceiling is attached during the test.

3.5 test specimen : All parts of a suspended ceiling submitted for test including hangers, fittings and insulating material.

3.6 test assembly : An assembly comprising the suspended ceiling under test (the test specimen) and a supporting construction defined according to the type of test chosen.

4 Apparatus and equipment

Except as otherwise stated, the apparatus shall be as specified in ISO 834, with the exception that for all tests of suspended ceilings the walls of the cavity shall be sealed as specified in figure 1, in order to restrict the transfer of hot gases.

5 Standard heating and pressure conditions

Suspended ceilings shall be tested according to the requirements specified in ISO 834 respectively for heating and for pressure conditions.

6 Preparation of test specimen

6.1 Size of specimen

Where it is not possible to test suspended ceilings of the full size at which they will be installed in a building, the following shall be the minimum dimensions of the part of the test assembly exposed in the furnace :

- span of supporting construction : 4 m
- width of suspended ceiling : 3 m

Suspended ceilings of a minimum width of 2 m may be tested under special conditions, but in which case the test conditions and dimensions shall be clearly stated in the test report.

6.2 Choice of form of construction and method of fixing

6.2.1 The suspended ceiling shall be tested in conjunction with one of the supporting constructions specified in clause 7. If any uncertainty exists as to which supporting construction to use for the test, the test sponsor shall decide on advice given by the testing laboratory. (See A.6.)

6.2.2 Each test specimen shall reproduce the boundary conditions (including all edge members, joints and seals) and incorporate the method of fixing and of support as well as the expansion joints of the same type and frequency as used in practice.

6.2.3 The supporting construction (beams and topping) shall be built as far as possible before the suspended ceiling is installed.

6.3 Allowance for ducts, insulation fittings and combustible materials in the cavity

6.3.1 When preparing the test specimen, account shall be taken of any features such as ducts, insulation materials (see A.2.2) and recessed light fittings which are known to be incorporated in the suspended ceiling or be present in the ceiling cavity when the whole assembly is installed in service.

6.3.2 All combustible material and fittings known to be present in the cavity in practice shall be included in the test assembly. (See A.2.3.)

6.4 Conditioning of test specimen

The test specimen shall be conditioned as specified in ISO 834. The covering (topping) shall be conditioned to moisture equilibrium or may be drier.

7 Test requirements

7.1 Types of supporting construction

Tests shall be carried out using one of the supporting constructions as follows :

- a) steel beams covered with nominally reinforced concrete slabs of width 550 ± 100 mm, thickness 50 ± 2 mm and density not less than 2200 kg/m^3 ;
- b) steel beams covered with nominally reinforced aerated concrete slabs of width 550 ± 100 mm, thickness 100 ± 2 mm and density $600 \pm 50 \text{ kg/m}^3$.

7.2 Tests with steel beams and aerated concrete slabs

7.2.1 The general form of assembly for these tests shall be as given in figure 1.

7.2.2 The beams shall be made of steel with a U/F value¹⁾ larger than or equal to 290 m^{-1} (for example IPE 140, according to Euronorm 19 and Euronorm 53) except that if the results of the test are to be used for subsequent extrapolation by calculation, the steel shall have a U/F value smaller than or equal to 160 m^{-1} (for example HE 140 B, according to Euronorm 19 and Euronorm 53). See clauses A.5 and A.6.

7.2.3 The joint between the edge of the topping and the furnace wall shall be completely filled with rigid or semi-rigid non-combustible high temperature mineral or ceramic fibre strips of density approximately $125 \pm 25 \text{ kg/m}^3$ (see figure 1) and glued to the furnace walls to provide an effective seal. Any joints between the cover slabs shall be properly sealed. Good thermal contact shall be ensured between the beams and the slabs²⁾ for unloaded specimens.

7.2.4 For testing suspended ceilings 2 m wide the steel beams shall be as shown in figure 1. For wider ceilings the number of steel beams and the spacing between the beams shall be adjusted as near as possible to 750 mm to ensure even spacing between the beams, provided that the space between the outer line of beams and the furnace wall shall always be 250 mm.

7.2.5 The furnace thermocouples shall be as specified in ISO 834; in addition thermocouples with a wire diameter of not more than 0,7 mm shall be as specified in figure 1 and located as follows.

- a) Temperature on flanges of beams. At least three thermocouples for loaded beams and at least six for unloaded beams shall be peened³⁾ or welded onto each steel beam to measure the temperature of the bottom flange. On each flange one thermocouple shall be located at midspan of the beam and the other two at a point approximately 500 mm from the midspan of the beam (see figure 1).
- b) Temperature of covering slab. One thermocouple for each space between beams, excluding the 250 mm end spaces to measure the temperature of the soffit, shall be fixed to the underside of the slab⁴⁾ at approximately the midpoint between the beams and at half span (see figure 1).

7.2.6 If additional information is required for use in assessment, then thermocouples with a wire diameter of not more than 0,25 mm shall be fixed as follows.

- a) Temperature in the cavity. One other thermocouple for each space shall be placed between beams, excluding the 250 mm end spaces.

1) U is the heat exposed surface of the steel beam per unit length in square metres per metre, i.e. the total surface of the steel beam except for the part covered by the slab, and F is the volume of the steel beam per unit length in cubic metres per metre or cross-sectional area, so giving different U/F values according to the type of steel beam profile (see figure 2).

2) See 8.2 and the annex.

3) Thermocouples shall be peened by drilling a shallow hole into the metal component, of a size just large enough to accommodate the hot-junction of the thermocouple. When the thermocouple hot-junction is in place, the edges of the hole are peened by using a pointed chisel-type tool to close the hole. This method gives a reliable system for measuring metal temperatures provided that the two thermocouple wires are not allowed to be in contact at any point outside the hole.

4) For the method of attachment of thermocouples, see ISO 834.