



SLOVENSKI STANDARD

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Test methods for determining the contribution to the fire resistance of structural members
- Part 5: Applied protection to concrete/profiled sheet steel composite member

Prüfverfahren zur Bestimmung des Beitrages zum Feuerwiderstand von tragenden
Bauteilen - Teil 5: Brandschutzmaßnahmen für profilierte Stahlblech/Beton-
Verbundkonstruktionen

Méthodes d'essai pour déterminer la contribution à la résistance au feu des éléments de
construction - Partie 5: Protection appliquée aux dalles mixtes béton/tôle d'acier profilée

Ta slovenski standard je istoveten z: prEN 13381-5

ICS:

13.220.50	Požarna odpornost gradbenih materialov in elementov	Fire-resistance of building materials and elements
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Test methods for determining the contribution to the fire resistance of structural members - Part 5: Applied protection to concrete/profiled sheet steel composite member

Méthodes d'essai pour déterminer la contribution à la résistance au feu des éléments de construction - Partie 5: Protection appliquée aux dalles mixtes béton/tôle d'acier profilée

Prüfverfahren zur Bestimmung des Beitrages zum Feuerwiderstand von tragenden Bauteilen - Teil 5: Brandschutzmaßnahmen für profilierte Stahlblech/Beton Verbundkonstruktionen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 127.

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

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

Contents

Page

Foreword.....	4
1 Scope.....	5
2 Normative references	5
3 Terms and definitions, symbols and units	6
3.1 Terms and definitions.....	6
3.2 Symbols and units	7
4 Test equipment.....	8
4.1 General.....	8
4.2 Furnace	8
4.3 Loading equipment.....	8
5 Test conditions.....	8
5.1 General.....	8
5.2 Support and restraint conditions	9
5.2.1 Standard conditions	9
5.2.2 Other support and restraint conditions	9
5.3 Loading conditions	9
6 Test specimens	10
6.1 Number of test specimens	10
6.2 Size of test specimens.....	10
6.3 Construction of test specimens	10
6.3.1 Construction of concrete/steel composite test slabs	10
6.3.2 Fabrication of concrete/steel composite slab test members	11
6.3.3 Application of the fire protection system to the composite test slab	11
6.4 Composition of test specimen component materials	12
6.4.1 Profiled steel sheet	12
6.4.2 Concrete.....	12
6.4.3 Steel reinforcement.....	12
6.4.4 Fire protection system.....	12
6.5 Properties of test materials.....	13
6.5.1 General.....	13
6.5.2 Concrete.....	13
6.5.3 Steel.....	13
6.5.4 Fire protection material	13
6.6 Verification of the test specimen.....	14
7 Installation of the test construction	14
8 Conditioning of the test construction.....	14
9 Application of instrumentation.....	14
9.1 General.....	14
9.2 Instrumentation for measurement of furnace temperature	14
9.3 Instrumentation for measurement of test specimen temperature	15
9.3.1 General.....	15
9.3.2 Mandatory thermocouples	15
9.3.3 Optional thermocouples.....	15
9.4 Instrumentation for measurement of pressure.....	15
9.5 Instrumentation for measurement of deformation	15
9.6 Instrumentation for measurement of applied load	16
10 Test procedure	16

10.1	General	16
10.2	Furnace temperature and pressure	16
10.3	Application and control of load	16
10.4	Temperature of test specimen	16
10.5	Deformation	16
10.6	Observations	16
10.7	Termination of test	16
11	Test results	17
11.1	Acceptability of test results	17
11.2	Presentation of test results	17
12	Test report	18
13	Assessment	18
13.1	General	18
13.2	Profiled steel sheet temperature	19
13.3	Equivalent thickness of concrete	19
13.4	Limiting exposure time	19
13.5	Insulation	20
14	Report of the assessment	20
15	Limits of applicability of the results of the assessment	21
Annex A	(normative) Test method to the smouldering fire or slow heating curve	28
A.1	Introduction	28
A.2	Test conditions	28
A.3	Termination of the test	29
A.4	Evaluation of the results	29
Annex B	(normative) Measurement of properties of fire protection materials	31
B.1	General	31
B.2	Thickness of fire protection materials	31
B.3	Density of applied fire protection materials	32
B.4	Moisture content of applied fire protection materials	32
	Bibliography	34

Foreword

This document (prEN 13381-5:2008) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede ENV 13381-5:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of 89/106/EEC.

This European Standard 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 standard 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 6: Applied protection to concrete filled hollow steel composite columns.
- Part 7: Applied protection to timber members.
- Annexes A and B are normative.

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 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.

The specific health and safety instructions contained within this Standard shall be followed.

1 Scope

This European Standard specifies a test method for determining the contribution of fire protection systems to the fire resistance of structural concrete/profiled sheet steel composite members or slabs. The concrete can be lightweight, normal-weight or heavy-weight concrete and of strength classes 20/25 (LC/C/HC) to 50/60 (LC/C/HC).

The method is applicable to all fire protection systems used for the protection of such structural composite members or slabs and includes sprayed fire protection, coatings, cladding protection systems and multi-layer or composite fire protection materials.

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

The test method is only applicable to fire protection systems which are fixed directly to the underside of the concrete/steel composite member or slab. Fire protection systems where the fire protection material is not attached directly to the composite member, leading to a continuous cavity between the concrete/steel composite member and the fire protection system of size greater than 5 mm is the subject of prEN 13381-1.

This European Standard contains the fire test which specifies the tests which shall be carried out to determine the ability of the fire protection system to remain coherent and fixed to the composite member and to provide data on the temperatures of the steel sheet, throughout the depth of the concrete (for extended application purposes) and the unexposed surface of the concrete, 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 concrete/steel composite members in accordance with the procedures given in EN 1994-1-2.

This European Standard also contains the assessment which prescribes how the analysis of the test data shall be made and gives guidance to the procedures by which interpolation shall 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 steel/concrete composite structures, steel types and thicknesses, concrete densities, strengths, thicknesses and production techniques over the range of thicknesses of the applied fire protection system tested.

2 Normative references

This European Standard 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 Standard 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 206-1, *Concrete – Part 1: Specification, performance, production and conformity*

prEN 13381-5:2008 (E)

EN 10080, *Steel for the reinforcement of concrete – Weldable ribbed reinforcing steel B 500 – Technical delivery conditions for bars, coils and welded fabric*

EN 10147, *Continuously hot-dip zinc coated structural steels strip and sheet – Technical delivery conditions*

EN 1992-1-1, *Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings*

EN 1994-1-1:1, *Eurocode 4: Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings*

ISO 8421-2, *Fire Protection – Vocabulary – Part 2: Structural fire protection*

EN ISO 13943, *Fire safety – Vocabulary (ISO 13943:1999)*

3 Terms and definitions, symbols and units**3.1 Terms and definitions**

For the purposes of this European Standard, the terms and definitions given in EN 1363-1, EN ISO 13943, ISO 8421-2 and EN 206-1, together with the following, apply.

3.1.1

concrete/steel composite member or slab (generally referred to as slab)

element of building construction which is loadbearing and is fabricated from a profiled steel sheet lower surface, defined according to EN 10147, and a concrete upper layer, defined according to EN 206-1. It may contain steel reinforcing bars

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3.1.2

fire protection material

any material or combination of materials applied to the surface of a concrete/steel composite slab for the purpose of increasing its fire resistance

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3.1.3

passive fire protection materials

materials which do not change their physical form on heating, providing fire protection by virtue of their physical or thermal properties. They may include materials containing water which, on heating, evaporates 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 provides 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 the structural concrete/steel composite slab

3.1.6

fire protection

protection afforded to the concrete/steel composite slab by the fire protection system such that the temperature throughout the depth of the structural slab and upon any steel reinforcing bars within it is limited throughout the period of exposure to fire

3.1.7**test specimen**

concrete/steel composite test slab plus the fire protection system under test

3.1.8**fire protection thickness**

thickness of a single layer fire protection system or combined thickness of all layers of a multilayer fire protection system

3.1.9**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

3.1.10**equivalent thickness of concrete**

theoretical thickness of concrete which provides the same thermal insulation for a given period of test as does the given thickness of the applied fire protection system

3.1.11**limiting exposure time**

time at which the adherence of a fire protection system to the concrete/steel composite test slab can be no longer considered acceptable, as indicated by a defined, significant increase in maximum recorded temperature at any point on the steel surface

3.1.12**limiting temperature**

maximum value of temperature reached on the lower surface of the ribs of the profiled steel sheet when the limiting exposure time is reached

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3.2 Symbols and units

Symbol	Unit	Designation
L_{exp}	mm	Length of the test specimen exposed to the furnace.
L_{sup}	mm	Centre to centre distance between the supports of the test specimen.
L_{spec}	mm	Total length of the test specimen.
W_{exp}	mm	Width of test specimen exposed to the furnace.
h	mm	Thickness of concrete in concrete/steel composite test specimen. (h_1 = depth of concrete above the steel ribs and h_2 = depth of concrete within the steel profile. Thickness $h = h_1 + h_2$)
l_p	mm	Length of the components of the trapezoidal or re-entrant profile of the steel sheet (l_{p1} , l_{p2} and l_{p3})
P	kN	Loading applied to concrete/steel composite test specimen.
$\theta_{m,l}(\theta_{m,u})$	°C	Limiting temperature.
h_{eff}	mm	the effective thickness of the concrete/steel composite test slab.
h_e	mm	the equivalent effective thickness of the concrete/steel composite test slab.
h_{eq}	mm	the equivalent thickness of concrete corresponding to the particular thickness of the fire protection system tested.
t_r	min	The time at which an increase of the characteristic temperature of all thermocouples on the unexposed concrete surface of 140 °C (or a maximum of 180 °C from a single thermocouple) is recorded.

prEN 13381-5:2008 (E)

f_y	N/mm ²	Yield strength of steel.
d_p	mm	Thickness of fire protection material.

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 along the length and width of the test specimen.

The loading equipment shall not inhibit the free movement of air above the test specimen and no part of the loading equipment, other than at the loading points, shall be closer than 60 mm to the unexposed surface of the test specimen.

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5 Test conditions

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5.1 General

Test specimens, subjected to predefined loading, are heated upon a furnace under specified temperature/time conditions, in horizontal orientation, with fire exposure applied from below.

Tests are carried out on a loaded large size test slab and an unloaded small size test slab to provide information on:

- the temperature of the profiled steel sheet behind the fire protection system;
- the behaviour of the fire protection system and its stickability;
- the temperature of the unexposed side of the test specimen;
- the temperature throughout the concrete (optional for extended application purposes).

It is recommended that the test be continued until the temperature of the exposed profiled steel surface reaches a mean value of at least 400 °C, (or any single maximum value of 500 °C is recorded), to give the necessary information on the stickability of the fire protection system. These temperatures may be modified if requested by the sponsor.

If the recommended termination temperatures are not reached after 6 hours test duration the test shall normally be terminated.

The procedures given in EN 1363-1 and EN 1363-2 (if relevant) shall be followed in the performance of this test method unless specific contrary instruction is given.

5.2 Support and restraint conditions

5.2.1 Standard conditions

The concrete/steel composite slab test specimens shall be tested as a simply supported one way structure with two free edges and an exposed surface and span as specified in 6.3.

The concrete/steel composite slab test specimens shall be installed onto the furnace to allow freedom for longitudinal movement and deflection using at one side rolling support(s) and at the other hinge support(s).

The surface of the bearings shall be smooth concrete or steel plates. The width of the bearings shall be the minimum representative of practice.

5.2.2 Other support and restraint conditions

If the support and restraint conditions differ from the standard conditions specified in 5.2.1, these conditions shall be described in the test report and the validity of the test results will be restricted to those tested.

5.3 Loading conditions

Loading shall be applied to the full size test specimens.

The magnitude and distribution of the load shall be such that the moment caused by the applied load (P) taking account of the dead weight of the specimen (measured or derived from samples of the components, see 6.5.1) and the weight of load distribution plates or beams represents 60 % of the design moment resistance according to equation 7.5 (b) of EN 1994-1-1.

The design moment resistance shall be calculated from the nominal material properties of the particular profiled steel sheet and the actual properties of the concrete used.

If the calculated load, when first applied, causes a deformation, at normal temperature, exceeding $L_{sup}/250$ then it shall be reduced until this criterion is met.

The load shall be symmetrically applied to the test specimen along two transverse loading lines, each one at a distance ($L_{sup}/4$) from each of the supports. The proportion of the total load applied at each loading position shall be $P/2$, as specified in Figure 1. The load shall produce stresses approximating to a uniformly distributed load.

Point loads shall be transferred to the test specimen through load distribution beams or plates (see Figure 1a)).

The total contact area between these and the concrete surface of the test specimen shall be as specified in EN 1363-1, provided that the load distribution beam or plate chosen has a flexural rigidity large enough to give the required distribution of the load.

Load distribution beams, for safety reasons, shall have a height to width ratio of < 1 .

If the load distribution beams or plates are of steel or other high conductivity material, they shall be insulated from the concrete surface of the test specimen by a suitable thermal insulation material.

Unexposed surface thermocouples shall not be closer than 100 mm to any part of the load distribution system as shown in Figure 1a).

6 Test specimens

6.1 Number of test specimens

At least one loaded full size concrete/steel composite test slab with the maximum thickness of applied fire protection system and one unloaded small size concrete/steel composite test slab with the minimum thickness of applied fire protection system shall be tested. If the fire protection system is only available in one thickness, the full size loaded test only shall be carried out, at that thickness and the applicability of the result restricted.

Additional small scale tests (one test per variable) may be carried out to provide further test data for the fire protection system when:

- it is to be applied to a concrete/steel composite member of composite thickness less than that specified in this test method;
- it is to be applied at intermediate fire protection thicknesses between maximum and minimum thickness;
- the test is carried out to the smouldering curve, in which case a small size test slab with both maximum and minimum thickness of applied fire protection material shall be tested, according to Annex A.

6.2 Size of test specimens

The size of the test specimens shall be as specified in Table 1 and exemplified in Figure 1.

6.3 Construction of test specimens

6.3.1 Construction of concrete/steel composite test slabs

The concrete/steel composite test slabs shall comprise a trapezoidal or re-entrant steel profile plus concrete of thickness h_1 , given in Table 1, over the upper ribs of the profiled steel sheet. The concrete shall contain prefabricated welded steel mesh, and may also include additional reinforcing bars.

The welded steel mesh, placed towards the unexposed surface in both small and large test slabs shall comprise 4,0 mm diameter ribbed bars such that the area of reinforcing steel bars is (70 to 100) mm² per metre of width of the concrete/steel composite test element.

The position of the welded steel mesh with respect to the exposed steel and unexposed concrete surfaces shall be ensured by the use of spacers, either plastic or concrete, such that the concrete cover obtained is (20,0 ± 2,0) mm.

For large test slabs, only, a second welded steel mesh, laid on the surface of the upper ribs of the profiled steel sheet shall be used. It shall comprise 6,0 mm diameter ribbed bars such that the area of reinforcing steel bars is (70 to 100) mm² per meter of width of the concrete/steel composite test element.

The actual position of the main reinforcing bars at the exposed and unexposed surfaces shall be accurately measured and recorded after the test at the positions of the thermocouples specified under 9.3. This shall be achieved by cutting the composite slab into at least two pieces through or close to the required positions.

Lifting hooks may be incorporated into the composite slab. These shall be of sufficient number and location to avoid longitudinal and transverse moments. Alternatively, the composite slabs shall be supported on steel beams for lifting purposes.