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Extended application of results from fire resistance tests - Part 13: Load bearing columns

Erweiterter Anwendungsbereich der Ergebnisse aus Feuerwiderstandsprüfungen - Teil 13: Tragende Stützen

Application étendue des résultats des essais de résistance au feu - Partie 13 : Poteaux porteurs

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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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Foreword

This document (prEN 15080-13:2009) 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 has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative Annex ZA, which is an integral part of this document.

This document is based on the draft for beams (prEN 15080-8).

Sections 1 to 6 are almost identical to the final version of prEN 15080-8.

Annex A, GUIDELINES FOR MAKING ASSESSMENTS has been taken directly from prEN 15080-8 with ‘beam’ changed to ‘column’ and some of the examples changed

Some of the figures contain text and do not yet conform to CEN rules.

The document needs:

An example of EXAP on a steel column

An example of EXAP on a concrete column

An example of EXAP on a timber column – Is this practical? Is this required?

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1 Scope

This Part of EN 15080 identifies the parameters and factors that affect the fire resistance of columns, when fully exposed to fire on all sides, and need to be taken into account when considering extended application of results of columns tested in accordance with EN 1365-4. It also gives the methodology to be used when preparing an extended application, including rules and calculation methods which can be applied to establish the resultant influence of a variation in one or more parameters and to determine the field of extended application.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1363-1, *Fire resistance tests — Part 1: General Requirements*

EN 1363-2, *Fire resistance tests — Part 2: Alternative and additional procedures*

EN 1365-4, *Fire resistance tests for load bearing elements — Part 3: Columns*

EN 15080-1, *Extended application of results from fire resistance tests — Part 1: General principles*

EN 13502-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance test (excluding products for use in ventilation systems)*

EN 1992-1-2, *Eurocode 2. Design of concrete structures — Part 1-2: General - Structural fire design*

EN 1993-1-2, *Eurocode 3. Design of steel structures. Part 1-2: General - Structural fire design*

EN 1994-1-2, *Eurocode 4. Design of composite steel and concrete structures — Part 1-2: General - Structural fire design*

EN 1995-1-1, *Eurocode 5. Timber structures — Part 1-1: General — Common rules and rules for buildings*

EN 1995-1-2, *Eurocode 5. Design of timber structures — Part 1-2: General — Structural fire design*

EN 338, *Structural timber — Strength classes*

EN 1194, *Glued laminated timber — Strength classes and determination of charactersitic values*

EN 10025, *Hot rolled products of non-alloy structural steels — Technical delivery conditions*

EN 10080–1, *Steel for the reinforcement of concrete — Weldable reinforcing steel — Part 1: General requirements*

EN 10138-1, *Prestressing steels — Part 1: General requirements*

ENV 13381-7, *Contribution to fire resistance of structural members — Part 7: Timber elements*

ISO 13943, *Glossary of fire terms and definitions*

3 Terms and Definitions

The definitions given in ISO 13943, EN 1363-1 and EN 1365-4 together with the following apply:

3.1
Test result
outcome of a testing process and its associated procedures detailed within EN 1365-4 (which may include some processing of the results from the testing of a number of specimens). A test result is expressed in terms of one or more fire performance parameter(s)

3.2
direct field of application of test results
outcome of a process (involving the application of defined rules) whereby a test result is deemed to be equally valid for variations in one or more of the product properties and/or intended end use application(s)

NOTE The direct field of application of test results are presented in EN 1365-4.

3.3
extended field of application of test results
outcome of a process (involving the application of defined rules that may incorporate calculation procedures) that predicts, for a variation of a product property and/or its intended end use application(s), a test result on the basis of one or more test results to the same test standard, i.e. to EN 1365-4

3.4
classification
process defined in EN 13501-2, whereby the fire performance parameters obtained from the results of one test, or a set of tests, or from a process of extended application, are compared with limiting values for those parameters that are set as criteria for achieving a certain classification

NOTE The relevant classes and related criteria for fire resistance are specified in Commission Decisions (2000/367/EC, 2000/147/EC and 2001/671/EC).

3.5
reference test
fire resistance test according to EN 1365-4 on a column from which the test result is used for the process of extended application

NOTE There may be more than one reference test.

3.6
parameter
aspect of the reference scenario that may vary in practice and may result in a change of the fire resistance performance

NOTE Examples are the load level and the height.

3.7
modelling factor
factor determined for a considered relevant structural failure mode on basis of the assessment of the reference test(s), which takes into account the differences between the test results and calculated results, and which is used to adjust the results of the extended application

3.8
Calculated structural resistance
resistance to axial compression of a column in a fire test calculated at the end of the test

3.9
effective structural resistance
predicted resistance to axial compression of a column for use in an extended application

3.10
relative resistance
ratio of the compressive resistance of a column in a fire resistance test to the resistance at normal temperatures calculated with all safety factors taken as unity

3.11
target classification
fire resistance that the extended application is required to achieve

4 Basis and methodology of establishing the extended application

4.1 General

An extended application analysis is required when the application of a column is not covered by the field of direct application given in the classification document of the product.

The situation of (a) fire test(s) carried out according to EN 1365-4 will be referred to as the "reference test" and "reference scenario". The result of a test, i.e. the fire resistance with respect to the load bearing capacity, will be referred as "$t_{ref,fi}$".

If more then one reference test is available, normally they will not be identical due to differences in design or differences between test conditions (for example load level or restraint conditions). In that case it is possible that in the classification report all reference columns are classified with the same classification "R_{ref}" although the actual test results ($t_{ref,fi}$) given in the test reports may differ.

4.2 Basic principles

4.2.1 General

It is assumed that extended application is made by appropriately qualified and experienced persons in the field of structural fire design.

The reference test(s) shall be well documented, i.e. an insight into the performance of the test specimen(s) and the mode of failure, leading to R_{ref}, are available.

Three analyses (described in 4.3, 4.4 and 4.5) should be carried out, where appropriate. It shall be decided whether:

— the field of application can be extended, maintaining the classification R_{ref} or changing the classification and if so, by how much;

— extension is not possible (new tests are required).

Any predicted increase in fire resistance shall not exceed the lesser of 15 minutes and 20 % of the target classification.

NOTE This is illustrated in A.1.

4.2.2 Basis of the extended application

An adequate understanding of the structural and thermal performance, as well as an understanding of other relevant features, shall be achieved based on the scope of the required extended application. For minor or obvious extensions to the reference test, the depth of analysis required may be reduced.

4.2.3 Mode of failure

Any assessment shall consider the possibility that the mode or cause of failure, such as structural collapse or failure of a fire protection system, might change and that the mode or cause of failure in a fire test may no longer be critical if one or more parameters are changed.

If a change of failure mode is expected, then extended application is not possible unless additional information is available.

NOTE For additional information see A.1.

4.2.4 Methods of analysis

When analysing the reference test(s) the rules given in the Eurocodes shall be used if applicable. Additional rules are given in this standard; these are also applicable in cases where the Eurocodes do not fully cover the construction to be assessed. Other calculation models, as well as empirical rules, shall be validated on the basis of similar tests as the reference test(s). Historic data and ad hoc tests may be used to supplement to the information of the reference test(s).

4.3 Basic thermal analysis

If the extended application is intended to be for a cross section of a size or shape different from the reference test(s) or for a different resistance time or another nominal fire curve, then a thermal assessment shall be made. The analysis should lead to an understanding of the temperature distribution and material strength variation throughout the column.

The analysis may take the form of a finite element or finite difference thermal analysis. In limited circumstances, when a dimension is changed, it may be possible to show, using a simple calculation, that the temperature distribution measured in the test can be conservatively used for the modified cross section.

For timber columns, it may be sufficient to analyse the charring depth instead of carrying out a complete thermal analysis. Where a thermal analysis is carried out, the position of the char-line shall be taken as the position of the 300 °C isotherm.

4.4 Basic structural analysis

4.4.1 General

The structural behaviour of the reference test(s) and of the situation to be assessed shall be analysed. The depth of structural analysis will depend on the complexity of the column and the extent of the proposed extended application. For any assessment, as appropriate, the following limit states should be considered:

— Compression failure;

— Flexural buckling;

— Torsional buckling;

— Local instability.

NOTE It is normally not necessary to consider vertical contraction (negative elongation) as specified in EN 1365-4.

The assessment shall also include:

— Connections, either mechanical of glued, between parts of the construction;

— Boundary conditions;

— Material properties.

4.4.2 Modelling factor

Any assessment shall take into account the accuracy of the structural model used. Models which over estimate the load resistance of the reference test(s), shall have a modelling factor applied when used to make an assessment for extended application.

In making any assessment the effective structural resistance shall be determined as follows:

$$R_{\text{eff}} = R \times k_{\text{mf}}$$

where:

R_{eff} is the effective structural resistance

R is the calculated structural resistance

k_{mf} is the modelling factor

For a single reference test, the modelling factor is defined as:

$$k_{\text{mf}} = \frac{F}{R} \quad \text{but not greater than 1,0}$$

Where:

F is the applied load or moment in the reference test

For more than one reference test:

$$k_{\text{mf}} = \frac{1}{n}\sum\frac{F_i}{R_i} \quad \text{but not greater than 1,0}$$

where:

F_{i} is the applied load or moment in the reference test i

R_{i} is the calculated structural resistance of test i calculated using the measured temperature distribution.

n is the number of tests

and with each individual value:

$$(F_i / R_i) \leq 1,3$$

If the value of (F_i / R_i) exceeds 1,3 then that test should not be used as part of the assessment of extended application.

NOTE 1 If the measured temperature distribution is not sufficiently comprehensive to allow the structural resistance to be adequately predicted then it may be supplemented with computed temperatures.

NOTE 2 If the value of (F_i / R_i) exceeds 1.3 there may be something wrong with the test data or the some aspect of the engineering model being used so use the particular test may be considered unreliable.

The above does not mention the temperature distribution across the section. If the temperature distribution is predicted then the predicted structural resistance should be computed using the predicted temperatures. Temperature was not mentioned in the EXAP for beams.

4.4.3 Material properties

The reference test(s) should be assessed using measured material strength. If the actual material strength is not available then the strength should be taken from Table 1.

In making any assessment of extended application, mean material properties shall be assumed. If the actual mean value is unknown, then values for the mean strength should be taken from Table 1.

NOTE The values in table are conservative values for the mean strength

For additional information see A.1.

Table 1 – Conservative values for mean strength

Material	Mean strength[(a)]
Concrete compressive strength	f_{ck} + 8 N/mm^2
Reinforcement steel to EN 10080 for concrete	f_{sk} × 1,1
Prestressing steel to EN 10138-1 for concrete	f_{pk} × 1,1
Hot rolled structural steel to EN 10025	f_y × 1,1
Timber - Structural timber, strength classes C14 to C40 to EN 338	f_k × 1,5
- glued laminated timber, all strength classes to EN 1194	f_k × 1,3
- LVL	f_k × 1,25
Other materials	to be estimated
(a) $f_{i\,k}$ and f_y are the characteristic strength values (5 % fractile)	
Table 1 is taken from the latest EXAP for beams	