

**Samverkanskonstruktioner (stål och betong) –  
Dimensionering – Eurocode 4 –  
Del 1-2: Brandteknisk dimensionering**

**Eurocode 4: Design of composite steel  
and concrete structures –  
Part 1-2: General rules – Structural fire design**



## **Samverkanskonstruktioner (stål och betong) – Dimensionering – Eurocode 4 – Del 1-2: Brandteknisk dimensionering**

*Eurocode 4: Design of composite steel and concrete structures – Part 1-2: General rules – Structural fire design*

Den europeiska förstandarden ENV 1994-1-2: 1994 gäller som svensk standard och publiceras i form av en svensk försöksstandard, som innehåller den engelska versionen av ENV 1994-1-2

Försöksstandarden förutsätter att den tillämpas i kombination med reglerna i ett svenskt anpassningsdokument, NAD, till standarden. Boverket i samråd med Banverket och Vägverket ger ut NAD-dokumentet.

ENV1994-1-2 kommer att revideras och delvis omarbetas i samband med att den publiceras som europastandard, EN. Det finns för närvarande inga planer på att översätta försöksstandarden till svenska.

Del 1-2 är en del av sammanlagt 3 delar. Övriga delar är del 1-1: Allmänna regler och del 2: Broar.

Enligt 1:5 i Boverkets Konstruktionsregler BKR 94 (BFS 1993:58) godtages metoder och konstruktionslösningar enligt denna försöksstandard som alternativ till sådana som anges i BKR 94, med tillägg och ändringar angivna i tillhörande NAD.



**EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM**

**ENV 1994-1-2**

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Descriptors: buildings, steel construction, concrete structures, design, safety, requirements, accident prevention, fire protection  
fire resistance, mechanical properties, thermodynamic properties, computation, mechanical strength

English version

**Eurocode 4: Design of composite steel and concrete structures –  
Part 1-2: General rules – Structural fire design**

Eurocode 4 – Bases du calcul des structures mixtes acier-béton – Partie 1-2: Règles générales – Calcul du comportement au feu

Eurocode 4 – Bemessung und Konstruktion von Verbundtragwerken aus Stahl und Beton – Teil 1-2: Allgemeine Regeln – Tragwerksbemessung für den Brandfall

This European Prestandard (ENV) was approved by CEN on 1993-11-23 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into an European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

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- Annex A** [informative]   Stress-strain relationships at elevated temperatures for structural steels.
- Annex B** [informative]   Stress-strain relationships at elevated temperatures for siliceous concrete.
- Annex C** [informative]   Concrete stress-strain relationships adapted to natural fires with a decreasing heating branch.
- Annex D** [normative]    Model for the calculation of the sagging moment resistance of a steel beam connected to a concrete slab and subject to fire beneath the concrete slab.
- Annex E** [normative]    Model for the calculation of the sagging and hogging moment resistances of a partially encased steel beam connected to a concrete slab and subject to the ISO-fire conditions beneath the concrete slab.
- Annex F** [normative]    Balanced summation model for the calculation of the ISO-fire resistance of composite columns with partially encased steel sections, for bending around the weak axis.
- Annex G** [normative]    Simple calculation model for concrete filled hollow sections exposed to the ISO-fire conditions.
- Annex H** [informative]   Planning and evaluation of experimental models.

## ***Foreword***

### ***General***

#### ***Objectives of the Eurocodes***

- (1) The "Structural Eurocodes" comprise a group of standards for the structural and geotechnical design of buildings and civil engineering works.
- (2) They cover execution and control only to the extent that is necessary to indicate the quality of the construction products, and the standard of the workmanship needed to comply with the assumptions of the design rules.
- (3) Until the necessary set of harmonized technical specifications for products and for the methods of testing their performance are available, some of the Structural Eurocodes cover some of these aspects in informative Annexes.

#### ***Background of the Eurocode Programme***

- (4) The Commission of the European Communities (CEC) initiated the work of establishing a set of harmonized technical rules for the design of building and civil engineering works which would initially serve as an alternative to the different rules in force in the various Member States and would ultimately replace them. These technical rules became known as the "Structural Eurocodes".
- (5) In 1990, after consulting their respective Member States, the CEC transferred the work of further development, issue and updating of the Structural Eurocodes to CEN, and the EFTA Secretariat agreed to support the CEN work.
- (6) CEN Technical Committee CEN/TC250 is responsible for all Structural Eurocodes.

#### ***Eurocode Programme***

- (7) Work is in hand on the following Structural Eurocodes, each generally consisting of a number of parts:

EN 1991 Eurocode 1	Basis of design and actions on structures
EN 1992 Eurocode 2	Design of concrete structures
EN 1993 Eurocode 3	Design of steel structures
EN 1994 Eurocode 4	Design of composite steel and concrete structures
EN 1995 Eurocode 5	Design of timber structures
EN 1996 Eurocode 6	Design of masonry structures
EN 1997 Eurocode 7	Geotechnical design
EN 1998 Eurocode 8	Design provisions for earthquake resistance of structures
EN 1999 Eurocode 9	Design of aluminium alloy structures
- (8) Separate sub-committees have been formed by CEN/TC250 for the various Eurocodes listed above.
- (9) This Part 1.2 of Eurocode 4 is being published as an European Prestandard (ENV) with an initial life of three years, from the date on the version is made available by CEN CS to Members of CEN.
- (10) This Prestandard is intended for experimental practical application and for the submission of comments.
- (11) After approximately two years CEN members will be invited to submit formal comments to be taken into account in determining future action.
- (12) Meanwhile feedback and comments on this Prestandard should be sent to the Secretariat of sub-committee CEN/TC 250/SC 4 at the following address:

NSAI  
Glasnevin, Dublin 9  
IRELAND

or to your national standards organization.



### ***National Application Documents (NAD's)***

(13) In view of the responsibilities of authorities in member countries for the safety, health and other matters covered by the essential requirements of the Construction Products Directive (CPD), certain safety elements in this ENV have been assigned indicative values which are identified by [ ], ("boxed values"). The authorities in each member country are expected to assign definitive values to these safety elements.

(14) Some of the supporting European or International Standards may not be available by the time this Prestandard is issued. It is therefore anticipated that a National Application Document (NAD) giving definitive values for safety elements, referencing compatible supporting standards and providing national guidance on the application of this Prestandard, will be issued by each member country or its Standards Organization.

(15) It is intended that this Prestandard is used in conjunction with the NAD valid in the country where the building or civil engineering works is located.

### ***Matters specific to this prestandard***

#### ***Safety requirements***

(16) The scope of Eurocode 4 is defined in ENV 1994-1-1, section 1.1.1 and 1.1.2, and the scope of this Part 1.2 of Eurocode 4 is defined in section 1.1. Additional parts of Eurocode 4 which are planned are indicated in ENV 1994-1-1, section 1.1.3.

(17) The general objectives of fire protection are to limit risks with respect to the individual and society, neighbouring property, and where required, directly exposed property, in the case of fire.

(18) Construction Products Directive 89/106/EEC gives the following essential requirement for the limitation of fire risks:

"The construction works must be designed and build in such a way, that in the event of an outbreak of fire

- the load bearing resistance of the construction can be assumed for a specified period of time
- the generation and spread of fire and smoke within the works are limited
- the spread of fire to neighbouring construction works is limited
- the occupants can leave the works or can be rescued by other means
- the safety of rescue teams is taken into consideration".

(19) According to the Interpretative Document "Safety in Case of Fire" the essential requirement may be observed by following various fire safety strategies, including passive and active fire protection measures.

(20) The Structural Eurocodes deal with specific aspects of passive fire protection in terms of designing structures and parts thereof for adequate load bearing resistance and for limiting fire spread as relevant.

(21) Required functions and levels of performance are generally specified by the national authorities - mostly in terms of standard fire resistance rating. Where fire safety engineering for assessing passive and active measures is accepted, requirements by authorities will be less prescriptive and may allow for alternative strategies.

(22) This Part 1.2, together with ENV 1991-2-2, Actions on structures exposed to fire, gives the supplements to ENV 1994-1-1, which are necessary so that structures designed according to this set of Structural Eurocodes may also comply with structural fire resistance requirements.

(23) Supplementary requirements concerning, for example

- the possible installation and maintenance of sprinkler systems
- conditions on occupancy of building or fire compartment
- the use of approved insulation and coating materials, including their maintenance

are not given in this document, because they are subject to specification by the competent authority.

*Design procedures*

(24) A full analytical procedure for structural fire design would take into account the behaviour of the structural system at elevated temperatures, the potential heat exposure and the beneficial effects of active fire protection systems, together with the uncertainties associated with these three features and the importance of the structure (consequences of failure).

(25) At the present time it is possible to undertake a procedure for determining adequate performance which incorporates some, if not all, of these parameters and to demonstrate that the structure, or its components, will give adequate performance in a real building fire. However the principal current procedure in European countries is one based on results from standard fire resistance tests. The grading system in regulations, which call for specific periods of fire resistance, takes into account (though not explicitly), the features and uncertainties described above.

(26) Due to the limitations of the test method, further tests or analyses may be used. Nevertheless, the results of standard fire tests form the bulk of input for calculation models for structural fire design. This prestandard therefore deals in the main with the design for the standard fire resistance.

(27) Application of this Part 1.2 of Eurocode 4 with the thermal actions given in ENV 1991-2-2, is illustrated in table 0.1. For design according to this part, ENV 1991-2-2 is required for the determination of temperature fields in structural elements, or when using advanced calculation models for the analysis of the structural response.

Table 0.1: Design procedures

Thermal actions given in ENV 1991-2-2		according to national specifications:	design by tabular data given in ENV 1994-1-2	design by calculation models given in ENV 1994-1-2
standard temperature-time curve	FOR VERIFYING	standard fire resistance requirements	as relevant 1) or from fire resistance tests	as relevant 1)
other nominal temperature-time curves		other nominal fire resistance requirements	not applicable	by advanced calculation models
standard temperature-time curve	FOR VERIFYING	fire resistance - for equivalent time of fire exposure	not applicable	by advanced calculation models
parametric fire exposure		fire resistance - for specified period of time or - for entire fire duration	not applicable	by advanced calculation models
1) depending on the assessment methods included in this document				

*Design aids*

(28) Where simple calculation models are not available, the Eurocode fire parts give design solutions in terms of tabular data (based on tests or advanced calculation models), which may be used within the specified limits of validity.

(29) It is expected, that design aids based on the calculation models given in ENV 1994-1-2, will be prepared by interested external organizations.

# 1 General

## 1.1 Scope

- (1)P This Part 1.2 of Eurocode 4 deals with the design of composite steel and concrete structures for the accidental situation of fire exposure and shall be used in conjunction with ENV 1994-1-1 and ENV 1991-2-2. This Part 1.2 only identifies differences from, or supplements to, normal temperature design.
- (2)P This document deals only with passive methods of fire protection. Active methods are not covered.
- (3)P This Part 1.2 applies to structures which for reasons of general fire safety, are required to fulfil certain functions in exposure to fire, in terms of
  - avoiding premature collapse of the structure (load bearing function)
  - limiting fire spread (flames, hot gases, excessive heat) beyond designated areas (separating function).
- (4)P This Part 1.2 gives principles (i)P and application rules (j) (see section 1.2 in ENV 1994-1-1), for designing structures for specified requirements in respect to the aforementioned functions and levels of performance.
- (5) In this document, columns subjected to fire conditions are assumed to be equally heated all around their cross-section, whereas beams supporting a floor are supposed to be heated only from the three lower sides.
- (6) For beams connected to slabs with profiled steel sheets a three side fire exposure may be assumed, when at least 90 % of the upper side of the steel profile is directly covered by the steel sheet.
- (7)P This document only applies to structures or parts of structures, which are within the scope of ENV 1994-1-1 and are designed accordingly.
- (8) The commonly used composite cross-section types, partially developed in view of fire resistance requirements are described in figures 1.1 to 1.8.
- (9)P For all composite cross-sections longitudinal shear connection between steel and concrete shall be assured according to the principles of ENV 1994-1-1.
- (10) Typical examples of concrete slabs with profiled steel sheets with or without reinforcing bars are given in figure 1.1.

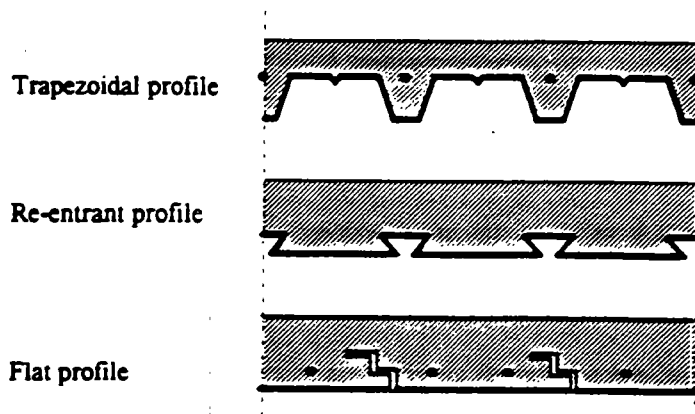


Fig. 1.1

- (11) Typical examples of composite beams are given in figures 1.2 to 1.5.
  - Note: No rules are given in ENV 1994-1-1 for the normal temperature design of a steel beam partially encased in a slab, as given in figure 1.4.
  - Note: Constructional detailing of steel beams with partial concrete encasement as given in figures 1.3 and 1.5, is covered in section 5.