Subject	Revised numbering – all clauses
Clause N°/ Subclause N° / Annex	Eurocode Material Fire Parts EN 199x-1-2

Reason for change

Ease of use, clarity and consistency. Based on recommended structure from TC250 (ref.)

Original content

N/A

Change

N/A

Background information

Changes reflect an improved layout and are based on recommended structure provided by TC250.

Subject	Revised harmonised table of content
Clause N°/ Subclause N° / Annex	Eurocode Material Fire Parts EN 199x-1-2

Reason for change

The extensive analysis and comparison of the table of content of all Eurocode Material Fire Parts (EN 199x-1-2) showed that, with the exceptions of sections 1 and 2, the other sections are **not** organised in the same way and are **not** harmonised at all (see tables 1 to 6). The largest deviations and inconsistencies are found in sections 3 and 4.

EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
1. General	1 General	1 General	1. General	1 General
2 Basis of design	2 Basis of design	2 Basis of design	2. Basic principles and rules	2 Basis of design
3 Material properties	3 Material properties	3 Material properties	3. Materials	3 Material
4 Structural fire design	4 Design procedure	4 Design procedures for mechanical resistance	4 Design Procedures for obtaining fire resistance of masonry walls	4 Structural fire design
	5 Constructional details	5 Design procedures for wall and floor assemblies	5 Detailing	
		6 Connections		
		7 Detailing		

Table 1: Comparison of table of content of all Eurocode Material Fire Parts

EN 1992-1-2	EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
1 General 1.1 Scope 1.1.1 Scope of Eurocode 2 1.1.2 Scope of Part 1-2 of Eurocode 2 1.2 Normative references 1.3 Assumptions 1.4 Distinctions between principles and application rules 1.5 Definitions 1.6 Symbols 1.6.1 Supplementary symbols to EN 1992-1-1 1.6.2 Supplementary subscripts to EN 1992-1-1	1. General 1.1 Scope 1.2 Normative references 1.3 Assumptions 1.4 Distinction between principles and application rules 1.5 Terms and definitions 1.6 Symbols	1 General 1.1 Scope 1.2 Normative references 1.3 Assumptions 1.4 Distinction between Principles and Application Rules 1.5 Definitions 1.5.1 Special terms relating to design in general 1.5.2 Terms relating to material and products properties 1.5.3 Terms relating to heat transfer analysis 1.5.4 Terms relating to mechanical behaviour analysis 1.6 Symbols	1 General 1.1 Scope 1.1.1 Scope of Eurocode 5 1.1.2 Scope of EN 1995-1-2 1.2 Normative references 1.3 Assumptions 1.4 Distinction between principles and application rules 1.5 Terms and definitions 1.6 Symbols	1. General 1.1 Scope 1.2 Normative references 1.3 Assumptions 1.4 Distinction between Principles and application Rules 1.5 Definitions 1.5.1 Special terms relating to fire design in general 1.5.2 Special terms relating to calculation methods 1.6 Symbols	1 General 1.1 Scope 1.1.1 Scope of EN 1999 1.1.2 Scope of EN 1999-1-2 1.2 Normative references 1.3 Assumptions 1.4 Distinction between principles and application rules 1.5 Terms and definitions 1.5.1 Special terms relating to design in general 1.5.2 Terms relating to thermal actions 1.5.3 Terms relating to material and products 1.5.4 Terms relating to heat transfer analysis 1.5.5 Terms relating to mechanical behaviour analysis 1.6 Symbols

Table 2: Comparison of table of content for Section 1 of all Eurocode Material Fire Parts

EN 1992-1-2	EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
2 Basis of design 2.1 Requirements 2.1.1 General 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties 2.4 Verification methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of part of the structure 2.4.4 Global structural analysis	2 Basis of design 2.1 Requirements 2.1.1 Basic requirements 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties 2.4 Verification methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of part of the structure 2.4.4 Global structural analysis	2 Basis of design 2.1 Requirements 2.1.1 Basic requirements 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties 2.4 Verification methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of part of the structure 2.4.4 Global structural analysis	2 Basis of design 2.1 Requirements 2.1.1 Basic requirements 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties and resistances 2.4 Verification methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of parts of the structure 2.4.4 Global structural analysis	2. Basic principles and rules 2.1 Performance requirement 2.1.1 General 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties 2.4 Assessment methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of part of the structure 2.4.4 Global structural analysis	2 Basis of design 2.1 Requirements 2.1.1 Basic requirements 2.1.2 Nominal fire exposure 2.1.3 Parametric fire exposure 2.2 Actions 2.3 Design values of material properties 2.4 Verification methods 2.4.1 General 2.4.2 Member analysis 2.4.3 Analysis of part of the structure 2.4.4 Global structural analysis

Table 3: Comparison of table of content for Section 2 of all Eurocode Material Fire Parts

EN 1992-1-2	EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
3 Material properties **3.1 General** **3.2 Strength and deformation properties at elevated temperatures** 3.2.1 General 3.2.2 Concrete 3.2.2.1 Concrete under compression 3.2.2.2 Tensile strength 3.2.3 Reinforcing steel 3.2.4 Prestressing steel **3.3 Thermal and physical properties of concrete with siliceous and calcareous aggregates** 3.3.1 Thermal elongation 3.3.2 Specific heat 3.3.3 Thermal conductivity **3.4 Thermal elongation of reinforcing and prestressing steel**	3 Material properties **3.1 General** **3.2 Mechanical properties of carbon steels** 3.2.1 Strength and deformation properties 3.2.2 Unit mass **3.3 Mechanical properties of stainless steels** **3.4 Thermal properties** 3.4.1 Carbon steels 3.4.2 Stainless steels 3.4.3 Fire protection materials	3 Material properties **3.1 General** **3.2 Mechanical properties** 3.2.1 Strength and deformation properties of structural steel 3.2.2 Strength and deformation properties of concrete 3.2.3 Reinforcing steels **3.3 Thermal properties** 3.3.1 Structural and reinforcing steels 3.3.2 Normal weight concrete 3.3.3 Light weight concrete 3.3.4 Fire protection materials **3.4 Density**	3 Material properties **3.1 General** **3.2 Mechanical properties** **3.3 Thermal properties** **3.4 Charring depth** 3.4.1 General 3.4.2 Surfaces unprotected throughout the time of fire exposure 3.4.3 Surfaces of beams and columns initially protected from fire exposure 3.4.3.1 General 3.4.3.2 Charring rates 3.4.3.3 Start of charring 3.4.3.4 Failure times of fire protective claddings **3.5 Adhesives**	3. Materials **3.1 Units** **3.2 Mortar** **3.3 Mechanical properties of masonry** 3.3.1 Mechanical properties of masonry at normal temperature 3.3.2 Strength and deformation properties of masonry at elevated temperature 3.3.2.1 General 3.3.2.2 Unit mass 3.3.3 Thermal properties 3.3.3.1 Thermal elongation 3.3.3.2 Specific heat capacity 3.3.3.3 Thermal conductivity	3 Material **3.1 General** **3.2 Mechanical properties of aluminium alloys** 3.2.1 Strength and deformation properties 3.2.2 Unit mass **3.3 Thermal properties** 3.3.1 Aluminium alloys 3.3.2 Fire protection materials

Table 4: Comparison of table of content for Section 3 of all Eurocode Material Fire Parts

EN 1992-1-2	EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
4 Design procedures **4.1 General** **4.2 Simplified calculation method** 4.2.1 General 4.2.2 Temperature profiles 4.2.3 Reduced cross-section 4.2.4 Strength reduction 4.2.4.1 General 4.2.4.2 Concrete 4.2.4.3 Steel **4.3 Advanced calculation methods** 4.3.1 General 4.3.2 Thermal response 4.3.3 Mechanical response 4.3.4 Validation of advanced calculation models **4.4 Shear, torsion and anchorage** **4.5 Spalling** 4.5.1 Explosive spalling 4.5.2 Falling off of concrete **4.6 Joints** **4.7 Protective layers**	4 Structural fire design **4.1 General** **4.2 Simple calculation models** 4.2.1 General 4.2.2 Classification of cross-sections 4.2.3 Resistance 4.2.4 Critical temperature 4.2.5 Steel temperature development **4.3 Advanced calculation models** 4.3.1 General 4.3.2 Thermal response 4.3.3 Mechanical response 4.3.4 Validation of advanced calculation models	4 Design procedure **4.1 Introduction** **4.2 Tabulated data** 4.2.1 Scope of application 4.2.2 Composite beam comprising steel beam with partial concrete encasement 4.2.3 Composite columns **4.3 Simple Calculation Models** 4.3.1 General rules for composite slabs and composite beams 4.3.2 Unprotected composite slabs 4.3.3 Protected composite slabs 4.3.4 Composite beams 4.3.5 Composite columns **4.4 Advanced calculation models** 4.4.1 Basis of analysis 4.4.2 Thermal response 4.4.3 Mechanical response 4.4.4 Validation of advanced calculation models	4 Design procedures for mechanical resistance **4.1 General** **4.2 Simplified rules for determining cross-sectional properties** 4.2.1 General 4.2.2 Reduced cross-section method 4.2.3 Reduced properties method **4.3 Simplified rules for analysis of structural members and components** 4.3.1 General 4.3.2 Beams 4.3.3 Columns 4.3.4 Mechanically jointed members 4.3.5 Bracings **4.4 Advanced calculation methods**	4 Design Procedures for obtaining fire resistance of masonry walls **4.1 General information on the design of walls** 4.1.1 Wall types by function 4.1.2 Cavity walls and untied walls comprising independent leaves **4.2 Surface finishes - rendering mortar and plaster** **4.3 Additional requirements for masonry walls** **4.4 Assessment by testing** **4.5 Assessment by tabulated data** **4.6 Assessment by calculation**	4 Structural fire design **4.1 General** **4.2 Simple calculation models** 4.2.1 General 4.2.2 Resistance 4.2.3 Aluminium temperature development **4.3 Advanced calculation models** 4.3.1 General 4.3.2 Thermal response 4.3.3 Mechanical response 4.3.4 Validation of advanced calculation models

Table 5: Comparison of table of content for Section 4 of all Eurocode Material Fire Parts

EN 1991-1-2	EN 1992-1-2	EN 1993-1-2	EN 1994-1-2	EN 1995-1-2	EN 1996-1-2	EN 1999-1-2
	5 Tabulated data **5.1 Scope** **5.2 General design rules** **5.3 Columns** 5.3.1 General 5.3.2 Method A 5.3.3 Method B **5.4 Walls** 5.4.2 Load-bearing solid walls 5.4.3 Fire walls **5.5 Tensile members** **5.6 Beams** 5.6.1 General 5.6.2 Simply supported beams 5.6.3 Continuous beams 5.6.4 Beams exposed on all sides **5.7 Slabs** 5.7.1 General 5.7.2 Simply supported solid slabs 5.7.3 Continuous solid slabs 5.7.4 Flat slabs 5.7.5 Ribbed slabs		5 Constructional details **5.1 Introduction** **5.2 Composite beams** **5.3 Composite columns** 5.3.1 Composite columns with partially encased steel sections 5.3.2 Composite columns with concrete filled hollow sections **5.4 Connections between composite beams and columns** 5.4.1 General 5.4.2 Connections between composite beams and composite columns with steel sections encased in concrete 5.4.3 Connections between composite beams and composite columns with partially encased steel sections 5.4.4 Connections between composite beams and composite columns with concrete filled hollow sections	5 Design procedures for wall and floor assemblies **5.1 General** **5.2 Analysis of load-bearing function** **5.3 Analysis of separating function**	5 Detailing **5.1 General** **5.2 Junctions and joints** **5.3 Fixtures, pipes and cables**	

Table 6: Comparison of table of content for Section 5 of all Eurocode Material Fire Parts

Original content

See tables 1 to 6.

Change

A proposal for a harmonised table of content of all Eurocode Material Fire Parts (EN 199x-1-2) has been prepared and is shown in the following:

Section 1 Scope
- 1.1 Scope of EN 199x
- 1.2 Scope of EN 199x-1-2
- 1.3 Assumptions
- 1.4 Distinction between principles and application rules

Section 2 Normative references

Section 3 Terms, definitions and symbols
- 3.1 Terms and definitions
- 3.2 Symbols and abbreviations

Section 4 Basis of design
- 4.1 General
- 4.2 Nominal fire exposure
- 4.3 Physically based fire exposure
- 4.4 Actions
- 4.5 Design values of material properties
- 4.6 Verification methods
- 4.7 Member analysis
- 4.8 Analysis of parts of the structure
- 4.9 Global structural analysis

Section 5 Material properties
- 5.1 General
- 5.2 Thermal properties
  - 5.2.1 Material a
    - 5.2.1.1 General
    - 5.2.1.2 Emissivity coefficient
    - 5.2.1.3 Thermal conductivity
    - 5.2.1.4 Specific heat
    - 5.2.1.5 Density
  - 5.2.2 Material b
  - 5.2.3 Material c
- 5.3 Mechanical properties
  - 5.3.1 Material a
    - 5.3.1.1 General
    - 5.3.1.2 Thermal elongation
    - 5.3.1.3 …
  - 5.3.2 Material b
  - 5.3.3 Material c
- 5.4 ….

Section 6 Tabulated design data
- 6.1 General
- 6.2 …

Section 7 Simplified design methods
- 7.1 General
- 7.2 …

Section 8 Advanced design methods
- 8.1 General
- 8.2 Thermal analysis
- 8.3 Mechanical analysis
- 8.4 Validation of advanced design methods

Section 9 Detailing
- 9.1 General
- 9.2 …

Background information

The sections 1 to 3 are based on the recommended structure from TC250.

The section 4 (basis of design, former section 2) has been harmonised. The clauses on *Member analysis (former 2.4.2), Analysis of parts of the structure (former 2.4.3) and Global structural analysis (former 2.4.4)* are considered as separate sub-chapters (4.7, 4.8 and 4.9) in order to improve ease of use and clarity.

The Section 5 (material properties, former section 3) has been harmonised. The recommended order of the clauses reflects the common advanced design procedure in structural fire engineering, which foresees first a thermal analysis followed by a mechanical analysis of members, parts of the structure or the whole structure. Thus, first the thermal properties (section 5.2) are given and subsequently the mechanical properties (section 5.3). Emissivity coefficient, thermal conductivity, specific heat and density are often used and needed for the thermal analysis and thus are given under the section 5.2 (thermal properties). Thermal elongation is not used for the thermal analysis but may be used for the mechanical analysis and is thus a mechanical property; this is the reason why it is given under the section 5.3 (mechanical properties).

Eurocode 4 Fire Part (EN 1994-1-2) gives three different fire design procedures based on *Tabulated data*, *Simple calculation model*s and *Advanced calculation model*s. In order to improve the ease of use, the clarity and the consistency between all Eurocode Material Fire Parts, the PT proposes to include the same three different fire design procedures in all Eurocode Material Fire Parts, even if a specific Eurocode Material Fire Part (e.g. EN 1993-1-2) may not give any *Tabulated data.* The recommended order of the sections 6 to 8 reflects the common fire design procedure in the practice, first the simplest fire design based on *Tabulated design data (section 6),* then the fire design based on *Simplified design methods (section 7)* and finally the fire design based on *Advanced design methods (section 8).* Figure 1 explains the basic idea of the proposed harmonised table of content for the sections 6 to 8.

- 6 Tabulated design data
  - 6.1 xx
  - 6.2 xx
  - …..
- 7 Simplified design methods
  - 7.1 xx
  - 7.2 xx
  - ….
- 8 Advanced design methods
  - 8.1 xx
  - 8.2 xx
  - ….

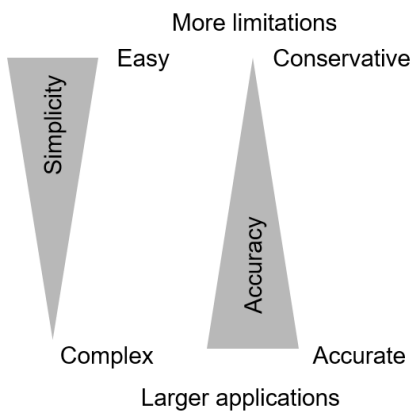

Figure 1: Proposed table of content for sections 6 to 8 of all Eurocode Material Fire Parts

A definition of *Tabulated design data*, *Simplified design methods* and *Advanced design methods* has been introduced at the beginning of each section (see also background document to task 10). The word *design* is introduced in the title of sections 6 to 8 in order to underline that these sections give methods for the fire design. The word *methods* instead of *models* is used in the title of sections 6 to 8 as this word is more general.

Ease of use justification

The proposed harmonised table of content of all Eurocode Material Fire Parts (EN 199x-1-2) significantly improves the ease of use, the clarity and the consistency between all Eurocode Material Fire Parts.

Subject	Wording
Clause N°/ Subclause N° / Annex	1.1.2 (1) and others

Reason for change

Original content

EN 1993-1-2

Change

This Part of EN 1993

Background information

Ease of use justification

Subject	Passive methods of fire protection
Clause N°/ Subclause N° / Annex	1.1.2 (2)

Reason for change

Original content

EN 1993-1-2 deals only with passive methods of fire protection.

Change

Clause deleted

Background information

Ease of use justification

Subject	Field of application
Clause N°/ Subclause N° / Annex	1.1.2 (3)

Reason for change

Original content

EN 1993-1-2 applies to steel structures that are required to fulfil this load bearing function if exposed to fire, in terms of avoiding premature collapse of the structure.

Change

(2)P This Part of EN 1993 applies to steel structures required to fulfil a loadbearing function.

Background information

Ease of use justification

Subject	Wording
Clause N°/ Subclause N° / Annex	1.1.2 (4)

Reason for change

Original content

for designing structures

Change

for the design of structures

Background information

Ease of use justification

Subject	Wording
Clause N°/ Subclause N° / Annex	1.1.2 (6), (7), (8) and (9)

Reason for change

Original content

The methods given

Change

(5)P The methods given in this Part of EN 1993

Background information

Ease of use justification

Subject	Wording
Clause N°/ Subclause N° / Annex	1.3

Reason for change

Original content

Any passive fire protection systems

Change

any fire protection measure

Background information

Ease of use justification

Subject	Term and definitions
Clause N°/ Subclause N° / Annex	1.4

Reason for change

Original content

The rules given in clause 1.4 of EN1990 and EN1991-1-2 apply.

Change

(1) P For the purposes of this Part of EN 1993, the definitions of EN 1990 and EN 1991-1-2 apply with the following additional definitions:

Background information

Ease of use justification

Subject	Deformation criteria
Clause N°/ Subclause N° / Annex	2.1.1 (3) and (4) in EN 1992-1-2, EN 1994-1-2, EN 1995-1-2, EN 1996-1-2 2.1.1 (2) and (3) in EN 1993-1-2 2.1.1 (5) and (6) in EN 1999-1-2

Reason for change

The relevant clauses were not consistent in the different Eurocodes.

The wording was not particularly clear.

Original content

In EN 1992-1-2

(3)P Deformation criteria shall be applied where the means of protection, or the design criteria for separating elements, require consideration of the deformation of the load bearing structure.

(4) Consideration of the deformation of the load bearing structure is not necessary in the following cases, as relevant:

- the efficiency of the means of protection has been evaluated according to 4.7,

- the separating elements have to fulfil requirements according to nominal fire exposure.

In EN 1993-1-2

(2) Deformation criteria should be applied where the protection aims, or the design criteria for separating elements, require consideration of the deformation of the load bearing structure.

(3) Except from (2) consideration of the deformation of the load bearing structure is not necessary in the following cases, as relevant:
- the efficiency of the means of protection has been evaluated according to section 3.4.3;
and

- the separating elements have to fulfil requirements according to a nominal fire exposure.

In EN 1994-1-2

(3)P Deformation criterion shall be applied where the means of protection, or the design criterion for separating members, require consideration of the deformation of the load bearing structure.

(4) Consideration of the deformation of the load bearing structure is not necessary in the following cases,

as relevant:

- the efficiency of the means of protection has been evaluated according to 3.3.4 and

- the separating elements have to fulfill requirements according to a nominal fire exposure.

In EN 1995-1-2

(3)P Deformation criteria shall be applied where the means of protection, or the design criteria

for separating elements, require that the deformation of the load-bearing structure is taken into account.

(4) Consideration of the deformation of the load-bearing structure is not necessary in the following cases, as relevant:

− the efficiency of the means of protection has been proved according to 3.4.3 or 5.2;

− the separating elements fulfil the requirements of a nominal fire exposure.

In EN 1996-1-2

(3)P Deformation criteria shall be applied where the means of protection, or the design criteria for separating elements, requires consideration of the deformation of the load bearing structure.

(4) Consideration of the deformation of the load bearing structure is not necessary in the following case:

- the separating elements have to fulfil requirements according to a nominal fire exposure.

In EN 1999-1-2

(5) Deformation criteria should be applied where the protection aims, or the design criteria for separating elements, require consideration of the deformation of the load bearing structure.

(6) Except from (5), consideration of the deformation of the load bearing structure is not necessary in the following cases, as relevant:

- the efficiency of the means of protection has been evaluated according to section 3.3.2;

- the separating components have to fulfil requirements according to a nominal fire exposure.

Change

(2) P Deformation criteria shall be applied where the means of protection require consideration of the deformation of the loadbearing structure.

(3) Consideration of the deformation of the loadbearing structure is not necessary when the efficiency of the means of protection has been proved using appropriate test procedure,

(4) P Deformation criteria shall be applied where the design criteria for separating elements require consideration of the deformation of the loadbearing structure.

(5) Consideration of the deformation of the loadbearing structure is not necessary when the separating elements fulfil the requirements of a nominal fire exposure.

Background information

The wording was not particularly clear, with a clause stating two obligations, followed by a clause giving two exceptions.

In the proposed wording, one clause is given for one requirement, immediately followed by the exception related to that requirement. This pair of clauses is proposed for each of the two requirements.

Ease of use justification

We think that the new wording is clearer, which makes the code easier to use.

Subject	Wording
Clause N°/ Subclause N° / Annex	2.1.2

Reason for change

Wrong utilisation of the word “criteria”.

The wording was different in the different Eurocodes.

“Should” was used in EN 1993-1-2 and ‘Shall” in the other Eurocodes.

Original content

(1)P For the standard fire exposure, members shall comply with criteria R, E and I as follows:

- separating only: integrity (criterion E) and, when requested, insulation (criterion I)

- load bearing only: mechanical resistance (criterion R)

- separating and load bearing: criteria R, E and, when requested I

(2) Criterion “R” is assumed to be satisfied where the load bearing function is maintained during the required time of fire exposure.

(3) Criterion “I” may be assumed to be satisfied where the average temperature rise over the whole of the non-exposed surface is limited to 140 K, and the maximum temperature rise at any point of that surface does not exceed 180 K

(4) With the external fire exposure curve the same criteria (R, E, I) should apply, however the reference to this specific curve should be identified by the letters "ef" (see EN 1991-1-2)

(5) With the hydrocarbon fire exposure curve the same criteria (R, E, I) should apply, however the reference to this specific curve should be identified by the letters "HC".

(6) Where a vertical separating element with or without load-bearing function has to comply with impact resistance requirement (criterion M), the element should resist a horizontal concentrated load as specified in EN 1363 Part 2.

Change

The word “criteria” should be replaced by the word “function”.

“Shall” will be used in clause (1)

Background information

The R, E and I functions have obviously been copied by the writers of the Eurocodes from the test standards (EN 13501) where they have been present long before Eurocodes.

In this standard, yet, R, E, and I are defined as “performance” in the sense of “the ability of an element”.

In order to judge whether each performance is achieved or not, some criteria must be used (such as limits of deflections, limits of temperature increase…). A criteria is a well-defined mean used to verify whether a performance is achieved or not.

In the Eurocodes yet, R, E and I performances have been confused with criteria. It is proposed here to replace the word criteria by the word “function”, seen here as an equivalent to “performance” (the fact to fulfil the function is the performance).

Criteria should only be used when a given rule is given in order to judge about achieving the performance or not.

Ease of use justification

Subject	Material properties
Clause N°/ Subclause N° / Annex	2.3 (1)

Reason for change

Clarity

Original content

mechanical (strength and deformation) material properties

Change

mechanical (strength and stiffness) material properties

Background information

“Deformation” is not a material property. In addition to strength, “stiffness” is one the most used mechanical material property. As the code writers explicitly refer to “f_k or E_k” later in the text, it seems indeed clear that they had stiffness in mind. The new wording is in that sense more correct.

Ease of use justification

Subject	Partial safety factor
Clause N°/ Subclause N° / Annex	2.3 (1)

Reason for change

Clarity

Original content

is the partial factor for the relevant material property, for the fire situation.

Change

is the partial factor for the relevant mechanical material property for the fire situation, as defined according to 4.5 (2).

Background information

The word “mechanical” has been added because this clause (1) is on mechanical material properties.

The reference to clause (2) that follows is to indicate where the information about the partial factor can be found.

Ease of use justification

Subject	Partial factor
Clause N°/ Subclause N° / Annex	2.3.1 NOTE

Reason for change

Wording

Original content

NOTE: For the mechanical properties of steel, the partial factor for the fire situation is given in the national annex. The use of □M,fi = 1.0 is recommended.

Change

(2) The recommended partial factor for the relevant mechanical material property for the fire situation is defined as follows:

$\gamma_{M,fi} = 1{,}0$

NOTE: Information on national choice may be found in the national annex.

Background information

The wording has been adapted in order to have the N. D. P. mentioned in a note, according to the recommend format for the NDP's in the Eurocodes.

Ease of use justification

Subject	Thermal material properties
Clause N°/ Subclause N° / Annex	2.3 (2)

Reason for change

See background information

Original content

(2) Design values of thermal material properties Xd,fi are defined as follows:

- if an increase of the property is favourable for safety:

Xd,fi = Xk,□ /□M,fi (2.2a)

- if an increase of the property is unfavourable for safety:

Xd,fi = □M,fi Xk,□ (2.2b)

where:

Xk, is the value of a material property in fire design, generally dependent on the material

temperature, see section 3;

□M,fi is the partial factor for the relevant material property, for the fire situation.

NOTE: For thermal properties of steel, the partial factor for the fire situation see national annex. The use of

□M,fi = 1.0 is recommended.

Change

(3) P Design values of thermal material properties for the fire situation are defined as their characteristic values.

Background information

See Background Document about Task 1 “Reduction of NDP’s”.

Ease of use justification

Subject	Verification
Clause N°/ Subclause N° / Annex	2.4.1 (2)

Reason for change

Wording

Original content

It shall be verified that, during the relevant duration of fire exposure t :

Change

Mechanical resistance shall be verified for the required duration of fire exposure t according to Eq. (4.2):

Background information

It was not appropriate in this clause that the equation is part of the sentence. The equation was in fact considered as the verb in the missing end of the sentence: “It shall be verified that $E_{fi,d}$ is less or equal to $R_{fi,d,t}$.”

The new formulation is a now complete sentence, with a reference to the equation.

Ease of use justification

Subject	Reference to EN 1990
Clause N°/ Subclause N° / Annex	2.4.1 (3)

Reason for change

Original content

(3) The structural analysis for the fire situation should be carried out according to EN 1990 5.1.4 (2).

NOTE 1: For member analysis, see 2.4.2;

For analysis of parts of the structure, see 2.4.3;

For global structural analysis, see 2.4.4.

NOTE 2: For verifying standard fire resistance requirements, a member analysis is sufficient.

Change

(3) The structural analysis for the fire situation should be carried out according to Section 5.1 of EN1990.

NOTE: For verifying resistance requirements based on the standard fire curve, a member analysis is sufficient.

Background information

Ease of use justification

Subject	Effects of thermal deformations
Clause N°/ Subclause N° / Annex	2.4.2 (4)

Reason for change

Clarity

Original content

Only the effects of thermal deformations resulting from thermal gradients across the cross-section need to be considered. The effects of axial or in-plain thermal expansions may be neglected.

Change

P The effects of thermal deformations resulting from thermal gradients across the cross-section shall be considered. The effects of axial or in-plane thermal expansions may be neglected.

Background information

Utilisation of the terms “need to be considered” is not clear and does not conform to the Eurocode terminology. The terms “shall be considered” conforms to the Eurocode terminology.

As a “shall” verb is used, this becomes a principle.

Ease of use justification

Subject	Boundary conditions
Clause N°/ Subclause N° / Annex	2.4.2 (5)

Reason for change

Clarity

Original content

The boundary conditions at supports and ends of member may be assumed to remain unchanged throughout the fire exposure

Change

The kinematic boundary conditions at supports and ends of members, applicable at time t = 0, may be assumed to remain unchanged throughout the fire exposure.

Background information

The terms “boundary conditions” is not as clear as it should be.

The terms “kinematic boundary conditions” indicate that it is referred here to displacements and/or rotations.

The words “applicable at time t = 0” were used in some Eurocodes and not in some others. It is proposed to use the same wording in all Eurocodes.

The meaning of “remain unchanged” is that each displacement/rotation is assumed to be fixed or free, but this assumption is valid throughout the fire exposure.

Ease of use justification

Subject	Verification methods
Clause N°/ Subclause N° / Annex	2.4.2 (6)

Reason for change

Clarity

Original content

Simplified or advanced calculation methods given in clauses 4.2 and 4.3 respectively are suitable for verifying members under fire conditions.

Change

Tabulated design data, simplified or advanced design methods given in sections 6, 7 and 8 respectively are suitable for verifying members under fire conditions.

Background information

The references to section numbers has to be adapted to reflect the new organisation of the sections.

“Tabulated design data” has been added as this design method is typically used for the verification of members

Ease of use justification

Subject	Analysis of part of the structure
Clause N°/ Subclause N° / Annex	2.4.3 (1)

Reason for change

Original content

2.4.2 (1) applies

Change

The effect of actions should be determined for time t = 0 using combination factors according to EN 1991-1-2 Section 6.3.2.

Background information

Ease of use justification

Subject	Alternative
Clause N°/ Subclause N° / Annex	2.4.3 (2)

Reason for change

Original content

As an alternative to carrying out a structural analysis for the fire situation at time t = 0,

Change

As an alternative to (1)

Background information

Ease of use justification

Subject	Boundary conditions
Clause N°/ Subclause N° / Annex	2.4.3 (5)

Reason for change

Physical impossibility

Original content

(5) The boundary conditions at supports and forces and moments at boundaries of part of the structure may be assumed to remain unchanged throughout the fire exposure.

Change

This clause is deleted

Background information

This clause has been deleted because it was not physically correct.

In fact, for any degree of freedom at the boundary of a structure or part of a structure, it is possible to fix only one of the two conditions: either the force or the displacement (either the moment or the rotation). It is not possible to fix both.

In some cases, it is obvious that the force has to be fixed (and the displacement is thus left free) as was recommended by this clause. This is the case, for example if one or two stories are extracted from a multi storey building. For the vertical degrees of freedom on the upper boundaries, the vertical forces representing the action of the upper stories will be applied and kept constant, whereas the corresponding vertical displacements will be free and will change during the course of the fire.

Yet, in other cases, it is obvious that the displacement has to be fixed and the reaction force will be given by the response of the structure. In the same case of one or two stories extracted from a multi storey building, the vertical displacements at the lower boundaries will be fixed and the vertical reactions will come as a result of the analysis of the structure.

Another case is when the substructure consist of a few spans of a beam that extends continuously on the left and on the right. Giving a constant value to the bending moment at the left and right boundaries as recommended by the clause would force to leave the rotation free and this would prevent the development of a plastic hinge at the extremities of the substructure. The substructure would be considered as simply supported at its extremities.

Another case is when a plane frame is extracted from a 3D structure but analysed as a 3D structure in order to detect, for example, possible lateral torsional buckling of the beams or out of plane buckling of the columns. It will be necessary here to fix the displacements perpendicular to the frame at boundaries were it is supported by transverse elements. The out of plane support forces will therefore develop during the analysis depending of the propensity of the elements to develop out of plane instability. If the out of plane reaction force at these points would have to keep the value of 0, as recommended by the clause, this would prevent any out of plane support of the frame.

Ease of use justification

It is estimated that the clauses that are now present in the section on “parts of the structure” given sufficient information to guide the designer into the choice about the conditions at the boundaries.

Subject	Global structural analysis
Clause N°/ Subclause N° / Annex	2.4.4 (1)

Reason for change

Clarity

Original content

Where a global structural analysis for the fire situation is carried out, the relevant failure mode in fire exposure, the temperature-dependent material properties and member stiffness , effects of thermal deformations (indirect fire actions) should be taken into account.

Change

(1) P A global structural analysis for the fire situation shall take into account:

- the relevant failure mode in fire exposure;
- the temperature-dependent material properties and member stiffness;
- effects of thermal expansions and deformations (indirect fire actions).

Background information

There is no need to mention "*Where* a global structural analysis … is carried out", because this clause is about global structural analysis.

These 3 items are essential if the global analysis has to reflect the behaviour of the structure. This is why "should" has been replaced by "shall" and, as a consequence, this clause becomes a principle.

Separating the 3 items under 3 bullet points is adding clarity, compared to the long sentence of the original wording.

Ease of use justification

Subject	Properties at 20°C
Clause N°/ Subclause N° / Annex	3.1 (2)

Reason for change

Original content

(2) The mechanical properties of steel at 20 °C should be taken as those given in EN 1993-1-1 for normal temperature design.

Change

(2) P The mechanical properties of steel at normal temperature (20°C) shall be taken as those given in EN 1993-1-1 for normal temperature design.

Background information

Ease of use justification

Subject	Thermal elongation
Clause N°/ Subclause N° / Annex	3.4.1.1

Reason for change

Consistency with physics

Original content

N/A

Change

This clause moved to mechanical properties

Background information

Thermal elongation is not a thermal property; it does not influence the temperature distribution and is not used in thermal analyses. On the contrary, it is used in mechanical analyses where it induces displacements or thermal restrain forces. It is thus in fact a mechanical material property.

Ease of use justification

Subject	Simple and advanced calculation models
Clause N°/ Subclause N° / Annex	4.2 and 4.3

Reason for change

Original content

No definition

Change

Definitions have been added, see Task 10 of HGFPT

Background information

Ease of use justification

Subject	Separate calculation models
Clause N°/ Subclause N° / Annex	4.3.1 (3)

Reason for change

Original content

Advanced calculation methods should include separate calculation models

Change

Advanced design methods may include separate calculation models

Background information

The utilisation of “should” is not appropriate because it implies an obligation to have separate calculation models. On the contrary, it should be allowed to use coupled thermos-mechanical models. Such models are probably not yet very common, but there is no reason to prevent their development and utilisation because, in fact, such coupled models are deemed to be more realistic, in some aspects, than uncoupled separate models. This is why the term “may” that indicates a permission to do so has been used.

Ease of use justification

Subject	Temperature range / history
Clause N°/ Subclause N° / Annex	4.3.1 (4)

Reason for change

Original content

material properties are known for the relevant temperature range

Change

material properties are known for the relevant temperature history

Background information

With the introduction of physically based fire models that usually comprise a decay phase, knowledge of the properties in the relevant temperature range is not sufficient anymore. If the material experiences a cooling phase, knowledge of the properties during cooling as well during heating is required. This is why “temperature range” has been replaced by “temperature history”.

Ease of use justification

Subject	Advanced calculation methods JMF
Clause N°/ Subclause N° / Annex	4.3.3 (1)

Reason for change

Fundamental requirement

Original content

Advanced calculation methods for mechanical response should be based on the acknowledged principles and assumptions of the theory of structural mechanics…

Change

P Advanced design methods for mechanical analysis shall be based on the acknowledged principles and assumptions of the theory of structural mechanics,

Background information

“Advanced calculation method” has been replaced by “advanced design method” to maintain consistency with the terminology that we proposed for the new generation of Eurocodes.

It cannot be envisaged that advanced design methods are not based on acknowledged principles and assumptions of the theory of structural mechanics. This is why “should” has been replaced by “shall”. As a consequence, this clause becomes a principle.

Ease of use justification

Subject	Mechanical analysis JMF
Clause N°/ Subclause N° / Annex	New 8.3 (2)

Reason for change

Essential requirements

Original content

N/A

Change

(2) P The mechanical response model shall consider:

- The material temperatures calculated according to 8.2.
- The temperature dependent mechanical properties of the materials, see Section 5.3.

Background information

These two requirements are considered as essentials.

It adds to the clarity and ease of use to refer to the clauses that treat temperature calculations and mechanical properties.

Ease of use justification

Subject	Thermally induced strains and stresses
Clause N°/ Subclause N° / Annex	4.3.3 (2)

Reason for change

Essential requirements

Original content

The effects of thermally induced strains and stresses both due to temperature rise and due to temperature differentials, should be considered.

Change

P The effects of thermally induced strains and stresses due to temperature rise and temperature differentials shall be considered.

Background information

These two requirements are essential, in line with the requirements for global analysis which is typically done using an advanced design method. Therefore “should” has been replaced by “shall“ and this clause becomes a principle.

Ease of use justification

Subject	Mechanical model
Clause N°/ Subclause N° / Annex	4.3.3 (3)

Reason for change

Original content

The model for mechanical response should also take account of:

- the combined effects of mechanical actions, geometrical imperfections and thermal actions;

- the temperature dependent mechanical properties of the material, see section 3;

- geometrical non-linear effects;

- the effects of non-linear material properties, including the unfavourable effects of loading and unloading on the structural stiffness.

Change

The mechanical response model should also take account of:

- geometrical imperfections;

- geometrical non-linear effects;

- the non-linear material behaviour, including the effects of loading and unloading on the structural stiffness.

Background information

Ease of use justification

Subject	
Clause N°/ Subclause N° / Annex	

Reason for change

Original content

Change

Background information

Ease of use justification

Subject	
Clause N°/ Subclause N° / Annex	

Reason for change

Original content

Change

Background information

Ease of use justification

Subject	
Clause N°/ Subclause N° / Annex	

Reason for change

Original content

Change

Background information

Ease of use justification

Subject	
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Reason for change

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Reason for change

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Reason for change

Original content

Change

Background information

Ease of use justification

Subject	
Clause N°/ Subclause N° / Annex	

Reason for change

Original content

Change

Background information

Ease of use justification