Singapore Standards Council

SS EN 1995-1-2 : 2018
EN 1995-1-2:2004, IDT
(ICS 13.220.50; 91.010.30; 91.080.20)

SINGAPORE STANDARD

Eurocode 5: Design of timber structures

– Part 1-2 : General – Structural fire design

Published by
Enterprise Singapore

SS EN 1995-1-2 : 2018
EN 1995-1-2:2004, IDT
(ICS 13.220.50; 91.010.30; 91.080.20)

SINGAPORE STANDARD

Eurocode 5: Design of timber structures

– Part 1-2 : General – Structural fire design

ISBN 978-981-47-8488-7

This Singapore Standard was approved by the Building and Construction Standards Committee on behalf of the Singapore Standards Council on 23 February 2018.

First published, 2018

The Building and Construction Standards Committee, appointed by the Standards Council, consists of the following members:

		Name	Capacity
Chairman	:	Ar. Chan Kok Way	*Individual Capacity*
Deputy Chairman	:	Er. Clement Tseng	*Building and Construction Authority*
Secretary	:	Ms Amy Sim	*Standards Development Organisation – The Institution of Engineers, Singapore*
Members	:	Mr Bin Chee Kwan	*National Environment Agency*
		Er. Chan Ewe Jin	*The Institution of Engineers, Singapore*
		Mr Shawn Chan	*Singapore Manufacturing Federation*
		Mr Chee Kheng Chye	*Housing & Development Board*
		Mr Chng Chee Beow	*Real Estate Developers' Association of Singapore*
		Mr Dominic Choy	*Singapore Contractors Association Ltd*
		Er. Paul Fok	*Land Transport Authority*
		Mr Goh Ngan Hong	*Singapore Institute of Surveyors and Valuers*
		Mr Desmond Hill	*Individual Capacity*
		Prof Ho Puay Peng	*National University of Singapore*
		Mr Benedict Lee Khee Chong	*Singapore Institute of Architects*
		Er. Lee Chuan Seng	*Individual Capacity*
		A/Prof Leong Eng Choon	*Nanyang Technological University*
		Mr Darren Lim	*Building and Construction Authority*
		Dr Lim Lan Yuan	*Association of Property and Facility Managers*
		Er. Lim Peng Hong	*Association of Consulting Engineers Singapore*
		Er. Mohd Ismadi	*Ministry of Manpower*
		Ms Kay Pungkothai	*National Parks Board*
		Er. Yvonne Soh	*Singapore Green Building Council*
		Mr Christopher Tan	*Singapore Civil Defence Force*
		Er. Tang Pei Luen	*JTC Corporation*
		Mr Young Joo Chye	*PUB, Singapore National Water Agency*

The Technical Committee on Building Structures and Sub-structures, appointed by the Building and Construction Standards Committee and responsible for the preparation of this standard, consists of representatives from the following organisations:

		Name	Capacity
Co-Chairmen	:	Er. Lim Peng Hong	*Individual Capacity*
		Er. Chew Keat Chuan	*Building and Construction Authority*
Secretary	:	Ms Jasmine Bai	*Standards Development Organisation – The Institution of Engineers, Singapore*

Members	:	Er. Chan Ewe Jin	*The Institution of Engineers, Singapore*
		Er. Dr Chiew Sing Ping	*Individual Capacity*
		Er. Lee Tuck Cheong	*Association of Consulting Engineers Singapore*
		Er. Dr Richard Liew Jat Yuen	*Individual Capacity*
		Er. Neo Bian Hong	*Land Transport Authority*
		Mr Ng Yek Meng	*Singapore Contractors Association Ltd*
		Dr Ng Yiaw Heong	*Singapore Structural Steel Society*
		Dr Gary Ong Khim Chye	*Singapore Concrete Institute*
		Er. Poh Puay Yong	*Housing & Development Board*
		Mr Sze Thiam Siong	*Singapore Welding Society*
		Dr Tam Chat Tim	*Individual Capacity*
		Er. Dr Tan Guan	*Individual Capacity*
		Prof Tan Kiang Hwee	*National University of Singapore*
		Er. Dr Tan Teng Hooi	*Individual Capacity*
		Er. Tang Pei Luen	*JTC Corporation*
		A/Prof Susanto Teng	*Nanyang Technological University*
		LTC Tong Hong Haey	*Singapore Civil Defence Force*

The Working Group, appointed by the Technical Committee on Building Structures and Sub-structures to assist in the preparation of this standard, comprises the following experts who contribute in their *individual capacity*:

		Name
Convenor	:	Er. Dr Tan Teng Hooi
Secretary	:	Ms Jasmine Bai
Members	:	Er. Adrian Billinghurst
		Er. Cherlyn Leong Pei Ying
		Er. Lim Kim Cheong
		Er. Lung Hian Hao
		Er. Poh Puay Yong
		Er. Dr See Lin Ming
		LTC Tong Hong Haey
		Er. Serena Yap

The organisations in which the experts of the Working Group are involved are:

Arup Singapore Pte Ltd
Aurecon Singapore Pte Ltd
Building and Construction Authority
Housing & Development Board
JTC Corporation
Lim Kim Cheong Consultants
Singapore Civil Defence Force
Singapore University of Social Sciences
Worley Parsons Pte Ltd

National Foreword

This Singapore Standard was prepared by Working Group appointed by the Technical Committee on Building Structures and Sub-structures under the direction of the Building and Construction Standards Committee.

This SS EN is the identical implementation of EN 1995-1-2:2004 'Eurocode 5: Design of timber structures – Part 1-2: General – Structural fire design' and is adopted with permission of CEN, Avenue Marnix 17, 1000 Brussels.

This SS EN incorporates the EN Corrigenda June 2006 and March 2009.

Attention is drawn to the following:

– The comma has been used throughout as a decimal marker whereas in Singapore Standards, it is a practice to use a full point on the baseline as the decimal marker.

– The Singapore Standards which implement international or European publications referred to in this document may be found in the SS Electronic Catalogue at: http://www.singaporestandardseshop.sg

The EN gives values with notes indicating where national choices may be made. Where a normative part of the EN allows for national choice to be made, the range and possible choice will be given in the normative text, and a note will qualify it as a Nationally Determined Parameter (NDP). NDPs can be a specific value for a factor, a specific level or class, a particular method or a particular application rule if several are proposed in the EN.

The requirements of this SS EN 1995-1-2 : 2018 are to be read in conjunction with the Singapore National Annex (NA to SS EN 1995-1-2 : 2018) which contains information on the Singapore Nationally Determined Parameters and is published separately.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

At the time of publication, this standard is expected to be used as a reference in the Building and Construction Authority's 'Approved Document – Acceptable Solutions'. At this point in time, the data for use in design based on the limit state concept for all species of tropical timbers used in building and construction are still incomplete. However, some guidance can be obtained from Timber Research and Development Association (TRADA).

Attention is drawn to the possibility that some of the elements of this Singapore Standard may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions.*

2. *An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR.*

3. *Compliance with a SS or TR does not exempt users from any legal obligations*

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1995-1-2

November 2004

ICS 91.010.30; 13.220.50; 91.080.20

Supersedes ENV 1995-1-2:1994

English version

Eurocode 5: Design of timber structures - Part 1-2: General - Structural fire design

Eurocode 5: Conception et Calcul des structures en bois - Part 1-2: Généralités - Calcul des structures au feu

Eurocode 5: Entwurf, Berechnung und Bemessung von Holzbauten - Teil 1-2: Allgemeine Regeln - Bemessung für den Brandfall

This European Standard was approved by CEN on 16 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

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

Ref. No. EN 1995-1-2:2004: E

Contents

Foreword

This European Standard EN 1995-1-2 has been prepared by Technical Committee CEN/TC250 “Structural Eurocodes”, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a National Standard, either by publication of an identical text or by endorsement, at the latest by May 2005, and conflicting national standards shall be withdrawn at the latest by March 2010.

This European Standard supersedes ENV 1995-1-2:1994.

CEN/TC250 is responsible for all Structural Eurocodes.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Background of the Eurocode programme

In 1975, the Commission of the European Community decided on an action programme in the field of construction, based on article 95 of the Treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980’s.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement[1] between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links *de facto* the Eurocodes with the provisions of all the Council’s Directives and/or Commission’s Decisions dealing with European standards (e.g. the Council Directive 89/106/EEC on construction products - CPD - and Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of setting up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of Parts:

EN 1990	Eurocode :	Basis of Structural Design
EN 1991	Eurocode 1:	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

[1] Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

EN 1998	Eurocode 8:	Design of structures for earthquake resistance
EN 1999	Eurocode 9:	Design of aluminium structures

Eurocode standards recognise the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognise that EUROCODES serve as reference documents for the following purposes:

- as a means to prove compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 – Mechanical resistance and stability – and Essential Requirement N°2 – Safety in case of fire;
- as a basis for specifying contracts for construction works and related engineering services;
- as a framework for drawing up harmonised technical specifications for construction products (ENs and ETAs).

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents[2] referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards[3]. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

National Standards implementing Eurocodes

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National Foreword, and may be followed by a National Annex.

The National annex may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, *i.e.*:

- values and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- country specific data (geographical, climatic, etc.), e.g. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode.

It may also contain

[2] According to Art. 3.3 of the CPD, the essential requirements (ERs) shall be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for harmonised ENs and ETAGs/ETAs.

[3] According to Art. 12 of the CPD the interpretative documents shall:
give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary;
indicate methods of correlating these classes or levels of requirement with the technical specifications, e.g. methods of calculation and of proof, technical rules for project design, etc.;
serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals.
The Eurocodes, *de facto*, play a similar role in the field of the ER 1 and a part of ER 2.

– decisions on the application of informative annexes,
– references to non-contradictory complementary information to assist the user to apply the Eurocode.

Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works[4]. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes shall clearly mention which Nationally Determined Parameters have been taken into account.

Additional information specific to EN 1995-1-2

EN 1995-1-2 describes the principles, requirements and rules for the structural design of buildings exposed to fire, including the following aspects.

Safety requirements

EN 1995-1-2 is intended for clients (e.g. for the formulation of their specific requirements), designers, contractors and relevant authorities.

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

Construction Products Directive 89/106/EEC gives the following essential requirement for the limitation of fire risks:
"The construction works must be designed and built 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 is 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".

According to the Interpretative Document "Safety in Case of Fire[5]" the essential requirement may be observed by following the various fire safety strategies prevailing in the Member States like conventional fire scenarios (nominal fires) or natural fire scenarios (parametric fires), including passive and/or active fire protection measures.

The fire parts of 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 appropriate.

Required functions and levels of performance can be specified either in terms of nominal (standard) fire resistance rating, generally given in National fire regulations, or by referring to the fire safety engineering for assessing passive and active measures.
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 a competent authority.

[4] see Art.3.3 and Art.12 of the CPD, as well as clauses 4.2*,* 4.3.1, 4.3.2 and 5.2 of ID 1.
[5] see clauses 2.2, 3.2(4) and 4.2.3.3

Numerical values for partial factors and other reliability elements are given as recommended values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and of quality management applies.

Design procedure

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).

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, where the procedure is based on a nominal (standard) fire the classification system, which calls for specific periods of fire resistance, takes into account (though not explicitly), the features and uncertainties described above.

Options for the application of Part 1-2 of EN 1995 are illustrated in figure 1. The prescriptive and performance-based approaches are identified. The prescriptive approach uses nominal fires to generate thermal actions. The performance-based approach, using fire safety engineering, refers to thermal actions based on physical and chemical parameters.

For design according to this part, EN 1991-1-2 is required for the determination of thermal and mechanical actions acting on the structure.

Design aids

It is expected that design aids based on the calculation models given in EN 1995-1-2, will be prepared by interested external organisations.

The main text of EN 1995-1-2 includes most of the principal concepts and rules necessary for direct application of structural fire design to timber structures.

In an annex F (informative), guidance is given to help the user select the relevant procedures for the design of timber structures.

National annex for EN 1995-1-2

This standard gives alternative procedures, values and recommendations with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1995-1-2 should have a National annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1995-1-2 through clauses:
2.1.3(2) Maximum temperature rise for separating function in parametric fire exposure;
2.3(1)P Partial factor for material properties;
2.3(2)P Partial factor for material properties;
2.4.2(3) Reduction factor for combination of actions;
4.2.1(1) Method for determining cross-sectional properties.

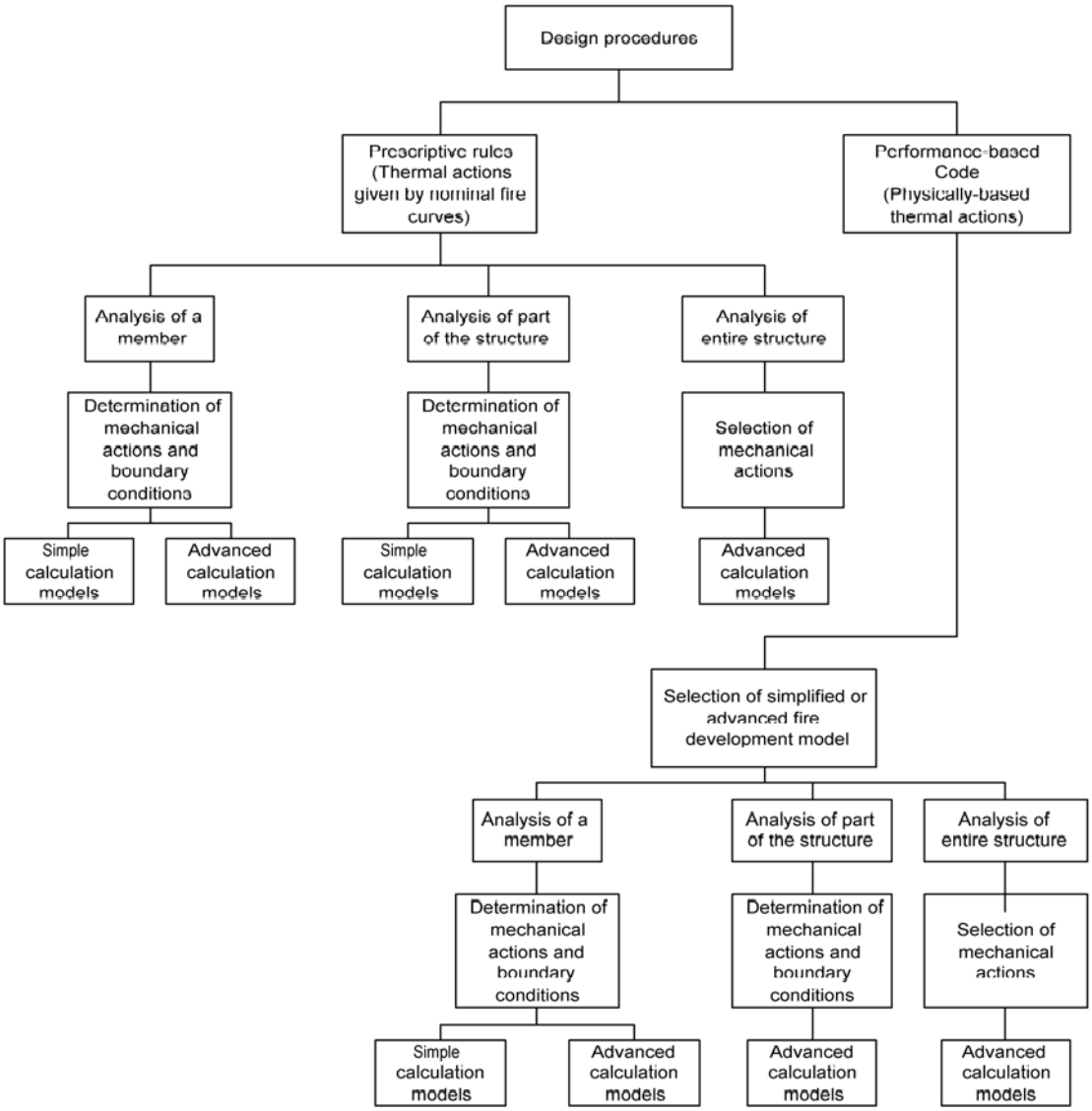

Figure 1 – Alternative design procedures

Section 1 General

1.1 Scope

1.1.1 Scope of Eurocode 5

(1)P Eurocode 5 applies to the design of buildings and civil engineering works in timber (solid timber, sawn, planed or in pole form, glued laminated timber or wood-based structural products, e.g. LVL) or wood-based panels jointed together with adhesives or mechanical fasteners. It complies with the principles and requirements for the safety and serviceability of structures and the basis of design and verification given in EN 1990:2002.

(2)P Eurocode 5 is only concerned with requirements for mechanical resistance, serviceability, durability and fire resistance of timber structures. Other requirements, e.g concerning thermal or sound insulation, are not considered.

(3) Eurocode 5 is intended to be used in conjunction with:
EN 1990:2002 Eurocode - Basis of structural design"
EN 1991 "Actions on structures"
EN´s for construction products relevant to timber structures
EN 1998 "Design of structures for earthquake resistance", when timber structures are built in seismic regions.

(4) Eurocode 5 is subdivided into various parts:
EN 1995-1 General
EN 1995-2 Bridges

(5) EN 1995-1 "General" comprises:
EN 1995-1-1 General – Common rules and rules for buildings
EN 1995-1-2 General – Structural Fire Design

(6) EN 1995-2 refers to the General rules in EN 1995-1-1. The clauses in EN 1995-2 supplement the clauses in EN 1995-1.

1.1.2 Scope of EN 1995-1-2

(1)P EN 1995-1-2 deals with the design of timber structures for the accidental situation of fire exposure and is intended to be used in conjunction with EN 1995-1-1 and EN 1991-1-2:2002. EN 1995-1-2 only identifies differences from, or supplements normal temperature design.

(2)P EN 1995-1-2 deals only with passive methods of fire protection. Active methods are not covered.

(3)P EN 1995-1-2 applies to building structures that are required to fulfil certain functions when exposed 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 EN 1995-1-2 gives principles and application rules for designing structures for specified requirements in respect of the aforementioned functions and levels of performance.

(5)P EN 1995-1-2 applies to structures or parts of structures that are within the scope of EN 1995-1-1 and are designed accordingly.

(6)P The methods given in EN 1995-1-2 are applicable to all products covered by product standards made reference to in this Part.

1.2 Normative references

(1)P 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).

European Standards:

EN 300	Oriented strand boards (OSB) – Definition, classification and specifications
EN 301	Adhesives, phenolic and aminoplastic for load-bearing timber structures; classification and performance requirements
EN 309	Wood particleboards – Definition and classification
EN 313-1	Plywood – Classification and terminology. Part 1: Classification
EN 314-2	Plywood – Bonding quality. Part 2: Requirements
EN 316	Wood fibreboards – Definition, classification and symbols
EN 520	Gypsum plasterboards - Specifications - Test methods
EN 912	Timber fasteners – Specifications for connectors for timber
EN 1363-1	Fire resistance tests – Part 1: General requirements
EN 1365-1	Fire resistance tests for loadbearing elements – Part 1: Walls
EN 1365-2	Fire resistance tests for loadbearing elements – Part 2: Floors and roofs
EN 1990:2002	Eurocode: Basis of structural design
EN 1991-1-1:2002	Eurocode 1 Actions on structures Part 1-1: General actions – Densities, self-weight and imposed loads for buildings
EN 1991-1-2:2002	Eurocode 1: Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire
EN 1993-1-2	Eurocode 3: Design of steel structures – Part 1-2: General – Structural fire design
EN 1995-1-1	Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings
EN 12369–1	Wood-based panels – Characteristic values for structural design – Part 1: OSB, particleboards and fibreboards
EN 13162	Thermal insulation products for buildings – factory-made mineral wool (MW) products – Specifications M/103
ENV 13381-7	Test methods for determining the contribution to the fire resistance of structural members – Part 7: Applied protection to timber members
EN 13986	Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking
EN 14081-1	Timber structures – Strength graded structural timber with rectangular cross section – Part 1, General requirements
EN 14080	Timber structures – Glued laminated timber – Requirements
EN 14374	Timber structures – Structural laminated veneer lumber – Requirements