

**SINGAPORE STANDARD**

# **Eurocode 2 : Design of concrete structures**

**– Part 1-1 : General rules and rules for buildings**

(This national standard is the identical implementation of EN 1992-1-1 : 2004 and is adopted with permission of CEN, Avenue Marnix 17, 1000 Brussels)



Published by

**Enterprise**  
**Singapore**

**SS EN 1992-1-1 : 2008**

EN 1992-1-1 : 2004, IDT

(ICS 91.010.30 ; 91.080.40)

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ISBN 981-4154-71-7

This Singapore Standard was approved by the Building and Construction Standards Committee on behalf of the Standards Council of Singapore on 15 June 2008.

First published, 2008

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*National University of Singapore*

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*Singapore Concrete Institute*

*Surbana International Consultants Pte Ltd*

## National Foreword

This Singapore Standard was prepared by the Technical Committee on Building Structure and Sub-structure under the direction of the Building and Construction Standards Committee.

This SS EN is the identical implementation of EN 1992-1-1 : 2004 'Eurocode 2 : Design of concrete structures – Part 1-1 : General rules and rules for buildings' and is adopted with permission of CEN Rue de Stassart 36, B-1050 Brussels.

This SS EN incorporates the EN corrigendum, EN 1992-1-1/AC dated 16 January 2008.

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 1992-1-1 : 2008 are to be read in conjunction with the Singapore National Annex (NA to SS EN 1992-1-1 : 2008) which contains information on the Singapore Nationally Determined Parameters and is published separately.

National choice is allowed in EN 1992-1-1 through the following clauses:

– 2.3.3 (3)	– 4.4.1.3 (4)	– 6.4.3 (6)	– 9.2.1.3 (1)	– 11.3.5 (1)P
– 2.4.2.1 (1)	– 5.1.3 (1)P	– 6.4.4 (1)	– 9.2.1.4 (1)	– 11.3.5 (2)P
– 2.4.2.2 (1)	– 5.2 (5)	– 6.4.5 (3)	– 9.2.2 (4)	– 11.3.7 (1)
– 2.4.2.2 (2)	– 5.5 (4)	– 6.4.5 (4)	– 9.2.2 (5)	– 11.6.1 (1)
– 2.4.2.2 (3)	– 5.6.3 (4)	– 6.5.2 (2)	– 9.2.2 (2)	– 11.6.1 (2)
– 2.4.2.3 (1)	– 5.8.3.1 (1)	– 6.5.4 (4)	– 9.2.2 (7)	– 11/6/2 (1)
– 2.4.2.4 (1)	– 5.8.3.3 (1)	– 6.5.4 (6)	– 9.2.2 (8)	– 11.6.4.1 (1)
– 2.4.2.4 (2)	– 5.8.3.3 (2)	– 6.8.4 (1)	– 9.3.1.1 (3)	– 12.3.1 (1)
– 2.4.2.5 (2)	– 5.8.5 (1)	– 6.8.4 (5)	– 9.5.2 (21)	– 12.6.3 (2)
– 3.1.2 (2)P	– 5.8.6 (3)	– 6.8.6 (1)	– 9.5.2 (2)	– A.2.1 (1)
– 3.1.2 (4)	– 5.10.1 (6)	– 6.8.6 (3)	– 9.5.2 (3)	– A.2.1 (2)
– 3.1.6 (1)P	– 5.10.2.1 (1)P	– 6.8.7 (1)	– 9.5.3 (3)	– A.2.2 (1)
– 3.1.6 (2)P	– 5.10.2.1 (2)	– 7.2 (2)	– 9.6.2 (1)	– A.2.2 (2)
– 3.2.2 (3)P	– 5.10.2.2 (4)	– 7.2 (3)	– 9.6.3 (1)	– A.2.3 (1)
– 3.2.7 (2)	– 5.10.2.2 (5)	– 7.2 (5)	– 9.7 (1)	– C.1 (1)
– 3.3.4 (5)	– 5.10.3 (2)	– 7.3.1 (5)	– 9.8.1 (3)	– C.1 (3)
– 3.3.6 (7)	– 5.10.8 (2)	– 7.3.2 (4)	– 9.8.2.1 (1)	– E.1 (2)
– 4.4.1.2 (3)	– 5.10.8 (3)	– 7.3.4 (3)	– 9.8.3 (1)	– J.1 (2)
– 4.4.1.2 (5)	– 5.10.9 (1)P	– 7.4.2 (2)	– 9.8.3 (2)	– J.2.2 (2)
– 4.4.1.2 (6)	– 6.2.2 (1)	– 8.2 (2)	– 9.8.4 (1)	– J.3 (2)
– 4.4.1.2 (7)	– 6.2.2 (6)	– 8.3 (2)	– 9.8.5 (3)	– J.3 (3)

– 4.4.1.2 (8)	– 6.2.3 (2)	– 8.6 (2)	– 9.10.2.2 (2)
– 4.4.1.2 (13)	– 6.2.3 (3)	– 8.8 (1)	– 9.10.2.3 (3)
– 4.4.1.3 (1)P	– 6.2.4 (4)	– 9.2.1.1 (1)	– 9.10.2.3 (4)
– 4.4.1.3 (3)	– 6.2.4 (6)	– 9.2.1.1 (3)	– 9.10.2.4 (2)

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'.

The SS EN 1992-1-1 allows industry designers to phase in to the EN and prepare for necessary changes. There will be a co-existence period of 3 years for the SS CP 65 'Code of practice for structural use of concrete' (Part 1 : 1999 and Part 2 : 1996) and this SS EN. SS CP 65 will be withdrawn on a date to be announced by the Regulator.

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.

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- 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.*
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ICS 91.010.30; 91.080.40

Supersedes ENV 1992-1-1:1991, ENV 1992-1-3:1994,  
ENV 1992-1-4:1994, ENV 1992-1-5:1994, ENV 1992-1-  
6:1994, ENV 1992-3:1998

English version

## Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

Eurocode 2: Calcul des structures en béton - Partie 1-1 :  
Règles générales et règles pour les bâtiments

Eurocode 2: Bemessung und konstruktion von Stahlbeton-  
und Spannbetontragwerken - Teil 1-1: Allgemeine  
Bemessungsregeln und Regeln für den Hochbau

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.

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



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## Foreword

This European Standard EN 1992, Eurocode 2: Design of concrete structures: General rules and rules for buildings, has been prepared by Technical Committee CEN/TC250 « Structural Eurocodes », the Secretariat of which is held by BSI. CEN/TC250 is responsible for all Structural Eurocodes.

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 latest by March 2010.

This Eurocode supersedes ENV 1992-1-1, 1992-1-3, 1992-1-4, 1992-1-5, 1992-1-6 and 1992-3.

According to the CEN-CENELEC Internal Regulations, the National Standard Organisations of the following countries are bound to implement these European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary,



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Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

### Background to 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 1980s.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement<sup>1</sup> between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to 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 0:	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
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

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<sup>1</sup> 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).

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<sup>2</sup> referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards<sup>3</sup>. 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 contain

- 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

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<sup>2</sup> 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.

<sup>3</sup> According to Art. 12 of the CPD the interpretative documents shall :

- a) 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 ;
- b) 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. ;
- c) 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.

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construction products and the technical rules for works<sup>4</sup>. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

### **Additional information specific to EN 1992-1-1**

EN 1992-1-1 describes the principles and requirements for safety, serviceability and durability of concrete structures, together with specific provisions for buildings. It is based on the limit state concept used in conjunction with a partial factor method.

For the design of new structures, EN 1992-1-1 is intended to be used, for direct application, together with other parts of EN 1992, Eurocodes EN 1990, 1991, 1997 and 1998.

EN 1992-1-1 also serves as a reference document for other CEN TCs concerning structural matters.

EN 1992-1-1 is intended for use by:

- committees drafting other standards for structural design and related product, testing and execution standards;
- clients (e.g. for the formulation of their specific requirements on reliability levels and durability);
- designers and constructors ;
- relevant authorities.

Numerical values for partial factors and other reliability parameters are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and of quality management applies. When EN 1992-1-1 is used as a base document by other CEN/TCs the same values need to be taken.

### **National annex for EN 1992-1-1**

This standard gives values with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1992-1-1 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 1992-1-1 through the following clauses:

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<sup>4</sup> 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.

2.3.3 (3)	5.10.3 (2)	9.2.2 (7)
2.4.2.1 (1)	5.10.8 (2)	9.2.2 (8)
2.4.2.2 (1)	5.10.8 (3)	9.3.1.1(3)
2.4.2.2 (2)	5.10.9 (1)P	9.5.2 (1)
2.4.2.2 (3)	6.2.2 (1)	9.5.2 (2)
2.4.2.3 (1)	6.2.2 (6)	9.5.2 (3)
2.4.2.4 (1)	6.2.3 (2)	9.5.3 (3)
2.4.2.4 (2)	6.2.3 (3)	9.6.2 (1)
2.4.2.5 (2)	6.2.4 (4)	9.6.3 (1)
3.1.2 (2)P	6.2.4 (6)	9.7 (1)
3.1.2 (4)	6.4.3 (6)	9.8.1 (3)
3.1.6 (1)P	6.4.4 (1)	9.8.2.1 (1)
3.1.6 (2)P	6.4.5 (3)	9.8.3 (1)
3.2.2 (3)P	6.4.5 (4)	9.8.3 (2)
3.2.7 (2)	6.5.2 (2)	9.8.4 (1)
3.3.4 (5)	6.5.4 (4)	9.8.5 (3)
3.3.6 (7)	6.5.4 (6)	9.10.2.2 (2)
4.4.1.2 (3)	6.8.4 (1)	9.10.2.3 (3)
4.4.1.2 (5)	6.8.4 (5)	9.10.2.3 (4)
4.4.1.2 (6)	6.8.6 (1)	9.10.2.4 (2)
4.4.1.2 (7)	6.8.6 (3)	11.3.5 (1)P
4.4.1.2 (8)	6.8.7 (1)	11.3.5 (2)P
4.4.1.2 (13)	7.2 (2)	11.3.7 (1)
4.4.1.3 (1)P	7.2 (3)	11.6.1 (1)
4.4.1.3 (3)	7.2 (5)	11.6.1 (2)
4.4.1.3 (4)	7.3.1 (5)	11.6.2 (1)
5.1.3 (1)P	7.3.2 (4)	11.6.4.1 (1)
5.2 (5)	7.3.4 (3)	12.3.1 (1)
5.5 (4)	7.4.2 (2)	12.6.3 (2)
5.6.3 (4)	8.2 (2)	A.2.1 (1)
5.8.3.1 (1)	8.3 (2)	A.2.1 (2)
5.8.3.3 (1)	8.6 (2)	A.2.2 (1)
5.8.3.3 (2)	8.8 (1)	A.2.2 (2)
5.8.5 (1)	9.2.1.1 (1)	A.2.3 (1)
5.8.6 (3)	9.2.1.1 (3)	C.1 (1)
5.10.1 (6)	9.2.1.2 (1)	C.1 (3)
5.10.2.1 (1)P	9.2.1.4 (1)	E.1 (2)
5.10.2.1 (2)	9.2.2 (4)	J.1 (2)
5.10.2.2 (4)	9.2.2 (5)	J.2.2 (2)
5.10.2.2 (5)	9.2.2 (6)	J.3 (2)
		J.3 (3)

## **SECTION 1 GENERAL**

### **1.1 Scope**

#### **1.1.1 Scope of Eurocode 2**

(1)P Eurocode 2 applies to the design of buildings and civil engineering works in plain, reinforced and prestressed concrete. It complies with the principles and requirements for the safety and serviceability of structures, the basis of their design and verification that are given in EN 1990: Basis of structural design.

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

(3)P Eurocode 2 is intended to be used in conjunction with:

EN 1990: Basis of structural design  
EN 1991: Actions on structures  
hEN's: Construction products relevant for concrete structures  
ENV 13670: Execution of concrete structures  
EN 1997: Geotechnical design  
EN 1998: Design of structures for earthquake resistance, when concrete structures are built in seismic regions.

(4)P Eurocode 2 is subdivided into the following parts:

Part 1.1: General rules and rules for buildings  
Part 1.2: Structural fire design  
Part 2: Reinforced and prestressed concrete bridges  
Part 3: Liquid retaining and containing structures

#### **1.1.2 Scope of Part 1-1 of Eurocode 2**

(1)P Part 1-1 of Eurocode 2 gives a general basis for the design of structures in plain, reinforced and prestressed concrete made with normal and light weight aggregates together with specific rules for buildings.

(2)P The following subjects are dealt with in Part 1-1.

Section 1: General  
Section 2: Basis of design  
Section 3: Materials  
Section 4: Durability and cover to reinforcement  
Section 5: Structural analysis  
Section 6: Ultimate limit states  
Section 7: Serviceability limit states  
Section 8: Detailing of reinforcement and prestressing tendons - General  
Section 9: Detailing of members and particular rules

Section 10: Additional rules for precast concrete elements and structures

Section 11: Lightweight aggregate concrete structures

Section 12: Plain and lightly reinforced concrete structures

(3)P Sections 1 and 2 provide additional clauses to those given in EN 1990 “Basis of structural design”.

(4)P This Part 1-1 does not cover:

- the use of plain reinforcement
- resistance to fire;
- particular aspects of special types of building (such as tall buildings);
- particular aspects of special types of civil engineering works (such as viaducts, bridges, dams, pressure vessels, offshore platforms or liquid-retaining structures);
- no-fines concrete and aerated concrete components, and those made with heavy aggregate or containing structural steel sections (see Eurocode 4 for composite steel-concrete structures).

## **1.2 Normative references**

(1)P The following normative documents contain provisions which, through references in this text, constitutive provisions of this European standard. For dated references, subsequent amendments to or revisions of any of these publications do not apply. However, parties to agreements based on this European standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the normative document referred to applies.