

SINGAPORE STANDARD

Eurocode 3 : Design of steel structures

– Part 5 : Piling

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Building and Construction Authority
CSC Holdings Ltd
Ryobi-Kiso (S) Pte Ltd
National University of Singapore
Singapore Polytechnic
TYH Consulting Engineers

National Foreword

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

This SS EN is the identical implementation of EN 1993-5 : 2007 'Eurocode 3 : Design of steel structures – Part 5 : Piling' (incorporating the CEN Corrigendum EN 1993-5 : 2007/AC : 2009, denoted by AC> <AC) and is adopted with permission of CEN Rue de Stassart 36, B-1050 Brussels.

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 1993-5 : 2010 are to be read in conjunction with the Singapore National Annex (NA) to SS EN 1993-5 : 2010 which contains information on the Singapore Nationally Determined Parameters and is published separately.

National choice is allowed in EN 1993-5 through the following clauses:

- | | | |
|-------------|--------------|-------------|
| – 3.7 (1) | – 5.2.2 (13) | – 7.2.3 (2) |
| – 3.9 (1)P | – 5.2.5 (7) | – 7.4.2 (4) |
| – 4.4 (1) | – 5.5.4 (2) | – A.3.1 (3) |
| – 5.1.1 (4) | – 6.4 (3) | – B.5.4 (1) |
| – 5.2.2 (2) | – 7.1 (4) | – D.2.2 (5) |

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'.

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.*

English Version

Eurocode 3 - Design of steel structures - Part 5: Piling

Eurocode 3 - Calcul des structures en acier - Partie 5:
Pieux et palplanches

Eurocode 3 - Bemessung und Konstruktion von
Stahlbauten - Teil 5: Pfähle und Spundwände

This European Standard was approved by CEN on 12 June 2006.

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 CEN Management Centre 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 CEN Management Centre has the same status as the official versions.

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



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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents	Page
Foreword	4
1 General	7
1.1 Scope	7
1.2 Normative references	8
1.3 Assumptions	8
1.4 Distinction between principles and application rules	9
1.5 Definitions	9
1.6 Symbols	9
1.7 Units	10
1.8 Terminology	11
1.9 Convention for sheet pile axes.....	19
2 Basis of design	20
2.1 General	20
2.2 Ultimate limit state criteria	20
2.3 Serviceability limit state criteria	21
2.4 Site investigation and soil parameters	21
2.5 Analysis	22
2.6 Design assisted by testing.....	23
2.7 Driveability	24
3 Material properties.....	25
3.1 General	25
3.2 Bearing piles	25
3.3 Hot rolled steel sheet piles.....	25
3.4 Cold formed steel sheet piles.....	25
3.5 Sections used for waling and bracing	26
3.6 Connecting devices.....	26
3.7 Steel members used for anchors	26
3.8 Steel members used for combined walls	26
3.9 Fracture toughness.....	27
4 Durability	28
4.1 General	28
4.2 Durability requirements for bearing piles.....	29
4.3 Durability requirements for sheet piling.....	30
4.4 Corrosion rates for design.....	30
5 Ultimate limit states.....	32
5.1 Basis	32
5.2 Sheet piling	32
5.3 Bearing piles	46
5.4 High modulus walls	48
5.5 Combined walls	49
6 Serviceability limit states	52
6.1 Basis	52
6.2 Displacements of retaining walls.....	52
6.3 Displacements of bearing piles	52
6.4 Structural aspects of steel sheet piling.....	52
7 Anchors, walings, bracing and connections	54
7.1 General	54

7.2	Anchorage	54
7.3	Walings and bracing	56
7.4	Connections	56
8	Execution	64
8.1	General	64
8.2	Steel sheet piling.....	64
8.3	Bearing piles	64
8.4	Anchorage	64
8.5	Walings, bracings and connections	64
A	[normative] - Thin walled steel sheet piling	65
A.1	General	65
A.2	Basis of design.....	66
A.3	Properties of materials and cross-sections.....	66
A.4	Local buckling	70
A.5	Resistance of cross-sections	72
A.6	Design by calculation	76
A.7	Design assisted by testing.....	77
B	[informative] - Testing of thin walled steel sheet piles	79
B.1	General	79
B.2	Single span beam test	79
B.3	Intermediate support test	80
B.4	Double span beam test.....	81
B.5	Evaluation of test results.....	82
C	[informative] - Guidance for the design of steel sheet piling	84
C.1	Design of sheet pile cross section at ultimate limit state	84
C.2	Serviceability limit state	87
D	[informative] - Primary elements of combined walls	89
D.1	I-sections used as primary elements	89
D.2	Tubular piles used as primary elements.....	91

Foreword

This European Standard EN 1993-5, “Eurocode 3: Design of steel structures: Part 5 Piling”, 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 August 2007, and conflicting National Standards shall be withdrawn at latest by March 2010.

This Eurocode supersedes ENV 1993-5:1998.

According to the CEN-CENELEC Internal Regulations, the National Standard Organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, 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 1980's.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement¹ 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
EN 1998	Eurocode 8: Design of structures for earthquake resistance
EN 1999	Eurocode 9: Design of aluminium structures

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).

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 Documents² referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standard³. 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 a 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 (informative).

The National Annex (informative) 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 for partial factors and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- geographical and climatic data specific to the Member State, e.g. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

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 hENs and ETAGs/ETAs.

3 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.

Links between Eurocodes and product harmonised technical specifications (ENs and ETAs)

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works⁴. 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 1993-5

EN 1993-5 gives design rules for steel sheet piling and bearing piles to supplement the generic rules in EN 1993-1.

EN 1993-5 is intended to be used with Eurocodes EN 1990 - Basis of design, EN 1991 - Actions on structures and Part 1 of EN 1997 Geotechnical Design.

Matters that are already covered in those documents are not repeated.

EN 1993-5 is intended for use by

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

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

Annex A and Annex B have been prepared to complement the provisions of EN 1993-1-3 for class 4 steel sheet piles.

Annex C gives guidance on the plastic design of steel sheet pile retaining structures.

Annex D gives one possible set of design rules for primary elements of combined walls.

Reference should be made to EN 1997 for geotechnical design which is not covered in this document.

National Annex for EN 1993-5

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-5 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 1993-5 through clauses:

3.7 (1)	5.2.2 (13)	7.2.3 (2)
3.9 (1)P	5.2.5 (7)	7.4.2 (4)
4.4 (1)	5.5.4 (2)	A.3.1 (3)
5.1.1 (4)	6.4 (3)	B.5.4 (1)
5.2.2 (2)	7.1 (4)	D.2.2 (5)

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.

1 General

1.1 Scope

- (1) Part 5 of EN 1993 provides principles and application rules for the structural design of bearing piles and sheet piles made of steel.
- (2) It also provides examples of detailing for foundation and retaining wall structures.
- (3) The field of application includes:
 - steel piled foundations for civil engineering works on land and over water;
 - temporary or permanent structures needed to carry out steel piling work;
 - temporary or permanent retaining structures composed of steel sheet piles, including all kinds of combined walls.
- (4) The field of application excludes:
 - offshore platforms;
 - dolphins.
- (5) Part 5 of EN 1993 also includes application rules for steel piles filled with concrete.
- (6) Special requirements for seismic design are not covered. Where the effects of ground movements caused by earthquakes are relevant see EN 1998.
- (7) Design provisions are also given for walings, bracing and anchorages, see section 7.
- (8) The design of steel sheet piling using class 1, 2 and 3 cross-sections is covered in sections 5 and 6, whereas the design of class 4 cross-sections is covered in annex A.

NOTE: The testing of class 4 sheet piles is covered in annex B.

- (9) The design procedures for crimped U-piles and straight web steel sheet piles utilise design resistances obtained by testing. Reference should be made to EN 10248 for testing procedures.
- (10) Geotechnical aspects are not covered in this document. Reference is made to EN 1997.
- (11) Provisions for taking into account the effects of corrosion in the design of piling are given in section 4.
- (12) Allowance for plastic global analysis in accordance with 5.4.3 of EN 1993-1-1 is given in 5.2.

NOTE: Guidance for the design of steel sheet pile walls allowing for plastic global analysis is given in Annex C.

- (13) The design of combined walls at ultimate limit states is covered in section 5 including general provisions for the design of primary elements.

NOTE: Guidance for the design of both tubular piles and I-sections used as primary elements is given in Annex D.

1.2 Normative references

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.

- | | | |
|-----------|-------------|--|
| 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 |
| | Part 1.1: | General rules: General rules and rules for buildings; |
| | Part 1.2: | General rules: Structural fire design; |
| | Part 1.3: | General rules: Supplementary rules for cold formed thin gauge members and sheeting; |
| | Part 1.5: | General rules: Plated structural elements; |
| | Part 1.6: | General rules: Strength and stability of shell structures |
| | Part 1.8: | General rules: Design of joints |
| | Part 1.9: | General rules: Fatigue |
| | Part 1.10: | General rules: Material toughness and through-thickness properties |
| | Part 1.11: | General rules: Design of structures with tension components made of steel |
| EN 1994 | Eurocode 4: | Design of composite steel and concrete structures |
| EN 1997 | Eurocode 7: | Geotechnical design |
| EN 1998 | Eurocode 8: | Earthquake resistant design of structures; |
| EN 10002 | | Metallic materials; tensile testing; |
| EN 10027 | | Designation systems for steel; |
| EN 10210 | | Hot finished structural hollow sections of non-alloy fine grain structural steels; |
| EN 10219 | | Cold formed structural hollow sections of non-alloy fine grain structural steels; |
| EN 10248 | | Hot rolled sheet piling of non alloy steels; |
| EN 10249 | | Cold formed sheet piling of non alloy steels; |
| EN 1536 | | Execution of special geotechnical work - Bored piles; |
| EN 1537 | | Execution of special geotechnical work - Ground anchors; |
| EN 12063 | | Execution of special geotechnical work - Sheet-pile walls; |
| EN 12699 | | Execution of special geotechnical work - Displacement piles; |
| EN 14199 | | Execution of special geotechnical work - Micro piles; |
| EN 10045 | | Metallic materials; Charpy impact test; |
| EN 1090-2 | | Execution of steel structures and aluminium structures, Part 2: Technical requirements for steel structures. |