

SS EN 1991-3:2010(2023)+C1:2023
EN 1991-3:2006, IDT
(ICS 91.010.30)

SINGAPORE STANDARD

Eurocode 1 – Actions on structures

– Part 3 : Actions induced by cranes and machinery

The national standard is the identical implementation of EN 1991-3:2006 and is adopted with permission of CEN, Rue de la Science 23 B - 1040 Brussels

Incorporating Corrigendum No. 1
Confirmed 2023

SS EN 1991-3:2010(2023)+C1:2023
EN 1991-3:2006, IDT
(ICS 91.010.30)

SINGAPORE STANDARD

Eurocode 1 – Actions on structures

– Part 3: Actions induced by cranes and machinery

Published by Enterprise Singapore

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilming, without permission in writing from Enterprise Singapore. Request for permission can be sent to: standards@enterprisesg.gov.sg.

© CEN 2006
© Enterprise Singapore 2010

ISBN 978-981-5118-61-2

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 1991-3 : 2006 'Eurocode 1 – Actions on structures – Part 3: Actions induced by cranes and machinery' including the corrigendum to this standard, is adopted with permission of CEN, Rue de la Science 23 B - 1040 Brussels. The Corrigendum can be found at the back of the standard.

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 1991-3 : 2010 are to be read in conjunction with the Singapore National Annex (NA) to SS EN 1991-3 : 2010 which contains information on the Singapore Nationally Determined Parameters and is published separately.

National choice is allowed in EN 1991-3 through the following clauses:

- 2.1(2)
- 2.5.2.1(2)
- 2.5.3(2)
- 2.7.3(3)
- A.2.2(1)
- A.2.2(2)
- A.2.3(1)

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

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. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as "mature standards". Mature standards will not be subject to further review unless there are requests to review such standards.*
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 and the Singapore Standards Council 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. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*
3. *Compliance with a SS or TR does not exempt users from any legal obligations.*

English Version

Eurocode 1 - Actions on structures - Part 3: Actions induced by cranes and machinery

Eurocode 1 - Actions sur les structures - Partie 3: Actions induites par les appareils de levage et les machines

Eurocode 1 - Einwirkungen auf Tragwerke - Teil 3: Einwirkungen infolge von Kranen und Maschinen

This European Standard was approved by CEN on 9 January 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 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, Romania, 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

CONTENTS	Page
FOREWORD.....	4
BACKGROUND OF THE EUROCODE PROGRAMME.....	4
STATUS AND FIELD OF APPLICATION OF EUROCODES.....	5
NATIONAL STANDARDS IMPLEMENTING EUROCODES.....	6
LINKS BETWEEN EUROCODES AND HARMONISED TECHNICAL SPECIFICATIONS (ENs AND ETAs) FOR PRODUCTS.....	6
ADDITIONAL INFORMATION SPECIFIC FOR EN 1991-3.....	6
NATIONAL ANNEX FOR EN 1991-3.....	7
SECTION 1 GENERAL.....	8
1.1 SCOPE.....	8
1.2 NORMATIVE REFERENCES.....	8
1.3 DISTINCTION BETWEEN PRINCIPLES AND APPLICATION RULES.....	8
1.4 TERMS AND DEFINITIONS.....	9
1.4.1 Terms and definitions specifically for hoists and cranes on runway beams.....	9
1.4.2 Terms and definitions specifically for actions induced by machines.....	11
1.5 SYMBOLS.....	12
SECTION 2 ACTIONS INDUCED BY HOISTS AND CRANES ON RUNWAY BEAMS 14	
2.1 FIELD OF APPLICATION.....	14
2.2 CLASSIFICATIONS OF ACTIONS.....	14
2.2.1 General.....	14
2.2.2 Variable actions.....	14
2.2.3 Accidental actions.....	15
2.3 DESIGN SITUATIONS.....	16
2.4 REPRESENTATION OF CRANE ACTIONS.....	17
2.5 LOAD ARRANGEMENTS.....	17
2.5.1 Monorail hoist blocks underslung from runway beams.....	17
2.5.1.1 Vertical loads.....	17
2.5.1.2 Horizontal forces.....	17
2.5.2 Overhead travelling cranes.....	17
2.5.2.1 Vertical loads.....	17
2.5.2.2 Horizontal forces.....	18
2.5.3 Multiple crane action.....	20
2.6 VERTICAL CRANE LOADS - CHARACTERISTIC VALUES.....	21
2.7 HORIZONTAL CRANE LOADS - CHARACTERISTIC VALUES.....	23
2.7.1 General.....	23
2.7.2 Longitudinal forces $H_{L,i}$ and transverse forces $H_{T,i}$ caused by acceleration and deceleration of the crane.....	23
2.7.3 Drive force K	25
2.7.4 Horizontal forces $H_{S,i,j,k}$ and the guide force S caused by skewing of the crane..	26
2.8 TEMPERATURE EFFECTS.....	30
2.9 LOADS ON ACCESS WALKWAYS, STAIRS, PLATFORMS AND GUARD RAILS.....	30
2.9.1 Vertical loads.....	30
2.9.2 Horizontal loads.....	30
2.10 TEST LOADS.....	30
2.11 ACCIDENTAL ACTIONS.....	31
2.11.1 Buffer forces $H_{B,1}$ related to crane movement.....	31
2.11.2 Buffer forces $H_{B,2}$ related to movements of the crab.....	32
2.11.3 Tilting forces.....	32

2.12	FATIGUE LOADS	32
2.12.1	<i>Single crane action</i>	32
2.12.2	<i>Stress range effects of multiple wheel or crane actions</i>	35
SECTION 3 ACTIONS INDUCED BY MACHINERY		36
3.1	FIELD OF APPLICATION.....	36
3.2	CLASSIFICATION OF ACTIONS.....	36
3.2.1	<i>General</i>	36
3.2.2	<i>Permanent actions</i>	36
3.2.3	<i>Variable actions</i>	37
3.2.4	<i>Accidental actions</i>	37
3.3	DESIGN SITUATIONS	37
3.4	REPRESENTATION OF ACTIONS.....	37
3.4.1	<i>Nature of the loads</i>	37
3.4.2	<i>Modelling of dynamic actions</i>	38
3.4.3	<i>Modelling of the machinery-structure interaction</i>	38
3.5	CHARACTERISTIC VALUES	39
3.6	SERVICEABILITY CRITERIA	41
ANNEX A (NORMATIVE).....		43
BASIS OF DESIGN – SUPPLEMENTARY CLAUSES TO EN 1990 FOR RUNWAY BEAMS LOADED BY CRANES		43
A.1	GENERAL	43
A.2	ULTIMATE LIMIT STATES.....	43
A.2.1	<i>Combinations of actions</i>	43
A.2.2	<i>Partial factors</i>	44
A.2.3	<i>ψ-factors for crane loads</i>	44
A.3	SERVICEABILITY LIMIT STATES.....	45
A.3.1	<i>Combinations of actions</i>	45
A.3.2	<i>Partial factors</i>	45
A.3.3	<i>ψ-factors for crane actions</i>	45
A.4	FATIGUE	45
ANNEX B (INFORMATIVE)		46
GUIDANCE FOR CRANE CLASSIFICATION FOR FATIGUE		46

Foreword

This European Standard (EN 1991-3:2006) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI.

CEN/TC 250 is responsible for all Structural Eurocodes.

This European Standard supersedes ENV 1991-5:1998.

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 October 2006, and conflicting national standards shall be withdrawn at the latest by March 2010.

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, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the 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 1980s.

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).

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).

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

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 standards³. 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

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 :

- 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.

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:

- 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 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 for EN 1991-3

EN 1991-3 gives design guidance and actions for the structural design of buildings and civil engineering works, including the following aspects:

- actions induced by cranes, and
- actions induced by machinery.

EN 1991-3 is intended for clients, designers, contractors and public authorities.

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.

EN 1991-3 is intended to be used with EN 1990, the other Parts of EN 1991 and EN 1992 to EN 1999 for the design of structures.

National annex for EN 1991-3

This Standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices have to be made. Therefore the National Standard implementing EN 1991-3 should have a National Annex containing all Nationally Determined Parameters to be used for the design of members to be constructed in the relevant country.

National choice is allowed in EN 1991-3 through the following paragraphs:

Paragraph	Item
2.1 (2)	Procedure when actions are given by the crane supplier
2.5.2.1 (2)	Eccentricity of wheel loads
2.5.3 (2)	Maximum number of cranes to be considered in the most unfavourable position
2.7.3 (3)	Value of friction factor
A2.2 (1)	Definition of γ -values for cases STR and GEO
A2.2 (2)	Definition of γ -values for case EQU
A2.3 (1)	Definition of ψ -values

Section 1 General

1.1 Scope

(1) Part 3 of EN 1991 specifies imposed loads (models and representative values) associated with cranes on runway beams and stationary machines which include, when relevant, dynamic effects and braking, acceleration and accidental forces.

(2) Section 1 defines common definitions and notations.

(3) Section 2 specifies actions induced by cranes on runways.

(4) Section 3 specifies actions induced by stationary machines.

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 (including amendments).

ISO 3898 Basis of design of structures - Notations. General symbols

ISO 2394 General principles on reliability for structures

ISO 8930 General principles on reliability for structures. List of equivalent terms

EN 1990 Eurocode: Basis of Structural Design

EN 13001-1 Cranes – General design – Part 1: General principles and requirements

EN 13001-2 Cranes – General design – Part 2: Load effects

EN 1993-1-9 Design of steel structures – Part 1-9: Fatigue

EN 1993-6 Design of steel structures – Part 6: Crane runway beams