

# *Geregistreeerde Belgische norm*

**NBN EN 1991-3**

1e uitg., november 2006

**Normklasse: B 03**

## **Eurocode 1 - Belastingen op constructies - Deel 3: Belastingen veroorzaakt door kranen en machines (+ AC:2012)**

Eurocode 1 - Actions sur les structures - Partie 3: Actions induites par les appareils de levage et les machines (+ AC:2012)

Eurocode 1 - Actions on structures - Part 3: Actions induced by cranes and machinery (+ AC:2012)

### **Toelating tot publicatie: 31 augustus 2006**

Vervangt NBN ENV 1991-5 (1999).

Deze Europese norm EN 1991-3:2006 heeft de status van een Belgische norm.

Deze Europese norm bestaat in drie officiële versies (Duits, Engels, Frans).

Deze norm mag in België slechts samen met zijn nationale bijlage (ANB) worden toegepast. Deze laatste legt hoofdzakelijk de waarden van de parameters vast die op nationaal vlak worden bepaald.



**Bureau voor Normalisatie - Birminghamstraat 131 - 1070 Brussel - België**

Tel: +32 2 738 01 12 - Fax: +32 2 733 42 64 - E-mail: [info@nbn.be](mailto:info@nbn.be) - NBN Online: [www.nbn.be](http://www.nbn.be)  
Bank 000-3255621-10 IBAN BE41 0003 2556 2110 BIC BPOTBEB1 BTW BE0880857592

*norme belge  
enregistrée*

**NBN EN 1991-3**

1e éd., novembre 2006

**Indice de classement: B 03**

---

**Eurocode 1 - Actions sur les structures - Partie 3: Actions induites par les appareils de levage et les machines (+ AC:2012)**

Eurocode 1 - Belastingen op constructies - Deel 3: Belastingen veroorzaakt door kranen en machines (+ AC:2012)

Eurocode 1 - Actions on structures - Part 3: Actions induced by cranes and machinery (+ AC:2012)

---

**Autorisation de publication: 31 août 2006**

Remplace NBN ENV 1991-5 (1999).

La présente norme européenne EN 1991-3:2006 a le statut d'une norme belge.

La présente norme européenne existe en trois versions officielles (allemand, anglais, français).

Cette norme ne peut être utilisée en Belgique qu'en combinaison avec son annexe nationale (ANB) qui fixe principalement la valeur des paramètres à déterminer au niveau national.



**Bureau de Normalisation - Rue de Birmingham 131 - 1070 Bruxelles - Belgique**

Tél: +32 2 738 01 12 - Fax: +32 2 733 42 64 - E-mail: info@nbn.be - NBN Online: www.nbn.be  
Banque 000-3255621-10 IBAN BE41 0003 2556 2110 BIC BPOTBEB1 TVA BE0880857592

# NATIONAAL VOORWOORD VAN NBN EN 1991-3:2006

1. De norm NBN EN 1991-3:2006 «Eurocode 1 – Belastingen op constructies – Deel 3: Belastingen veroorzaakt door kranen en machines» omvat de nationale bijlage NBN EN 1991-3 ANB:2011 met een normatief karakter in België. Hij vervangt vanaf de datum van de publicatie in het Belgisch Staatsblad van de bekrachtiging van de norm NBN EN 1991-3 ANB:2011, de volgende norm:

*NBN ENV 1991-5:1999 «Eurocode 1 – Grondslag voor ontwerp en belastingen op draagsystemen - Deel 5: Belastingen van kranen en andere machines»*

2. De Europese normen (EN) waarnaar de tekst van deze norm met hun Engelse titel verwijst, dragen in België de volgende Nederlandstalige titels:

Vermelde Norm	Nederlandstalige titel (NBN)
ISO 3898 Basis of design of structures – Notations. General Symbols	NBN ISO 3898 Grondslagen voor het ontwerpen van draagsystemen Notaties – Algemene symbolen.
ISO 2394 General principles on reliability for structures	NBN ISO 2394 Algemene beginselen voor de betrouwbaarheid van draagsystemen.
ISO 8930 General principles on reliability for structures List of equivalent terms.	NBN ISO 8930 Algemene beginselen voor de betrouwbaarheid van draagsystemen – Lijst van gelijkwaardige termen
EN 1990 Eurocode : Basis of Structural Design	NBN EN 1990 Eurocode - Grondslag voor constructief ontwerp
EN 13001-1 Cranes – General design – Part 1 : General principles and requirements	NBN EN 13001-1 Hijskranen - Algemeen ontwerp – Deel 1: Algemene grondslagen en eisen
EN 13001-2 Cranes – General design – Part 2 : Load effects	NBN EN 13001-2 Hijskranen - Algemeen ontwerp – Deel 2: Belastingseffecten
EN 1993-1-9 Design of steel structures – Part 1-9 : Fatigue	NBN EN 1993-1-9 Ontwerp en berekening van staalconstructies – Deel 1-9: Algemene regels – Vermoeiing
EN 1993-6 Design of steel structures – Part 6 : Crane runway beams	NBN EN 1993-6 Ontwerp en berekening van staalconstructies – Deel 6: Kraanbanen

## AVANT-PROPOS NATIONAL À LA NBN EN 1991-3:2006

1. La norme NBN EN 1991-3:2006 "Eurocode 1 – Actions sur les structures – Partie 3: Actions induites par les appareils de levage et les machines" comprend l'annexe nationale NBN EN 1991-3 ANB:2011 qui a un caractère normatif en Belgique. Elle remplace à partir de la date de publication au Moniteur Belge de l'homologation de la norme NBN EN 1991-3 ANB :2011, la norme suivante :

*NBN ENV 1991-5:1999 "Eurocode 1 : Bases de calcul et actions sur les structures - Partie 5: Actions induites par les ponts roulants et autres machines".*

2. La version en langue française de l'EN 1991-3:2006 a été rédigée en France par l'AFNOR.  
En conséquence, on y rencontre certaines expressions d'usage moins courant en Belgique.

Une liste de termes équivalents est donnée ci-après :

<b>Terme de l'EN 1991-3</b>	<b>Terme équivalent en Belgique</b>
client	le maître de l'ouvrage assisté de ses bureaux d'architectes, d'ingénierie et de consultance

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**

<b>CONTENTS</b>	<b>Page</b>
<b>FOREWORD</b> .....	<b>4</b>
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
<b>SECTION 1 GENERAL</b> .....	<b>8</b>
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
<b>SECTION 2 ACTIONS INDUCED BY HOISTS AND CRANES ON RUNWAY BEAMS</b> <b>14</b>	
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
<b>SECTION 3 ACTIONS INDUCED BY MACHINERY .....</b>		<b>36</b>
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
<b>ANNEX A (NORMATIVE).....</b>		<b>43</b>
<b>BASIS OF DESIGN – SUPPLEMENTARY CLAUSES TO EN 1990 FOR RUNWAY BEAMS LOADED BY CRANES .....</b>		<b>43</b>
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><math>\psi</math>-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><math>\psi</math>-factors for crane actions</i> .....	45
A.4	FATIGUE .....	45
<b>ANNEX B (INFORMATIVE) .....</b>		<b>46</b>
<b>GUIDANCE FOR CRANE CLASSIFICATION FOR FATIGUE .....</b>		<b>46</b>

EN 1991-3:2006 (E)

## 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 agreement<sup>1</sup> 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).

---

<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).



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 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

<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.

EN 1991-3:2006 (E)

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 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 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.

---

<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.

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 $\gamma$ -values for cases STR and GEO
A2.2 (2)	Definition of $\gamma$ -values for case EQU
A2.3 (1)	Definition of $\psi$ -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

### 1.3 Distinction between Principles and Application Rules

- (1) Depending on the character of the individual clauses, distinction is made in this Part of prEN 1991 between Principles and Application Rules.
- (2) The Principles comprise:
  - general statements and definitions for which there is no alternative, as well as
  - requirements and analytical models for which no alternative is permitted unless specifically stated.
- (3) The Principles are identified by the letter P following the paragraph number.