

# SVENSK STANDARD

## SS-EN 1991-2

Fastställt/Approved: 2003-10-17

Publicerad/Published: 2010-03-10

Utgåva/Edition: 1

Språk/Language: engelska/English

ICS: 91.010.30; 91.070.01; 91.070.60; 93.040

---

### **Eurokod 1: Laster på bärverk – Del 2: Trafiklast på broar**

### **Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges**

This preview is downloaded from [www.sis.se](http://www.sis.se). Buy the entire standard via <https://www.sis.se/std-72046>

# Hitta rätt produkt och ett leveranssätt som passar dig

## Standarder

Genom att följa gällande standard både effektiviserar och säkrar du ditt arbete. Många standarder ingår dessutom ofta i paket.

## Tjänster

Abonnemang är tjänsten där vi uppdaterar dig med aktuella standarder när förändringar sker på dem du valt att abonnera på.

På så sätt är du säker på att du alltid arbetar efter rätt utgåva.

e-nav är vår online-tjänst som ger dig och dina kollegor tillgång till standarder ni valt att abonnera på dygnet runt. Med e-nav kan samma standard användas av flera personer samtidigt.

## Leveranssätt

Du väljer hur du vill ha dina standarder levererade. Vi kan erbjuda dig dem på papper och som pdf.

## Andra produkter

Vi har böcker som underlättar arbetet att följa en standard. Med våra böcker får du ökad förståelse för hur standarder ska följas och vilka fördelar den ger dig i ditt arbete. Vi tar fram många egna publikationer och fungerar även som återförsäljare. Det gör att du hos oss kan hitta över 500 unika titlar. Vi har även tekniska rapporter, specifikationer och "workshop agreement".

Matriser är en översikt på standarder och handböcker som bör läsas tillsammans. De finns på [sis.se](http://sis.se) och ger dig en bra bild över hur olika produkter hör ihop.

## Standardiseringsprojekt

Du kan påverka innehållet i framtida standarder genom att delta i någon av SIS ca 400 Tekniska Kommittéer.

# Find the right product and the type of delivery that suits you

## Standards

By complying with current standards, you can make your work more efficient and ensure reliability. Also, several of the standards are often supplied in packages.

## Services

Subscription is the service that keeps you up to date with current standards when changes occur in the ones you have chosen to subscribe to. This ensures that you are always working with the right edition.

e-nav is our online service that gives you and your colleagues access to the standards you subscribe to 24 hours a day. With e-nav, the same standards can be used by several people at once.

## Type of delivery

You choose how you want your standards delivered. We can supply them both on paper and as PDF files.

## Other products

We have books that facilitate standards compliance. They make it easier to understand how compliance works and how this benefits you in your operation. We produce many publications of our own, and also act as retailers. This means that we have more than 500 unique titles for you to choose from. We also have technical reports, specifications and workshop agreements.

Matrices, listed at [sis.se](http://sis.se), provide an overview of which publications belong together.

## Standardisation project

You can influence the content of future standards by taking part in one or other of SIS's 400 or so Technical Committees.

Europastandarden EN 1991-2:2003 gäller som svensk standard. Standarden fastställdes 2003-10-17 som SS-EN 1991-2 och har utgivits i svensk språkversion. Detta dokument återger EN 1991-2:2003 i engelsk språkversion. De båda språkversionerna gäller parallellt.

SS-EN 1991-2 utgåva 1 och SS-ENV 1991-3, utgåva 1 gäller parallellt längst till 2010-03-30.

The European Standard EN 1991-2:2003 has the status of a Swedish Standard. The standard was 2003-10-17 approved and published as SS-EN 1991-2 in Swedish. This document contains a English language version of EN 1991-2:2003. The two versions are valid in parallel.

SS-EN 1991-2, edition 1 and SS-ENV 1991-3, edition 1, are valid for and run parallel longest to 2010-03-30.

© Copyright/Upphovsrätten till denna produkt tillhör SIS, Swedish Standards Institute, Stockholm, Sverige. Användningen av denna produkt regleras av slutanvändarlicensen som återfinns i denna produkt, se standardens sista sidor.

© Copyright SIS, Swedish Standards Institute, Stockholm, Sweden. All rights reserved. The use of this product is governed by the end-user licence for this product. You will find the licence in the end of this document.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00.

Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), tel +46 8 555 520 00.

Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

SIS Förlag AB, SE 118 80 Stockholm, Sweden. Tel: +46 8 555 523 10. Fax: +46 8 555 523 11.

E-mail: [sis.sales@sis.se](mailto:sis.sales@sis.se) Internet: [www.sis.se](http://www.sis.se)



EUROPEAN STANDARD

**EN 1991-2**

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2003

ICS 91.010.30; 93.040

Supersedes ENV 1991-3:1995

English version

## Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges

Eurocode 1: Actions sur les structures - Partie 2: Actions sur les ponts, dues au trafic

Eurocode 1: Einwirkungen auf Tragwerke - Teil 2: Verkehrslasten auf Brücken

This European Standard was approved by CEN on 28 November 2002.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, 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**

**FOREWORD..... 7**

BACKGROUND OF THE EUROCODE PROGRAMME ..... 7

STATUS AND FIELD OF APPLICATION OF EUROCODES ..... 8

NATIONAL STANDARDS IMPLEMENTING EUROCODES ..... 9

LINKS BETWEEN EUROCODES AND HARMONISED TECHNICAL SPECIFICATIONS (ENs AND ETAs) FOR PRODUCTS ..... 9

ADDITIONAL INFORMATION SPECIFIC TO EN 1991-2 ..... 9

NATIONAL ANNEX FOR EN 1991-2 ..... 11

**SECTION 1 GENERAL ..... 15**

1.1 SCOPE ..... 15

1.2 NORMATIVE REFERENCES..... 16

1.3 DISTINCTION BETWEEN PRINCIPLES AND APPLICATION RULES ..... 16

1.4 TERMS AND DEFINITIONS..... 17

*1.4.1 Harmonised terms and common definitions*..... 17

*1.4.2 Terms and definitions specifically for road bridges* ..... 19

*1.4.3 Terms and definitions specifically for railway bridges*..... 20

1.5 SYMBOLS ..... 21

*1.5.1 Common symbols* ..... 21

*1.5.2 Symbols specifically for sections 4 and 5*..... 21

*1.5.3 Symbols specifically for section 6* ..... 23

**SECTION 2 CLASSIFICATION OF ACTIONS..... 27**

2.1 GENERAL ..... 27

2.2 VARIABLE ACTIONS..... 27

2.3 ACTIONS FOR ACCIDENTAL DESIGN SITUATIONS..... 28

**SECTION 3 DESIGN SITUATIONS..... 30**

**SECTION 4 ROAD TRAFFIC ACTIONS AND OTHER ACTIONS SPECIFICALLY FOR ROAD BRIDGES..... 31**

4.1 FIELD OF APPLICATION ..... 31

4.2 REPRESENTATION OF ACTIONS ..... 31

*4.2.1 Models of road traffic loads*..... 31

*4.2.2 Loading classes* ..... 32

*4.2.3 Divisions of the carriageway into notional lanes* ..... 32

*4.2.4 Location and numbering of the lanes for design*..... 33

*4.2.5 Application of the load models on the individual lanes* ..... 34

4.3 VERTICAL LOADS - CHARACTERISTIC VALUES ..... 35

*4.3.1 General and associated design situations*..... 35

*4.3.2 Load Model 1* ..... 35

*4.3.3 Load Model 2* ..... 38

*4.3.4 Load Model 3 (special vehicles)*..... 39

*4.3.5 Load Model 4 (crowd loading)*..... 39

*4.3.6 Dispersal of concentrated loads*..... 40

4.4 HORIZONTAL FORCES - CHARACTERISTIC VALUES ..... 41

*4.4.1 Braking and acceleration forces* ..... 41

4.4.2 <i>Centrifugal and other transverse forces</i> .....	42
4.5 <u>GROUPS OF TRAFFIC LOADS ON ROAD BRIDGES</u> .....	42
4.5.1 <i>Characteristic values of the multi-component action</i> .....	42
4.5.2 <i>Other representative values of the multi-component action</i> .....	44
4.5.3 <i>Groups of loads in transient design situations</i> .....	44
4.6 <u>FATIGUE LOAD MODELS</u> .....	45
4.6.1 <i>General</i> .....	45
4.6.2 <i>Fatigue Load Model 1 (similar to LMI)</i> .....	48
4.6.3 <i>Fatigue Load Model 2 (set of "frequent" lorries)</i> .....	48
4.6.4 <i>Fatigue Load Model 3 (single vehicle model)</i> .....	49
4.6.5 <i>Fatigue Load Model 4 (set of "standard" lorries)</i> .....	50
4.6.6 <i>Fatigue Load Model 5 (based on recorded road traffic data)</i> .....	53
4.7 <u>ACTIONS FOR ACCIDENTAL DESIGN SITUATIONS</u> .....	53
4.7.1 <i>General</i> .....	53
4.7.2 <i>Collision forces from vehicles under the bridge</i> .....	53
4.7.2.1 <i>Collision forces on piers and other supporting members</i> .....	53
4.7.2.2 <i>Collision forces on decks</i> .....	53
4.7.3 <i>Actions from vehicles on the bridge</i> .....	54
4.7.3.1 <i>Vehicle on footways and cycle tracks on road bridges</i> .....	54
4.7.3.2 <i>Collision forces on kerbs</i> .....	55
4.7.3.3 <i>Collision forces on vehicle restraint systems</i> .....	55
4.7.3.4 <i>Collision forces on structural members</i> .....	56
4.8 <u>ACTIONS ON PEDESTRIAN PARAPETS</u> .....	56
4.9 <u>LOAD MODELS FOR ABUTMENTS AND WALLS ADJACENT TO BRIDGES</u> .....	57
4.9.1 <i>Vertical loads</i> .....	57
4.9.2 <i>Horizontal force</i> .....	57
<b><u>SECTION 5 ACTIONS ON FOOTWAYS, CYCLE TRACKS AND FOOTBRIDGES</u></b> .....	<b>59</b>
5.1 <u>FIELD OF APPLICATION</u> .....	59
5.2 <u>REPRESENTATION OF ACTIONS</u> .....	59
5.2.1 <i>Models of the loads</i> .....	59
5.2.2 <i>Loading classes</i> .....	60
5.2.3 <i>Application of the load models</i> .....	60
5.3 <u>STATIC MODELS FOR VERTICAL LOADS - CHARACTERISTIC VALUES</u> .....	60
5.3.1 <i>General</i> .....	60
5.3.2 <i>Load Models</i> .....	61
5.3.2.1 <i>Uniformly distributed load</i> .....	61
5.3.2.2 <i>Concentrated load</i> .....	61
5.3.2.3 <i>Service vehicle</i> .....	62
5.4 <u>STATIC MODEL FOR HORIZONTAL FORCES - CHARACTERISTIC VALUES</u> .....	62
5.5 <u>GROUPS OF TRAFFIC LOADS ON FOOTBRIDGES</u> .....	62
5.6 <u>ACTIONS FOR ACCIDENTAL DESIGN SITUATIONS FOR FOOTBRIDGES</u> .....	63
5.6.1 <i>General</i> .....	63
5.6.2 <i>Collision forces from road vehicles under the bridge</i> .....	63
5.6.2.1 <i>Collision forces on piers</i> .....	63
5.6.2.2 <i>Collision forces on decks</i> .....	64
5.6.3 <i>Accidental presence of vehicles on the bridge</i> .....	64
5.7 <u>DYNAMIC MODELS OF PEDESTRIAN LOADS</u> .....	65
5.8 <u>ACTIONS ON PARAPETS</u> .....	65

5.9 LOAD MODEL FOR ABUTMENTS AND WALLS ADJACENT TO BRIDGES.....	65
---	----

## **SECTION 6 RAIL TRAFFIC ACTIONS AND OTHER ACTIONS**

<b><u>SPECIFICALLY FOR RAILWAY BRIDGES</u></b> .....	<b>66</b>
--	-----------

6.1 FIELD OF APPLICATION.....	66
6.2 REPRESENTATION OF ACTIONS – NATURE OF RAIL TRAFFIC LOADS .....	67
6.3 VERTICAL LOADS - CHARACTERISTIC VALUES (STATIC EFFECTS) AND ECCENTRICITY AND DISTRIBUTION OF LOADING.....	67
6.3.1 <i>General</i> .....	67
6.3.2 <i>Load Model 71</i> .....	67
6.3.3 <i>Load Models SW/0 and SW/2</i> .....	68
6.3.4 <i>Load Model “unloaded train”</i> .....	69
6.3.5 <i>Eccentricity of vertical loads (Load Models 71 and SW/0)</i> .....	69
6.3.6 <i>Distribution of axle loads by the rails, sleepers and ballast</i> .....	70
6.3.6.1 <i>Longitudinal distribution of a point force or wheel load by the rail</i> .....	70
6.3.6.2 <i>Longitudinal distribution of load by sleepers and ballast</i> .....	71
6.3.6.3 <i>Transverse distribution of actions by the sleepers and ballast</i> .....	71
6.3.6.4 <i>Equivalent vertical loading for earthworks and earth pressure effects</i> ...	73
6.3.7 <i>Actions for non-public footpaths</i> .....	74
6.4 DYNAMIC EFFECTS (INCLUDING RESONANCE) .....	74
6.4.1 <i>Introduction</i> .....	74
6.4.2 <i>Factors influencing dynamic behaviour</i> .....	74
6.4.3 <i>General design rules</i> .....	75
6.4.4 <i>Requirement for a static or dynamic analysis</i> .....	75
6.4.5 <i>Dynamic factor <math>\Phi</math> (<math>\Phi_2</math>, <math>\Phi_3</math>)</i> .....	78
6.4.5.1 <i>Field of application</i> .....	78
6.4.5.2 <i>Definition of the dynamic factor <math>\Phi</math></i> .....	78
6.4.5.3 <i>Determinant length <math>L_\phi</math></i> .....	79
6.4.5.4 <i>Reduced dynamic effects</i> .....	82
6.4.6 <i>Requirements for a dynamic analysis</i> .....	83
6.4.6.1 <i>Loading and load combinations</i> .....	83
6.4.6.2 <i>Speeds to be considered</i> .....	87
6.4.6.3 <i>Bridge parameters</i> .....	88
6.4.6.4 <i>Modelling the excitation and dynamic behaviour of the structure</i> .....	89
6.4.6.5 <i>Verifications of the limit states</i> .....	91
6.4.6.6 <i>Additional verification for fatigue where dynamic analysis is required</i> .....	92
6.5 HORIZONTAL FORCES - CHARACTERISTIC VALUES.....	93
6.5.1 <i>Centrifugal forces</i> .....	93
6.5.2 <i>Nosing force</i> .....	97
6.5.3 <i>Actions due to traction and braking</i> .....	97
6.5.4 <i>Combined response of structure and track to variable actions</i> .....	98
6.5.4.1 <i>General principles</i> .....	98
6.5.4.2 <i>Parameters affecting the combined response of the structure and track</i> .....	99
6.5.4.3 <i>Actions to be considered</i> .....	101
6.5.4.4 <i>Modelling and calculation of the combined track/structure system</i> .....	102
6.5.4.5 <i>Design criteria</i> .....	104
6.5.4.6 <i>Calculation methods</i> .....	105
6.6 AERODYNAMIC ACTIONS FROM PASSING TRAINS .....	108
6.6.1 <i>General</i> .....	108
6.6.2 <i>Simple vertical surfaces parallel to the track (e.g. noise barriers)</i> .....	109



6.6.3 <i>Simple horizontal surfaces above the track (e.g. overhead protective structures)</i> .....	110
6.6.4 <i>Simple horizontal surfaces adjacent to the track (e.g. platform canopies with no vertical wall)</i> .....	111
6.6.5 <i>Multiple-surface structures alongside the track with vertical and horizontal or inclined surfaces (e.g. bent noise barriers, platform canopies with vertical walls etc.)</i> .....	112
6.6.6 <i>Surfaces enclosing the structure gauge of the tracks over a limited length (up to 20 m) (horizontal surface above the tracks and at least one vertical wall, e.g. scaffolding, temporary constructions)</i> .....	112
6.7 <b>DERAILMENT AND OTHER ACTIONS FOR RAILWAY BRIDGES</b> .....	113
6.7.1 <i>Derailment actions from rail traffic on a railway bridge</i> .....	113
6.7.2 <i>Derailment under or adjacent to a structure and other actions for Accidental Design Situations</i> .....	115
6.7.3 <i>Other actions</i> .....	115
6.8 <b>APPLICATION OF TRAFFIC LOADS ON RAILWAY BRIDGES</b> .....	115
6.8.1 <i>General</i> .....	115
6.8.2 <i>Groups of Loads - Characteristic values of the multicomponent action</i> .....	118
6.8.3 <i>Groups of Loads - Other representative values of the multicomponent actions</i> .....	120
6.8.3.1 <i>Frequent values of the multicomponent actions</i> .....	120
6.8.3.2 <i>Quasi-permanent values of the multicomponent actions</i> .....	121
6.8.4 <i>Traffic loads in Transient Design Situations</i> .....	121
6.9 <b>TRAFFIC LOADS FOR FATIGUE</b> .....	121
<b><u>ANNEX A (INFORMATIVE) MODELS OF SPECIAL VEHICLES FOR ROAD BRIDGES</u></b> .....	<b>123</b>
A.1 <b>SCOPE AND FIELD OF APPLICATION</b> .....	123
A.2 <b>BASIC MODELS OF SPECIAL VEHICLES</b> .....	123
A.3 <b>APPLICATION OF SPECIAL VEHICLE LOAD MODELS ON THE CARRIAGEWAY</b> .....	125
<b><u>ANNEX B (INFORMATIVE) FATIGUE LIFE ASSESSMENT FOR ROAD BRIDGES ASSESSMENT METHOD BASED ON RECORDED TRAFFIC</u></b> .....	<b>128</b>
<b><u>ANNEX C (NORMATIVE) DYNAMIC FACTORS <math>1 + \phi</math> FOR REAL TRAINS</u></b> .....	<b>132</b>
<b><u>ANNEX D (NORMATIVE) BASIS FOR THE FATIGUE ASSESSMENT OF RAILWAY STRUCTURES</u></b> .....	<b>134</b>
D.1 <b>ASSUMPTIONS FOR FATIGUE ACTIONS</b> .....	134
D.2 <b>GENERAL DESIGN METHOD</b> .....	135
D.3 <b>TRAIN TYPES FOR FATIGUE</b> .....	135
<b><u>ANNEX E (INFORMATIVE) LIMITS OF VALIDITY OF LOAD MODEL HSLM AND THE SELECTION OF THE CRITICAL UNIVERSAL TRAIN FROM HSLM-A</u></b> .....	<b>141</b>
E.1 <b>LIMITS OF VALIDITY OF LOAD MODEL HSLM</b> .....	141
E.2 <b>SELECTION OF A UNIVERSAL TRAIN FROM HSLM-A</b> .....	142
<b><u>ANNEX F (INFORMATIVE) CRITERIA TO BE SATISFIED IF A DYNAMIC ANALYSIS IS NOT REQUIRED</u></b> .....	<b>150</b>

<b><u>ANNEX G (INFORMATIVE) METHOD FOR DETERMINING THE COMBINED RESPONSE OF A STRUCTURE AND TRACK TO VARIABLE ACTIONS</u></b> .....	<b>155</b>
G.1 INTRODUCTION.....	155
G.2 LIMITS OF VALIDITY OF CALCULATION METHOD.....	155
G.3 STRUCTURES CONSISTING OF A SINGLE BRIDGE DECK.....	156
G.4 STRUCTURES CONSISTING OF A SUCCESSION OF DECKS.....	162
<b><u>ANNEX H (INFORMATIVE) LOAD MODELS FOR RAIL TRAFFIC LOADS IN TRANSIENT DESIGN SITUATIONS</u></b> .....	<b>164</b>

## Foreword

This document (EN 1991-2:2003) has been prepared by Technical Committee CEN/TC 250 "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 March 2004, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document supersedes ENV 1991-3:1995.

CEN/TC 250 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, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, 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 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 standards with a view to achieving a full compatibility of these technical specifications with the Eurocodes.

---

<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.

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,
- 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 to EN 1991-2**

EN 1991-2 defines models of traffic loads for the design of road bridges, footbridges and railway bridges. For the design of new bridges, EN 1991-2 is intended to be used, for direct application, together with Eurocodes EN 1990 to 1999.

The bases for combinations of traffic loads with non-traffic loads are given in EN 1990, A2.

---

<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 (Interpretative Document Nr. 1).

Complementary rules may be specified for individual projects :

- when traffic loads need to be considered which are not defined in this Part of Eurocode 1 (*e.g.* site loads, military loads, tramway loads) ;
- for bridges intended for both road and rail traffic ;
- for actions to be considered in accidental design situations ;
- for masonry arch bridges.

For road bridges, Load Models 1 and 2, defined in 4.3.2 and 4.3.3, and taken into account with adjustment factors  $\alpha$  and  $\beta$  equal to 1, are deemed to represent the most severe traffic met or expected in practice, other than that of special vehicles requiring permits to travel, on the main routes of European countries. The traffic on other routes in these countries and in some other countries may be substantially lighter, or better controlled. However it should be noted that a great number of existing bridges do not meet the requirements of this EN 1991-2 and the associated Structural Eurocodes EN 1992 to EN 1999.

It is therefore recommended to the national authorities that values of the adjustment factors  $\alpha$  and  $\beta$  be chosen for road bridge design corresponding possibly to several classes of routes on which the bridges are located, but remain as few and simple as possible, based on consideration of the national traffic regulations and the efficiency of the associated control.

For railway bridges, Load Model 71 (together with Load Model SW/0 for continuous bridges), defined in 6.3.2, represent the static effect of standard rail traffic operating over the standard-gauge or wide-gauge European mainline-network. Load Model SW/2, defined in 6.3.3, represents the static effect of heavy rail traffic. The lines, or sections of lines, over which such loads shall be taken into account are defined in the National Annex (see below) or for the individual project.

Provision is made for varying the specified loading to cater for variations in the type, volume and maximum weight of rail traffic on different railways, as well as for different qualities of track. The characteristic values given for Load Models 71 and SW/0 may be multiplied by a factor  $\alpha$  for lines carrying rail traffic which is heavier or lighter than the standard.

In addition two other load models are given for railway bridges :

- load model "unloaded train" for checking the lateral stability of single track bridges and
- load model HSLM to represent the loading from passenger trains at speeds exceeding 200 km/h.

Guidance is also given on aerodynamic actions on structures adjacent to railway tracks as a result of passing trains and on other actions from railway infrastructure.

Bridges are essentially public works, for which :

- the European Directive 89/440/EEC on contracts for public works is particularly relevant, and
- public authorities have responsibilities as owners.

Public authorities may also have responsibilities for the issue of regulations on authorised traffic (especially on vehicle loads) and for delivery and control dispensations when relevant, e.g. for special vehicles.

EN 1991-2 is therefore intended for use by :

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

Where a Table or a Figure are part of a NOTE, the Table or the Figure number is followed by (n) (e.g. Table 4.5(n)).

### National Annex for EN 1991-2

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 1991-2 should have a National Annex containing all Nationally Determined Parameters to be used for the design of bridges to be constructed in the relevant country.

National choice is allowed in EN 1991-2 through the following clauses :

Section 1 : General	
1.1(3)	Complementary rules for retaining walls, buried structures and tunnels.

Section 2 : Classification of actions	
2.2(2) NOTE 2	Use of infrequent values of loading for road bridges
2.3(1)	Definition of appropriate protection against collisions
2.3(4)	Rules concerning collisions forces from various origins

Section 3 : Design situations	
(5)	Rules for bridges carrying both road and rail traffic

Section 4 : Road traffic actions and other actions specifically for road bridges	
4.1(1) NOTE 2	Road traffic actions for loaded lengths greater than 200m
4.1(2) NOTE 1	Specific load models for bridges with limitation of vehicle weight
4.2.1(1) NOTE 2	Definition of complementary load models
4.2.1(2)	Definition of models of special vehicles
4.2.3(1)	Conventional height of kerbs
4.3.1(2) NOTE 2	Use of LM2
4.3.2(3) NOTES 1 & 2	Values of $\alpha$ factors

4.3.2(6)	Use of simplified alternative load models
4.3.3(2)	Values of $\beta$ factor
4.3.3(4) NOTE 2	Selection of wheel contact surface for LM2
4.3.4(1)	Definition of Load Model 3 (special vehicles)
4.4.1(2) NOTE 2	Upper limit of the braking force on road bridges
4.4.1(2) NOTE 3	Horizontal forces associated with LM3
4.4.1(3)	Horizontal forces associated with Load Model 3
4.4.1(6)	Braking force transmitted by expansion joints
4.4.2(4)	Lateral forces on road bridge decks
4.5.1 – Table 4.4a Notes a and b	Consideration of horizontal forces in gr1 a
4.5.2 NOTE 3	Use of infrequent values of variable actions
4.6.1(2) NOTE 2	Use of Fatigue Load Models
4.6.1(3) NOTE 1	Definition of traffic categories
4.6.1(6)	Definition of additional amplification factor (fatigue)
4.6.4(3)	Adjustment of Fatigue Load Model 3
4.6.5(1) NOTE 2	Road traffic characteristics for the use of Fatigue Load Model 4
4.6.6(1)	Use of Fatigue Load Model 5
4.7.2.1(1)	Definition of impact force and height of impact
4.7.2.2(1) NOTE 1	Definition of collision forces on decks
4.7.3.3(1) NOTE 1	Definition of collision forces on vehicle restraint systems
4.7.3.3(1) NOTE 3	Definition of vertical force acting simultaneously with the horizontal collision force
4.7.3.3(2)	Design load for the structure supporting a vehicle parapet
4.7.3.4(1)	Definition of collision forces on unprotected vertical structural members
4.8(1) NOTE 2	Definition of actions on pedestrian parapets
4.8(3)	Definition of design loads due to pedestrian parapets for the supporting structure
4.9.1(1) NOTE 1	Definition of load models on embankments

Section 5 : Actions on footways, cycle tracks and footbridges	
5.2.3(2)	Definition of load models for inspection gangways
5.3.2.1(1)	Definition of the characteristic value of the uniformly distributed load
5.3.2.2(1)	Definition of the characteristic value of the concentrated load on footbridges
5.3.2.3(1)P NOTE 1	Definition of service vehicles for footbridges
5.4(2)	Characteristic value of the horizontal force on footbridges



5.6.1(1)	Definition of specific collision forces
5.6.2.1(1)	Collision forces on piers
5.6.2.2(1)	Collision forces on decks
5.6.3(2) NOTE 2	Definition of a load model for accidental presence of a vehicle on a footbridge
5.7(3)	Definition of dynamic models of pedestrian loads

Section 6 : Rail traffic actions and other actions specifically for railway bridges	
6.1(2)	Traffic outside the scope of EN1991-2, alternative load models
6.1(3)P	Other types of railways
6.1(7)	Temporary bridges
6.3.2(3)P	Values of $\alpha$ factor
6.3.3(4)P	Choice of lines for heavy rail traffic
6.4.4	Alternative requirements for a dynamic analysis
6.4.5.2(3)P	Choice of dynamic factor
6.4.5.3(1)	Alternative values of determinant lengths
6.4.5.3 Table 6.2	Determinant length of cantilevers
6.4.6.1.1(6)	Additional requirements for the application of HSLM
6.4.6.1.1(7)	Loading and methodology for dynamic analysis
6.4.6.1.2(3) Table 6.5	Additional load cases depending upon number of tracks
6.4.6.3.1(3) Table 6.6	Values of damping
6.4.6.3.2(3)	Alternative density values of materials
6.4.6.3.3(3) NOTE 1 NOTE 2	Enhanced Young's modulus Other material properties
6.4.6.4(4)	Reduction of peak response at resonance and alternative additional damping values
6.4.6.4(5)	Allowance for track defects and vehicle imperfections
6.5.1(2)	Increased height of centre of gravity for centrifugal forces
6.5.3(5)	Actions due to braking for loaded lengths greater than 300 m
6.5.3(9)P	Alternative requirements for the application of traction and braking forces
6.5.4.1(5)	Combined response of structure and track, requirements for non-ballasted track
6.5.4.3.(2) NOTES 1 & 2	Alternative requirements for temperature range
6.5.4.4(2) NOTE 1	Longitudinal shear resistance between track and bridge deck
6.5.4.5	Alternative design criteria
6.5.4.5.1(2)	Minimum value of track radius
6.5.4.5.1(2)	Limiting values for rail stresses
6.5.4.6	Alternative calculation methods
6.5.4.6.1(1)	Alternative criteria for simplified calculation methods
6.5.4.6.1(4)	Longitudinal plastic shear resistance between track and bridge deck
6.6.1(3)	Aerodynamic actions, alternative values
6.7.1(2)P	Derailment of rail traffic, additional requirements

6.7.1(8)P	Derailment of rail traffic, measures for structural elements situated above the level of the rails and requirements to retain a derailed train on the structure
6.7.3(1)P	Other actions
6.8.1(11)P Table 6.10	Number of tracks loaded when checking drainage and structural clearances
6.8.2(2) Table 6.11	Assessment of groups of loads
6.8.3.1(1)	Frequent values of multi-component actions
6.8.3.2(1)	Quasi-permanent values of multi-component actions
6.9(6)	Fatigue load models, structural life
6.9(7)	Fatigue load models, special traffic
Annex C(3)P	Dynamic factor
Annex C(3)P	Method of dynamic analysis
Annex D2(2)	Partial safety factor for fatigue loading

## Section 1 General

### 1.1 Scope

(1) EN 1991-2 defines imposed loads (models and representative values) associated with road traffic, pedestrian actions and rail traffic which include, when relevant, dynamic effects and centrifugal, braking and acceleration actions and actions for accidental design situations.

(2) Imposed loads defined in EN 1991-2 are intended to be used for the design of new bridges, including piers, abutments, upstand walls, wing walls and flank walls etc., and their foundations.

(3) The load models and values given in EN 1991-2 should be used for the design of retaining walls adjacent to roads and railway lines.

NOTE For some models only, applicability conditions are defined in EN 1991-2. For the design of buried structures, retaining walls and tunnels, provisions other than those in EN 1990 to EN 1999 may be necessary. Possible complementary conditions may be defined in the National Annex or for the individual project.

(4) EN 1991-2 is intended to be used in conjunction with EN 1990 (especially A2) and EN 1991 to EN 1999.

(5) Section 1 gives definitions and symbols.

(6) Section 2 defines loading principles for road bridges, footbridges (or cycle-track bridges) and railway bridges.

(7) Section 3 is concerned with design situations and gives guidance on simultaneity of traffic load models and on combinations with non-traffic actions.

(8) Section 4 defines :

- imposed loads (models and representative values) due to traffic actions on road bridges and their conditions of mutual combination and of combination with pedestrian and cycle traffic (see section 5) ;
- other actions specifically for the design of road bridges.

(9) Section 5 defines :

- imposed loads (models and representative values) on footways, cycle tracks and footbridges ;
- other actions specifically for the design of footbridges.

(10) Sections 4 and 5 also define loads transmitted to the structure by vehicle restraint systems and/or pedestrian parapets.