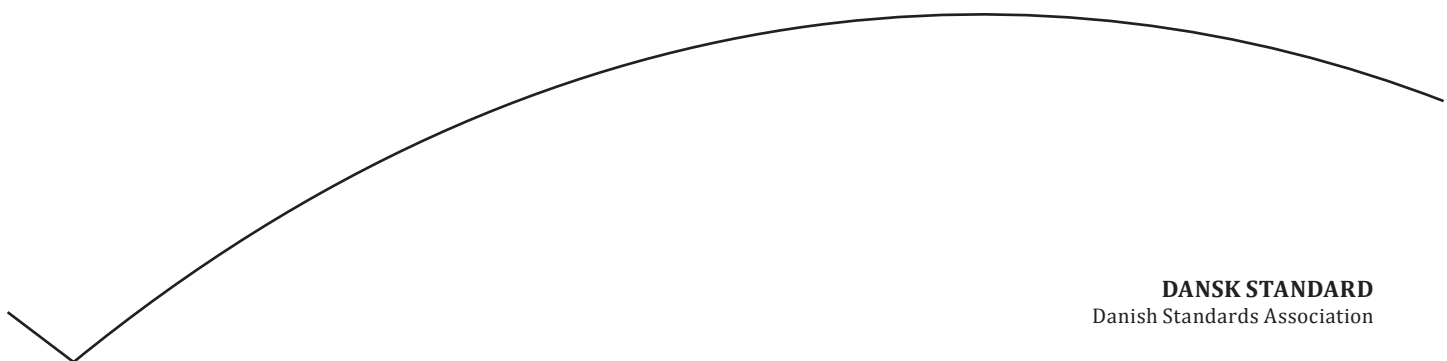


This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

# Eurocode 1: Last på bygværker – Trafiklast på broer – Interaktion mellem spor og bro

Eurocode 1: Actions on Structures – Traffic Loads on Bridges – Track-Bridge Interaction



**DANSK STANDARD**  
Danish Standards Association

Göteborg Plads 1  
DK-2150 Nordhavn

Tel: +45 39 96 61 01

Tel: +45 39 96 61 01

dansk.standard@ds.dk

www.ds.dk

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

DS projekt: M322063  
ICS: 91.010.30; 93.040

**Første del af denne publikations betegnelse er:**  
DS/CEN/TR, hvilket betyder, at det er en europæisk teknisk rapport, der har status som DS-information.

**Denne publikations overensstemmelse er:**  
IDT med: CEN/TR 17231:2018

DS-publikationen er på engelsk.

---

### **DS-publikationstyper**

Dansk Standard udgiver forskellige publikationstyper.  
Typen på denne publikation fremgår af forsiden.

Der kan være tale om:

#### **Dansk standard**

- standard, der er udarbejdet på nationalt niveau, eller som er baseret på et andet lands nationale standard, eller
- standard, der er udarbejdet på internationalt og/eller europæisk niveau, og som har fået status som dansk standard

#### **DS-information**

- publikation, der er udarbejdet på nationalt niveau, og som ikke har opnået status som standard, eller
- publikation, der er udarbejdet på internationalt og/eller europæisk niveau, og som ikke har fået status som standard, fx en teknisk rapport, eller
- europæisk præstandard

#### **DS-håndbog**

- samling af standarder, eventuelt suppleret med informativt materiale

#### **DS-hæfte**

- publikation med informativt materiale

Til disse publikationstyper kan endvidere udgives

- tillæg og rettelsesblade

### **DS-publikationsform**

Publikationstyperne udgives i forskellig form som henholdsvis

- fuldttekstpublikation (publikationen er trykt i sin helhed)
- godkendelsesblad (publikationen leveres i kopi med et trykt DS-omslag)
- elektronisk (publikationen leveres på et elektronisk medie)

### **DS-betegnelse**

Alle DS-publikationers betegnelse begynder med DS efterfulgt af et eller flere præfikser og et nr., fx **DS 383**, **DS/EN 5414** osv. Hvis der efter nr. er angivet et **A** eller **Cor**, betyder det, enten at det er et **tillæg** eller et **rettelsesblad** til hovedstandard, eller at det er indført i hovedstandard.

DS-betegnelse angives på forsiden.

### **Overensstemmelse med anden publikation:**

Overensstemmelse kan enten være IDT, EQV, NEQ eller MOD

- **IDT:** Når publikationen er identisk med en given publikation.
- **EQV:** Når publikationen teknisk er i overensstemmelse med en given publikation, men præsentationen er ændret.
- **NEQ:** Når publikationen teknisk eller præsentationsmæssigt ikke er i overensstemmelse med en given standard, men udarbejdet på baggrund af denne.
- **MOD:** Når publikationen er modificeret i forhold til en given publikation.

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

## TECHNISCHER BERICHT

August 2018

ICS 91.010.30; 93.040

English Version

## Eurocode 1: Actions on Structures - Traffic Loads on Bridges - Track-Bridge Interaction

Eurocode 1 : Actions sur les structures - Actions sur les  
ponts, dues au trafic - Interaction voie-pont

Eurocode 1: Einwirkungen auf Tragwerke -  
Verkehrslasten auf Brücken - Gleis-Brücken  
Interaktion

This Technical Report was approved by CEN on 16 April 2018. It has been drawn up by the Technical Committee CEN/TC 250.

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



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

<b>Contents</b>		Page
European foreword.....		5
Introduction .....		6
1	Scope .....	7
2	Normative references .....	7
3	Terms and definitions .....	7
4	Symbols and abbreviations .....	9
5	Description of the Technical Issue .....	10
5.1	General.....	10
5.2	Axial effects .....	11
5.2.1	Origin of axial forces and displacements.....	11
5.2.2	Force transfer between track and deck ends.....	11
5.2.3	Rail stresses .....	11
5.2.4	Forces acting on the fixed point (e.g. Bearing forces).....	14
5.2.5	Interaction with sub-structure.....	14
5.3	Vertical effects.....	15
5.3.1	Effect of vertical forces and displacements .....	15
5.3.2	Bridge deck end rotation.....	15
5.4	Limits to the need for detailed calculations .....	16
5.5	Calculation of multiple loading conditions.....	17
5.6	Effect of bridge deformations .....	17
5.6.1	Effect on track geometry .....	17
5.6.2	Effect on stability of ballasted track.....	18
5.6.3	Effect of ballast degradation over structural joints.....	18
5.7	Effects on track construction and maintenance activities .....	18
6	History and background .....	19
6.1	Existing codes and standards .....	19
6.2	Differences between national rules.....	21
7	Case studies .....	21
7.1	Scheldt River Bridge (Belgium) .....	21
7.2	Dedicated high speed lines in France and Spain.....	21
7.3	Olifants River Bridge (South Africa).....	21
7.4	Bridges on Denver RTD (USA) .....	21
7.5	Historic bridges in central Europe.....	22
7.6	Semi-integral bridges on German high speed lines .....	22
8	Design considerations for track.....	23
8.1	Representation of axial behaviour of track.....	23
8.2	Understanding of ballast behaviour .....	24
8.2.1	Ballast properties.....	24
8.2.2	Importance of effective ballast retention.....	24
8.3	Description/ limitations of available track devices for mitigation of effects.....	24
8.3.1	Principles .....	24
8.3.2	Practical solutions .....	26
8.4	Description/ limitations of bridge design for mitigation of effects .....	31

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

8.4.1	General .....	31
8.4.2	"Steering bars" and virtual fixed points .....	31
8.4.3	Damper Systems.....	32
8.5	Effects of track curvature and switches and crossings .....	32
9	Design criteria .....	33
9.1	General .....	33
9.1.1	Rail stress .....	33
9.1.2	Rail break containment.....	33
9.2	Displacement limits .....	33
9.3	Differentiation between ultimate- and service-loading .....	35
9.4	Safety factors .....	35
9.5	Differences between ballasted and ballastless tracks .....	35
9.6	Calculations for configurations with rail expansion devices.....	36
10	Calculation methods .....	36
10.1	Methods in EN 1991-2:2003 .....	36
10.1.1	General .....	36
10.1.2	Software based on UIC 774-3R.....	38
10.1.3	Linear analysis with manual intervention (LAMI) .....	38
10.2	Load configurations .....	40
10.3	Sensitivity analysis.....	40
10.4	Numerical comparisons of calculation methods .....	41
11	Information and process management.....	46
12	GUIDANCE – Current best practice .....	47
12.1	Bridge design principles .....	47
12.2	Track design principles.....	47
12.2.1	Ballasted track.....	47
12.2.2	Ballastless track.....	47
12.2.3	Special rail fastening systems .....	48
12.2.4	Rail expansion devices.....	48
12.2.5	Derivation of the behaviour.....	48
13	Recommendations for future standards development.....	49
14	Recommendations for future research and development.....	49
14.1	General .....	49
14.2	Improved input data for existing calculation methods.....	49
14.3	Extension of existing models to include other track configurations .....	50
14.4	Collecting data for better verification of analytical models.....	50
14.5	Providing a basis for developing new, more rigorous, models.....	50
Annex A (informative)	Calculation of rail break gap .....	51
A.1	Rail break gap for track with conventional fastenings (not on a bridge) .....	51
A.2	Rail break gap for track on a bridge, with conventional fastenings.....	52
A.3	Rail break gap for track with sliding (ZLR) fastenings .....	54
A.4	Limiting values of rail break gap .....	54
Annex B (informative)	Algebraic studies of longitudinal track characteristics .....	55
B.1	Algebraic representations of behaviour .....	55
B.1.1	Sliding action.....	55
B.1.2	The <i>k</i> -function.....	56

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

<b>B.1.3</b>	<b>Temperature change</b> .....	<b>57</b>
<b>B.1.4</b>	<b>Temperature gradients</b> .....	<b>67</b>
<b>B.1.5</b>	<b>Track springs</b> .....	<b>67</b>
<b>B.1.6</b>	<b>Joint movements</b> .....	<b>71</b>
<b>B.1.7</b>	<b>Track forces resulting from joint movements</b> .....	<b>73</b>
<b>B.2</b>	<b>The Two Spreadsheet Method</b> .....	<b>77</b>
<b>B.2.1</b>	<b>General</b> .....	<b>77</b>
<b>B.2.2</b>	<b>The Temperature Stress Spreadsheet (TSS)</b> .....	<b>77</b>
<b>B.2.3</b>	<b>The Additional Stress Spreadsheet (ASS)</b> .....	<b>80</b>
<b>Annex C (informative) Examples of Track-Bridge Interaction calculations</b> .....		<b>83</b>
<b>C.1</b>	<b>Introduction to calculation methods</b> .....	<b>83</b>
<b>C.2</b>	<b>Example 1: Simply supported deck with no rail expansion device</b> .....	<b>83</b>
<b>C.3</b>	<b>Example 2: Series of continuous decks with no rail expansion device</b> .....	<b>85</b>
<b>C.4</b>	<b>Continuous deck with a rail expansion device</b> .....	<b>88</b>
<b>Annex D (informative) Alternative method for determining the combined response of a structure and track to variable actions</b> .....		<b>91</b>
<b>Annex E (informative) Proposed revision of EN 1991-2:2003, 6.5.4</b> .....		<b>92</b>
<b>E.1</b>	<b>General</b> .....	<b>92</b>
<b>E.2</b>	<b>Combined response of structure and track to variable actions</b> .....	<b>92</b>
<b>E.2.1</b>	<b>General principles</b> .....	<b>92</b>
<b>E.2.2</b>	<b>Parameters affecting the combined response of the structure and track</b> .....	<b>92</b>
<b>E.2.3</b>	<b>Actions to be considered</b> .....	<b>95</b>
<b>E.2.4</b>	<b>Modelling and calculation of the combined track/structure system</b> .....	<b>95</b>
<b>E.2.5</b>	<b>Design criteria</b> .....	<b>98</b>
<b>E.2.6</b>	<b>Calculation methods</b> .....	<b>100</b>
<b>Bibliography</b> .....		<b>104</b>

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

## **European foreword**

This document (CEN/TR 17231:2018) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

## **Introduction**

The subject of Track-Bridge Interaction has become particularly important with respect to longer span bridges and viaducts supporting tracks, especially for those carrying high speed trains. However, investigations which have been undertaken in order to address that specific issue have raised points which are relevant to all types of railway bridge. Consequently, the content of this Technical Report is intended to be applicable to all types of railway bridge, for both ballasted and ballastless track, and for all types of railway (e.g. conventional railways, metro and light rail systems, and high speed railways).

It is also clear that the increased availability of computational methods of analysis, since the basis for existing codes was laid down in the 1990s, has made it possible to consider approaches to calculation of Track-Bridge Interaction effects which could not be expected to be used in routine procedures in the past.

There are three principal 'outputs' set out in the final sections of this Technical Report. They are as follows:

- 1) Guidance for designers and maintainers of railway track and structures to assist them in adopting current best practice in taking Track-Bridge Interaction effects into account (Clause 12 of this report).
- 2) Recommendations for future development of standards, especially the revision of the relevant section of the Eurocode EN 1991-2:2003 6.5.4 (Clause 13 and Annex E of this report).
- 3) Identification of areas in which new research and development is needed to make further improvements in approaches to Track-Bridge Interaction (Clause 14 of this report).



This is a preview of "DS/CEN/TR 17231:2018". [Click here to purchase the full version from the ANSI store.](#)

## **1 Scope**

This document reviews current practice with regard to designing, constructing and maintaining the parts of bridges and tracks where railway rails are installed across discontinuities in supporting structures. Current Standards and Codes of Practice are examined and some particular case histories are reviewed.

The document gives guidance with respect to current best practice and makes recommendations for future standards development and also identifies areas in which further research and development is needed.

## **2 Normative references**

There are no normative references in this document.