DS/EN 1991-2 DK NA:2015

1 May 2015

National Annex to

Eurocode 1: Actions on Load-carrying Structures Part 2: Traffic Loads on Bridges

Preface

The implementation of Eurocodes has involved the preparation of

- National Annexes to the bridge-specific Eurocodes
- Addenda to National Annexes for bridge-specific sections in Eurocodes for loads.

Together with the basic Eurocodes, including the related National Annexes, these constitute the codes of practices to be applied in the design of bridges in Denmark.

Scope

This National Annex sets out the conditions for implementation of EN 1991-2.

Contents

This National Annex contains the national choices that apply in Denmark.

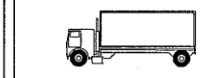
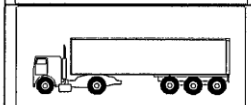
The national choices may be in the form of current national values, a choice between several methods or addition of supplementary instruction.

In connection with the national choices, the national annexes may refer to Banedanmark's Railway Standards (e.g. BN1-59) or Danish Road Directorate's Road Standards.
Several references are made to the Infrastructure Manager (IF). IF is the authority which has ownership and holds maintenance responsibility for a road bridge or for a railway bridge. Examples of IFs include the Danish Road Directorate, municipalities, Banedanmark and regional railway providers.

In addition, the National Annex includes an overview of all the items where it has been possible to make a national choice.

Items for which national choices have been made

Page	Item	Subject	National choice
15	1.1 (3), NOTE	Load models for retaining walls	The rules of BN1-59 apply to retaining walls, sheet-pile walls and by railways and in relation to railway bridges.
30	3 (5)	Combined road bridges and railway bridges	Load combinations and special examinations shall be determined in each individual case.
	Actions on Road bridges		
31	4.1 (1), NOTE 2	Load models for loaded lengths (influence lengths) greater than 200 m	Load models shall be determined in each individual case. Load models for classification and load bearing capacity assessment of existing bridges with long spans are specified in Annex A (see national choice for Annex A).
31	4.1 (2), NOTE 1	Specific load models for bridges with limitation of vehicle weight, etc.	A distinction is made between four bridge classes (bridge groups). Bridge classes (bridge groups) and related load models have been defined in "Design guide for load and calculation basis for bridges".
31	4.2.1 (1), NOTE 2	Complementary models	Load models for classification and load bearing capacity assessment of existing bridges are specified in Annex A (see national choice for Annex A).
32	4.2.1 (2)	Load models for special vehicles	Load models for classification and load bearing capacity assessment of existing bridges are specified in Annex A (see national choice for Annex A).
35	4.3.2 (3), NOTES 1 and 2	Adjustment factors for load model 1	The following factors shall be applied: Bridge class 1: α_{Qi} =1.00, α_{q1} = 6.0/9.0 = 0.67 Bridge class 2: α_{Qi} =0.80, α_{q1} = 3.0/9.0 = 0.33 In both cases, α_{qr} = 1.00
38	4.3.2 (6)	Simplified load model 1 for calculation of global effects	The simplified load model is not applied
39	4.3.3 (2)	Adjustment factor for axle load for load model 2	β_Q = 0.80
39	4.3.3 (4), NOTE 2	Contact surface for wheel load, load model 2 (single axle)	The same contact surface as for load model 1 is applied
39	4.3.4 (1)	Special vehicles to be taken into account	Bridge class 1: Bridges shall be designed so that they at least obtain class 150 for normal passage. Bridge class 2: Bridges shall be designed so that they at least obtain class 80 for normal passage. Footpath areas on road bridges, which are separated from the carriageway area by kerbstones, see 4.2.3 (1), and which, in future, are not assumed to be included permanently as part of the carriageway area, shall be designed so as to ensure at least class 60 in normal passage. Passage types and the axle configuration for standard vehicles as well as impact factor

<table>
<tr><th>Page</th><th>Item</th><th>Subject</th><th>National choice</th></tr>
<tr><td></td><td></td><td></td><td>have been described in Annex A (see national choice for Annex A).</td></tr>
<tr><td>41</td><td>4.4.1 (3)</td><td>Horizontal forces associated with load model 3 (special vehicles)</td><td>Braking forces from special vehicles are specified Annex A (see national choice for Annex A).</td></tr>
<tr><td>42</td><td>4.4.2 (4)</td><td>Min. horizontal load, transverse</td><td>As minimum transverse force, a horizontal force equal to 25% of the longitudinal brake or acceleration force, randomly located, shall be applied.</td></tr>
<tr><td>45</td><td>4.6.1 (2), NOTE 2</td><td>Load models for verification of fatigue</td><td>Fatigue load models 1, 4 and 5 can be applied.</td></tr>
<tr><td>50</td><td>4.6.4 (3)</td><td>Fatigue load model 3</td><td>Fatigue load model 3 cannot be applied</td></tr>
<tr><td>51</td><td>4.6.5 (1)</td><td>Fatigue load model 4</td><td>Table 4.7 shall be replaced by the following table, since the following traffic types shall be applied for traffic categories 1 to 4 in Table 4.5(n):
Traffic categories 1 and 2: Only 'Long distance'
Traffic category 3: Only 'Medium distance'
Traffic category 4: Only 'Local traffic'</td></tr>
<tr><td></td><td></td><td colspan="2">Table 4.7 DK NA
<table>
<tr><th colspan="3">VEHICLE TYPE</th><th colspan="3">TRAFFIC TYPE</th><th></th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td></td><td></td><td></td><td>Long distance</td><td>Medium distance</td><td>Local traffic</td><td></td></tr>
<tr><td>LORRY</td><td>Axle spacing (m)</td><td>Equivalent axle loads (kN)</td><td>Lorry percentage</td><td>Lorry percentage</td><td>Lorry percentage</td><td>Wheel type</td></tr>
<tr><td>  </td><td>4,5</td><td>70
130</td><td>20,0</td><td>50,0</td><td>80,0</td><td>A
B</td></tr>
<tr><td>  </td><td>3,20
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90</td><td>80,0</td><td>50,0</td><td>20,0</td><td>A
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</table></td></tr>
<tr><td>53</td><td>4.6.6 (1)</td><td>Fatigue load model 5</td><td>Fatigue load model 5 is only used if the Infrastructure Manager so allows; reference is made to Annex B, which should be regarded as informative.</td></tr>
<tr><td>55</td><td>4.7.3.3 (1), NOTE 1</td><td>Collision forces on vehicle restraint systems</td><td>A horizontal force equivalent to class A for bridges shall be used where a steel vehicle parapet in strength class H2 is prescribed, assuming a stanchion distance of 3.0 m, corresponding to the greatest occurring reactions.

For other types of vehicle restraint systems and other strength classes, the class shall be determined in each individual case.

The same applies to bridges, where the risk and consequences of failure of the restraint systems is particularly high, e.g. at a long valley bridge, at crowd zones or similar locations.</td></tr>
</table>

Page	Item	Subject	National choice
56	4.7.3.3 (2)	Supporting structures for restraint systems, etc.	Support details (embedded anchor bolts, edge beams and bridge decks) shall be designed for 1.50 times the load which the stanchion is able to transfer at full flow corresponding to the plastic state.
56	4.8 (1), NOTE 2	Actions on bridge decks from pedestrian parapets	The recommended values can be used as minimum values. In addition, actions as set out in the "Equipment, vehicle restraint system: Mounting of vehicle and pedestrian parapets" shall be used.
57	4.8 (3)	Supporting structure for pedestrian parapets which are not protected against collision	Support details (embedded anchor bolts, edge beams and bridge decks) shall be designed for 1.50 times the load which the stanchion is able to transfer at full flow corresponding to the plastic state.
	Actions on footbridges		
60	5.2.3 (2)	Load model for inspection gangways	In addition to the recommended values, the following loads shall be applied for railway bridges: For inspection gangways on railway bridges with a width of 0.60 -0,75 m, a surface load of 4 kN/m ^{2} and the concentrated load of 3 kN shall be applied. The same loads shall be used for mounted escape platforms. For access routes, inspection platforms, engine driver platforms or similar on railway bridges with a width greater than 0.75 m, a surface load of 5 kN/m ^{2} and a concentrated load of 50 kN distributed on 200x200 mm shall be applied. For platforms located on bridges, the load models as for footbridges shall be applied.
62	5.3.2.3 (1)P, NOTE 1.	Service vehicle	The vehicle defined in 5.6.3 shall be used, since the axle loads specified shall be multiplied by 1.5. The Infrastructure Manager may determine other loads (fire engine, tractor, ambulance, etc.).
63	5.6.1 (1), NOTE	Accidental design situations	In each individual project, it shall be assessed whether other forces/cases may be relevant.
65	5.7 (3)	Dynamic model for pedestrian load	Dynamic model for pedestrian load is in "Design guide for load and calculation basis for bridges".
	Actions on railway bridges		
66	6.1 (7)	Loads and other requirements for temporary railway bridges	Maximum axle load, linear loading and section speed for the section concerned are applied unless otherwise agreed with the Infrastructure Manager of the specific project.
68	6.3.2 (3)P	α factor for load model 71 (LM71)	For LM71 and SW/0, α = 1.33 shall be applied

Page	Item	Subject	National choice
69	6.3.3 (4)P	Load model SW/2	Load model SW/2 shall not be applied if α = 1.33 for LM71 and SW/0.
74	6.3.7 (4)	Actions on railings	Section is annulled. 0.8 kN/m horizontal or vertical shall be used as load; see 4.8 (1) NOTE 2.
79	6.4.5.2 (3)P, NOTE	Dynamic factor Φ	Φ_2 is applied for main sections, Φ_3 for other sections
81	6.4.5.3 Table 6.2, Note a	Determinant length of cantilevers greater than 0.50 m	A special dynamic analysis shall be carried out subject to agreement with the relevant Infrastructure Manager.
85	6.4.6.1.1 (6), Table 6.4, NOTE	Additional requirements in connection with dynamic analysis of complex structures	Additional requirements shall be listed in each individual case by the relevant Infrastructure Manager.
86	6.4.6.1.1 (7), NOTE	Dynamic analysis in case where frequency requirements are not observed at speeds ≤ 200 km/h	Loading and methodology to be specified subject to agreement with the relevant Infrastructure Manager
86	6.4.6.1.2 (3), Table 6.5 , Note a	Loads for dynamic analysis for bridges with two tracks and traffic in the same direction or three or more tracks with section speed > 200 km/h	Loading and methodology to be specified subject to agreement with the Infrastructure Manager
88	6.4.6.3.1 (3), Table 6.6	Damping	Alternative lower values on the safe side shall be approved by the Infrastructure Manager.
89	6.4.6.3.2 (3), NOTE	Specific density value of the concrete	Where the specific density value of the concrete may impact significantly on the result, it may be determined by sampling and testing subject to agreement with the Infrastructure Manager.
89	6.4.6.3.3 (3), NOTE 1.	E module for the concrete	Where further determination the concrete E module is required to ensure the reliability of the dynamic analysis, it may be determined by sampling and testing subject to agreement with the Infrastructure Manager.
89	6.4.6.3.3 (3), NOTE 2.	Values of other material properties	Application is subject to agreement with the Infrastructure Manager.
90	6.4.6.4 (4), NOTES	Reduction of peak response and additional damping values at resonance	Use of this method for dynamic analysis of the interaction between train carriage and the structure and values for damping is subject to agreement with the Infrastructure Manager
98	6.5.3 (5)	Actions due to braking for loaded lengths greater than 300 m	Supplementary provisions shall be determined for the specific project subject to agreement with the Infrastructure Manager
99	6.5.4.1 (5)	Combined response of track and structure when absorbing actions due to braking, etc. special rules for non-ballasted tracks	Supplementary provisions shall be determined for the specific project subject to agreement with the Infrastructure Manager
103	6.5.4.4 (2), NOTE 1	Longitudinal shear resistance between track and bridge deck	Values to be determined subject to agreement with the Infrastructure Manager
104	6.5.4.5.1 (2), NOTE	Reduction of the minimum value of track radius for ballasted tracks with supplementary fixing sideways	Reduction to be agreed with the Infrastructure Manager
104	6.5.4.5.1 (2), NOTE	Maximum permissible additional tensioning in rails for other track structure standards and other types of rails	To be specified for the specific project subject to agreement with the Infrastructure Manager
113	6.7.1 (2)P	Derailment actions	The factor of 1.4 in (3)P and (4)P is changed to 1.0. The design shall further account for loads from crane supports as specified in BN1-59.

Page	Item	Subject	National choice
115	6.7.1 (8)P, NOTE 1 & NOTE 2	Requirement for remedial measures to reduce the impact of derailment to structural elements above SO	Rules for protective rails are specified in BN1-59.
115	6.7.3 (1)P	Other actions	Other actions shall be determined for the specific project subject to agreement with the Infrastructure Manager
121	6.9 (3)	Traffic with a high α value, fatigue	α=1.10 shall be applied for LM71 and SW/0 in connection with fatigue models on the basis of the general method specified in Annex D.
121	6.9 (6)	Structural life, fatigue	See DS/EN 1990/A1 DK NA 2009, A2.1.1 (1) note3 (120 years)
122	6.9 (7)	Traffic composition, fatigue	Annex D to be applied, since the number of trains shall be multiplied by the following factors: Table D.1: 1.00 (Other sections, S-train tracks) Table D.2: 1.25 (Main tracks, TEN sections) Table D.3. NA
123	Annex A Models of special vehicles for road bridges (Informative)		Informative Annex A is replaced by normative Annex A to the national annex, which contains the Danish load models for heavy special transports, which shall be used for classification and assessment.. Annex A is drafted in a separate document.
132	Annex C Dynamic factors 1+φ for Real Trains) (3)P, NOTE	Dynamic factor depending on state of maintenance. Choice of method for dynamic analysis	Equation expression (C.2) for carefully maintained tracks applies only to high-speed and main tracks, while expression (C.1) applies to other sections. Dynamic analysis to be carried out in accordance with annex C and 6.4.6

banedanmark

Vejdirektoratet

Overview of possible national choices

The following overview shows the places where national choices are possible and which informative annexes that apply/do not apply.

In addition, this National Annex provides references to supplementary (non-conflicting) information which may be of assistance to the user of the Eurocode.

Page	Item	Subject	National choice
15	1.1 (3), NOTE	Load models for retaining walls	National choice stated
28	2.2 (2), NOTE 2	Infrequent load combinations for road bridges	No national choice
28	2.3 (1), NOTE	Appropriate protection against collision and unintentional presence of vehicles and trains	No national choice
29	2.3 (4)	Collision forces etc.	No national choice
30	3 (5)	Combined road bridges and railway bridges	National choice stated
	Actions on Road bridges		
31	4.1 (1), NOTE 2	Load models for loaded lengths (influence lengths) greater than 200 m	National choice stated
31	4.1 (2), NOTE 1	Special load models for bridges on local and private roads with signage etc.	National choice stated
31	4.2.1 (1), NOTE 2	Complementary models	National choice stated
32	4.2.1 (2)	Load models for special vehicles	National choice stated
32	4.2.3 (1), NOTE	Requirements for kerb heights for separation towards carriageway area	No national choice
35	4.3.1 (2), NOTE 2	Use of load model 2	No national choice
35	4.3.2 (3), NOTES 1 and 2	Adjustment factors for load model 1	National choice stated
38	4.3.2 (6)	Simplified load model 1 for calculation of global effects	National choice stated
39	4.3.3 (2)	Adjustment factor for axle load for load model 2	National choice stated
39	4.3.3 (4), NOTE 2	Contact surface for wheel load, load model 2 (single axle)	National choice stated
39	4.3.4 (1)	Special vehicles to be taken into account	National choice stated
41	4.4.1 (2), NOTE 2	Upper limit of braking force	No national choice
41	4.4.1 (3)	Horizontal forces associated with load model 3 (special vehicles)	National choice stated
41	4.4.1 (6)	Horizontal force to be transmitted by expansion joint etc.	No national choice
42	4.4.2 (4), NOTE	Min. horizontal load, transverse	National choice stated
43	4.5.1 – Table 4.4a Notes a and b	Definition of load groups consisting of corresponding loads	No national choice
44	4.5.2 (1), NOTE 3	Infrequent values of traffic loads etc.	No national choice
45	4.6.1 (2), NOTE 2	Load models for verification of fatigue	National choice stated
46	4.6.1 (3)	Traffic categories and the number of heavy vehicles	No national choice
47	4.6.1 (6)	Additional dynamic factor near expansion joints	No national choice
50	4.6.4 (3)	Fatigue load model 3	National choice stated
51	4.6.5 (1)	Fatigue load model 4	National choice stated
53	4.6.6 (1)	Fatigue load model 5	National choice stated
53	4.7.2.1 (1)	Collision forces on columns etc.	No national choice
53	4.7.2.2 (1)	Collision forces on bridge decks etc.	No national choice
55	4.7.3.3 (1), NOTE 1	Collision forces on vehicle restraint systems	National choice stated
56	4.7.3.3 (1), NOTE 3	Vertical force which occurs simultaneously with the horizontal collision force	No national choice
56	4.7.3.3 (2)	Supporting structures for restraint systems, etc.	National choice stated

Page	Item	Subject	National choice
56	4.7.3.4 (1)	Collision forces on unprotected structural members	No national choice
56	4.8 (1), NOTE 2	Actions on bridge decks from pedestrian parapets	National choice stated
57	4.8 (3)	Supporting structure for pedestrian parapets which are not protected against collision	National choice stated
57	4.9.1 (1)	Load model for traffic load behind embankment	No national choice
	Actions on footbridges		
60	5.2.3 (2)	Load model for inspection gangways	National choice stated
61	5.3.2.1 (1)	Loads on pedestrian areas on road bridges	No national choice
61	5.3.2.2 (1)	Concentrated load	No national choice
62	5.3.2.3 (1)P, NOTE 1	Service vehicle	National choice stated
62	5.4 (2)	Horizontal forces	No national choice
63	5.6.1 (1), NOTE	Accidental design situations	National choice stated
63	5.6.2.1 (1)	Collision forces on columns etc.	No national choice
64	5.6.2.2 (1)	Collision forces on bridge decks etc.	No national choice
65	5.6.3 (2)	Load model for accidental presence of a vehicle on a bridge deck	No national choice
65	5.7 (3)	Dynamic model for pedestrian load	National choice stated
	Actions on railway bridges		
66	6.1 (2), NOTE	Load models other than those described in section 6	No national choice
66	6.1 (3)P	Types of railways not covered by section 6	No national choice
66	6.1 (7)	Loads and other requirements for temporary railway bridges	National choice stated
68	6.3.2 (3)P	α factor for load model 71 (LM71)	National choice stated
69	6.3.3 (4)P	Load model SW/2	National choice stated
74	6.3.7 (4)	Actions on railings	National choice
75	6.4.4 (1)	Requirement for dynamic analysis	No national choice
79	6.4.5.2 (3)P	Dynamic factor Φ	National choice stated
79	6.4.5.3 (1)	Determinant length L_Φ	No national choice
81	6.4.5.3 Table 6.2, Note a	Determinant length of cantilevers greater than 0.50 m	National choice stated
85	6.4.6.1.1 (6), Table 6.4, NOTE	Additional requirements in connection with dynamic analysis of complex structures	National choice stated
86	6.4.6.1.1 (7), NOTE	Dynamic analysis in case where frequency requirements are not observed at speeds ≤ 200 km/h	National choice stated
86	6.4.6.1.2 (3), Table 6.5, Note a	Loads for dynamic analysis for bridges with two tracks and traffic in the same direction or three or more tracks with section speed > 200 km/h	National choice stated
88	6.4.6.3.1 (3), Table 6.6	Damping	National choice stated
89	6.4.6.3.2 (3), NOTE	Specific density value of the concrete	National choice stated
89	6.4.6.3.3 (3), NOTE 1	E module for the concrete	National choice stated
89	6.4.6.3.3 (3), NOTE 2	Values of other material properties	National choice stated
90	6.4.6.4 (4), NOTE	Reduction of peak response at resonance	National choice stated
91	6.4.6.4 (4), NOTE	Reduction of peak response at resonance, alternative additional damping values	No values to be stated
91	6.4.6.4 (5), NOTE	Increase of dynamic load effects as a result of track defects and vehicle imperfections	No national choice
93	6.5.1 (2)	Centrifugal forces, point of application of stacked containers	No national choice
98	6.5.3 (5)	Actions due to braking for loaded lengths greater than 300 m	National choice stated
98	6.5.3 (9)P	Traction and braking forces for bridges with two or more tracks	No national choice
99	6.5.4.1 (5)	Combined response of track and structure when absorbing actions due to braking, etc. special rules for non-ballasted tracks	National choice stated

Page	Item	Subject	National choice
102	6.5.4.3 (2), NOTE 1	Temperature range ΔT_N	No national choice
102	6.5.4.3 (2), NOTE 2	Temperature range ΔT_N for simplified calculations	No values to be stated
103	6.5.4.4 (2), NOTE 1	Longitudinal shear resistance between track and bridge deck	National choice stated
104	6.5.4.5, NOTE	Design criteria	No national choice
104	6.5.4.5.1 (2), NOTE	Reduction of the minimum value of track radius for ballasted tracks with supplementary fixing sideways	National choice stated
104	6.5.4.5.1 (2), NOTE	Maximum permissible additional tensioning in rails for other track structure standards and other types of rails	National choice stated
105	6.5.4.6, NOTE	Alternative calculation methods	No national choice
106	6.5.4.6.1 (1), NOTE	Simplified calculation/verification for a single deck	No national choice
107	6.5.4.6.1 (4)	Alternative values of k (longitudinal plastic shear resistance)	No national choice
108	6.6.1 (3)	Approximate equivalent loads of aerodynamic actions on structures during passing of trains	No national choice
113	6.7.1 (2)P	Derailment actions	National choice stated
115	6.7.1 (8)P, NOTE 1 & NOTE 2	Requirement for remedial measures to reduce the impact of derailment to structural elements above SO	National choice stated
115	6.7.3 (1)P	Other accidental actions	National choice stated
118	6.8.1 (11)P, Table 6.10	Checking of clearances and drainage	No national choice
119	6.8.2 (2), Table 6.11	Factors for sub-loads in load groups, characteristic load conditions	No national choice
120	6.8.3.1 (1)	Factors for sub-loads in load groups, frequent load conditions	No national choice
121	6.8.3.2 (1)	Factors for sub-loads in load groups, quasi-permanent load conditions	No national choice
121	6.9 (6)	Structural life, fatigue	National choice stated
122	6.9 (7)	Traffic composition, fatigue	National choice stated
	Annex A Models of special vehicles for road bridges (Informative)		National choice stated The new Annex A is Normative
	Annex B fatigue life assessment of road bridges. Assessment methods based on recorded traffic (Informative)		This annex applies as an informative annex
	Annex C Dynamic factors 1+φ for Real Trains (Normative)		
132	C (3)P, NOTE	Dynamic factor depending on state of maintenance.	National choice stated
132	C (3)P, NOTE	Calculation of dynamic factor	No national choice
	Annex D Basis for the fatigue assessment of railway structures (Normative)		
134	D.2 (2), NOTE	Partial coefficient γ_{Ff} on the load side in connection with fatigue test	No national choice
	Annex E Limits of validity of Load Model HSLM and selection of the critical Universal Train from HSLM-A (Informative)		This annex applies as an informative annex

Page	Item	Subject	National choice
	Annex F Criteria to be satisfied if a dynamic analysis is not required (Informative)		This annex applies as an informative annex
	Annex G Method for determining the combined response of a structure and track to variable actions (Informative)		This annex applies as an informative annex
	Annex H Load models for rail traffic loads in Transient Design situations (Informative)		This annex applies as an informative annex

Note: No national choice implies that a recommendation in the code of practice is observed.

DISCLAIMER

The translation into English of Road Standards (Vejregler), Tender Specifications and National Annexes is to be regarded entirely as a service. In the event of any discrepancy or shortcomings in the translation, the Danish version will prevail. At any time the Danish versions of Road Standards (Vejregler), Tender Specifications and National Annexes are those in force.