DS/EN 1990/A1 DK NA:2017

National Annex to

Eurocode 0: Design Basis of Structural Bearings
Annex A2 Applications for Bridges

Foreword

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 standard to be applied in the design of bridges in Denmark.

Field of application

This National Annex sets out the conditions for implementation of Annex A2 of EN 1990/A1.

Content

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 an 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.

Reference may also be made to the infrastructure manager (IF). IF is the authority which has ownership and/or holds the 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 a national choice has been made

Page	Item	Subject	National choice
	General Clauses		
6	A2.1.1(1), NOTE 3	Instruction on the use of Table 2.1 in EN 1990 concerning setting of requirements for the expected lifespan of bridges.	For road bridges, the required expected lifespan is 120 years. For railway bridges it is 120 years. For footbridges, the requirement for the expected lifespan is 100 years, but this can be deviated from subject to special agreement with the Infrastructure Manager.
7	A2.2.1(2), NOTE 1	Action combinations with actions which fall outside the scope of EN 1991, e.g. ice load etc.	Ice load is defined in Addendum DK:2015 Ice load. Wave and current load can be determined on the basis of DS449:1983, Standard for the design and construction of pile supported offshore steel structures.
16	A2.3.1(1)	Values of γ factors (partial coefficients) for traffic load etc.	The selected values are stated in the following tables A2.4 (A) DK NA, A2.4 (B+C) DK NA and under the section on design values for fatigue.
17	A2.3.1(5)	Design of geotechnical structures, choice of method.	Design method 3 is used.
17	A2.3.1(7)	Definition of ice load etc.	Ice load is defined in Addendum DK:2015 Ice load. Wave and current load can be determined on the basis of DS449:1983, Code of Practice for the design and construction of pile supported offshore steel structures.
17	A2.3.1(8)	Values of γ_P factors for prestress.	The values are stated in the following tables A2.4 (A) DA NA, A2.4 (B+C) DK NA.
18	A2.3.1 Table A2.4(A), NOTE 1	Values of γ factors (partial coefficients).	The values are stated in the following tables A2.4 (A) DK NA, A2.4 (B+C) DK NA and under the section on design values for fatigue.
18	A2.3.1 Table A2.4(A), NOTE 2	Values of γ factors (partial coefficients).	The values are stated in the following tables A2.4 (A) DK NA, A2.4 (B+C) DK NA and under the section on design values for fatigue.
19	A2.3.1 Table A2.4(B), NOTE 1	Choice between (6.10) or (6.10a) + (6.10b).	Set of formulas (6.10a) + (6.10b) is chosen. (as in DS/EN 1990 DK NA).
19	A2.3.1 Table A2.4(B), NOTE 2	Values of γ and ξ.	The values are stated in the following table A2.4 (B+C) DK NA.
21	A2.3.1 Table A2.4(C), NOTE	Values of γ.	Table A2.4 (C) is omitted and replaced by A2.4 (B+C) DK NA.
22	A2.3.2(1)	Design values in Table A2.5 for accident load conditions, non-dominant variable actions and earthquake load conditions.	The values are stated in the following table A2.5 DK NA.
	Clauses specific for road bridges		
10	A2.2.2(3)	Combination rules for special vehicles.	Combination rules for special transport are specified in "Design guide for Load and Calculation Basis for Bridges".
10	A2.2.2(4)	Combination rules for snow loads and traffic loads.	Snow loads on road bridges may be excluded.
10	A2.2.2(6)	Combination rules for wind and thermal actions.	Combination rules for wind and thermal actions are specified in "Design guide for load and calculation basis for bridges".
	Clauses specific for footbridges		
10	A2.2.3(2)	Combination rules for wind and thermal actions.	Combination rules for wind and thermal actions are specified in "Design guide for load and calculation basis for bridges".
10	A2.2.3(3)	Combination rules for snow loads and traffic loads.	Snow loads on footbridges may be excluded, see, however, A2.2.3(4), NOTE.
10	A2.2.3(4)	Combination rules for footbridges where pedestrians and cyclists are fully protected from all types of weather.	Combination rules shall be agreed in connection with the specific project.

Page	Item	Subject	National choice
	Clauses specific for railway bridges		
11	A2.2.4 (1)	Combination rules for snow loading on railway bridges.	Snow loads on railway bridges may be excluded.
11	A2.2.4 (4)	Maximum wind speed compatible with rail traffic.	Only the characteristic wind load F_{Wk} is applied.
25	A2.4.4.1 (1), NOTE 3	Deformations and vibration requirements for temporary railway bridges.	Temporary railway bridges shall observe the same requirements as permanent smaller railway bridges unless otherwise agreed with the Infrastructure Manager.
28	A2.4.4.2.3(3)	Additional limits of angular rotations at the end of decks in relation to expansion joints, rail expansion joints and points.	Supplementary requirements shall be agreed with the Infrastructure Manager.
28	A2.4.4.2.4(2) Table A2.8, NOTE 3	Maximum differential cross deflection expressed as change in the radius of curvature, r_i and angular rotations α_i.	Supplementary requirements shall be agreed with the Infrastructure Manager.
31	A2.4.4.3.2(6)	Requirements for passenger comfort for temporary bridges.	Temporary railway bridges shall observe the same requirements as permanent smaller railway bridges unless otherwise agreed with the Infrastructure Manager.

Addendum to DS/EN 1990 DK NA

For bridges, the following changes apply in relation to DS/EN 1990 DK NA:

- Table B2 DK NA, stated in DK NA, does not apply. To be replaced by the original table B2 in DS/EN 1990

- Section B4 in DK NA does not apply and is replaced by the following:

  (1) Checking of design must be carried out of the project documentation for detailed projects prepared for traffic bearing bridges and structural constructions (railway bridges, road bridges and footbridges) as well as bridges and structural constructions situated immediately adjacent to, along or above traffic structures for railways, roads and paths.

  (2) In cases where the consequences from a collapse would be exceptionally serious, estimated from the number of fatalities and/or the scope of financial losses, as a minimum, the design check should always consist of one independent check of the project documentation from the detailed project.

  (3) In case of it being a complex structure, or if the execution is associated to the procurement procedure design-build contract, likewise as a minimum, one independent inspection should be carried out of the project documentation from the detailed project.

  (4) The design check must be carried out by one or more persons, who hold the skills and the experience required within the technical discipline, which are involved in the project concerned.

  (5) What is meant by an independent check is, this connection, that of a check carried out by persons, who are independent of the company/-ies that has/have conducted – or participated in – the preparation of the detailed project. The demand for independence also applies to the company, at

which the checker is employed, including other parts of the company, such as the parent company, sister companies or other companies under the same ownership.

(6) The design check must be carried out subject to the Infrastructure Manager’s safety management system, or to the safety management system, which is applied by the Infrastructure Manager, and on whose land the structure is being erected. In case of differences in the requirement for the design check it will be the strictest requirements that will apply.

- Table C2 DK NA, stated in DK NA, does not apply. To be replaced by the original Table C2 in DS/EN 1990

Design Values for Actions in ULS

Table A2.4 (A) DK NA Design values of actions in persistent and transient design situations (EQU and UPL) (Set A)

Limit state				EQU/UPL	UPL
Action combinations				1	2
Reference equation				(6.10)	(6.10)
Partial coefficients for loads					
Permanent load	Weight general (**)(1)	Unfavourable	$\gamma_{Gj,sup} \cdot K_{FI}$	$1.1 \cdot K_{FI}$	$1.0 \cdot K_{FI}$
		Favourable	$\gamma_{Gj,inf}$(1)	0.9	1.0
	Weight of soil and (ground)water, geotechnical structures (***)	Unfavourable	$\gamma_{Gj,sup} \cdot K_{FI}$	$1.1 \cdot K_{FI}$	$1.05 \cdot K_{FI}$
		Favourable	$\gamma_{Gj,inf}$	0.9	1.0
Prestress	P			γ_P	γ_P
Variable load(*)	Dominant, $Q_{k,1}$	Unfavourable		$\gamma_{Q1} \cdot K_{FI}$	$\gamma_{Q1} \cdot K_{FI}$
	Other, $Q_{k,i}$	Unfavourable		$\gamma_{Qi} \cdot \psi_{0,i}\ K_{FI}$	$\gamma_{Qi} \cdot \psi_{0,i}\ K_{FI}$

(*) Variable actions are those considered in Tables A2.1 to A2.3

(**) Covers all types of permanent dead load, see 2.1 in DS/EN 1991-1-1.

(***) Covers weight of soil and (ground)water, which will affect the geotechnical structure as geotechnical action, see 1.5.2.1 in DS/EN 1997-1

NOTE 1: Action combination 2 is only used for geotechnical structures where the water pressure is maximized at overflows, see 1.5.2.1 in DS/EN 1997-1.

NOTE 2 The following γ values are used for persistent and transient design situations:
γ_Q = 1.40 for traffic load on bridges
γ_Q = 1.20 for heavy special transports on tracks (SW2)
γ_Q = 1.40 for payloads under construction (regarding Q_c, see EN 1991-1-6)
γ_Q = 1.50 for all other variable actions (natural loads and other payloads etc.)
γ_P = 1.00 unless otherwise specified in the relevant Eurocodes
γ_{Gset} = 1.00 for settlement that is unfavourable (0 where favourable)

(1) Where a counterweight is used, the variability of its characteristics may be taken into account, for example, by one or both of the following recommended rules:
- by applying a partial coefficient $\gamma_{Gj,inf}$ =0.80 where the self-weight is not well defined (e.g. containers),
- by considering a variation of its project-defined position specified proportionately to the dimensions of the bridge, where the magnitude of the counterweight is well defined. For launching of steel bridges, the variation of the counterweight position of ± 1 m is often applied.

K_{FI} depends on the consequence class defined in Annex B Table B3 in EN 1990, and has the following values, since consequence class CC1 cannot be used for bridges:

Consequence class CC3: K_{FI} = 1.10
Consequence class CC2: K_{FI} = 1.00 (CC2 can only be used for bridges in exceptional cases)

NOTE 3: If an anchor, a bearing that can absorb tension or similar, is added to achieve static equilibrium, this structural element shall be designed for the calculated force which lacks to achieve static equilibrium.

Table A2.4 (B+C) DK NA Calculated Design Values for Persistent and Temporary Design Situations (STR/GEO) (Set B+C)

Limit state				**STR/GEO**				**STR**
Action combinations				**1**	**2**	**3**	**4**	**5**
Reference equation				**(6.10a)**	**(6.10b)**	**(6.10a)**	**(6.10b)**	**(6.10a)**
Partial coefficients for loads								
Permanent load	Weight general (**)	Unfavourable	$\gamma_{Gj,sup} \cdot K_{FI}$	$1.25 \cdot K_{FI}$	$1.0 \cdot K_{FI}$	1.25	1.0	1.0
		Favourable	$\gamma_{Gj,inf}$	1.0	0.9	1.0	0.9	1.0
	Weight of soil and (ground)water, geotechnical structures (***)	Unfavourable	$\gamma_{Gj,sup}$	1.0	1.0	1.0	1.0	1.0
		Favourable	$\gamma_{Gj,inf}$	1.0	1.0	1.0	1.0	1.0
Prestress	P			γ_P	γ_P	γ_P	γ_P	1.0
Variable load(*)	Dominant, $Q_{k,1}$	Unfavourable		0	$\gamma_{Q1} \cdot K_{FI}$	0	γ_{Q1}	0
	Other, $Q_{k,i}$	Unfavourable		0	$\gamma_{Qi} \cdot K_{FI}$	0	$\gamma_{Qi} \cdot \psi_{0,i}$	0
Factor on partial coefficient for strength parameters and resistance								
	Construction materials, cf. DS/EN 1992-1996, 1999		γ_0	1.0	1.0	K_{FI}	K_{FI}	$1.25 \cdot K_{FI}$
	Soil parameters and resistance, cf. DS/EN 1997-1			1.0	1.0	K_{FI}	K_{FI}	1.0 ($\gamma_M = \gamma_R = 1.0$)

(*) Variable actions are those considered in Tables A2.1 to A2.3

(**) Covers all types of permanent dead load, see 2.1 in DS/EN 1991-1-1.

(***) Covers weight of soil and (ground)water, which will affect the geotechnical structure as geotechnical action, see 1.5.2.1 in DS/EN 1997-1

NOTE 1: Equations 6.10a and 6.10b are used for STR and GEO. Equation 6.10a only includes permanent actions.

For structures not affected by geotechnical actions, this can only be demonstrated by using action combination 1 and 2.

For structures also affected by geotechnical actions, it should be demonstrated using action combination 1 and 2, action combination 3 and 4, and action combination 5.

For structures solely affected by geotechnical actions, it may be demonstrated using only action combination 3 and 4, and action combination 5.

For K_{FI} =1.0, action combination 1 and 2 is identical to action combination 3 and 4. For $K_{FI} \neq 1.0$ can K_{FI}, load effects (shear forces) are multiplied instead of the load, if the load effects are linearly proportional to the associated load.

Geotechnical actions are actions transferred to a structure from soil, filling, stagnant water or groundwater. The action from soil and filling is, in addition to weight, determined by the soil and filling strength and deformation properties, as expressed by the angle of friction. Examples of geotechnical actions include soil and water pressure on a wall structure.

Factor γ_0 on partial coefficient for strength parameters and resistance will appear in the following manner.

In action combinations 3 and 4, which are used for geotechnical structures; cf. DS/EN 1997-1, the K_{FI} factor is applied to all incoming partial coefficients for the soil strength parameters and resistance as well as the material strengths and resistance of the construction materials.

In action combination 5, which is used for demonstrating STR for construction materials, which are part of geotechnical structures, the usual partial coefficients are sued for the construction materials multiplied by 1.25 K_{FI}. For the soil strength parameters and resistance, a partial coefficient of $\gamma_M = \gamma_R$ =1.0 is applied, see DS/EN 1997-1.

NOTE 2: The following γ values are used for persistent and transient design situations:

γ_Q = 1.40 for traffic load on bridges
γ_Q = 1.20 for heavy special transports on tracks (SW2)
γ_Q = 1.40 for payloads under construction (regarding Q_c, see EN 1991-1-6)
γ_Q = 1.50 for all other variable actions (natural loads, etc.)
γ_P = 1.00 unless otherwise specified in the relevant Eurocodes
γ_{Gset} = 1.00 for settlement that is unfavourable (0 where favourable)

See also EN 1991 – EN 1999 for γ values for imposed deformations.

K_{FI} depends on the consequence class defined in Annex B Table B3 in EN 1990, and has the following values, since consequence class CC1 cannot be used for bridges:

Consequence class CC3: K_{FI} = 1.10
Consequence class CC2: K_{FI} = 1.00 (CC2 can only be used for bridges in exceptional cases)

NOTE 3: The characteristic values of all permanent actions from one source are multiplied by $\gamma_{Gj,sup}$ if the total resulting action effect is unfavourable and by γGj,inf if the total resulting action effect is favourable. For example, all actions originating from the self-weight of the structure may be considered as coming from one source. This also applies if different materials are involved.

NOTE 4: Not applicable

NOTE 5: Waves and currents are included in the combination tables appended as annexes in 'Design guide for load and calculation basis for bridges' and Railway Standard BN1-59 Load and calculation regulations for railway bridges and land structures.

Design Values for Fatigue Loads

For fatigue loads, resulting from traffic load, a partial coefficient of 1.00 is used for train loads and 1.10 for traffic load on road bridges and footbridges. For wind action, wave and current load, respectively, 1.30 is used.

Design values of actions for use in cases of accidental and seismic design situations

Table A2.5 DK NA Design values of actions for use in cases of accidental and seismic design situations

Design situation	Permanent actions		Prestress	Accidental or seismic action	Accompanying variable actions (**)	
	Unfavourable	Favourable			Dominant	Others
Accidental (*) (Equation 6.11a/b)	$G_{kj,sup}$	$G_{kj,inf}$	P	A_d	$\Psi_{2,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$
Seismic (***) (Equation 6.12a/b)	$G_{kj,sup}$	$G_{kj,inf}$	P	A_{Ed}	$\Psi_{2,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$

(*) The following values are used for $\Psi_{2.1}$ for accident design situations:
$\Psi_{2.1} = \Psi_{1.1}$ for $Q_{k,1}$ corresponding to gr1 for footbridges
$\Psi_{2,1} = \Psi_{1,1}$ for $Q_{k,1}$ corresponding to gr1a for road bridges
$\Psi_{2,1} = \Psi_{1,1}$ for Qk,1 corresponding to LM71, including α factor. In case of derailing, where A_d is the derailed train, $\Psi_{1,i}$ is used for other tracks on the bridge.

(**) Variable actions are those considered in Tables A2.1 to A2.3

(***)The following values are used for $\Psi_{2,1}$ for seismic design situations:
$\Psi_{2,1} = 0.30$ for gr1 for footbridges
$\Psi_{2,1} = 0.30$ for gr1a for road bridges
$\Psi_{2,1} = 0.40$ for LM71, including α-factor, since load is only exerted onto one track

For bridges, the design value of the seismic action, A_{Ed}, is determined on the basis of the vertical action as:

$A_{Ed} = 1.5\% \ (\Sigma G_{k,j}$ "+" $\Sigma_{i\geq 1}\Psi_{2,i}\ Q_{k,i})$

All vertical actions are considered able to contribute to the calculation of seismic action. Seismic action is calculated as the bound action. Seismic action is considered able to occur in combination with the associated vertical action.

Seismic action loads have their application area in the centres of gravity of the associated vertical actions and are considered as being able to work in any direction, but in such a way that this direction is the same for all simultaneous seismic actions.

Structures need not be examined for simultaneous seismic action and wind action.

NOTE 1: Seismic action is used to assess the structure of the seismic design situation. Seismic action does not cover imperfections in the structure, as these are assessed and included in accordance with regulations stated in the material-specific Eurocodes, see also Table A1.3 DK NA in EN 1990 DK NA

Seismic action covers actions to be considered to protect the strength and stability of the structure against minor earthquakes. Seismic action is the minimum horizontal action which a structure should be expected to be affected by.

Design Values of Actions in Serviceability Limit States

Table A2.6 DK NA Design Value of Actions in Serviceability Limit States					
Combination	Permanent actions		Prestress	Variable actions	
	Unfavourable	Favourable		Dominant	Others
Characteristic	$G_{kj,sup}$	$G_{kj,inf}$	P	$Q_{k,1}$	$\Psi_{0,i}\ Q_{k,i}$
Frequent	$G_{kj,sup}$	$G_{kj,inf}$	P	$\Psi_{1,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$
Quasi-permanent	$G_{kj,sup}$	$G_{kj,inf}$	P	$\Psi_{2,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$

Overview of Possible National Choices

The following overview shows the places where a national choice is possible and which informative annexes that apply/do not apply. Moreover, it is stated where a national choice has been made.

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
	General Clauses		
6	A2.1.1(1), NOTE 3	Instruction on the use of Table 2.1 in EN 1990 concerning setting of requirements for the expected lifespan of bridges.	National choice stated.
7	A2.2.1(2), NOTE 1	Action combinations with actions which fall outside the scope of EN 1991, e.g. ice load etc.	National choice stated.
12	A2.2.6(1), NOTE 1	Values of ψ factors (combination factors).	No national choice.
16	A2.3.1(1)	Values of γ factors (partial coefficients) for traffic load etc.	National choice stated.
17	A2.3.1(5)	Design of geotechnical structures, choice of method.	National choice stated.
17	A2.3.1(7)	Definition of ice load etc.	National choice stated.
17	A2.3.1(8)	Values of γ_P factors for prestress.	No national choice.
18	A2.3.1 Table A2.4(A), NOTE 1	Values of γ factors (partial coefficients).	National choice stated.
18	A2.3.1 Table A2.4(A), NOTE 2	Values of γ factors (partial coefficients).	National choice stated.
19	A2.3.1 Table A2.4(B), NOTE 1	Choice between (6.10) or (6.10a) + (6.10b).	National choice stated.
19	A2.3.1 Table A2.4(B), NOTE 2	Values of and γ and ξ factors (partial coefficients).	National choice stated.
20	A2.3.1 Table A2.4(B), NOTE 4	Values of γ_{Sd} for model uncertainty.	No national choice.
21	A2.3.1 Table A2.4(C), NOTE	Values of γ factors (partial coefficients).	National choice stated.
22	A2.3.2(1)	Design values in Table A2.5 for accident load conditions, non-dominant variable actions and earthquake load conditions.	National choice stated.
22	A2.3.2 Table A2.5, NOTE	Values of design values of actions (γ factor).	No national choice.
22	A2.4.1(1), NOTE 1 (Table A2.6)	Values of γ factors (partial coefficients) in the serviceability limit state.	No national choice.
23	A2.4.1(1), NOTE 2	Rare combinations in the serviceability limit state.	No national choice.
23	A2.4.1(2)	Requirements and criteria in the serviceability limit state.	No national choice.

Page	Item	Subject	National choice
	Clauses specific for road bridges		
9	A2.2.2(1)	Rare combinations in the serviceability limit state.	No national choice.
10	A2.2.2(3)	Combination rules for special vehicles.	National choice stated.
10	A2.2.2(4)	Combination rules for snow loads and traffic loads.	National choice stated.
10	A2.2.2(6)	Combination rules for wind and thermal actions.	National choice stated.
13	A2.2.6(1), NOTE 2	Values of $\psi_{1,infq}$ factors for rare combinations in the serviceability limit state.	No national choice.
13	A2.2.6(1), NOTE 3	Determination of actions caused by water (current, waves) in the execution limit state.	No national choice.
	Clauses specific for footbridges		
10	A2.2.3(2)	Combination rules for wind and thermal actions.	National choice stated.
10	A2.2.3(3)	Combination rules for snow loads and traffic loads.	National choice stated.
10	A2.2.3(4)	Combination rules for footbridges which are protected against bad weather.	National choice stated.
24	A2.4.3.2(1)	Comfort criteria for footbridges.	No national choice.
	Clauses specific for railway bridges		
11	A2.2.4 (1)	Combination rules for snow loading on railway bridges.	National choice stated.
11	A2.2.4 (4)	Maximum wind speed compatible with rail traffic.	National choice stated.
25	A2.4.4.1 (1), NOTE 3	Deformations and vibration requirements for temporary railway bridges.	National choice stated.
26	A2.4.4.2.1(4)P	Maximum peak values of bridge deck acceleration and associated frequency limits.	No national choice.
27	A2.4.4.2.2 (2) Table A2.7, NOTE	Limit values for rotation deformation of bridge deck.	No national choice.
27	A2.4.4.2.2 (3)P, NOTE	Limit value for total rotation deformation.	No national choice.
27	A2.4.4.2.3 (1), NOTE	Vertical deformation of bridge deck for railway bridges with and without ballast.	No national choice.
27	A2.4.4.2.3(2), NOTE	Limit values for rotations/angular rotations of the bridge deck ends for railway bridges without ballast.	No national choice.

Page	Item	Subject	National choice
28	A2.4.4.2.3(3)	Additional limits of angular rotations at the end of bridge decks in relation to expansion joints, rail expansion joints and points.	National choice stated.
28	A2.4.4.2.4(2) Table A2.8, NOTE 3	Maximum differential cross deflection expressed as change in the radius of curvature, r_i and angular rotations α_i.	National choice stated.
29	A2.4.4.2.4(3), NOTE	Requirements for the lowest cross natural frequency.	No national choice.
31	A2.4.4.3.2(6)	Requirements for passenger comfort for temporary bridges.	National choice stated.

Note: No national choice implies that a recommendation in the standard is observed.