danish housing
and planning authority

DS/EN 1993-1-1 DK NA:2019

National Annex to
Eurocode 3: Design of steel structures –
Part 1-1: General rules and rules for buildings

Foreword

This National Annex (NA) is a revision of DS/EN 1993-1-1 DK NA:2015 and replaces the latter as from 2019-09-09. For a transition period until 2019-12-31, this National Annex as well as the previous National Annex will be applicable.

Text has been added under Clause 6.1(1) Ultimate limit states – General in relation to level of checking.
Previous, valid versions of the NAs as well as addenda to these can be found at www.eurocodes.dk.

This NA lays down the conditions for the implementation in Denmark of EN 1993-1-1 for construction works in conformity with the Danish Building Regulations.

This NA applies to construction works covered by section 16(1) of the Danish Building Regulations as well as to construction works covered by sections 24 to 27 of the Danish Building Regulations.

A National Annex contains national provisions, viz. nationally applicable values or selected methods. The Annex may furthermore provide non-contradictory, complementary information.

This NA includes:

- an overview of possible national choices and clauses containing complementary information;
- national choices;
- non-contradictory, complementary information.

For structures covered by sections 24 to 27 of the Danish Building Regulations BR18, or not covered by the Danish Building Regulations, levels of checking may still be used for the calculation of structures in ultimate limit states. For structures covered by section 16(1) of the Danish Building Regulations, levels of checking cannot be applied.

Overview of possible national choices and complementary information

The list below identifies the clauses where national choices are possible and the applicable/not applicable informative annexes. Furthermore, clauses giving complementary information are identified. Complementary information is given at the end of this National Annex.

Clause	**Subject**	**National choice [1)]**	**Complementary information[2)]**
2.3.1(1)	Actions and environmental influences	Unchanged	
3.1(2)	Materials, General	National choice	
3.2.1(1)	Material properties	National choice	
3.2.2(1)	Ductility requirements	Unchanged	
3.2.3(1)	Fracture toughness	Unchanged	
3.2.3(3)B	Fracture toughness	Unchanged	
3.2.4(1)B	Through-thickness properties	Unchanged	Complementary information
5.2.1(3)	Effects of deformed geometry of the structure	National choice	
5.2.2(8)	Structural stability of frames		Complementary information
5.3.2(3)	Imperfections for global analysis of frames	Unchanged	
5.3.2(11)	Imperfections for global analysis of frames	National choice	
5.3.4(3)	Member imperfections	Unchanged	
6.1(1)	Ultimate limit states, General	National choice	
6.1(1)2B	Ultimate limit states, General	National choice	
6.2.2	Resistance of cross-sections - Section properties		Complementary information
6.3.2.2(2)	Lateral torsional buckling curves – General case	Unchanged	
6.3.2.3(1)	Lateral torsional buckling curves for rolled sections or equivalent welded sections	Unchanged	
6.3.2.3(2)	Lateral torsional buckling curves for rolled sections or equivalent welded sections	National choice	Complementary information
6.3.2.4(1)B	Simplified assessment methods for beams with restraints in buildings	Unchanged	
6.3.2.4(2)B	Simplified assessment methods for beams with restraints in buildings	Unchanged	

Clause	**Subject**	**National choice [1)]**	**Complementary information[2)]**
6.3.3(5)	Interactive factors for members in bending and axial compression	National choice	Complementary information
6.3.4(1)	General method for lateral and lateral torsional buckling of structural components	National choice	
7.2.1(1)B	Vertical deflections	National choice	
7.2.2(1)B	Horizontal deflections	National choice	
7.2.3(1)B	Dynamic effects	Unchanged	
Annex A	Method 1: Interaction factors	Applicable	
Annex B	Method 2: Interaction factors	Applicable	Complementary information
Annex AB	Complementary design rules	Applicable	
Annex BB	Buckling of structural members	Applicable	
BB.1.3(3)B	Hollow sections as members	National choice	
C.2.2(3)	Selection of execution class – general	National choice	
C.2.2(4)	Selection of execution class – components	National choice	

[1)]
Unchanged: Recommendations in the Eurocode to be followed.
No choice made: The Eurocode does not recommend values or methods but allows the option of determining national values or methods.
Applicable: The Annex is applicable in Denmark and has the same status as specified in the Eurocode.
National choice: A national choice has been made.

[2)]
Complementary information: Non-contradictory complementary information on how to use the Eurocode.

National choices

3.1(2) Materials, General
The standard applies to steel materials in accordance with Table 3.1 of DS/EN 1993-1-1 or equivalent.

3.2.1(1) Material properties
The values of f_y and f_u specified in (1) a) should be used.

5.2.1(3) Effects of deformed geometry of the structure
A lower value of α_{cr} than that given in (5.1) may be used if justification of its application is documented.

5.3.2(11) Imperfections for global analysis of frames
Which of the methods referred to in (3), (6) and (11) to be used should be determined for each individual case.

6.1(1) Ultimate limit states, General
The below expressions for γ_{Mi} are used, including the factor (γ_0) for the partial factors for strength parameters and resistances, cf. National Annex to EN 1990, Table A1.2(B+C) DK NA:

$$\gamma_{M0} = 1{,}1 \cdot \gamma_0 \cdot \gamma_3$$
$$\gamma_{M1} = 1{,}2 \cdot \gamma_0 \cdot \gamma_3$$
$$\gamma_{M2} = 1{,}35 \cdot \gamma_0 \cdot \gamma_3$$

The factor γ_0 takes into account the combination of actions, cf. National Annex to EN 1990, Table A1.2(B+C) DK NA.

Limit state	**STR/GEO**				**STR**
Combination of actions	1	2	3	4	5
$\boldsymbol{\gamma_0}$	1,0	1,0	K_{FI}	K_{FI}	$1{,}2 \cdot K_{FI}$

The factor γ_3 takes into account the level of checking of the product. The reduced level of checking is not used.

Extended level of checking: $\gamma_3 = 0{,}95$
Normal level of checking: $\gamma_3 = 1{,}00$

For structures covered by section 16(1) of the Danish Building Regulations, the extended level of checking cannot be applied, and γ_3.is taken as 1,00.

The partial factors are determined in accordance with the National Annex to EN 1990, Annex F, *Partial factors for resistance*, where $\gamma_M = \gamma_1 \gamma_2 \gamma_3 \gamma_4$,, where the values of γ_{Mi} given above include the factor γ_0 .

γ_1 takes into account the type of failure;
γ_2 takes into account the uncertainty related to the design model;
γ_3 takes into account the extent of checking;
γ_4 takes into account the variation of the strength parameter or resistance.

When determining γ_1, the following types of failure have been assumed:

γ_{M0}: Warning of failure with residual resistance
γ_{M1}: Warning of failure without residual resistance
γ_{M2}: No warning of failure

For accidental and seismic design situations the following values are used:

$\gamma_{M0} = 1{,}0$
$\gamma_{M1} = 1{,}0$
$\gamma_{M2} = 1{,}0$

6.1(1) Note 2B Ultimate limit states, General
See 6.1(1)

6.3.2.3(2) Lateral torsional buckling curves for rolled sections or equivalent welded sections
$f = 1$. The determination of M_{cr} takes into account the moment distribution between lateral restraints. See also the complementary information.

6.3.3(5) Uniform members in bending and axial compression
Both Method 1 and Method 2 may be used to determine the values of the interaction factors k_{yy}, k_{yz}, k_{zy} og k_{zz}. See also the complementary information.

6.3.4(1) General method for lateral and lateral torsional buckling of structural components
The relevance of using the method in 6.3.4 is to be evaluated for each case.

7.2.1(1)B Vertical deflections
For *beams*, the following values of the maximum deflection (w_3 in EN 1990, Figure A1.1) due to one variable action without allowance for impact, if any, may serve as guidance as to what may be regarded as acceptable deflections:

- floors $l/400$
- roofs and external walls $l/200$

Where l is:

- the span of simply supported and continuous beams;

- twice the projection of cantilevered structures.

The values apply both to main and secondary elements, but only the deflection of the element considered is to be used in the assessment.

For secondary sheeting in the form of uninsulated roof sheeting and for facade sheeting, the deflection due to permanent and variable actions should not exceed $l/90$.

For roof sheeting with external insulation and roofing felt, the deflection due to permanent and variable actions should not exceed:

$l/150$	for	$l < 4\,500$ mm
30 mm	for	$4\,500 \text{ mm} \leq l < 6\,000$ mm
$l/200$	for	$6\,000 \text{ mm} \leq l$

7.2.1(1)B Horizontal deflections

For *columns*, the following numerical values of the maximum deflection of the column head due to one variable action may serve as guidance to what may be regarded as acceptable deflections:

- frames in buildings without cranes $h/150$
- columns in single-storey skeleton structures $h/300$
- columns in multi-storey skeleton structures, for each storey $h/300$
  for the total height $h_e/500$

Where

- h is the height of the individual column
- h_e is the total height of the building.

BB.1.3(3)B Hollow sections as members

Further information on buckling lengths of compression members should be found in textbooks.

C.2.2(3) Selection of execution class

The execution class is selected on the basis of the consequences class.

Table C.1 DK NA — Selection of execution class (EXC)

Consequences class	Type of action	
	Static, quasi-static or seismic DCL [a]	Fatigue [b] or seismic DCM or DCH [a]
CC3, if covered by DS/EN 1990 DK NA, B4 (4)	EXC3 [c]	EXC3 [c]
CC3	EXC3 [c]	EXC3 [c]
CC2	EXC2	EXC3
CC1	EXC1/EXC2 [d]	EXC2
[a] Seismic ductility classes are defined in DS/EN 1998-1: Low = DCL, medium = DCM, high = DCH.		

[b] See DS/EN 1993-1-9. See C.2.2(4). [c] EXC4 should be used for structural components/details where the consequences of failure are particularly severe. See C.2.2(4). [d] For welds, see C.2.2(4).

C.2.2(4) Selection of execution class

Footnote d):

For the execution of welds, DS/EN 1993-1-8 specifies that a weld of at least quality level C (according to EN ISO 5817) is normally required unless otherwise specified. Therefore, at least execution class EXC2 should be applied for the welded connections in the structure. Alternatively, for steels of quality < S355, EXC1 may be used supplemented by a requirement for the weld quality to conform to level C according to EN ISO 5817.

Footnotes b) and c):

For welds in fatigue critical joints, the detail category is specified (cf. DS/EN 1993-1-9) and any supplementary execution requirements according to the guidelines in EN 1090-2, 7.6.2.

For welds in critical joints, including fatigue critical joints, weld inspection classes WIC1 to WIC5 are specified in accordance with the guidelines in EN 1090-2, Annex L.The associated additional extent of testing according to EN 1090-2, Table L.2 applies.

Non-contradictory, complementary information.

3.2.4(1) Through-thickness properties
Reference is made to non-contradictory, complementary information in the National Annex to EN 1993-1-10, 3.2(2).

5.2.2(8) Structural stability of frames
Detailed guidelines are not given for structural analyses of the stability of frames using a method based on equivalent buckling lengths. Guidance should be found in specialist literature, or the method of analysis should be documented by other means.

6.2.2 Resistance of cross-sections - Section properties
For a long-threaded structural component, the gross cross section and the net cross section are taken as the stress area as defined in DS/EN 1993-1-8, 1.5. The connection at the end of the component should also conform to the design rules for bolted connections specified in DS/EN 1993-1-8.

6.3.2.3(2) Lateral torsional buckling curves – General case
Justification for changing 6.3.2.3(2) Lateral torsional buckling curves for rolled sections or equivalent welded sections
The specified method assumes (cf. ECCS Publication 119) that when calculating M_{cr} and consequently λ_{LT}, a uniform moment distribution between the lateral restraints is taken into account corresponding to $\Psi = 1$ in Table 6.6 in EN 1993-1-1, and not the real moment distribution as in 6.3.2.2.
The real moment distribution has been taken into account by the factor f. The text of the change specifies that also when using this method, M_{cr} is to be determined on the basis of the real moment distribution between the lateral restraints, and f is taken as 1.

6.3.3(5) Uniform members in bending and axial compression
Method 1 is recommended for significant structures and where cost is decisive, and as a basis for the preparation for design programs.
Method 2 is recommended as a simpler method for less significant structures.
See also the national choice.

Annex B, Method 2 – Interaction factors k_{ij} for interaction formula in 6.3.3(4)
Table B.3: Equivalent uniform moment factors C_m in Tables B.1 and B.2
M_s is to be obtained according to the value of bending moment diagram which yields a local extreme ($dM_s/dx = 0$) between end points of beam elements ($x = 0$ and $x = L$).
Where a local extreme does not exist, M_s is to be taken as the value obtained at the centre of the beam element.